FINAL
Olean Well Field OU4 Superfund Site
Feasibility Study Report
Olean, New York

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List of Abbreviations and Acronyms

µg/L	micrograms per liter
1,1,1-TCA	1,1,1-trichloroethane
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
Alcas	Alcas Cutlery Corporation
AMSL	above mean sea level
ARAR	applicable or relevant and appropriate requirement
AS	air sparging
AVX	AVX Corporation
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	contaminants of concern
DNAPL	dense non-aqueous-phase liquid
DO	dissolved oxygen
DOC	dissolved organic carbon
DPT	direct-push technology
EC	Engineering control
EPA	U.S. Environmental Protection Agency
FS	feasibility study
ft/ft	foot per foot
ft/day	foot per day
ft/year	foot per year

GRA	general response action
HHRA	human health risk assessment
HI	hazard index
IC	institutional control
ISCO	in-situ chemical oxidation
ISCR	in-situ chemical reduction
Loohn's	Loohn's Dry Cleaners and Launderers
McGraw-Edison	McGraw-Edison Corporation
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	monitored natural attenuation
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
O&M	operation and maintenance
ORP	oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
OU2	Operable Unit 2
OU3	Operable Unit 3
OU4	Operable Unit 4
OWF	Olean Well Field
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRB	permeable reactive barrier
PRP	potentially responsible party
PVC	polyvinyl chloride
RA	remedial action
RAO	remedial action objective
RI	remedial investigation
ROD	Record of Decision
ROD Amendment	Amendment to the OU2 ROD related to the AVX source area
SCG	standards, criteria, and guidance
SCO	Soil Cleanup Objective

List of Abbreviations and Acronyms (cont.)

Site	Olean Well Field Superfund Site
SLERA	screening level ecological risk assessment
SPDES	(New York) State Pollutant Discharge Elimination System
SRI	supplemental remedial investigation
SVE	soil vapor extraction
TBC	to be considered
TCE	trichloroethene
trans-1,2-DCE	trans-1,2-dichloroethene
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
VOC	volatile organic compound
WSP	WSP USA Solutions Inc.
ZVI	zero-valent iron

Executive Summary

WSP USA Solutions Inc., formerly Ecology and Environment Engineering and Geology, P.C. (WSP) was contracted by U.S. Army Corps of Engineers (USACE), Kansas City District to conduct a Feasibility Study (FS) for Operable Unit 4 (OU4) at the Olean Well Field (OWF) Superfund Site (Site) in Olean, New York. The purpose of the FS is to summarize the results of the remedial investigation and risk assessments performed at OU4 and develop and evaluate remedial alternatives to address groundwater contamination within OU4.

ES.1 Background

The Site was placed on the Superfund program's National Priorities List in September 1983 by the U.S. Environmental Protection Agency (EPA) following the discovery of trichloroethene (TCE) in three municipal water supply wells and 50 private wells in 1981. The Site has undergone various remedial investigations and remedial actions to date. This FS focuses on the remedial alternatives for the groundwater contamination related to OU4 at the Site. The primary contaminants of concern for OU4 are 10 volatile organic compounds of interest and 1,4 dioxane:

Alkanes: 1,1,1-Trichloroethane and Related

- 1,1,1-trichloroethane (1,1,1-TCA)
- 1,1-dichloroethane (1,1-DCA)
- 1,2-dichloroethane (1,2-DCA)
- 1,1-dichloroethene (1,1-DCE)
- Chloroethane
- 1,4-dioxane

Alkenes: Tetrachloroethene, Trichloroethene, and Related

- PCE
- TCE
- Cis-1,2-dichloroethene (cis-1,2-DCE)

- Trans-1,2-dichloroethene (trans-1,2-DCE)
- Vinyl chloride

The FS identifies applicable or relevant and appropriate requirements (ARARs) for the Site, including location-, chemical-, and action-specific state and federal ARARs and "To be Considered" (TBC) non-promulgated criteria, advisories, guidance, and proposed standards issued by federal and state governments (EPA 1989). These ARARs were developed by reviewing federal environment laws and regulations, New York State laws, and New York State Department of Environmental Conservation (NYSDEC) regulations to determine which state laws and regulations are ARARs and/or TBCs for this cleanup action.

ES.2 Human Health and Ecological Risk Assessment

Human health and ecological risk assessments were completed for OU4 as part of the remedial investigation (RI; WSP 2022). The Human Health Risk Assessment (HHRA) concluded that there is no current exposure to groundwater contamination at OU4 and groundwater is not expected to be used as a source of drinking water in the future. Tap water is provided to individuals from a public water supply system. If the groundwater were to be used for residential purposes in the future, it would present an unacceptable cancer risk due to the presence of TCE, vinyl chloride, 1,4-dioxane, and arsenic. Some of these compounds—arsenic, manganese, iron, cis-1,2-DCE, TCE, and vinyl chloride—also present non-cancerous hazards. The metals identified, however, are not considered site-related and are not retained as contaminants of concern. In addition, although 1,1,1-TCA, 1,1-DCA, 1,2-DCA, 1,1-DCE, trans-1,2-DCE, and chloroethane were not associated with elevated risk or hazard, concentrations of these chemicals were identified at levels exceeding EPA Maximum Contaminant Levels and/or NYSDEC Groundwater Quality Standards. Contaminated soil does not present an unacceptable cancer risk or non-cancer hazard. Exposure to surface water and sediment contaminants did not yield risks above EPA thresholds. Vapor intrusion was not found to be a completed pathway at the time of a 2009 study completed by an EPA contractor, though it may present a future risk if the contaminant plume continues migrating toward an existing building within OU4 or if a new building is constructed and intercepts the contaminant plume.

The screening-level ecological risk assessment (SLERA) considered potential ecological risks to terrestrial and aquatic assessment endpoints in a variety of plants, invertebrates, invertebrates, and animals. The results of the SLERA suggest that potential ecological risks from metals and organic compounds in surface water, soil, and sediment are negligible and, therefore, further characterization of these media for ecological risk assessment purposes is not warranted.

ES.3 Remedial Action Goals

The focus of this FS is to address groundwater contamination at OU4. The remedial action objectives (RAOs) for groundwater were developed based on the nature and extent of contamination, consideration of quantitative human health and ecological risk evaluation, and potential ARARs and standards, criteria, and guidance (SCGs). Based on this evaluation, the RAOs for OU4 are to:

- Eliminate the potential for future human exposure to site contaminants in groundwater at OU4 via direct contact, ingestion, or inhalation of vapors.
- Restore groundwater to beneficial use as a source of drinking water in a reasonable timeframe, by reducing contaminant levels to the more stringent federal or state drinking water standards.

Based on the results of the SLERA, contamination poses no to low risk to ecological receptors; therefore, RAOs associated with ecological receptors have not been developed.

ES.4 General Response Actions

General response actions (GRAs) are broad categories of remedies that are capable of remediating contamination at a particular site. Each GRA may include several technologies or process options, some of which might be extensive enough to satisfy the RAOs and ARARs on their own, while others must be combined with different technologies and/or process options to achieve the remedial goals and objectives for OU4. The identification of GRAs is the first step in the identification of remedial technology types and specific process options. GRAs identified for contaminated groundwater on-site are no action, institutional controls (ICs), monitored natural attenuation (MNA), in-situ treatment and treatment of extracted groundwater.

ES.5 Technology Screening

The selection of technologies and process options within each GRA is based on addressing volatile organic compound and 1,4-dioxane contamination in groundwater. The remedy selection process was focused to reflect only those potentially applicable technologies and process options common to remedial actions performed or considered at sites like OU4. A screening of technologies and process options was performed to identify technologies that will be applicable for addressing the groundwater contamination in OU4.

ES.6 Development of Remedial Alternatives

Based on the RAOs and GRAs for OU4, six alternatives were developed for this FS. Each of the alternatives evaluated in this FS takes into consideration the implementation and operation of the 2015 Operable Unit 2 (OU2) amended remedy at the AVX Corporation property. The alternatives generally fall within four different categories: no action, limited action, in situ treatment, and extracted groundwater treatment. The six alternatives considered in this FS are:

- Alternative 1 – No Action
- Alternative 2 – Monitored Natural Attenuation (MNA) and ICs
  - MNA monitoring of a selection of monitoring wells
  - ICs including, but not limited to, groundwater use restrictions

- Alternative 3 – Permeable Reactive Barrier with Long-term Monitoring and ICs
  - Installation of one permeable reactive barrier (PRB) on the downgradient end of the contaminant plume within OU4
  - Long-term monitoring of a selection of monitoring wells
  - ICs, including, but not limited to, groundwater use restrictions
- Alternative 4 – Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and ICs
  - Installation of an Air Sparging/Soil Vapor Extraction (AS/SVE) system to treat higher contamination areas
  - Long-term monitoring of a selection of monitoring wells
  - ICs, including, but not limited to, groundwater use restrictions
- Alternative 5 – In situ Chemical/Biological Treatment, Long-term Monitoring, and ICs
  - In situ Chemical Reduction, Chemical Oxidation or Enhanced Bioremediation to address higher contamination areas
  - Long-term monitoring of a selection of monitoring wells
  - ICs including, but not limited to, groundwater use restrictions
- Alternative 6 – Pump and Treat, Long-term Monitoring, and ICs
  - Installation of a pump-and-treat system (horizontal/vertical wells and/or hydraulic trench) to extract and treat contaminated groundwater
  - Long-term monitoring of a selection of monitoring wells
  - ICs including, but not limited to, groundwater use restrictions

ES.7 Detailed Evaluation of Alternatives

Each of the six alternatives are described in detail and then evaluated against seven of the nine evaluation criteria set forth in the National Contingency Plan, 40 Code of Federal Regulations §300.430(e)(9)(iii); specifically, 1) overall protection of human health and the environment; 2) compliance with ARARs; 3) long-term effectiveness and permanence; 4) short-term effectiveness; 5) reduction of toxicity, mobility and volume through treatment; 6) implementability; and 7) cost. The two remaining criteria—state and community acceptance—will be evaluated following public and state review of the FS and the proposed plan. Cost evaluations include the development of capital costs, operations and maintenance costs, total costs, and present-worth costs.

ES.8 Comparative Analysis of Alternatives

The six alternatives were compared according to seven of the nine criteria discussed in the alternative evaluation. Alternative 1 is not protective of human health and the environment; will not achieve ARARs within a reasonable time frame; is not effective in the long term; and does not reduce the mobility, volume, and toxicity of contaminants through treatment. Alternative 2 will not achieve ARARs within a reasonable time frame; is not effective in the long term; and does not reduce the mobility, volume, and toxicity of contaminants through treatment. Alternatives 3 through 6 will be the most protective of human health and the environment. Alternative 5 is expected to achieve ARARs within the fastest time frame, though Alternatives 3, 4, and 6 are also expected to achieve ARARs in a reasonable time frame. Alternative 5 offers the most long-term effectiveness and permanence, followed by Alternatives 4, 6, and 3. Alternatives 1 and 2 offer the least short-term impacts, while Alternative 3 has the greatest adverse short-term impact, followed by Alternatives 5, 6, and 4. Alternative 5 reduces the mobility, toxicity, and volume of the contamination to the greatest extent, though Alternatives 4 and 6 also reduce the volume of contamination. Alternative 6 also offers a reduction in contaminant mobility due to the extraction of groundwater creating a hydraulic barrier in the subsurface. Alternative 3 provides some reduction in contaminant mobility, toxicity, and volume by treating the contaminated groundwater that passes through it. Alternative 5 is the most implementable of the active alternatives. Alternatives 3 through 6 are readily implementable from both the technical and administrative perspective, while Alternative 6 is the most difficult to implement. Cost comparisons are shown in Table 6-1; Alternative 5 has the highest present value cost, and Alternative 2 has the lowest present value cost (not including Alternative 1, which does not have an associated cost).

1 Introduction

This Feasibility Study (FS) report for Operable Unit 4 (OU4) at the Olean Well Field (OWF) Superfund Site (Site) was prepared by WSP USA Solutions Inc., formerly Ecology and Environment Engineering and Geology, P.C. (WSP) for the U.S. Environmental Protection Agency (EPA) under the U.S. Army Corps of Engineers (USACE) Kansas City Division, Contract No. W912DQ-19-D-3003. The purpose of this report is to summarize the results of the remedial investigation (RI) and risk assessments performed at OU4 (see Figure 1-1) and develop and evaluate remedial action alternatives to address groundwater contamination within OU4.

1.1 Organization of the Report

This section summarizes the existing site conditions and site history for OU4. Section 2 presents the results of the remedial investigation (RI) and risk assessments. Section 3 identifies the remedial action objectives (RAOs), identifies applicable or relevant and appropriate requirements (ARARs), to be considered (TBC) guidance, and the cleanup levels for OU4. Section 4 identifies and evaluates remedial technologies for groundwater at the Site and describes the developed remedial alternatives. Section 5 provides an individual analysis for each of the remedial alternatives based on their overall protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, reduction of toxicity, mobility, and volume through treatment, short-term effectiveness, implementability, and cost. Section 6 provides a comparative analysis of the alternatives using the same criteria used in Section 5. Section 7 includes the references cited in this FS report.

1.2 Site Background

On the Allegheny River and at the confluence of Olean Creek, the city of Olean was established in 1837. The town of Olean originally occupied all the land that is now known as Cattaraugus County, but now is comprised of the land surrounding the city of Olean. Today, Olean is the largest city in Cattaraugus County, serving as a financial, business, industrial, and cultural center. The population of the city is approximately 15,000 (U.S. Census Bureau 2010). The OU4 portion of the site is used for residential, industrial, and commercial purposes. An unnamed stream is depicted on Figure 1-4 of the RI report (WSP 2022) that originates from northeast of the intersection of Goodrich and Dugan Streets, crosses OU4 from north to south, and empties into the Allegheny River. The stream passes under several streets before entering the vicinity of the Butler and Andrews Streets Fill Area and Seneca Avenue Landfill. It then crosses underneath the railroad tracks, picks up flow volume from the New York State Pollutant Discharge Elimination System (SPDES) Outfall 004 effluent (associated with the AVX Corporation [AVX] property), and flows southward into the Allegheny River.

The EPA placed the Site on the Superfund program's National Priorities List in September 1983 following the discovery of trichloroethene (TCE) in three municipal water supply wells (see Figure 1-2 in the RI) and 50 private wells in 1981 (EPA 1985). Between 1984 and 1985, an RI/FS was performed by a contractor for the NYSDEC RI/FS investigation. Additional investigations were also performed by three private-party potentially responsible parties (PRPs) at the Site: McGraw-Edison Corporation (now Cooper Industries, Inc.), AVX , Inc. (now KAVX), and Alcas Cutlery.

In 1985, the EPA issued a first Record of Decision (ROD) for the Olean Well Field. In subsequent years, numerous additional studies were performed by the EPA and some of the PRPs at the Site, including McGraw-Edison and AVX. The EPA issued an Operable Unit One ("OU1") ROD for the Site. The selected remedy included the following:

1. Installation of two air strippers at the contaminated municipal wells and the reactivation of those wells;
2. Extension of the City of Olean water lines into the Towns of Olean and Portville and the subsequent connection of approximately 93 private well users to the public water supply system;
3. Inspection of McGraw-Edison's industrial sewer and evaluation of repair and replacement options; and
4. Long-term groundwater monitoring.

The ROD also called for a second OU2 RI/FS to further delineate the sources of contamination at the Site and evaluate source control remedial alternatives. The OU2 RI/FS was a "mixed funding" RI/FS whereby the McGraw, AVX, and Alcas PRPs performed the RI/FS on their respective properties and the EPA performed the RI/FS on 10 additional properties. The OU2 RI/FS reports were written by the PRPs with information given to them by the EPA regarding the properties the EPA had investigated. In 1996, the OU2 ROD was issued calling for different source control remedies for each of the four source areas: AVX, McGraw-Edison, Alcas, and Loohn's Dry Cleaners and Launderers ("Loohn's"). The EPA completed the remedy at the Loohn's facility. The OU2 remedy was constructed at the McGraw-Edison facility by Cooper Industries, Inc., and the groundwater extraction treatment system at the site continues to be in operation.

Due to previously unknown conditions, the EPA issued an amended OU2 ROD for the Alcas source area in 2014, which also selected a remedy for a new operable unit, Operable Unit 3 (OU3), related to property adjacent to the Alcas facility, denominated by the EPA as "Parcel B." In 2021, Arconic and Cutco completed the remedial designs of the selected remedies for OU2 and OU3.

Also due to unknown conditions at the time of the OU2 ROD, in September 2015 the EPA issued an amendment to the OU2 ROD related to the AVX source area ("ROD Amendment"). Through the ROD Amendment, the EPA selected a modified interim remedy to contain soil and groundwater contamination at the AVX property. The major components of the amended remedy for the AVX property were:

- Maintenance of the exposure barrier utilizing existing surface covers to minimize leaching of volatile organic compounds (VOCs) from soil to groundwater;
- Construction and operation of a hydraulic trench containment system involving a gravel trench coupled with active groundwater recovery and treatment to prevent migration of groundwater downgradient of the AVX property;
- Hydraulic pumping containment utilizing and maintaining the existing AVX property production well as an active groundwater recovery system; and
- Implementation of institutional controls, including soil and groundwater use restrictions.

The ROD Amendment also stated that a change in the current use of the building in the future would trigger the performance of an FS to evaluate source control and/or restoration actions, leading to the selection of a final remedy.

AVX, Alcas Cutlery, and McGraw-Edison properties, along with the former Loohn's site, were identified as sources of contamination to the aquifers. As of August 2020, the AVX manufacturing building has been dismantled and removed.

1.3 Physical Site Characteristics

The city of Olean is located in the glaciated portion of the Allegheny Plateau physiographic province, which is characterized by steep valley walls, wide ridge tops, and flat-topped hills between drainageways (NRCS 2007).

Within the county, the topography of the plateau ranges from approximately 1,400 feet to 2,200 feet above mean sea level (AMSL; NRCS 2007). Ground elevation at OU4 ranges from a high of approximately 1,426 feet AMSL in the north to 1,413 feet AMSL in the south. Topography has influenced the locations where contaminants infiltrated the ground upgradient of OU4. It is believed that TCE, reported to have been released upgradient of OU4, travelled south with topography overland. The OU4 RI (WSP 2022) concluded that some of the TCE could have infiltrated groundwater as it flowed south on the AVX property, and some will have reached the low swampy area before infiltrating the ground or continuing toward the culvert that passes under the railroad and onto OU4.

Soils at OU4 of the Olean Site consist primarily of Olean silt loam and Canandaigua silt loam (NRCS 2007, 2013). However, a high degree of disturbance throughout the OU4 area may have resulted in presence of non-native soils. The

Olean soil series is described as very deep, moderately well drained soils. Permeability is moderate in the surface layer and upper part of the subsoil, moderate or moderately slow in the lower part of the subsoil, and rapid or very rapid in the substratum (NRCS 2005). The Canandaigua soil series is described as consisting of very deep, poorly, and very poorly drained soils formed in silty glacio-lacustrine sediments. These soils are on lowland lake plains and in depressional areas on glaciated uplands (NRCS 2013).

Located in the Appalachian Highlands, Olean is a valley-fill geologic environment formed when fluvial sediments filled a valley previously cut into the sedimentary bedrock by glacial activity (USGS 1987).

The upper 100 feet of unconsolidated sediments in the area can be divided into five lithologic units based on color, texture, grain size, and mode of deposition. The lithologic units have been grouped into four hydrogeologic units, historically referred to as (in descending order) the upper aquifer, upper aquitard, lower aquifer, and lower aquitard (ES 1985).

The upper aquifer, encompassing the top two lithologic units, is comprised of glaciofluvial coarse sands and sandy gravels and recent fluvial deposits of fine sands and silts with some clay. The upper aquifer is not continuous across Olean OU4. The thickest portion of the aquifer (approximately 41 feet) is along the Allegheny River. The aquifer thins to the north, pinching out north of OU4, near the northern extent of the undeveloped area that is south of the manufacturing building on the AVX property (USGS 1987; ES 1985).

The upper aquitard is located below the upper aquifer and above the lower aquifer. The upper aquitard is a low-permeability lodgment till composed of greater than 50 percent silt and clay. In OU4, the upper aquitard varies in thickness from 6 feet to 34.5 feet. The thinnest zone occurs approximately 1,500 feet southeast of the AVX property and the thickest zone occurs near the AVX plant (ES 1985).

The 1985 OWF RI/FS (ES 1985) describes local hydrogeologic unit geometry and present isopach (thickness) of the upper aquifer; elevation of the top of the upper aquitard; and a profile of the unconsolidated units between wells CW-5 and CW-19. Both the information presented in the 1985 OWF RI/FS report (ES 1985), as well as that described above, in the 1987 U.S. Geological Survey report, depict the upper aquifer extending considerably onto the AVX property, perhaps as far north as the AVX manufacturing building (ES 1985; USGS 1987).

The lower aquifer, also referred to as the City Aquifer, underlies the upper aquitard and consists of glacial outwash deposits of sand, silt, and gravel. The lower aquifer is approximately 70 feet thick in the northern portion of Olean OU4 and thins to approximately 30 feet south of the Allegheny River. The lower aquifer is the main source of water for the city and town of Olean. In addition, several industrial facilities (Olean Steel, McGraw-Edison [Cooper], and AVX) have in the past or continue to utilize wells completed in the lower aquifer for process water (ES 1985).

Glaciolacustrine sediments that accumulated in a proglacial lake, comprised of relatively impermeable red and gray silt and clay with localized layers of fine to very fine sand, make up the lower aquitard (ES 1985). The stratigraphy of the Olean OU4 upper aquifer consists of silty loam, fill, and organic horizon.

The Allegheny River is the major drainage feature in Olean. The Allegheny River flows west through the city of Olean and eventually drains into the Ohio River, approximately 135 miles to the southwest. Two major creeks, Olean Creek and Haskell Creek, discharge into the Allegheny River in Olean. OU4 is located between the two creeks. Shallow monitoring well groundwater elevations indicate that shallow groundwater flows generally south, toward the Allegheny River. Deep monitoring well groundwater elevations indicate that, in the City Aquifer, groundwater flows generally west, parallel to the river valley under natural conditions. The upper aquifer is recharged by the infiltration of precipitation. Recharge to the lower aquifer is via leakage of shallow groundwater through the upper aquitard. The entire area within which OU4 and AVX property falls is a zone of recharge.

During Phase I of the OU4 RI, soil borings encountered water at depths of less than 3 feet below ground surface (bgs) to more than 20 feet bgs at different locations. Nearly all soil borings on the westernmost portion of OU4 contained significant amounts of groundwater. Groundwater was observed to be laterally discontinuous and appeared to favor sandier deposits and occasionally showed signs of being perched (accumulated above less permeable layers).

North of the railroad tracks, groundwater flow is in a south to southeast direction while south of the tracks, the unnamed stream acts as a groundwater divide. Groundwater east of the stream generally flows in a south-southwest direction while groundwater west of the stream generally flows in a southeast direction.

During Phase II, water levels measured in shallow monitoring wells and piezometers on the OU4 property and the AVX property during June 2017 ranged from approximately 1,413.1 feet AMSL to approximately 1,430.6 feet AMSL. Elevations measured in October 2017 and June 2019 were similar.

As reported in the 1985 OWF RI/FS, contaminant migration in the study area occurs primarily in the subsurface environment. Groundwater contaminants entering the upper aquifer are transported both horizontally, toward the river and vertically, downward through the upper aquitard into the lower aquifer. In the lower aquifer, movement is directed to the west and southwest and can be fairly rapid when the municipal wells are pumping (ES 1985).

The climate of Olean and the broader western New York region is dominated by masses of cold, dry air that originate in the northern interior of the continent, and warm, humid air that has been conditioned by the Gulf of Mexico and adjacent subtropical waters. These combine to produce a humid continental climate, characterized by long, cold winters and pleasantly warm summers, with occasional intervals of sultry conditions. Prevailing winds are generally from the west, with a southwest component emerging during the warmer months and a northwest component in the colder months (NOAA 2019). Wind speed averages 8 to 10 miles per hour (ES 1985). The mean annual precipitation for the Olean area since 2000 is approximately 41 inches. Mean annual snowfall for the same period is 63.4 inches (NOAA 2021).

1.4 Geology

Olean is located in the Allegheny Plateau portion of the Appalachian Highlands region. It is a valley-fill geologic environment that formed when fluvial sediments filled a valley previously cut into the sedimentary bedrock by glacial activity (USGS 1987).

The upper 100 feet of unconsolidated sediments in the area can be divided into five lithologic units based on color, texture, grain size, and mode of deposition. The lithologic units have been grouped into four hydrogeologic units, historically referred to as (in descending order) the upper aquifer, upper aquitard, lower aquifer, and lower aquitard (ES 1985).

The upper aquifer, encompassing the top two lithologic units, is composed of glaciofluvial coarse sands and sandy gravels and recent fluvial deposits of fine sands and silts with some clay. The upper aquifer is not continuous across the OWF. The thickest portion of the aquifer (approximately 41 feet) is found along the Allegheny River. The aquifer thins to the north, pinching out north of OU4, near the northern extent of the undeveloped area that is located south of the manufacturing building on the AVX property (USGS 1987; ES 1985).

The upper aquitard is located below the upper aquifer and above the lower aquifer. The upper aquitard is a low-permeability lodgment till composed of greater than 50 percent silt and clay. In the OWF, the upper aquitard varies in thickness from 6 to 34.5 feet. The thinnest zone occurs approximately 1,500 feet southeast of the AVX property, and the thickest zone occurs near the AVX plant (ES 1985).

The lower aquifer, also referred to as the City Aquifer, underlies the upper aquitard and consists of glacial outwash deposits of sand, silt, and gravel. The lower aquifer is approximately 70 feet thick in the northern portion of the OWF and thins to approximately 30 feet south of the Allegheny River. The lower aquifer is the main source of water for the city and town of Olean. In addition, several industrial facilities (Olean Steel, McGraw-Edison [Cooper Industries, Inc.], and AVX) have utilized in the past, or continue to utilize, wells completed in the lower aquifer for process water (ES 1985).

The Allegheny River is the major drainage feature in Olean. This river flows west near Olean and eventually drains into the Ohio River, approximately 135 miles to the southwest. Two major creeks, Olean Creek and Haskell Creek, discharge into the Allegheny River in Olean. OU4 is located between Olean and Haskell Creeks and is bisected by an unnamed stream that originates to the north of OU4 and flows south, emptying into the Allegheny River. Shallow monitoring well groundwater elevations indicate that shallow groundwater (i.e., generally that found in wells up to approximately 25 feet deep) flows generally south, toward the Allegheny River. Deep monitoring well groundwater elevations indicate that deep groundwater (i.e., generally that found in wells 30 feet deep and greater, including the City Aquifer), flows generally west, parallel to the river valley under natural conditions.

The upper aquifer is recharged by the infiltration of precipitation. Recharge to the lower aquifer occurs via leakage of shallow groundwater through the upper aquitard. The magnitude of upper aquitard leakage on OU4 and the surrounding area is variable and generally dependent on the thickness and permeability of the upper aquitard and relative head differences between the upper aquifer and lower aquifer. Consistent with observations made during the current investigation (WSP 2022), the 1985 OWF RI/FS characterized the entire area within which OU4 and the AVX property fall as a zone of recharge (vertical component of groundwater flow is predominantly downward), with a zone of discharge beginning nearly at the Allegheny River and continuing south (ES 1985).

North of the railroad tracks, groundwater flows in a south to southeast direction, while south of the tracks the unnamed stream acts as a groundwater divide. Groundwater east of the stream generally flows in a south to southwest direction, while groundwater west of the stream generally flows in a southeast direction. A groundwater divide is apparent in the area north of the railroad tracks, with groundwater on the eastern side of this area flowing in a south to southwest direction, and groundwater on the western side of this area flowing in a south to southeast direction. This apparent divide is generally centered on the location of the historic drainage swale. Groundwater was observed to be laterally discontinuous, appeared to favor sandier deposits, and occasionally showed signs of being perched (accumulated above less permeable layers).

An example of the discontinuous nature of soil conditions at OU4 was seen in T09-L04 during the RI field investigation, where wet gravel was initially observed from 16 to 24 feet bgs. Groundwater sample collection was attempted but was unsuccessful due to insufficient yield. Additional attempts made within 2 feet of the original borehole were unsuccessful at locating any wet material or yielding groundwater.

Groundwater sample collection was generally successful when the screen point sampler encountered soils with a greater proportion of sand relative to silt and clay. The sandy layers generally ranged from 0.5 to 2 feet in thickness, forming lenses of sandy soil or silty sand that were more permeable than the overlying and underlying soils. In some cases, such as soil borings T05-R03A, T06-L05, and T10-L01, two groundwater samples were obtained, one from each of two distinct wet zones that were separated by dryer less permeable soil. Within these borings, oxidation-reduction potential (ORP) and dissolved oxygen (DO) content of the two zones were notably different from one another. These differences illustrate how groundwater quality and quantity within OU4 can vary significantly over small changes laterally and with depth. Many borings encountered silty material that appeared moist in the soil cores but did not produce free water, preventing sample collection.

2 Nature and Extent of Contamination

The nature and extent of contamination at OU4 was delineated during the RI using previous characterization of the site and additional collected data. Soil, surface water, and groundwater samples were collected from 2017 through 2019. Sample data were used to estimate risks to potential human and ecological receptors.

2.1 Summary of Site Contamination

The contaminants of concern (COCs) for OU4 are 10 VOCs of interest and 1,4-dioxane:

Alkanes: 1,1,1-Trichloroethane and Related

- 1,1,1-trichloroethane (1,1,1-TCA)
- 1,1-dichloroethane (1,1-DCA)
- 1,2-dichloroethane (1,2-DCA)
- 1,1-dichloroethene (1,1-DCE)
- Chloroethane
- 1,4-dioxane

Alkenes: Tetrachloroethene, Trichloroethene, and Related

- PCE
- TCE
- Cis-1,2-dichloroethene (cis-1,2-DCE)
- Trans-1,2-dichloroethene (trans-1,2-DCE)
- Vinyl chloride

The RI field investigation consisted of a Phase I study in summer 2016 and a Phase II study from summer 2017 through fall 2019. The Phase I study involved installation of 192 soil borings and collection of 389 soil samples and 173 groundwater samples from borings. Water and sediment samples were also collected from 10 locations along the unnamed stream for analysis of target compound list

VOCs: semivolatile organic compounds, pesticides, polychlorinated biphenyls, and target analyte list inorganics. The Phase II study involved installation of 12 shallow monitoring wells and five deep monitoring wells. Soil samples were also collected from the shallow wells. Each lithologic unit on OU4 was also sampled during well installation. Based on the results of the field investigation, a revised conceptual site model (CSM) for the site was prepared. (See Figures 2-1 through 2-3 for the revised CSM).

Shallow groundwater contaminants on OU4 originate from multiple upgradient source areas on the AVX property (north of OU4). For OU4, shallow groundwater contamination is greatest in the northern part of the site. Dense non-aqueous-phase liquid (DNAPL) could be present on-site, per analysis of VOC solubility in the samples (WSP 2022). If present, it would be a continuous and passive source of TCE to groundwater, but none was observed in the OU4 soil samples. No VOC source areas have been identified on OU4.

A total of 401 soil samples were collected from OU4 in this investigation. Soil samples containing the greatest concentrations of VOCs of interest were collected at or below the water table. The two highest concentrations of total VOCs (primarily TCE) in groundwater grab samples were collected from OU4 during the on- and off-site groundwater investigation conducted by AVX in August 2007 and were from soil borings GP-104 and GP-117. Of the 78 samples in which TCE was detected, 13 exceeded the Protection of Groundwater Soil Cleanup Objective (SCO; 0.47 milligrams per kilogram [mg/kg]) and five exceeded the Residential Use SCO (10 mg/kg). The greatest concentration of TCE in soil during the Phase I study (550 mg/kg) was detected in sample T03-R03B, collected from a depth of 10.5 to 11.5 feet bgs.

Cis-1,2-DCE and trans-1,2-DCE were detected in 19 and 11 soil samples, respectively. Cis-1,2-DCE was detected more frequently and at greater concentration than trans-1,2-DCE.

Vinyl chloride was detected in 15 soil samples, exceeding the Protection of Groundwater SCO (0.02 mg/kg) in 13 samples and the Residential Use SCO (0.21 mg/kg) in five samples. The greatest concentration of vinyl chloride (0.79 mg/kg) was detected in T03-R03, from 15 to 16 feet bgs. Four additional VOCs were detected above one or both applicable SCOs: 1,2,4-trimethylbenzene; benzene; naphthalene; and toluene. Of these, naphthalene exceeded applicable SCOs by the greatest magnitude.

In groundwater, PCE concentrations within OU4 are generally greatest in the northern portion of the former Weller property and the northwestern portion of the current Mastel Ford property. The greatest concentrations of PCE detected in OU4 groundwater was 31 micrograms per liter (µg/L), detected in each of three direct-push technology (DPT) groundwater samples: T09-L01B, T09-L01E, and T10-R01A. Twenty of 173 DPT groundwater samples exceeded the NYSDEC groundwater standard for PCE (5 µg/L).

