FOCUSED FEASIBILITY STUDY REPORT
CLAREMONT POLYCHEMICAL SITE OU-5
OFF-SITE GROUNDWATER PLUME
(NYSDEC Site # 130015)

NYSDEC STANDBY ENGINEERING CONTRACT
Work Assignment # D007625-43

PREPARED FOR

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List of Abbreviations

1,1,1-TCA	1,1,1-trichloroethane
1,2-DCE	cis-1,2-Dichloroethene
3D	Three-Dimensional/Three Dimensions
ACOE	Army Corps of Engineers
AOP	Advanced Oxidation Processes
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CCWPCP	Cedar Creek Water Pollution Control Plant
CERCLA	Superfund or Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CHP	Catalyzed Hydrogen Peroxide
CPC	Claremont Polychemical
COC	Contaminant of Concern
DER	Division of Environmental Remediation
DISV	Discretization by Vertices
DNAPL	Dense Non-Aqueous Phase Liquids
EC	Emerging Contaminant
FAL	Former Aluminum Louvre
f_{oc}	Organic Carbon Content of Soil
FRTR	Federal Remediation Technology Roundtable
FFS	Focused Feasibility Study
ft/d	Feet Per Day
GAC	Granular Activated Carbon
gpm	Gallons Per Minute
GRAs	General Response Actions
GWET	Groundwater Extraction and Treatment
HDR	Henningson, Durham & Richardson Architecture and Engineering, P.C.
ICs	Institutional Controls
ISCO	*In-Situ* Chemical Oxidation
ITRC	Interstate Technology & Regulatory Council
K_{oc}	Soil Organic Carbon-Water Partitioning Coefficient

LTEV	Low-Temperature Enhanced Volatilization
LTM	Long-Term Monitoring
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
msl	Mean Sea Level
NaOH	Sodium Hydroxide
NCDPW	Nassau County Department of Public Works
NCFTC	Nassau County Fireman's Training Center
NPL	National Priorities List
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OBL	Old Bethpage Landfill
O&M	Operation and Maintenance
OU	Operable Unit
PCE	Tetrachloroethene
PFOS	Perfluorooctanesulfonic acid
PFOA	Perfluorooctanoic acid
pH	Potential of Hydrogen
POTW	Publicly Owned Treatment Works
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROW	Right-of-Way
SCG	Standards, Criteria, and Guidance
SO_4^-	Sulfate Free Radical
SPDES	State Pollutant Discharge Elimination System
SSF	State Superfund Program
SVE	Soil Vapor Extraction
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TSDF	Treatment/Storage/Disposal Facility
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

UV	Ultraviolet
VFWD	Village of Farmingdale Water District
VOC	Volatile Organic Compound
VPB	Vertical Profile Borings

EXECUTIVE SUMMARY

Claremont Polychemical Corporation (CPC), a former manufacturer of pigments for plastics and inks, coated metal flakes, and vinyl stabilizers, operated from 1966 to 1980. Past handling, storage, and disposal practices resulted in volatile organic compound (VOC) contamination in on-site and off-site groundwater. As a result, the sites were placed on the National Priorities List in June 1986.

The analytical results of groundwater samples collected from monitoring wells show contaminated groundwater originating from CPC extends off-site approximately 1.25 miles to the Melville Road in Farmingdale New York. Groundwater contamination from CPC has co-mingled with groundwater contamination from other nearby sites potentially including Former Aluminum Louver (FAL), Old Bethpage Landfill (OBL), and the Nassau County's Fireman's Training Center (NCFTC). The responsible parties have implemented remedial measures to eliminate or control the off-site groundwater contamination. Groundwater remediation infrastructure originally used to remediate off-site groundwater from the Old Bethpage Landfill has been used in recent years to remediate offsite groundwater from CPC. Despite these efforts, groundwater contamination continues to migrate to the south toward public water supply wells. After a review of the historical data, the New York State Department of Environmental Conservation (NYSDEC) determined further action is warranted to protect public health and the environment.

Remedial actions to protect public health and the environment were evaluated during the completion of the Focused Feasibility Study (FFS). This FFS report addresses off-site groundwater contamination within what is administratively known as Operable Unit 3 (OU3), identifies technologies, and evaluates remedial alternatives that could be implemented to remediate the groundwater contamination and achieve the Remedial Action Objectives (RAOs).

The RAOs are goals designed to be protective of human health and the environment, and include:

a) Groundwater RAOs for Public Health Protection
    i. Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards; and
    ii. Prevent contact with contaminated groundwater.
b) Groundwater RAOs for Environmental Protection
c) Restore groundwater aquifer to pre-disposal/pre-release conditions, to the extent practicable;
d) Prevent adverse impacts to the quantity or quality of the groundwater resources associated with the Nassau-Suffolk Sole Source Aquifer.

The primary objective of the FFS is to ensure that appropriate remedial alternatives are identified and evaluated such that relevant information concerning potential remedial actions can be considered and an appropriate remedy selected. The FFS relied on a groundwater flow model

constructed by the New York State Department of Environmental Conservation to compare groundwater extraction alternatives and quantify the daily volume of groundwater that must be extracted, treated, and discharged to achieve the RAOs.

Based on the groundwater flow modeling, a total of five remedial alternatives were evaluated in this FFS, inclusive of the "No Further Action" alternative as a means of comparison. This evaluation included remedial alternatives designed to hydraulically contain and treat groundwater containing contaminants at concentrations exceeding State and Federal standards. The following alternatives were evaluated based on the results of the groundwater flow modeling:

- Alternative 1 – No Further Action
- Alternative 2 – CPC groundwater extraction and treatment system (GWET)
- Alternative 3 – FTC GWET
- Alternative 4 – CPC & FTC GWET System Plus Two Extraction Wells North of Melville Road
- Alternative 5 – CPC & FTC GWET System Plus Two Extraction Wells South of Melville Road

The results of the evaluation indicate that Alternative 4 would achieve the RAO of restoring the groundwater quality to pre-disposal/pre-release conditions to the extent practicable in the most heavily impacted portions of the CPC plume; it would not provide hydraulic control of the entire CPC plume as placing extraction wells to provide hydraulic containment of the Site Related Chemicals of Concern and Chemical Specific Standards, Criteria, and Guidance (SCG) plume could negatively impact the Farmingdale Water District wells. This alternative would rely upon existing wellhead treatment and natural processes to remove contaminant of concern (COCs) to the SCGs.

Alternative 4 would also include the use of an existing treatment plant (including treatment plant upgrades) and return the treated water to the aquifer through a recharge basin in the vicinity of the treatment plant. A portion of the treated water would also be used for irrigation at Bethpage State Park. Alternative 4 can be completed in a manner that would not negatively affect the environment (surface water, wetlands, and the saltwater interface) or the safe yield of the aquifer.

1 INTRODUCTION

Henningson, Durham & Richardson Architecture and Engineering, P.C. (HDR) was retained by the NYSDEC to conduct a Focused Feasibility Study (FFS) for intercepting and remediating groundwater containing VOCs originating from the Claremont Polychemical Site (CPC or Site) located in Old Bethpage, Nassau County, New York (**Figure 1-1**). This contaminated groundwater has potential to impact the Village of Farmingdale public supply wells and more investigation was required to determine the future impact on these wells and a feasibility study to determine measures that can be applied to prevent it. HDR prepared this FFS in general conformance with Section 4 of the Technical Guidance for Site Investigation and Remediation (*DER-10*) (NYSDEC Division of Environmental Remediation [DER], May 3, 2010). The primary objective of the FFS is to identify and evaluate appropriate remedial alternatives such that relevant information concerning potential remedial actions can be considered and an appropriate remedy selected.

2 SITE DESCRIPTION AND HISTORY

2.1 General Site Description and Background

CPC is located on a 9.5-acre parcel in an industrial section of Old Bethpage, Nassau County, New York (**Figure 12-1**). CPC lies approximately 800 feet west of the border between Nassau and Suffolk Counties and is accessed via Winding Road on the property's western boundary. Surrounding land use consists of commercial and light industrial to the north, Bethpage State Park to the south, Farmingdale University to the east, and the Old Bethpage Landfill to the west. The former 35,000 square foot Process Building, demolished in 2012, was the only building historically on the property.

CPC, a former manufacturer of pigments for plastics and inks, coated metal flakes, and vinyl stabilizers, operated from 1966 to 1980. According to the "Third Five-Year Review Report for Claremont Polychemical Corporation" prepared by the Environmental Protection Agency (EPA), dated August 2019 during its operation, CPC disposed of liquid waste in three leaching basins and deposited solid wastes and treatment sludges in drums or in aboveground storage tanks. The wastes generated were organic solvents, resins, and wash wastes (mineral spirits). A solvent recovery system (steam distillation), two pigment dust collectors, and a sump were located inside the Process Building. Five concrete treatment basins, each with a capacity of 5,000 gallons, were located to the west of the building. Six aboveground storage tanks were located east of the building. Other features included an underground tank farm, construction and demolition debris, dry wells and a water supply well (EPA 2019).

In 1979, the Nassau County Department of Health (NCDH) found 2,000 to 3,000 drums of inks, resins, and organic solvents throughout the CPC Site during a series of inspections. Inspectors identified releases associated with damaged or mishandled drums in several areas including one larger release located east of the Process Building (referred to as the "spill area"). CPC sorted and removed the drums in 1980 (EPA 2019). In October 1980, NYSDEC ordered CPC to commence clean-up activities at the Site. CPC ceased operations at the Site in 1980 without performing the clean-up activities required by NYSDEC (EPA 2019). EPA proposed the Site for listing on the National Priorities List (NPL) in October 1986 and CPC was listed on the NPL in June 1986.

2.2 Operable Units

An operable unit (OU) represents a portion of a remedial program that for technical or administrative reasons can be addressed separately to investigate, eliminate, or mitigate a release, threat of release or exposure pathway resulting from contamination. CPC is divided into six OUs. These OUs address the identification and abatement of the source of on-Site contamination and the on-Site and off-Site groundwater contamination. The OUs are:

- OU-1 - Treatment and removal of wastes in underground storage tanks.
- OU-2 - Compatibility testing, bulking/consolidation and treatment/disposal of wastes in deteriorated containers, aboveground tanks, and treatment basins; soil under the former

Process Building; removal of miscellaneous construction debris; operation of a soil vapor extraction system; and institutional controls.

- OU-3 - Treatment of tetrachloroethene (PCE)-contaminated soils via low-temperature enhanced volatilization (LTEV).
- OU-4 - Treatment of the CPC on-Site contaminated groundwater.
- OU-5 - Treatment of the CPC off-Site contaminated groundwater.
- OU-6 - Decontamination of the former Process Building.

The EPA issued two RODs selecting remedies for the CPC Site and two Explanations of Significant Differences (ESDs) which modified these remedies. The first ROD, signed on September 22, 1989, addressed the OU-2 wastes remediated during the September 1988 removal action and called for compatibility testing, bulking/consolidation and treatment/disposal of wastes in deteriorated containers, aboveground tanks, and treatment basins. In April 2003, the EPA issued an ESD to include additional remedial actions for OU-2. These remedial actions included:

- Removal of miscellaneous construction debris;
- Operation of a soil vapor extraction system (SVE);
- Institutional controls (e.g., requiring the current and future owners to maintain the integrity of the Process Building's concrete floor so long as cadmium-contaminated soil remained underneath it, restricting the use of the CPC Site to commercial/light industrial uses, and prohibiting the occupation of buildings on the CPC Site without vapor sampling and mitigation, if necessary); and
- Sampling, cleaning and closing of septic systems.

The second ROD, signed on September 28, 1990, addressed the remedy for the remaining OUs:

- OU-1 - Treatment and removal of wastes in underground storage tanks.
- OU-3 - Treatment of PCE-contaminated soils via LTEV.
- OU-4 - Treatment of the CPC on-Site contaminated groundwater.
- OU-5 - Treatment of the CPC off-Site contaminated groundwater.
- OU-6 - Decontamination of the former Process Building.

The remedial action objectives (RAOs) were identified as achieving substantial risk reduction through a combination of source control with active restoration of the groundwater remediation. During the implementation of the second ROD, it became apparent that three of the OBL Site groundwater recovery wells were capturing the CPC off-Site groundwater plume. EPA decided to modify the selected remedy for OU-5. In September 2000, EPA issued an ESD that stated that the OBL groundwater treatment facility would be used to remediate the CPC off-Site groundwater plume, in lieu of constructing a new treatment system.

2.2.1 Operable Unit 1

OU-1 consisted of the treatment and removal of wastes in underground storage tanks. Under this OU, 14 underground storage tanks and their contents were removed and shipped off-site for treatment and disposal. All 14 tanks, including the contents, were removed during the OU-1 remedial action which allowed for unlimited use and unrestricted exposure. The OU1 remedial action was completed in August 1991.

2.2.2 Operable Unit 2

This OU addressed the wastes remediated during the September 1988 removal action. This action included compatibility testing, bulking/consolidation and treatment/disposal of wastes in deteriorated containers, aboveground tanks, and treatment basins. Upon completion of this remedial action, stabilized wastes were removed and properly disposed off-site.

In March 2013, the 35,000-square foot one-story Process Building was demolished; however, the concrete floor of the building remained intact and undisturbed as an institutional control to limit exposure to VOC and cadmium-contaminated soil. In August 2014, EPA addressed VOC-contaminated soil beneath the former process building by excavating and shipping approximately 1,100 tons of contaminated soil for off-site disposal. Because some cadmium-contaminated soil may still be present above levels that do not allow for unlimited use and unrestricted exposure to the CPC Property, OU-2 is subject to periodic EPA review.

2.2.3 Operable Unit 3

OU-3 addressed the treatment of soil contaminated with PCE via LTEV located in the former "spill area" east of the former Process Building. Approximately 8,800 tons of soils contaminated with PCE were excavated, treated and backfilled on the Site. The OU-3 remedy achieved soil standards which allow for unrestricted use and unlimited exposure.

2.2.4 Operable Unit 4

OU-4 addresses the on-Site extraction and treatment of groundwater via metals precipitation, air stripping, carbon adsorption, and reinjection. The OU-4 remedy was constructed by the EPA and Army Corps of Engineers (ACOE) to hydraulically contain VOCs in on-Site groundwater. System operation began in February 2000, Plant operation and maintenance was performed from 2000 to October 1, 2016, at which time the OU-4 GWET system was shut down.

2.2.5 Operable Unit 5

OU-5 addresses off-Site remediation of groundwater by GWET. In 2016, the former Old Bethpage Landfill GWET system was used as the remedy for OU5 operating extraction wells RW-3, RW-4, and RW-5. OU-5 GWET system includes a groundwater recovery system, water conveyance system, discharge system, monitoring wells, air stripper, and a treatment plant facility. The treated effluent discharges to Recharge Basin No. 1. Secondary discharge is directed to a recharge basin west of the Bethpage State Park Black Course for golf course irrigation in the summer. The five extraction/recovery well pump houses (RW-1, RW-2, RW-3, RW-4 and RW-5) and the discharge location are shown on **Figure 2-1**.

2.2.6 Operable Unit 6

OU-6 addressed the decontamination of the former Process Building. This remedy consisted of decontamination of the Process Building via vacuuming and dusting of the contaminated surfaces and removing the asbestos insulation for off-site treatment and disposal. All hazardous substances, asbestos containing materials, and salvageable materials were removed from this building and disposed properly off-site prior to building decontamination. The Process Building walls and interior surfaces were pressure washed. The OU-6 remedy achieved health-based standards which allow for unrestricted use and unlimited exposure.

2.3 CPC Site-Related Contaminants of Concern

The contaminants of concern (COCs) for this FFS were identified based on a review of the 1990 USEPA comprehensive ROD to include metals, VOCs (including ethenes and ethanes), and semi-VOCs. The COCs are identified in **Table 2-1**.

The emerging contaminant (EC) compounds 1,4-dioxane, perfluorooctanesulfonic acid (PFOS), and perfluorooctanoic acid (PFOA) are not listed as COCs in the 1990 ROD. Recent sampling shows they are present in groundwater at concentrations above the New York State Department of Health Drinking Water Program Maximum Contaminant Levels, which became effective on August 26th, 2020. Process treatment for these emerging contaminants are included in the identification and screening of technologies for the purposes of this FFS.

2.4 Other Sites, Related Contaminants of Concern

There are other potential sources of groundwater contamination in the vicinity of CPC that may be contributing to the groundwater contamination in this area. These include the FAL, OBL, and NCFTC. The locations of these potential sources are presented on **Figure 2-2**.

2.4.1 Former Aluminum Louvre

FAL is located approximately 1,300 feet to the north of CPC at 160 Bethpage-Sweet Hollow Road and 301 Winding Road and manufactured louvers, which involved: stamping, cutting, and shaping of metal stock, degreasing parts, and painting. From 1986-1993, Aluminum Louvre generated halogenated solvent waste, including PCE, TCE, DCE and 1,1,1-trichloroethane (1,1,1-TCA). Nassau County records indicate that Aluminum Louvre used TCE and 1,1,1-TCA from 1983-1994. In 1997, a contaminated dry well was remediated under a voluntary cleanup agreement at the 301 Winding Road property. Dry well remediation was also conducted under a separate voluntary cleanup agreement at the 161 Bethpage-Sweet Hollow Road property in 1999-2000. In 2007, the USEPA collected soil and groundwater samples at the site and found both media to be contaminated with metals, VOCs (including chlorinated ethenes primarily TCE and ethanes), and semi-VOCs in the groundwater other volatile organic compounds. The NYSDEC investigated the properties in 2008-2009 as part of the Old Bethpage Industrial Area Site Characterization and determined that the site should be listed on the Registry of Inactive Hazardous Waste Disposal Sites. The FAL COCs identified from the 2019 FAL OU2 ROD for off-site groundwater exceeding the SCGs are included in **Table 2-3** (NYSDEC, 2019).

2.4.2 Old Bethpage Landfill

OBL is in Old Bethpage, New York, roughly 500 feet west of CPC. The Town of Oyster Bay operated the 65-acre landfill from 1957 to 1986. In addition to municipal wastes and garbage, industrial wastes from local industries were also reportedly disposed in the landfill in the late 1960s and early 1970s. In 1979, local, state and federal investigations were initiated to evaluate the groundwater quality beneath and adjacent to the OBL. The data collected during these investigations indicated the presence of metals, VOCs (including chlorinated ethenes and ethanes), and semi-VOCs in the groundwater. The Site was listed on the National Priorities List (NPL) on September 8, 1983 and in 1986, all landfilling activities ceased. The OBL groundwater Applicable or Relevant and Appropriate Requirements (ARAR) identified from the 1988 OBL ROD are included in **Table 2-4**.

2.4.3 Nassau County Fire Training Center

FTC is a 12-acre site used as an advanced fire-fighting training facility by the Nassau County volunteer fire fighters. The site is located on Winding Road near Round Swamp Road, 1,600 feet southwest of CPC and is bordered on the northwest by OBL. Training exercises were historically conducted in open burn areas and in building mockups. Fuel oil and gasoline are used to ignite wooden pallets and straw for firefighting exercises. However, between 1970 and 1980, various spent organic solvents were reportedly accepted at the site for burning. Until 1986 unburned fuel and solvents were washed out of the burn areas by high pressure hoses and collected in dry wells across the site. Incombustible solvents may have been disposed directly into drywells. Additional subsurface contamination may have occurred from leaking gasoline and fuel oil tanks and associated piping. After 1980, solvent donations were no longer accepted at the site. In 1984, site improvements were made to prevent further subsurface contamination from training activities. Training areas were paved and bermed, dry well inlets were sealed, a new system of concrete drainpipes was installed, and an oil-water separator was constructed to treat runoff from the site for discharge to the sanitary sewer. Between 1985 and 1987, the Nassau County Department of Public Works (NCDPW) conducted several investigations of the site to determine the extent of dry well soil contamination, floating oil and gasoline plumes, and associated dissolved contaminants in groundwater. The FTC groundwater COCs include VOCs (including Benzene, Toulene, Ethylbenzene, and Xylene (BTEX) compounds and chlorinated ethenes and ethanes) in the groundwater identified from the 1993 FTC ROD. A complete list of COCs are included in **Table 2-5**. The remedy for FTC included groundwater extraction and treatment systems (GWET). The FTC GWET has been shut down since 2012.

2.5 Applicable Standards, Criteria, and Guidance

SCGs are intended to apply to the selected remedy. An index to potentially applicable New York State SCGs is provided on DEC’s website, which lists the SCGs potentially applicable to site investigation and remediation activities conducted in New York State. It may be accessed here: https://www.dec.ny.gov/regulations/61794.html.

2.6 Physical Setting

2.6.1 Topography

The topography in the vicinity of the Site is relatively hilly, resulting mainly from interlobate morainal deposits, meltwater channel gravels and deltaic beds that make up a north-south range of hills including the Manetto Hills. The Manetto Hills were formed during the advance and retreat of continental ice sheets of the Wisconsin aged glacier during the Pleistocene Epoch, which last retreated approximately 15,000 years ago. The roughly east-west trending ridge that forms the spine of Long Island, located to the north of the site, is an accumulation of glacial deposits that represents the southernmost terminus of the glacier and represents the highest elevations in this area (Buxton and Shernoff, 1999). South of the site and the Manetto Hills, the ground surface dips gently southward to the Atlantic Ocean.

2.6.2 Geology

The CPC is located in the Atlantic Coastal Plain physiographic province. This region is bordered to the south and east by the Atlantic Ocean and to the north and west by the Piedmont and New England physiographic provinces (Fenneman, 1938). Four distinct geologic units lie beneath CPC including deposits associated with the Ronkonkoma and/or Harbor Hill glaciation (upper glacial), the Magothy Formation and Matawan Group (Magothy), a clay member of the Raritan Formation (Raritan clay), and the Lloyd Sand of the Raritan Formation (Lloyd). A stratigraphic column of the geology of Nassau County is shown on **Figure 2-33**. A generalized hydrogeological cross-section is shown on **Figure 2-4** (Barlow, 2003 & Buxton & Douglas 1999)).

The Ronkonkoma ice sheet deposited a mantle of glacial drift on the Cretaceous, Pliocene, and early Pleistocene deposits. The drift ranges from unstratified till to stratified outwash and mainly occurs in three forms; basal drift, terminal moraine, and an outwash plain. South of the Ronkonkoma moraine is a relatively flat outwash plain that generally extends from the center of Long Island to the south shore. This outwash plain is composed of well-rounded coarse-grained sand and gravel (Isbister, 1966).

The Harbor Hill drift covers most of northern Nassau County and consists of outwash and till. Outwash deposits of the Harbor Hill ice sheet often thinly cover and are generally indistinguishable from the Ronkonkoma outwash (from the Ronkonkoma moraine) to the south shore of Long Island. Its surface is generally irregular as it includes numerous kettles, depressions, and small hills (Isbister, 1966).

The CPC Site and OU5 area is located on the Manetto Hills south of the terminal moraines. The material is predominantly medium to coarse-grained sand with minor amounts of fine sand and silt. The glacial outwash extends from ground surface to an unknown depth as the transition between the upper glacial and Magothy is not always distinct but is estimated to be 75 feet below ground surface (bgs) based on published literature (Isbister, 1966). A surficial geologic map of the area showing the geologic units at land surface is presented as **Figure 2-5**.

The Magothy deposits are undifferentiated and lie unconformably on the Raritan clay. The Magothy, like the Lloyd Sand and Raritan clay, are early Cretaceous deposits of continental origin and are mostly deltaic quartzose very fine to coarse-grained sand and silty sand with interbedded silt and clay. The Magothy ranges in thickness from zero at its northern limit to more than 900 feet in southeastern Nassau County. The Magothy's upper surface slopes to the southeast and ranges from 200 feet above mean sea level (msl) to more than 450 feet below msl. The Magothy commonly has a 25 to 50-foot thick coarse sand and gravel layer near its base (Isbister, 1966).

2.6.3 Hydrogeology

Regional groundwater recharge occurs most prominently along the moraine north of the site which serves as not only a deep recharge zone but also as a groundwater divide. Although the moraine area is the most important regional recharge feature, groundwater recharge takes place across most of the land surface of Long Island. In general, groundwater moves away from the recharge area along the central spine of the island toward the coastal areas. The regional groundwater flow direction in the Magothy aquifer can be inferred from the 2016 potentiometric surface map provided by the United States Geological Survey (USGS) (Monti et al., 2017) and is presented as **Figure 2-66**. Based on the potentiometric surface of the Magothy aquifer, the groundwater flow direction at and down-gradient of CPC is to the south to southeast.

Groundwater in the shallow portions of the Magothy aquifer in the vicinity of CPC occurs as an unconfined aquifer. However, lenses of silt and clay, whose overlapping arrangement produces anisotropy ranging from approximately 36:1 to 120:1, cause a confining effect with depth (Isbister, 1966 and Reilly et al., 1983). The storativity of the Magothy ranges from water table conditions (0.25) to confined conditions (0.0006) depending on the location and depth (Reilly et al., 1983). Hydraulic conductivity estimates for the regional Magothy Formation based on aquifer tests of permeable portions of the aquifer range from approximately 27 feet per day (ft/d) to 150 ft/d with an average of approximately 67 ft/d (Isbister, 1966). More recent studies contain average values of hydraulic conductivity for the Magothy Formation to be in the range of 35 to 90 ft/d (Cartwright, 2002; Misut and Feldman, 1996; Smolensky and Feldman, 1995). The horizontal hydraulic gradient in shallow portions of the Magothy can range from 0.0001 to 0.001 feet per foot; however, the hydraulic gradient can be affected by hydraulic stresses such as local pumping, recharge basins, and remediation systems (Busciolano et al, 1998).

The Nassau/Suffolk Aquifer, that includes the upper glacial, Magothy, and Lloyd aquifers, was designated as a Sole Source Aquifer by the USEPA in 1978. The Nassau/Suffolk Aquifer is considered the sole source of drinking water in Nassau County. In the vicinity of CPC three public drinking water wells operated by the Village of Farmingdale Water District (VFWD) that have the potential to be affected by the groundwater from CPC. A detailed discussion of the geology and hydrogeology can be found in the RI report (HDR, 2019).

3 REMEDIAL INVESTIGATION SUMMARY

3.1 Remedial Investigation

The nature and extent of groundwater contamination has been characterized through the drilling, testing, and sampling of monitoring wells and vertical profile brings (VPBs). Groundwater samples were collected from a network of monitoring wells to measure the concentration and spatial distribution of COCs as part of the Remedial Investigation (RI).

The results show chlorinated solvents (including PCE, TCE, cis-1,2-Dichloroethene (cis-1,2-DCE), and DCA), petroleum related compounds (including benzene, toluene, ethylbenzene, and xylene), 1,4-dioxane, methyl ethyl ketone (MEK), chloromethane, styrene, and 2-Hexanone were detected at concentrations that exceeded the Class GA Groundwater Standards.

Data collected during the RI shows that groundwater contaminated with VOCs primarily PCE at concentrations that exceed SCGs has migrated from the CPC Site. As shown of Figure **3-1**the data also shows the PCE migrating from CPC has potentially comingled with:

- Chlorinated VOCs (mainly TCE) migrating from the FAL;
- Chlorinated VOCs migrating from the OBL; and
- BTEX (and potentially chlorinated VOCs) migrating from the FTC.

The plume of groundwater containing COCs at concentrations greater than the NYSDOH maximum contaminant level (MCLs) created by CPC is more than 7,000 feet long, 2,000 feet wide and 400 feet deep. The plume of groundwater containing COCs (CPC Plume and Plume created by nearby source areas) at concentrations greater than the NYSDOH MCLs is more than 7,000 feet long, 5,000 feet wide and 400 feet deep. This is shown on **Figures 3-2 and 3-3** A detailed discussion of the nature and extent of groundwater contamination can be found in the RI report (HDR, 2019).

3.2 Groundwater Modeling

A groundwater flow model was completed by the NYSDEC as a quantitative method of evaluating and comparing groundwater extraction alternatives that could be used to remediate groundwater to SCGs. The NYSDEC report documenting the model is included as Appendix A. [Note the NYSDEC report is in preparation and planned for publication in the near future.]

MODFLOW 6 and MODPATH were used to conduct the modeling. MODFLOW 6 is a modular hydrologic model that simulates three dimensional(3D) groundwater flow in aquifers while MODPATH is a particle tracking post processing model that calculates the path lines along which a groundwater particle would travel based on the MODFLOW results.

The basis for the groundwater flow model used during the FFS is the USGS 2018 Long Island regional groundwater flow model (Walter et. al, 2020). This 25-layer, island-wide model was developed as part of the on-going USGS study on the groundwater sustainability of the Long

Island aquifer system. The USGS regional model includes an update to the geologic framework of the island and simulated groundwater recharge, pumpage and discharge using average conditions between 2005 and 2015.

3.2.1 Focus Area Model

To develop the focused area model, the regional model dataset (including boundary conditions such as general head boundaries, flows at the boundary zones, recharge, pumpage, etc.) within approximately 5 miles east and west, 5 miles north to the groundwater divide, and over 8 miles to south of the study area were exported. Within this sub-regional model area, the base grid with 500-foot square cells was re-discretized using quadtrees under the Discretization by Vertices (DISV) Package. Within the immediate study area (approximately 1 mile in all directions), 2 levels of quadtree refinement were assigned. The first level reduced the base grid by 2, meaning each cell is 250-foot square. The second level quadtree reduces the base grid within a half-mile of the focus area by 4, meaning each base cell is 125-foot square. Beyond the focus area of 125-ft and 250-ft square cells, the cells are the same as the base grid 500-ft on each side.

Vertically, the regional and focus area model layer thicknesses are coincident and cover the entire depth of unconsolidated material with bedrock used as the lowerboundary. A brief overview of the model layers is presented below:

- Model layers 1 through 4 represent the lower portions the Upper Glacial Aquifer as well as in the southern areas the Gardiner's Clay.
- Model layers 5 to 23 in the study area represent the Magothy aquifer. A clay-dominant zone referred to as the "Lignitic Clay" was added to the model in layers 9 and 10. The lateral extents of the Lignitic Clay were based on the extents estimated by CDM in a nearby modeling effort (CDM, 2008).
- Model layer 24 represents the Raritan confining unit. Initial hydraulic properties (e.g., hydraulic conductivity) were set to match the regional model.
- Model layer 25 represents the Lloyd aquifer.

As part of model calibration, horizontal and vertical hydraulic conductivity parameter zones within the model were constructed to be used as multipliers. Reasonable Upper and Lower bounds for horizontal and vertical hydraulic conductivity multipliers were set each zone. The focus area model was calibrated using parameter estimation (PEST) techniques (see Doherty and Hunt, 2010) to solve for groundwater level and stream flow targets at Massapequa Creek. In addition to using multipliers for the hydraulic conductivity, other multipliers were used including recharge rate, pumping/injection rates, and riverbed elevation and conductance. The parameter multiplier values for the iteration that resulted in the lowest RMSE was then imported into the model prior to evaluating remedial alternatives.

Maps depicting the groundwater contamination as described in Section 3.1 were used in the groundwater flow modeling. MODPATH was used to assign particles at the centroid of each model cell within the groundwater contamination in the model domain. MODPATH then calculated the forward path along which each particle travels from its origin to its ultimate discharge location. This process was used to refine each remedial alternative to better understand portion of the CPC plume captured by each extraction wells and the return of the treated water to the aquifer system (i.e., recharge basins). The number of wells and pumping rates needed to meet the goals for each remedial alternative was determined through a series of modeling iterations.

4 REMEDIAL GOALS AND REMEDIAL ACTION OBJECTIVES

4.1 Remedial Goals

The remedial goals for remedial actions undertaken pursuant to the New York State Inactive Hazardous Waste Disposal Remedial Program (State Superfund Program or SSF), are defined by Environmental Conservation Law, Article 27, Title 13. The stated goal of the SSF is to restore a site to pre-disposal conditions, to the extent feasible. The goal of the SSF program is to select a remedy that results in a remedial action that eliminates or mitigates significant threats to public health or to the environment posed by the disposal of hazardous wastes at the site.

4.2 Remedial Action Objectives

RAOs are goals set for environmental media (e.g., soil and groundwater) that are intended to provide protection for public health and the environment. RAOs form the basis of this FFS by providing overall goals for site remediation. RAOs are developed to define site-specific concerns that must be addressed and to what levels to protect human health and the environment. The RAOs for groundwater are presented below.

e) Groundwater RAOs for Public Health Protection

  iii. Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards; and

  iv. Prevent contact with contaminated groundwater.

f) Groundwater RAOs for Environmental Protection

  i. Restore groundwater aquifer to pre-disposal/pre-release conditions, to the extent practicable;

  ii. Prevent adverse impacts to the quantity or quality of the groundwater resources associated with the Nassau-Suffolk Sole Source Aquifer.

The remedial goals for the COCs based on the contaminant specific SCGs are presented in **Table 4-1**.

5 GENERAL RESPONSE ACTIONS

General Response Actions (GRAs) are broad classes of responses or remedies developed to meet the RAOs for the groundwater contamination associated with the Site. The GRAs consider the nature of the contamination, the contaminants of concern, the physical and hydrogeological characteristics of the site, and existing site infrastructure. As described in Section 3, groundwater within the off-site area has been impacted by VOCs and 1,4-dioxane at concentrations exceeding SCGs. VOCs exceeding the SCGs are present over an approximate 7,000 foot long by 2,000 foot wide area at depths ranging from less than 100 feet bgs to more than 400 feet bgs (Figure 3-2).

GRAs that could be applied to address the contamination at this Site include physical and chemical in-situ treatments, ex-situ treatments, disposal/discharge, or various combinations thereof. Seven GRAs have been identified for groundwater and are listed in **Table 5-1**.

- No Further Action
- Institutional Controls (ICs) with Long-Term Monitoring (LTM)
- Monitored Natural Attenuation (MNA) with LTM
- Containment
- In-Situ Treatment
- Ex-situ Treatment
- Groundwater Disposal/Discharge

5.1 No Further Action

Consideration of a 'No Further Action' response action is required under NYSDEC DER 10. The No Further Action response serves as a baseline against which the performance of other GRAs may be compared. Under the No Further Action response, no remedial actions will be performed to reduce the toxicity, mobility, or volume of contaminated groundwater beyond what is currently being implemented to contain the on-site contamination and associated hot spots. No ICs for the CPC plume will be implemented as part of the No Further Action GRA. At this particular site, the no further action alternative assumes that no additional remedial actions will be taken beyond what has already been implemented or planned in regard to the on-site and off-site groundwater contamination. On-going CPC remedial efforts being conducted include operation of the of former OBL GWET system including recovery wells RW-3, RW-4 and RW-5.

5.2 Institutional Controls with Long-Term Monitoring

ICs are legal or administrative measures designed to prevent or reduce human exposure to hazardous substances when active remedial measures do not achieve cleanup limits. Such measures may include groundwater use restrictions. ICs are often implemented in conjunction with other remedy components. LTM is typically completed to demonstrate compliance with the ICs.

5.3 Monitored Natural Attenuation with Long-Term Monitoring

This GRA relies on natural mechanisms including dispersion, dilution, adsorption, diffusion, volatilization, biodegradation, and chemical reactions with subsurface materials to reduce contaminant concentrations in groundwater. There is no intervention to modify the physical, geochemical, or hydrological regime. Comprehensive LTM is a required component of this GRA to evaluate and verify the progress of MNA, as is a contingency plan that defines the appropriate response action(s) should MNA not achieve the RAOs as expected.

5.4 Containment

Groundwater containment is typically achieved using physical vertical barriers, surface caps to limit precipitation infiltration, or hydraulic controls (e.g., interceptor trenches and extraction wells). Containment actions are taken to inhibit further migration of contaminated groundwater by minimizing recharge to the groundwater table through surface caps and/or altering the groundwater flow direction through hydraulic controls (i.e., minimizing mobility of contaminants). Containment options typically are not aimed at reducing the volume or toxicity of contaminants; however, containment that involves groundwater extraction and ex-situ treatment will result in reducing the mass of contaminants in the aquifer.

5.5 In-situ Treatment

In-situ treatment technologies may be used to reduce contaminant concentrations in-place without removal or containment of groundwater. Many *in-situ* treatment options (e.g., thermal treatment and *in-situ* chemical oxidation) are typically applied for source areas or areas where contaminant concentrations are found to be very high. However, other *in-situ* treatment options (i.e. enhanced biological treatment, in-well air stripping, or in-situ flushing) can also be applied at areas of lower contaminant concentrations.

5.6 Ex-situ Treatment

Ex-situ treatment GRAs are typically paired with GRAs involving collection of contaminated groundwater. The goal of *ex-situ* treatment is to reduce concentrations of contaminants in groundwater to levels required for the selected discharge process option(s). *Ex-situ* treatment includes technologies that involve biological and physical/chemical processes, as well as transport for off-site treatment.

5.7 Groundwater Disposal/Discharge

Groundwater disposal/discharge GRAs are typically paired with GRAs involving the collection of contaminated groundwater. Extracted groundwater could be transported to a permitted Resource Conservation and Recovery Act (RCRA) treatment/storage/disposal facility (TSDF) or discharged to a publicly owned treatment works (POTW) for treatment. Alternatively, the groundwater could be treated on-site using *ex-situ* treatment and then discharged to a POTW, to a nearby surface water body, or released into the subsurface via recharge basins. There may also be opportunities to beneficially re-use the treated water.

6 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Specific technologies associated with the GRAs are further assessed in the following sections. The technologies are screened to identify those that appear to be most appropriate to the site-specific conditions and on-site groundwater contamination, technically implementable, and capable of achieving the site's RAOs. Site-specific conditions, including contamination type, concentration, location (aerial extent and depth), geology/hydrogeology, and estimated quantity were considered during the initial screening process. The initial screening was also based on the effectiveness for treating the contaminants present at the site, implementability given site-specific conditions, and relative cost.

Remedial technologies that were deemed to be not technically appropriate or cost prohibitive were dropped from further consideration. The discussion below is grouped by the GRA (i.e., in-situ treatment, ex-situ treatment, containment, and reduction). Technologies that may be appropriate for addressing the contaminants at the site, and that were thus retained for further evaluation, are identified in the text

Several databases, guidance documents, and journal articles addressing groundwater remediation were used to identify potentially applicable remedial technologies. The following sources are of particular note:

- Federal Remediation Technologies Roundtable (FRTR) website: (http://www.frtr.gov/matrix2/top_page.html)
- USEPA Hazardous Waste Clean-up Information web site: (http://www.clu-in.org/)
- A Decision Flowchart for the Use of Monitored Natural Attenuation and Enhanced Attenuation at Sites with Chlorinated Organic Plumes - The Interstate Technology & Regulatory Council, Enhanced Attenuation: Chlorinated Organics Team (ITRC, 2007)
- Critical Review of State-of-the-Art In-situ Thermal Technologies for Dense Non-Aqueous Phase Liquid (DNAPL) Source Zone Treatment (ESTCP, 2010)
- Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Sites (USEPA, 1996)

6.1 No Further Action

The no further action option is included as a basis for comparison with active groundwater remediation technologies in accordance with Section 4.2 of NYSDEC DER-10. At this site, the no further action alternative assumes that no additional remedial actions will be taken beyond what has already been implemented or planned in regard to the on-site and off-site groundwater contamination. The on-going remedial efforts that include groundwater extraction and treatment in several locations are described in detail in Section 3. Previous groundwater modeling and groundwater quality monitoring have demonstrated that no further action will fail to achieve the established RAO's. If no further remedial action is taken, contaminants already present in the groundwater downgradient from the CPC site will remain in place and/or move down gradient in the direction of groundwater flow. However, as previously mentioned, this GRA is retained as a basis for comparison.

6.2 Institutional Controls and Long-Term Monitoring

Institutional Controls consist of administrative restrictions focused on minimizing potential contact with contaminated groundwater. LTM includes long-term monitoring of groundwater to monitor the effectiveness of groundwater remediation and compliance with the ICs. These process options could be combined with other GRAs to achieve the RAOs; therefore, ICs and LTM have been retained for further evaluation.

6.3 MNA and Long-Term Monitoring

MNA relies on natural mechanisms occurring in the aquifer—including dispersion, dilution, adsorption, diffusion, volatilization, biodegradation, and chemical reactions with subsurface materials—to reduce contaminant concentrations in groundwater. There is no intervention to modify the physical, geochemical, or hydrological regime in the aquifer to promote the natural attenuation of the site contaminants. MNA is used in combination with LTM to assess the progress, effectiveness, and protectiveness of natural attenuation. Regulatory approval of this option usually requires modeling and evaluation of contaminant degradation rates and pathways, as well as predicting contaminant concentrations at potential down gradient receptor points over time (ITRC, 2007).

Site modeling is performed to evaluate whether natural processes of contaminant degradation could reduce contaminant concentrations below regulatory standards or risk-based levels before potential exposure pathways are completed or to identify where additional measures (e.g., ICs) may be necessary to protect public health. In addition, LTM must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives and the longer remedial timeframe associated with its use. MNA/LTM has been retained for further evaluation with another remedial technology, as site conditions (e.g., location in a Sole Source Aquifer) make its use independent of another remedial action unlikely.

6.4 Containment

Containment technologies are designed to prevent migration of contaminants to existing or potential down gradient receptors. Containment technologies include hydraulic control, vertical barriers, and surface caps. These technologies provide containment by preventing the migration of groundwater from a source area. Hydraulic control is accomplished by installing extraction wells or interceptor trenches for collecting and treating the groundwater to stop contaminated groundwater from migrating past a certain point in the subsurface. Once treated, the water can be recharged to the subsurface, sent to a public sewer, or discharged to surface water. The technology classes and associated process options screened under containment are described below.

6.4.1 Hydraulic Control

Extraction Wells: Hydraulic control may be achieved by controlling the direction of groundwater flow with well capture zones. These extraction or groundwater pumping wells create points of low hydraulic head to which nearby groundwater flows. When groundwater is pumped from extraction wells, the groundwater potentiometric surface (or generally the groundwater level) is modified, and this results in changes to the groundwater flow directions near the well. By optimizing the locations of the extraction wells and adjusting the groundwater pumping rates, a potentiometric surface can be modified to capture the contaminated groundwater. This capture zone prevents contaminated groundwater from migrating toward down gradient receptors. This technology has been used at many sites and is technically feasible. The water that is extracted typically requires treatment and disposal. Hydraulic control using groundwater extraction wells will be retained for further evaluation.

Interceptor Trenches: Interceptor trenches refer to a wide range of lateral groundwater collection systems from tile-drain systems to deep horizontal well installations. Recent technology advances in trench construction methods, such as continuous trenching equipment, use of biodegradable slurries, geotextiles, or plastic shoring materials, and other innovations have led to the more frequent use of interceptor trenches. All of these construction methods involve the installation of a horizontal collection system which intersects a large cross-section of the groundwater system. Groundwater is directed to the interceptor trench as a result of a hydraulic head drop maintained across the length of the trench.

The hydraulic head drop can be a result of gravity drainage (as in a traditional French or tile drains) or can be induced by pumping from a collection sump attached to the trench system. Interceptor trenches are typically used in shallow groundwater collection applications in unconsolidated media. This technology is not feasible for the CPC Site because the groundwater contamination is more than 400 feet deep, well below the practical limit of trenching. Therefore, interceptor trenches will not be retained for further evaluation.

6.4.2 Vertical Barrier

Vertical barriers (e.g., slurry walls, grout curtains, sheet pile walls) are used to slow groundwater flow, minimize migration of contaminated groundwater, divert contaminated groundwater from a drinking water intake and/or provide a hydrodynamic barrier to enhance the efficacy of a hydraulic barrier (i.e. groundwater pump & treat system). These technologies are not feasible for the CPC Site because the groundwater contamination is more than 400 feet deep, well below the practical limit to which a vertical barrier can be installed. The density of buildings, roads, and subsurface utilities within the footprint of the CPC plume will also make the installation of a slurry wall impractical. Therefore, slurry walls will not be retained for further evaluation.

6.4.3 Surface Capping

Surface capping prevents or reduces infiltration of rainwater to the aquifer. Caps (or covers), which involve installing low-permeability material at the ground surface, are typically constructed of soil and synthetic material, asphalt, or bituminous concrete. Capping will not achieve the RAOs and is not implementable over a 7,000 foot long, 2,000-foot-wide CPC plume and will not limit the upgradient subsurface flow from transporting contamination to downgradient areas. Therefore, installation of a multimedia cap will not be retained for further evaluation.

6.5 In-Situ Treatment

The remedial technologies identified under in-situ treatment consist of measures to treat contaminated groundwater in-situ (i.e., without removal). The remedial technologies and associated process options screened under this GRA are described below.

6.5.1 In-Situ Biological Treatment

Bioremediation is a technology in which the physical, chemical, and biological conditions of a contaminated medium are modified to accelerate contaminant removal through the natural biodegradation and mineralization processes. Biodegradation is the process whereby microorganisms alter the structure of a chemical, while mineralization is the complete biodegradation of a chemical to carbon dioxide, water, and simple inorganic compounds. Biodegradation and mineralization are potentially applicable to VOCs and 1,4-dioxane. Heavier, more chemically complex organic compounds (e.g., pesticides, dioxins/furans) tend to be recalcitrant (resistant) to biodegradation and mineralization.

In nature, both partial biodegradation and complete mineralization take place; the processes, however, are frequently slow. Biostimulation, bioaugmentation, and in-situ adsorption and biodegradation are processes used to enhance the rates of biodegradation and mineralization. Biostimulation involves the addition of amendments such as food grade carbon substrates and nutrients to stimulate biodegradation. Bioaugmentation involves the addition of selectively cultured naturally occurring microbes that are known to degrade the contaminants of concern. In-situ adsorption and biodegradation are composed of very fine particles of activated carbon (1-2μm) suspended in water through the use of unique organic polymer dispersion chemistry. Once in the subsurface, the material behaves as a colloidal biomatrix binding to the aquifer matrix. Once contaminants are sorbed onto the regenerative matrix, biodegradation processes reportedly achieve complete remediation at an accelerated rate.

The in-situ biological treatments listed above are potentially effective. However, the large area (greater than 7,000 foot long, 2,000-foot-wide CPC plume) and depth (greater than 400 feet) of contamination will require a closely spaced grid of multi-depth injection points within the highly developed commercial/residential CPC plume footprint to achieve RAOs. The highly -developed nature and large size of the Site will make it difficult to achieve the necessary injection density and result in significant costs for this alternative; therefore, this technology will not be retained for further evaluation.

6.5.2 In-Situ Chemical Oxidation

ISCO involves the delivery and distribution of oxidants and other amendments into the subsurface to transform COCs into innocuous end products such as carbon dioxide, water, and inorganic compounds. The appropriateness of ISCO technology at a site depends on matching the oxidant and delivery system to the site contaminants and site conditions.

The most common oxidants used for ISCO are permanganate, catalyzed hydrogen peroxide (CHP), and activated persulfate. Each of these oxidants was evaluated as a potentially feasible process option. Permanganate is an oxidizing agent with a unique affinity for oxidizing organic compounds with carbon-carbon double bonds (e.g., TCE and 1,2-DCE). Compared to the other commonly used oxidants, permanganate is more stable in the subsurface. Unlike CHP, permanganate does not degrade naturally and can persist in the subsurface indefinitely (i.e., it is only consumed by interaction with contaminants or natural organic material). CHP involves the injection of hydrogen peroxide under acidic conditions in the presence of a ferrous iron catalyst to form hydroxyl free radicals. Hydroxyl radicals are very effective and nonspecific oxidizing agents. However, they are unstable and have a fairly short active life (i.e., on the order of hours or a few days). Sodium persulfate dissociates in water to form the persulfate anion which, although a strong oxidant, is kinetically slow in oxidizing many organic contaminants. When catalyzed or 'activated' in the presence of high pH (e.g., via addition of sodium hydroxide [NaOH]), heat (thermal catalyzation), a ferrous salt, or hydrogen peroxide, the persulfate ion is converted to the sulfate free radical (SO4•-). The sulfate free radical is a very potent oxidizing agent that has a greater oxidation potential and can degrade a wider range of environmental contaminants at faster rates than the persulfate anion. For ISCO to be effective, the oxidant must come into direct contact with COCs. Accordingly, this remedial approach generally includes several injections over time to ensure contact with the site contaminants accompanied by groundwater sampling and analysis.

ISCO treatment is potentially effective. However, the large area (greater than 7,000 foot long, 2,000-foot-wide CPC plume) and depth (greater than 400 feet) of contamination will require a closely spaced grid of multi-depth injection points within the highly developed commercial/residential CPC plume footprint to achieve RAOs. The highly -developed nature and large size of the Site will make it difficult to achieve the necessary injection density and result in significant costs for this alternative; therefore, this technology will not be retained for further evaluation.

6.5.3 In-Situ Air Sparging with Soil Vapor Extraction

In-situ air sparging involves injection of a gas (typically air) under pressure into the saturated zone to volatilize groundwater contaminants, and SVE wells are used to capture the contaminants. Volatilized vapors migrate into the vadose zone where they are extracted under vacuum, generally by an SVE system. Air sparging has been used at many sites to treat chlorinated VOCs; but not 1,4-dioxane. Successful use of air sparging technology depends on the ability of the system to effectively deliver air to the treatment area and the ability of the subsurface media to transmit the air. Heterogeneous conditions and possible semi-confined groundwater conditions, limit the effectiveness of this technology because of the preferential flow paths for the air. This technology also has a depth limitation since at great depths below the groundwater surface very large pressures will be required to force the air into the aquifer. This technology is not feasible because the groundwater contamination is more than 400 feet deep, well below the practical limit of sparging. Therefore, in-situ air sparging with SVE will not be retained for further evaluation.

6.6 Ex-situ Treatment

Ex-situ treatment is required when the selected remedy involves groundwater extraction, and when the groundwater requires treatment prior to recharge, reuse, or disposal. Although the technologies used for treating extracted groundwater are important aspects of a remedy, they have little influence on reducing contaminant levels in the aquifer or minimizing contaminant migration. Therefore, the technologies presented in USEPA's *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites* (1996) were evaluated.

These *ex-situ* treatment technologies are well-understood methods that have been used for many years in the treatment of drinking water and/or municipal or industrial wastewater. The technologies presented below are the technologies retained for the development of remedial alternatives.

The technologies for treatment of extracted groundwater containing site contaminants including VOCs and 1,4-dioxane include the following:

- Air stripping: Ex-situ air stripping has been used in conjunction with extraction and treatment systems to enhance performance; it separates volatile organic compounds from groundwater by increasing the surface area of the contaminated water exposed to air. Methods include packed towers, diffused, tray and spray aeration.
- Adsorption/Granular Activated Carbon (GAC): The adsorption process consists of passing contaminated groundwater through a sorbent media. Contaminants are adsorbed onto the media, reducing their concentration in the bulk liquid phase. Adsorption mechanisms are generally categorized as physical, chemical, or electrostatic adsorption. Adsorption is a viable technology for organic constituent's treatment of extracted groundwater.
- Advanced Oxidation Processes (AOPs): AOPs including the use of Ultraviolet (UV) radiation, catalytic oxidation, ozone, and/or hydrogen peroxide can destroy organic contaminants in groundwater. AOPs are a viable technology for 1,4-dioxane in water. AOPs use hydroxyl radicals, which are powerful oxidizers, to sequentially oxidize organic contaminants to carbon dioxide, water, and residual chloride. While its high energy requirements limit its cost-effectiveness, it is one of only a few technologies with commercial viability to treat 1,4-dioxane. AOPs may also be useful as an enhancement to other technologies, if the need to treat other recalcitrant residual contamination arises.

The technologies outlined above have been retained for further evaluation.

6.7 Groundwater Discharge

Groundwater discharge will be required for remedies that involved groundwater extraction. The primary options for discharge include surface water, aquifer recharge/well injection, irrigation, or transport to an off-site location (e.g., POTW or RCRA TSDF) for treatment and disposal. These options are described and evaluated below.

6.7.1 Discharge Untreated or Treated Water to Publicly Owned Treatment Works

This process option involves the direct discharge of untreated extracted groundwater or treated effluent to a local POTW for treatment and subsequent discharge. The extracted water/treated effluent would be directed to a wastewater treatment facility operated by the Cedar Creek Water Pollution Control Plant (CCWPCP). A discharge approval will need to be obtained from the facility, and the ex-situ treatment system will need to be designed to meet existing discharge limitations. Based on discussions with representatives of Nassau County, CCWPCP does not have the future infrastructure capacity to receive the volume of water likely to be discharged. The discharge of untreated groundwater or treated effluent to a POTW will not, therefore, be retained as a process option due to the volume of discharge anticipated.

6.7.2 Discharge Untreated Water to RCRA Treatment/Storage/Disposal Facility

This process option involves the transport of extracted groundwater to a licensed RCRA facility for treatment and/or disposal. This process option is not feasible based on the large volumes of water anticipated to be extracted. As part of the technology screening, it was determined that a suitable facility for this process option was not present in the vicinity of the site, the necessary infrastructure (e.g., suitable roadway or rail) are not present, and the overall environmental impact associated with implementing this option will be high. Therefore, this process option will not be retained for further evaluation.

6.7.3 Discharge to Recharge Basin/Infiltration Galleries

A recharge basin allows treated water to seep through the ground surface in a controlled area. An infiltration gallery includes a subsurface network of perforated pipes in trenches that return the treated water below the surface, but above the water table. Numerous recharge basins are present within Nassau County, and may be able to receive treated water discharge. Additional recharge basins and/or galleries may be required to assist in handling the volume of discharge water generated as a result of groundwater extraction. Recharge basins and infiltration galleries have therefore been retained for further evaluation.

6.7.4 Well Injection

This process option involves the use of injection wells to pump treated water under pressure into the subsurface. The use of injection wells, alone or in combination with recharge basins or infiltration galleries, may be able to receive a portion of the treated water discharge. The use of injection wells will therefore be retained for further evaluation.

6.7.5 Irrigation

Irrigation allows treated water to be discharged through land application or irrigation of vegetation. The use of irrigation could seasonally receive a portion of the discharge flow as one component of the overall discharge design. This process option will be retained for further evaluation.

6.8 Evaluation of Technologies and Selection of Representative Technologies

Groundwater remedial technologies under each type of GRA were screened for potential applicability, effectiveness, and implementation at the site. In addition to No Further Action, the following technologies pass the screening process and will be further evaluated:

- ICs with LTM
- MNA/LTM
- Containment
    - Hydraulic Containment
        - Extraction Wells
- Ex-Situ Treatment
    - Ex-situ Physical/Chemical Treatment
        - Air Stripping
        - Adsorption
        - AOP
- Groundwater Discharge
    - Discharge to Recharge Basin
    - Well Injection
    - Irrigation

7 DEVELOPMENT AND ANALYSIS OF ALTERNATIVES

In accordance with NYSDEC's *DER-10* (NYSDEC, 2010) remedial alternatives are developed by combining the remedial technologies that have successfully passed the screening stage into a range of alternatives. NYSDEC's *DER-10* requires a No Further Action alternative. Other alternatives are to be included based on returning the aquifer to current, intended, and reasonably anticipated future use of the site. Remedial alternatives were developed based on the retained technologies and Site-specific conditions as described previously in this document.

Based on the plumes defined in Section 3.0 and site-specific conditions, 5 alternatives were developed for analysis with the groundwater flow model. The presence of the existing well systems at CPC and FTC were considered when developing the alternatives. The groundwater flow modeling allowed for a quantitative evaluation of the extraction and discharge options for each alternative. The groundwater flow modeling with particle tracking analysis was completed iteratively by adjusting the location and flow rate of each extraction well until the remedial goal of the alternative was met.