TCE groundwater contamination was found to be widespread on both OU4 and the AVX property. TCE was detected in 134 of 173 DPT groundwater samples collected on OU4 and exceeded the NYSDEC groundwater standard for TCE (5 µg/L) in 71 samples.

The greatest detected groundwater concentration of TCE in groundwater in OU4 (28,000 µg/L) was detected in soil boring T04-R04, from 18 to 19 feet bgs, in the vicinity of well AVX-24S and historic DPT location GP-104.

Cis-1,2-DCE was also found to be widespread on both OU4 and the AVX property and is distributed similarly to TCE. The greatest detected groundwater concentration of cis-1,2-DCE in groundwater for OU4 (2,400 µg/L) was detected in soil boring T09-CL from 16 to 17 feet bgs, in the vicinity of MW-26S. Concentrations of various COCs are depicted in Figures 2-4 through 2-14.

In surface water, TCE was not detected, but PCE and DCE were detected in all samples at trace levels.

There is evidence that natural attenuation of chlorinated VOCs occurs in some areas of OU4 (WSP 2022). Natural attenuation likely occurs primarily along the central axis of the total VOC plume and onto the Mastel Ford property. Groundwater flow has been observed to spread contamination south and southeast, onto the former Weller and the Mastel Ford properties.

2.2 Contaminant Fate and Transport

2.2.1 General Factors Influencing Fate and Transport

Knowledge of contaminant fate and transport is important in determining how contaminants will be distributed throughout the environmental media at OU4. General factors controlling contaminant fate and transport include the following:

- The uppermost lithologic unit on OU4, known as the upper aquifer, consists of alluvial silt, sand, and gravel. The upper aquifer thins northward but is present nearly as far north as the AVX manufacturing building (USGS 1987).
- Fill material is found within 10 feet of the ground surface west of the unnamed stream, primarily on the former Weller property and farther west on the former Dal-Tile property, as well as east of the stream on the Mastel Ford property. West of the stream, the fill material was observed to contain multicolored mottled clayey soil with pieces of tile and brick. East of the stream, the fill was observed to contain large pieces of concrete and voids, brick, glass, plastic, and metal debris.
- The upper aquitard is composed of glacial till containing a dense mix of sand, silt, and clay.
- The lower aquifer, also known as the City Aquifer, underlies the upper aquitard. This unit is comprised of glacial outwash deposits of sand, gravel, and silt with relatively few fines.

- A shallow drainage swale that is no longer evident was historically present on the southern undeveloped portion of the AVX property. The swale began near the location where the end of a broken polyvinyl chloride (PVC) drainpipe, which is connected to a floor drain at the manufacturing building loading dock, exits the ground. Historically, the swale flattened out and was less defined as it entered the topo-graphic low area to the south. As reported in the AVX-17S Area Investigation Report, channeling of the drainage swale took place along the southern property boundary to improve drainage and reduce surface-water accumulation in the low-lying area in the vicinity of well AVX-17S (BBL 2005).
- A second, minor topographic swale is present in the vicinity of wells AVX-10S/D. The drainage swale is shown on the conceptual site model figures (Figures 2-1 through 2-3). This swale is shown in the 1,430-foot contour and aligns with the AVX-5 series wells, AVX-17S and the topographic low swampy area. Overland flow that occurs here would move downslope, past the AVX-5 series wells and toward the topographic low swampy area located 100 to 200 feet to the southwest. Elevated contaminant contours surrounding the drainage swale for 1,1-DCA, 1,1-DCE, 1,4-dioxane, TCE, cis-1,2-DCE, and 1,1,1-TCA that surround wells AVX-10S, AVX-5S, and AVX-17S (see Figures 2-4 through 2-9) suggest that a portion of contaminants in surface waters that have followed topography in this area may have infiltrated the ground surface and contributed to contamination in these monitoring wells.
- A previously leaky industrial sewer crosses the undeveloped property south of the AVX manufacturing building and residential properties and an independent auto repair shop on the western portion of OU4. The sewer was assessed in the early 1980s and was determined to be a potential conduit for movement of ground water and contaminants. The sewer was repaired between 1985 and 1994 (Geraghty and Miller Inc 1994).
- A junction box currently exists at the location presumed to be that of a corrugated metal and corrugated high density polyethylene pipe that conveys non-contact cooling water and production well bypass water. The junction box is located in proximity to the leaky industrial sewer line, which suggests the possibility that water was infiltrating from the junction box into the leaky industrial sewer.
- An unnamed stream crosses OU4, flowing north to south. The stream is a tributary to the Allegheny River and has been shown to be a gaining stream during each of the OU4 Phase II sampling events. It is largely supplied by effluent from AVX SPDES Outfall 004, located on the AVX property immediately north of the culvert that passes under the railroad tracks. The unnamed stream also accommodates surface water flow that originates north of OU4, beginning northeast of the intersection of Goodrich Avenue and Dugan Road (County Highway 92), as well as surface runoff originating on the AVX property from the Southern Undeveloped Property source area and from the land between Butler Avenue and the culvert under the railroad tracks leading to OU4. This area contains the historic Seneca Avenue landfill.

- Discharge from Outfall 004 is groundwater from the City Aquifer, produced by AVX pumping well PW-1. Groundwater pumped by PW-1 was used for noncontact cooling during operations. Though operations ended in 2018, PW-1 continues to pump at a rate up to 300 to 400 gallons per minute and discharge to Outfall 004 as part of the ongoing environmental remediation on the AVX property (EPA 2015a).
- Shallow groundwater in the upper aquifer/aquitard units (i.e., groundwater in wells up to 25 feet deep) north of the railroad tracks flows in a south to southeast direction, while south of the tracks the unnamed stream acts as a groundwater divide. Flow east of the stream is generally in a south-southwest direction, while flow west of the stream is generally in a southeast direction.
- Deep groundwater (i.e., groundwater in wells more than 30 feet deep, referred to as the City Aquifer) flows generally west, parallel to the Allegheny River valley.
- Vertical downward hydraulic groundwater gradients from the shallow aquifer to the City Aquifer calculated at shallow/deep well pairs averaged 0.57 foot per foot (ft/ft; ranged 0.37 ft/ft to 0.86 ft/ft) north of the railroad tracks; averaged 0.29 ft/ft (ranged 0.27 ft/ft to 0.32 ft/ft) south of the railroad tracks; and averaged 0.45 ft/ft (ranged 0.27 to 0.86 ft/ft) among all well pairs.
- Average shallow horizontal hydraulic gradient in the upper aquifer/aquitard units north of the railroad tracks was determined to be 0.0033 ft/ft; while south of the railroad tracks it was determined to be 0.0022 ft/ft east of the unnamed stream; 0.0025 ft/ft west of the unnamed stream; and 0.0027 ft/ft across OU4 and AVX, combined.
- Average hydraulic conductivity on OU4 in the upper aquifer unit, calculated from shallow monitoring well data, ranged from 0.25 to 2.18 foot per day (ft/day), with an average of 0.89 ft/day.
- Average groundwater velocity was determined to be 2.70 feet per year (ft/year) north of the railroad tracks, 0.98 ft/year east of the unnamed stream, 2.71 ft/year west of the unnamed stream, and 2.37 ft/year from AVX-5S to MW-29S. This represents a bulk number for the shallow hydrogeologic unit and some sand layers could have higher flow rates.

2.2.2 Potential Sources of Contamination

No sources of VOC contamination were identified within OU4. The lack of evidence of a spill of TCE in the unsaturated zone in soil samples collected from soil borings in this area indicates that source material potentially present here migrated onto OU4 from upgradient areas. Consistent with previous investigations (BBL 2003, 2005; Arcadis 2009), three source areas were confirmed on the AVX property during the current OU4 RI: The Former Solvent underground storage tank (UST) source area; the Stage I Remedial Action (RA) source area; and the northern portion of the Southern Undeveloped Property source area (Arcadis 2009).

The Former Solvent UST source area is comprised of contaminated soil left in place following removal of a 1,000-gallon concrete UST from the southeast corner of the AVX manufacturing building. The Stage I RA source area is comprised of contaminated soils left in place following excavation near the southeast corner of the AVX manufacturing building in July 2000. Contaminants in both sites are dominated by 1,1,1-TCA, followed by TCE, toluene, acetone, and other VOCs. The Southern Undeveloped Property source area, south of the AVX manufacturing building, contains several key features: a broken PVC pipe connecting to a floor drain at the manufacturing building loading dock, a drainage swale extending from said pipe, and the surrounding area, where it is believed chlorinated VOCs (specifically, TCE) were released to the ground surface.

2.2.3 Routes of Migration

Mechanisms that can result in migration of contaminants from off-site (i.e., not on or within OU4) source areas include surface water flow, infiltration, and groundwater flow.

Surface water on OU4 flows in an overall southerly direction, toward and eventually reaching the Allegheny River, located approximately 275 feet south-southwest of OU4. In the vicinity of the unnamed stream, or one of several minor tributaries thereof, surface water flows into the stream and, eventually, the Allegheny River. Overland flow of surface water on OU4 would allow some degree of lateral migration of contamination at the ground surface; however, current contamination detected at the ground surface was generally extremely low, and no documented incidences or evidence of chlorinated VOC spills have been found on OU4.

Although groundwater flow is the primary transport method, infiltration of surface water is expected in all areas not covered by a relatively impermeable barrier (i.e., concrete or asphalt) or structure. Infiltration is a greater factor in contaminant migration in unimproved areas that are continuously saturated and areas with high concentration of contaminants at the ground surface. Generally during the Phase II study, very little soil contamination was found in the unsaturated zone, particularly within 2 feet of the ground surface on OU4. While the unnamed stream flows continuously, overall concentrations of contaminants in the stream and sediments are relatively low; therefore, infiltration of surface water in these areas does not play a significant role in contaminant introduction or movement on OU4.

Groundwater flow is the primary contaminant transport mechanism at OU4 and on the upgradient AVX property affecting contaminants found in the subsurface. It drives both vertical and lateral migration of contaminants within the saturated zone and is responsible for mobilizing contaminants considerable distances from source areas. Groundwater in the overburden at OU4 is typically encountered 8 to 12 feet bgs, except immediately adjacent to (west of) the unnamed stream, as well as east of the unnamed stream. Groundwater levels in these areas have depths of 1 to 2 feet bgs or less. North of the railroad tracks, groundwater flows in a south to southeast direction, while south of the tracks the unnamed stream acts as a groundwater divide. Groundwater east of the stream generally flows in a south-southwest direction while groundwater west of the stream generally flows in a southeast direction.

2.2.4 Contaminant Persistence and Behavioral Characteristics

Chlorinated VOCs and 1,4-dioxane are the primary COCs at OU4.

Due to the moderate water solubility and sorption characteristics of chlorinated VOCs, these compounds may leach from soils and enter groundwater in the dissolved phase. It is possible for them to form a separate phase within an aquifer (i.e., DNAPL) given sufficient volume. These compounds also have a high potential for volatilization to the atmosphere. Chlorinated VOC degradation results in numerous byproducts that may not have been originally placed in the environment. The rate and extent depend on factors such as nutrient availability and microbial composition in soil and groundwater, and length of time passed since discharge. Bioaccumulation of chlorinated VOCs is not significant.

1,4-Dioxane is a heterocyclic organic compound. It will not form a separate phase. 1,4-Dioxane has a moderately high potential for volatilization to the atmosphere and a short half-life (one to three days) due to photooxidation. It moves rapidly from soil to groundwater and is relatively resistant to biodegradation in water and soil. 1,4-Dioxane may migrate rapidly in groundwater, ahead of other contaminants (EPA 2017).

The groundwater transport of aqueous-phase organic contaminants in the overburden groundwater is dependent on the physical characteristics of the aquifer and the chemical properties of the contaminant. Hydraulic conductivity in the upper aquifer unit ranged from 0.25 ft/day to 2.18 ft/day and averaged 0.89 ft/day within OU4. Horizontal hydraulic gradients on OU4 were calculated for both groundwater and surface water (0.0022-0.0225 and 0.00081, respectively). Shallow groundwater seepage velocities on OU4 were estimated to be to be 0.98 ft/year east of the unnamed stream and 2.71 ft/year west of the unnamed stream.

Using values from the 1985 OWF RI/FS, a mean shallow aquifer hydraulic conductivity for both OU4 and the AVX property was calculated to be 6.2 ft/day (as reported in the 1985 OWF RI/FS), as derived from slug tests. This value was used with a horizontal gradient of 0.02 and an effective porosity of 0.43. These values were obtained from the 1985 OWF RI/FS report to calculate an overall seepage velocity for the entire AVX property and OU4 area of 105 ft/year (ES 1985).

A portion of the VOCs discharged from the pipe or dumped at the head of the swale would flow downgradient, flowing along the ground surface more quickly than liquids underground because water flowing on the surface is relatively unimpeded by soil. Therefore, liquids released at the north end of the swale could travel for 300 feet or more before infiltrating (see Figure 2-1).

Detection of TCE and cis-1,2-DCE on the former Weller property and Mastel Ford property and the AVX properties was widespread during the current and historic investigations (BBL 2003, 2005; Arcadis 2009). This contaminant was detected at particularly high concentrations in the vicinity of PVC drainpipe, soil boring GP-22, and piezometer PZ-3I near the head of the swale pathway. The detection of cis-1,2-DCE at significant concentrations in groundwater suggests some TCE breakdown.

2.2.5 Observed and Predicted Migration

Potential significant migration pathways include surface water flow, infiltration, and groundwater flow.

Surface water flow can cause lateral migration of near-surface soil contaminants during significant precipitation events. Overland surface water flow plays a relatively minor role in contaminant mobilization on OU4 in recent years. In the surface samples from the unnamed stream, PCE exceeded the applicable screening criterion, and concentrations generally decreased from upstream to downstream. In addition, TCE was the only other VOC that exceeded applicable screening criteria. It was detected at 5.4 µg/L at location SW-06 in July 2016.

Groundwater flow in the shallow subsurface is the primary contaminant transport mechanism within OU4 and the AVX property for the VOCs of interest. Overburden groundwater flows downgradient and off-site with continuous recharge from the upgradient sources, where it generally originates on the AVX property. A portion of OU4 groundwater is also recharged by precipitation that infiltrates the ground and further mobilizes contamination. While 1,1,1-TCA detection upgradient of OU4 is widespread, the only significant concentrations found within OU4 were its breakdown products: 1,1-DCA and 1,1-DCE, as well as 1,4-Dioxane. 1,4-Dioxane's presence on OU4 suggests that this chemical originated from the Former Solvent UST and Stage I RA source areas on the AVX property. Concentrations of TCE; cis-1,2-DCE; trans-1,2-DCE; and vinyl chloride occur within OU4 primarily downgradient of the drainage swale pathway, the low swampy area, and the Southern Undeveloped Property.

Based on the time that has passed since TCE was reportedly first used on the AVX property in 1950, the distance that TCE could have migrated ranges from approximately 36 feet to 1,150 feet. Using the range of contaminant velocities, the RI concluded that TCE potentially reached the Allegheny River as long as 45 years ago in 1977. Based on the time that has passed since PCE was reportedly first used on the AVX property in 1970, the distance that PCE could have migrated ranges from 12 feet to 700 feet. Therefore, it is reasonable to estimate that PCE that infiltrated the ground in the Stage I RA source area, could have nearly reached the central portion of the former Weller property, and could certainly have migrated onto the northwestern portion of the Mastel Ford property.

Based on the time that has passed since 1,1,1-TCA was reportedly first used on the AVX property in 1970, the distance that 1,1,1-TCA could have migrated ranges from 25 feet to 1,100 feet. Therefore, it is reasonable to estimate that 1,1,1-TCA that infiltrated the ground in the Stage I RA source area, could have reached East State Street (New York State Route 417).

2.2.6 Natural Attenuation Evaluation

The purpose of the natural attenuation evaluation is to determine whether natural attenuation of chlorinated VOCs occurs within OU4 through reductive dechlorination. Groundwater samples from OU4 monitoring wells taken during June 2019 were used for analysis.

An increase in the concentration of daughter products (e.g., cis-1,2-DCE and vinyl chloride) relative to the concentration of the parent compound (e.g., TCE) is a key requirement for establishing the occurrence of natural attenuation by degradation processes. Detected concentrations of TCE in samples collected from OU4 range from 0.16 µg/L at MW-26S (located near the central portion of the former Weller property) to 12,000 µg/L at AVX-24S (located at the far northern/upgradient edge of OU4). Detected concentrations of cis-1,2-DCE and vinyl chloride range from 0.26 µg/L and 0.58 µg/L, respectively, to a high of 7,000 µg/L and 1,100 µg/L, respectively, in the sample collected from AVX-24S. This suggests that natural attenuation occurs within the plume. Note that these concentrations are from the 2017-2019 groundwater sampling, collected from 13 to 27 feet bgs and not the historic DPT sampling, collected from 18 to 19 feet bgs.

Greater dissolved organic carbon (DOC) concentrations (greater than 20 milligrams per liter [mg/L]) indicate favorable conditions for natural attenuation (WSP 2022). However, DOC concentrations in samples collected from monitoring wells on OU4 ranged from non-detect to 9.9 mg/L in MW-25S. Therefore, DOC concentrations on OU4 does not provide significant support of natural attenuation occurrence. Benzene, toluene, ethylbenzene, and xylene (BTEX) compounds can also be a source of carbon and energy used to reduce chlorinated compounds. Low levels of BTEX have been detected throughout OU4.

Chloride is produced during reductive dechlorination. Review of the data obtained from the cluster of City Aquifer wells (CW-10, CW-10A, and CW-10B) adjacent to the contaminant plume suggests that background levels are less than 10 mg/L. Chloride levels in monitoring wells on OU4 average approximately 40 mg/L. The increase in chloride levels suggests that reductive dechlorination may occur in the center of the contaminant plume, increasing chloride levels downgradient.

Reductive dechlorination, the primary biological treatment mechanism, occurs only in anaerobic conditions (less than 0.5 mg/L of DO). DO levels measured on OU4 showed fairly anaerobic conditions across the site; a majority of the shallow monitoring wells yielded DO concentrations below 0.5 mg/L.

ORP indicates the availability of electrons. ORP is generally limited to providing a relative comparison of electron availability. For OU4 groundwater, a general trend was observed from west to east sitewide. ORP readings on the former

Weller property are highest, decreasing to the east. ORP readings on the Mastel Ford property are generally negative, with the exception of monitoring well MW-35S. This parameter provides moderate support for natural attenuation in the eastern portion of OU4.
The presence of ferrous iron suggests sufficient reducing conditions to promote reductive dechlorination. Overall, ferrous iron concentrations in groundwater samples provide strong evidence of conditions that favor reductive dechlorination, especially on the Mastel Ford property.

Sulfate can compete as an electron acceptor under anaerobic conditions. A localized depletion of this anion compared to background concentrations suggests the occurrence of active anaerobic metabolism. Sulfate levels indicated a lower potential and moderate potential favoring natural attenuation for the former Weller property and Mastel Ford property, respectively.

Nitrate plays a role in natural attenuation similar to that of sulfate, and its concentrations are interpreted in a similar fashion. A localized depletion of this anion suggests the occurrence of active anaerobic metabolism. Nitrate concentrations were non-detect on the former Weller and Mastel Ford properties. There is insufficient evidence that nitrate levels are depleted on OU4. This provides minor evidence for the presence of conditions favoring natural attenuation on OU4.

Methane is an important parameter evaluated by the methane/ethane/ethene analysis. The presence of methane suggests strong reducing conditions, which are conducive to reductive dechlorination. A localized increase of methane suggests the occurrence of active anaerobic metabolism. Significantly elevated concentrations of methane were detected in monitoring wells MW-27S, MW-35S, AVX-24S, MW-33S, MW-30S, and MW-32S, ranging from 0.63 mg/L to 4.42 mg/L. Given that AVX-24S and MW-27S are the two areas of highest TCE concentration, there is an indication that some anaerobic metabolism, contributing to natural attenuation, occurs in these portions of the contaminant plume.

Ethene and ethane are final end-products of reductive dechlorination but require reducing conditions to be produced. The detection of ethane and ethene in monitoring wells AVX-24S, MW-27S, and MW-28S, with the highest concentration of both compounds in AVX-24S, suggests reducing conditions exist in the plume. In addition, ethane and ethene were detected in MW-33S and MW-35S, which are located downgradient of the plume. The presence of these compounds is an indicator of conditions favoring natural attenuation on OU4.

Overall, there is some evidence that natural attenuation of chlorinated VOCs occurs on OU4.

2.3 Risk Assessment Summary

The HHRA evaluated soil exposures to residents, outdoor workers, and construction workers on OU4, sediment and surface water exposures to adolescent recreational users using the unnamed stream, and groundwater exposures to future residents and indoor workers. Cancer risks were compared to the target risk range (10^{-4} and 10^{-6}), and non-cancer hazards were compared to the threshold of 1 established by the National Contingency Plan. Contamination in soil did not present cancer risk or non-cancer hazard exceeding these benchmarks. The child resident was associated with a hazard index (HI) greater than 1 due to exposure to arsenic, cobalt, iron, and manganese through ingestion of soil. However, the HI for each affected target organ was less than 1; therefore, these metals are not associated with unacceptable risk. Exposure to surface water and sediment contaminants also did not yield risks above EPA thresholds.

There is no current exposure to groundwater at the Site and groundwater is not expected to be used in the future. Institutional controls (ICs) were previously implemented to restrict the withdrawal of groundwater for use as drinking water (EPA 1985) and tap water is provided to individuals residing on OU4 from a public water supply system. However, if the groundwater was to be used for residential purposes in the future, it would present an unacceptable cancer risk due to ingestion of 1,4-dioxane and arsenic and ingestion of, dermal contact with, and inhalation of TCE and vinyl chloride. Non-cancer hazard also exceeded the threshold of 1 due to ingestion of cis-1,2-DCE, TCE, vinyl chloride, arsenic, iron, and manganese; dermal contact with cis-1,2-DCE and TCE; and inhalation of TCE and vinyl chloride. The HHRA determined that the use of groundwater as tap water for indoor workers would present the same risks.

It is unknown whether the metals within OU4 groundwater are: (1) related to an off-site source, (2) representative of natural background concentrations, or (3) mobilized due to contaminant-related geochemistry. Five metals were detected above applicable screening criteria in one or more wells: arsenic, total chromium, total and dissolved iron, total and dissolved manganese, and sodium. Each of these metals, however, are known to be naturally occurring and are commonly detected within groundwater in the northeastern United States. The elevated concentrations observed are not believed to be attributable to activities conducted by AVX, but rather to natural mineralogical variability, potentially combined with the presence of metals-containing fill. The fill historically used to increase the grade at OU4 is of unknown origin, and observations during the RI indicated the widespread presence of broken tiles, cinders, ash, concrete containing steel rebar, and slag material in both surface and subsurface soils. Each of these materials likely contributes to elevated metals concentrations. In addition, the review of background records found no documentation of large-scale use by AVX of products containing metals. As a result, the metals identified in the risk assessment are not considered site-related and are, therefore, not retained as COCs.

Vapor intrusion was evaluated qualitatively as a potential exposure pathway in the HHRA. For a health risk to exist, a source, a receptor, and a pathway must be present. Although a groundwater source and existing and potential future receptors are present, there is no current pathway for vapor intrusion into indoor air. According to the *OSWER Technical Guide for Assessing and Mitigating the Vapor*

Intrusion Pathway from Subsurface Vapor Sources to Indoor Air, a buffer zone of approximately 100 feet is used as a guideline to determine which buildings should be included in a vapor intrusion investigation (EPA 2015b). The occupied buildings within OU4 were identified to be approximately 100 feet or more from the edge of the contaminant plume; therefore, vapor intrusion was not found to be a currently completed pathway. In addition, a vapor intrusion study was performed in the vicinity of the Site in 2009. Approximately 33 sub-slab soil gas wells were installed in residential and commercial buildings during this effort, but the results of the study indicated that there were no impacts to the buildings on site. Nevertheless, the groundwater contaminant plume should not be considered stagnant or fixed, and a completed vapor intrusion pathway could potentially exist under future conditions. Should buildings be constructed within OU4, or should the contaminant plume migrate further downgradient toward the existing building on the Mastel Ford property, indoor air sampling may be required to reevaluate the vapor intrusion risk.

The screening-level ecological risk assessment (SLERA) considered potential ecological risks to terrestrial and aquatic assessment endpoints in a variety of plants, invertebrates and animals. Although potential risks to terrestrial plants, soil invertebrates, mammals and birds from select metals, polychlorinated biphenyls (PCBs), VOCs, and polycyclic aromatic hydrocarbons (PAHs) in surface soil exceeded acceptable levels for isolated sample locations, a risk within the entire OU4 area to these assessment endpoints was considered unlikely, especially given the conservative nature of the screening levels for these assessment .endpoints For aquatic biota, birds and mammals, and benthic organisms, surface water did not pose a considerable risk. Overall, the results of the SLERA suggest that potential ecological risks from metals and organic compounds in surface water, soil, and sediment are negligible and, therefore, further characterization of these media for ecological risk assessment purposes is not warranted.

Additional details regarding the HHRA and SLERA are discussed in the RI (WSP 2022).

3 Identification of Remedial Action Objectives and Standards, Criteria, and Guidelines

This section establishes RAOs, standards, criteria, and guidance (SCGs) and explains the selection of cleanup levels.

3.1 Remedial Action Objectives

RAOs are goals set for environmental media, such as sediment, soil, groundwater, and surface water (media-specific objectives), that are intended to protect human health and the environment. These RAOs form the basis for the FS by providing overall goals for site remediation. The RAOs are considered when identifying appropriate remedial technologies, formulating alternatives for the site, and during the evaluation of remedial alternatives. RAOs are based on engineering judgment, risk-based information established in the risk assessment, and potential ARARs, TBC, and guidance.

The focus of this FS is to address groundwater contamination at OU4. Residual soil and surface water contamination may be addressed by having surface water infiltration further mobilize the contaminants downward and be treated by the groundwater remedy. In addition, as described in Section 2.3, soil and surface water risks on site were found to be either negligible or not unacceptable. Therefore, soil and surface water contamination will not be directly addressed by this FS.

The RAOs for groundwater were developed based on the nature and extent of contamination, consideration of quantitative human health and ecological risk evaluation, and potential ARARs and SCGs. Based on this evaluation, the RAOs for OU4 are to:

- Eliminate the potential for future human exposure to site contaminants in groundwater at OU4 via direct contact, ingestion, or inhalation of vapors.
- Restore groundwater to beneficial use as a source of drinking water in a reasonable timeframe, by reducing contaminant levels to the more stringent federal or state drinking water standards.

Based on the results of the SLERA, contamination poses no to low risk to ecological receptors; therefore, RAOs associated with ecological receptors have not been developed.

3.2 Standards, Criteria, and Guidance

Standards and criteria refer to promulgated and legally enforceable rules or regulations. Guidance refers to policy documents that are non-promulgated and, therefore, are not legally enforceable. SCGs include ARARs, and other criteria TBC:

- Applicable requirements are legally enforceable cleanup or control standards or regulations and other substantive environmental protection requirements, criteria, or limitations promulgated under state or federal law that specifically address a hazardous substance, pollutant, contaminant, RA, location, or other circumstance at a National Priorities List site. "Applicability" implies that the RA or the circumstances at the site satisfy all of the jurisdictional prerequisites of a requirement, including the party subject to the law, the circumstances or activities that fall under the authority of the law, the time period during which the law is in effect, and the types of activities the statute or regulations require, limit, or prohibit.
- ARARs, as defined in the Comprehensive Environmental Response, Compensation, and Liability Act Section 121(d), include those standards, requirements, criteria, or limitations that have been promulgated under federal or state law, whichever is more stringent, that may not be "applicable" to the specific contaminant released or the remedial actions contemplated but are sufficiently similar to site conditions to be considered relevant and appropriate. If a relevant or appropriate requirement is well suited to a site, it carries the same weight as an applicable requirement during the evaluation of remedial alternatives.
- TBC criteria are non-promulgated advisories or guidance issued by federal or state agencies that may be used to evaluate whether a remedial alternative is protective of human health and the environment in cases where there are no standards or regulations for a particular contaminant or site condition. TBCs are not potential ARARs because they are neither promulgated nor enforceable, although it may be necessary to consult TBCs to interpret ARARs, or to determine preliminary remediation goals when ARARs do not exist for particular contaminants or are not sufficiently protective. Unlike ARARs, compliance with TBCs is not mandatory. The three types of SCGs (chemical-specific, location-specific, and action-specific) are described as follows:
  - Chemical-specific SCGs are usually health- or risk-based numerical values or methodologies that establish an acceptable amount or concentration of a chemical in the ambient environment. They are used to assess the extent of RA required and to establish cleanup levels for a site.
  - Location-specific SCGs are restrictions placed on the concentration of hazardous substances or the conduct of activity solely because the activities occur in special locations. Examples of location-specific SCGs include

building code requirements and zoning requirements. Location-specific SCGs are commonly associated with features such as wetlands, flood-plains, sensitive ecosystems, or historic buildings that are located on or close to the site.

- Action-specific SCGs are usually technology- or activity-based requirements that guide how remedial actions are conducted. These may include recordkeeping and reporting requirements; permitting requirements; design and performance standards for remedial actions; and treatment, storage, and disposal requirements.

ARARs, TBCs, and other guidelines relevant to OU4 are shown in Tables 3-1a through 3-1c.

3.3 Selection of Cleanup Levels

The proposed cleanup levels were selected by review of the ARARs, other guidance documents, and the results of the RI. Given that the RI found contamination sources within OU4 and that the contamination appears to be migrating in the shallow groundwater from the AVX property, groundwater contaminants are the focus of this FS. Cleanup levels were selected from the chemical-specific ARARs listed in Table 3-1a for groundwater.

The values for PCE, TCE, and vinyl chloride were sourced from 40 Code of Federal Regulations (CFR) Part 141 Subpart G, EPA's Maximum Contaminant Levels and 6 New York Codes, Rules, and Regulations (NYCRR) Part 703, Section 5, NYSDEC's Groundwater Quality Standards. Values for 1,1,1-TCA, 1,2-DCA, 1,1-DCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and chloroethane were sourced from 6 NYCRR Part 703, Section 5, NYSDEC's Groundwater Quality Standards. The cleanup objective for 1,4-dioxane was sourced from 10 NYCRR Part 5, Section 1, New York State Department of Health's Drinking Water Supply standards. The final selected cleanup levels are presented in Table 3-2.

4 Technology Screening and Development of Remedial Alternatives

Development of the alternatives was based on the results of preliminary screening of general response actions (GRAs) and technologies. The purpose of the preliminary screening is to eliminate remedial actions that may not be effective based on anticipated on-site conditions or that cannot be implemented at the site. The GRAs considered are intended to include those actions that are most appropriate for the site and, therefore, are not exhaustive.

4.1 General Response Actions and Screening of Technologies

Based on the information in the RI, GRAs were identified for OU4 of the Olean site. GRAs are broad categories of remedies that are capable of remediating contamination at a particular site. Each GRA may include several technologies or process options, some of which might be extensive enough to satisfy the RAOs and ARARs on their own, while others must be combined with different technologies and/or process options to achieve the remedial goals and objectives for OU4. The identification of GRAs is the first step in the identification of remedial technology types and specific process options.

Potential RAs, including GRAs and specific remedial technologies, were evaluated during the preliminary screening based on effectiveness, implementability, and relative cost. Past performance (e.g., demonstrated technologies) and operating reliability were also considered when identifying and screening applicable technologies. Technologies that were not initially considered effective and/or technically or administratively feasible were eliminated from further consideration.

GRAs identified for contaminated groundwater on-site are as follows:

- No action
- ICs
- Monitored natural attenuation (MNA)

- In-situ treatment
- Treatment of extracted groundwater

The selection of technologies and process options within each GRA is based on addressing VOC and 1,4-dioxane contamination in groundwater. The remedy selection process is focused to reflect only those potentially applicable technologies and process options common to RAs performed or considered at sites similar to OU4. GRAs were not identified for surface soils. A screening of technologies and process options was performed to identify technologies that will be applicable for addressing the groundwater contamination in OU4. A summary of the retained technologies associated with the GRAs is provided in Table 4-1.

4.2 Development of Remedial Alternatives

Based on the RAOs and GRAs for OU4, six alternatives were developed for this FS. The alternatives generally fall within four different categories: no action, limited action, in situ treatment, and extracted groundwater treatment. Each alternative is discussed in the following sections.

With the exception of Alternative 1, each of the action alternatives can reduce groundwater contamination. However, it is uncertain as to whether an individual technology can achieve the RAOs alone. Long-term monitoring will be conducted to determine whether the RAOs are achieved by the selected alternative. Based on long-term monitoring results, additional treatment may be required to achieve the RAOs of the project and target areas with contaminant concentrations above cleanup levels

4.2.1 Alternative 1 – No Action

The no action alternative is included for OU4 pursuant to the National Contingency Plan (40 CFR §300.340(e)(6)). This alternative is used as a basis for comparison with the other alternatives. Under this alternative, no remedial or limited action takes place. Because this alternative will result in contaminants remaining above levels that allow for unrestricted use and unlimited exposure, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requires that OU4 be reviewed at least once every five years.