Based on the retained remedial technologies, five groundwater remedial alternatives were developed and summarized in **Table 7-1.** These five alternatives are listed below, and described in the following sections:

- Alternative 1 – No Further Action
- Alternative 2 – GWET Utilizing CPC Infrastructure
- Alternative 3 – GWET Utilizing FTC Infrastructure
- Alternative 4 – GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells North of Melville Road
- Alternative 5 – GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells South of Melville Road

7.1 Common Components

The common components across each of the groundwater alternatives are the extraction of contaminated groundwater from the aquifer, *ex-situ* treatment, a conveyance system, treated water management, and performance monitoring. The common groundwater components are described in below.

7.1.1 Groundwater Extraction

Groundwater extraction would be achieved through high capacity extraction wells. The location and design pumping rate(s) used for existing CPC or FTC GWET extraction wells were used for many of the remedial alternatives. The pumping rates and locations of new extraction wells proposed for each alternative were determined using groundwater flow modeling. The flow rate of each existing extraction well and the location, depth, and flow rate for each new extraction well would be further refined during the remedial design.

7.1.2 *Ex-situ* Treatment:

Depending on the alternative, the contaminated groundwater from each extraction well would be treated at either the CPC treatment plant or FTC treatment plant. Groundwater from the extraction well(s) would be conveyed to the treatment plant using existing piping networks where possible. It is anticipated for cost estimating purposes that the treatment system would include a wet well, air stripping, GAC and AOP.

- The groundwater conveyance system will deliver the water to a wet well.
- Groundwater from the wet well would be transferred into an air stripper for VOC treatment. Both the CPC and FTC treatment plants have existing air strippers that will be used. Based on the total flow rate for each alternative, additional air strippers would be used for the removal of VOCs in groundwater.
- Liquid effluent from the air stripper would then pass through a liquid-phase GAC network to remove PFOS/PFOA. Based on the total flow rate for each alternative, parallel trains of liquid GAC vessels in series or multi-series of units 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. Vapor effluent from the air stripper would be treated using GAC.
- Liquid effluent from the GAC would then pass through AOP treatment to treat 1,4-dioxane. For the purpose of this FFS, AOP utilizing ozone with hydrogen peroxide is assumed for the removal of 1,4-dioxane. Based on the total flow rate for each alternative, a single AOP unit or a series of units in parallel would be used to treat 1,4-dioxane. Hydrogen peroxide material/storage are assumed as part of the AOP system.
- After treatment, groundwater would be managed as described below.

Pilot testing, bench testing, and field measurements in the pre-design phase of the work would be required to determine if any type of pre-treatment of the groundwater is required prior to passing through the treatment plant.

Operation and maintenance (O&M) costs associated with each treatment system would include the following:

- Annual Operational Labor: Includes annual labor costs for operating the treatment plant.
- Annual Power (Extraction and Treatment): Includes annual power usage for the extraction pumps, any booster pumps, air stripper blower(s), transfer pumps, duct heater, AOP unit(s), and operating the treatment plant building.
- Annual Material/Chemicals Usage: Includes annual costs for replacing/regenerating spent GAC, pre-treatment agent, and chemicals for the AOP.
- Annual System Maintenance: Includes annual material and labor costs for system maintenance.

- Treatment Plant Monitoring: Includes annual material and labor costs for the collection of monthly process samples to verify the system is operating within the permissible limits. Water samples would be collected from the influent and effluent of the treatment system and analyzed for VOCs, pH, Total Dissolved Solids (TDS), total iron, total manganese, and total zinc. The effluent limits for these parameters are likely to be approved as a State Pollutant Discharge Elimination System (SPDES) permit equivalent. Air samples would be collected at the effluent of the air stripper.

7.1.3 Treated Water Management

The treated effluent would be primarily be discharged to Recharge Basin No. 1 north west of the Old Bethpage Landfill. Discharge to Recharge Basin No. 33, located west of the Bethpage State Park Black Course, would be directed as needed based on flow volume and irrigation needs of Bethpage State Park Black Course. DEPENDING ON ALTERNATIVE SELECTED

7.1.4 Conveyance System

The existing CPC and FTC conveyance piping will be used to convey water from the existing wells. Prior to use the existing conveyance piping would be inspected and flushed. Groundwater extracted from new wells would be conveyed to the treatment plant in new piping. The pipe conveyance system is assumed to be installed within Bethpage State Park or the street right of way (ROW); however, the specific location and routing of piping would be refined during the remedial design. For the purpose of this FFS, costs are estimated for the following tasks associated with the installation of the pipe conveyance system: implementation of soil erosion and sediment control; trenching for pipe installation, vaults, and junctions; road crossings and repairs; road closure permits; and asphalt/concrete disposal. Where possible, directional drilling would be used to install conveyance pipes to limit disruption of public streets and residential areas. Applicability of directional drilling would be determined during the remedial design phase.

7.1.5 Performance Monitoring

A performance monitoring program would be implemented to confirm that the groundwater extraction and treatment system is achieving remedial objectives. For the purpose of this FFS, the performance monitoring plan would include:

- Monthly evaluation of influent, treatment, and effluent process parameters, such as temperature, flow rate, pH, temperature;
- Laboratory analysis of influent, mid-treatment, and effluent liquid and vapor samples for compliance with applicable permits (or permit equivalence); and
- Preparation of an annual report.

7.1.6 Long Term Monitoring

A LTM program would be implemented to assess the contaminated area outside the active treatment area for each alternative as well as asses the performance of the remediation progress within the CPC plume throughout the period of performance. A monitoring frequency of once per every year for LTM is included under each of the alternatives. For the purposes of estimating present worth costs, an LTM period of 30 years is assumed for all of the alternatives. The LTM would include:

- Installation of four monitoring wells (400 feet deep);
- Collection of synoptic water level measurements and groundwater samples from existing wells and the four new monitoring wells annually through year 30;
- Analysis of groundwater samples for COCs—the results of these analyses would be used to establish baseline conditions and final attainment of SCGs; and
- Preparation of an annual LTM report.

The final number and location of wells associated with LTM would be determined during the remedial design phase of this project to optimize monitoring locations.

7.1.7 Period of Performance

The period of performance of all alternatives was estimated based on the following hydrogeological assumptions:

- It is assumed that on-site source areas have been remediated or hydraulically contained by on-site groundwater extraction and treatment systems;
- A calculation of the pore volume of the CPC plumes is estimated based on the volume of the plume, 0.43 total porosity, the number of pore flushes necessary to reduce the concentration of VOCs to the SCGs (5 µg/l), a soil organic carbon-water partitioning coefficient (K_{oc}) of 94.9 (PCE), organic carbon content of soil (f_{oc}) of 0.0001, bulk density of 1.80, and the extraction rate estimated for each alternative; and
- Based on the above, it is estimated that the period of performance for Alternative 2, 3, 4, and 5 would be greater than 30 years. For the purpose of estimating net present worth costs for each alternative, a period of 30 years was used for Alternatives 2, 3, 4, and 5.

7.1.8 Public Well Head Treatment Contingency

Each Alternative includes a contingency for the addition of treatment at the existing Village of Farmingdale municipal supply wells. An evaluation of wellhead treatment contingency or the provision of alternate water supplies is recommended for all remedial alternatives. Wellhead treatment cost estimates were evaluated for cost analysis purposes. The contingency system would be constructed if data collected at the existing municipal supply wells indicate that treatment is required. Two treatment systems would be constructed, one for Well 1-3 and a second system for Wells 2-2/2-3. The treatment systems would consist of ultraviolet advanced oxidation processes (UV AOP) and GAC filtration vessels.

7.2 Alternative 1 - No Further Action

The No Further Action alternative is included as a basis for comparison with active groundwater remediation technologies in accordance with NYSDEC DER-10. At this particular site, the No Further Action alternative assumes that no additional remedial actions would be taken beyond what has already been implemented. Current remedial actions include the operation of CPC GWET (RW-3, RW-4, and RW-5) and LTM with institutional controls. The layout of this the current remedial action is presented on **Figure 7-2**.

7.3 Alternative 2 - GWET Utilizing CPC Infrastructure

Alternative 2 consists of a groundwater extraction system using existing five CPC Site wells (RW-1, RW-2, RW-3, RW-4, and RW-5) to capture groundwater in the CPC plume. These well locations are presented on **Figure 7-3**. Each extraction well would be pumped at 210 gallons per minute (gpm), pumping a total of 1,050 gpm. The volume of COC impacted groundwater upgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 would be reduced under Alternative 2 by extracting 1,050 gpm over an estimated 35 years. This alternative would use the existing groundwater conveyance piping and treatment at the existing Claremont Treatment Plant. The plant is currently designed to treat VOC impacted groundwater and will require upgrading to treat 1,4 dioxane and PFOS/PFOA. The anticipated treatment system upgrades consist of ultraviolet advanced oxidation processes (UV AOP) to treat 1,4, dioxane and GAC filtration vessels to treat PFOS/PFOA. Alternative 2 also includes LTM with institutional controls.

7.4 Alternative 3 - GWET Utilizing FTC Infrastructure

Alternative 3 consists of a groundwater extraction system using existing FTC wells ORW-2, ORW-4, ORW-6 and ORW-7 to capture groundwater in the CPC plume. These well locations are presented on **Figure 7-4**. Each extraction well would be pumped at 250 gpm, pumping a total of 1,000 gpm. The volume of COC impacted groundwater upgradient of extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 would be reduced under Alternative 3 by extracting 1,000 gpm over an estimated 35 years. This alternative would use the existing groundwater conveyance piping. Treatment would be at the existing Firemen's Training Center Treatment Plant. Because the FTC infrastructure is owned by Nassau County, this alternative will require coordination with the County. The plant is currently designed to treat VOC impacted groundwater and will require upgrading to treat 1,4 dioxane and PFOS/PFOA. The anticipated treatment system upgrades consist of UV AOP to treat 1,4, dioxane and GAC filtration vessels to treat PFOS/PFOA. Alternative 3 also includes LTM with institutional controls.

7.5 Alternative 4 - GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells North of Melville Road

Alternative 4 consists of a groundwater extraction system using three wells from the CPC GWET system (RW-3, RW-4, and RW-5) and three wells (ORW-4, ORW-6 and ORW-7) from the FTC GWET system. RW-3, RW-4, and RW-5 would each be pumped at 210 gpm and ORW-4, ORW-6, and ORW-7 would each be pumped at 250 gpm. These well locations are presented on **Figure**

7-5. Because the FTC infrastructure is owned by Nassau County, this alternative will require coordination with the County. This alternative also includes the addition of new pumping wells, Well A1 and Well A2, located on Bethpage State Park property to capture contaminated groundwater down-gradient of RW-3, RW-4, and RW-5. Extraction wells A1 and A2 would each be pumped at 250 gpm with the water conveyed to the FTC treatment plant in new piping. Therefore, the total extraction rate of this alternative is 1,880 gpm. The volume of COC impacted groundwater upgradient of the eight extraction wells would be reduced under Alternative 4 by extracting 1,880 gpm over an estimated 30 years. Treatment would be at the existing Firemen's Training Center Treatment Plant. This alternative would require the installation of conveyance piping to connect the Claremont system to the Fireman's Training Center system as well as the piping required for the new wells. The plant is currently designed to treat VOC impacted groundwater and will require upgrading to treat 1,4 dioxane and PFOS/PFOA. The anticipated treatment system upgrades consist of UV AOP to treat 1,4, dioxane and GAC filtration vessels to treat PFOS/PFOA. Alternative G4 also includes LTM with institutional controls.

7.6 Alternative 5 - GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells South of Melville Road

Alternative 5 consists of a groundwater extraction system using three wells from the CPC GWET system (RW-3, RW-4, and RW-5) and three wells (ORW-4, ORW-6 and ORW-7) from the FTC GWET system. Because the FTC infrastructure is owned by Nassau County, this alternative will require coordination with the County. This alternative also includes the addition of two new pumping wells (Well B1 and Well B2) to capture contaminated groundwater down-gradient of RW-3, RW-4, and RW-5. These wells would be installed on the shoulder of public right-a-way roads and completed in vaults. These well locations are presented on **Figure 7-6**. RW-3, RW-4, and RW-5 would each be pumped at 210 gpm and ORW-4, ORW-6, and ORW-7 would each be pumped at 250 gpm. Extraction wells B1 and B2 would each be pumped at 330 gpm with the water conveyed to the FTC treatment plant in new piping. Therefore, the total extraction rate of this alternative is 2,040. The volume of COC impacted groundwater upgradient of the eight extraction wells would be reduced under Alternative 5 by extracting 2,040 gpm over an estimated 35 years. Treatment would be at the existing FTC Treatment Plant. This alternative would require the installation of conveyance piping to connect the Claremont system to the NCFTC system as wells as the piping required for the new wells. The plant is currently designed to treat VOC impacted groundwater and will require upgrading to treat 1,4 dioxane and PFOS/PFOA. The anticipated treatment system upgrades consist of UV AOP to treat 1,4, dioxane and GAC filtration vessels to treat PFOS/PFOA. Alternative 5 also includes LTM with institutional controls.

8 EVALUATION OF ALTERNATIVES

This section presents a detailed evaluation of the remedial alternatives described in Section 7 relative to the eight evaluation criteria summarized below. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative.

8.1 Evaluation Criteria

The evaluation was based on criteria established under NYSDEC *DER-10: Technical Guidance for Site Investigation and Remediation*, Section 4.2. The evaluation criteria are as follows:

- **Overall protection of human health and the environment:** This criterion is an evaluation of the alternative's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced, or controlled through removal, treatment, engineering controls, or ICs. The alternative's ability to achieve each of the RAOs is evaluated.
- **Compliance with Standards, Criteria, and Guidance:** This criterion evaluates the compliance of the alternative with all identified SCGs and evaluates whether or not the remedy will achieve compliance.
- **Long-term effectiveness and permanence**: Each alternative is evaluated for its long-term effectiveness after implementation. If wastes or treated residuals remain after the selected remedy has been implemented, the following items are evaluated:
    - The magnitude of the remaining risks (i.e., whether there will be any significant threats, exposure pathways, or risks to the community and environment from the remaining wastes or treated residuals);
    - The adequacy of the engineering and ICs intended to limit the risk;
    - The reliability of these controls; and
    - The ability of the remedy to continue to meet RAOs in the future.
- **Reduction of toxicity, mobility, or volume of contamination through treatment:** Each alternative's ability to reduce the toxicity, mobility, or volume of COCs is evaluated. Preference is given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the wastes at the site.
- **Short-term impacts and effectiveness:** The potential short-term adverse impacts and risks of the remedy upon the community, the workers, and the environment during construction, and/or implementation are evaluated. A discussion is presented as to how the identified potential adverse impacts to the community or workers at the site will be controlled, as well as the effectiveness of those controls. A discussion of engineering controls that will be used to mitigate short-term impacts (e.g., dust control measures) is provided. The length of time needed to achieve the remedial objectives is also estimated.
- **Implementability:** The technical and administrative feasibility of implementing each alternative is evaluated for this criterion. Technical feasibility includes the difficulties

associated with construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc.

- **Cost Effectiveness: T**his criterion is an evaluation of the overall cost effectiveness of an alternative or remedy. This criterion evaluates the estimated capital, operations, maintenance, and monitoring costs. Costs are estimated and presented on a present-worth basis. The present worth costs were estimated with expected accuracies of -30 to +50 percent in accordance with NYSDEC and USEPA guidance. Because detailed remedial design activities have not been performed, a contingency has been included within the cost for each alternative to account for potential changes in scope (and costs) that may be identified during the design and implementation activities. In accordance with USEPA and NYSDEC guidance, a 3 percent discount rate (before taxes and after inflation) was used to calculate present worth.
- **Land Use:** This criterion evaluates the current, intended, and reasonably anticipated future use of the site and its surroundings, as it relates to an alternative or remedy when unrestricted levels are not achieved. Alternative 1 – No Further Action

8.1.1 Overall Protection of Human Health and the Environment

Alternative 1 provides no further control of exposure to contaminated groundwater and no further reduction in risk to the environment posed by contaminated groundwater. The No Further Action alternative does not attain the groundwater RAOs and does not provide protection of human health and the environment. The alternative allows for the continued migration of contaminated groundwater.

8.1.2 Compliance with SCGs

Alternative 1 does not comply with SCGs. Contaminated groundwater would continue to exhibit concentrations above the SCGs, and it would continue to migrate in the down-gradient direction towards receptors. This continued migration would result in a larger volume of the aquifer containing groundwater with COCs at concentrations exceeding SCGs.

8.1.3 Long-Term Effectiveness and Permanence

Alternative 1 does not provide long-term effectiveness or permanence. Under this alternative, contaminants in the groundwater would continue to migrate towards receptors and RAOs for the site would not be met in the long term.

8.1.4 Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment

Alternative 1 would not provide a reduction in toxicity, mobility, or volume of contaminated groundwater for COCs that occur downgradient of the CPC extraction wells (RW-3, RW-4, and RW-5) and these COCs would continue to migrate toward public water supplies.

8.1.5 Short-Term Impacts and Effectiveness

This alternative does not include any additional work installation of new extraction system components and does not result in disruption of properties overlying the CPC plume; therefore, no additional short-term risks are posed to the community, workers, or the environment, as no additional remedial action would occur.

8.1.6 Implementability

There are no implementability concerns posed by this remedy, as no additional remedial actions are being implemented.

8.1.7 Cost Effectiveness

Because this is a No Further Action alternative, the capital, O&M, and net present worth costs are estimated to be $0 (**Table 8-2** and Appendix A.).

8.1.8 Land Use

The No Further Action alternative would result in groundwater contaminants in excess of SCGs remaining in the aquifer. No environmental easements would be put in place. This alternative would not affect the current, intended, or reasonably anticipated future use of the area, which is a mix of residential, commercial/industrial, and recreational use.

8.2 Alternative 2 - GWET Utilizing CPC Infrastructure

8.2.1 Overall Protection of Human Health and the Environment

This alternative would remove contaminant mass upgradient from extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5; however, it would not be successful at achieving the RAO and it would not provide hydraulic control of impacted groundwater downgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5. Groundwater containing VOCs greater than the SCGs downgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 would continue to migrate, potentially impacting receptors. LTM would be used to monitor remediation progress throughout the operational years of the extraction and treatment system. This alternative would rely on the design, construction, operation, and maintenance of wellhead treatment systems, if necessary, for areas downgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5.

8.2.2 Compliance with SCGs

Alternative 2 will eventually reduce the concentration of COCs in groundwater upgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 to below the SCGs; however, contaminated groundwater downgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 will continue to have concentrations above the SCGs. As such, groundwater containing VOCs downgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 would continue to migrate, potentially impacting downgradient receptors. Treated water would meet the New York State groundwater effluent limitations prior to being discharged.

8.2.3 Long-Term Effectiveness and Permanence

Groundwater extraction and treatment systems have been demonstrated to be effective and reliable at numerous sites for groundwater treatment for VOCs. Alternative 2 would provide long-term effectiveness and permanence at extracting groundwater upgradient from extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5. VOCs would be permanently removed from groundwater with air stripping and PFOS/PFOA would be removed using GAC processes. 1,4-Dioxane would be permanently removed from groundwater with AOP.

Alternative 2 would not achieve the RAOs. Alternative 2 would not be effective in managing areas of the CPC plume downgradient from extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5, as these areas of the CPC plume are outside the area of active remediation and are not hydraulically contained by the groundwater extraction system. Groundwater downgradient from extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 would continue to migrate, potentially impacting downgradient receptors. Alternative 2 would not allow unrestricted use of the area's groundwater resources. The concentration of COCs in groundwater withdrawn by public water supply wells may increase during the operation of the remedy requiring implementation of the Public Well Head Treatment Contingency.

Alternative 2 would provide long-term effectiveness by extracting groundwater containing COCs at concentrations above the SCGs, through ICs and implementation of the Public Well Head Treatment Contingency. A LTM program would be implemented to verify the long-term effectiveness of the extraction and treatment system and to assess the remedy's ability to protect human health and the environment.

8.2.4 Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment

Alternative 2 would reduce the toxicity, mobility, and volume of COCs in the aquifer upgradient from extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 through groundwater extraction and treatment. VOCs would be permanently removed from groundwater with air stripping and GAC processes. 1,4-Dioxane would be permanently removed from groundwater with AOP and PFAS would be removed using GAC. Contaminants trapped on the GAC adsorption media would be destroyed during regeneration or disposed in accordance with applicable waste regulations. AOP provides complete destruction and mineralization of many chlorinated solvents, including 1,4-dioxane. Alternative 2 would reduce the mobility of COCs upgradient from extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 by hydraulically containing groundwater with COCs. The volume of groundwater upgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 has been estimated to be roughly 4 billion gallons of groundwater. The volume COC impacted groundwater upgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 would be reduced under Alternative 2 by extracting 1,050 gpm over an estimated 35 years. The toxicity, mobility, and volume of contamination would not be reduced in the portion of groundwater downgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 unless implementation of the Public Well Head Treatment Contingency takes place.

8.2.5 Short-Term Impacts and Effectiveness

Extraction of contaminated groundwater to the surface for treatment increases the risks of exposure to workers, the community, and the environment. Safety measures, including community air monitoring, traffic control plans, and street closure permits would be implemented during construction to mitigate these potential impacts. Because much of the infrastructure for Alternative 2 currently exists the short-term impacts would be limited. Short-term impacts would be encountered during:

- Installation of new pumps in 5 extraction wells; and
- The addition of AOP and GAC at the existing treatment plant.

Contaminated water produced during construction, and LTM would be appropriately managed according to Federal, State, and local regulations.

8.2.6 Implementability

Groundwater extraction and treatment uses well-established technologies and the equipment and services needed to install and operate the treatment system and to sample groundwater monitoring wells are commercially available. PDI, and pilot testing would be necessary to refine flow rates. The treatment components can be expanded to improve treatment effectiveness or handle increased flow rates, if required.

Alternative 2 uses existing extraction wells, conveyance piping, treatment system, and recharge basins. New pumps would be installed in the 5 extraction wells and treatment plant upgrades would be needed but these would cause limited disruption.

8.2.7 Cost Effectiveness

The total cost for Alternative 2 is approximately $55 M. This alternative includes capital costs associated with upgrading extraction wells and modification of the treatment plant. Periodic costs include O&M costs for the extraction and treatment system and costs to implement a LTM program. The estimated cost for Alternative 2 is summarized in **Table 8-2**, and a breakdown of costs for this alternative is provided within Appendix A.

8.2.8 Land Use

Alternative 2 focuses on remediating groundwater upgradient of extraction wells RW-1, RW-2, RW-3, RW-4, and RW-5 and thus allows contaminants outside of this area to continue to migrate, potentially to downgradient receptors. However, this alternative would not affect the current, intended, or reasonably anticipated future use of the area, which is a mix of residential, commercial/industrial, and recreational use.

8.3 Alternative 3 - GWET Utilizing FTC Infrastructure

8.3.1 Overall Protection of Human Health and the Environment

This alternative would remove contaminant mass upgradient from extraction wells ORW-2, ORW-4, ORW-6 and ORW-7; however, it would not be successful at achieving the RAO and it would not provide hydraulic control of impacted groundwater downgradient of extraction wells ORW-2, ORW-4, ORW-6 and ORW-7. Groundwater containing VOCs greater than the SCGs downgradient of extraction wells ORW-2, ORW-4, ORW-6 and ORW-7 would continue to migrate, potentially impacting receptors. LTM would be used to monitor remediation progress throughout the operational years of the extraction and treatment system. This alternative would rely on the design, construction, operation, and maintenance of wellhead treatment systems, if necessary, for areas downgradient of extraction wells ORW-2, ORW-4, ORW-6 and ORW-7.

8.3.2 Compliance with SCGs

Alternative 3 will eventually reduce the concentration of COCs in groundwater upgradient of extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 to below the SCGs; however, contaminated groundwater downgradient of extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 will continue to have concentrations above the SCGs. Groundwater containing VOCs downgradient of extraction wells ORW-2, ORW-4, ORW-6 and ORW-7 would continue to migrate, potentially impacting downgradient receptors. Treated water would meet the New York State groundwater effluent limitations prior to being discharged. Alternative 3 would continue until COCs upgradient of extraction wells ORW-2, ORW-4, ORW-6 and ORW-7 are below the SCGs.

8.3.3 Long-Term Effectiveness and Permanence

Groundwater extraction and treatment systems have been demonstrated to be effective and reliable for groundwater treatment of VOCs. Alternative 3 would provide long-term effectiveness and permanence by extracting groundwater upgradient from extraction wells ORW-2, ORW-4, ORW-6, and ORW-7. VOCs would be permanently removed from groundwater with air stripping and PFOS/PFOA would be removed using GAC processes. 1,4-Dioxane would be permanently removed from groundwater with AOP. A LTM program would be implemented to verify the long-term effectiveness of the extraction and treatment system.

Alternative 3 would not achieve the RAOs. Alternative 3 would not be effective in managing areas of the CPC plume downgradient from extraction wells ORW-2, ORW-4, ORW-6, and ORW-7, as these areas of the CPC plume are outside the area of active remediation and are not hydraulically contained by the groundwater extraction system. Groundwater downgradient from extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 would continue to migrate, potentially impacting downgradient receptors. Alternative 3 would not allow unrestricted use of the area’s groundwater resources. The concentration of COCs in groundwater withdrawn by public water supply wells may increase during the operation of the remedy requiring implementation of the Public Well Head Treatment Contingency.

8.3.4 Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment

Alternative 3 would reduce the toxicity, mobility, and volume of COCs in the aquifer upgradient from extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 through groundwater extraction and treatment. VOCs would be permanently removed from groundwater with air stripping and GAC processes. 1,4-Dioxane would be permanently removed from groundwater with AOP and PFAS would be removed using GAC. Contaminants trapped on the GAC adsorption media would be destroyed during regeneration or disposed in accordance with applicable waste regulations. AOP provides complete destruction and mineralization of many chlorinated solvents, including 1,4-dioxane. Alternative 3 would reduce the mobility of COCs upgradient from extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 by hydraulically containing groundwater with COCs. The volume of groundwater upgradient of extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 has been estimated to be roughly 4 billion gallons of groundwater. The volume of COC impacted groundwater upgradient of extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 would be reduced under Alternative 3 by extracting 1,000 gpm over an estimated 35 years. The toxicity, mobility, and volume of contamination would not be reduced in the portion of groundwater downgradient of extraction wells ORW-2, ORW-4, ORW-6, and ORW-7unless implementation of the Public Well Head Treatment Contingency takes place.

8.3.5 Short-Term Impacts and Effectiveness

Alternative 3 increases the risks of exposure to workers, the community, and the environment. Safety measures, including community air monitoring, traffic control plans, and street closure permits would be implemented during construction to mitigate these potential impacts. Because much of the infrastructure for Alternative 3 currently exists the short-term impacts would be limited. Short-term impacts would be encountered during:

- Installation of new pumps in 4 extraction wells; and
- The addition of AOP and GAC at the existing treatment plant.

Contaminated water produced during construction, and LTM would be appropriately managed according to Federal, State, and local regulations.

8.3.6 Implementability

Groundwater extraction and treatment uses well-established technologies and the equipment and services needed to install and operate the treatment system and to sample groundwater monitoring wells are commercially available. PDI, and pilot testing would be necessary to refine flow rates. Because the FTC infrastructure is owned by Nassau County, this alternative will require coordination with the County.

8.3.7 Cost Effectiveness

The total cost for Alternative 3 is approximately $53 M. This alternative includes capital costs associated with upgrading extraction wells, and modification of the treatment plant. Periodic costs include O&M costs for the extraction and treatment system and costs to implement a LTM program. The estimated cost for Alternative 3 is summarized in **Table 8-2**, and a breakdown of costs for this alternative is provided within Appendix A.

8.3.8 Land Use

Alternative 3 focuses on remediating groundwater upgradient of extraction wells ORW-2, ORW-4, ORW-6, and ORW-7 and thus allows contaminants outside of this area to continue to migrate, potentially to downgradient receptors. However, this alternative would not affect the current, intended, or reasonably anticipated future use of the area, which is a mix of residential, commercial/industrial, and recreational use.