4.2.2 Alternative 2 – Monitored Natural Attenuation and Institutional Controls

Alternative 2 involves the use of two limited actions – MNA and ICs. MNA refers to the monitoring of naturally occurring in-situ processes that decrease the mass or concentration of contaminants, observed and recorded over time, until site-specific remedial goals are achieved.

The processes involved in natural attenuation include dispersion, sorption, volatilization, and chemical/biological processes (i.e., stabilization, transformation, and/or destruction). Anaerobic biodegradation of site contaminants has been observed in the OU4 groundwater, making MNA a potentially viable limited action for the site. The attenuation process will be monitored by performing groundwater sampling throughout the contaminant plume. For the purposes of developing a cost associated with the groundwater monitoring portion of this alternative, it has been assumed that 21 existing groundwater wells and two newly installed wells (for a total of 23 groundwater monitoring wells) will be sampled quarterly for the first two years, semiannually for Years 3 through 5, and annually thereafter for VOCs and 1,4-dioxane, and quarterly for the first two years and annually for Years 3 through 30 for MNA parameters. A yearly summary report of the findings will be prepared for the duration of this alternative.

The locations of the two proposed wells are shown along with the existing monitoring well network in Figure 4-1. For cost-estimating and planning purposes, the existing wells proposed to be included in the groundwater sampling/long-term monitoring program: AVX-22S, AVX-23S, AVX-24S, CW-10B, CW-9A, MW-25S, MW-26S, MW-27S, MW-27D, MW-28S, MW-29S, MW-30S, MW-31S, MW-32S MW-33S, MW-34S, MW-35S, MW-35D, MW-36S, MW-36D, and MW-XX. Data from the sampling activities at the AVX property will be obtained for comparison with the OU4 data in the annual reports.

It is assumed that the new wells, MW-37S and MW-38S, will be constructed to a depth of 20 to 22 feet bgs, with a 10-foot slotted screen, with 2-inch-diameter PVC and a 4-inch-diameter borehole. Fine sand is anticipated to be used as the filter pack surrounding the screen and extending 2 feet above the top of screen. Two feet of bentonite seal will be placed above the filter pack, and the remaining portion of the borehole will be completed with grout.

ICs refer to non-physical means of enforcing a restriction on the use of property to limit human and environmental exposure. This is done through legal restrictions on groundwater use, restriction of potential site activities (e.g., zoning), providing notice to potential owners or members of the public, and/or preventing actions that will interfere with the effectiveness of the remedial program or with the effectiveness of maintenance and monitoring activities at OU4. ICs typically include easements, deed restrictions, covenants, well drilling prohibitions, groundwater use restrictions, zoning restrictions, and requirements to be incorporated into building or excavation permits. A Site Management Plan will be developed that will specify ICs to restrict exposure to hazardous substances until RAOs are met. In addition to groundwater use restrictions, construction of buildings of any kind will be prohibited unless an evaluation of the potential for vapor intrusion into such buildings is conducted, and mitigation, if necessary, is implemented.

ICs could include proprietary controls (e.g., deed restrictions for groundwater use and construction of buildings), existing governmental controls (e.g., well permit requirements), and informational devices (e.g., publishing advisories in local newspapers and issuing advisory letters to local governmental agencies regarding groundwater use in the impacted area).

Section 121(c) of CERCLA, 41 United States Code §9621(c), requires a review no less than every five years if hazardous substances, pollutants, and contaminants remain on site. Because this alternative will result in contaminant concentrations that remain above cleanup levels, CERCLA requires that OU4 be reviewed at least once every five years (five-year review) to evaluate the protectiveness of the remedy. Given the current uncertainty associated with the site-specific attenuation process, for cost-estimating purposes it has been assumed that 30 years of groundwater monitoring will be performed and six five-year reviews will be conducted.

4.2.3 Alternative 3 – Permeable Reactive Barrier with Long-term Monitoring and Institutional Controls

Alternative 3 involves using one permeable reactive barrier (PRB) in addition to long-term monitoring and ICs. The long-term monitoring network and ICs included in this remedial alternative are as described for Alternative 2.

A PRB creates a preferential path for groundwater to flow through reactive media that treat a contaminated groundwater plume. There are three common configurations of a PRB: a trench, a funnel wall and gate, and a series of injection wells. A trench-style PRB is dug perpendicular to the path of the plume and filled with reactive media. A funnel wall and gate PRB is an impermeable wall constructed perpendicular to the flow path of the plume with an opening (gate) filled with gravel and reactive media. A PRB created by a series of injection wells typically consists of one or two parallel lines of wells, oriented perpendicularly to the path of the plume, where reactive media is injected. The actual type of PRB will be determined during the remedial design.

The reactive media associated with a PRB is typically zero-valent iron (ZVI), which has been shown to reduce chlorinated VOCs and precipitate metals. ZVI will reduce chlorinated VOCs such as PCE, TCE, and 1,1-DCE to ethane. Other reactive media that are appropriate for the chlorinated VOCs are mulch or vegetative material, and/or a combination of ZVI and mulch or other carbon-based material. Mulch and vegetative material are anticipated to require more frequent replacement than ZVI. The selection of reactive media is based on the longevity of the reactive material as well as the byproducts of reactions within the PRB. Additional oxidizing material may be required to target 1,4-dioxane present within OU4 as it is not susceptible to chemical reduction (EPA 2022).

The remedial design will determine the configuration and location of the PRB as well as the reactive media to be implemented. For the purposes of developing an alternative and the associated cost, it has been assumed that one trench style PRB will be constructed. The PRB will be constructed at the downgradient boundary of the site to mitigate groundwater contaminant migration off site toward Allegheny River. It is also assumed that ZVI will be used as the medium. The exact location, orientation, and material used for the PRB will be determined during the remedial design.

The proposed location of the PRB is shown in Figure 4-2. For cost-estimating purposes, a depth of 20 feet and a thickness of 3 feet was assumed for the PRB. Reactive media will fill the trench up to the surface. Included in this alternative is groundwater monitoring at locations upgradient and downgradient of the PRB. The expected effective operational life of coarse ZVI is approximately 15 years (ITRC 2011). The location and dimensions of the PRB shown on Figure 4-2 are conceptual in nature and may be changed during the remedial design.

The remedial design will determine the overall operational period for the PRB. For the purposes of this alternative development, it is assumed that the PRB will be in operation for a period of 15 years and that it will be constructed so that there are no adverse impacts on the unnamed stream and so the stream does not impact its effectiveness. It was assumed that the coarse ZVI PRB material will not be replaced after 15 years. For the purposes of developing this alternative, it is assumed that long-term monitoring of attenuation processes will continue to be implemented for an additional 15 years after the conclusion of the PRB treatment.

As stated above, long-term groundwater monitoring will be conducted to determine whether the RAOs are achieved by the selected alternative. Sampling for VOCs and 1,4-dioxane will follow the same schedule as Alternative 2. For MNA parameter sampling, baseline samples will be collected from the monitoring well network one time before PRB installation, then once every five years through year 30. Because this alternative will result in contaminant concentrations that remain above the cleanup levels, CERCLA requires that OU4 be reviewed at least once every five years. If justified by the review, additional response actions might be implemented.

4.2.4 Alternative 4 – Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and Institutional Controls

Alternative 4 involves the construction of an air sparging (AS) and soil vapor extraction (SVE) system, as well as the use of the long-term monitoring network and ICs as described for Alternative 2. Implementation of the AS/SVE system will remove contaminants in the areas of highest groundwater contamination and mitigate migration of contaminants. The system will be operated until contaminant levels in the groundwater are no longer being effectively reduced, potentially due to low permeability of soils, after which the system will be removed from OU4 and the impacted area restored. The AS/SVE treatment will decrease the mass of contaminants, which will reduce the overall time to achieve groundwater cleanup goals.

AS is an in-situ technology in which air is injected through a contaminated aquifer to volatilize contaminants and flush contamination into the unsaturated zone. This technology typically is used in conjunction with SVE, a technology that creates a vacuum in the subsurface, to collect the VOC-laden sparge gas. An additional benefit of the SVE system is that it can also remove residual VOC contamination from the unsaturated zone. In order for this technology to be effective for

1,4-dioxane, enhancements such as heated air injection or increased injection/extraction flows may be required. Once the contaminated vapor is extracted, contaminants are adsorbed using activated carbon or broken down by a catalytic oxidizer. The selection of the vapor treatment method is dependent on the magnitude of contaminant concentrations in the extracted vapor, with higher concentrations requiring the use of a catalytic oxidizer to minimize costs and stay within emission limits without frequent replacement of treatment material.

While the remedial design will determine the exact number of AS and SVE wells, as well as the effluent pollution control equipment (i.e., catalytic oxidizer or granular activated carbon), it has been assumed for costing purposes that three AS wells will be constructed in each of the three areas of highest contamination (e.g., near monitoring wells MW-35S, AVX 24S, and MW-27S) for a total of nine AS wells, and 12 SVE wells will be constructed to collect the sparge gas. A pilot test is recommended as part of the remedial design to determine final configuration of the collection system and to determine the type of air treatment system that will be required.

Figure 4-3 shows the proposed layout of the AS/SVE wells and associated trailers. To avoid pipe crossings under the unnamed stream, there will be two separate treatment trailers and piping systems—one connecting the six AS wells and eight SVE wells west of the stream and the other connecting the three AS wells and four SVE wells east of the stream. The wells are centered around the higher contaminant areas in the vicinity of MW-27S (approximately 1,000 µg/L) and oriented along the northern border of OU4 where the highest concentrations of VOCs have been detected in the shallow groundwater. It is anticipated that the AS wells will be installed to depths of 15 feet below the water table with 2-foot screens, and the SVE wells will be installed to a depth of 4 to 10 feet with 2- to 4-foot screens. The proposed well diameter is 2 inches, with 4-inch-diameter boreholes. Fine sand is anticipated for use as the filter pack surrounding the screen and extending 1 to 2 feet above the top of screen. One to two feet of bentonite seal will be placed above the filter pack, and the remaining portion of the borehole will be completed with grout. The location and dimensions of the system shown on Figure 4-3 are conceptual in nature and may be changed during the remedial design.

This alternative requires treatment system maintenance, so an operation and maintenance (O&M) plan will be developed. The O&M plan will include system construction details, operating requirements, site inspection forms, sampling requirements, and maintenance activities. The remedial design will provide a time frame for the operations of the AS/SVE system. To develop a cost for this alternative, it has been assumed that the AS/SVE system will be in operation for a period of 10 years. The system will be constructed so that there are no adverse impacts on the unnamed stream and so the stream does not impact the system's effectiveness. For the purposes of developing this alternative, it is assumed that long-term monitoring of attenuation processes will continue to be implemented for a period of 20 years after the conclusion of the AS/SVE treatment.

As stated above, long-term groundwater monitoring will be conducted to determine whether the RAOs are achieved. Sampling for VOCs and 1,4-dioxane will follow the same schedule as Alternative 2. For MNA parameter sampling, baseline samples will be collected from the monitoring well network once before system installation, every three years during active treatment, and the last year of active treatment (i.e., during years 3, 6, 9, and 10), and every three years for years 11 to 30 (i.e., years 13, 16, 19, 22, etc.). Because this alternative will result in contaminant concentrations that remain above the cleanup levels, CERCLA requires that OU4 be reviewed at least once every five years. If justified by the review, additional response actions might be implemented.

4.2.5 Alternative 5 – In situ Chemical/Biological Treatment, Long-term Monitoring, and Institutional Controls

Alternative 5 involves the use of in situ chemical reduction (ISCR), in situ chemical oxidation (ISCO), and/or enhanced bioremediation through injection, as well as the use of the long-term monitoring network and ICs as described for Alternative 2. ISCR, ISCO, or enhanced bioremediation injections will decrease the overall operational time frame associated with achieving the groundwater cleanup goals by treating contaminants at the centralized hot spots.

Injection of ISCR materials is used to chemically reduce contaminants in the dissolved phase. ISCR is designed to create abiotic reductive dechlorination of VOCs. Reductants such as ZVI or zero-valent zinc are typically used for ISCR and are appropriate materials for this site. ISCR materials are typically injected in zones with elevated levels of contaminant concentrations. Once injection occurs, this technology is passive, requires no energy, and relies on transport of the dissolved VOCs to the treatment zone.

Injection of ISCO materials is used to chemically oxidize contaminants in the dissolved phase. ISCO material is a more appropriate injection material for the area contaminated with 1,4-dioxane. This technology works similarly to ISCR except that oxidants such as permanganate or hydrogen peroxide are typically used.

Enhanced bioremediation involves the injection of an electron donor (e.g., hydrogen) into an aquifer to increase the rate of anaerobic biodegradation already occurring in the subsurface. Reductive dechlorination, the anaerobic biodegradation of chlorinated VOCs, has been observed to occur on-site, so this process will enhance that existing mechanism. For cost-estimating purposes, it was assumed that electron donor material, such as 3-D Microemulsion or Hydrogen Release Compound® made by REGENESIS will be used. However, during the remedial design, other amendments can be considered and a treatability study is recommended to determine the amendment to be used as well as potential impacts to the public supply wells.

To increase the effectiveness of the injected amendment, electrokinetic-enhanced injection of the amendment could be implemented. This technology involves the installation of electrode wells below the ground surface that are powered and used to establish a voltage gradient and direct-current electric field that can transport material more easily through the subsurface (ESTCP 2018). It has been shown to enhance the mobility of reductants, oxidants, and bioamendments and could be used at OU4 to increase transport of the injected material.

This alternative will involve construction of multiple injection points within the contaminated plume, grouped in areas with the highest concentrations of contamination. The reductant, oxidant, or electron donor material will be injected intermittently, and groundwater concentration monitoring will guide injection timing. Injection wells and DPT can both be used to inject the amendment, with injection wells providing easy access to the same location for repeated injections and DPT allowing for flexibility in injection location and depth as needed.

The remedial design will determine the configuration and number of injection points, the frequency of injections, and the injected reagent and potential use of electrokinetic enhancement. For the purposes of developing this alternative and the associated costs, it has been assumed that eight lines of injection points will be installed downgradient of the higher contamination areas (approximately 1,000 µg/L), and electrokinetic enhancement will not be used. The locations and orientation of these injection point lines are shown in Figure 4-4. It is assumed that half of the injection points will be injection wells and half will be direct-push injections to allow for flexibility in injection locations. The proposed spacing of the injection points along these lines is 10 feet. The total length of injection points is approximately 827 feet, resulting in 83 injection points. It has been assumed that three rounds of injections with four sampling events associated with each injection round will be required over the course of two years and that a reductant will be used as the reagent. The location and timing of injections are conceptual in nature and may be changed during the remedial design. For the purposes of developing this alternative, it is assumed that long-term monitoring of attenuation processes will continue to be implemented for a period of 20 years after the conclusion of the injection treatments.

As stated above, long-term groundwater monitoring will be conducted to determine whether the RAOs are achieved by the selected alternative. Sampling for VOCs and 1,4-dioxane will follow the same schedule as Alternative 2. For MNA parameter sampling, baseline samples will be collected from the monitoring well network once before amendment injection, annually during active treatment and once after the end of treatment, and then every three years after the completion of active treatment. Because this alternative will result in contaminant concentrations that remain above the cleanup levels, CERCLA requires that OU4 be reviewed at least once every five years. If justified by the review, additional response actions might be implemented.

4.2.6 Alternative 6 – Pump and Treat, Long-term Monitoring, and Institutional Controls

Alternative 6 involves the extraction and treatment of groundwater, long-term monitoring of attenuation processes, and ICs as described for Alternative 2. Removal and treatment of contaminated groundwater will decrease the overall operational time frame associated with achieving the groundwater cleanup goals by removing contaminants at the centralized hot spots and preventing migration of contaminants.

While the remedial design will determine the method and volume of groundwater extraction, it is assumed for costing purposes that a horizontal well will be drilled east of the unnamed stream to minimize issues with poor permeability of subsurface soils, while three vertical wells will address contamination west of the stream. Groundwater will be pumped from the horizontal and vertical wells to two treatment systems, where it will be treated. To avoid pipe crossings under the unnamed stream, there will be two separate treatment trailers and piping systems. Another option for groundwater extraction and treatment is a hydraulic trench, which could be paired with singular or multiple horizontal or vertical wells.

The remedial design will determine the method of groundwater treatment. Typically, air stripping and/or granular activated carbon are used to treat extracted groundwater. Air stripper treatment involves the volatilization of contaminants into air, which is then treated or filtered before it is discharged. This treatment method is not effective for 1,4-dioxane (EPA 2022). For carbon adsorption, contaminated groundwater is pumped through vessels containing activated carbon. Another potential option for treatment is ultraviolet oxidation, where groundwater is pumped through oxidizers and irradiated with ultraviolet light, which is more effective in treating 1,4-dioxane. After treatment, the treated water will be discharged to the unnamed stream on the property or a publicly owned water treatment facility or reinjected into the ground. An SPDES permit equivalency would be required for discharge of the treated water to the unnamed stream or for reinjection of treated water into the ground, but would not be required if the treated water is discharged to a publicly owned water treatment facility. For cost-estimating purposes, discharge to the unnamed stream within OU4 was assumed. This alternative requires constant site maintenance, so an O&M plan will be developed. The O&M plan will include the system construction details, operating requirements, site inspection forms, sampling requirements, and maintenance activities.

Though the exact location, depth, and length of the horizontal well will be determined during the remedial design, a well with a depth of 10 to 15 feet and length of 160 horizontal feet was assumed for costing purposes. The riser for the well will be located close to AVX-24S, with the upgradient end of the well close to MW-27S. The groundwater extraction well stickup will be installed in a 4-inch-diameter borehole drilled using hollow stem augers, using a 2-inch-diameter PVC stickup. The horizontal well trench will be constructed using slotted pipe at a slope. The three vertical wells will be installed in the vicinity of MW-35S and

AVX-22S using a 4-inch-diameter borehole drilled using hollow stem augers with a 2-inch-diameter PVC stickup. The well layouts and proposed trailer locations are shown on Figure 4-5. The locations of these wells and treatment systems are conceptual in nature and may be changed during the remedial design if this alternative is selected.

For the purposes of developing a cost estimate, it has been assumed that the pump and treat system using air stripping and granular activated carbon for treatment will be in operation for 20 years. It is assumed that long-term monitoring of attenuation processes will continue for a period of 10 years after the conclusion of the pump-and-treat remedy. Long-term groundwater monitoring will be conducted to determine whether the RAOs are achieved by the selected alternative. Sampling for VOCs and 1,4-dioxane will follow the same schedule as Alternative 2. For MNA parameter sampling, baseline samples will be collected from the monitoring well network once before system installation, every five years during active treatment and the last year of active treatment (i.e., during years 5, 10, 15, and 20), and every three years for years 21 to 30 (i.e., years 23, 26, and 29). Because this alternative will result in contaminant concentrations that remain above the cleanup levels, CERCLA requires that OU4 be reviewed at least once every five years. If justified by the review, additional response actions might be implemented.

5 Remedial Alternative Evaluation

This section presents the CERCLA evaluation criteria and provides detailed individual analyses of the remedial alternatives with regards to each criterion.

5.1 Evaluation Criteria

The EPA has established nine evaluation criteria, as presented in 40 CFR §300.430(e)(9)(iii), to address the statutory requirements when evaluating remedial alternatives. The first two criteria relate to statutory requirements and are considered threshold criteria, which each remedial alternative must satisfy in order to be eligible for selection. The next five criteria are referred to as primary or balancing criteria and are used to evaluate the technical aspects of remedial alternatives in terms of relative effectiveness in order to assess each alternative's strength and weaknesses. The final two criteria are considered modifying criteria and will be addressed in the ROD once comments are received on the FS report and the proposed plan.

The nine criteria are as follows:

Threshold Criteria:

1. Overall protection of human health and the environment
2. Compliance with ARARs

Primary Criteria:

3. Long-term effectiveness and permanence
4. Short-term effectiveness
5. Reduction of toxicity, mobility, and volume through treatment
6. Implementability
7. Cost

Modifying Criteria:

8. State acceptance
9. Community acceptance

A detailed description of each evaluation criterion is provided in the following bullets:

- **Overall Protection of Human Health and the Environment**

  This criterion is used to assess the ability of a remedial alternative to protect human health and the environment from the identified short- and long-term risks from COCs identified as part of the RI. The overall assessment of protection draws on the assessments conducted under other evaluation criterion such as compliance with ARARs, long-term effectiveness and permanence, and short-term effectiveness. Evaluation under this criterion describes how site risks posed through each pathway are eliminated, reduced, or controlled through treatment, ICs, or engineering controls (ECs) under each remedial alternative. Protectiveness of human health and the environment is evaluated based on the remedial alternative's ability to reduce COCs to meet the RAOs and/or reduce exposure pathways.

- **Compliance with ARARs**

  This criterion is used to determine whether a remedial alternative will meet the ARARs identified in Section 3.2 or provide justification for invoking a waiver under Section 121 of CERCLA. This section also presents a discussion on how each alternative complies with the pertinent individual ARARs.

  The ability of a remedial alternative to comply with certain ARARs that have been identified for the RA can depend entirely on the way the remedy is implemented. For evaluation purposes, it is assumed that any remedy selected will be implemented in a manner that will meet these ARARs.

- **Long-term Effectiveness and Permanence**

  Long-term effectiveness and permanence are evaluated with regard to the residual risk posed by each alternative with respect to: (1) the residual risk remaining at the site after implementation of the remedial alternative; and (2) the long-term adequacy and reliability of the remedial alternative, including requirements for management and monitoring. Alternatives that afford the highest degree of long-term effectiveness and permanence leave little to no COCs at the site above the proposed cleanup levels.

- **Short-term Effectiveness**

  This criterion assesses the risk posed to the community, workers, and the environment during the implementation of the RA before the RAOs are achieved. Measures that will be taken to mitigate these risks will be addressed under this criterion, as well as consideration for the time required to achieve the RAOs.

- **Reduction of Toxicity, Mobility, and Volume through Treatment**

  Reduction of toxicity, mobility, and volume through treatment is the statutory preference by the EPA under CERCLA to select an RA that utilizes treatment technologies on-site. This criterion is used to assess the performance of remedial alternatives to reduce the inherent risk of the COCs in achieving this preference. Treatment technologies that permanently and significantly reduce toxicity, mobility, or volume are typically preferred over alternatives that only manage untreated wastes. Relevant factors to be considered in the assessment of this criterion include the amount of contaminated waste treated, destroyed, or recycled; the reduction in toxicity, mobility, or volume; the irreversibility of the treatment process, the type and quantity of residual waste; and the degree in which treatment is used as the primary RA of the alternative.

- **Implementability**

  This criterion is used to assess the technical feasibility (constructability, reliability of the technology, operation, and monitoring requirements); administrative feasibility (coordination with other agencies); and the availability of services, goods, and materials (labor, equipment, and materials) to implement the RA.

- **Cost**

  Costs included in the estimates are capital, annual O&M, periodic inspections, and CERCLA five-year reviews. Costs are evaluated over the estimated remediation period. The actual length of remediation of contaminants cannot be determined, though it is expected that remediation progress will be assessed and improved upon during each five-year review. Therefore, a 30-year period was used for estimation purposes, using present value discounting for O&M, inspections, and five-year reviews. An interest rate of 7% used to calculate present values was applied based on *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000), the preamble to the National Contingency Plan (55 CFR 8666), and the latest Office of Management and Budget Circular A-94 Appendix C (OMB 2020).

  Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Costs are based on information obtained from a variety of sources, including quotes from suppliers, published cost information for previous similar projects, cost estimates for materials, equipment and services provided, vendor information, generic unit costs based on engineering judgement, and the 2021 RSMeans Site Work and Landscape cost-estimating guide. A contingency fee of 20% and a legal, administrative, engineering, and construction management fee of 10% was added to the total capital cost and each periodic cost before the present values were calculated. Cost estimates developed for the alternatives analysis in the FS are intended to reflect actual costs with an accuracy of +50% and -30% (EPA 2000).

- **State Acceptance**

  This assessment evaluates the technical and administrative issues and concerns that the state (or support agency) may have regarding each of the remedial alternatives. State acceptance is not part of the evaluation process provided within this document. Following the issuance of the Proposed Plan, this criterion will be developed.

- **Community Acceptance**

  Community concerns include support or opposition to components of the preferred alternative or other alternatives and are addressed separately. Community acceptance will be included in the ROD, which will select the final RA following public comment.

5.2 Evaluation of Remedial Alternatives

The following sections evaluate each alternative using the EPA-developed criteria described above. Please note that the state and community acceptance criteria development is not part of this report preparation.

5.2.1 Alternative 1 - No Action

The No Action Alternative is evaluated as a procedural requirement under the Superfund program and as a basis for comparison with the other alternatives. The No Action alternative makes no provisions for treatment, containment, removal or disposal of wastes and no ICs will be implemented. The site will be left in its present condition and no protection to human health or the environment will be provided.

Overall Protection of Human Health and the Environment

This alternative offers no protection of human health and the environment because no action will be taken to reduce the contamination in groundwater, prevent use of the contaminated groundwater, or monitor changes in contaminant concentrations to determine whether the cleanup levels have been achieved.

Compliance with ARARs

ARARs are requirements that must be met (or waived) if an RA is to be taken. Under Alternative 1, no remedial activity will be performed and, as a result, all ARARs will not be met under this alternative.

Long-Term Effectiveness and Permanence

The No Action Alternative does not offer long-term effectiveness or permanence and current and potential future risks remain unchanged at the site.

Short-Term Effectiveness

Under the No Action Alternative, no additional short-term exposure risks will be created. There will also be no adverse impacts to traffic flow, water resources, ambient noise, or air quality from the implementation of this alternative.

Reduction of Mobility, Toxicity, and Volume through Treatment

This alternative involves no treatment. The toxicity, mobility, and volume of the COCs will remain the same under this alternative. Although dispersion and degradation processes may naturally occur (i.e., not through treatment), they will not be monitored or documented under this alternative and, therefore, there is no reduction of mobility, toxicity, and volume from Alternative 1.

Implementability
While technically implementable as no action will be taken, Alternative 1 is not considered to be administratively implementable because the groundwater contaminants remain at concentrations above their respective cleanup levels.

Cost
There are no capital or periodic costs associated with Alternative 1.

5.2.2 Alternative 2 – Monitored Natural Attenuation and Institutional Controls
Under this alternative, MNA and ICs will be implemented. The groundwater monitoring network will be expanded by installing two new groundwater monitoring wells. Groundwater sampling to document the MNA activity in the groundwater will be completed as well. A Site Management Plan will be developed to outline the sampling procedures, frequency for groundwater sample collection, and ICs to restrict exposure to hazardous substances until RAOs are met.

Overall Protection of Human Health and the Environment
Alternative 2 can provide protection of human health and the environment. Based on analytical data obtained from the RI, biodegradation of VOC contaminants occurs on-site. Degradation rates have not been determined and additional data is needed to ascertain when cleanup levels will be met. Initially, the ICs will limit human exposure to VOCs on-site until the MNA process reduces groundwater contaminant concentrations to levels that are close to their respective cleanup levels. The EPA considers MNA to be “an appropriate remediation method only where its use will be protective of human health and the environment and it will be capable of achieving site-specific remediation objectives within a timeframe that is reasonable compared to other alternatives” (EPA 1999). Given the concentrations of VOCs on site, the timeframe to achieve cleanup levels is uncertain; however, it is not anticipated to occur within a reasonable timeframe. The reliance on ICs does, however, make this alternative protective of human health and the environment.

Compliance with ARARs
MNA will result in a decrease in concentrations of VOCs. As degradation continues, the VOC concentrations in groundwater may reach levels that will meet their cleanup levels but it is unlikely that compliance with ARARs will be achieved within a reasonable timeframe as defined by the EPA (EPA 1999). Therefore, this alternative alone does not achieve compliance with the ARARs.

Long-Term Effectiveness and Permanence
The long-term effectiveness will be evaluated using data from the periodic sampling activities. As mentioned in Section 2.2.6, there is evidence that natural attenuation of chlorinated VOCs occurs at OU4. Natural attenuation likely occurs primarily along the central axis of the plume and onto the Mastel Ford property. The increase in concentration in daughter products with respect to TCE indicates that the plume is undergoing MNA. This attenuation process reduces chlorinated

VOCs by cleaving the chloride ions from the molecule, ultimately producing a benign compound. This reduction process is irreversible; therefore, this alternative offers long-term effectiveness and permanence. Though the amount of time it will take to achieve long-term effectiveness and permanence is uncertain, it is not anticipated to occur within a reasonable timeframe.

Short-Term Effectiveness

There will be a minor disturbance associated with the installation of two new groundwater monitoring wells. However, it is anticipated that this disturbance will be approximately five-working days in duration. Dust generation and noise propagated by drilling activities can be managed through the use of appropriate site controls and establishing reasonable work hours. The potential exposure to contaminated groundwater does still pose a short-term threat, which can be mitigated though the use of the appropriate personal protective equipment. Therefore, this alternative has minimal adverse impacts in the short term.

Reduction of Mobility, Toxicity, and Volume through Treatment

Organic carbon in the soil will interact with VOCs, reducing their mobility in groundwater. The natural occurring anaerobic dechlorination process will reduce the volume, and toxicity of contamination. However, none of these reductions are obtained through treatment.

Implementability

The installation of two new wells for the groundwater monitoring network is readily implementable and uses established construction processes. Sampling and analysis, documentation, and data evaluation will be necessary to quantify the MNA process. These processes are well documented and accepted by the EPA. ICs will be installed around the site, and will require coordination with property owners, which may be somewhat difficult in the privately owned residential parcels but is still implementable

Cost

The total capital costs associated with Alternative 2 is $107,000. Periodic costs were estimated to be $2,182,000. Assuming 30 years of operations, the 2022 total present worth of Alternative 2 is estimated to be $2,289,000. A cost breakdown of the individual components associated with Alternative 2 is presented in Table 5-1.

5.2.3 Alternative 3 – Permeable Reactive Barrier with Long-term Monitoring, and Institutional Controls

Alternative 3 consists of installing one PRB in addition to the long-term monitoring of attenuation processes and ICs. The PRB will be installed across the flow path of the contaminant plume, allowing the groundwater to passively move through the wall. The PRB will be constructed on the downgradient end of the contaminant plume within OU4. Groundwater sampling to document the attenuation processes in the groundwater will be completed as well. A Site Management

Plan will be developed to outline the sampling procedures, frequency for groundwater sample collection, and ICs to restrict exposure to hazardous substances until RAOs are met.

Overall Protection of Human Health and the Environment

Alternative 3 is protective of human health and the environment as the PRB will chemically reduce the contaminants in OU4 groundwater. Since groundwater contamination will be reduced, and the ICs as proposed will reduce exposure and attenuation processes will reduce the groundwater contamination at OU4, this alternative provides for protection of human health and the environment.

Compliance with Applicable or Relevant and Appropriate Requirements

The PRB and the attenuation processes within OU4 will cause a decrease in contaminant concentrations and are likely to achieve ARARs. Monitoring of groundwater will be used to confirm compliance with ARARs, though it may take significant time for all contamination to migrate through the PRB.

Long-Term Effectiveness and Permanence

Alternative 3 provides for long-term effectiveness and permanence. The PRB utilizes a reduction process that separates the chloride ions from the atom, rendering a simple non-toxic compound. The reduction process is irreversible; therefore, Alternative 3 offers long-term effectiveness and permanence, though it may take significant time for all contamination to migrate through the PRB.

Short-Term Effectiveness

For Alternative 3, the construction and implementation of the PRB and two new groundwater wells will have limited short-term impacts. These include exposure risks associated dust generation and sound disturbances during construction of the PRB and wells. There will be an increase in local truck traffic associated with removing excavation spoils and bringing on equipment and supplies. These are all common construction activities that have established control methods. The development of ECs by the construction contractor, such as a traffic control plan, dust/air monitoring program, use of personal protective equipment and other ECs (e.g., wetting excavated soils), can ease the impacts and lessen the adverse effects in the short term. There will be minimal impacts on the water resources during installation of the PRB as the unnamed stream will be dammed and pumped around the construction areas. Therefore, this alternative has minimal adverse impacts in the short term.

Reduction of Mobility, Toxicity, and Volume through Treatment

The PRB will reduce the off-site mobility, volume, and toxicity of contamination via reduction (i.e., destruction of the contaminant at the atomic level). Organic carbon in the soil will interact with VOCs, reducing their mobility in groundwater. As the PRB is targeting prevention of off-site migration of contamination, it will provide for a reduction in mobility, toxicity, and volume through treatment but not to the same extent as a remedy actively targeting high concentrations of contamination.

Implementability

This alternative can be implemented. The use of standard construction processes in combination with readily available chemical reagents allows for the PRB to be constructed. The use of ZVI is a proven technology associated with the degradation of VOC contaminants in groundwater and is a standard in situ reagent that is available in bulk. In order to treat 1,4-dioxane with a PRB, an additional oxidizing amendment will be required within the path of the 1,4-dioxane plume. This makes this alternative more difficult to implement as it requires accurate estimation of the area of treatment for 1,4-dioxane.

The installation of two new wells for the groundwater monitoring network is readily implementable and will use well-established construction process. ICs will be implemented for the site and will require coordination with property owners, which may be somewhat difficult in the privately owned residential parcels but is still implementable.

Cost

The total capital costs associated with Alternative 3 is $970,000. Periodic costs were estimated to be $1,465,000. Assuming 30 years of operation, the 2022 total present worth of Alternative 3 is estimated to be $2,435,000. A cost breakdown of the individual components associated with Alternative 3 is presented in Table 5-2.

5.2.4 Alternative 4 – Air Sparging and Soil Vapor Extraction, Long-term Monitoring, and Institutional Controls

For Alternative 4, a total of nine AS wells and 12 SVE wells will be installed and operated throughout the groundwater plume at OU4. Groundwater sampling to document the attenuation processes in the groundwater will be completed as well. A Site Management Plan will be developed to outline the sampling procedures, frequency of groundwater sample collection, and ICs to restrict exposure to hazardous substances until RAOs are met.

Overall Protection of Human Health and the Environment

Alternative 4 provides protection of human health and the environment as the AS/SVE system will mobilize and extract the groundwater VOC contaminants. Attenuation processes will provide for further VOC reduction within the contaminant plume. Finally, ICs will provide additional protection by reducing access to contaminated groundwater thereby reducing exposure.

Compliance with Applicable or Relevant and Appropriate Requirements

The AS/SVE system can be installed and operated in a manner such that compliance with ARARs can be achieved. Once installed, the system will decrease contaminant concentrations in the groundwater and groundwater cleanup levels will be achieved within a reasonable time frame as defined by the EPA (EPA 1999).

Attenuation processes will further reduce VOC contamination and help with achieving the ARARs for the site. Monitoring of groundwater will confirm that compliance with ARARs is achieved over time.

Long-Term Effectiveness and Permanence

Alternative 4 is effective in the long term because groundwater contaminants will be either removed or destroyed by the AS/SVE system. The AS/SVE system will volatilize VOCs, allowing for their capture/treatment above grade, and attenuation processes will provide a reduction process that separates the chloride ions from the atom, rendering a simple non-toxic compound. The reduction process is irreversible; therefore, this alternative provides for long-term effectiveness and permanence. However, treated contamination may remain in emitted air and spent carbon used for treatment, so the effectiveness of this alternative in eliminating contamination is slightly reduced.

Short-Term Effectiveness

For Alternative 4, the construction and implementation of the AS/SVE well systems and two groundwater wells will have limited short-term impacts. These include exposure risks associated with dust generation and sound disturbances during construction of the AS/SVE piping network and wells. There will be an increase in local truck traffic associated with removing excavation spoils and bringing on equipment and supplies. These are all common construction activities that have established control methods. The development of ECs by the construction contractor, such as a traffic control plan, a dust/air monitoring program, use of personal protective equipment, and other ECs (e.g., wetting excavated soils), can limit the impacts.

During the AS/SVE system operation, there will be an increase in ambient noise associated with running blowers and compressors. These noises can be mitigated by implementing the use of silencers and sound proofing structures. Therefore, this alternative has minimal adverse impacts in the short term.

Reduction of Mobility, Toxicity, and Volume through Treatment

Operation of the AS/SVE system will result in reduction of the volume of contaminants within the groundwater, as the contaminants will be volatilized and removed during system operation. Toxicity of the contaminants will be reduced through vapor treatment. AS/SVE relies on the volatilizing of groundwater contamination to allow for its collection, resulting in a temporary increase in mobility in order for the volatilized contaminants to be captured and treated. Overall, there is a decrease in mobility of contaminants because contaminants will be removed by the soil vapor extraction system. The implementation of AS/SVE will provide for a reduction in mobility, toxicity, and volume through treatment.

Implementability

Alternative 4 is implementable, as AS/SVE is a commonly used remedial technology that can be readily implemented. No specialized construction methods or process equipment will be required. Obtaining air permit equivalents will be straightforward and no other specialized permit equivalents will be required. Depending on concentrations of 1,4-dioxane in the extracted air, additional AS/SVE enhancements (e.g., heat) may be required, which will need to be evaluated during the remedial design.

The installation of two new wells for the groundwater monitoring network is again a well-established construction activity, which makes long-term groundwater monitoring readily implementable. ICs will be implemented for the site, and will require coordination with property owners, which may be somewhat difficult in the privately owned residential parcels, but they are still implementable.

Cost

The total capital costs associated with Alternative 4 is $882,000. Periodic costs were estimated to be $3,363,000. Assuming 30 years of operations, the 2022 total present worth of Alternative 4 is estimated to be $4,245,000. A cost breakdown of the individual components associated with Alternative 4 is presented in Table 5-3.

5.2.5 Alternative 5 – In situ Chemical/Biological Treatment, Long-term Monitoring, and Institutional Controls

ISCR, ISCO, and/or enhanced bioremediation are destruction techniques that degrade contaminants through chemical reduction, oxidation, and/or microorganism consumption. This alternative includes using eight groups of injection points where a reagent/amendment will be injected. Groundwater sampling to document the attenuation processes in the groundwater will be completed as well. A Site Management Plan will be developed to outline the sampling procedures, frequency for groundwater sample collection, and ICs to restrict exposure to hazardous substances until RAOs are met.

Overall Protection of Human Health and the Environment

Alternative 5 is protective of human health and the environment as the injected reagent/amendment, will degrade groundwater contaminants within OU4. Attenuation processes will provide for further VOC reduction within the contaminant plume. Finally, ICs will provide additional protection by reducing access to contaminated groundwater thereby reducing exposure.

Compliance with ARARs

Alternative 5 can be implemented in a manner that will be consistent with the ARARs. Use of the reagent or amendment injections requires a special permit equivalency to be issued by the EPA; however, it is a relatively straightforward process, and the permits should be readily attainable. Once the injections have been performed, contaminant concentrations will decrease in the groundwater. Repeated rounds of injections may reduce contaminant concentrations more quickly than for other alternatives. This treatment, along with attenuation processes within OU4 will allow for compliance with ARARs within a reasonable time frame as defined by EPA (EPA 1999). Groundwater monitoring will confirm that compliance with ARARs is achieved.

Long-Term Effectiveness and Permanence

Alternative 5 provides for long-term effectiveness and permanence. Groundwater contaminants will undergo a reduction process through treatment that separates the chloride ions for the atom, rendering a simple non-toxic compound. The reduction process is irreversible; therefore, Alternative 5 offers long-term effectiveness and permanence. If oxidants are selected for injection, the contaminants will also irreversibly break down into non-toxic compounds, and the alternative will offer long-term effectiveness and permanence.

Short-Term Effectiveness

For Alternative 5, the construction and use of multiple injection groups and two groundwater wells will have limited short-term impacts. These include exposure risks associated with dust generation and sound disturbances during construction. There will be an increase in local truck traffic associated with removing excavation spoils and bringing on equipment and supplies. These are all common construction activities that have established control methods. The development of ECs by the construction contractor, such as a traffic control plan, an air monitoring program, use of personal protective equipment and dust suppression protocols (e.g., wetting excavated soils) can ease the impacts and lessen the adverse impacts in the short term.

The potential exposure to the reagent/amendment during the injections also poses a short-term threat, which can be mitigated though the use of the appropriate personal protective equipment. Therefore, this alternative has minimal adverse impacts in the short term.

Reduction of Mobility, Toxicity, and Volume through Treatment

The use of an in-situ reagent/amendment via injections will reduce the mobility, volume, and toxicity of contamination via destruction of the contaminant at the atomic level. Organic carbon in the soil will interact with VOCs, reducing their mobility in groundwater. The use of an injected reagent/amendment will provide for a reduction in mobility, toxicity, and volume through treatment.

Implementability

Alternative 5 is implementable as in situ injections are a commonly used remedial technology. The installation of injection wells is identical to the installation of groundwater monitoring wells. Numerous reagents/amendments are readily available, and a suitable reagent or combination of reagents will be selected during the remedial design.

The installation of two new wells for the groundwater monitoring network is again a well-established construction activity, which makes long-term monitoring readily implementable. ICs will be implemented for the site, and will require coordination with property owners, which may be somewhat difficult in the privately owned residential parcels, but is still implementable.

Cost

The total capital costs associated with Alternative 5 are $1,439,000. Periodic costs were estimated to be $3,090,000. Assuming 30 years of operations, the 2022 total present worth of Alternative 5 is estimated to be $4,529,000. A cost breakdown of the individual components associated with Alternative 5 is presented in Table 5-4.

5.2.6 Alternative 6 – Pump-and-Treat, Long Term Monitoring, and Institutional Controls

The pump-and-treat system will require a horizontal groundwater extraction well, vertical wells, and a location to discharge the treated groundwater. Once the groundwater is extracted, it will be pumped to the equipment trailer to be treated using an air stripper followed by carbon treatment Groundwater sampling to document the attenuation processes in the groundwater will be completed as well. A Site Management Plan will be developed to outline the sampling procedures, frequency for groundwater sample collection, and ICs to restrict exposure to hazardous substances until RAOs are met.

Overall Protection of Human Health and the Environment

Alternative 6 can provide protection of human health and the environment. The pump and treat system will actively remove contaminated groundwater and provide a hydraulic barrier that retards the migration of groundwater contaminants. Attenuation processes will provide for VOC reduction within the contaminant plume. Finally, ICs will provide additional protection by reducing access to contaminated groundwater thereby reducing exposure.

Compliance with ARARs

Alternative 6 can be implemented in a manner that will be compliant with the identified ARARs. An SPDES permit equivalency will need to be obtained to discharge the treated effluent to the unnamed stream, with effluent monitored regularly to verify compliance with regulations. Depending upon the final treatment system design, an air discharge permit equivalent may also be needed based on the volume of contaminants discharged to the atmosphere from the air stripper. The pump-and-treat system and attenuation processes will decrease contaminant concentrations in the groundwater, and over time can put the site in compliance with ARARs associated with groundwater cleanup levels and within a reasonable time frame as defined by EPA (EPA 1999). Monitoring of groundwater will confirm that compliance with ARARs is achieved over time.

Long-Term Effectiveness and Permanence

Alternative 6 can provide long-term effectiveness and permanence. The pump-and-treat system will physically remove VOC contaminants from the aquifer, where they will be extracted from the influent via air stripping and further polished using granular activated carbon. As air stripping has not been shown to be an effective technology for treating 1,4-dioxane, additional treatment for 1,4-dioxane may be necessary to meet discharges requirements, depending on the discharge method. Attenuation processes utilize a reduction process that separates the chloride ions from the atom, rendering a simple non-toxic compound. The reduction process is irreversible; therefore, Alternative 6 offers long-term effectiveness and permanence. However, treated contamination may remain in emitted air and spent carbon used for treatment, so the effectiveness of this alternative in eliminating contamination is slightly reduced.

Short-Term Effectiveness

For Alternative 6, the construction and implementation of the pump-and-treat system and two groundwater monitoring wells will have limited short-term impacts. These include exposure risks associated with dust generation and sound disturbances during construction of the pump-and-treat extraction well or hydraulic trench, piping network, and groundwater wells. If a hydraulic trench is installed instead of an extraction well, shoring, and additional earthwork may be required, causing greater adverse short-term impacts. There will be an increase in local truck traffic associated with removing excavation spoils and bringing equipment and supplies to the site. These are all common construction activities that have established control methods. The development of ECs by the construction contractor, such as a traffic control plan, dust/air monitoring program, use of personal protective equipment and other ECs (e.g., wetting excavated soils), can ease the impacts and lessen the adverse effects associated with the short-term effectiveness.

During the pump-and-treat system operation, there will be an increase in ambient noise associated with running pumps within the treatment system. These noises can be mitigated by implementing the use of silencers and dedicated sound-proofing structures that encase the pumps. Therefore, this alternative has minimal adverse impacts in the short term.

Reduction of Mobility, Toxicity, and Volume through Treatment

Operation of the pump and treat system will result in reduction of the volume of contaminants within the groundwater, as the contaminants will be physically removed from the aquifer. Toxicity of the contaminants will be reduced through the treatment of the extracted groundwater. Mobility of the contaminants will be reduced by creating a gradient toward the extraction wells.

The extraction and treatment of groundwater will provide for a reduction of mobility, toxicity, and volume through treatment.

Implementability

Alternative 6 is implementable, as pump-and-treat is a commonly used remedial technology. No specialized construction methods or process equipment will be required. Obtainment of an air permit equivalence associated with the air stripper operations and an SPDES permit equivalence for discharge of the treated effluent will be straightforward and should not prove to be problematic. No other specialized permits will be required.

The installation of the horizontal extraction well will not require specialized permitting or equipment. ICs will be implemented for the site, and will require coordination with property owners, which may be somewhat difficult in the privately owned residential parcels but is still implementable.

The installation of two new wells for the groundwater monitoring network is again a well-established construction activity, which makes long-term monitoring readily implementable. ICs will be implemented for the site, and will require coordination with property owners, which may be somewhat difficult in the privately owned residential parcels but is still implementable.

Cost

The total capital costs associated with Alternative 6 is $724,000. Periodic costs were estimated to be $2,723,000. Assuming 30 years of operations, the 2022 total present worth of Alternative 6 is estimated to be $3,447,000. A cost breakdown of the individual components associated with Alternative 6 is presented in Table 5-5.

6 Comparative Evaluation of Alternatives

In Section 5, the six developed alternatives to address groundwater contamination at OU4 underwent an individual analysis using the EPA-established evaluation criteria, as presented in 40 CFR §300.430(e)(9)(iii). In this section of the FS, the same criteria will be used to perform a comparative evaluation analysis of the developed remedial alternatives to address the statutory requirements when evaluating remedial alternatives.

6.1 Overall Protection of Human Health and the Environment

Of the six alternatives, only Alternative 1 does not provide for any protection. Alternative 2 does provide for some protection in that the natural occurring processes that decrease contaminant concentration are tracked, but no active remediation is performed. The remaining four alternatives would be protective of human health and the environment.

6.2 Compliance with ARARs

Alternative 1 does not comply with the ARARs, and Alternative 2, given the probable length of time associated with obtaining the cleanup levels, will not achieve compliance within a reasonable timeframe.

Alternative 5 can most readily achieve compliance with the ARARs. The use of in situ treatment will directly address contamination in place. This approach can obtain the groundwater cleanup levels within the shortest period of operation. After Alternative 5, the next alternative that can obtain the ARARs in the shortest operational time frame is Alternatives 4 and 6, followed by Alternative 3.

6.3 Long-Term Effectiveness and Permanence

Alternative 1 does not provide long-term effectiveness and permanence as no active remediation is involved. Alternative 2 provides some long-term effectiveness and permanence as contamination will be reduced through attenuation processes, though the timeline of this reduction may not be reasonable. Of the remaining four alternatives, Alternative 5 is the most effective in the long term and is a permanent remedy. Alternative 5 utilizes an in-situ treatment technology to address contaminant hot spots in a manner that is far faster than the other three action alternatives. The treatment process breaks down the contaminants to less harmful compounds, thereby providing a permanent solution.

Alternatives 4 and 6 offer similar levels of long-term effectiveness and permanence in that both alternatives rely on physically removing and collecting (i.e., not destroying) the contaminants. Since the collected contaminants will be treated and discharged to the atmosphere and/or shipped off site for disposal (e.g., used carbon products), these two alternatives are less effective in the long term.

Alternative 3 is less effective in the long term because the PRB will only address contamination that passes through it and will not address higher contaminated areas within OU4.

6.4 Short-Term Effectiveness

Of the six alternatives, only Alternative 1 has no adverse short-term impacts since no work of any kind is undertaken. Alternative 2 has some adverse short-term impacts in that two additional groundwater wells will be installed and that there is potential exposure associated with the groundwater sampling program.

Alternative 3 has the most adverse short-term impacts. The construction of the PRB will require extensive earth work and shoring. Additionally, there will have to be one stream crossing installed. If Alternative 6 involves a hydraulic trench, it will require similar earth work and shoring to Alternative 3 though it is likely that no stream crossing will be involved. Alternative 5 has less short-term impacts than Alternative 3. The potential exposure associated with the reagent used for the injections elevates Alternative 5 above Alternative 4.

6.5 Reduction of Mobility, Toxicity, and Volume through Treatment

Alternatives 1 and 2 offer no reduction of mobility, toxicity, and volume through treatment.

Alternative 5 offers the most reduction of mobility, toxicity, and volume through destruction of the contaminants at the molecular level. The treatment process is irreversible and renders contaminants benign.

Alternatives 4 and 6 offer roughly the same overall reduction of contaminants. Treatment of extracted groundwater or soil vapor will reduce the toxicity and volume of VOCs. However, Alternative 6 offers a greater reduction in the mobility of the contaminants. By extracting groundwater, Alternative 6 will create a hydraulic barrier that will reduce the mobility of the contaminant plume.

Alternative 3 provides for a slight reduction of mobility, toxicity, and volume because it addresses contaminants migrating downgradient on the OU4 property.

6.6 Implementability

Alternative 1 will be the easiest alternative to implement from a technical standpoint because no work will be performed. However, from an administrative standpoint, it would be the most difficult to implement since OU4 does not satisfy the conditions to warrant implementation of a No Action decision (EPA 1991).

Alternative 2 will be the easiest to implement. The installation of two new groundwater wells accompanied by routine sampling, analysis and reporting is a straightforward, well-established process.

Alternatives 3 through 6 are implementable from both a technical and administrative perspective.

The most difficult alternative to implement will be Alternative 6. While construction of groundwater extraction and treatment systems, as well as effluent discharge line, are all established design and construction activities, the O&M associated with a groundwater treatment system is extensive. Typically, it will require constant monitoring and response to problems within a 24-hour window. Additionally, there are monthly sampling and reporting requirements associated with both air and water discharges. Granular activated carbon will require routine change out, with the spent carbon potentially having to be disposed of as a hazardous waste.

While Alternative 4 has some of the same components as Alternative 6, the potential installation of multiple single wells in addition to a horizontal well makes Alternative 6 more complex. If the design of the well system is changed to match Alternative 4, these become equally implementable.

Alternative 3 is more implementable than Alternatives 4 and 6. The PRB will require minimal maintenance after installation. However, there is extensive earthwork associated with a PRB installation.

The easiest of the active alternatives to implement is Alternative 5. In-situ injections are a straightforward established and accepted processes. Whether reagents are injected using direct-push methodology or a network of monitoring wells, neither method poses a technological challenge. While permits may be required to inject the reduction reagent, they will not be overly problematic to obtain.

6.7 Cost

The estimated capital costs, O&M costs, and present-worth costs for the alternatives discussed in this FS are compared in Table 6-1. There are no costs associated with Alternative 1. Using the present worth value for each alternative, Alternative 5 is the most expensive alternative due to high capital costs associated with installation of injection points and periodic costs associated with multiple injection events. Alternatives 4 and 6 are less expensive than Alternative 5 but have ongoing O&M costs for treatment, while Alternative 3 is less expensive. Alternatives 2 is the least expensive alternative.

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Tables

Table 3-1a: ARARs, TBCs, and Other Guidelines Screening Table, Chemical Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Chemical-specific ARARs, TBCs, and Other Guidelines			
Media	**Requirement**	**Code/Citation**	**Regulatory Synopsis**
Federal			
Groundwater	USEPA National Primary Drinking Water Regulations *Maximum Contaminant Levels*	42 U.S.C. § 300f and 40 CFR Part 141 Subpart G	Establishes health-based standards for public drinking water systems. Also establishes drinking water quality goals that are set at levels at which no adverse health effects are anticipated, with an adequate margin of safety.
State			
Soil	NYSDEC - Environmental Remediation Programs, Soil Cleanup Objectives	6 NYCRR Part 375-6.4(b)(3) and 375-6.5	Establishes standards for soil cleanups.
Soil	NYSDEC Commissioner Policy 51/Soil Cleanup Guidance	CP-51 Section 5	Section 5 of CP-51 describes the process for selecting soil cleanup objectives based on 6 NYCRR Part 375 Section 6.8 and Appendix E of the Technical Support Document for Part 375.
Groundwater	NYSDEC Water Quality Standards and Classifications	6 NYCRR Part 703	Establishes groundwater quality standards and effluent limitations.
Water	NYSDOH - Drinking Water Supplies: Public Water Systems	10 NYCRR Part 5-1	Sets MCLs for public drinking water supplies.
Water	NYSDOH - Sources of Water Supply – Standards of Raw Water Quality	10 NYCRR Part 170.4	Establishes quality standards for sources of water for public water supplies.
Water	NYSDOH – Ambient Water Quality Standards and Guidance Values	2021 Addendum to June 1998 Division of Water TOGS NO. 1.1.1	Establishes new water quality guidance values for emerging contaminants perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and 1,4-dioxane (1,4-dioxane).

Table 3-1a: ARARs, TBCs, and Other Guidelines Screening Table, Chemical Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Chemical-specific ARARs, TBCs, and Other Guidelines			
Media	**Requirement**	**Code/Citation**	**Regulatory Synopsis**
Air	NYSDEC Prevention and Control of Air Contaminants and Air Pollution: General Provisions, Permits and Registrations	6 NYCRR Part 200.1; 6 NYCRR Part 201.9.1	Establishes contaminant standards and permit requirements for air contamination sources.

Key:

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
MCL = Maximum Contaminant Level
NYCRR = New York Code of Rules and Regulations
NYSDEC = New York Department of Environmental Conservation
NYSDOH = New York State Department of Health
OU4 = Operable Unit 4
PFOS = perfluorooctane sulfonic acid
RCRA = Resource Conservation and Recovery Act
TBC = to be considered
TOGS = Technical and Operational Guidance Series
U.S.C. = United States Code
USEPA = U.S. Environmental Protection Agency

Table 3-1b: ARARs, TBCs, and Other Guidelines Screening Table, Action Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Action-specific ARARs, TBCs, and Other Guidelines			
Action	**Requirement**	**Code/Citation**	**Requirement Synopsis**
Federal			
Soil	RCRA Criteria for Municipal Solid Waste Landfills	40 CFR Part 258	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects.
Air	CAA - National Primary and Secondary Ambient Air Quality Standards for PM10 and PM2.5	40 CFR Parts 50.6 and 50.7	Establishes air quality standard for particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM10) and 2.5 micrometers (PM2.5).
Waste Transportation	USDOT Rules for Transportation of Hazardous Materials	49 CFR Parts 107, 171, 172, 177, 179	Outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous materials.
Waste Transportation	RCRA Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Establishes responsibilities for hazardous waste transporters.
General Requirements for Site Remediation	RCRA Identification and Listing of Hazardous Waste	40 CFR Part 261	Describes methods for identifying hazardous wastes and lists known hazardous wastes.
General Requirements for Site Remediation	RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Describes standards applicable to generators of hazardous wastes.

Table 3-1b: ARARs, TBCs, and Other Guidelines Screening Table, Action Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Action-specific ARARs, TBCs, and Other Guidelines			
Action	**Requirement**	**Code/Citation**	**Requirement Synopsis**
General Requirements for Site Remediation	RCRA – Preparedness and Prevention – Applicability and Design and Operation of Facility	40 CFR Parts 264.30 - 264.37	Outlines the requirements for safety equipment and spill control.
General Requirements for Site Remediation	RCRA – Contingency Plan and Emergency Procedures	40 CFR Parts 264.50 – 264.56	Outlines the requirements for emergency procedures to be used following any unplanned release of hazardous waste at the facility.
Disposal	RCRA Land Disposal Restrictions	40 CFR Part 268	Identifies hazardous wastes restricted from land disposal and provides treatment standards under which an otherwise prohibited waste may be land disposed.
Groundwater Discharge	CWA – EPA Administered Permit Programs: National Pollutant Discharge Elimination System (NPDES) and Criteria and Standards for the NPDES	40 CFR Parts 122 and 125	Provides NPDES permit requirements for point source discharges, including the NPDES Best Management Practice Program. These regulations include, but are not limited to, requirements for compliance with water quality standards, a discharge monitoring system, and records maintenance.

Table 3-1b: ARARs, TBCs, and Other Guidelines Screening Table, Action Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Action-specific ARARs, TBCs, and Other Guidelines			
Action	**Requirement**	**Code/Citation**	**Requirement Synopsis**
State			
Soil	NYSDEC - Technical Guidance for Site Investigation and Remediation	DER-10 Chapters 1,3 and 5	Provides guidance on investigations and remediation within New York.
Waste Transportation	New York State Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities	6 NYCRR Part 372	Establishes record keeping requirements and standards related to the manifest system for hazardous wastes.
Groundwater	New York State Groundwater Monitoring Well Decommissioning Policy	NYSDEC CP-43	Provides guidance on the decommissioning of groundwater monitoring wells.
Waste Transportation	New York State Waste Transporter Regulations	6 NYCRR Part 364	Establishes permit requirements for transportation of regulated waste.
Disposal	New York State Standards for Universal Waste (6 NYCRR Part 374-3) and Land Disposal Restrictions (6 NYCRR Part 376)	6 NYCRR Part 374-3 and 6 NYCRR Part 376	Establishes standards for the treatment and disposal of hazardous wastes.
Groundwater Discharge	New York State Pollution Discharge Elimination System (SPDES) Permits	6 NYCRR Parts 750	Governs the discharge of any wastes into or adjacent to State waters that may alter the physical, chemical, or biological properties of State waters, except as authorized pursuant to a NPDES or State permit.
Groundwater Discharge	New York State Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations	6 NYCRR Part 703	Establishes numerical criteria for groundwater treatment before discharge.

Table 3-1b: ARARs, TBCs, and Other Guidelines Screening Table, Action Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Action-specific ARARs, TBCs, and Other Guidelines			
Action	**Requirement**	**Code/Citation**	**Requirement Synopsis**
Groundwater Discharge	New York State Division of Water Technical and Operational Guidance Series (TOGS) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations	TOGS 1.1.1	Provides groundwater effluent limitations for use where there are no standards.
Air	NYSDEC - Prevention and Control of Air Contaminants and Air Pollution: Air Pollution Prohibited and Visible Emissions Limited	6 NYCRR Parts 211.1- and 211.2	Prohibits air pollution and visible emissions.
Air	NYSDEC Air Quality Classifications System – Classification Levels and Air Quality Standards - Particulates	6 NYCRR Part 257.3	Establishes air quality classification levels based on land use and associated air quality standards.
Air	NYSDOH - Generic Community Air Monitoring Plan	DER-10, Appendix 1A	Provides a generic plan for monitoring of air quality during remedial construction.
General Requirement for Site Remediation	New York State Hazardous Management Facilities	6 NYCRR Part 373	Regulates treatment, storage, and disposal of hazardous wastes.
General Requirement for Site Remediation	New York State Management of Specific Hazardous Waste	6 NYCRR Part 374	Establishes standards for the management of specific hazardous wastes.

Table 3-1b: ARARs, TBCs, and Other Guidelines Screening Table, Action Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Action-specific ARARs, TBCs, and Other Guidelines			
Action	**Requirement**	**Code/Citation**	**Requirement Synopsis**
General Requirement for Site Remediation	New York State Environmental Remediation Programs	6 NYCRR Part 375	Identifies process for investigation and remedial action at state funded Registry site; provides exception from NYSDEC permits.
General Requirement for Site Remediation	New York Solid Waste Management Facilities General Requirements	6 NYCRR Part 360	Sets standards and criteria for all solid waste management facilities, including design, construction, operation, and closure requirements for municipal solid waste landfills.
Noise	New York State - Noise from Heavy Motor Vehicles- Scope and Allowable Noise Levels	6 NYCRR Parts 450.1 and 450.3.	Provides sound level limits.
General Requirement for Site Remediation	New York State Hazardous Waste Management System – General	6 NYCRR Part 370	Provides definition of terms and general standards applicable to hazardous waste management systems.

Table 3-1b: ARARs, TBCs, and Other Guidelines Screening Table, Action Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Action-specific ARARs, TBCs, and Other Guidelines			
Action	**Requirement**	**Code/Citation**	**Requirement Synopsis**
General Requirement for Site Remediation	New York State Identification and Listing of Hazardous Waste	6 NYCRR Part 371	Describes methods for identifying hazardous wastes and lists known hazardous wastes.

Key:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CFR = Code of Federal Regulations
CWA = Clean Water Act
DER = Division of Environmental Remediation
EPA = U.S. Environmental Protection Agency
NYCRR = New York Code of Rules and Regulations
NPDES = National Pollutant Discharge Elimination System
NYSDEC = New York State Department of Environmental Conservation
NYSDOH = New York State Department of Health
OU4 = Operable Unit 4
PM10 = particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers
PM2.5 = particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
RCRA = Resource Conservation and Recovery Act
SPDES = (New York) State Pollutant Discharge Elimination System
TBC = to be considered
TOGS = Technical and Operational Guidance Series
USDOT = U.S. Department of Transportation
USEPA = U.S. Environmental Protection Agency

Table 3-1c: ARARs, TBCs, and Other Guidelines Screening Table, Location Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Location-specific ARARs, TBCs, and Other Guidelines			
Location	**Requirement**	**Code/Citation**	**Requirement Synopsis**
Federal			
Floodplains and Wetlands	USEPA Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR Part 6, Appendix A, Section 6	Establishes requirements associated with actions that have impacts on wetlands or floodplains.
	National Historic Preservation Act and Protection of Historic Properties	16 U.S.C. §470, et. seq. and 36 CFR Part 800	Establishes procedures to provide for preservation of historical and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.
	Endangered Species Act	16 U.S.C. §1531 et seq., 50 CFR Parts 17 and 424	Requires that the continued existence of any endangered or threatened species and/or its habitat not be impacted by a federal activity.
Floodplains	National Environmental Policy Act (NEPA); 40 CFR 6.302(b)(2005)	42 U.S.C. §§ 4321-4370h	Regulates activities within a floodplain.
State			
Surface Water	New York State – Use and Protection of Waters	6 NYCRR Part 608.5	Establishes requirements with excavation or placement of fill in navigable waters.
	New York State Endangered and Threatened Species of Fish and Wildlife	6 NYCRR Part 182	Provides standards for the protection of threatened and endangered species.
	New York State Wild, Scenic, and Recreational Rivers Permit Program	6 NYCRR Part 666	Provides regulations for the administration and management of the wild, scenic and recreations rivers system in New York State.

Table 3-1c: ARARs, TBCs, and Other Guidelines Screening Table, Location Specific
Olean Well Field OU4 Superfund Site
Olean, New York

Location-specific ARARs, TBCs, and Other Guidelines			
Location	**Requirement**	**Code/Citation**	**Requirement Synopsis**
Floodplains	New York State Floodplain Management Criteria for State Projects	6 NYCRR Part 502	Provides floodplain management criteria for State projects.