8.4 Alternative 4 - GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells North of Melville Road

8.4.1 Overall Protection of Human Health and the Environment

Alternative 4 would remove contaminant mass upgradient from the CPC GWET system (RW-3, RW-4, and RW-5) and three wells (ORW-4, ORW-6 and ORW-7) from the FTC GWET system and new wells A1 and A2. However, it would not be successful at achieving the RAO and it would not provide hydraulic control of impacted groundwater downgradient of the A1 and A2 extraction wells (roughly Melville Road). Groundwater containing VOCs greater than the SCGs downgradient of extraction wells A1 and A2 would continue to migrate, potentially impacting receptors. LTM would be used to monitor remediation progress throughout the operational years of the extraction and treatment system. This alternative would rely on the existing public water supply contingency plan for the design, construction, operation, and maintenance of wellhead treatment systems, if necessary, for areas downgradient of Melville Road.

8.4.2 Compliance with SCGs

Alternative 4 will reduce the concentration of COCs in groundwater upgradient of the eight extraction wells to below the SCGs; however, contaminated groundwater downgradient of the A1 and A2 extraction wells (roughly Melville Road) will continue to have concentrations above the SCGs. Groundwater containing VOCs downgradient of extraction wells A1 and A2 (roughly Melville Road) would continue to migrate, potentially impacting downgradient receptors. Treated water would meet the New York State groundwater effluent limitations prior to being discharged. Alternative 4 would continue until COCs upgradient of the eight extraction wells are below the SCGs.

8.4.3 Long-Term Effectiveness and Permanence

Groundwater extraction and treatment systems have been demonstrated to be effective and reliable for groundwater treatment of VOCs. Alternative 4 would provide long-term effectiveness and permanence by extracting groundwater upgradient from the eight extraction wells. VOCs would be permanently removed from groundwater with air stripping and PFOS/PFOA would be removed using GAC processes. 1,4-Dioxane would be permanently removed from groundwater with AOP. A LTM program would be implemented to verify the long-term effectiveness of the extraction and treatment system.

Alternative 4 would not achieve RAOs. Alternative 4 would not be effective in managing areas of the CPC plume downgradient from extraction wells A1 and A2 (roughly Melville Road), as these areas of the CPC plume are outside the area of active remediation and are not hydraulically contained by the groundwater extraction system. Groundwater downgradient from extraction wells A1 and A2 (roughly Melville Road) would continue to migrate, potentially impacting downgradient receptors. Alternative 4 would not allow unrestricted use of the area's groundwater resources. The concentration of COCs in groundwater withdrawn by public water supply wells may increase during the operation of the remedy requiring implementation of the Public Well Head Treatment Contingency.

8.4.4 Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment

Alternative 4 would reduce the toxicity, mobility, and volume of COCs in the aquifer upgradient from the eight extraction wells through groundwater extraction and treatment. VOCs would be permanently removed from groundwater with air stripping and GAC processes. 1,4-Dioxane would be permanently removed from groundwater with AOP and PFAS would be removed using GAC. Contaminants trapped on the GAC adsorption media would be destroyed during regeneration or disposed in accordance with applicable waste regulations. AOP provides complete destruction and mineralization of many chlorinated solvents, including 1,4-dioxane. Alternative 4 would reduce the mobility of COCs upgradient from the eight extraction wells by hydraulically containing groundwater with COCs. The volume of groundwater upgradient of the eight extraction wells has been estimated to be roughly 6 billion gallons of groundwater. The volume of COC impacted groundwater upgradient of the eight extraction wells would be reduced under Alternative 4 by extracting 1,880 gpm over an estimated 30 years. The toxicity, mobility, and volume of contamination would not be reduced in the portion of groundwater downgradient of the eight extraction wells unless implementation of the Public Well Head Treatment Contingency takes place.

8.4.5 Short-Term Impacts and Effectiveness

Extraction of contaminated groundwater to the surface for treatment increases the risks of exposure to workers, the community, and the environment. Safety measures, including community air monitoring, traffic control plans, and street closure permits would be implemented during construction to mitigate these potential impacts. Because much of the infrastructure for

Alternative 4 currently exists the short-term impacts would be limited. Short-term impacts would be encountered during:

- Installation of new wells A1 and A2 and respective connections to the treatment system,
- Installation of new pumps in 3 CPC extraction wells,
- Installation of new pumps in 4 FTC extraction wells, and
- The addition of AOP and GAC at the existing treatment plant.

Contaminated water produced during construction, and LTM would be appropriately managed according to Federal, State, and local regulations.

8.4.6 Implementability

Groundwater extraction and treatment uses well-established technologies and the equipment and services needed to install and operate the treatment system and to sample groundwater monitoring wells are commercially available. PDI, and pilot testing would be necessary to refine flow rates. The treatment components can be expanded to improve treatment effectiveness or handle increased flow rates, if required. Because the FTC infrastructure is owned by Nassau County, this alternative will require coordination with the County.

8.4.7 Cost Effectiveness

The total cost for Alternative 4 is approximately \$98M This alternative includes capital costs associated with upgrading extraction wells, and modification of the treatment plant. Periodic costs include O&M costs for the extraction and treatment system and costs to implement a LTM program. The estimated cost for Alternative 4 is summarized in **Table 8-2**, and a breakdown of costs for this alternative is provided within Appendix A.

8.4.8 Land Use

Alternative 4 focuses on remediating groundwater upgradient of the eight extraction wells and thus allows contaminants outside of this area to continue to migrate, potentially to downgradient receptors. However, this alternative would not affect the current, intended, or reasonably anticipated future use of the area, which is a mix of residential, commercial/industrial, and recreational use.

8.5 Alternative 5 - GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells South of Melville Road

8.5.1 Overall Protection of Human Health and the Environment

Alternative 5 would remove contaminant mass upgradient from the CPC GWET system (RW-3, RW-4, and RW-5) and three wells (ORW-4, ORW-6 and ORW-7) from the FTC GWET system and new wells B1 and B2. However, it would not be successful at achieving the RAO and it would not provide hydraulic control of impacted groundwater downgradient of extraction B1 and B2. The limited amount of groundwater containing VOCs greater than the SCGs downgradient of extraction wells B1 and B2 would continue to migrate, potentially impacting receptors. LTM would be used to monitor remediation progress throughout the operational years of the extraction and treatment system. This alternative would rely on the existing public water supply contingency plan for the design, construction, operation, and maintenance of wellhead treatment systems, if necessary, for areas downgradient of extraction wells B1 and B2.

8.5.2 Compliance with SCGs

Alternative 5 will reduce the concentration of COCs in groundwater upgradient of the eight extraction wells to below the SCGs; however, contaminated groundwater downgradient of extraction wells B1 and B2 will continue to have concentrations above the SCGs As such, groundwater containing VOCs downgradient of extraction B1 and B2 would continue to migrate, potentially impacting downgradient receptors. Treated water would meet the New York State groundwater effluent limitations prior to being discharged. Alternative 5 would continue until COCs upgradient of the eight extraction wells are below the SCGs.

8.5.3 Long-Term Effectiveness and Permanence

Groundwater extraction and treatment systems have been demonstrated to be effective and reliable at sites for groundwater treatment of VOCs. Alternative 5 would provide long-term effectiveness and permanence at extracting groundwater upgradient from the eight extraction wells. VOCs would be permanently removed from groundwater with air stripping and PFOS/PFOA would be removed using GAC processes. 1,4-Dioxane would be permanently removed from groundwater with AOP. A LTM program would be implemented to verify the long-term effectiveness of the extraction and treatment system.

Alternative 5 would not achieve the RAOs in the area down gradient of B1 and B2. Alternative 5 would not be effective in managing the limited area of the CPC plume downgradient from extraction wells B1 and B2, as this area is outside the area of active remediation and are not hydraulically contained by the groundwater extraction system. The groundwater downgradient from extraction wells B1 and B2 would continue to migrate, potentially impacting downgradient receptors. Alternative 5 would not allow unrestricted use of the area's groundwater resources. The concentration of COCs in groundwater withdrawn by public water supply wells may increase during the operation of the remedy requiring implementation of the Public Well Head Treatment Contingency.

8.5.4 Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment

Alternative 5 would reduce the toxicity, mobility, and volume of COCs in the aquifer upgradient from the eight extraction wells through groundwater extraction and treatment. VOCs would be permanently removed from groundwater with air stripping and GAC processes. 1,4-Dioxane would be permanently removed from groundwater with AOP and PFAS would be removed using GAC. Contaminants trapped on the GAC adsorption media would be destroyed during regeneration or disposed in accordance with applicable waste regulations. AOP provides complete destruction and mineralization of many chlorinated solvents, including 1,4-dioxane. Alternative 5 would reduce the mobility of COCs upgradient from the eight extraction wells by hydraulically containing groundwater with COCs. The volume of groundwater upgradient of the eight extraction wells has been estimated to be roughly eight billion gallons of groundwater. The volume of COC impacted groundwater upgradient of the eight extraction wells would be reduced under Alternative 5 by extracting 2,040 gpm over an estimated 35 years. The toxicity, mobility, and volume of contamination would not be reduced in the groundwater downgradient of extraction wells B1 and B2 unless implementation of the Public Well Head Treatment Contingency takes place.

8.5.5 Short-Term Impacts and Effectiveness

Extraction of contaminated groundwater to the surface for treatment increases the risks of exposure to workers, the community, and the environment. Safety measures, including community air monitoring, traffic control plans, and street closure permits would be implemented during construction to mitigate these potential impacts. Because much of the infrastructure for Alternative 5 currently exists the short-term impacts would be limited. Short-term impacts would be encountered during:

- Installation of new wells B1 and B2 and respective connections to the treatment system,
- Installation of new pumps in 3 CPC extraction wells,
- Installation of new pumps in 4 FTC extraction wells; and
- The addition of AOP and GAC at the existing treatment plant.

Contaminated water produced during construction, and LTM would be appropriately managed according to Federal, State, and local regulations.

8.5.6 Implementability

Groundwater extraction and treatment uses well-established technologies and the equipment and services needed to install and operate the treatment system and to sample groundwater monitoring wells are commercially available. PDI, and pilot testing would be necessary to refine flow rates. The treatment components can be expanded to improve treatment effectiveness or handle increased flow rates, if required. Because the FTC infrastructure is owned by Nassau County, this alternative will require coordination with the County.

8.5.7 Cost Effectiveness

The total cost for Alternative 5 is approximately $100M. This alternative includes capital costs associated with upgrading extraction wells, and modification of the treatment plant. Periodic costs include O&M costs for the extraction and treatment system and costs to implement a LTM program. The estimated cost for Alternative 5 is summarized in **Table 8-2**, and a breakdown of costs for this alternative is provided within Appendix A.

8.5.8 Land Use

Alternative 5 focuses on remediating groundwater upgradient of the eight extraction wells and thus allows contaminants outside of this limited area to continue to migrate, potentially to downgradient receptors. However, this alternative would not affect the current, intended, or reasonably anticipated future use of the area, which is a mix of residential, commercial/industrial, and recreational use.

9 COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, a comparative analysis was completed between the alternatives for each of the DER-10 evaluation criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative. The five groundwater alternatives that were individually evaluated in Section 8 include:

- Alternative 1 – No Further Action
- Alternative 2 – GWET Utilizing CPC Infrastructure
- Alternative 3 – GWET Utilizing FTC Infrastructure
- Alternative 4 – GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells North of Melville Road
- Alternative 5 – GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells South of Melville Road

Each of the remedial alternatives summarized above consists of groundwater extraction, *ex-situ* groundwater treatment, and managing and/or reusing the treated water. The overall effectiveness of the selected remedy would be evaluated through implementation of a LTM program. The primary difference between the remedial alternatives is the size and location of the remediation area.

9.1 Overall Protectiveness of Public Health and the Environment

Alternatives 2 through 5 remove contaminant mass from the most heavily impacted portions of the CPC plume; but they do not provide hydraulic control of the entire CPC plume. The potential for additional human exposure would exist under Alternatives 2 through 5 because municipal water supplies may become impacted as contaminated groundwater with COCs above the SCGs continues to migrate in the down-gradient direction. These alternatives, therefore, rely upon wellhead treatment and natural processes to remove COCs to the SCGs and provide protection of human health and the environment.

Alternative 5 would be the most protective as it would capture the largest portion of the CPC plume. Alternative 4 would be more protective than Alternative 2 through 3 as it captures more of the CPC plume than Alternatives 1 through 3 and slightly less protective of Alternative 5 as it captures slightly less portion of the CPC plume than Alternative 5. Alternative 1 is least protective of public health and the environment.

The potential for human exposure to contaminants resulting from remedy implementation also exists to a lesser extent for all alternatives, because contaminated groundwater is extracted from the aquifer and aboveground treatment is required. Also, direct contact with contaminants could occur during the short periods of time when GAC change-out is occurring. However, these exposures would be mitigated through standard work practices.

Each of the alternatives would transfer VOC concentrations from groundwater to vapor, which is mitigated with the use of GAC adsorption. The VOCs are then destroyed when the vapor phase GAC is recycled and regenerated. PFOS and PFOA would be destroyed when the liquid phase GAC is regenerated. The AOP technology included in each of the alternatives provides complete destruction and mineralization of many chlorinated solvents, including 1,4-dioxane.

9.2 Compliance with SCGs

Alternatives 1 through 5 are anticipated to effectively achieve SCGs through the extraction of COCs from a portion of the CPC plume and rely on natural processes and wellhead treatment of public water supplies to achieve SCGs for the remainder of the CPC plume. Alternative 5 would capture the greatest portion of the CPC plume. This alternative is therefore, the most effective at achieving the SCGs. Alternative 4 would extract and treat the next largest portion of the CPC plume. Alternatives 2 through 3 would capture the smallest portion of the CPC plume. These alternatives are therefore the least effective at achieving SCGs. Under each of the alternatives, extracted water would be treated to meet NYSDEC discharge effluent limitations prior to groundwater recharge, discharge to surface water, or beneficial reuse. Each of the alternatives therefore meets SCGs for treated water.

9.3 Long-Term Effectiveness and Permanence

Groundwater extraction and ex-situ treatment under each of the alternatives are considered effective technologies for addressing groundwater contaminated with COCs. Alternatives 4 is anticipated to achieve RAOs in the shortest remedial timeframe with the least long-term impacts. Alternative 4 would remove the portion of the VOC targeted by remediation the fastest (30 years) by extracting more groundwater (i.e., 1,880 gpm) from a slightly smaller portion of the CPC plume than Alternative 5. Alternative 4 would also cause less long-term impacts than Alternative 5 as the extraction wells are far enough from the municipal wells (i.e., 3,000 feet) as to not cause significant water level drawdown in the municipal wells.

Conversely, Alternative 5 would take slightly longer to achieve the SCGs (i.e., 35 years) in groundwater upgradient of the extraction wells than Alternative 4, as Alternative 5 would capture a larger portion of the CPC plume than Alternative 4 and extract groundwater at only a slightly higher pumping rate (i.e., 2,040 vs 1,880 gpm). Alternative 5 would also have greater potential long-term impacts than Alternative 4 as extracting groundwater roughly 1,000 feet from the municipal wells would potentially lower the water level and pumping rate in the municipal wells.

Alternatives 2 and 3 would take a similar amount of time (i.e., 35 years) as Alternative 5 to achieve the SCGs; however, these alternatives would remediate a smaller portion of the CPC plume than Alternatives 4 or 5. Alternatives 2 through 3 would not likely cause long-term impacts to the municipal wells as the extraction wells for these alternatives are roughly 5,000 feet from the municipal wells.

9.4 Reduction of Toxicity, Mobility, or Volume with Treatment

All of the alternatives would reduce the toxicity, mobility, and volume of contaminants in the aquifer by using extraction wells to remove contaminated groundwater and by providing surface treatment through air stripping, granulated active carbon, and AOP technologies.

Alternative 4 would reduce the toxicity, mobility, and volume of contaminants in the aquifer the greatest as the extraction wells (including new wells A1 and A2) are in the portion of the CPC plume highest concentration of the VOCs resulting in a shorter estimated time to reduce COC concentrations compared to Alternative 5. Alternative 5 would reduce the toxicity, mobility, and volume of contaminants in the aquifer the next greatest as wells B1 and B2 are located in a lower concentration portion of the CPC plume than Alternative 4. Therefore, Alternative 5 reduces the toxicity and volume of contamination less than Alternative 4.

Alternative 2 would reduce the toxicity, mobility, and volume of contaminants in the aquifer the next greatest as the extraction wells are in the portion of the CPC plume highest concentration of the VOCs. Alternative 3 would reduce the toxicity, mobility, and volume of contaminants in the aquifer the least as the extraction wells (FTC extraction wells ORW-4, ORW-6 and ORW-7) are not located in the portion of the CPC plume with the highest concentrations. Alternative 1 does not provide additional reduction of toxicity, mobility or volume of contaminants.

Each of the alternatives relies on commonly used treatment technologies to permanently destroy the contaminants once withdrawn from the aquifer. Following air stripping, any remaining contaminants trapped on the GAC adsorption media would be destroyed during regeneration or disposed of in accordance with applicable waste regulations. The AOP technology provides complete destruction and mineralization of many chlorinated solvents, including 1,4-dioxane.

9.5 Short-Term Impacts and Effectiveness

With the drilling of extraction wells, installation of underground conveyance piping, and construction upgrades of treatment plants, each of the alternatives would have short-term impacts on the community. While each of the alternative would have short-term impacts on the local communities, these disruptions would be mitigated through noise and traffic control plans, as well as community air monitoring programs during construction to minimize and address any potential impacts to the community, remediation workers, and the environment.

Alternative 1 (No Further Action) would produce the least short-term impacts to workers, the public, and the environment during construction as there are no construction activities for this alternative. Alternatives 2 and 3 include the installation of new pumps in the extraction wells and either CPC or FTC Treatment system upgrades. These alternatives would produce more short-term impacts to workers, the public, and the environment during construction than Alternative 1 (No Further Action) but less short-term impacts than Alternative 4 or 5. Alternative 4 includes the drilling and installing two extraction wells and the installation of conveyance piping in Bethpage State Park and CPC Treatment system upgrades. This alternative would produce more short term impacts to workers, the public, and the environment during construction than Alternatives 2 and 3 but less short-term impacts than Alternative 5. Alternative 5 includes drilling and installing two extraction wells and the installation of conveyance piping in the right-of-way south of Melville Road and would produce the greatest amount of short-term impacts to workers, the public, and the environment during construction.

9.6 Implementability

While each of the remedial alternatives are implementable, the degree of difficulty is determined by specific construction activities that will need to occur in heavily developed public areas. Alternative 1 (No Further Action), would be the easiest alternative to implement as it requires no land acquisition, construction, and would be disruptive to traffic.

Alternatives 2 through 4 would be the next easiest alternatives to implement as they also require no land acquisition, minimal construction, and would not be disruptive to traffic as all of the construction would occur on Bethpage State Park land or land owned by the Town of Oyster Bay or Nassau County. Alternative 5 would be the most challenging to implement. Alternative 5 will require the installation of two new extraction wells and the installation of conveyance piping within the public right-of-way. This alternative would; therefore, potentially be disruptive to local traffic.

Because the FTC infrastructure is owned by Nassau County, Alternatives 3 through 5 will require coordination with the County.

The equipment and services needed to sample groundwater monitoring wells are commercially available. The ex-situ treatment technologies proposed under all the alternatives are commercially available technologies and are typically easy to install and operate. Additional PDI, pilot testing, and property evaluation would be necessary to determine optimal well placement, flow rates, and any required pre-treatment.

9.7 Cost

The cost for each alternative, presented in order of increasing cost is:

- Alternative 1 – No Further Action (**$0**)
- Alternative 2 – GWET Utilizing CPC Infrastructure (**$55 M**)
- Alternative 3 – GWET Utilizing FTC Infrastructure (**$53 M**)
- Alternative 4 – GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells North of Melville Road (**$97 M**)
- Alternative 5 – GWET Utilizing CPC & FTC Infrastructure Plus Two Extraction Wells South of Melville Road (**$100 M**)

9.8 Land Use

Because Alternative 4 would remediate groundwater impacted with COCs above the SCGs more quickly than the other alternatives, it has the least effect on the current, intended and reasonably anticipated future use of the areas. Alternatives 1 through 3 and 5 would affect land use the most as these alternatives would take the longer to achieve the SCGs.

10 CERTIFICATION

I Thomas Heins certify that I am currently a NYS registered professional engineer and that this Feasibility Study Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

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Thomas Heins, P.E.

11 REFERENCES

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Tables

Table 2-1 Claremont Polychemical Site Site-Related COCs
Claremont Polychemical Site - Focused Feasibility Study Report
Town of Old Bethpage, Nassau County, New York

Site-Related Contaminants of Concern Claremont Polychemical (CPC) Site		
Organics	Alpha-BHC	1,1-Dichloroethene (1,1-DCE)
	Acetone	Ethylbenzene
	Benzene	Isophorone
	Benzo(a)pyrene	Methyl Chloride (Chloromethane)
	Benzoic Acid	Methyl Ethyl Ketone (MEK)
	Bis(2-ethylhexyl) phthalate (DEHP)	Methyl Isobutyl Ketone (MIBK)
	Chlorobenzene	Naphthalene
	Chloroethane (Ethyl Chloride)	Pentachlorophenol
	Chloroform	Phenol
	Diethyl phthalate	Tetrachloroethene (PCE)
	1,2-Dichlorobenzene	Toluene
	1,4-Dichlorobenzene	trans-1,2-Dichloroethene
	1,1-Dichloroethane (1,1-DCA)	Trichloroethene (TCE)
	1,2-Dichloroethane (1,2-DCA)	Vinyl Chloride (VC)
Inorganics	Antimony	Lead
	Arsenic	Manganese
	Barium	Mercury
	Beryllium	Nickel
	Cadmium	Thallium
	Chromium	Vanadium
	Copper	Zinc
	Iron	

Sources:
1989 USEPA OU2 Record of Decision
1990 USEPA Comprehensive ROD (OU1, OU3, OU4, OU5, and OU6)

Notes:
Methyl Ethyl Ketone (MEK) also known as 2-butanone
Methyl Isobutyl Ketone (MIBK) also known as 4-methyl, 2-Pentanone

Table 2-2 Former Aluminum Louvre Site COCs
Claremont Polychemical Site - Focused Feasibility Study Report
Town of Old Bethpage, Nassau County, New York

Site-Related Contaminants of Concern Former Aluminum Louvre (FAL) Site	
Organics	Trichloroethene (TCE)
	1,1,1-Tetrachloroethane (1,1,1-TCA)
	Tetrachloroethene (PCE)
	Dichloroethylene (DCE)
	cis-1,2-Dichloroethene (cDCE)
	1,1-Dichloroethane (DCA)

Source:
2019 NYSDEC FAL OU2 Record of Decision for Off-site Groundwater

Table 2-3 Old Bethpage Landfill COCs
Claremont Polychemical Site - Focused Feasibility Study Report
Town of Old Bethpage, Nassau County, New York

Site-Related Contaminants of Concern Old Bethpage Landfill (OBL) Site		
Organics	1,1,1-Trichloroethane (1,1,1-TCA)	Chloroethane
	1,1-Dichloroethane	Chloroform
	1,1-Dichloroethene	Dichlorobenzene (ortho/para, all isomers)
	1,2-Dichloroethane	Ethylbenzene
	1,2-Dichloroethene (trans)	Methylene Chloride
	1,2-Dichloropropane	Phenols (total)
	Benzene	Tetrachloroethene
	Bromodichloromethane	Toluene
	Bromoform	Trichloroethylene
	Carbon Tetrachloride	Vinyl Chloride
	Chlorobenzene	Xylene (all isomers)
	Chlorodibromomethane	
Inorganics	Barium	Lead
	Cadmium	Magnesium
	Chromium (hexavalent)	Manganese
	Copper	Mercury
	Cyanide	Silver
	Iron	Zinc
Other	Chloride	
	Nitrate	
	Sulfate	
	Total Dissolved Solids	

Source:
1988 USEPA Old Bethpage Landfill Record of Decision

Table 2-4 Fireman's Training Center Site-COCs

Claremont Polychemical Site - Focused Feasibility Study Report

Town of Old Bethpage, Nassau County, New York

Site-Related Contaminants of Concern Fireman's Training Center (FTC) Site	
Organics	Vinyl chloride
	Tetrachloroethylene (PCE)
	1,1-Dichloroethylene (1,1-DCE)
	1,2-Dichloroethane (1,2-DCA)
	1,1,1-Trichloroethane (1,1,1-TCA)
	Trichloroethylene (TCE)
	Benzene
	Xylene

Source:

1993 NYSDEC Fireman's Training Center Site Report

Table 4-1 Site Related Chemicals of Concern and Chemical Specific Standards, Criteria, and Guidance (SCG) Values
Claremont Polychemical Site - Focused Feasibility Study Report
Town of Old Bethpage, Nassau County, New York

Contaminant of Concern (COC)		CAS RN	NYSDEC Part 703.5 Class GA (µg/l) [A]	NYSDEC TOGS 1.1.1 Class GA (µg/l) [B]	NYSDOH Part 5, Subpart 5-1 (µg/l) [C]	Federal MCLs (µg/l) [D]	Federal MCLG (µg/l) [D]	Other EC Criteria (µg/l) [see notes]	Lowest SCG (µg/l)
Volatile Organic Compounds (VOCs)	Acetone	67-64-1	NS	50 GV	50 UOC	NS	NS	--	50
	Benzene	71-43-2	1	1	5	5	0	--	1
	Chlorobenzene	108-90-7	5	5	5	100	100	--	5
	Chloroethane (Ethyl Chloride)	75-00-3	5	5	5	NS	NS	--	5
	Chloromethane (Methyl Chloride)	74-87-3	5	5	5	NS	NS	--	5
	Chloroform	67-66-3	7	7	80 ^^	NS	70	--	7
	1,2-Dichlorobenzene	541-73-1	3 *	3 *	5	600	600	--	3
	1,4-Dichlorobenzene	106-46-7	3 *	3	5	75	75	--	3
	1,1-Dichloroethane (1,1-DCA)	75-34-3	5	5	5	NS	NS	--	5
	1,1-Dichloroethene (1,1-DCE)	75-35-4	5	5	5	7	7	--	5
	1,2-Dichloroethane (1,2-DCA)	107-06-2	0.6	0.6	5	5	0	--	0.6
	2-Butanone	78-93-3	NS	50 GV	50 UOC	NS	NS	--	50
	4-Methyl, 2-Pentanone	108-10-1	NS	NS	50 UOC	NS	NS	--	50
	Ethylbenzene	100-41-4	5	5	5	70	70	--	5
	Isophorone	78-59-1	NS	50 GV	50 UOC	NS	NS	--	50
	Tetrachloroethene (PCE)	127-18-4	5	5	5	5	0	--	5
	Toluene	108-88-3	5	5	5	1,000	1,000	--	5
	cis-1,2-Dichloroethene	156-59-2	5	5	5	70	70	--	5
	trans-1,2-Dichloroethene	156-60-5	5	5	5	100	100	--	5
	Trichloroethene (TCE)	79-01-6	5	5	5	5	0	--	5
	Vinyl chloride	75-01-4	2	2	2	2	0	--	2
Semi-Volatile Organic Compounds (SVOCs)	Benzoic Acid	65-85-0	NS	NS	50 UOC	NS	NS	--	50
	Bis(2-ethylhexyl) phthalate (DEHP)	117-81-7	5	5	6	6	0	--	5
	Diethyl phthalate (DEP)	84-66-2	NS	50 GV	50 UOC	NS	NS	--	50
	Naphthalene	91-20-3	NS	10 GV	50 UOC	NS	NS	--	10
	Benzo(a)pyrene	50-32-8	Non-Detect	Non-Detect	0.2	0.2	0	--	0 / Non-Detect
	Pentachlorophenol (PCP)	87-86-5	1 ***	1 ***	1	1	0	--	0 / Non-Detect
	Phenol	108-95-2	1 ***	1 ***	50 UOC	NS	NS	--	1
Pesticides	Alpha-BHC	319-84-6	0.01	0.01	50 UOC	NS	NS	--	0.01

Continued on next page. Footnotes on next page.