Key:
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
NEPA = National Environmental Policy Act
NYCRR = New York Code of Rules and Regulations
OU4 = Operable Unit 4
TBC = To Be Considered
U.S.C. = United States Code
USEPA = U.S. Environmental Protection Agency

Table 3-2 Contaminant Cleanup Levels

Contaminant	Cleanup Level (µg/L)	EPA MCL (µg/L)	NYSDEC GW (µg/L)[1]	NYSDOH Drinking Water (µg/L)[2]
1,1,1-trichloroethane	5	200	5	5
1,1-dichloroethane	5	--	5	5
1,2-dichloroethane	0.6	5	0.6	5
1,1-dichloroethene	5	7	5	5
Chloroethane	5	--	5	5
Tetrachloroethene	5	5	5	5
Trichloroethene	5	5	5	5
Cis-1,2-dichloroethene	5	70	5	5
Trans-1,2-dichloroethene	5	100	5	5
Vinyl chloride	2	2	2	2
1,4-dioxane[3]	1	--	--	1

Notes:
[1] 6 NYCRR Part 703.5: NYSDEC Water Quality Standards and Classifications
[2] 10 NYCRR Part 5-1: NYSDOH - Drinking Water Supplies: Public Water Systems
[3] 2021 Addendum to June 1998 TOGS NO. 1.1.1: NYSDOH – Ambient Water Quality Standards and Guidance Values

Key:
-- = concentration not listed in the regulation
EPA = Environmental Protection Agency
GW = groundwater
MCL = maximum contaminant level
µg/L = micrograms per liter
NYSDEC = New York State Department of Environmental Conservation
NYSDOH = New York State Department of Health
TOGS = Technical and Operational Guidance Series

Table 4-1 Screening of Technologies and Process Options for Site Groundwater
Olean Well Field OU4 Superfund Site, Olean, New York

General Response Action[1]	Remedial Technology	Process Option	Description	Technical Evaluation			Contaminants of Concern (COCs) Addressed by Technology/ Process Option	Retained?
				Effectiveness	Implementability	Relative Cost		
No Action	None	Not Applicable	No action	Required for consideration by the National Contingency Plan (NCP).	Easily implementable.	Minimal costs associated with five-year reviews.	None	Yes, as required by the NCP
Limited Action	Monitoring	Monitored Natural Attenuation (MNA)	Periodic sampling of groundwater within OU4 to document the attenuation through advection, dispersion, and biodegradation.	Does not actively reduce contamination. Anaerobic degradation has been shown to occur on-site and is an effective mechanism for MNA.	Easily implementable.	Low.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	Yes
In Situ Treatment	Physical Treatment	Air Sparging/Soil Vapor Extraction (SVE)	Air sparging is an in situ technology in which air is injected through a contaminated aquifer. This injected air helps to volatilize the contaminants up into the unsaturated zone where a vapor extraction system is used to remove the generated vapor-phase contamination. The vapor-phase contamination is then treated/destroyed using granular activated carbon or a catalytic oxidizer.	Effective for COCs in a shallow aquifer; however, low permeability soils mixed with sand stringer layers may reduce effectiveness. Must be used in combination with other technologies such as an SVE system with carbon or a catalytic oxidizer.	Difficult to implement. Sand stringer layers and low permeability may make it difficult to determine a good location for implementation.	Low to moderate capital costs, moderate maintenance costs.	Alkenes, alkanes, and 1,4-dioxane (all COCs)[2]	Yes
In Situ Treatment	Physical Treatment	In-Well Air Stripping	Air is injected into a vertical well screened at two depths. The lower screen is set in the groundwater saturated zone, and the upper screen is in the vadose zone. Pressurized air is injected into the well below the water table, aerating the water. The aerated water rises in the well and flows out of the system at the upper screen. The volatile organic compounds vaporize within the well at the top of the water table, as the air bubbles out of the water. The vapors are drawn off and treated by an SVE system using granular activated carbon or a catalytic oxidizer.	Can be somewhat effective for COCs. Has potential to make things worse if not implemented carefully and correctly. Zone and radius of influence can vary significantly. Designing an effective system may be difficult due the varied locations of contaminants.	Difficult to implement. Sand stringer layers and low permeability may make transmission of aerated groundwater difficult. Shallow groundwater leaves little vertical space for two screens within a single well, making construction of this option difficult.	Moderate to high capital costs, moderate maintenance costs.	Alkenes, alkanes, and 1,4-dioxane (all COCs)[2]	No

Technologies and Process Options in Shaded Rows have not been retained for further consideration in the FS.

General Response Action[1]	Remedial Technology	Process Option	Description	Technical Evaluation			Contaminants of Concern (COCs) Addressed by Technology/ Process Option	Retained?
				Effectiveness	Implementability	Relative Cost		
In Situ Treatment	Chemical Treatment	Carbon Adsorption of Extracted Vapor	Vapor-phase carbon adsorption is a technology in which vapor is pumped through one or more vessels containing activated carbon to which organic contaminants adsorb.	Effective for COCs. Can be used as primary treatment or polishing treatment step. Must be used in combination with the Air Sparging/SVE system.	Easy to implement.	Low capital and maintenance costs.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	Yes
In Situ Treatment	Chemical Treatment	Catalytic Oxidization of Extracted Vapor	Thermal or electrical catalytic oxidization is a technology in which vapor is pumped through a catalyst that destroys or breaks down organic contaminants.	Effective for COCs. Can be used as primary treatment. Must be used in combination with the Air Sparging/SVE.	Easy to implement.	Low to moderate capital and maintenance costs.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	Yes
In Situ Treatment	Chemical Treatment	In Situ Chemical Reduction (ISCR)	Chemical reduction is a process that makes use of strong chemical reducing agents like microscale or nanoscale zero-valent iron to treat chlorinated organic compounds in groundwater.	Effective for alkenes and alkanes. Can be used as stand alone or in combination with other technologies.	Easily implementable. May require multiple injection points and rounds for multiple plumes.	Low to moderate, depending on selected reducing agent.	Alkenes and alkanes (all COCs except 1,4-dioxane)	Yes
In Situ Treatment	Chemical Treatment	In Situ Chemical Oxidation (ISCO)	Chemical oxidation is a process where oxidation chemically converts contaminants to less toxic compounds. Oxidizing agents most commonly used are ozone, hydrogen peroxide, and permanganate. These oxidants have been able to cause the rapid and complete chemical destruction of many organic chemicals.	Effective for COCs. Can be used as stand alone or in combination with other technologies. However, due to anaerobic/ naturally reducing conditions in OU4, ISCO would be more difficult to implement in certain areas.	Easily implementable. May require multiple injection points and rounds for multiple plumes.	Moderate to high depending on the cost of the selected oxidant.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	Yes
In Situ Treatment	Chemical/ Biological Treatment	Permeable Reactive Barrier	A permeable reactive barrier consists of reactive/adsorptive materials (e.g., zero-valent iron [ZVI]) placed as a vertical and horizontal permeable barrier in the subsurface through which the contamination plume would flow over time. The water flowing through the barrier exits as treated water on the downgradient side of the barrier as the barrier adsorbs or breaks down contaminants.	Effective for COCs using ZVI, ZVI with carbon, or a biobarrier made of organic material (e.g., mulch). Can be used as stand alone or in combination with other technologies.	Easily implementable.	Moderate.	Alkenes, alkanes, and 1,4-dioxane (all COCs)[3]	Yes
In Situ Treatment	Biological Treatment	Enhanced Bioremediation	Bioremediation is a process in which indigenous or inoculated micro-	Effective for COCs. Can be used as stand	Easily implementable. May require multiple injection	Moderate.	Alkenes, alkanes, and 1,4-dioxane (all COCs)[3]	Yes

Technologies and Process Options in Shaded Rows have not been retained for further consideration in the FS.

General Response Action[1]	Remedial Technology	Process Option	Description	Technical Evaluation			Contaminants of Concern (COCs) Addressed by Technology/ Process Option	Retained?
				Effectiveness	Implementability	Relative Cost		
			organisms (i.e., fungi, bacteria, and other microbes) degrade (metabolize) organic contaminants found in soil and/or ground water. Enhanced bioremediation is a process that attempts to accelerate the natural biodegradation process by providing nutrients, electron acceptors, and competent degrading microorganisms that may otherwise limit the rapid conversion of contamination organics to innocuous end products.	alone or in combination with other technologies.	points and rounds for multiple plumes. Would require organisms that can degrade contaminants in an anaerobic environment.			
In Situ Treatment	Chemical/ Biological Treatment Enhancement	Electrokinetic Enhancement	Must be paired with injection of an amendment as a remedial technology enhancement for low permeability and/or heterogeneous soils. Establishes a voltage gradient between electrode wells to increase transport speed of amendment material.	Effective for COCs and low permeability and/or heterogeneous soils. Must be used in combination with other technologies.	Easily implementable. Requires installation of wells to create voltage gradient.	Moderate.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	Yes
In Situ Treatment	Biological Treatment	Phytoremediation	Phytoremediation is a form of bioremediation process that specifically uses plants to stabilize, degrade, volatilize, or extract organic or metal contaminants from soil or groundwater.	Effective for alkenes and 1,4-dioxane. Can only be used in lower contamination areas due to plant toxicity effects. Also, this technology causes a mass transfer of contamination from groundwater to plants, which would likely have to be disposed of as hazardous waste.	Easily implementable. Poplar trees have been demonstrated to work well in the stabilization, volatilization, and degradation of volatile organic compounds. However, this technology can take significantly longer to reach cleanup objectives and requires property owner approval.	Low.	Alkenes and 1,4-dioxane (not alkanes)	No
In Situ Treatment	Thermal Treatment	Thermal Desorption	Hot water or steam is forced into an aquifer through injection wells to vaporize volatile contaminants. Vaporized components rise to the unsaturated (vadose) zone where they are removed by vacuum extraction and then treated. Hot water or steam-based techniques include steam injection and vacuum extraction (SIVE), in situ steam-enhanced extraction (ISEE),	Effective for COCs. Can be used as stand alone or in combination with other technologies.	Easily implementable. May require longer duration of treatment to address multiple plumes.	High capital and maintenance costs.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	No

Technologies and Process Options in Shaded Rows have not been retained for further consideration in the FS.

General Response Action[1]	Remedial Technology	Process Option	Description	Technical Evaluation			Contaminants of Concern (COCs) Addressed by Technology/ Process Option	Retained?
				Effectiveness	Implementability	Relative Cost		
			and steam-enhanced recovery process (SERP).					
Extracted Groundwater Treatment	Physical Treatment	Pump and Treat with Air Stripping (Air Stripping of Extracted Groundwater)	Air stripping is a technology in which volatile organics are partitioned from groundwater by greatly increasing the surface area of the contaminated water exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. Air stripping involves the mass transfer of volatile contaminants from water to air. The contaminated air is then treated to remove/destroy the contaminants.	Very effective for alkanes and alkenes; however, low permeability soils mixed with sand stringer layers may make this less effective due to limited transmission. Typically used in combination with other technologies.	Difficult to implement. Sand stringer layers and low permeability may make extraction of groundwater difficult. Groundwater volume and recharge has been low during sampling events, so the time required for extraction and treatment would be longer.	Moderate to high capital cost. Moderate to high maintenance costs. Depends on type of equipment and groundwater flow rate.	Alkenes and alkanes (all COCs except 1,4-dioxane)	Yes
Extracted Groundwater Treatment	Physical Treatment	Carbon Adsorption of Extracted Groundwater	Liquid phase carbon adsorption is a technology in which groundwater is pumped through one or more vessels containing activated carbon to which dissolved organic contaminants adsorb.	Effective for alkanes and alkenes; however, low permeability soils mixed with sand stringer layers may make this less effective due to limited transmission. Can be used as primary treatment or polishing treatment step. Can be used as stand alone or in combination with other technologies.	Difficult to implement. Sand stringer layers and low permeability may make extraction of groundwater difficult. Groundwater volume and recharge has been slow during sampling events, so the time required for extraction and treatment would be longer.	Moderate to high capital cost. Low maintenance costs. Depends on type of equipment and groundwater flow rate.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	Yes
Extracted Groundwater Treatment	Chemical Treatment	Ultraviolet (UV) Oxidation of Extracted Groundwater	UV oxidation is a destruction process that oxidizes organic constituents in water by the addition of strong oxidizers and irradiation with UV light. Oxidation of target contaminants is caused by direct reaction with the oxidizers, UV photolysis, and through the synergistic action of UV light, in combination with ozone (O_3) and/or hydrogen peroxide (H_2O_2).	Effective for COCs; however, low permeability soils mixed with sand stringer layers may make this less effective due to limited transmission. Typically used in combination with other technologies.	Difficult to implement. Sand stringer layers and low permeability may make extraction of groundwater difficult. Groundwater volume and recharge has been low during sampling events, so the time required for extraction and treatment would be longer.	Moderate to high capital costs and moderate maintenance costs. Depends on type of equipment and groundwater flow rate.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	Yes
Extracted Groundwater Treatment	Biological Treatment	Bioreactors (Treating Extracted Groundwater)	Bioreactors degrade contaminants in water with microorganisms through attached or suspended biological systems. Activated sludge, fluidized	Effective for COCs; however, low permeability soils mixed with sand	Difficult to implement. Sand stringer layers and low permeability may make extraction of groundwater	Higher than other available process options that	Alkenes, alkanes, and 1,4-dioxane (all COCs)	No

Technologies and Process Options in Shaded Rows have not been retained for further consideration in the FS.

General Response Action[1]	Remedial Technology	Process Option	Description	Technical Evaluation			Contaminants of Concern (COCs) Addressed by Technology/ Process Option	Retained?
				Effectiveness	Implementability	Relative Cost		
			beds, or sequencing batch reactors are types of suspended growth systems. Upflow fixed-film bioreactors, rotating biological contactors (RBCs), and trickling filters are types of attached growth systems.	stringer layers may make this less effective due to limited transmission. Typically used in combination with other technologies.	difficult. Groundwater volume and recharge has been low during sampling events, so the time required for extraction and treatment would be longer.	are equally effective.		
Extracted Groundwater Treatment	Thermal Treatment	Steam Stripping of Extracted Groundwater	Steam stripping is a process similar to air stripping where the air phase has been replaced by steam. The operation's higher temperature results in a greater transfer of organic compounds from the groundwater phase to a steam distillate phase that must be condensed to separate the contaminated condensate and clean air. The contaminated condensate is then treated to remove/destroy the contaminants.	Effective for COCs; however, low permeability soils mixed with sand stringer layers may make this less effective due to limited transmission. Typically used in combination with other technologies.	Difficult to implement. Sand stringer layers and low permeability may make extraction of groundwater difficult. Groundwater volume and recharge has been low during sampling events, so the time required for extraction and treatment would be longer.	Higher than other available process options that are equally effective.	Alkenes, alkanes, and 1,4-dioxane (all COCs)	No

Notes:

[1] The Limited Action response actions, engineering controls and institutional controls, will be evaluated as part of other alternatives as they are not stand-alone alternatives.

[2] The effectiveness of this technology/process option in treating 1,4-dioxane may depend on the use of system enhancements such as heated air or increased air flow.

[3] The effectiveness of this technology/process option in treating 1,4-dioxane depends on the amendment used for treatment.

Table 5-1 Cost Estimate, Alternative 2 - Monitored Natural Attenuation (MNA) and Institutional Controls (ICs)
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Institutional Controls					
Environmental Easements & Deed Restrictions	Environmental easement for groundwater sampling access and deed restrictions to minimize groundwater use	1	LS	$20,000	$20,000
Work Plan / Final Report					
Work Plan / Final Report	Includes submittals and meetings during/after construction, not design.	1	LS	$25,000	$25,000
Site Preparation, Engineering and Access Controls					
Health and Safety requirements	Officer; assume on-site 100% of project duration, Assume 8 hrs/day, 5 days/week, $125/hr. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem	8	Day	$1,200	$9,600
Mobilization/Demobilization	Includes site prep, trailers, staging ,etc. and demobilization	1	LS	$5,000	$5,000
Surveying	Includes a 2-person crew surveying new well locations	1	Day	$1,907	$1,907
Site Clearing					
Remove individual trees in well locations	Selective clearing and grubbing, remove selective 8" to 12" diameter trees on site using chain saws and chipper, excludes stumps	3	EA	$440	$1,319
Grub & remove stumps	Selective clearing and grubbing, 1-1/2 C.Y. excavator, 8" to 12" diameter, stump removal on site by hydraulic excavator	3	EA	$124	$371
Monitoring Well Installation					
Well Drilling	Drill two wells and sample soils during drilling (4 1/4" diameter borehole, using hollow stem auger. 2" PVC casing), 4 1/4" auger drilling for 0-100 feet, and standard split spoon sampling 0-50 feet. Depth of each well is 22 feet.	44	LF	$36	$1,562
PID Rental	MiniRAE 3000 PID. Used during drilling and sampling	4	Day	$75	$300
Well Material	The 2-inch well installation includes: Screen, schedule 40 PVC, 2-inch I.D.; #10 slot screen; well riser; schedule 40 PVC, flush-jointed, 2-inch I.D. End cap (threaded) or top cap (slip); sand pack around 2-inch screen in 4-1/4" auger borehole; bentonite seal around 2-inch riser in 4-1/4" auger borehole; and cement/bentonite grout around 2-inch riser in 4-1/4" auger borehole.	2	EA	$2,476	$4,952
Well Development	Includes 2 person crew, 8-hour days, $125 per hour per person, Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person.	2	Day	$2,400	$4,800
Soil Sample Analysis	Includes analysis of samples collected every 2 feet until a depth of 10 feet, and every 5 feet after 10 feet depth. End sampling at 22 feet depth. Samples will be analyzed for VOCs and 1,4 - Dioxane.	14	EA	$148	$2,065
IDW Disposal	Includes: Mobilization, Drum loading & transport, Assume one drum of Disposal Soil, haz and one drum of Disposal Water, haz. Includes one TCLP test for water.	1	LS	$2,606	$2,606
				Capital Costs Subtotal:	$79,500
				10% Legal, administrative, engineering fees, construction management:	$8,000
				20% Contingencies:	$17,500
				Capital Cost Total:	**$107,000**

Key at end of table.

Table 5-1 Cost Estimate, Alternative 2 - Monitored Natural Attenuation (MNA) and Institutional Controls (ICs)
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Annual Groundwater Sampling/Reporting Costs (Quarterly for Years 1-2, Semi-Annual for Years 3-5, and Annual for Years 5-30)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter (2 of each)	1	Week	$1,042	$1,042
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for VOCs and 1,4-dioxane.	28	EA	$148	$4,130
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241
IC and Site Inspection	2 hours during each sampling event	2	HR	$125	$250
Data Evaluation and Reporting		1	LS	$7,000	$7,000
				Years 1-2 Annual Cost Subtotal:	$179,200
				10% Legal, Administrative and Engineering Fees:	$18,000
				20% Contingencies:	$39,500
				Years 1-2 Annual Cost Total:	**$236,700**
				Present Worth of Annual Costs for Years 1-2:	**$434,000**
				Years 3-5 Annual Cost Subtotal:	$89,600
				10% Legal, Administrative and Engineering Fees:	$9,000
				20% Contingencies:	$19,800
				Years 3-5 Annual Cost Total:	**$118,400**
				Present Worth of Annual Costs for Years 3-5:	**$269,000**
				Years 6-30 Annual Cost Subtotal:	$44,800
				10% Legal, Administrative and Engineering Fees:	$4,500
				20% Contingencies:	$9,900
				Years 6-30 Annual Cost Total:	**$59,200**
				Present Worth of Annual Costs for Years 6-30:	**$489,000**
MNA Parameter Monitoring (Quarterly for Years 1-2, Annual Years 3-30)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter, pH/DO/ORP meter (2 of each)	1	Week	$1,232	$1,232
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for alkalinity, sulfate, total sulfide, nitrate, chloride, total organic carbon, and divalent iron.	28	EA	$116	$3,248
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241

Key at end of table.

Table 5-1 Cost Estimate, Alternative 2 - Monitored Natural Attenuation (MNA) and Institutional Controls (ICs)
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
				Years 1-2 Annual Cost Subtotal:	$147,400
				10% Legal, Administrative and Engineering Fees:	$14,800
				20% Contingencies:	$32,500
				Years 1-2 Annual Cost Total:	**$194,700**
				Present Worth of Annual Costs for Years 1-2:	**$357,000**
				Years 3-30 Annual Cost Subtotal:	$36,900
				10% Legal, Administrative and Engineering Fees:	$3,700
				20% Contingencies:	$8,200
				Years 3-30 Annual Cost Total:	**$48,800**
				Present Worth of Annual Costs for Years 3-30:	**$517,000**
Periodic Costs (Every 5 Years)					
5-yr Review, Data Evaluation, and Reporting		1	LS	$35,000	$35,000
Institutional Controls	Maintain / Update Documentation	1	LS	$5,000	$5,000
				Periodic Cost Subtotal:	$40,000
				10% Legal, Administrative and Engineering Fees:	$4,000
				20% Contingencies:	$8,800
				Periodic Cost Total:	**$52,800**
				30-year Present Worth of Periodic Costs:	**$116,000**
				2022 Total Present Worth Cost	**$2,289,000**

Notes:

1. 30-year present worth of costs assumes 7% annual interest rate per "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA 540-R-00-002 July 2000).
2. Costs included in this estimate were obtained from vendors, RSMeans and estimated using experience from other engineering projects.
3. Legal, administrative and engineering fee percenta 10%
4. Contingencies (on costs and fees) 20%
5. Mobilization cost percentage of total capital costs 2.5%
6. Construction Duration (Assuming 5 day, 8hr/day work week)
   - Assume Mob/Demob Time 5 days
   - Clearing and Grubbing 2 days
   - Well Installation and Development 4 days
   - Total Project Time 0 months
7. In accordance with the USEPA requirements, a 5-year review will be completed at the site to evaluate site conditions as well as to recommend modifications to the selected remedy.

Key:

EA = Each
FS = Feasibility Study
HR = Hour
LF = Linear feet
LS = Lump sum
OU = Operable Unit

Key at end of table.

Table 5-2 Cost Estimate, Alternative 3 - Permeable Reactive Barrier (PRB) with Long-term Monitoring and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Institutional Controls					
Environmental Easements & Deed Restrictions	Environmental easement for groundwater sampling access and deed restrictions to minimize groundwater use	1	LS	$20,000	$20,000
Work Plan / Final Report					
Construction Documentation	Includes submittals and meetings during/after construction	1	LS	$75,000	$75,000
Site Preparation, Engineering and Access Controls					
Health and Safety requirements	Officer; assume on-site 100% of project duration, Assume 8 hrs/day, 5 days/week, $125/hr. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem	42	Day	$1,200	$50,400
Mobilization/Demobilization	Includes site prep, trailers, staging ,etc. and demobilization	1	LS	$17,700	$17,700
Grading	Fine grading, finish grading, small area, to be paved with grader	694	SY	$6	$4,299
Community Air Monitoring	Includes Dust Trak II meters and enclosures to be used for 1 month	3	Ea	$608	$1,823
Decontamination Pad & Containment, Stone Cost	For equipment, personnel, and departing site vehicles. 100'x50'x6' area of crusher run stone	157	Ton	$11	$1,700
Stone Delivery, Placement and Grading	Delivery fee of $20 per 20 CY truck, 40 mile round trip hauling at 35 mph on average, and rough grading of the stone	93	LCY	$36	$3,352
Surveying	Includes a 2-person crew @ $125/hr, 8hr/day; assume 25% of project duration. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	11	Day	$2,400	$25,200
Site Fencing	Includes six foot high fence, add fencing fabric. To be placed around active construction	1,600	LF	$32	$51,536
Site Gates	Includes six foot high swing gate, 12' double gates	2	EA	$1,100	$2,199
Signage	Includes eight 2 ft x 2 ft reflective warning signs	8	EA	$112	$899
Site Clearing					
Clear excavation areas	Clear and grub dense brush including stumps	0.29	Acre	$8,662	$2,486
Remove trees	Cut & chip medium trees to 12" diameter	0.14	Acre	$7,541	$1,082
Grading	Minor grading in area of removal	1	Day	$2,414	$2,414

Key at end of table.

Table 5-2 Cost Estimate, Alternative 3 - Permeable Reactive Barrier (PRB) with Long-term Monitoring and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Monitoring Well Installation					
Well Drilling	Drill two wells and sample soils during drilling (4 1/4" diameter borehole, using hollow stem auger. 2" PVC casing), 4 1/4" auger drilling for 0-100 feet, and standard split spoon sampling 0-50 feet. Depth of each well is 22 feet.	44	LF	$36	$1,562
PID Rental	MiniRAE 3000 PID. Used during drilling and sampling	4	Day	$75	$300
Well Material	The 2-inch well installation includes: Screen, schedule 40 PVC, 2-inch I.D.; #10 slot screen; well riser; schedule 40 PVC, flush-jointed, 2-inch I.D. End cap (threaded) or top cap (slip); sand pack around 2-inch screen in 4-1/4" auger borehole; bentonite seal around 2-inch riser in 4-1/4" auger borehole; and cement/bentonite grout around 2-inch riser in 4-1/4" auger borehole.	2	EA	$2,476	$4,952
Well Development	Includes 2 person crew, 8-hour days, $125 per hour per person, Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per	2	Day	$2,400	$4,800
Soil Sample Analysis	Includes analysis of samples collected every 2 feet until a depth of 10 feet, and every 5 feet after 10 feet depth. End sampling at 22 feet depth. Samples will be analyzed for VOCs and 1,4 - Dioxane.	14	EA	$148	$2,065
IDW Disposal	Includes: Mobilization, Drum loading & transport, Assume one drum of Disposal Soil, haz and one drum of Disposal Water, haz. Includes one TCLP test for water.	1	LS	$2,606	$2,606
PRB Installation					
Shoring	Sheet piling, steel, 38 psf, 25' excavation, per S.F., drive, extract and salvage, excludes wales	6,250	SF	$29	$182,063
Wales	Connections and struts, 2/3 salvage	30	Ton	$580	$17,228
Excavation	Excavating, trench or continuous footing, common earth, 1-1/2 C.Y. excavator, 20' to 24' deep, excludes sheeting or dewatering	556	BCY	$5	$2,678
Dewatering	Dewatering excavated material for disposal, 1 week duration. 2" diaphragm pump attended and operating 8 hours/day with 20 LF of suction hose and 100 LF of discharge hose	5	Day	$1,118	$5,591
Transportation & Disposal	Transportation & disposal of excavated soils	894	Ton	$40	$35,778
Permitting	NPDES Permit and Water Disposal	1	LS	$75,000	$75,000
PRB Material	Includes Coarse ZVI as the reactive material inside the walls. One wall with a depth of 20 feet and total length of 250 feet will be constructed. Includes material, delivery, and installation costs.	1	LS	$130,952	$130,952
				Capital Costs Subtotal:	$725,700
				10% Legal, administrative, engineering fees, construction management:	$72,600
				20% Contingencies:	$159,700
				Capital Cost Total:	**$970,000**

Key at end of table.

Table 5-2 Cost Estimate, Alternative 3 - Permeable Reactive Barrier (PRB) with Long-term Monitoring and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Annual Groundwater Sampling/Reporting Costs (Quarterly for Years 1-2, Semi-Annual for Years 3-5, and Annual for Years 5-30)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter (2 of each)	1	Week	$1,042	$1,042
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for VOCs and 1,4-dioxane.	28	EA	$148	$4,130
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241
IC and Site Inspection	2 hours during each sampling event	2	HR	$125	$250
Data Evaluation and Reporting		1	LS	$7,000	$7,000
				Years 1-2 Annual Cost Subtotal:	$179,200
				10% Legal, Administrative and Engineering Fees:	$18,000
				20% Contingencies:	$39,500
				Years 1-2 Annual Cost Total:	**$236,700**
				Present Worth of Annual Costs for Years 1-2:	**$434,000**
				Years 3-5 Annual Cost Subtotal:	$89,600
				10% Legal, Administrative and Engineering Fees:	$9,000
				20% Contingencies:	$19,800
				Years 3-5 Annual Cost Total:	**$118,400**
				Present Worth of Annual Costs for Years 3-5:	**$269,000**
				Years 6-30 Annual Cost Subtotal:	$44,800
				10% Legal, Administrative and Engineering Fees:	$4,500
				20% Contingencies:	$9,900
				Years 6-30 Annual Cost Total:	**$59,200**
				Present Worth of Annual Costs for Years 6-30:	**$489,000**

Key at end of table.

Table 5-2 Cost Estimate, Alternative 3 - Permeable Reactive Barrier (PRB) with Long-term Monitoring and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
MNA Parameter Monitoring (Baseline 1st Year and Every Subsequent 5 Years)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter, pH/DO/ORP meter (2 of each)	1	Week	$1,232	$1,232
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for alkalinity, sulfate, total sulfide, nitrate, chloride, total organic carbon, and divalent iron.	28	EA	$116	$3,248
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241
				Periodic Cost Subtotal:	$36,845
				10% Legal, Administrative and Engineering Fees:	$3,700
				20% Contingencies:	$8,200
				Periodic Cost Total:	**$49,000**
				30-year Present Worth of Periodic Costs:	**$157,000**
Periodic Costs (Every 5 Years)					
5-yr Review, Data Evaluation, and Reporting		1	LS	$35,000	$35,000
Institutional Controls	Maintain / Update Documentation	1	LS	$5,000	$5,000
				Periodic Cost Subtotal:	$40,000
				10% Legal, Administrative and Engineering Fees:	$4,000
				20% Contingencies:	$8,800
				Periodic Cost Total:	**$52,800**
				30-year Present Worth of Periodic Costs:	**$116,000**
				2022 Total Present Worth Cost	**$2,435,000**

Key at end of table.

Table 5-2 Cost Estimate, Alternative 3 - Permeable Reactive Barrier (PRB) with Long-term Monitoring and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost

Notes:

1. 30-year present worth of costs assumes 7% annual interest rate per "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA 540-R-00-002 July 2000).
2. Costs included in this estimate were obtained from vendors, RSMeans and estimated using experience from other engineering projects.

3. Legal, administrative and engineering fee	10%	
4. Contingencies (on costs and fees)	20%	
5. Mobilization cost percentage of total capital costs	2.5%	
6. Acreages for clearing/grubbing		
Clearing acreage (PRB area, width of 50 feet)	0.287	acres
Tree removal acreage (half of PRB wall)	0.143	acres
7 BCY to ECY	1.150	ECY/BCY
8. ECY to tons	1.400	Tons/ECY
9. Construction Duration (Assuming 5 day, 8hr/day work week)		
Assume Mob/Demob Time	2	weeks
Clearing and Grubbing	1	weeks
Well Installation	4	days
PRB Construction	4	weeks
Total Project Time	2	months
Construction Seasons Required	1	construction season
10. PRB Dimensions		
Total Wall Length	250	LF
Wall Depth	20	LF

11. In accordance with the USEPA requirements, a 5-year review will be completed at the site to evaluate site conditions as well as to recommend modifications to the selected remedy.

Key:

BCY = Bank cubic yards
CY = Cubic Yards
EA = Each
ECY = Embankment cubic yards
FS = Feasibility Study
HR = Hour
LCY = Loose cubic yards
LF = Linear feet
LS = Lump sum
OU = Operable Unit
SF = Square feet
SY = Square yards

Table 5-3 Cost Estimate, Alternative 4 - Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Institutional Controls					
Environmental Easements & Deed Restrictions	Environmental easement for groundwater sampling access and deed restrictions to minimize groundwater use	1	LS	$20,000	$20,000
Pilot Study					
Pilot Study	Complete Pilot study to evaluate effectiveness of AS/SVE for site remediation	1	LS	$75,000	$75,000
Work Plan / Final Report					
Construction Documentation	Includes submittals and meetings during/after construction	1	LS	$75,000	$75,000
Site Preparation, Engineering and Access Controls					
Health and Safety requirements	Officer; assume on-site 100% of project duration, Assume 8 hrs/day, 5 days/week, $125/hr. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem	42	Day	$1,200	$50,400
Mobilization/Demobilization	Includes site prep, trailers, staging ,etc. and demobilization	1	LS	$16,100	$16,100
Community Air Monitoring	Includes Dust Trak II meters and enclosures to be used for 2 months	3	Ea	$1,215	$3,645.00
Decontamination Pad & Containment	For equipment, personnel, and departing site vehicles. 100'x50'x6" area of crusher run stone	157	Ton	$11	$1,700
Stone Delivery, Placement and Grading	Delivery fee of $20 per 20 CY truck, 40 mile round trip hauling at 35 mph	93	LCY	$36	$3,352
Surveying	Includes a 2-person crew @ $125/hr, 8hr/day; assume 25% of project duration. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person.	11	Day	$2,400	$25,200
Site Fencing	Includes six foot high fence, add fencing fabric. To be placed around active construction and moved as necessary (one AS/SVE area fenced in at a time)	790	LF	$32	$25,446
Site Gates	Includes six foot high swing gate, 12' double gates	2	Ea	$1,100	$2,199
Signage	Includes eight 2 ft x 2 ft reflective warning signs	8	Ea	$112	$899

Key at end of table.

Table 5-3 Cost Estimate, Alternative 4 - Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Site Clearing					
Clear excavation areas	Clear and grub dense brush including stumps	0.17	Acre	$8,662	$1,462
Remove trees	Cut & chip medium trees to 12" diameter	0.15	Acre	$7,541	$1,099
Grading	Minor grading in area of removal	2	Day	$2,414	$4,827
Monitoring Well Installation					
Well Drilling	Drill two wells and sample soils during drilling (4 1/4" diameter borehole, using hollow stem auger. 2" PVC casing), 4 1/4" auger drilling for 0-100 feet, and standard split spoon sampling 0-50 feet. Depth of each well is 22 feet.	44	LF	$36	$1,562
PID Rental	MiniRAE 3000 PID. Used during drilling and sampling	4	Day	$75	$300
Well Material	The 2-inch well installation includes: Screen, schedule 40 PVC, 2-inch I.D.; #10 slot screen; well riser; schedule 40 PVC, flush-jointed, 2-inch I.D. End cap (threaded) or top cap (slip); sand pack around 2-inch screen in 4-1/4" auger borehole; bentonite seal around 2-inch riser in 4-1/4" auger borehole; and cement/bentonite grout around 2-inch riser in 4-1/4" auger borehole.	2	EA	$2,476	$4,952
Well Development	Includes 2 person crew, 8-hour days, $125 per hour per person, Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	2	Day	$2,400	$4,800
Soil Sample Analysis	Includes analysis of samples collected every 2 feet until a depth of 10 feet, and every 5 feet after 10 feet depth. End sampling at 22 feet depth. Samples will be analyzed for VOCs and 1,4 - Dioxane.	14	EA	$148	$2,065
IDW Disposal	Includes: Mobilization, Drum loading & transport, Assume one drum of Disposal Soil, haz and one drum of Disposal Water, haz. Includes one TCLP test for water.	1	LS	$2,606	$2,606

Key at end of table.

Table 5-3 Cost Estimate, Alternative 4 - Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Soil Vapor Extraction (SVE) System and Air Sparging Installation (9 AS, 12 SVE)					
Well Drilling and Installation	6" diameter borehole, using hollow stem auger. 2" PVC	233	LF	$111	$25,738
Soil Sample Analysis	Include analysis of 3 total samples per well (2 at water table and 1 at bottom of boring). At AS wells only. Samples will be analyzed for VOCs and 1,4 - Dioxane	27	Ea	$148	$3,983
Horizontal Header Piping & Install	6" PVC connecting the SVE auxiliary piping with the SVE system	230	LF	$57	$12,997
Horizontal Auxiliary Piping & Install	2" PVC for auxiliary piping	445	LF	$29	$12,887
Well Protection	3' diameter concrete pipe, 3' length for each well	63	LF	$97	$6,105
Concrete Well Protection	Concrete mix to fill the area between the well protection concrete pipe and the well vault, Assuming 6 bags needed per well	126	Bag	$17	$2,180
Well Vaults	24" X 24" X 24" Vault, Bolt-Down	21	Ea	$330	$6,930
SVE System	SVE system, mobilization. Includes freight costs	2	Ea	$73,724	$147,447
Air Compressor	DeWalt 5-HP 60-Gallon Two-Stage for Air Sparging Wells	2	Ea	$1,334	$2,668
Catalytic Oxidizer	Falco 600 Electric Catalytic Oxidizer, 600 CFM capacity	2	Ea	$48,000	$96,000
Electrical Installation	Connect SVE system to electrical grid	2	Ea	$10,000	$20,000
				Capital Costs Subtotal:	$659,600
				10% Legal, administrative, engineering fees, construction management:	$66,000
				20% Contingencies:	$145,200
				Capital Cost Total:	**$882,000**

Key at end of table.

Table 5-3 Cost Estimate, Alternative 4 - Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Annual Groundwater Sampling/Reporting Costs (Quarterly for Years 1-2, Semi-Annual for Years 3-5, and Annual for Years 5-30)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter (2 of each)	1	Week	$1,042	$1,042
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for VOCs and 1,4-dioxane.	28	EA	$148	$4,130
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241
IC and Site Inspection	2 hours during each sampling event	2	HR	$125	$250
Data Evaluation and Reporting		1	LS	$7,000	$7,000
				Years 1-2 Annual Cost Subtotal:	$179,200
				10% Legal, Administrative and Engineering Fees:	$18,000
				20% Contingencies:	$39,500
				Years 1-2 Annual Cost Total:	**$236,700**
				Present Worth of Annual Costs for Years 1-2:	**$434,000**
				Years 3-5 Annual Cost Subtotal:	$89,600
				10% Legal, Administrative and Engineering Fees:	$9,000
				20% Contingencies:	$19,800
				Years 3-5 Annual Cost Total:	**$118,400**
				Present Worth of Annual Costs for Years 3-5:	**$269,000**
				Years 6-30 Annual Cost Subtotal:	$44,800
				10% Legal, Administrative and Engineering Fees:	$4,500
				20% Contingencies:	$9,900
				Years 6-30 Annual Cost Total:	**$59,200**
				Present Worth of Annual Costs for Years 6-30:	**$489,000**

Key at end of table.

Table 5-3 Cost Estimate, Alternative 4 - Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
MNA Parameter Monitoring (Baseline 1st Year, Every 3 Years During Active Treatment, After System Removal, Every 3 Years Subsequent)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter, pH/DO/ORP meter (2 of each)	1	Week	$1,232	$1,232
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for alkalinity, sulfate, total sulfide, nitrate, chloride, total organic carbon, and divalent iron.	28	EA	$116	$3,248
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241
				Periodic Cost Subtotal:	$36,845
				10% Legal, Administrative and Engineering Fees:	$3,700
				20% Contingencies:	$8,200
				Periodic Cost Total:	**$49,000**
				30-year Present Worth of Periodic Costs:	**$259,000**

Key at end of table.

Table 5-3 Cost Estimate, Alternative 4 - Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
SVE System O & M Costs - Years 1 through 10					
Monthly Inspection Labor	Influent/Effluent sampling (includes 1 QA/QC), inspection of wells/system and recording of flow and vacuum measurements (includes 4 hours of labor for two people, $125/hour). Monthly event, but costs for four events are included with the quarterly sampling activities.	8	Events	$1,400	$11,200
Extraction Well Sampling Labor	Each event involves one 2-person crew, sampling all SVE wells and influent/effluent (plus 1 QA/QC) for soil vapor for 3 days (10 hrs/day)	4	Events	$8,700	$34,800
Soil Vapor Sampling Equipment	Peristaltic pump, PID rental	20	Day	$130	$2,600
Monthly SVE Sampling and Analysis	Influent/Effluent analysis costs	8	Events	$3,461	$27,684
Quarterly SVE Sampling and Analysis	Extraction Well analysis costs	4	Events	$17,303	$69,210
Tubing	3/16" x 3/8" Silicone Tubing for soil vapor sampling. Soil vapor tubing needs to be new for each event (3 feet of tubing for influent/effluent sampling, 15 feet for each SVE well)	828	LF	$2	$1,648
IDW Disposal	Includes: Mobilization, drum loading & transport of two drums of groundwater sampling water, haz, includes cost for TCLP test for water	4	LS	$1,561	$6,244
Electricity and Internet Utilities	Temporary utilities, power for job duration, incl. elevator, etc, max	2	Ea	$3,900	$7,800
Data Evaluation and Reporting		1	LS	$30,000	$30,000
				SVE System O&M Cost Subtotal:	$191,200
				10% Legal, Administrative and Engineering Fees:	$19,200
				20% Contingencies:	$42,100
				SVE System O&M Cost Total:	**$252,500**
				10-year Present Worth of SVE System O&M Costs:	**$1,796,000**
Periodic Costs (Every 5 Years)					
5-yr Review, Data Evaluation, and Reporting		1	LS	$35,000	$35,000
Institutional Controls	Maintain / Update Documentation	1	LS	$5,000	$5,000
				Periodic Cost Subtotal:	$40,000
				10% Legal, Administrative and Engineering Fees:	$4,000
				20% Contingencies:	$8,800
				Periodic Cost Total:	**$52,800**
				30-year Present Worth of Periodic Costs:	**$116,000**
				2022 Total Present Worth Cost	**$4,245,000**

Key at end of table.

Table 5-3 Cost Estimate, Alternative 4 - Air Sparging/Soil Vapor Extraction, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost

Notes:

1. 30-year present worth of costs assumes 7% annual interest rate per "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA 540-R-00-002 July 2000).
2. Costs included in this estimate were obtained from vendors, RSMeans and estimated using experience from other engineering projects.

3. Legal, administrative and engineering fee	10%	
4. Contingencies (on costs and fees)	20%	
5. Mobilization cost percentage of total capital costs	2.5%	
6. Acreages for clearing/grubbing		
Clearing acreage (SVE/AS well areas, trailer areas)	0.169	acres
Tree removal acreage (SVE/AS well areas, trailer areas)	0.146	acres
7 BCY to ECY	1.150	ECY/BCY
8. ECY to tons	1.400	Tons/ECY

9. Historical Cost Indices from 2021 RSMeans Site Work and Landscape Cost Data were used to escalate costs.

2018	229.6
2019	234.00
2020	245.10
2021	249.80
2022	252.90

10. Construction Duration (Assuming 5 day, 8hr/day work week)

Assume Mob/Demob Time	2	weeks
Clearing and Grubbing	1	weeks
Well Installation	4	days
AS/SVE System Construction	4	weeks
Total Project Time	2	mo
Construction Seasons Required	1	construction season

11. AS/SVE System Details

Number of AS wells	9
Number of SVE wells	12
Length of header piping	230
Length of auxiliary piping	445

12. In accordance with the USEPA requirements, a 5-year review will be completed at the site to evaluate site conditions as well as to recommend modifications to the selected remedy.

Key:

BCY = Bank cubic yards
CY = Cubic Yards
EA = Each
ECY = Embankment cubic yards
FS = Feasibility Study
HR = Hour
LCY = Loose cubic yards
LF = Linear feet
LS = Lump sum
OU = Operable Unit
SF = Square feet
SY = Square yards

Key at end of table.

Table 5-4 Cost Estimate, Alternative 5 – In-situ Chemical/Biological Treatment, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Institutional Controls					
Environmental Easements & Deed Restrictions	Environmental easement for groundwater sampling access and deed restrictions to minimize groundwater use	1	LS	$20,000	$20,000
Treatability Study					
Treatability Study	Complete treatability study to evaluate effectiveness of different injection amendments and enhancements for site remediation	1	LS	$200,000	$200,000
Work Plan / Final Report					
Construction Documentation	Includes submittals and meetings during/after construction	1	LS	$50,000	$50,000
Site Preparation, Engineering and Access Controls					
Health and Safety requirements	Officer; assume on-site 100% of project duration, Assume 8 hrs/day, 5 days/week, $125/hr. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem	31	Day	$1,200	$37,200
Mobilization/Demobilization	Includes site prep, trailers, staging ,etc. and demobilization	1	LS	$26,300	$26,300
Community Air Monitoring	Includes Dust Trak II meters and enclosures to be used for 1 month	3	Ea	$608	$1,822.50
Decontamination Pad & Containment	For equipment, personnel, and departing site vehicles. 100'x50'x6" area of crusher run stone	157	Ton	$11	$1,700
Stone Delivery, Placement and Grading	Delivery fee of $20 per 20 CY truck, 40 mile round trip hauling at 35 mph on	93	LCY	$36	$3,352
Surveying	Includes a 2-person crew @ $125/hr, 8hr/day; assume 25% of project duration. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person.	8	Day	$2,400	$18,600
Site Fencing	Includes six foot high fence, add fencing fabric. To be placed around active construction and moved as necessary (one injection area fenced in at a time)	788	LF	$32	$25,381
Site Gates	Includes six foot high swing gate, 12' double gates	2	Ea	$1,100	$2,199
Signage	Includes eight 2 ft x 2 ft reflective warning signs	8	Ea	$112	$899
Site Clearing					
Clear excavation areas	Clear and grub dense brush including stumps	0.14	Acre	$8,662	$1,243
Remove trees	Cut & chip medium trees to 12" diameter	0.14	Acre	$7,541	$1,082
Grading	Minor grading in area of removal	2	Day	$2,414	$4,827

Key at end of table.

Table 5-4 Cost Estimate, Alternative 5 – In-situ Chemical/Biological Treatment, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Monitoring Well Installation					
Well Drilling	Drill two wells and sample soils during drilling (4 1/4" diameter borehole, using hollow stem auger. 2" PVC casing), 4 1/4" auger drilling for 0-100 feet, and standard split spoon sampling 0-50 feet. Depth of each well is 22 feet.	44	LF	$36	$1,562
PID Rental	MiniRAE 3000 PID. Used during drilling and sampling	4	Day	$75	$300
Well Material	The 2-inch well installation includes: Screen, schedule 40 PVC, 2-inch I.D.; #10 slot screen; well riser; schedule 40 PVC, flush-jointed, 2-inch I.D. End cap (threaded) or top cap (slip); sand pack around 2-inch screen in 4-1/4" auger borehole; bentonite seal around 2-inch riser in 4-1/4" auger borehole; and cement/bentonite grout around 2-inch riser in 4-1/4" auger borehole.	2	EA	$2,476	$4,952
Well Development	Includes 2 person crew, 8-hour days, $125 per hour per person, Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per	2	Day	$2,400	$4,800
Soil Sample Analysis	Includes analysis of samples collected every 2 feet until a depth of 10 feet, and every 5 feet after 10 feet depth. End sampling at 22 feet depth. Samples will be analyzed for VOCs and 1,4 - Dioxane.	14	EA	$148	$2,065
IDW Disposal	Includes: Mobilization, Drum loading & transport, Assume one drum of Disposal Soil, haz and one drum of Disposal Water, haz. Includes one TCLP test for water.	1	LS	$2,606	$2,606
Chemical Reduction Injection System					
Injection Well Installation	Installation of 1-foot wells to be capped and reused for future injections. Includes Sch 40 PVC, screen, riser, sand, bentonite, and locking cap. Assume 20 foot depth for all 42 wells.	840	feet	$12	$10,080
First Injection Application	Material, drilling and injection services from Regenesis (sulfidated micro-ZVI and activated carbon). Reagent will be injected into 83 total injection points (42 wells and 41 DPT points), spaced 10 feet apart, to a depth of 20 feet.	1	LS	$454,038	$454,038
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	4	Events	$29,000	$116,000
Data Evaluation and Reporting	Total of 4 reports for injections.	1	LS	$85,000	$85,000
				Capital Costs Subtotal:	$1,076,100
				10% Legal, administrative, engineering fees, construction management:	$107,700
				20% Contingencies:	$236,800
				Capital Cost Total:	**$1,439,000**

Key at end of table.

Table 5-4 Cost Estimate, Alternative 5 – In-situ Chemical/Biological Treatment, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Annual Groundwater Sampling/Reporting Costs (Quarterly for Years 1-2, Semi-Annual for Years 3-5, and Annual for Years 5-30)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter (2 of each)	1	Week	$1,042	$1,042
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for VOCs and 1,4-dioxane.	28	EA	$148	$4,130
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241
IC and Site Inspection	2 hours during each sampling event	2	HR	$125	$250
Data Evaluation and Reporting		1	LS	$7,000	$7,000
				Years 1-2 Annual Cost Subtotal:	$179,200
				10% Legal, Administrative and Engineering Fees:	$18,000
				20% Contingencies:	$39,500
				Years 1-2 Annual Cost Total:	**$236,700**
				Present Worth of Annual Costs for Years 1-2:	**$434,000**
				Years 3-5 Annual Cost Subtotal:	$89,600
				10% Legal, Administrative and Engineering Fees:	$9,000
				20% Contingencies:	$19,800
				Years 3-5 Annual Cost Total:	**$118,400**
				Present Worth of Annual Costs for Years 3-5:	**$269,000**
				Years 6-30 Annual Cost Subtotal:	$44,800
				10% Legal, Administrative and Engineering Fees:	$4,500
				20% Contingencies:	$9,900
				Years 6-30 Annual Cost Total:	**$59,200**
				Present Worth of Annual Costs for Years 6-30:	**$489,000**

Key at end of table.

Table 5-4 Cost Estimate, Alternative 5 – In-situ Chemical/Biological Treatment, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
MNA Parameter Monitoring (Baseline 1st Year, Annual Samping Years 2-3, Every 3 Years Subsequent)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter, pH/DO/ORP meter (2 of each)	1	Week	$1,232	$1,232
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for alkalinity, sulfate, total sulfide, nitrate, chloride, total organic carbon, and divalent iron.	28	EA	$116	$3,248
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241
				Periodic Cost Subtotal:	$36,845
				10% Legal, Administrative and Engineering Fees:	$3,700
				20% Contingencies:	$8,200
				Periodic Cost Total:	**$49,000**
				30-year Present Worth of Periodic Costs:	**$282,000**
Chemical Reduction Material Injection					
Future Injection Applications	Material, drilling and injection services from Regenesis (sulfidated micro-ZVI and activated carbon). Reagent will be injected into 83 total injection points (42 wells and 41 DPT points) with a depth of 20 feet each, with 2 injections occurring after construction.	2	LS	$454,038	$908,075
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	8	Events	$29,000	$232,000
Data Evaluation and Reporting	Total of 4 reports for injections (quarterly).	1	LS	$60,000	$60,000
				Injection Cost Subtotal:	$1,200,100
				10% Legal, Administrative and Engineering Fees:	$120,100
				20% Contingencies:	$264,100
				Injection Cost Total:	**$1,584,300**
				1-year Present Worth of Injection Costs:	**$1,500,000**

Key at end of table.

Table 5-4 Cost Estimate, Alternative 5 – In-situ Chemical/Biological Treatment, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Periodic Costs (Every 5 Years)					
5-yr Review, Data Evaluation, and Reporting		1	LS	$35,000	$35,000
Institutional Controls	Maintain / Update Documentation	1	LS	$5,000	$5,000
				Periodic Cost Subtotal:	$40,000
				10% Legal, Administrative and Engineering Fees:	$4,000
				20% Contingencies:	$8,800
				Periodic Cost Total:	**$52,800**
				30-year Present Worth of Periodic Costs:	**$116,000**
				2022 Total Present Worth Cost	**$4,529,000**

Notes:

1. 30-year present worth of costs assumes 7% annual interest rate per "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA 540-R-00-002 July 2000).
2. Costs included in this estimate were obtained from vendors, RSMeans and estimated using experience from other engineering projects.

3. Legal, administrative and engineering fee	10%	
4. Contingencies (on costs and fees)	20%	
5. Mobilization cost percentage of total capital costs	2.5%	
6. Acreages for clearing/grubbing		
Clearing acreage (ISCR areas)	0.143	acres
Tree removal acreage (ISCR areas)	0.143	acres
7 BCY to ECY	1.150	ECY/BCY
8. ECY to tons	1.400	Tons/ECY

9. Historical Cost Indices from 2021 RSMeans Site Work and Landscape Cost Data were used to escalate costs.

2018	229.6
2019	234.00
2020	245.10
2021	249.80
2022	252.90

10. Construction Duration (Assuming 5 day, 8hr/day work week)

Assume Mob/Demob Time	2	weeks
Clearing and Grubbing	1	weeks
Well Installation	4	days
ISCR Construction/Injection	2	weeks
Total Project Time	1	mo
Construction Seasons Required	1	construction season

11. ISCR Details

Number of Injection and Wells Points (1" D)	83	
Spacing between Injection points	10	LF
Depth of Injection Points	20	LF

12. In accordance with the USEPA requirements, a 5-year review will be completed at the site to evaluate site conditions as well as to recommend modifications to the selected remedy.

Description	Comments	Quantity	Unit	Unit Cost	Cost

Key:

BCY = Bank cubic yards
CY = Cubic Yards
EA = Each
ECY = Embankment cubic yards
FS = Feasibility Study
HR = Hour
LCY = Loose cubic yards
LF = Linear feet
LS = Lump sum
OU = Operable Unit
SF = Square feet
SY = Square yards

Table 5-5 Cost Estimate, Alternative 6 - Pump and Treat, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Institutional Controls					
Environmental Easements & Deed Restrictions	Environmental easement for groundwater sampling access and deed restrictions to minimize groundwater use	1	LS	$20,000	$20,000
Pilot Study					
Pilot Study	Complete pilot study to evaluate effectiveness of pump and treat of groundwater for site remediation	1	LS	$75,000	$75,000
Work Plan / Final Report					
Construction Documentation	Includes submittals and meetings during/after construction	1	LS	$100,000	$100,000
Site Preparation, Engineering and Access Controls					
Health and Safety requirements	Officer; assume on-site 100% of project duration, Assume 8 hrs/day, 5 days/week, $125/hr. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem	36	Day	$1,200	$43,200
Mobilization/Demobilization	Includes site prep, trailers, staging ,etc. and demobilization	1	LS	$13,300	$13,300
Community Air Monitoring	Includes Dust Trak II meters and enclosures to be used for 1 month	3	Ea	$1,823	$5,467.50
Decontamination Pad & Containment	For equipment, personnel, and departing site vehicles. 100'x50'x6" area of crusher run stone	157	Ton	$11	$1,700
Surveying	Includes a 2-person crew @ $125/hr, 8hr/day; assume 25% of project duration, Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	9	Day	$2,400	$21,600
Site Fencing	Includes six foot high fence, add fencing fabric. To be placed around active construction and moved as necessary (horizontal well installation area)	920	LF	$32	$29,633
Site Gates	Includes six foot high swing gate, 12' double gates	2	Ea	$1,100	$2,199
Signage	Includes eight 2 ft x 2 ft reflective warning signs	8	Ea	$112	$899

Key at end of table.

Table 5-5 Cost Estimate, Alternative 6 - Pump and Treat, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Site Clearing					
Clear excavation areas	Clear and grub dense brush including stumps	0.09	Acre	$8,662	$795
Remove trees	Cut & chip medium trees to 12" diameter	0.09	Acre	$7,541	$692
Grading	Minor grading in area of removal	2	Day	$2,414	$4,827
Monitoring Well Installation					
Well Drilling	Drill two wells and sample soils during drilling (4 1/4" diameter borehole, using hollow stem auger. 2" PVC casing), 4 1/4" auger drilling for 0-100 feet, and standard split spoon sampling 0-50 feet. Depth of each well is 22 feet.	44	LF	$36	$1,562
PID Rental	MiniRAE 3000 PID. Used during drilling and sampling	4	Day	$75	$300
Well Material	The 2-inch well installation includes: Screen, schedule 40 PVC, 2-inch I.D.; #10 slot screen; well riser; schedule 40 PVC, flush-jointed, 2-inch I.D. End cap (threaded) or top cap (slip); sand pack around 2-inch screen in 4-1/4" auger borehole; bentonite seal around 2-inch riser in 4-1/4" auger borehole; and cement/bentonite grout around 2-inch riser in 4-1/4" auger borehole.	2	EA	$2,476	$4,952
Well Development	Includes 2 person crew, 8-hour days, $125 per hour per person, Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per	2	Day	$2,400	$4,800
Soil Sample Analysis	Includes analysis of samples collected every 2 feet until a depth of 10 feet, and every 5 feet after 10 feet depth. End sampling at 22 feet depth. Samples will be analyzed for VOCs and 1,4 - Dioxane.	14	EA	$148	$2,065
IDW Disposal	Includes: Mobilization, Drum loading & transport, Assume one drum of	1	LS	$2,606	$2,606

Key at end of table.

Table 5-5 Cost Estimate, Alternative 6 - Pump and Treat, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Pump and Treat System Installation					
Boring	Horizontal boring, small diameter boring, sandy soil, 3", includes casing only, 100' minimum, excludes jacking pits or dewatering	160	LF	$27	$4,304
Jacking Pits	Horizontal boring, prepare jacking pits, includes mobilization and demobilization, minimum	1	EA	$3,789	$3,789
Dewatering	Dewatering excavated material for disposal, 1 week duration	5	Day	$1,118	$5,591
Disposal & Transportation	Only the pipe bedding volume will be disposed of, the rest of the excavated material will be backfilled into the trench	3	Ton	$40	$120
Perforated Piping for Horizontal Well	4" perforated corrugated PE pipe	160	LF	$2	$251
Vertical Well Drilling and Installation	2" PVC wells, includes material and installation. Depth of horizontal well riser is 10 feet, depth of vertical wells is 20 feet.	70	LF	$54	$3,745
Pumping Well Header Piping & Install	6" PVC, includes material and install	242	LF	$57	$13,675
Well Protection	3' diameter concrete pipe, 3' length for each well	12	LF	$97	$1,163
Concrete Well Protection	Concrete mix to fill the area between the well protection concrete pipe and the well vault, Assuming 6 bags needed per well	24	Bag	$17	$415
Well Vaults	24" X 24" X 24" Vault, Bolt-Down	4	Ea	$330	$1,320
Equipment Trailer Treatment Train	Includes purchase of trailer, pumps, tray air stripper and holding tank + freight cost	2	EA	$83,063	$166,126
Discharge Piping	6" PVC, includes material and install	95	LF	$57	$5,368
				Capital Costs Subtotal:	$541,500
				10% Legal, administrative, engineering fees, construction management:	$54,200
				20% Contingencies:	$119,200
				Capital Cost Total:	**$724,000**

Key at end of table.

Table 5-5 Cost Estimate, Alternative 6 - Pump and Treat, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Annual Groundwater Sampling/Reporting Costs (Quarterly for Years 1-2, Semi-Annual for Years 3-5, and Annual for Years 5-30)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter (2 of each)	1	Week	$1,042	$1,042
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for VOCs and 1,4-dioxane.	28	EA	$148	$4,130
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of	1	LS	$2,241	$2,241
IC and Site Inspection	2 hours during each sampling event	2	HR	$125	$250
Data Evaluation and Reporting		1	LS	$7,000	$7,000
				Years 1-2 Annual Cost Subtotal:	$179,200
				10% Legal, Administrative and Engineering Fees:	$18,000
				20% Contingencies:	$39,500
				Years 1-2 Annual Cost Total:	**$236,700**
				Present Worth of Annual Costs for Years 1-2:	**$434,000**
				Years 3-5 Annual Cost Subtotal:	$89,600
				10% Legal, Administrative and Engineering Fees:	$9,000
				20% Contingencies:	$19,800
				Years 3-5 Annual Cost Total:	**$118,400**
				Present Worth of Annual Costs for Years 3-5:	**$269,000**
				Years 6-30 Annual Cost Subtotal:	$44,800
				10% Legal, Administrative and Engineering Fees:	$4,500
				20% Contingencies:	$9,900
				Years 6-30 Annual Cost Total:	**$59,200**
				Present Worth of Annual Costs for Years 6-30:	**$489,000**

Key at end of table.

Table 5-5 Cost Estimate, Alternative 6 - Pump and Treat, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
MNA Parameter Monitoring (Baseline 1st Year, Every 5 Years During Active Treatment, After System Removal, Every 3 Years Subsequent)					
Groundwater Sampling Labor	Each event involves two 2-person crews, 10-hour days, one week of sampling (5 days), $125 per hour per person, Assume five wells (3 per team) will be sampled per day. Add $200/day ($125 for lodging + $75 per diem) for lodging and per diem per person	1	Events	$29,000	$29,000
Groundwater Sampling Equipment	Peristaltic pump, PID rental, turbidity meter, pH/DO/ORP meter (2 of each)	1	Week	$1,232	$1,232
Tubing	3/16" x 3/8" Silicone Tubing for three wells at 35 foot depth and 23 wells at 20 foot depth	565	LF	$2	$1,124
Groundwater Sampling Analysis	Includes sample bottles and 2 QA/QC samples. Analysis for alkalinity, sulfate, total sulfide, nitrate, chloride, total organic carbon, and divalent iron.	28	EA	$116	$3,248
IDW Disposal	Includes: Mobilization, drum loading & transport of one drum of groundwater sampling water, haz, includes cost for TCLP test for water	1	LS	$2,241	$2,241
				Periodic Cost Subtotal:	$36,845
				10% Legal, Administrative and Engineering Fees:	$3,700
				20% Contingencies:	$8,200
				Periodic Cost Total:	**$49,000**
				30-year Present Worth of Periodic Costs:	**$164,000**
Pump and Treat System Monitoring - Years 1 through 20					
Monthly System Inspection Labor & Sample Analysis	Influent/Effluent/Discharge sampling (includes 1 QA/QC), inspection of system, maintenance of system (see bag/sock/filter replacements below), and recording of flow measurements.	12	Events	$1,590	$19,080
#5 Micron Bags	Assume to be changed once a week, $6 per bag	12	Month	$24	$288
#25 Micron Bags	Assume to be changed once a week, $6 per bag	12	Month	$24	$288
Chitosan Flock Socks	Assume to be changed once a week, $150 per sock	12	Month	$600	$7,200
Weekly Filter Change	Weekly filter replacement labor costs	12	Month	$1,000	$12,000
Pod Sand Media Filter	Assume to be changed once a month (labor inc. with monthly inspection)	12	Month	$2,000	$24,000
Load into Haul Trucks	For spent filter media disposal	4	BCY	$19	$71
Disposal & Transportation	Assume 900 lbs/sand media filter, Includes hauling and disposal costs	5	Ton	$40	$216
Data Evaluation and Reporting		1	LS	$25,000	$25,000
				Pump & Treat Monitoring Cost Subtotal:	$88,200
				10% Legal, Administrative and Engineering Fees:	$8,820
				20% Contingencies:	$19,500
				Pump & Treat Monitoring Cost Total:	**$116,600**
				Present Worth of Pump & Treat Monitoring Costs:	**$1,251,000**

Key at end of table.

Table 5-5 Cost Estimate, Alternative 6 - Pump and Treat, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost
Periodic Costs (Every 5 Years)					
5-yr Review, Data Evaluation, and Reporting		1	LS	$35,000	$35,000
Institutional Controls	Maintain / Update Documentation	1	LS	$5,000	$5,000
				Periodic Cost Subtotal:	$40,000
				10% Legal, Administrative and Engineering Fees:	$4,000
				20% Contingencies:	$8,800
				Periodic Cost Total:	**$52,800**
				30-year Present Worth of Periodic Costs:	**$116,000**
				2022 Total Present Worth Cost	**$3,447,000**

Notes:

1. 30-year present worth of costs assumes 7% annual interest rate per "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA 540-R-00-002 July 2000).
2. Costs included in this estimate were obtained from vendors, RSMeans and estimated using experience from other engineering projects.
3. Legal, administrative and engineering fee 10%
4. Contingencies (on costs and fees) 20%
5. Mobilization cost percentage of total capital costs 2.5%
6. Acreages for clearing/grubbing
   - Clearing acreage (Horizontal well area) 0.092 acres
   - Tree removal acreage (Horizontal well area) 0.092 acres
7. BCY to ECY 1.150 ECY/BCY
8. ECY to tons 1.400 Tons/ECY
9. Historical Cost Indices from 2021 RSMeans Site Work and Landscape Cost Data were used to escalate costs.
   - 2018 229.6
   - 2019 234.00
   - 2020 245.10
   - 2021 249.80
   - 2022 252.90
10. Construction Duration (Assuming 5 day, 8hr/day work week)
    - Assume Mob/Demob Time 2 weeks
    - Clearing and Grubbing 1 weeks
    - Well Installation 4 days
    - Pump and Treat System Construction 3 weeks
    - Total Project Time 2 mo
    - Construction Seasons Required 1 construction season
11. Pump & treat system details
    - Length of Horizontal Trench 160 LF
    - Starting Depth 10 LF
    - Ending Depth 15 LF
    - Header Piping Length 242 LF *Includes both horizontal and vertical systems
    - Discharge Piping Length 95 LF *Includes both horizontal and vertical systems
12. In accordance with the USEPA requirements, a 5-year review will be completed at the site to evaluate site conditions as well as to recommend modifications to the selected remedy.

Table 5-5 Cost Estimate, Alternative 6 - Pump and Treat, Long-term Monitoring, and ICs
Olean Well Field Site OU4 FS, Olean, New York

Description	Comments	Quantity	Unit	Unit Cost	Cost

Key:

BCY = Bank cubic yards
CY = Cubic Yards
EA = Each
ECY = Embankment cubic yards
FS = Feasibility Study
HR = Hour
LCY = Loose cubic yards
LF = Linear feet
LS = Lump sum
OU = Operable Unit
SF = Square feet
SY = Square yards

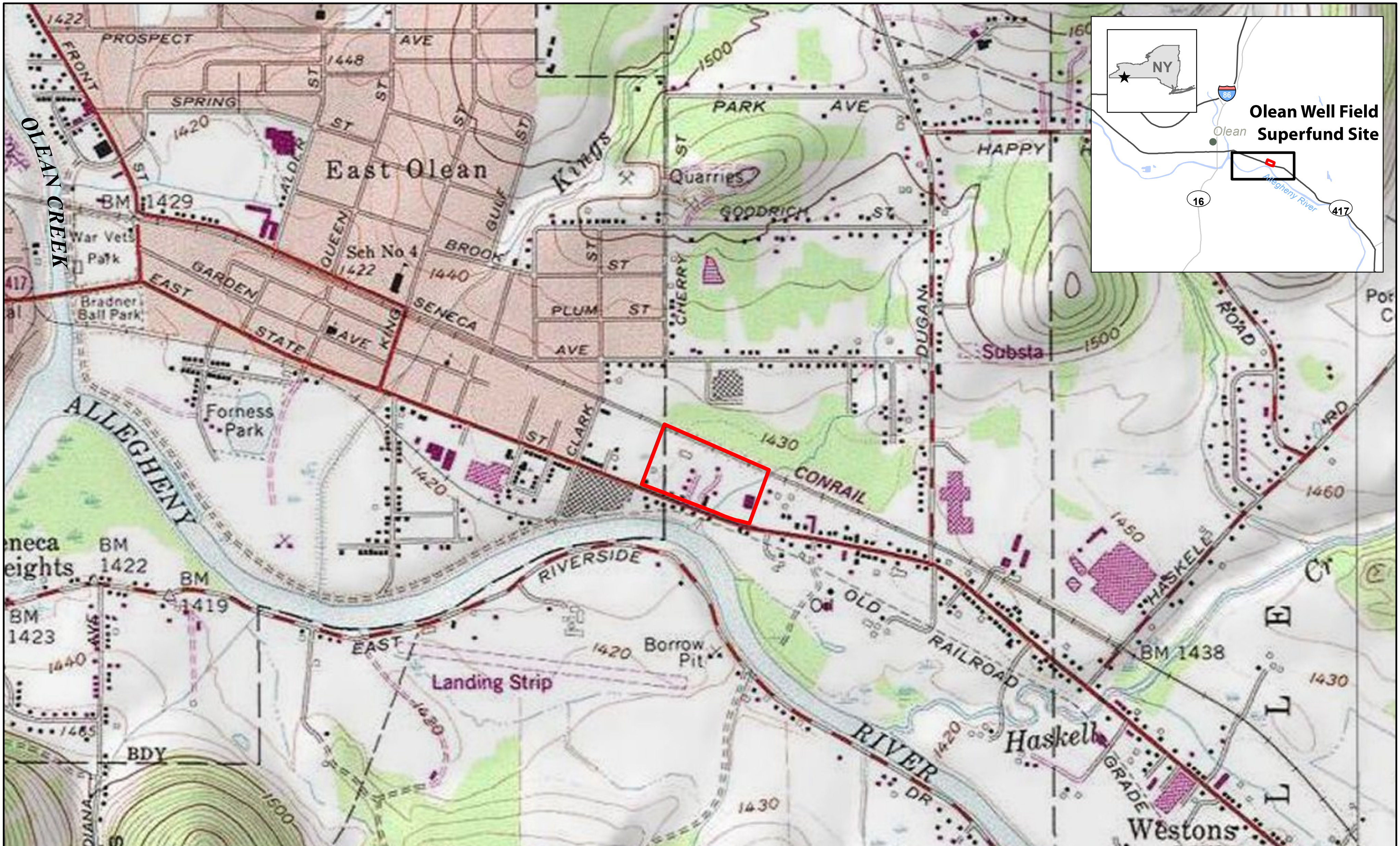
Table 6-1 Summary of Total Present Worth Values of All Alternatives, Olean Well Field Site OU4 FS, Olean, New York

Alternative	Capital Cost	Periodic Cost	2022 Total Present Value of Alternatives
1 - No Action	$0	$0	$0
2 - Monitored Natural Attenuation (MNA) and Institutional Controls (ICs)	$107,000	$2,182,000	$2,289,000
3 - Permeable Reactive Barrier with Long Term Monitoring and ICs	$970,000	$1,465,000	$2,435,000
4 - Air Sparging and Soil Vapor Extraction, Long Term Monitoring and ICs	$882,000	$3,363,000	$4,245,000
5 - In-situ Chemical/Biological Treatment, Long Term Monitoring and ICs	$1,439,000	$3,090,000	$4,529,000
6 - Pump and Treat, Long Term Monitoring and ICs	$724,000	$2,723,000	$3,447,000

Key:
FS = Feasibility Study
ICs = Institutional Controls
MNA = monitored natural attenuation
OU4 = Operable Unit 4
Note: All alternatives have a project duration of 30 years.