Table 4-1 Site Related Chemicals of Concern and Chemical Specific Standards, Criteria, and Guidance (SCG) Values
Claremont Polychemical Site - Focused Feasibility Study Report
Town of Old Bethpage, Nassau County, New York

Contaminant of Concern (COC)		CAS RN	NYSDEC Part 703.5 Class GA (µg/l) [A]	NYSDEC TOGS 1.1.1 Class GA (µg/l) [B]	NYSDOH Part 5, Subpart 5-1 (µg/l) [C]	Federal MCLs (µg/l) [D]	Federal MCLG (µg/l) [D]	Other EC Criteria (µg/l) [see notes]	Lowest SCG (µg/l)
Inorganics	Antimony	7440-36-0	3	3	6	6	6	--	3
	Arsenic	7440-38-2	25	25	10	10	0	--	0 / Non-Detect
	Barium	7440-39-3	1,000	1,000	2,000	2,000	2,000	--	1,000
	Beryllium	7440-41-7	NS	3 GV	4	4	4	--	3
	Cadmium	7440-43-9	5	5	5	5	5	--	5
	Chromium	7440-47-3	50	50	100	100	100	--	50
	Copper	7440-50-8	200	200	1,300	1,300	1,300	--	200
	Iron	7439-89-6	300 ^	300 ^	300 ^	300 #	NS	--	300
	Lead	7439-92-1	25	25	15	15	0	--	0 / Non-Detect
	Manganese	7439-96-5	300 ^	300 ^	300 ^	50 #	NS	--	50
	Mercury	7439-97-6	0.7	0.7	2	2	2	--	0.7
	Nickel	7440-02-0	100	100	NS	NS	NS	--	100
	Thallium	7440-28-0	NS	0.5 GV	2	2	0.5	--	0.5
	Vanadium	7440-62-2	NS	NS	NS	NS	NS	--	N/A
	Zinc	7440-66-6	NS	2,000 GV	5000	500 #	NS	--	500
Emerging Contaminants (ECs)	1,4-Dioxane	123-91-1	NS	NS	1.0	NS	NS	0.35 [E]	1.0 [C]
	PFOS	1763-23-1	NS	NS	0.010	NS	NS	--	0.010 [C]
	PFOA	335-57-1	NS	NS	0.010	NS	NS	--	0.010 [C]

Abbreviations

µg/l - Micrograms per liter
EC - Emerging Contaminant
GW - Groundwater
GV - Guidance Value
MCL - Maximum Contaminant Level
MCLG - Maximum Contaminant Level Goal
NS - No standard, goal or guidance value.
SCG - Standards, Criteria, and Guidance
UOC - Unspecified Organic Contaminant (NYSDOH)
POC - Principal Organic Contaminant (NYSDOH)
PFNA - Perfluorononanoic acid
PFOS - Perfluorooctanesulfonic acid
PFOA - Perfluorooctanoic acid
PFAS - Per- and Polyfluoroalkyl Substances
Total PFAS = Sum of PFAS compounds (see Reference [C])

Standards, Criteria, and Guidance Value Sources

[A] Title 6 NYCRR Part 703.5 Water Quality Standards for Taste-, Color- and Odor-producing, Toxic and Other Deleterious Substances (current through August 15, 2020). Table 1 (Class GA waters)

[B] New York State Department of Environmental Conservation (NYSDEC) Technical and Operational Guidance Series (TOGS) 1.1.1 (June 1998) and Subsequent Addenda (April 2000 & June 2004) and Errata (January 1999). Table 1 (Class GA waters)

[C] New York State Department of Health (NYSDOH) Title 10 NYCRR Chapter 1 Part 5 Subpart 5.1. (Subpart 5-1.52 Tables, Effective Date August 26, 2020). NYSDOH POC Criteria = 5 ug/L (Tables 3 and 9D); UOC Criteria = 50 ug/L (Table 3)

[D] United States Environmental Protection Agency (USEPA), 2011, 40 CFR Part 141 – National Primary Drinking Water Regulations, 40 FR 59570

[E] USEPA Technical Fact Sheet - 1,4-Dioxane (November 2017) [Note that criteria is based on 10^-6 lifetime excess cancer risk in drinking water (EPA IRIS, 2013)]

* - NYSDEC criteria applies to each isomer (1,2-, 1,3-, and 1,4-dichlorobenzen) individually
** - NYSDEC & NYSDOH criteria applies to isomers (1,2-, 1,3-, and 1,4-xylene) individually, not total xylenes.
*** - Phenols - Standard applies to sum of phenolic compounds.
^ NYSDEC 703.5, TOGS 1.1.1, NYSDOH - Sum of Iron & Manganese - 500 µg/L also applies.
^^ Applies to Total Trihalomethanes (incl. chloroform, bromodichloromethane, dibromochloromethane, and bromoform)
# Secondary MCL.

Table 5-1 General Response Actions

Claremont Polychemical Site - Focused Feasibility Study Report

Town of Old Bethpage, Nassau County, New York

Response Action	Description	Media
No Further Action (NFA)	Included as a basis of comparison against which other GRAs may be compared. For this site, the NFA option assumes that no *additional* actions will be taken beyond what has already been implemented including continued operation OBL GWET system including recovery wells RW-3, RW-4 and RW-5.	Groundwater
Institutional Controls (ICs) with Long-Term Monitoring (LTM)	Reduces access and exposure to site contaminants through restrictions or limitations of site use. Can be used in conjunction with or as an enhancement to another GRA and may be paired with a LTM program.	Groundwater
Monitored Natural Attenuation (MNA) with LTM	Relies on natural destructive (biodegradation and chemical reactions) and non-destructive mechanisms (incl. dilution, dispersion, adsorption) to reduce contaminant concentrations. Can be implemented in conjunction with other active remedial technologies.	Groundwater
Containment	Employs physical limitations such as vertical barriers or caps to reduce infiltration of precipitation or may employ hydraulic controls such as interceptor trenches and extraction wells. This method is used to inhibit further migration of contaminated groundwater and does not reduce volume or toxicity of contaminants on its own.	Groundwater
In-Situ Treatment	Used to reduce contaminant concentrations in-place without removal or containment of groundwater. These methods may include thermal treatment or chemical oxidation in source areas or options such as enhanced biological treatment, air sparge/soil vapor extraction for areas with lower concentrations.	Groundwater
Ex-situ Treatment	Typically paired with collection of contaminated groundwater and aimed at reducing contaminant concentrations to meet selected discharge option(s). Can employ physical, chemical, or biological processes or transportation off-site.	Groundwater
Groundwater Disposal/Discharge	Typically paired with collection of contaminated groundwater and ex-situ treatment. Extracted groundwater can be handled at a TSDF, discharged to a POTW or treated and returned to the environment through nearby surface water, recharge basin, or other beneficial re-use.	Groundwater

Table 8-1 Evaluation of Groundwater Alternatives Summary

Claremont Polychemical Site - Focused Feasibility Study Report

Town of Old Bethpage, Nassau County, New York

Alt. No.	Alternative Name	Overall Protectiveness of Public Health and the Environment	Compliance with SCGs	Long Term Effectiveness and Permanence	Reduction of Toxicity, mobility or Volume of Contamination Thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness (excludes common remedial actions)	Land Use Criteria
1	No Further Action	- Does not attain groundwater RAOs	- Does not comply.	- Does not provide long term effectiveness or permanence. - Contaminants would continue to migrate towards receptors and RAOs would not be met in the long term.	- Does not reduce toxicity, mobility, or volume of contamination present.	- Does not result in disruption of properties overlying the CPC plume. - No additional short-term risk are posed to the community, workers or environment.	- No concerns.	1. Capital Costs: $ - 2. O&M Costs: $ - 3. Periodic Costs: $ - **Total Present Value: $ -**	- No environmental easements required. - Does not impact current, intended, or reasonably anticipated future use of the area.
2	GWET Using CPC Infrastructure	- Removes contaminant mass north of RW-1, RW-2, RW-3, RW-4, and RW-5. - Downgragient contaminant mass would continue to migrate, potentially impacting receptors. - LTM to monitor remediation during operation. - Wellhead treatment systems at receptors may be necessary for downgradient areas. - Would not achieve RAOs.	- Upgradient groundwater would eventually meet SCGs - Downgradient, contaminants would continue to migrate. - Treated water would meet NYS effluent limitations prior to discharge.	- Would not achieve RAOs - Would not allow unrestricted use of groundwater. - Will rely on IC and LTM. - Concentration of COCs in groundwater withdrawn by public water supply may increase.	- Would reduce toxicity, mobility, and volume of contamination in groundwater upgradient of the existing CPC infrastructure. - Downgradient groundwater would not see similar reduction.	- Extraction increases risk of exposure to workers, the community, and environment. - Impacts limited in duration as infrastructure already exists. - Impacts include: installation of new pumps in the RWs and addition of AOP and GAC to the treatment facility.	- Relies on well established technology that is commercially available. - PDI and pilot testing required to refine flow rates	1. Capital Costs: $ 7,121,000 2. O&M Costs: $ 33,841,000 3. Periodic Costs: $ 14,133,000 **Total Present Value: $ 55,095,000**	- No environmental easements required. - Does not impact current, intended, or reasonably anticipated future use of the area.
3	GWET Utilizing FTC Infrastructure	- Removes contaminant mass north of FTC ORW-2, ORW-4, ORW-6 and ORW-7. - Downgradient contaminant mass would continue to migrate, potentially impacting receptors. - LTM to monitor remediation during operation. - Wellhead treatment systems at receptors may be necessary for downgradient areas. - Would not achieve RAOs.	- Upgradient groundwater would eventually meet SCGs - Downgradient, contaminants would continue to migrate. - Treated water would meet NYS effluent limitations prior to discharge.	- Would not achieve RAOs - Would not allow unrestricted use of groundwater. - Will rely on IC and LTM. - Concentration of COCs in groundwater withdrawn by public water supply may increase.	- Would reduce toxicity, mobility, and volume of contamination in groundwater upgradient of the existing FTC infrastructure. - Downgradient groundwater would not see similar reduction.	- Extraction increases risk of exposure to workers, the community, and environment. - Impacts limited in duration as infrastructure already exists. - Impacts include: installation of new pumps in the RWs and addition of AOP and GAC to the treatment facility.	- Relies on well established technology that is commercially available. - PDI and pilot testing required to refine flow rates - Additional coordination with FTC GWET infrastructure owner required.	1. Capital Costs: $ 6,526,000 2. O&M Costs: $ 34,972,000 3. Periodic Costs: $ 11,346,000 **Total Present Value: $ 52,844,000**	- No environmental easements required. - Does not impact current, intended, or reasonably anticipated future use of the area. - Additional coordination with FTC GWET infrastructure owner required.
4	GWET Utilizing CPC & FTC Infrastructure, Plus Two Extraction Wells North of Melville Road	- Removes contaminant mass north of CPC RWs 3, 4, and 5; FTC ORWs 4, 6, and 7; and new wells A1 and A2. - Downgradient contaminant mass would continue to migrate, potentially impacting receptors. - LTM to monitor remediation during operation. - Wellhead treatment systems at receptors may be necessary for downgradient areas. - Would not achieve RAOs.	- Upgradient groundwater would eventually meet SCGs - Downgradient, contaminants would continue to migrate. - Treated water would meet NYS effluent limitations prior to discharge.	- Would not achieve RAOs - Would not allow unrestricted use of groundwater. - Will rely on IC and LTM. - Concentration of COCs in groundwater withdrawn by public water supply may increase.	- Would reduce toxicity, mobility, and volume of contamination in groundwater upgradient of the existing FTC and Well A1/A2 infrastructure. - Downgradient groundwater would not see similar reduction.	- Installation of new wells A1 and A2 - Installation of new pumps in selected CPC and FTC extraction wells - Addition of GAC and AOP to existing GWET. - Extraction increases risk of exposure to workers, the community, and environment. - Impacts limited in duration as infrastructure already exists.	- Relies on well established technology that is commercially available. - PDI and pilot testing required to refine flow rates - Additional coordination with FTC GWET infrastructure owner required.	1. Capital Costs: $ 17,024,000 2. O&M Costs: $ 58,872,000 3. Periodic Costs: $ 22,056,000 **Total Present Value: $ 97,952,000**	- No environmental easements required. - Does not impact current, intended, or reasonably anticipated future use of the area. - Additional coordination with FTC GWET infrastructure owner required.
5	GWET Utilizing CPC & FTC Infrastructure, Plus Two Extraction Wells South of Melville Road	- Removes contaminant mass north of CPC RWs 3, 4, and 5; FTC ORWs 4, 6, and 7; and new wells B1 and B2. - Downgradient contaminant mass would continue to migrate, potentially impacting receptors. - LTM to monitor remediation during operation. - Wellhead treatment systems at receptors may be necessary for downgradient areas. - Would not achieve RAOs.	- Upgradient groundwater would eventually meet SCGs - Downgradient, contaminants would continue to migrate. - Treated water would meet NYS effluent limitations prior to discharge.	- Would not achieve RAOs - Would not allow unrestricted use of groundwater. - Will rely on IC and LTM. - Concentration of COCs in groundwater withdrawn by public water supply may increase.	- Would reduce toxicity, mobility, and volume of contamination in groundwater upgradient of the existing FTC and Well B1/B2 infrastructure. - Downgradient groundwater would not see similar reduction.	- Installation of new wells B1 and B2 - Installation of new pumps in selected CPC and FTC extraction wells - Addition of GAC and AOP to existing GWET. - Extraction increases risk of exposure to workers, the community, and environment. - Impacts limited in duration as infrastructure already exists.	- Relies on well established technology that is commercially available. - PDI and pilot testing required to refine flow rates - Additional coordination with FTC GWET infrastructure owner required.	1. Capital Costs: $ 17,495,000 2. O&M Costs: $ 60,890,000 3. Periodic Costs: $ 22,056,000 **Total Present Value: $ 100,441,000**	- No environmental easements required. - Does not impact current, intended, or reasonably anticipated future use of the area. - Additional coordination with FTC GWET infrastructure owner required.

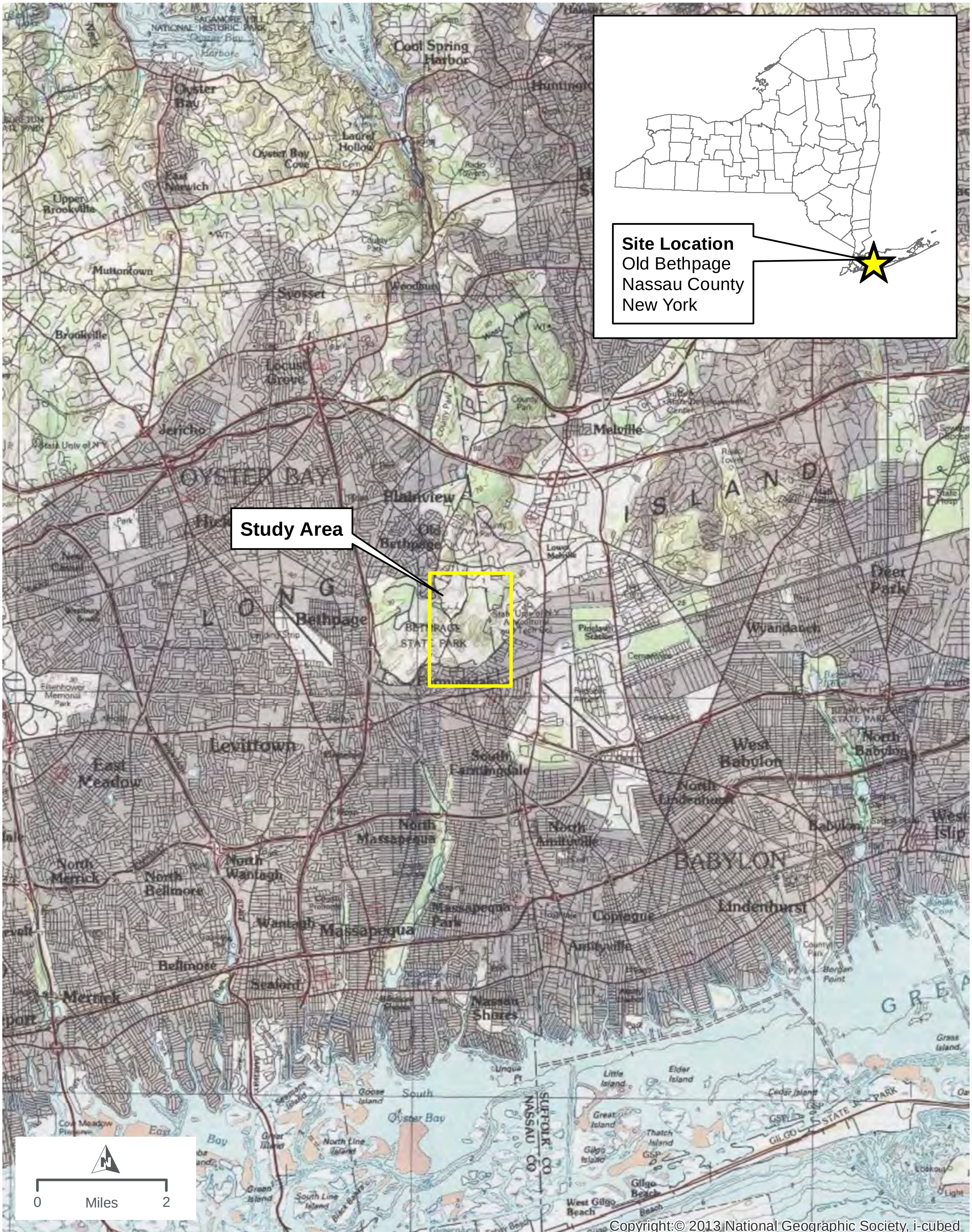
Table 8-2 Summary of Cost Estimates
Claremont Polychemical Site - Focused Feasibility Study Report
Town of Old Bethpage, Nassau County, New York

Site:	Claremont Polychemical	**Base Year:**	2021
Location:	Nassau County, New York	**Date:**	October 13, 2021
Phase:	Feasibility (-30% - +50%)		

Description	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Public Well Head Treatment Contingency (Note 1)	
	No Further Action (With Existing & Planned Remedial Systems)	Claremont Polychemical Corporation (CPC) GWET	Firemen's Training Center GWET	CPC and FTC GWET systems + 2 New Wells North of Melville Road	CPC and FTC GWET systems + 2 New Wells South of Melville Rd.	Well No. 1-3, Plant 1	Wells No. 2-2 and 2-3, Plant 2
Capital Cost	$ -	$ 7,121,000	$ 6,526,000	$ 17,024,000	$ 17,495,000	$ 4,760,000	$ 7,910,000
Total O&M Cost (NPV)	$ -	$ 33,841,000	$ 34,972,000	$ 58,872,000	$ 60,890,000	$ 535,000	$ 1,120,000
Total Periodic Cost (NPV)	$ -	$ 14,133,000	$ 11,346,000	$ 22,056,000	$ 22,056,000		
Total Present Value of Options	**$ -**	**$ 55,095,000**	**$ 52,844,000**	**$ 97,952,000**	**$ 100,441,000**	**$ 16,742,128**	**$ 32,994,080**

Note 1: Costs based on Water Supply Evaluation, Village of Farmingdale, P.W. Grosser Consulting, Inc., December 2020.

Figures



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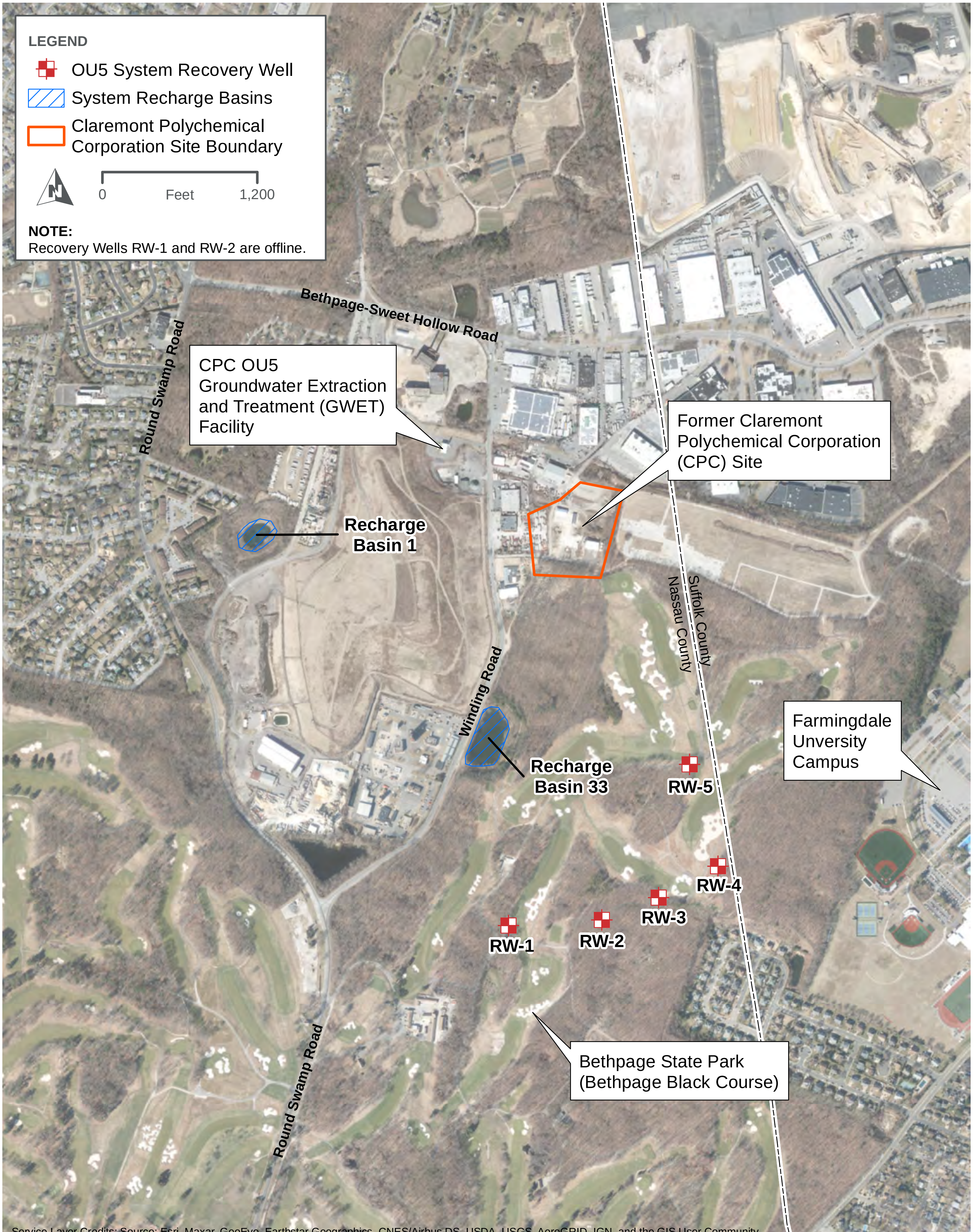
SITE LOCATION (OLD BETHPAGE, NY)

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 1-1

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\0000000000275962\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 1-1 SITE LOCATION.MXD - USER: CMILLS - DATE: 10/4/2021



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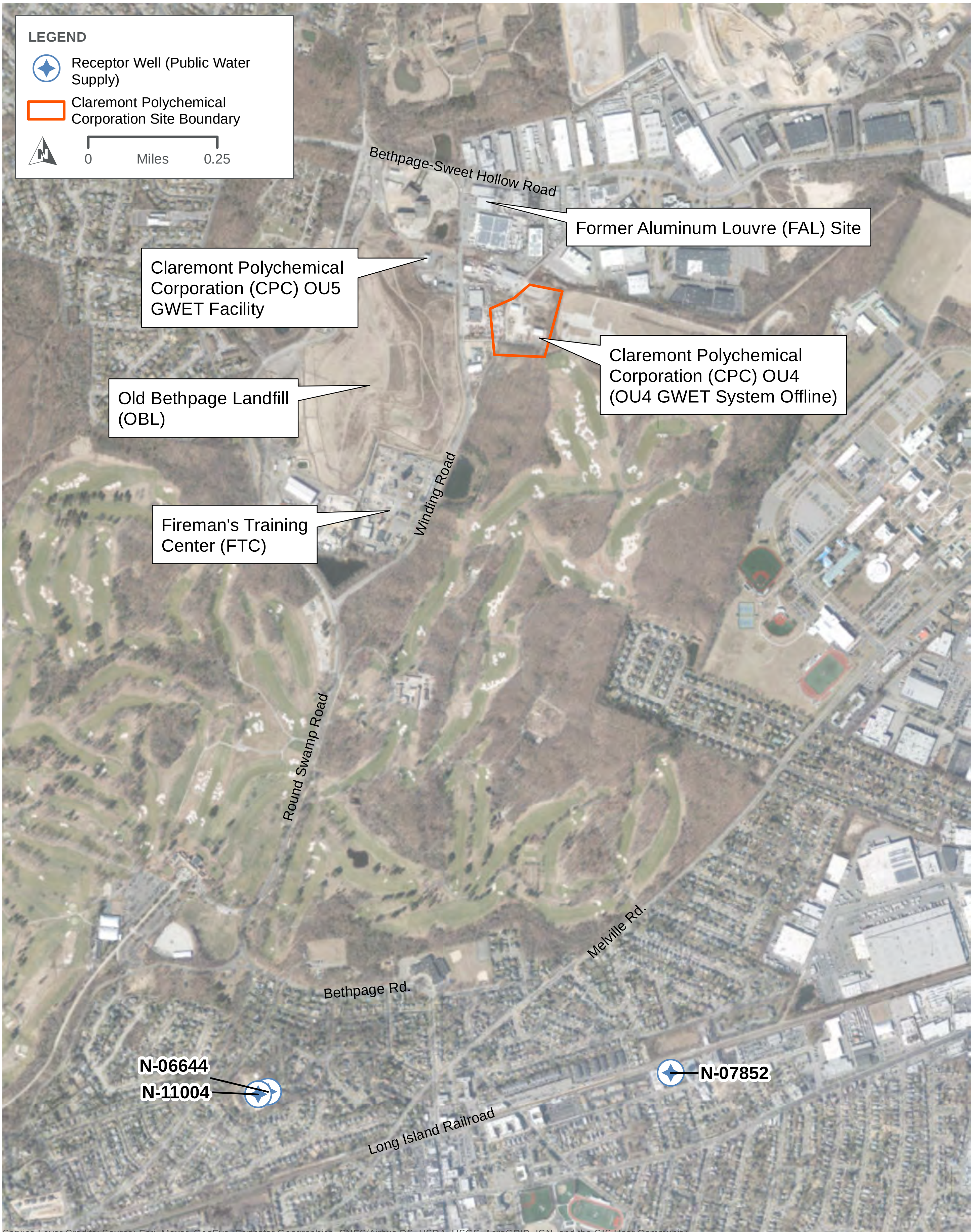
SITE AREA AND OU5 GWET SYSTEM

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 2-1

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\0000000002759621\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 2-1 SITE AREA AND OU5 GWET.MXD - USER: CMILLS - DATE: 10/12/2021



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POTENTIAL SOURCES AND RECEPTORS