Figures

Document Path: L:\PROJECTS\Olean_Wells\Maps\MXD\Report\2022_02_28\1-1_SiteLocation.mxd



Legend

Olean Well Field Superfund Site (approximate location)

OU4 Site (approximate location)

N

0 1,000 2,000 Feet

Coordinate System:
North American Datum 1983
New York State Plane West FIPS 3103
Units: Feet

Source:
ESRI 2017; National Geographic Society 2019; USACE.

Olean Well Field OU4
Cattaraugus County, New York

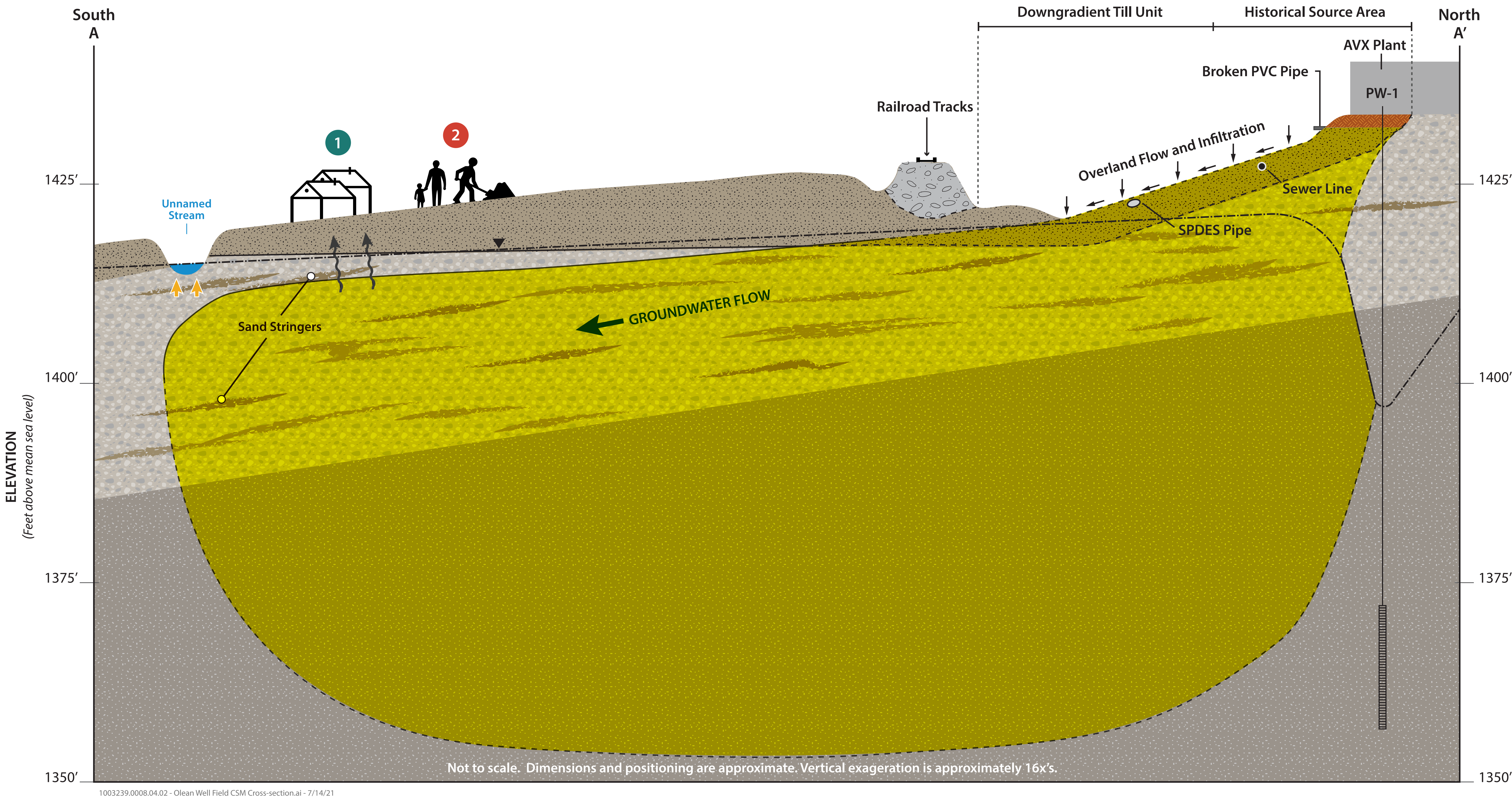
Figure 1-1
Site Location Map

1003239.0008.04.02 - Olean Well Field CSM Site Layout.ai 7/6/22

NOTES: *Allegheny River is located approximately 300′ south of OU4.*
The area south of the AVX building found between the fence (to the north) and the Railroad Tracks (to the south) is collectively referenced as the Southern Undeveloped Property source area.
Dimensions and positioning are approximate.

NOT TO SCALE

Figure 2-1
Olean Well Field OU4
Revised Conceptual Site Model Layout
Cattaraugus County, New York



LEGEND

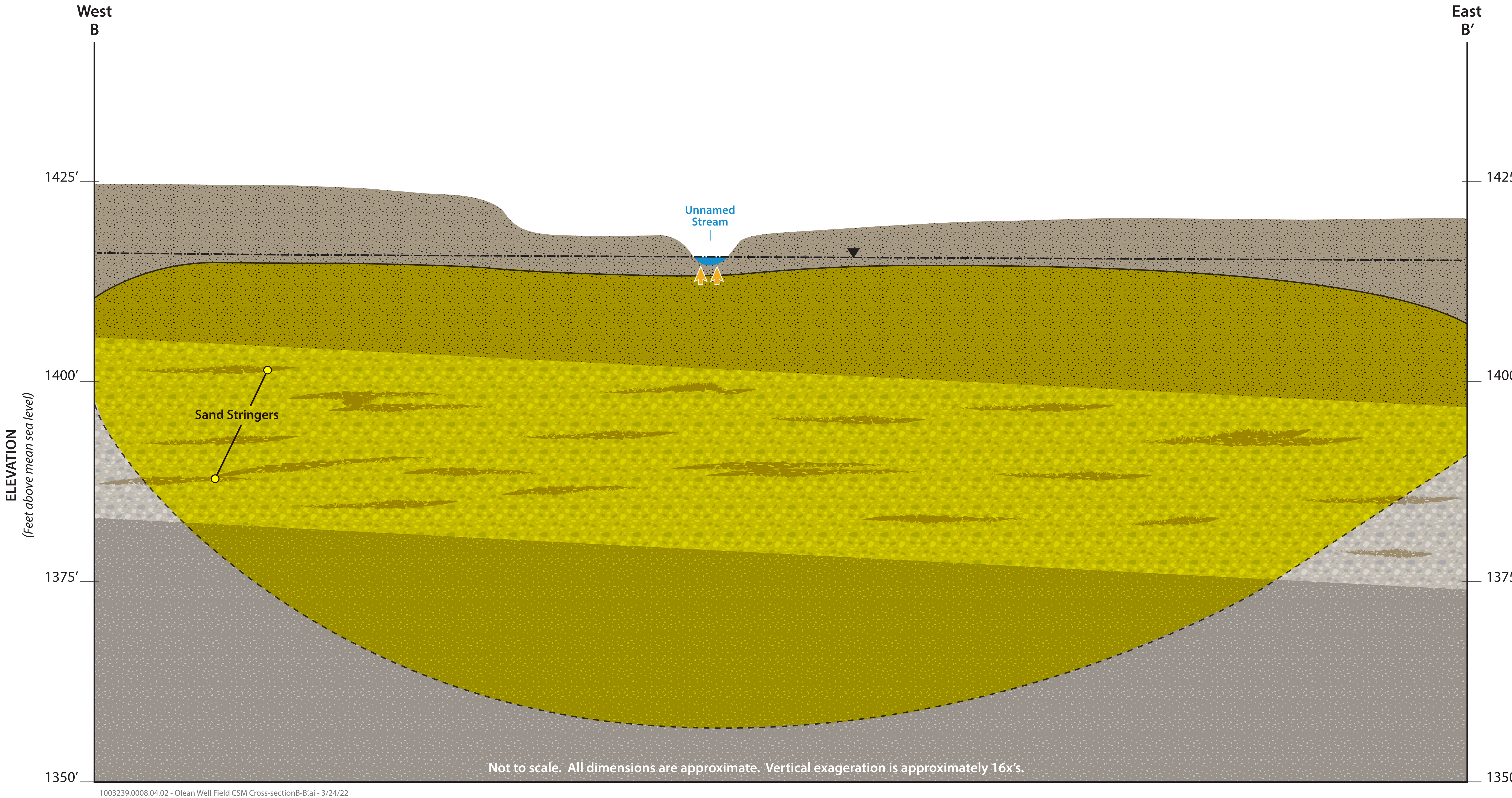
- Upper Aquifer (Alluvial deposits)
- Glacial Till (Upper aquitard)
- City Aquifer (Outwash sand and gravel)
- Approximate location of VOC groundwater plume (dashed where inferred)
- Potential Soil Vapors
- Former Solvent UST and Stage I RA Excavation Area
- Water Table
- Potential Surface Water/ Groundwater VOC Exchange
- Railroad Ballast

NOTES

1. Potential exposure of residents and workers to VOCs through soil vapor intrusion.
2. Potential exposure of residents, visitors, construction/utility workers and trespassers to VOCs through contact with soil.

Lithology source: Hydrogeology of the Olean area, Cattaraugus County, New York, USGS, 1987.

Figure 2-2
Olean Well Field OU4
Revised Conceptual Site Model Cross Section A-A'
Cattaraugus County, New York



LEGEND

- Upper Aquifer (Alluvial deposits)
- Glacial Till (Upper aquitard)
- City Aquifer (Outwash sand and gravel)
- Approximate location of VOC groundwater plume (dashed where inferred)
- Potential Surface Water/ Groundwater VOC Exchange
- Water Table

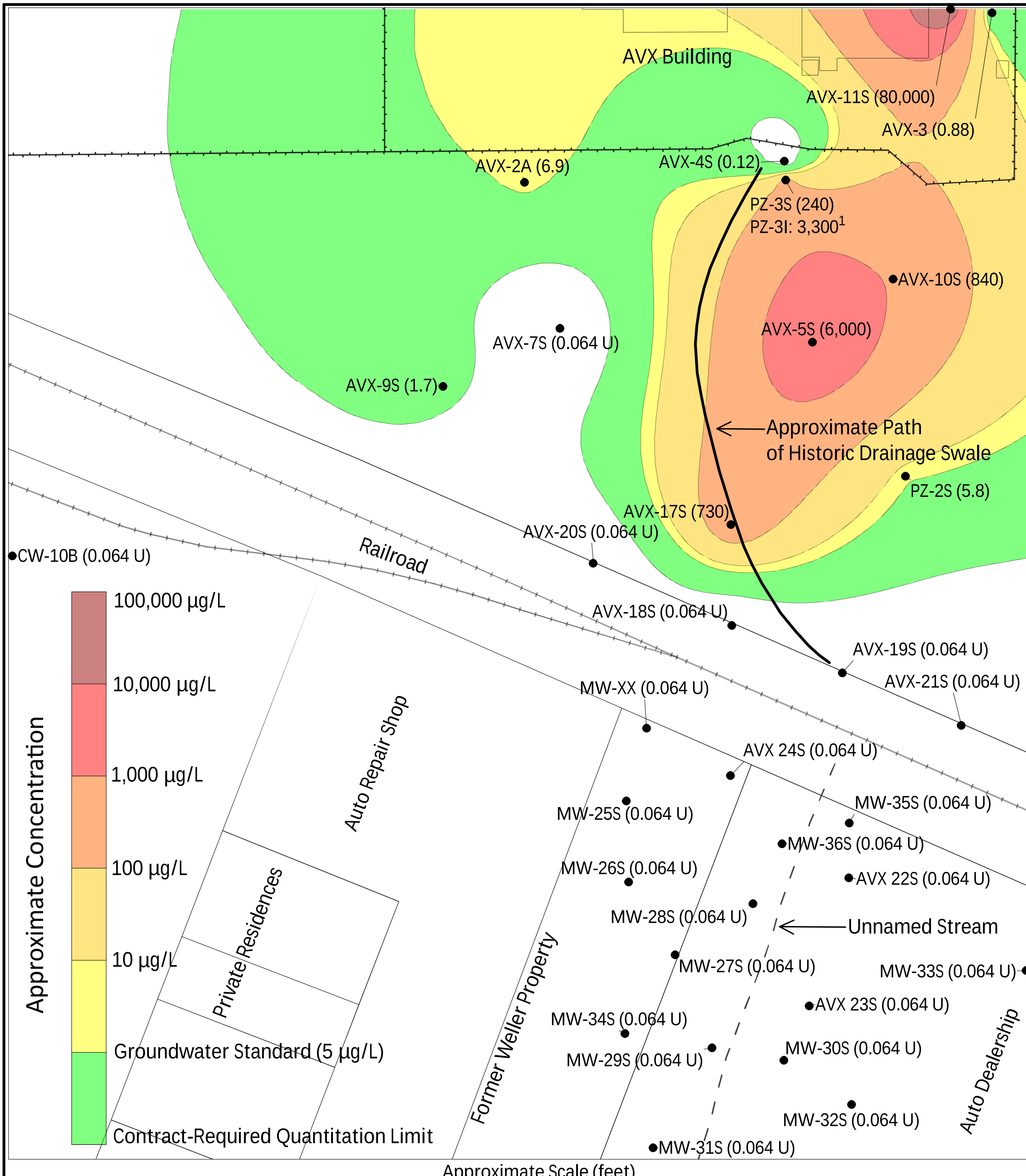
NOTES

Lithology source: Hydrogeology of the Olean area, Cattaraugus County, New York, USGS, 1987.

Groundwater flow in Upper Aquifer and Glacial Till is in a general north to south direction.

Groundwater flow in City Aquifer is in a general east to west direction.

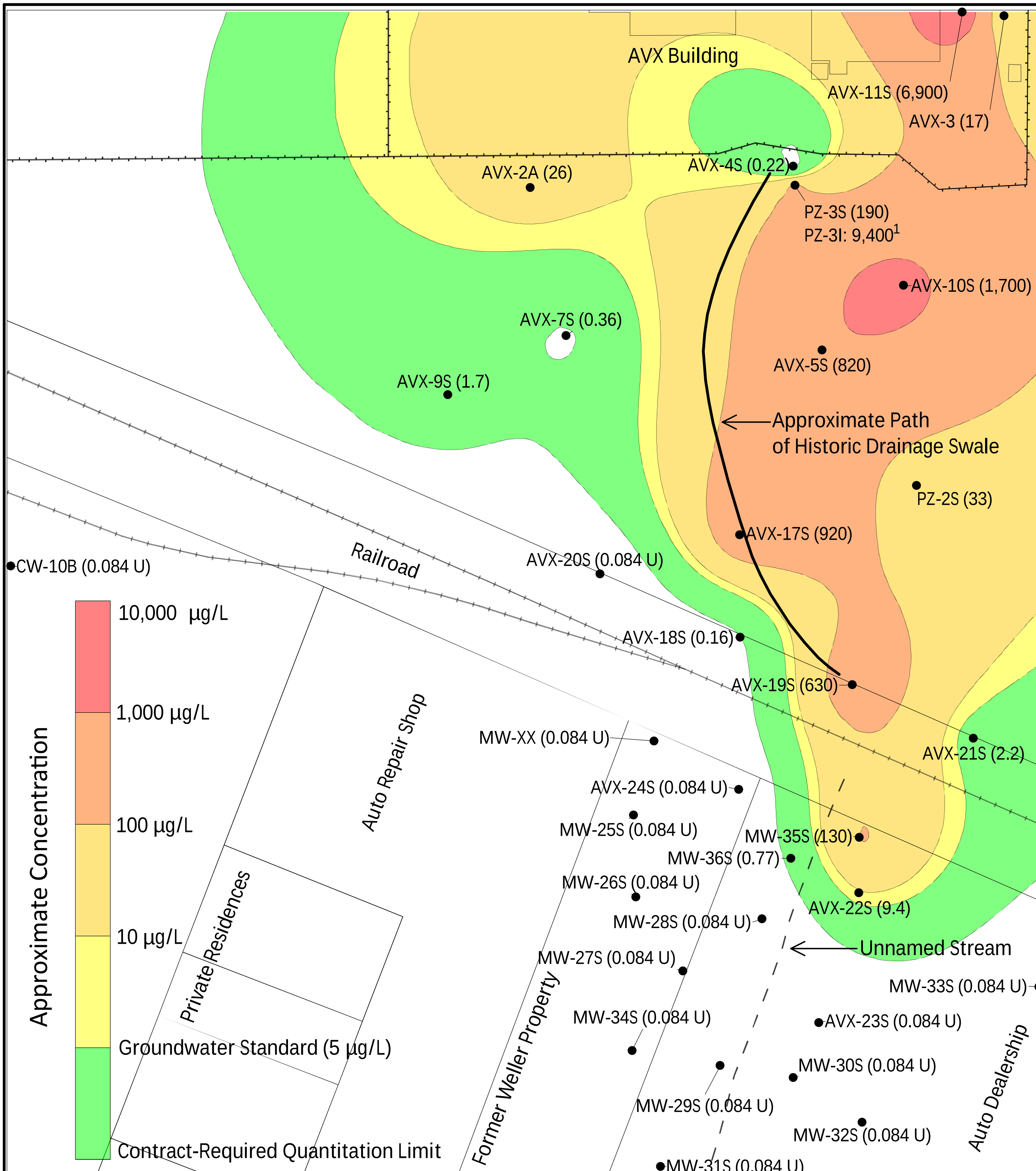
Figure 2-3
Olean Well Field OU4
Revised Conceptual Site Model Cross Section B-B'
Cattaraugus County, New York



Note:
1) PZ-3I value (3,300 µg/L) provided for discussion only, not for contouring.

Contaminant concentrations (µg/L) in parentheses.
ND = not detected above contract-required quantitation limit (0.5 µg/L).
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.

Figure 2-4
Olean Well Field OU4
1,1,1-Trichloroethane
(1,1,1-TCA)
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY



Note:
1) PZ-3I value (9,400 µg/L) provided for discussion only, not for contouring.

Contaminant concentrations (µg/L) in parentheses.
Contract-required quantitation limit = 0.5 µg/L.
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.

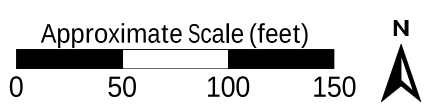
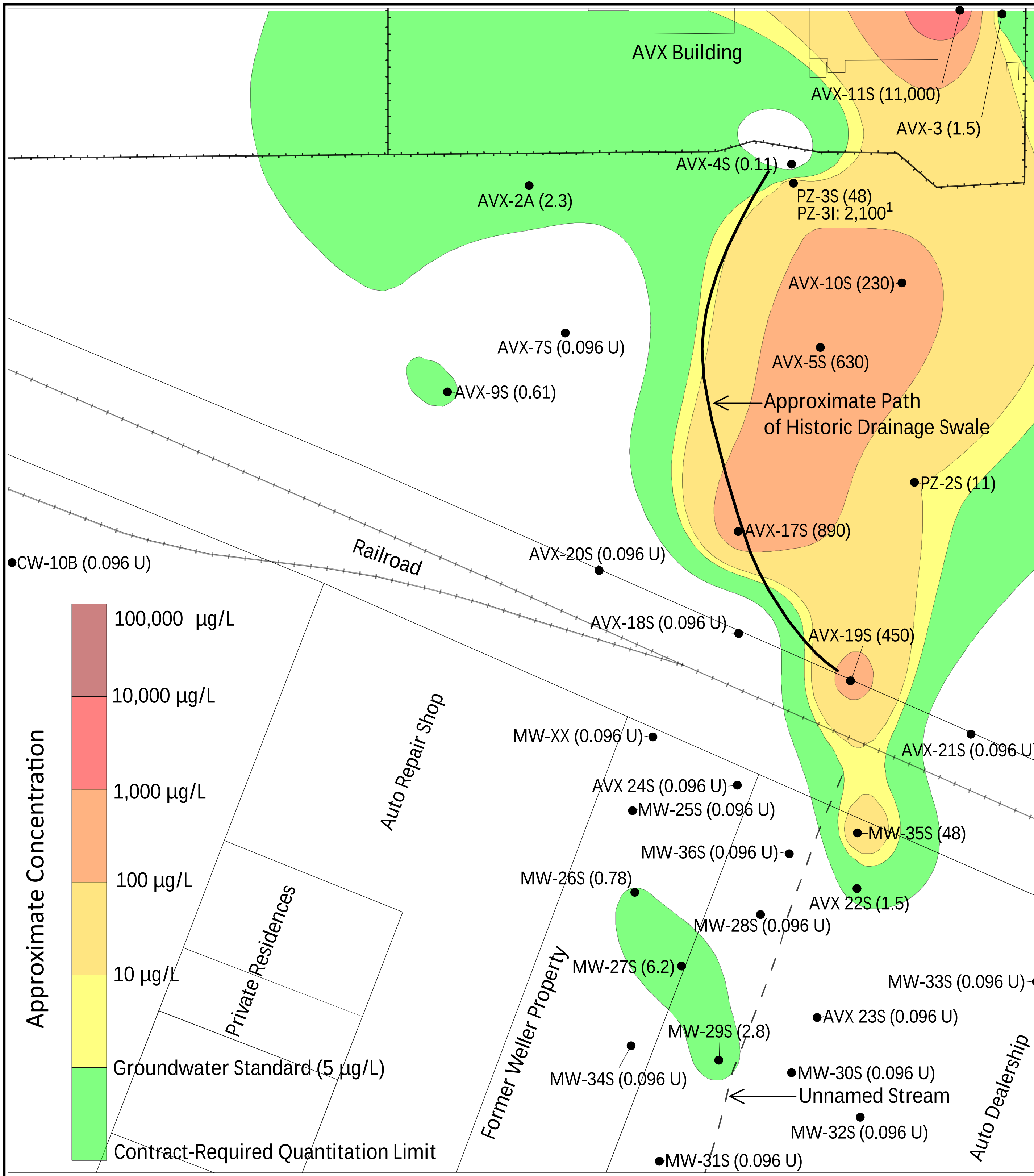


Figure 2-5
Olean Well Field OU4
1,1-Dichloroethane (1,1-DCA)
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY



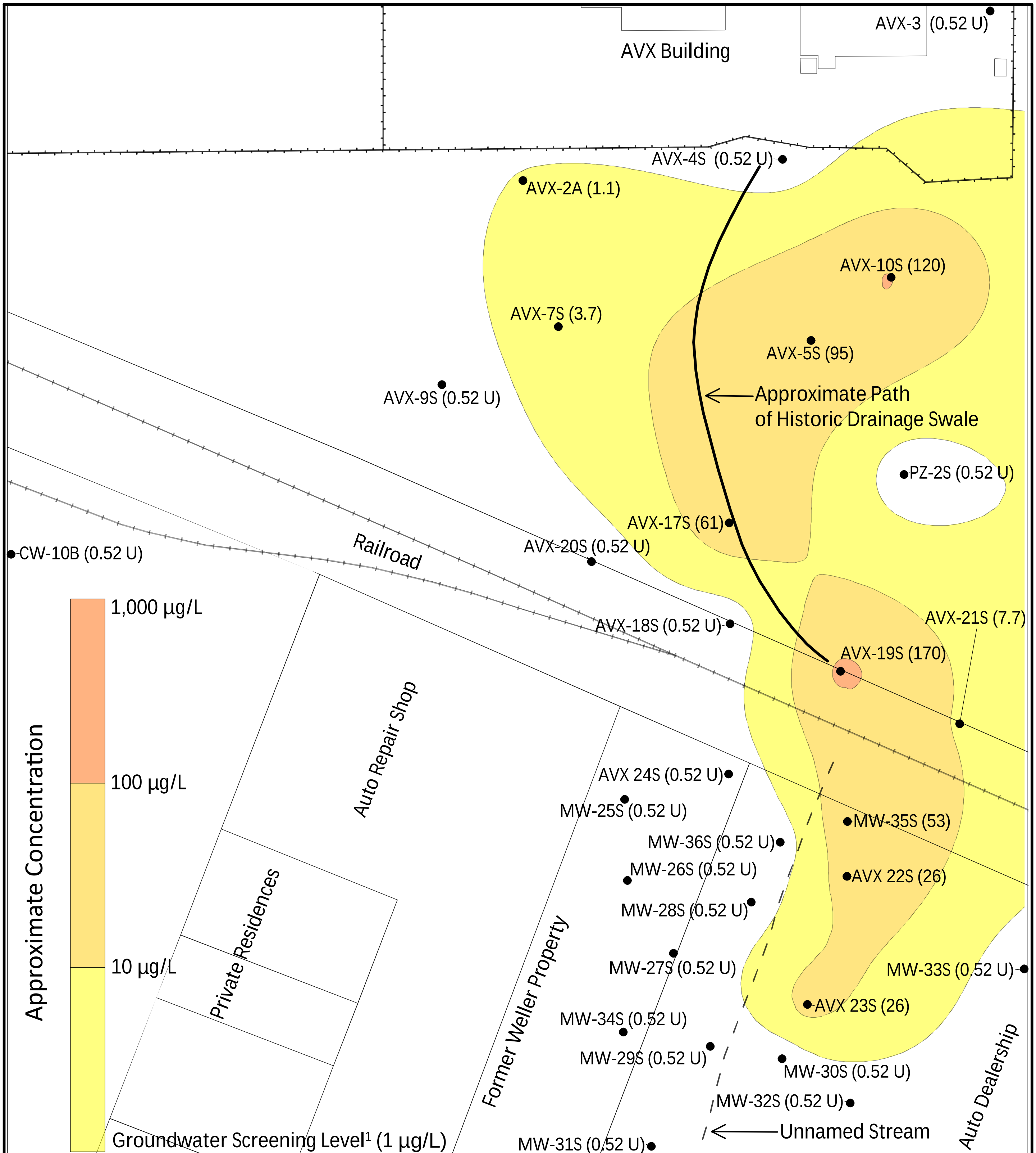
Note:
1) PZ-3I value (2,100 µg/L) provided for discussion, not for contouring.

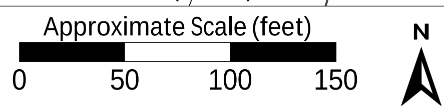
Contaminant concentrations (µg/L) in parentheses.
Contract-required quantitation limit = 0.5 µg/L.
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.

Approximate Scale (feet)
0 50 100 150

N

Figure 2-6
Olean Well Field OU4
1,1-Dichloroethene (1,1-DCE)
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY

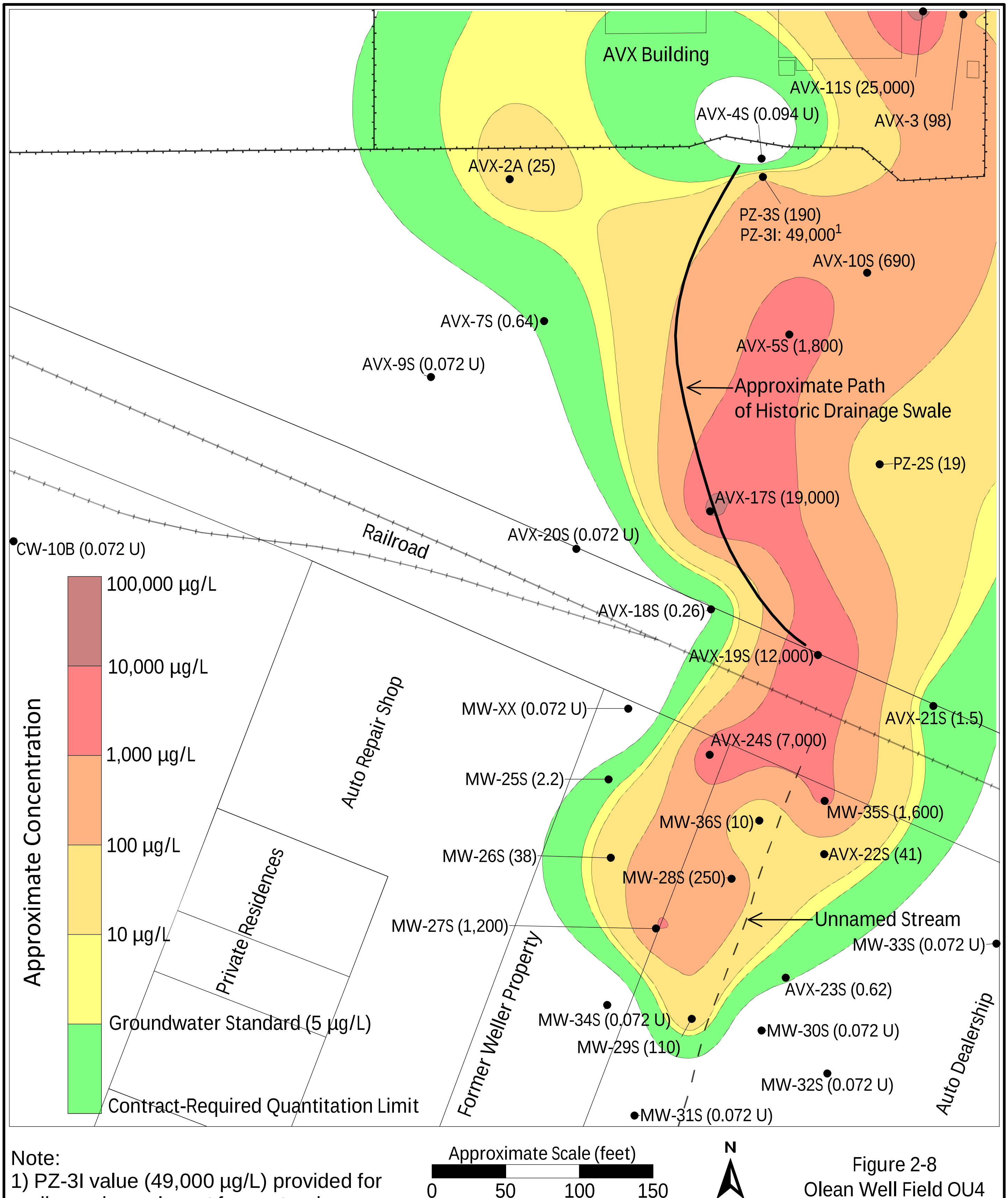




Note:
1) Maximum Contaminant Level (MCL)
recommended by New York State Department of Health = 1.0 µg/L.

Contaminant concentrations (µg/L) in parentheses.
No data available to contour beyond limits shown.
U = analyte not detected above the provided method detection limit.
Figure and contours were generated using Surfer©.

Figure 2-7
Olean Well Field OU4
1,4-Dioxane
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY



Note:
1) PZ-3I value (49,000 µg/L) provided for discussion only, not for contouring.