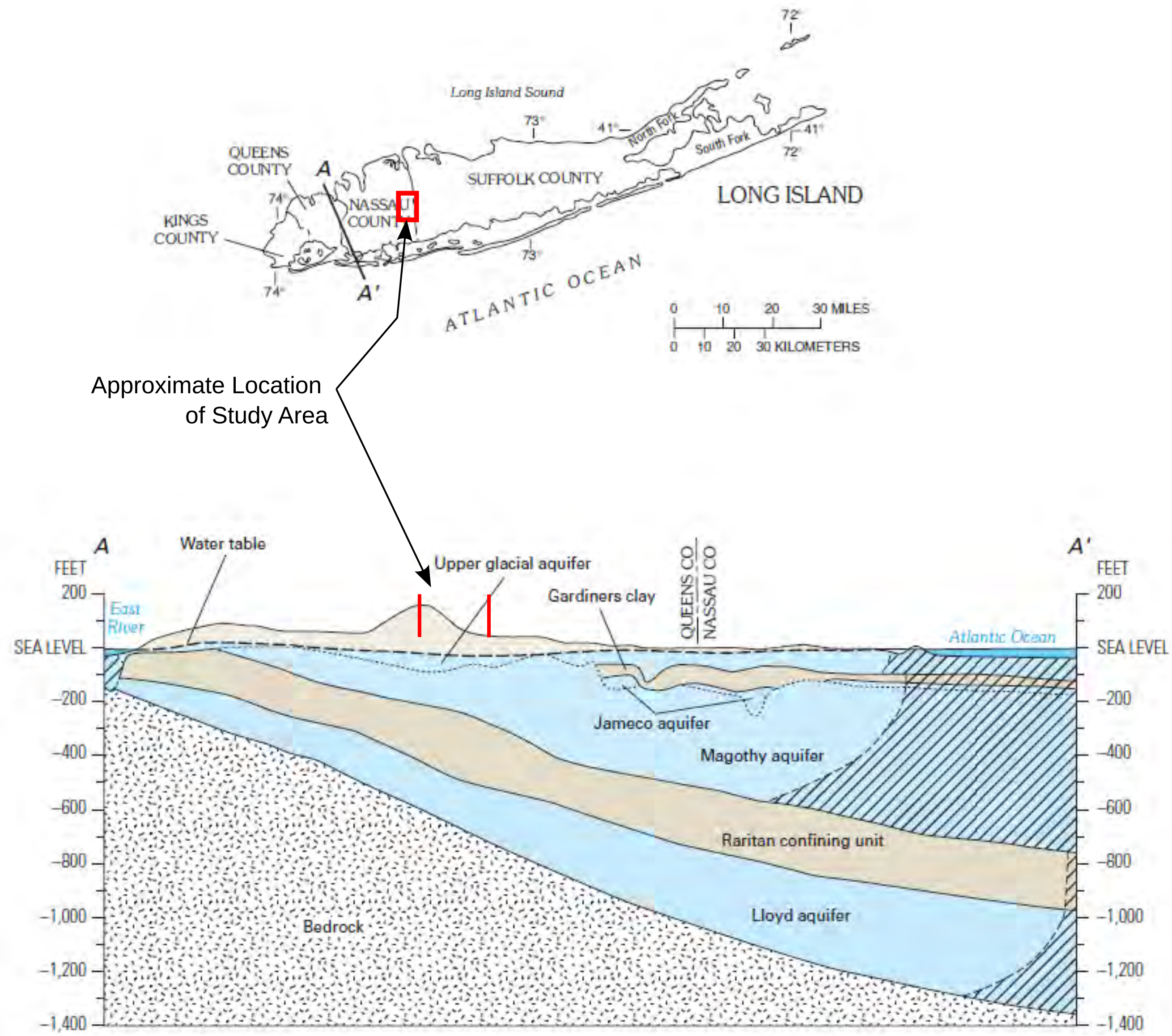
CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 2-2

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\000000000275962\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 2-2 POTENTIAL SOURCES AND RECEPTORS.MXD - USER: CMILLS - DATE: 10/13/2021

System	Series	Geologic Units		Hydrogeologic Unit	Range of Thickness (feet)	Range of Altitude of Upper Surface, in feet above or below sea level
Quaternary	Holocene	Shore, beach Salt-Marsh deposits, and alluvium				
Quaternary	Pleistocene	Wisconsin Glaciation (Harbor Hill, Interstadial Marine, and Ronkonkoma Drift)	Till (ground terminal moraine) Outwash 20-foot Clay (marine)	Upper Glacial aquifer	0 to 450	Land Surface
Quaternary	Pleistocene	Sangamon Interglaciation	Gardiners Clay (marine)	Gardiners Clay	0 to 320	-40 to -250
Quaternary	Pleistocene	Pre-Wisconsin Glaciation (Illinoian)	Jameco Gravel	Jameco aquifer	0 to 185	-90 to -450
Tertiary	Pliocene	Mannetto Gravel		Unsaturated	0-220	0 to -120
Cretaceous	Upper Cretaceous	Matawan Group - Magothy Formation (undifferentiated)		Magothy aquifer	0 to 800	200 to -350
Cretaceous	Upper Cretaceous	Raritan Formation	Clay member	Raritan Clay confining unit	0 to 300	-100 to -1,000
Cretaceous	Upper Cretaceous	Raritan Formation	Lloyd sand member	Lloyd aquifer	0 to 300	-200 to -1,200
Precambrian		Crystaline Bedrock		Bedrock	–	-400 to -1,500

Source:
Isbister, J., 1966, Geology and Hydrology of Northeastern Nassau County, Long Island, New York: U.S. Geological Survey Water-Supply Paper 1825, 89 p.



LEGEND

Area of salty ground water

Confining unit

Sea level refers to the National Geodetic Vertical Datum of 1929

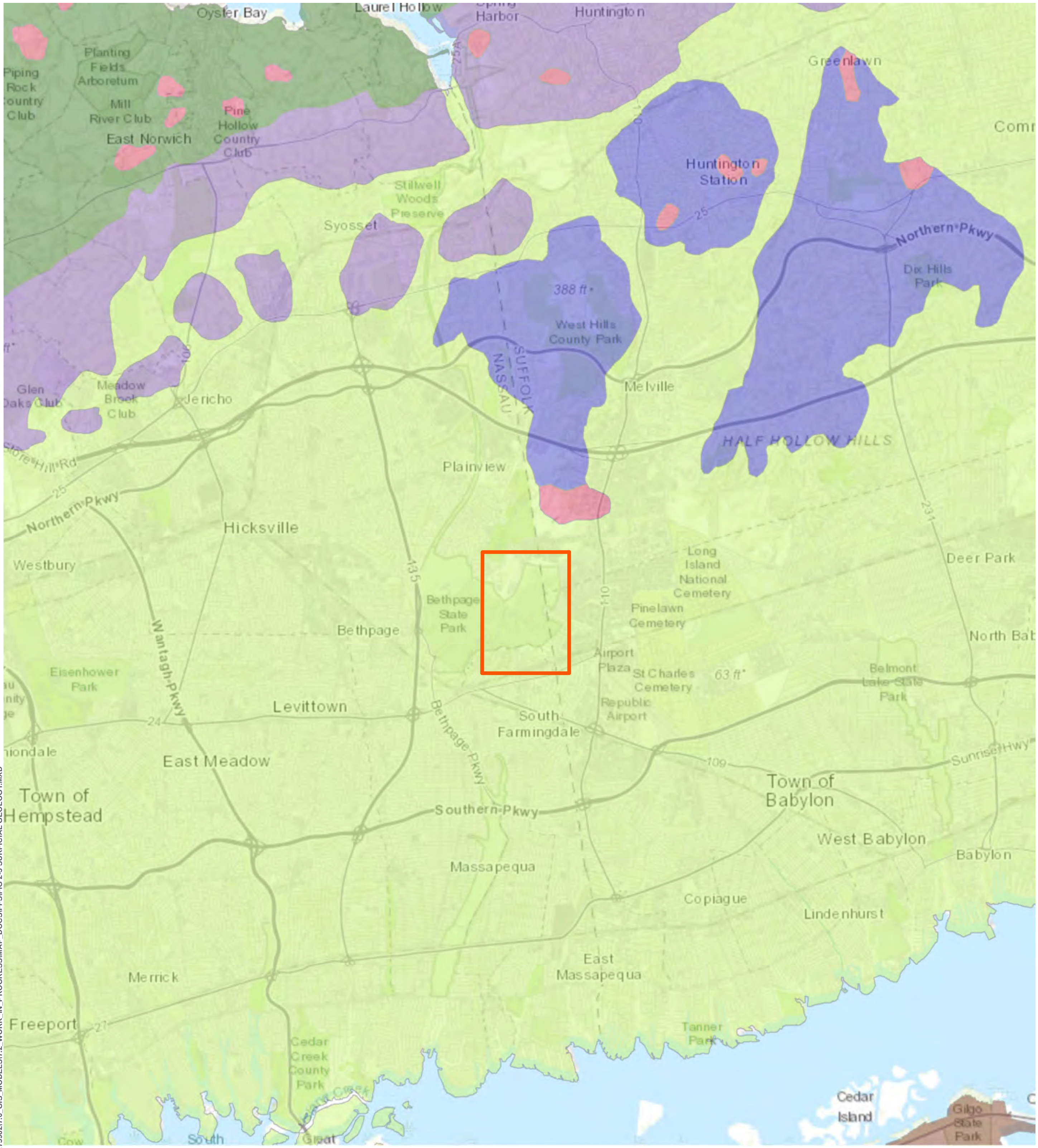
Notes:

Vertical Exaggeration: 30X

Figure modified from:

(1) Barlow, P. M., 2003, Ground Water in Freshwater-Saltwater Environments of the Atlantic Coast, U.S. Geological Survey Circular 1262, 121 p.

(2) Buxton, Herbert T.; Smolensky, Douglas A., 1999, Simulation of the effects of development of the ground-water flow system of Long Island, New York: U.S. Geological Survey Water-Resources Investigations Report 98-4069, 57 p.



LEGEND

Approximate Location of Study Area	
Kame Moraine	Morainic
Beach	Outwash Sand and Gravel
Kame and Ice Contact	Till

0 Miles 2

Geologic Data Source: United States Geological Survey, NYS GIS Clearinghouse
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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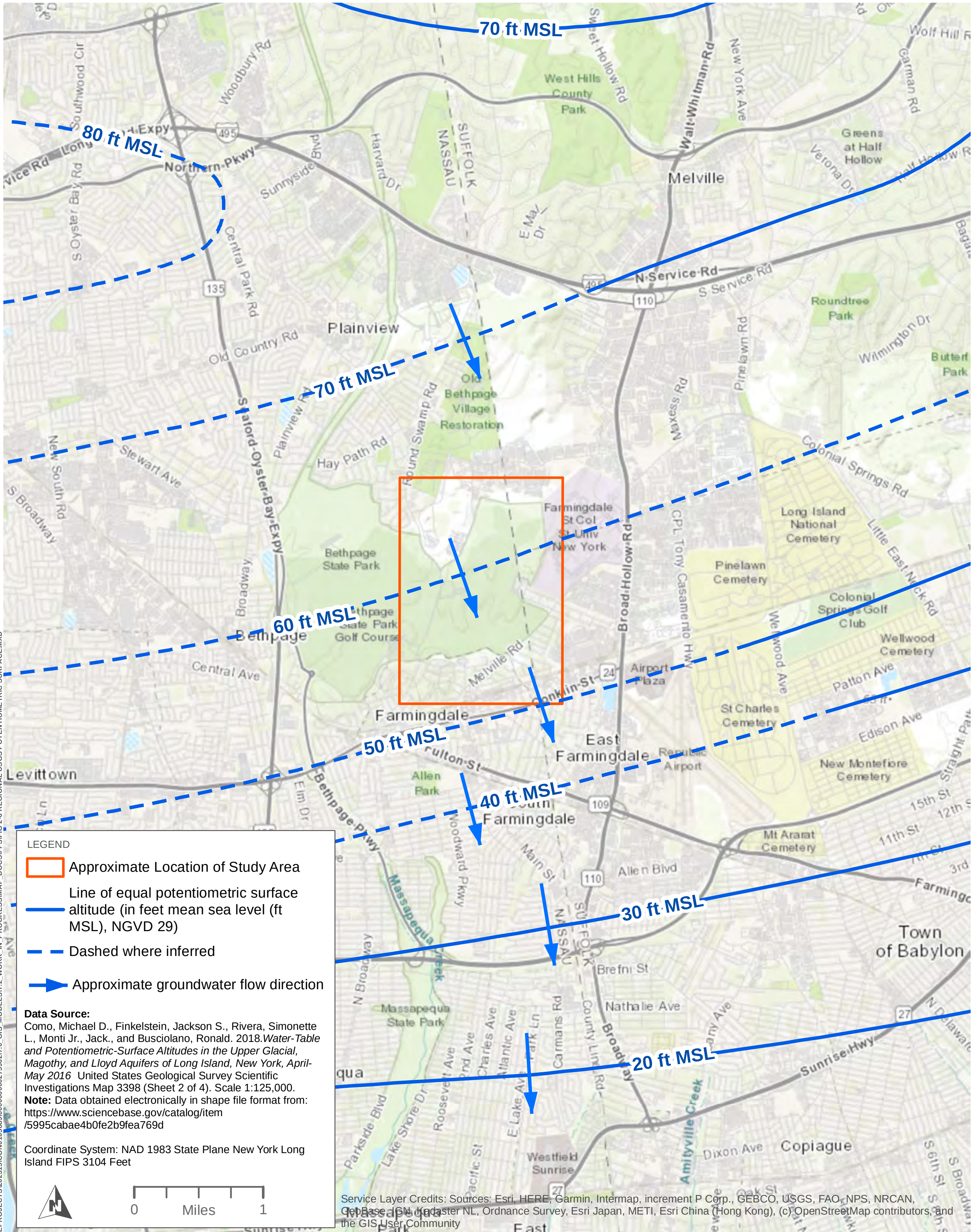
SURFICIAL GEOLOGY

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 2-5

PATH: \\MAHPI-FILE01\ACTIVE\PROJECTS\202315\CON0105889\0000000\2759621\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 2-5 SURFICIAL GEOLOGY.MXD



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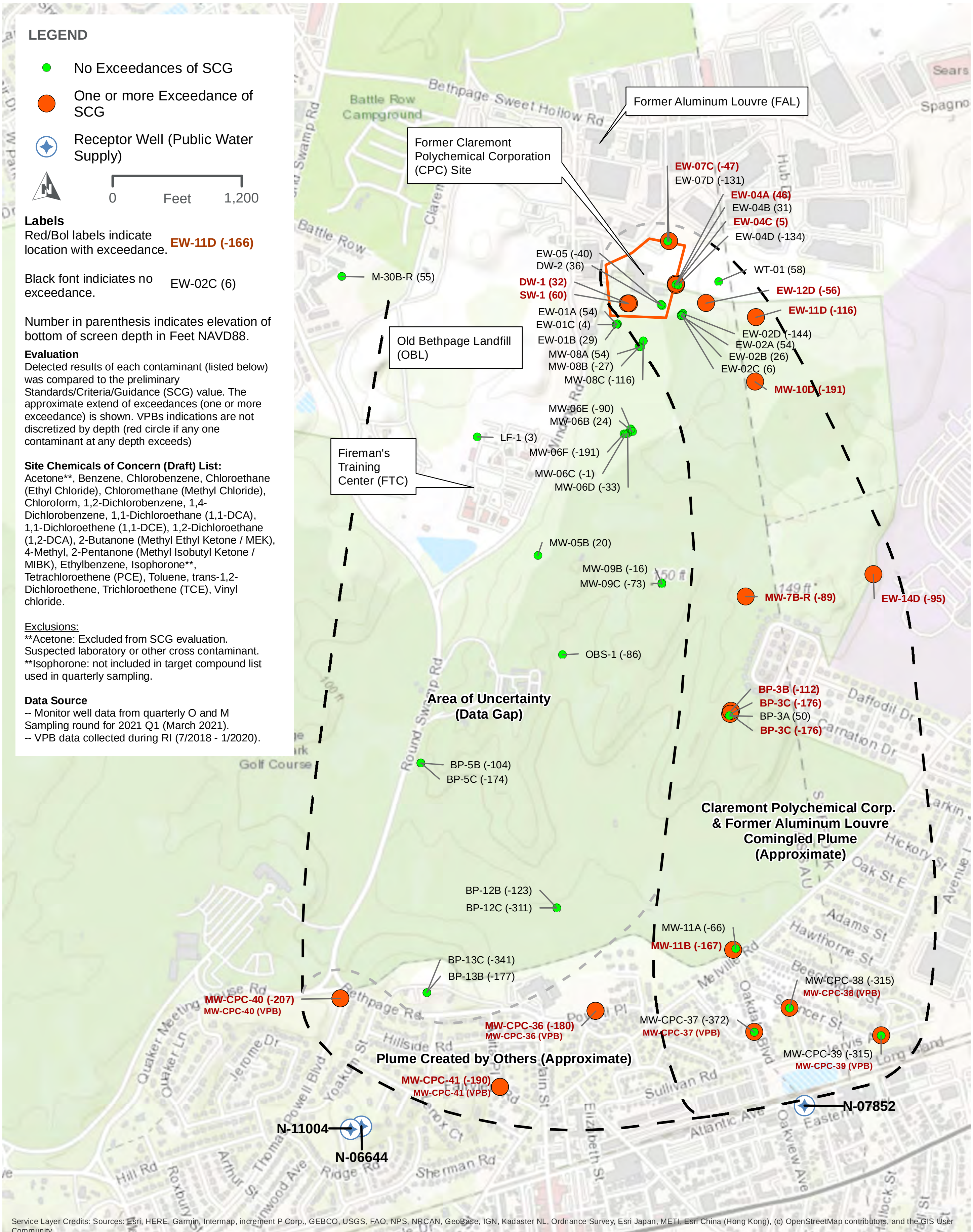
POTENTIOMETRIC SURFACE OF THE MAGOTHY AQUIFER

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 2-6

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\COND10588900000002759627.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 2-6 REGIONAL USGS POTENTIOMETRIC SURFACE.MXD



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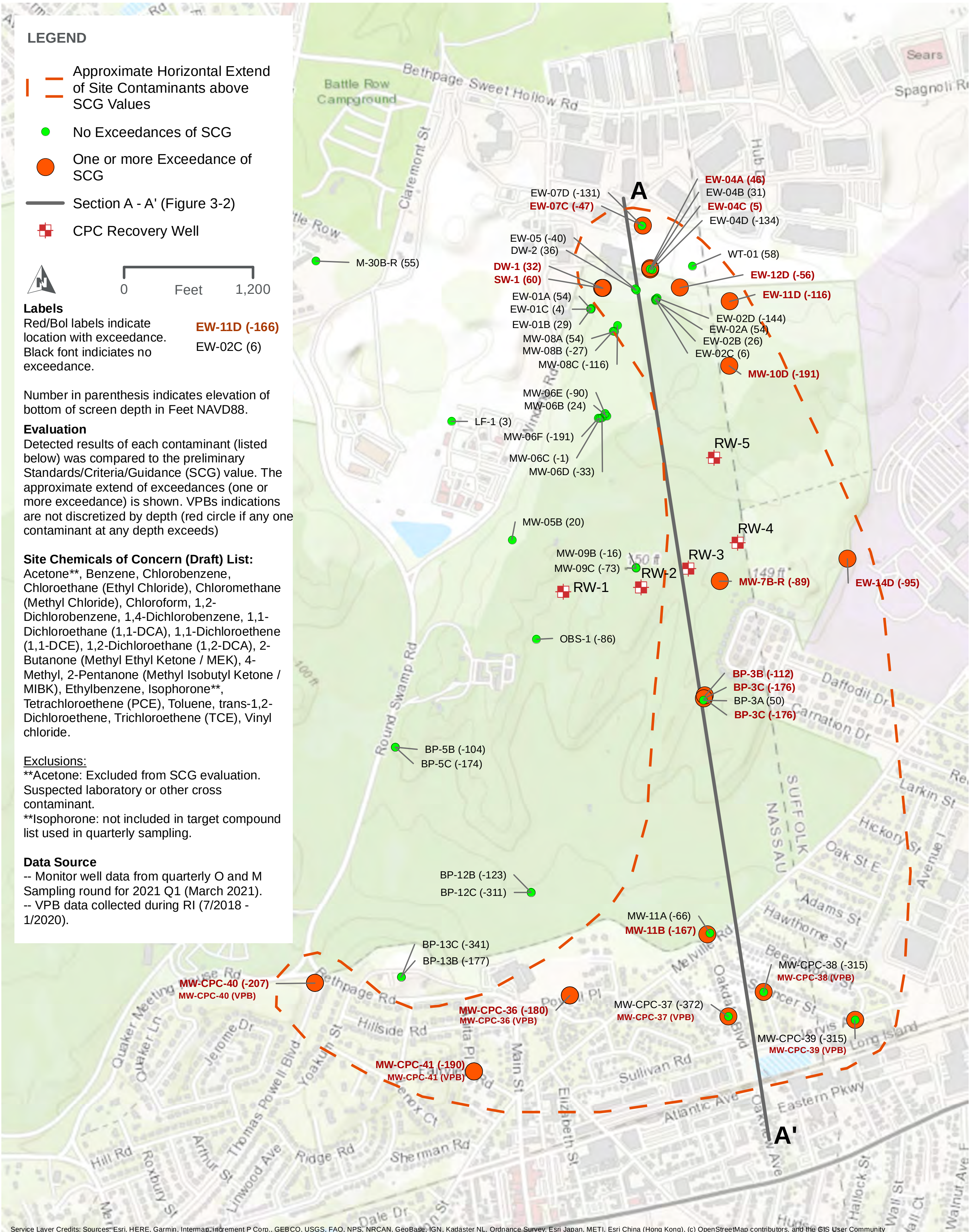
HORIZONTAL EXTENT OF CONTAMINATION AND POTENTIAL SOURCES

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 3-1

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\0000000002759621\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 3-1 HORIZONTAL EXTENT AND POTENTIAL SOURCES.MXD - USER: CMILLS - DATE: 10/13/2021



LEGEND

- Approximate Horizontal Extend of Site Contaminants above SCG Values
- No Exceedances of SCG
- One or more Exceedance of SCG
- Section A - A' (Figure 3-2)
- CPC Recovery Well

0 Feet 1,200

Labels

Red/Bol labels indicate location with exceedance. Black font indicates no exceedance.

EW-11D (-166)

EW-02C (6)

Number in parenthesis indicates elevation of bottom of screen depth in Feet NAVD88.

Evaluation

Detected results of each contaminant (listed below) was compared to the preliminary Standards/Criteria/Guidance (SCG) value. The approximate extend of exceedances (one or more exceedance) is shown. VPBs indications are not discretized by depth (red circle if any one contaminant at any depth exceeds)

Site Chemicals of Concern (Draft) List:

Acetone**, Benzene, Chlorobenzene, Chloroethane (Ethyl Chloride), Chloromethane (Methyl Chloride), Chloroform, 1,2-Dichlorobenzene, 1,4-Dichlorobenzene, 1,1-Dichloroethane (1,1-DCA), 1,1-Dichloroethene (1,1-DCE), 1,2-Dichloroethane (1,2-DCA), 2-Butanone (Methyl Ethyl Ketone / MEK), 4-Methyl, 2-Pentanone (Methyl Isobutyl Ketone / MIBK), Ethylbenzene, Isophorone**, Tetrachloroethene (PCE), Toluene, trans-1,2-Dichloroethene, Trichloroethene (TCE), Vinyl chloride.

Exclusions:

**Acetone: Excluded from SCG evaluation. Suspected laboratory or other cross contaminant.

**Isophorone: not included in target compound list used in quarterly sampling.

Data Source

-- Monitor well data from quarterly O and M Sampling round for 2021 Q1 (March 2021).

-- VPB data collected during RI (7/2018 - 1/2020).

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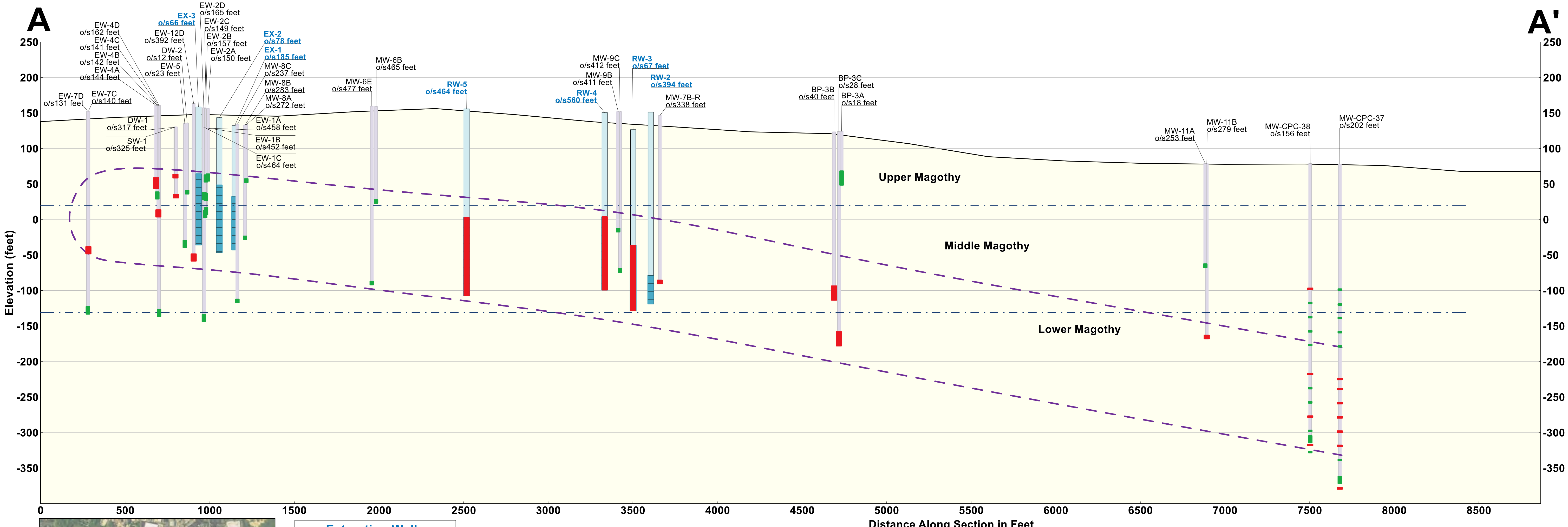
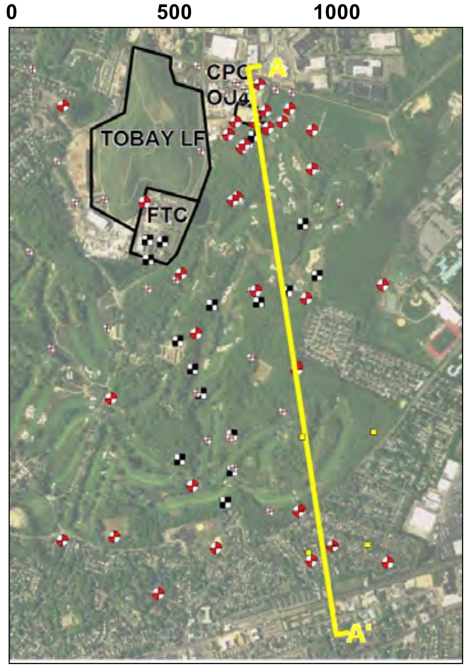
APPROXIMATE HORIZONTAL EXTENT OF SCG EXCEEDANCES

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 3-2

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\000000000275962\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 3-2 HORIZONTAL EXTENT OF SCG EXCEEDANCES.MXD - USER: CMILLS - DATE: 10/13/2021





Extraction Wells Within 700 feet of section
Casing
Screen

Monitor Wells Within 500 feet of section
Casing
Screen

- Indicates no COCs detected above respective SCG.
- One or more COCs detected above respective SCG.
- Approximate Vertical Extent of Selected Site Contaminants above SCGs

NOTES
Each COC (a subset list of volatile organic compounds [VOCs] from the SCG table included in the FFS) was compared against its respective SCG value. If one or more compound exceeded its SCG, it is indicated in red. Detections without exceedances and non-detect results are shown as green.

*Length of red/green symbol representative of screen length of well screen or VPB sample and is NOT an indication of magnitude.

DATA SOURCES:
MW Data collected during Q1 2021 O&M Sampling (March 2021)
RW Data collected during Q1 2021 Monitoring (February 2021)
VPB Data - Collected August 2018 (applies to MW-CPC-37 and -38 only)

Aquifer boundaries based on elevations presented on the quarterly groundwater elevation figures.

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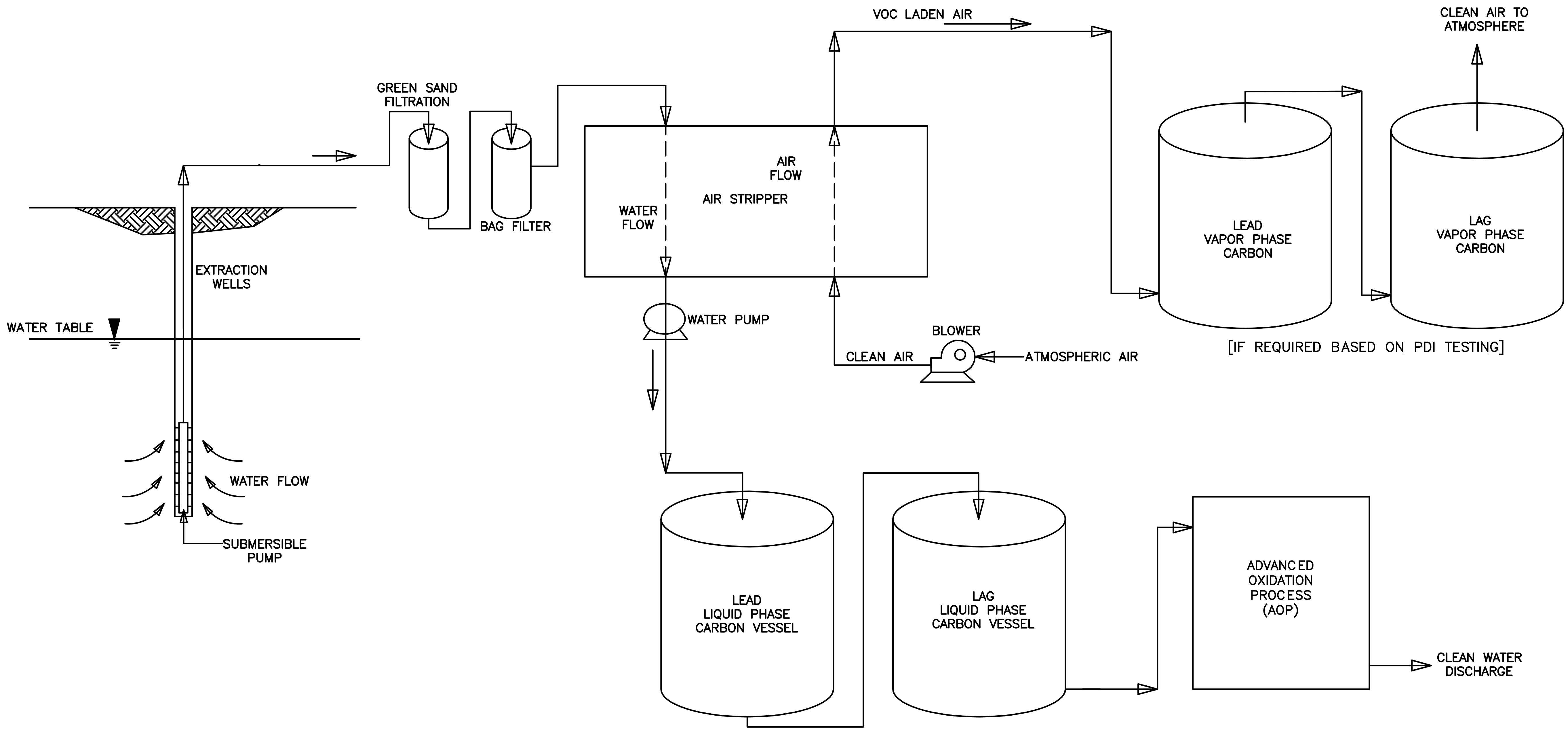
APPROXIMATE VERTICAL EXTENT OF CONTAMINATION CROSS SECTION A-A'

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC Site #130015)

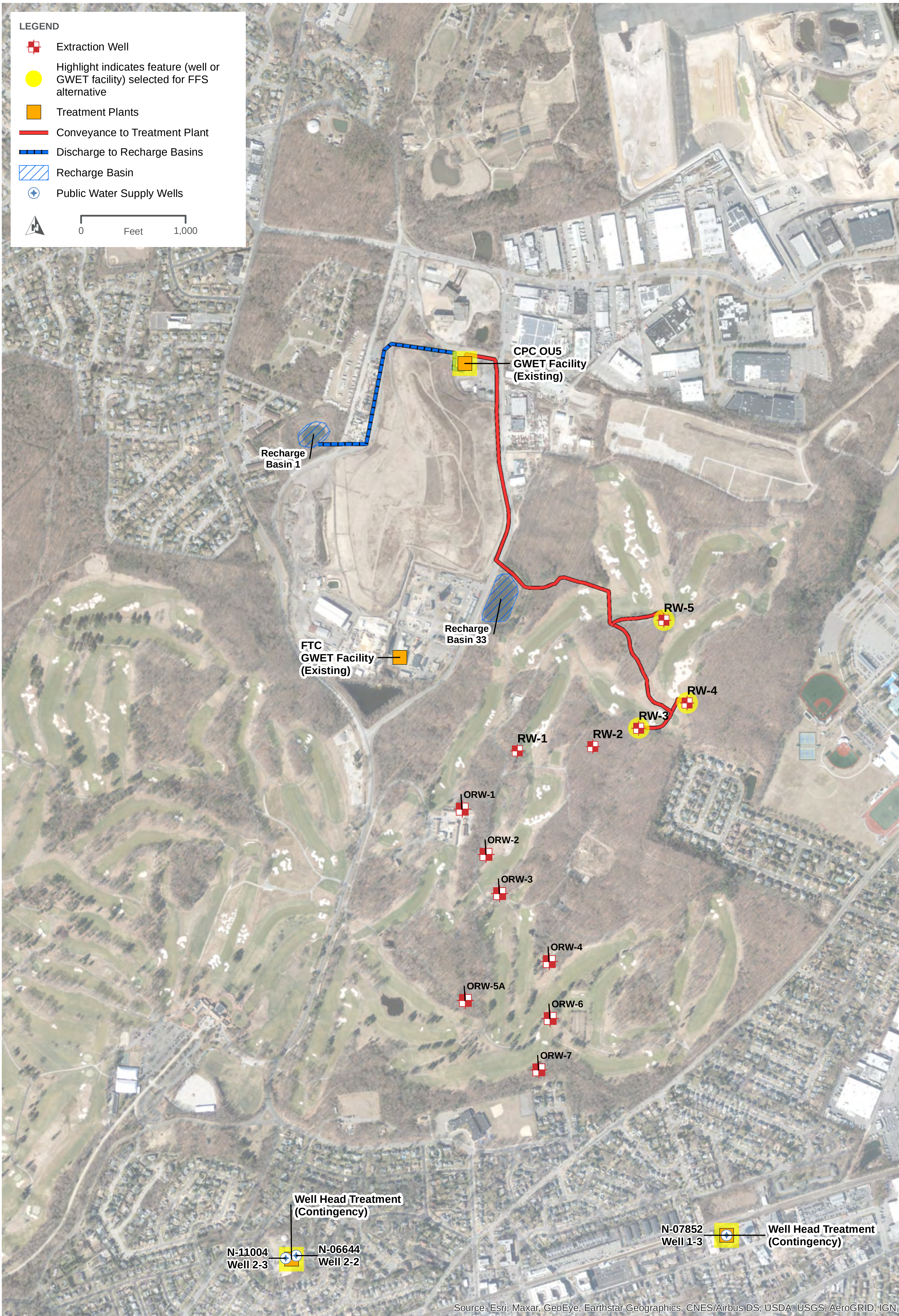
FIGURE 3-3



TYPICAL TREATMENT SYSTEM PROCESS SCHEMATIC

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC Site #130015)

FIGURE 7-1



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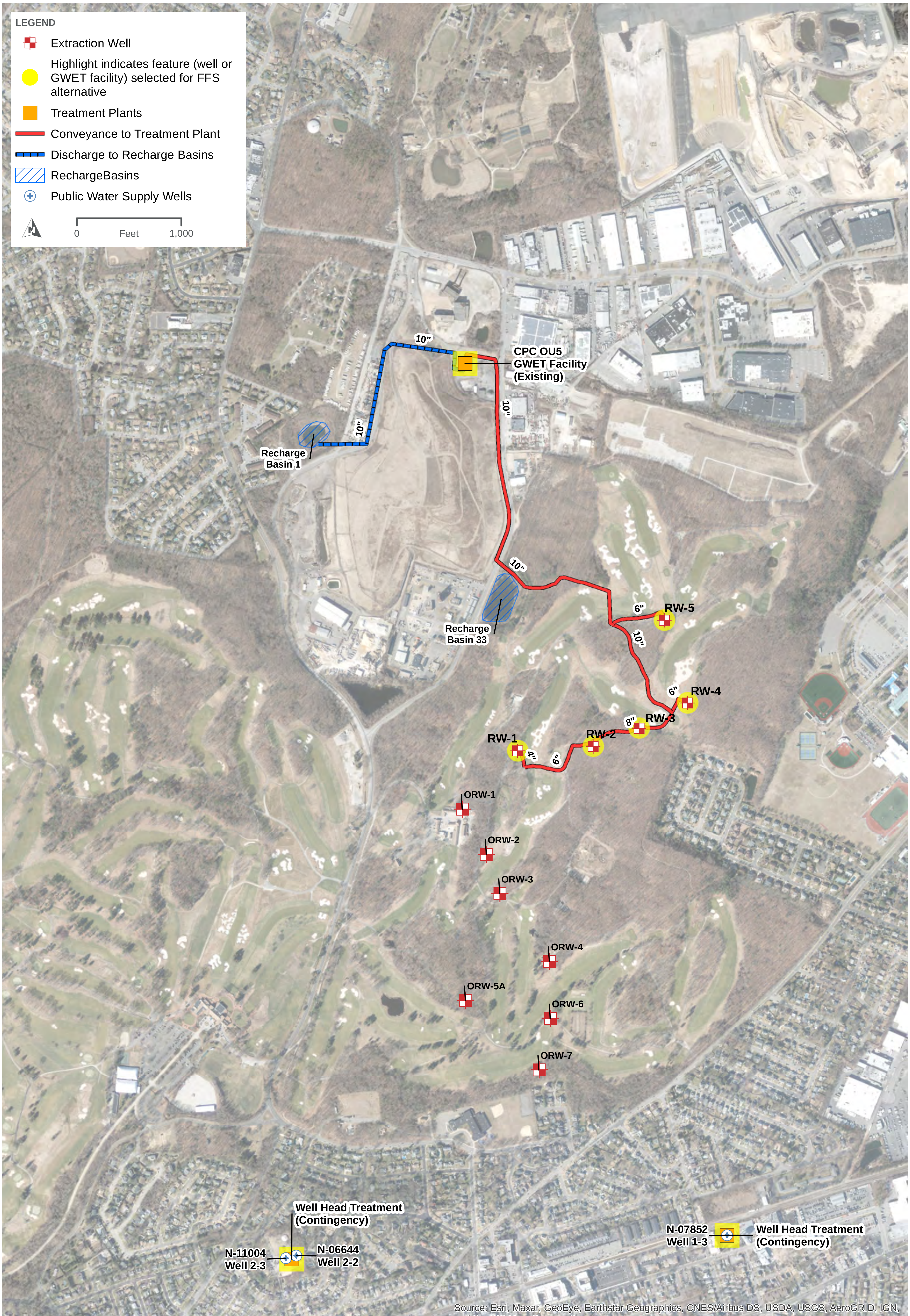
ALTERNATIVE 1 - NO FURTHER ACTION

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 7-2

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\000000000275962\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 7-2 ALTERNATIVE 1.MXD - USER: CMILLS - DATE: 10/8/2021

OU5 - FFS



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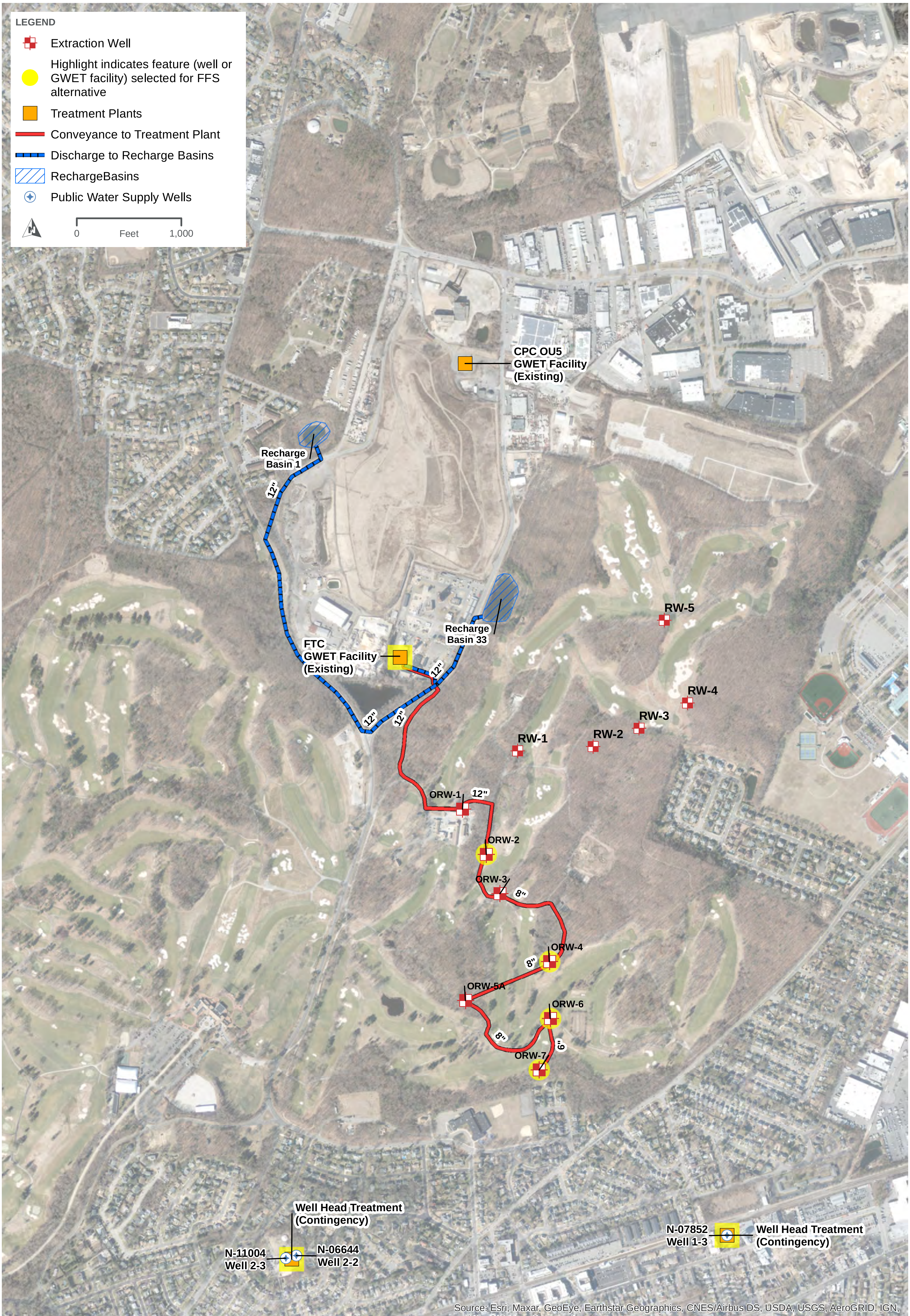
FFS ALTERNATIVE 2

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 7-3

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\000000000275962\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 7-3 ALTERNATIVE 2.MXD - USER: CMILLS - DATE: 10/8/2021



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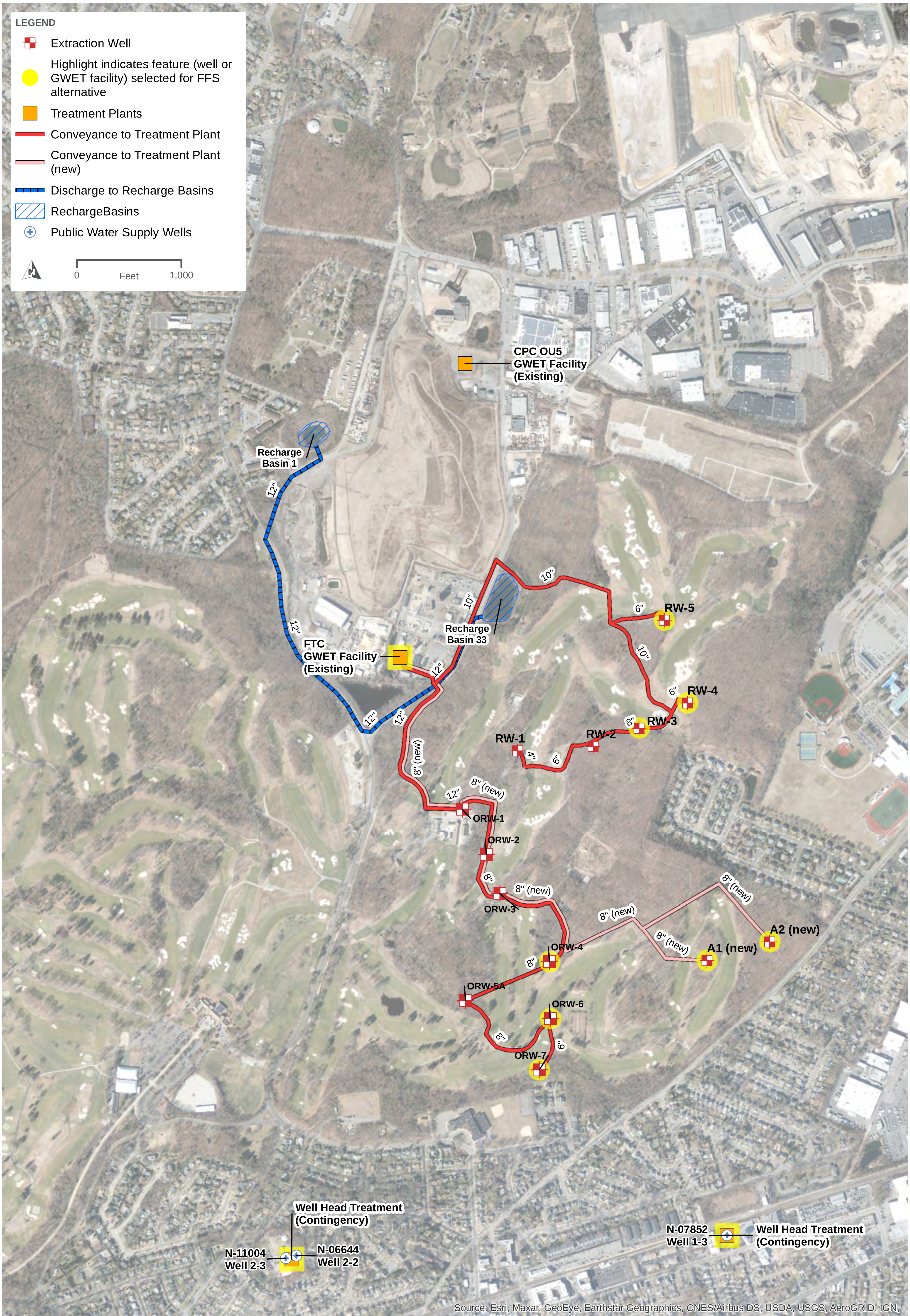
FFS ALTERNATIVE 3

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 7-4

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\000000000275962\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 7-4 ALTERNATIVE 3.MXD - USER: CMILLS - DATE: 10/8/2021



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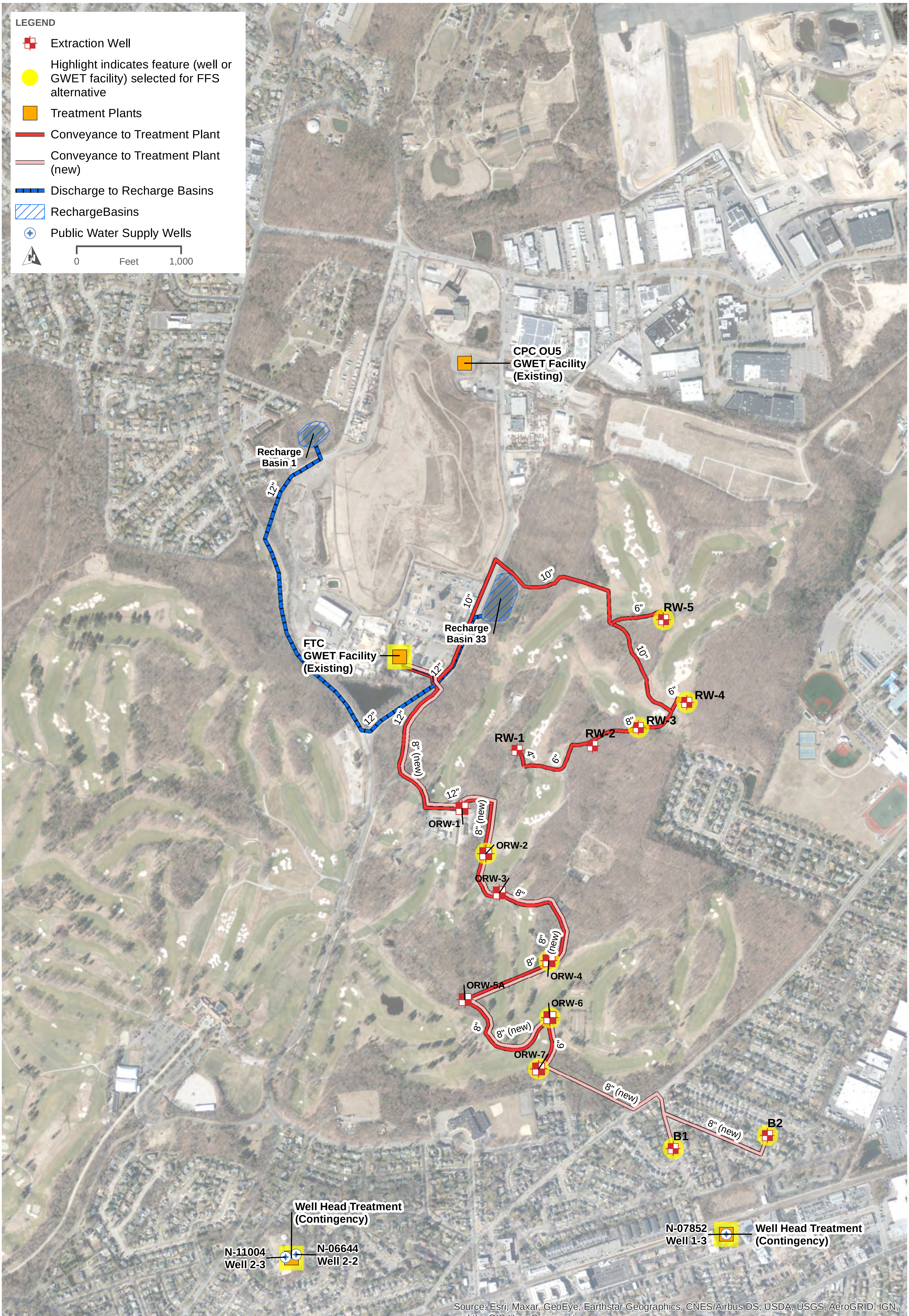
FFS ALTERNATIVE 4

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 7-5

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\202315\CON0105889\0000000002759627.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\FFS\FIG 7-5 ALTERNATIVE 4.MXD - USER: CMILLS - DATE: 10/8/2021



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FFS ALTERNATIVE 5

CLAREMONT POLYCHEMICAL CORPORATION (NYSDEC SITE #130015)

FIGURE 7-6

Appendix B

Alternative 1 Cost Breakdown

No Further Action (With Existing & Planned Remedial Systems)

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: No Further Action (With Existing & Planned Remedial Systems)

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
1	**TOTAL CAPITAL COST**				**$ -**	

O&M COST:

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
2	**Long-Term Monitoring and Reporting**					
2.1	Site-Wide Long-Term Monitoring	0	LS		$ -	
	Sub-Total				**$ -**	
	Project Management	5%			$ -	
	Contingency	10%			$ -	5% scope + 5% bid.
	Sub-Total				**$ -**	

PERIODIC COSTS:

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
3	**ICs**						
3.1	Institutional Controls	5	0	LS		$ -	
	Sub-Total					**$ -**	
	Project Management		5%			$ -	
	Contingency		10%			$ -	5% scope + 5% bid.
	Sub-Total					**$ -**	

PRESENT VALUE ANALYSIS: Rate of Return: 5% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
1	**Capital Cost**	0	$ -	**$ -**	
2	**O & M**				
2.1	Long-Term Monitoring and Reporting		$ -	$ -	Annual cost for the life of the system
	Sub-Total			**$ -**	**NPV Assuming 5% Return and 3% Inflation**
3	**Periodic Costs**				
3.1	ICs	5	$ -	$ -	Every 5 years
	Sub-Total			**$ -**	**NPV Assuming 5% Return and 3% Inflation**
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ -**	

***** The annual and periodic costs over the life of the system changes on an annual basis as noted. For simplicity, the total O&M and periodic costs over the 30 years are presented.

Alternative 2 Cost Breakdown

Claremont Polychemical Corporation (CPC) GWET

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing existing wells RW-1, RW-2, RW-3, RW-4, and RW-5, the existing groundwater conveyance piping, and the existing discharge system. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
1. CAPITAL COSTS:						
1.0	**Pre-Design Investigation**					
1.0.1	Pre-Design Investigation	1	LS	$ 250,000	$ 250,000	Includes installation of 4 new wells
	Sub-Total				**$ 250,000**	
1.1	**Existing extraction well improvements**					
1.1.1	Site preparation	1	LS	$ 40,000	$40,000	
1.1.2	Well re-development	5	EA	$ 7,500	$37,500	
1.1.3	VFD Pumps	5	EA	$ 50,000	$250,000	
1.1.4	Flow Control System	1	LS	$ 450,000	$450,000	
	Sub-Total				**$ 777,500**	
1.2	**Ex-Situ Treatment**					
1.2.1	Building addition	1	LS	$ 388,000	$388,000	
1.2.2	AOP system	1	LS	$ 1,200,000	$1,200,000	
1.2.3	Liquid GAC System	3	EA	$ 350,000	$1,050,000	
1.2.4	Vapor GAC System	1	EA	$ 96,315	$96,315	
1.2.5	System Installation	1	LS	$ 615,000	$615,000	
	Sub-Total				**$ 3,349,315**	
1.3	**Discharge - Existing Recharge Basin**					
1.3.1	Basin upgrades	1	LS	$ 250,000	$250,000	
	Sub-Total				**$ 250,000**	
1.4	**Conveyance System**					
1.4.1	Inspect and Flush system	1	LS	$ 120,000	$ 120,000	
	Sub-Total				**$ 120,000**	
Sub-Total					**$ 4,746,815**	Sub-Total All Construction Costs.
Sub-Total						
	Contingency	25%			$ 1,187,000	10% scope + 15% bid.
Sub-Total					**$ 5,933,815**	
Project Management		5%			$ 297,000	
Remedial Design		6%			$ 356,000	
Construction Management		6%			$ 356,000	
Construction Oversight		3%			$ 178,000	
TOTAL CAPITAL COST					**$ 7,120,815**	

Alternative 2 Cost Breakdown

Claremont Polychemical Corporation (CPC) GWET

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing existing wells RW-1, RW-2, RW-3, RW-4, and RW-5, the existing groundwater conveyance piping, and the existing discharge system. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
2. OPERATIONAL AND MAINTENANCE COSTs:						
Item No.	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
2.1	**Annual O & M**					
2.1.1	Annual Operational Labor	1	LS	$ 136,700	$136,700	
2.1.2	Annual Power (Extraction & Treatment)	1	LS	$ 337,900	$337,900	
2.1.3	Annual Material/Chemicals Usage	1	LS	$ 469,400	$469,400	
2.1.4	Annual System Maintenance	1	LS	$ 51,400	$51,400	
2.1.5	Treatment Plant Monitoring	1	LS	$ 116,600	$116,600	
2.1.6						
	Sub-Total				**$ 1,112,000**	
2.2	**Site-Wide Long-Term Monitoring**					
2.2.1	Site-Wide Long-Term Monitoring				$157,000	
	Sub-Total				**$ 157,000**	
2.3	**Recharge Basin Maintenance**					
2.3.1	Annual Maintenance Costs	1	LS	$ 28,900	$28,900	
	Sub-Total				**$ 28,900**	
	Sub-Total				**$ 1,297,900**	Sub-Total All Annual O & M Costs.
	Sub-Total					
	Contingency	10%			$ 130,000	5% scope + 5% bid.
	Sub-Total				**$ 1,427,900**	
	Project Management	5%			$ 71,000	
	TOTAL ANNUAL O & M COST				**$ 1,498,900**	

Item No.	Description	Frequency	Quantity	Unit	Unit Cost	Total	Notes
3. PERIODIC COSTS:		**Frequency**					
3.1	**Once in Every 2 Years**						
3.1.1	Extraction Well Pump Rehabilitation	2	15	EA	$ 50,000	$750,000	
	Contingency		15%			$ 113,000	10% scope + 5% bid.
	Sub-Total					**$ 863,000**	
	Project Management		5%			$ 43,000	
	Technical Support		3%			$ 26,000	
	TOTAL PERIODIC COSTS @ EVERY 2 YEARS					**$ 932,000**	
3.2	**Once in Every 5 Years**						
3.2.1	Extraction Well Maintenance	5	6	EA	$ 50,000	$300,000	
3.2.2	Bag Filter Pump Replacement	5	6	EA	$ 24,400	$146,400	
3.2.3	Air Stripper Cleaning	5	6	EA	$ 10,000	$60,000	
3.2.4	Replace Interconnection Piping and Valves	5	6	EA	$ 8,000	$48,000	
		5	6	LS	$ 25,000	$150,000	
	Sub-Total					**$ 704,400**	
	Contingency		10%			$ 70,000	5% scope + 5% bid.
	Sub-Total					**$ 774,400**	
	Project Management		5%			$ 39,000	
	TOTAL PERIODIC COSTS @ YEAR 5, 10, 15, 20, 25 and 30					**$ 813,400**	
3.3	**Once in Every 10 Years**						
3.3.1	Bag Filter Pump Replacement	10	3	EA	$ 25,000	$75,000	
	Sub-Total					**$ 75,000**	
	Contingency		10%			$ 8,000	5% scope + 5% bid.
	Sub-Total					**$ 83,000**	
	Project Management		5%			$ 4,000	
	TOTAL PERIODIC COSTS @ YEAR 10, 20 and 30					**$ 87,000**	

Alternative 2 Cost Breakdown

Claremont Polychemical Corporation (CPC) GWET

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing existing wells RW-1, RW-2, RW-3, RW-4, and RW-5, the existing groundwater conveyance piping, and the existing discharge system. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

PRESENT VALUE ANALYSIS: Rate of Return: 5% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
A	**1. CAPITAL COSTS:**	0	$ 7,120,815	**$ 7,121,000**	
B	**2. OPERATIONAL AND MAINTENANCE COSTs:**				
	TOTAL ANNUAL O & M COST		$ 1,498,900	$ 33,840,500	Annual cost for the life of the system
	Sub-Total			**$ 33,841,000**	**NPV Assuming 5% Return and 3% Inflation**
C	**Periodic Costs**				
3.1	TOTAL PERIODIC COSTS @ EVERY 2 YEARS		$ 932,000	$ 10,419,669	Every 2 years
3.2	TOTAL PERIODIC COSTS @ YEAR 5, 10, 15, 20, 25 and 30		$ 813,400	$ 3,532,918	Every 5 years
3.3	TOTAL PERIODIC COSTS @ YEAR 10, 20 and 30		$ 87,000	$ 179,861	Every 10 years
	Sub-Total			**$ 14,133,000**	**NPV Assuming 5% Return and 3% Inflation**
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 55,095,000**	

***** The annual and periodic costs over the life of the system changes on an annual basis as noted. For simplicity, the total O&M and periodic costs over the 30 years are presented.

Alternative 3 Cost Breakdown

Firemen's Training Center GWET

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing existing FTC wells ORW-2, ORW-4, ORW-6 and ORW-7 , the existing groundwater conveyance piping, and the existing discharge system. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
1. CAPITAL COSTS:						
1.0	**Pre-Design Investigation**					
1.0.1	Pre-Design Investigation	1	LS	$ 250,000	$ 250,000	
	Sub-Total				**$ 250,000**	
1.1	**Existing extraction well improvements**					
1.1.1	Site preparation	1	LS	$ 40,000	$ 40,000	
1.1.2	Well re-development	4	EA	$ 7,500	$ 30,000	
1.1.3	VFD Pumps	4	EA	$ 50,000	$ 200,000	
1.1.4	Flow Control System	1	LS	$ 450,000	$ 450,000	
	Sub-Total				**$ 720,000**	
1.2	**Ex-Situ Treatment**					
1.2.1	Building improvement	1	LS	$ 275,000	$ 275,000	
1.2.2	AOP system	1	EA	$ 1,200,000	$ 1,200,000	
1.2.3	GAC System	3	EA	$ 350,000	$ 1,050,000	
1.2.4	Air Stripper Re-start/Cleaning	1	LS	$ 24,400	$ 24,400	
1.2.5	Vapor GAC System	1	EA	$ 96,315	$ 96,315	
1.2.6	System Installation	1	LS	$ 615,000	$ 615,000	
	Sub-Total				**$ 3,260,715**	
1.3	**Discharge - Existing Recharge Basin**					
1.3.1	Basin upgrades/maintenance	1	LS	$ 250,000	$ 250,000	
	Sub-Total				**$ 250,000**	
1.4	**Conveyance System**					
1.4.1	Inspect and Flush system	1	LS	$ 120,000	$ 120,000	
	Sub-Total				**$ 120,000**	
	Sub-Total				**$ 4,350,715**	Sub-Total All Construction Costs.
	Sub-Total					
	Contingency	25%			$ 1,088,000	10% scope + 15% bid.
	Sub-Total				**$ 5,438,715**	
	Project Management	5%			$ 272,000	
	Remedial Design	6%			$ 326,000	
	Construction Management	6%			$ 326,000	
	Construction Oversight	3%			$ 163,000	
	TOTAL CAPITAL COST				**$ 6,526,000**	

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Alternative 3 Cost Breakdown

Firemen's Training Center GWET

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing existing FTC wells ORW-2, ORW-4, ORW-6 and ORW-7 , the existing groundwater conveyance piping, and the existing discharge system. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Frequency	Quantity	Unit	Unit Cost	Total	Notes
2. OPERATIONAL AND MAINTENANCE COSTS:							
Item No.	**Description**		**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
2.1	**Annual O & M**						
2.1.1	Annual Operational Labor		1	LS	$ 136,700	$136,700	
2.1.2	Annual Power (Extraction & Treatment)		1	LS	$ 381,000	$381,000	
2.1.3	Annual Material/Chemicals Usage		1	LS	$ 469,400	$469,400	
2.1.4	Annual System Maintenance		1	LS	$ 51,400	$51,400	
2.1.5	Treatment Plant Monitoring		1	LS	$ 116,600	$116,600	
	Sub-Total					**$ 1,155,100**	
2.2	**Site-Wide Long-Term Monitoring**						
2.2.1	Site-Wide Long-Term Monitoring		1	LS	$ 157,000	$157,000	
	Sub-Total					**$ 157,000**	
2.3	**Recharge Basin Maintenance**						
2.3.1	Annual Maintenance Costs		1	LS	$ 28,900	$ 28,900	
	Sub-Total					**$ 28,900**	
	Sub-Total					**$ 1,341,000**	Sub-Total All Annual O & M Costs.
	Sub-Total						
	Contingency		10%			$ 134,000	5% scope + 5% bid.
	Sub-Total					**$ 1,475,000**	
	Project Management		5%			$ 74,000	
	TOTAL ANNUAL O & M COST					**$ 1,549,000**	
3. PERIODIC COSTS:		**Frequency**					
3.1	**Once in Every 2 Years**						
3.1.1	Extraction Well Pump Rehabilitation	2	15	EA	$ 40,000	$600,000	
	Contingency		15%			$ 90,000	10% scope + 5% bid.
	Sub-Total					**$ 690,000**	
	Project Management		5%			$ 35,000	
	Technical Support		3%			$ 21,000	
	TOTAL PERIODIC COSTS @ EVERY 2 YEARS					**$ 746,000**	
3.2	**Once in Every 5 Years**						
3.2.1	Extraction Well Rehabilitation	5	6	LS	$ 40,000	$240,000	
3.2.2	Air Stripper Cleaning	5	6	LS	$ 19,520	$117,120	
3.2.3	Replace Interconnection Piping and Valves	5	6	LS	$ 8,000	$48,000	
3.2.4	Recharge Basin Rehabilitation	5	6	LS	$ 6,400	$38,400	
3.2.5	Institutional Controls	5	6	LS	$ 20,000	$120,000	
	Sub-Total					**$ 563,520**	
	Contingency		10%			$ 56,000	5% scope + 5% bid.
	Sub-Total					**$ 619,520**	
	Project Management		5%			$ 31,000	
	TOTAL PERIODIC COSTS @ YEAR 5, 10, 15, 20, 25 and 30					**$ 650,520**	
3.3	**Once in Every 10 Years**						
3.3.1	Bag Filter Pump Replacement	10	3	EA	$ 25,000	$75,000	
						$0	
	Sub-Total					**$ 75,000**	
	Contingency		10%			$ 8,000	5% scope + 5% bid.
	Sub-Total					**$ 83,000**	
	Project Management		5%			$ 4,000	
	TOTAL PERIODIC COSTS @ YEAR 10, 20 and 30					**$ 87,000**	

Alternative 3 Cost Breakdown

Firemen's Training Center GWET

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing existing FTC wells ORW-2, ORW-4, ORW-6 and ORW-7 , the existing groundwater conveyance piping, and the existing discharge system. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

PRESENT VALUE ANALYSIS: Rate of Return: 5% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
A	**1. CAPITAL COSTS:**	0	$ 6,526,000	**$ 6,526,000**	
B	**2. OPERATIONAL AND MAINTENANCE COSTS:**				
	TOTAL ANNUAL O & M COST		$ 1,549,000	$ 34,971,602	Annual cost for the life of the system
	Sub-Total			**$ 34,972,000**	**NPV Assuming 5% Return and 3% Inflation**
C	**Periodic Costs**				
3.1	TOTAL PERIODIC COSTS @ EVERY 2 YEARS		$ 746,000	$ 8,340,207	Every 2 years
3.2	TOTAL PERIODIC COSTS @ YEAR 5, 10, 15, 20, 25 and 30		$ 650,520	$ 2,825,465	Every 5 years
3.3	TOTAL PERIODIC COSTS @ YEAR 10, 20 and 30		$ 87,000	$ 179,861	Every 10 years
	Sub-Total			**$ 11,346,000**	**NPV Assuming 5% Return and 3% Inflation**
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 52,844,000**	

***** The annual and periodic costs over the life of the system changes on an annual basis as noted. For simplicity, the total O&M and periodic costs over the 30 years are presented.

Alternative 4 Cost Breakdown

CPC and FTC GWET systems + 2 New Wells North of Melville Road

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing wells RW-3, RW-4, RW-5, ORW-4, ORW-6 and ORW-7 . This alternative also includes Well A1 and Well A2, located on Bethpage State Park property. The existing groundwater conveyance piping from CPC would be re-routed to FTC, and the existing discharge system would be improved. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
1. CAPITAL COSTS:						
1.0	**Pre-Design Investigation**					
1.0.1	Pre-Design Investigation	1	LS	$ 450,000	$ 450,000	
	Sub-Total				**$ 450,000**	
1.1	**Existing extraction well improvements**					
1.1.1	Site preparation	1	LS	$ 80,000	$80,000	
1.1.2	Well re-development	6	EA	$ 7,500	$45,000	
1.1.3	VFD Pumps	8	EA	$ 50,000	$400,000	
1.1.4	Flow Control System	1	LS	$ 900,000	$900,000	
1.1.5	Install Wells A1 and A2	2	EA	830,000	$1,660,000	
	Sub-Total				**$ 3,085,000**	
1.2	**Ex-Situ Treatment**					
1.2.1	Building improvement	1	LS	$ 550,000	$550,000	
1.2.2	AOP system	2	EA	$ 1,200,000	$2,400,000	
1.2.3	GAC System	6	EA	$ 350,000	$2,100,000	
1.2.4	Air Stripper Re-start/Cleaning	1	LS	$ 24,400	$ 24,400	
1.2.5	Additional Air Stripper	1	EA	$ 285,265	$ 285,265	
1.2.6	Vapor GAC System	2	Ea	$ 96,315	$ 192,630	
1.2.7	System Installation	1	LS	$ 1,168,500	$ 1,168,500	
	Sub-Total				**$ 6,720,795**	
1.3	**Discharge - Existing Recharge Basin**					
1.3.1	Basin upgrades	1	LS	$ 300,000	$300,000	
1.3.2	New Discharge to Basin 1	1	LS	$ 1,000,000	$1,000,000	
	Sub-Total				**$ 1,300,000**	
1.4	**Conveyance System**					
1.4.1	Inspect and Flush system	1	LS	$ 140,000	$140,000	
1.4.2	New Connection to FTC	1	LS	$ 500,000	$500,000	
1.4.3	Well A1 and A2 Piping	1	LS	$ 900,000	$900,000	
	Sub-Total				**$ 1,540,000**	
	Sub-Total				**$ 13,095,795**	Sub-Total All Construction Costs.
	Sub-Total					
	Contingency	25%			$ 3,274,000	10% scope + 15% bid.
	Sub-Total				**$ 16,369,795**	
	Project Management	5%			$ 164,000	
	Remedial Design	6%			$ 196,000	
	Construction Management	6%			$ 196,000	
	Construction Oversight	3%			$ 98,000	
	TOTAL CAPITAL COST				**$ 17,024,000**	

Alternative 4 Cost Breakdown

CPC and FTC GWET systems + 2 New Wells North of Melville Road

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing wells RW-3, RW-4, RW-5, ORW-4, ORW-6 and ORW-7 . This alternative also includes Well A1 and Well A2, located on Bethpage State Park property. The existing groundwater conveyance piping from CPC would be re-routed to FTC, and the existing discharge system would be improved. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.		Description	Frequency	Quantity	Unit	Unit Cost	Total	Notes
2. OPERATIONAL AND MAINTENANCE COSTs:								
Item No.		**Description**		**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
2.1	**Annual O & M**							
	2.1.1	Annual Operational Labor		1	LS	$ 259,730	$259,730	
	2.1.2	Annual Power (Extraction & Treatment)		1	LS	$ 572,000	$572,000	
	2.1.3	Annual Material/Chemicals Usage		1	LS	$ 891,860	$891,860	
	2.1.4	Annual System Maintenance		1	LS	$ 97,660	$97,660	
	2.1.5	Treatment Plant Monitoring		1	LS	$ 221,540	$221,540	
		Sub-Total					**$ 2,042,790**	
2.2	**Site-Wide Long-Term Monitoring**							
	2.2.1	Site-Wide Long-Term Monitoring		1	LS	$ 157,000	$157,000	
		Sub-Total					**$ 157,000**	
2.3	**Recharge Basin Maintenance**							
	2.3.1	Annual Maintenance Costs		1	LS	$ 57,800	$57,800	
		Sub-Total					**$ 57,800**	
	Sub-Total						**$ 2,257,590**	Sub-Total All Annual O & M Costs.
		Contingency		10%			$ 226,000	5% scope + 5% bid.
	Sub-Total						**$ 2,483,590**	
	Project Management			5%			$ 124,000	
	TOTAL ANNUAL O & M COST						**$ 2,607,590**	
3. PERIODIC COSTS:			**Frequency**					
3.1	**Once in Every 2 Years**							
	3.1.1	Extraction Well Pump Rehabilitation	2	15	EA	$ 80,000	$1,200,000	
	Contingency			15%			$ 180,000	10% scope + 5% bid.
	Sub-Total						**$ 1,380,000**	
	Project Management			5%			$ 69,000	
	Technical Support			3%			$ 41,000	
	TOTAL PERIODIC COSTS @ EVERY 2 YEARS						**$ 1,490,000**	
3.2	**Once in Every 5 Years**							
	3.2.1	Extraction Well Pump Replacement	5	6	EA	$ 40,000	$240,000	
	3.2.2	Replace Interconnection Piping and Valves	5	6	EA	$ 46,360	$278,160	
	3.2.3	Recharge Basin Rehabilitation	5	6	EA	$ 19,000	$114,000	
	3.2.4	Institutional Controls	5	6	EA	$ 15,200	$91,200	
	3.2.5		5	6	LS	$ 47,500	$285,000	
		Sub-Total					**$ 1,008,360**	
	Contingency			10%			$ 101,000	5% scope + 5% bid.
	Sub-Total						**$ 1,109,360**	
	Project Management			5%			$ 55,000	
	TOTAL PERIODIC COSTS @ YEAR 5, 10, 15, 20, 25 and 30						**$ 1,164,360**	
3.3	**Once in Every 10 Years**							
	3.3.1	Bag Filter Pump Replacement	10	3	EA	$ 47,500	$142,500	
	3.3.2		3		LS		$0	
	3.3.3		3		EA		$0	
		Sub-Total					**$ 142,500**	
	Contingency			10%			$ 14,000	5% scope + 5% bid.
	Sub-Total						**$ 156,500**	
	Project Management			5%			$ 8,000	
	TOTAL PERIODIC COSTS @ YEAR 10, 20 and 30						**$ 164,500**	

HDR

Alternative 4 Cost Breakdown

CPC and FTC GWET systems + 2 New Wells North of Melville Road

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing wells RW-3, RW-4, RW-5, ORW-4, ORW-6 and ORW-7 . This alternative also includes Well A1 and Well A2, located on Bethpage State Park property. The existing groundwater conveyance piping from CPC would be re-routed to FTC, and the existing discharge system would be improved. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

PRESENT VALUE ANALYSIS: Rate of Return: 5% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
A	**#REF!**	0	$ 17,024,000	**$ 17,024,000**	
B	**2. OPERATIONAL AND MAINTENANCE COSTs:**				
	TOTAL ANNUAL O & M COST		$ 2,607,590	$ 58,871,271	Annual cost for the life of the system
	Sub-Total			**$ 58,872,000**	**NPV Assuming 5% Return and 3% Inflation**
C	**Periodic Costs**				
3.1	TOTAL PERIODIC COSTS @ EVERY 2 YEARS		$ 1,490,000	$ 16,658,054	Every 2 years
3.2	TOTAL PERIODIC COSTS @ YEAR 5, 10, 15, 20, 25 and 30		$ 1,164,360	$ 5,057,276	Every 5 years
3.3	TOTAL PERIODIC COSTS @ YEAR 10, 20 and 30		$ 164,500	$ 340,082	Every 10 years
	Sub-Total			**$ 22,056,000**	**NPV Assuming 5% Return and 3% Inflation**
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 97,952,000**	

***** The annual and periodic costs over the life of the system changes on an annual basis as noted. For simplicity, the total O&M and periodic costs over the 30 years are presented.

Alternative 5 Cost Breakdown

CPC and FTC GWET systems + 2 New Wells South of Melville Rd.

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing wells RW-3, RW-4, RW-5, ORW-4, ORW-6 and ORW-7. This alternative also includes Well B1 and Well B2, installed in public right-a-ways South of Melville Road. The existing groundwater conveyance piping from CPC would be re-routed to FTC, and the existing discharge system would be improved. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
1. CAPITAL COSTS:							
1.0		**Pre-Design Investigation**					
	1.0.1	Pre-Design Investigation	1	LS	$ 450,000	$ 450,000	
		Sub-Total				**$ 450,000**	
1.1		**Existing extraction well improvements**					
	1.1.1	Site preparation	1	LS	$ 80,000	$80,000	
	1.1.2	Well re-development	6	EA	$ 7,500	$45,000	
	1.1.3	VFD Pumps	8	EA	$ 50,000	$400,000	
	1.1.4	Flow Control System	1	LS	$ 900,000	$900,000	
	1.1.5	Install Wells B1 and B2	2	EA	830,000	$1,660,000	
		Sub-Total				**$ 3,085,000**	
1.2		**Ex-Situ Treatment**					
	1.2.1	Building improvement	1	LS	$ 550,000	$550,000	
	1.2.2	AOP system	2	EA	$ 1,200,000	$2,400,000	
	1.2.3	GAC System	6	EA	$ 350,000	$2,100,000	
	1.2.4	Air Stripper Re-start/Cleaning	1	LS	$ 24,400	$ 24,400	
	1.2.5	Additional Air Stripper	1	EA	$ 285,265	$ 285,265	
	1.2.5	Vapor GAC System	2	EA	$ 96,315	$ 192,630	
	1.2.6	System Installation	1	LS	$ 1,230,000	$ 1,230,000	
		Sub-Total				**$ 6,782,295**	
1.3		**Discharge - Existing Recharge Basin**					
	1.3.1	Basin upgrades	1	LS	$ 300,000	$300,000	
		New Discharge to Basin 1	1	LS	$ 1,000,000	$1,000,000	
		Sub-Total				**$ 1,300,000**	
1.4		**Conveyance System**					
	1.4.1	Inspect and Flush system	1	LS	$ 140,000	$140,000	
	1.4.2	New Connection to FTC	1	LS	$ 500,000	$500,000	
	1.4.3	Well B1 and B2 Piping	1	LS	$ 1,200,000	$1,200,000	
		Sub-Total				**$ 1,840,000**	
	Sub-Total					**$ 13,457,295**	Sub-Total All Construction Costs.
	Sub-Total						
		Contingency	25%			$ 3,364,000	10% scope + 15% bid.
	Sub-Total					**$ 16,821,295**	
	Project Management		5%			$ 168,000	
	Remedial Design		6%			$ 202,000	
	Construction Management		6%			$ 202,000	
	Construction Oversight		3%			$ 101,000	
	TOTAL CAPITAL COST					**$ 17,495,000**	

Alternative 5 Cost Breakdown

CPC and FTC GWET systems + 2 New Wells South of Melville Rd.

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing wells RW-3, RW-4, RW-5, ORW-4, ORW-6 and ORW-7. This alternative also includes Well B1 and Well B2, installed in public right-a-ways South of Melville Road. The existing groundwater conveyance piping from CPC would be re-routed to FTC, and the existing discharge system would be improved. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

2. OPERATIONAL AND MAINTENANCE COSTs:

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
2.1	**Annual O & M**					
2.1.1	Annual Operational Labor	1	LS	$ 273,400	$273,400	
2.1.2	Annual Power (Extraction & Treatment)	1	LS	$ 572,000	$572,000	
2.1.3	Annual Material/Chemicals Usage	1	LS	$ 938,800	$938,800	
2.1.4	Annual System Maintenance	1	LS	$ 102,800	$102,800	
2.1.5	Treatment Plant Monitoring	1	LS	$ 233,200	$233,200	
	Sub-Total				**$ 2,120,200**	
2.2	**Site-Wide Long-Term Monitoring**					
2.2.1	Site-Wide Long-Term Monitoring	1	LS	$ 157,000	$157,000	
	Sub-Total				**$ 157,000**	
2.3	**Recharge Basin Maintenance**					
2.3.1	Annual Maintenance Costs	1	LS	$ 57,800	$57,800	
	Sub-Total				**$ 57,800**	
	Sub-Total				**$ 2,335,000**	Sub-Total All Annual O & M Costs.
	Contingency	10%			$ 234,000	5% scope + 5% bid.
	Sub-Total				**$ 2,569,000**	
	Project Management	5%			$ 128,000	
	TOTAL ANNUAL O & M COST				**$ 2,697,000**	

3. PERIODIC COSTS:

Item No.	Description	Frequency	Quantity	Unit	Unit Cost	Total	Notes
3.1	**Once in Every 2 Years**						
3.1.1	Extraction Well Pump Rehabilitation	2	15	EA	$ 80,000	$1,200,000	
	Contingency		15%			$ 180,000	10% scope + 5% bid.
	Sub-Total					**$ 1,380,000**	
	Project Management		5%			$ 69,000	
	Technical Support		3%			$ 41,000	
	TOTAL PERIODIC COSTS @ EVERY 2 YEARS					**$ 1,490,000**	
3.2	**Once in Every 5 Years**						
3.2.1	Extraction Well Pump Replacement	5	6	EA	$ 40,000	$240,000	
3.2.2	Replace Interconnection Piping and Valves	5	6	EA	$ 46,360	$278,160	
3.2.3	Recharge Basin Rehabilitation	5	6	EA	$ 19,000	$114,000	
3.2.4	Institutional Controls	5	6	EA	$ 15,200	$91,200	
3.2.5		5	6	LS	$ 47,500	$285,000	
	Sub-Total					**$ 1,008,360**	
	Contingency		10%			$ 101,000	5% scope + 5% bid.
	Sub-Total					**$ 1,109,360**	
	Project Management		5%			$ 55,000	
	TOTAL PERIODIC COSTS @ YEAR 5, 10, 15, 20, 25 and 30					**$ 1,164,360**	
3.3	**Once in Every 10 Years**						
3.3.1	Bag Filter Pump Replacement	10	3	EA	$ 47,500	$142,500	
3.3.2		3		LS		$0	
3.3.3		3		EA		$0	
	Sub-Total					**$ 142,500**	
	Contingency		10%			$ 14,000	5% scope + 5% bid.
	Sub-Total					**$ 156,500**	
	Project Management		5%			$ 8,000	
	TOTAL PERIODIC COSTS @ YEAR 10, 20 and 30					**$ 164,500**	

Alternative 5 Cost Breakdown

CPC and FTC GWET systems + 2 New Wells South of Melville Rd.

Site: Claremont Polychemical
Location: Nassau County, New York
Phase: Feasibility (-30% - +50%)
Base Year: 2021
Date: October 13, 2021

Description: Groundwater extraction utilizing wells RW-3, RW-4, RW-5, ORW-4, ORW-6 and ORW-7. This alternative also includes Well B1 and Well B2, installed in public right-a-ways South of Melville Road. The existing groundwater conveyance piping from CPC would be re-routed to FTC, and the existing discharge system would be improved. Current VOC treatment would be upgraded to include UV AOP and GAC. Includes LTM with institutional controls and a contingency for treatment at the two existing Village of Farmingdale municipal supply wells using UV AOP and GAC.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

PRESENT VALUE ANALYSIS: Rate of Return: 5% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost	Present Value	Notes
A	**#REF!**	0	$ 17,495,000	**$ 17,495,000**	
B	**2. OPERATIONAL AND MAINTENANCE COSTs:**				
	TOTAL ANNUAL O & M COST		$ 2,697,000	$ 60,889,871	Annual cost for the life of the system
	Sub-Total			**$ 60,890,000**	**NPV Assuming 5% Return and 3% Inflation**
C	**Periodic Costs**				
3.1	TOTAL PERIODIC COSTS @ EVERY 2 YEARS		$ 1,490,000	$ 16,658,054	Every 2 years
3.2	TOTAL PERIODIC COSTS @ YEAR 5, 10, 15, 20, 25 and 30		$ 1,164,360	$ 5,057,276	Every 5 years
3.3	TOTAL PERIODIC COSTS @ YEAR 10, 20 and 30		$ 164,500	$ 340,082	Every 10 years
	Sub-Total			**$ 22,056,000**	**NPV Assuming 5% Return and 3% Inflation**
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 100,441,000**	

***** The annual and periodic costs over the life of the system changes on an annual basis as noted. For simplicity, the total O&M and periodic costs over the 30 years are presented.