Contaminant concentrations (µg/L) in parentheses.
Contract-required quantitation limit = 0.5 µg/L.
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.

Figure 2-8
Olean Well Field OU4
cis-1,2-Dichloroethene
(cis-1,2-DCE)
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY

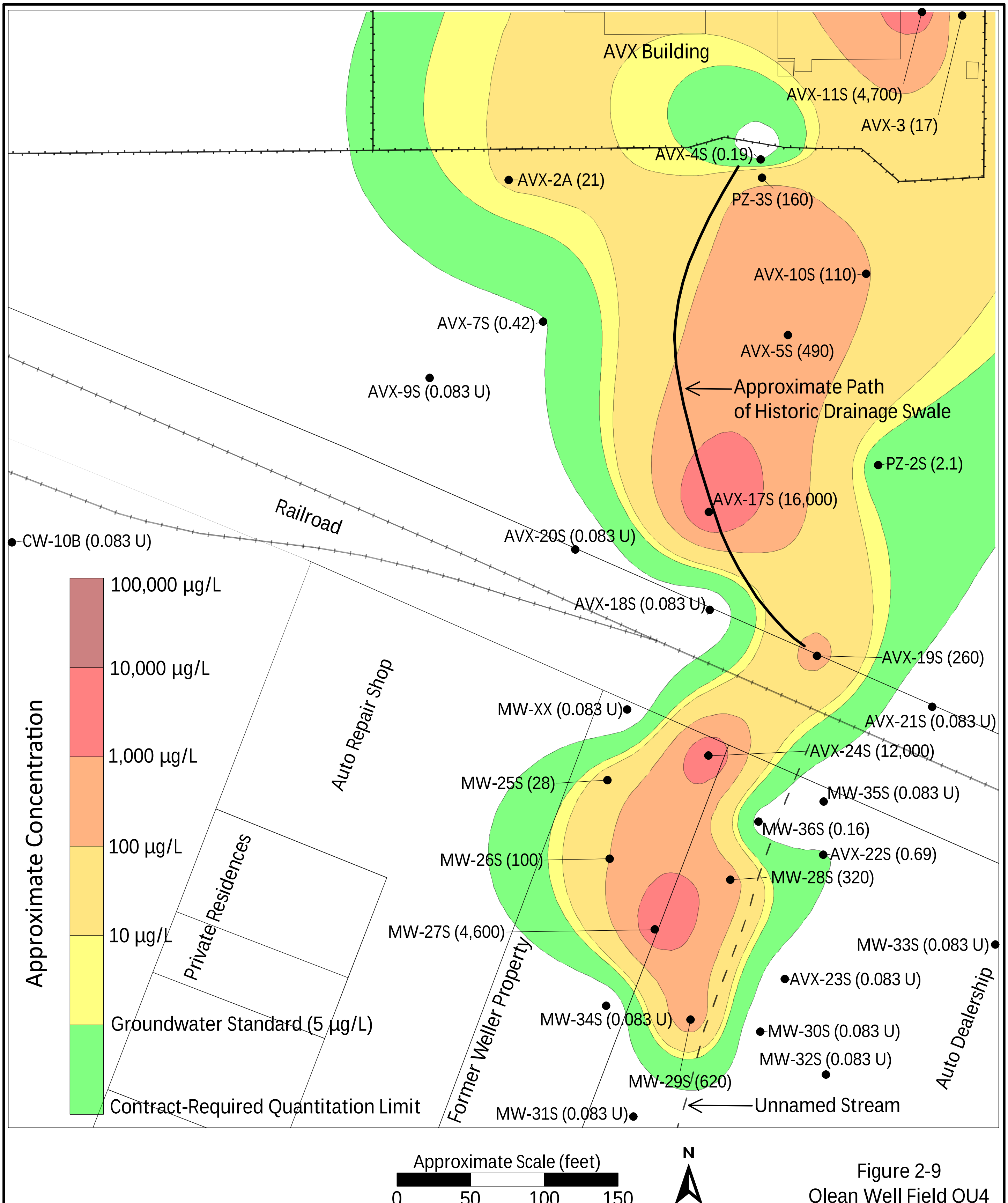


Figure 2-9
Olean Well Field OU4
Trichloroethene (TCE)
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY

Contaminant concentrations (µg/L) in parentheses.
Contract-required quantitation limit = 0.5 µg/L.
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.

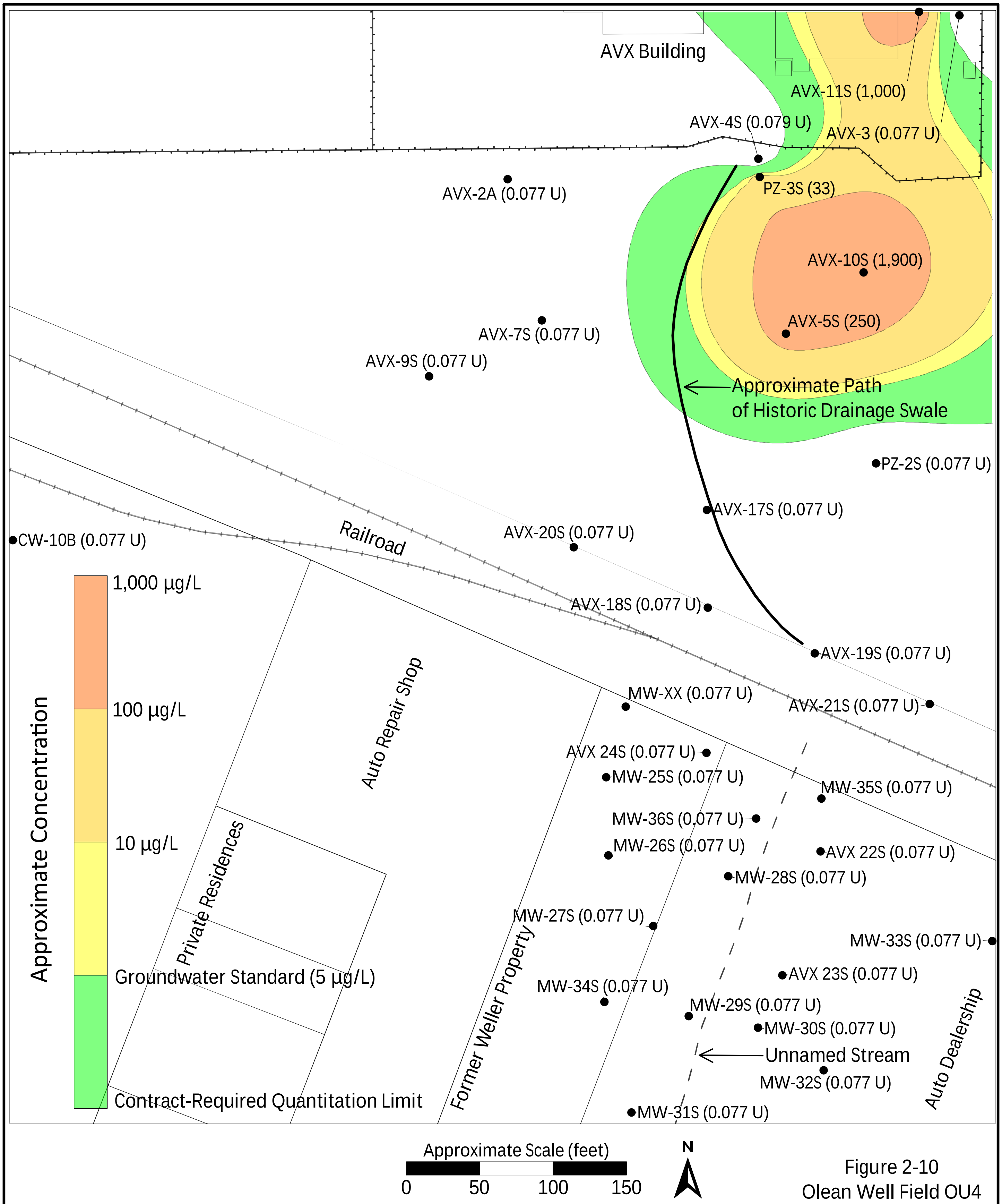


Figure 2-10
Olean Well Field OU4
Chloroethane
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY

Contaminant concentrations (µg/L) in parentheses.
Contract-required quantitation limit = 0.5 µg/L.
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.

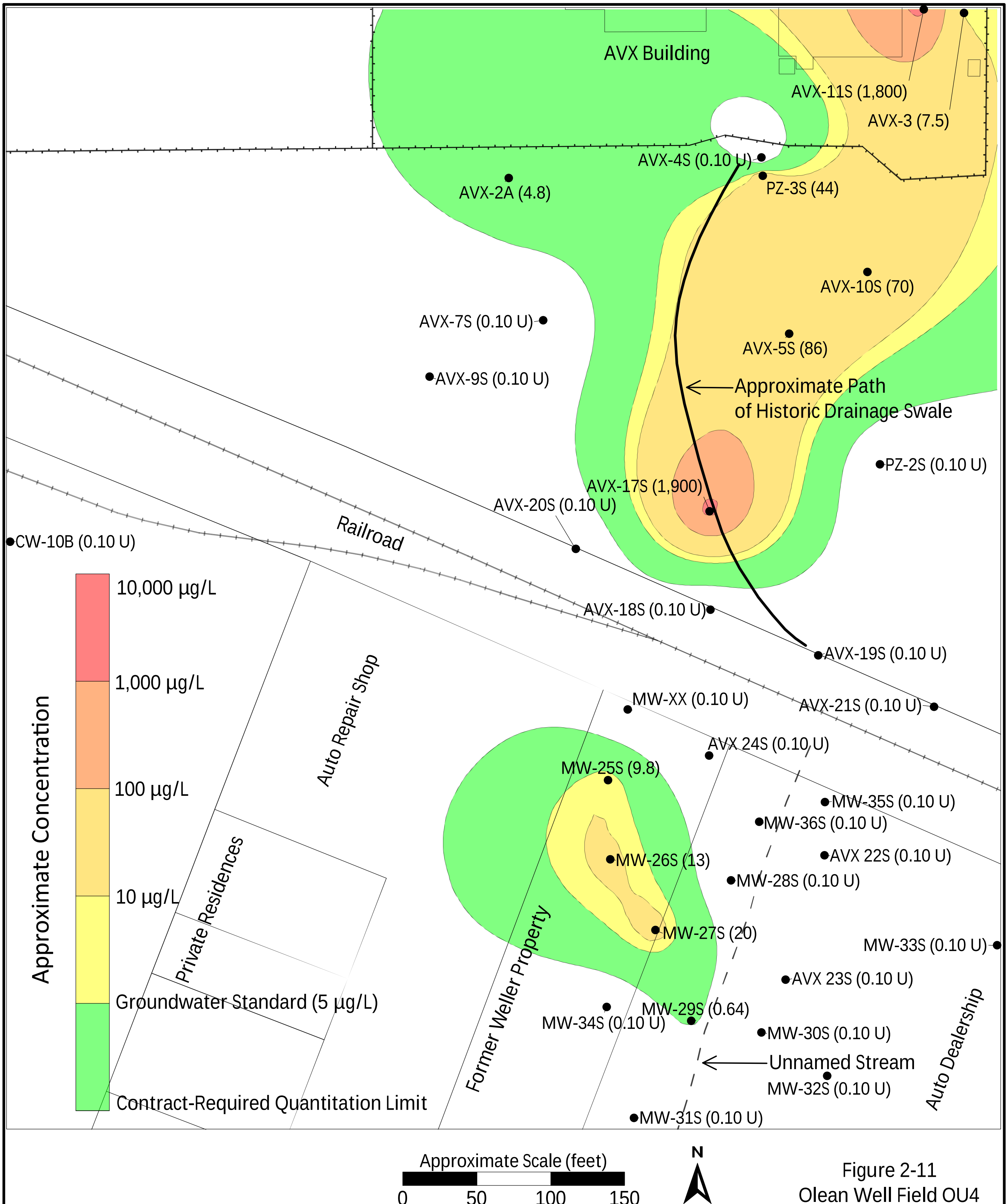
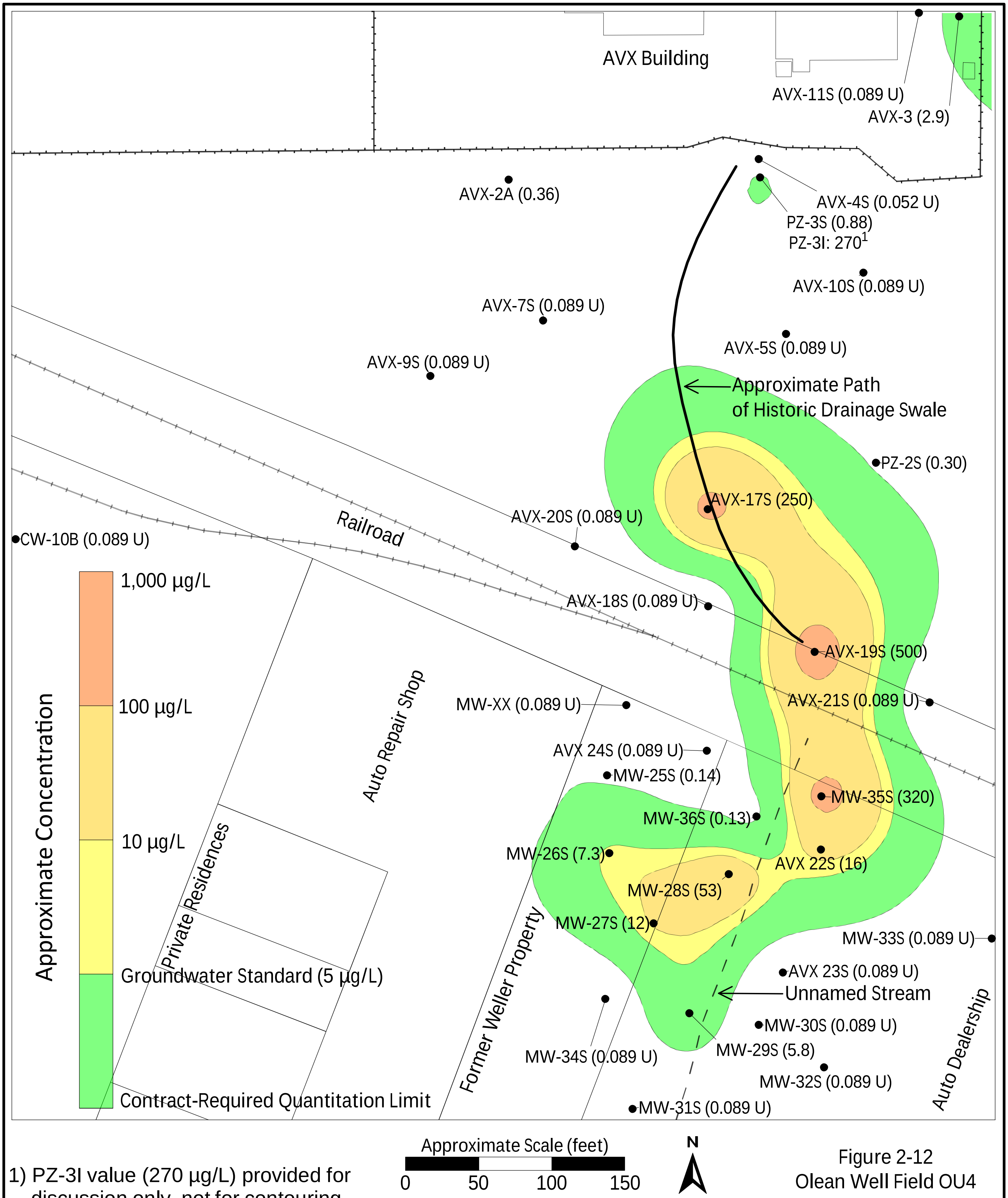


Figure 2-11
Olean Well Field OU4
Tetrachloroethene (PCE)
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY

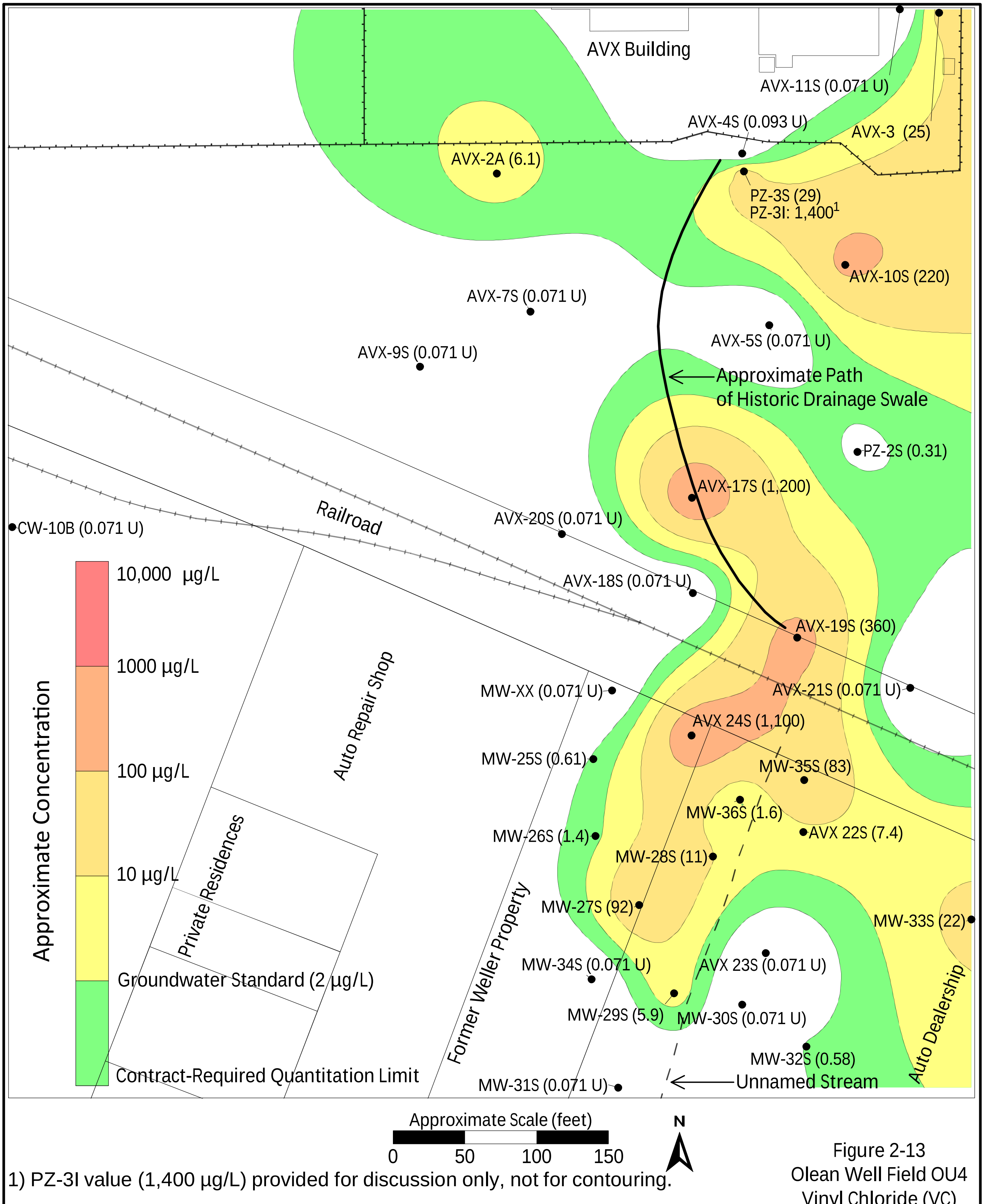
Contaminant concentrations (µg/L) in parentheses.
Contract-required quantitation limit = 0.5 µg/L.
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.



1) PZ-3I value (270 µg/L) provided for discussion only, not for contouring.

Contaminant concentrations (µg/L) in parentheses.
Contract-required quantitation limit = 0.5 µg/L.
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.

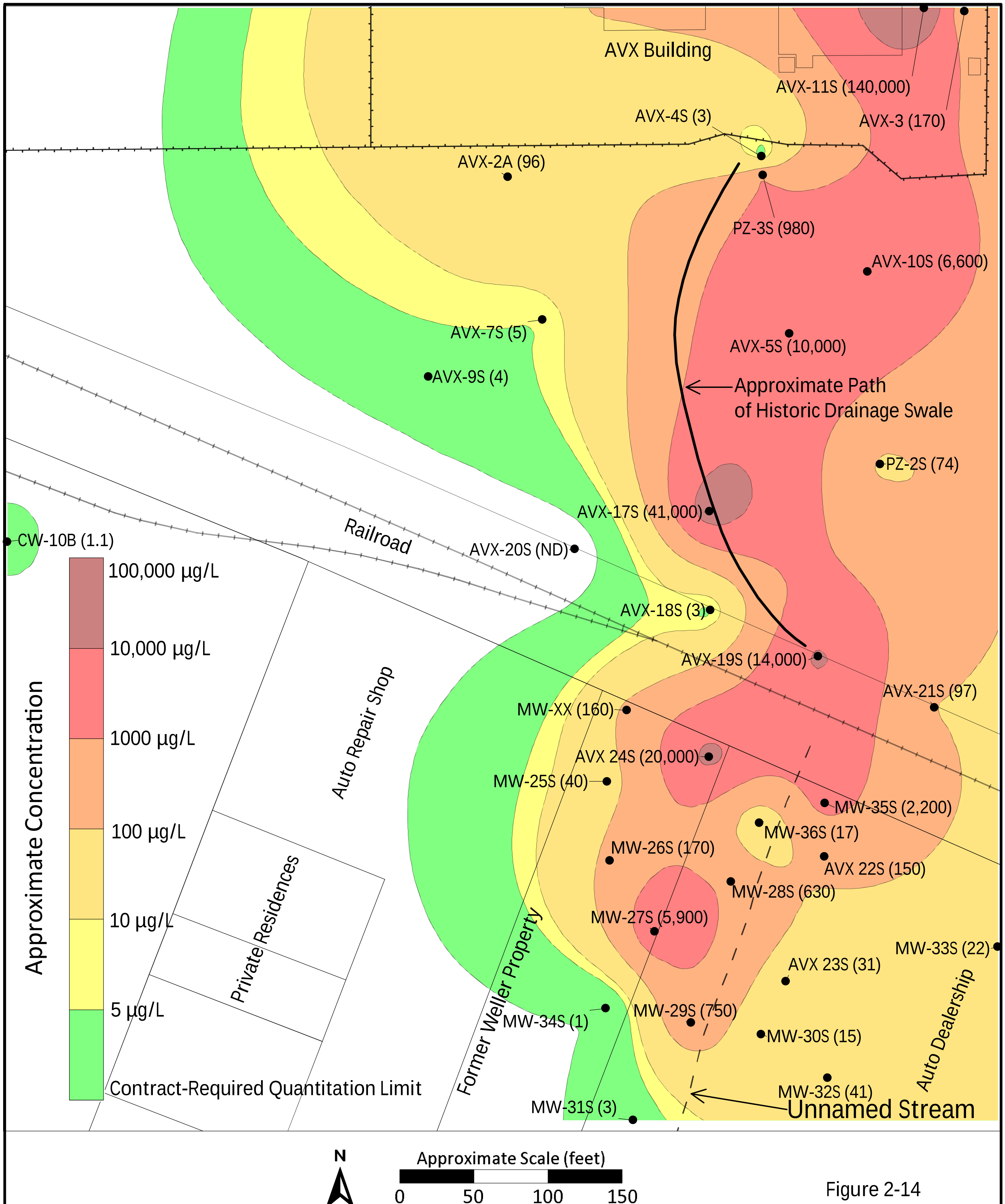
Figure 2-12
Olean Well Field OU4
trans-1,2-Dichloroethene
(trans 1,2-DCE)
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY



1) PZ-3I value (1,400 µg/L) provided for discussion only, not for contouring.

Contaminant concentrations (µg/L) in parentheses.
Contract-required quantitation limit = 0.5 µg/L.
No data available to contour beyond limits shown.
Figure and contours were generated using Surfer©.

Figure 2-13
Olean Well Field OU4
Vinyl Chloride (VC)
in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY



Contaminant concentrations (µg/L) in parentheses.
ND = not detected above contract-required quantitation limit (0.5 µg/L).
No data available to contour beyond limits shown.
VOC = volatile organic compound.
Figure and contours were generated using Surfer©.

Figure 2-14
Olean Well Field OU4
Total VOCs in Shallow Wells
Round III (June 2019)
Cattaraugus County, NY

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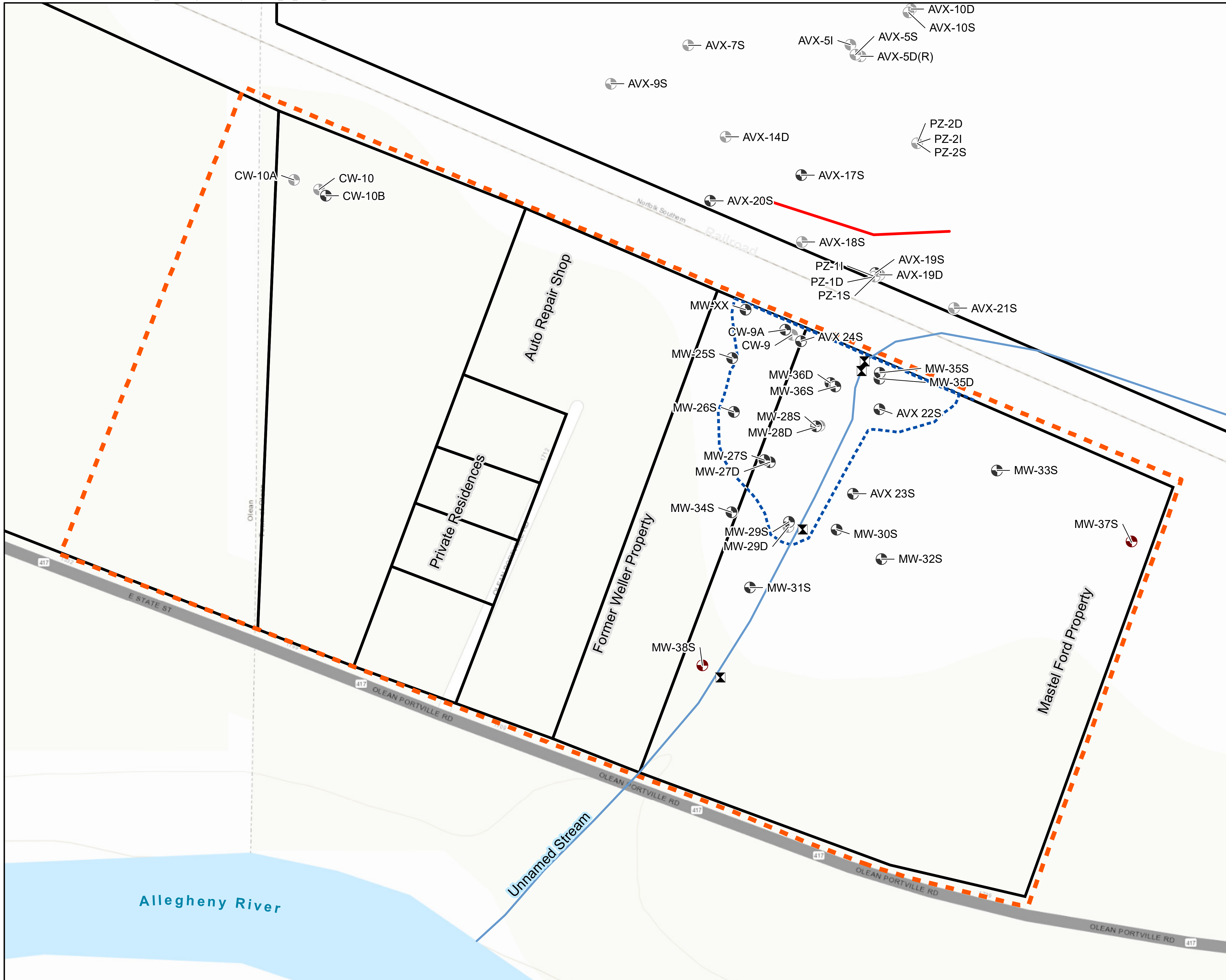

Figure 4-1
Olean Well Field OU4
Alternative 2:
Monitored Natural Attenuation and Institutional Controls
Cattaraugus County, NY

Legend

- Proposed New Monitoring Network Wells
- Monitoring Well Network
- Existing Wells/Piezometers
- Staff gauge
- Proposed AVX Hydraulic Pumping Trench
- Stream
- Parcel Boundary
- Approximate OU4 Boundary
- Approximate Outline of 100 ug/L Total VOC Plume

N

0 25 50 Meters

0 100 200 Feet

Data Source: Cattaraugus County 2016; Ecology and Environment, Inc. 2019; ESRI 2017.

Document Path: L:\PROJECTS\Olean_Wells\Maps\MXD\Report\2022_05_23\4-2_Alt3.mxd

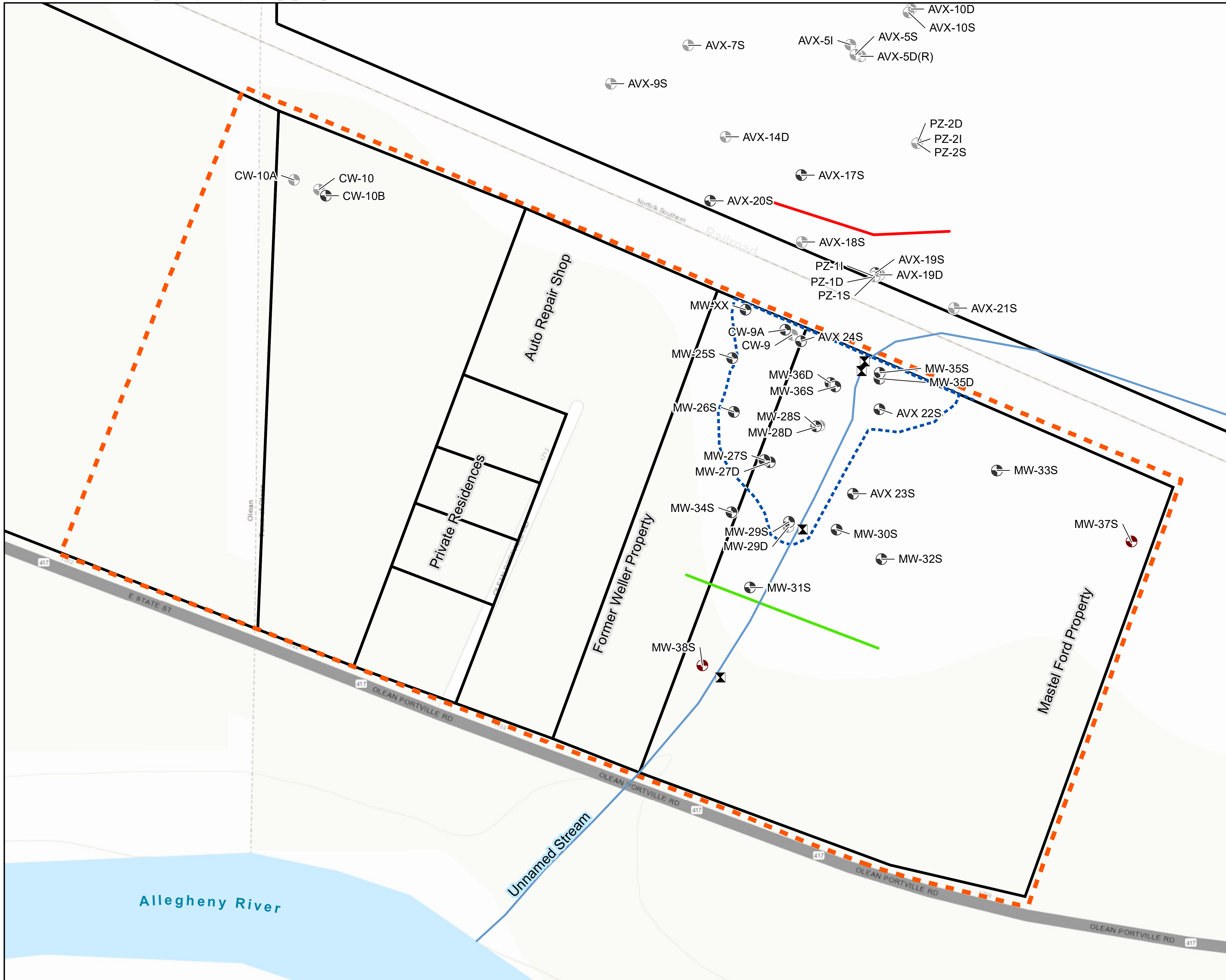

Figure 4-2
Olean Well Field OU4
Alternative 3:
Permeable Reactive Barrier with Long-term Monitoring and Institutional Controls

Cattaraugus County, NY

Legend

- Proposed New Monitoring Network Wells
- Monitoring Well Network
- Existing Wells/Piezometers
- Staff gauge
- Proposed AVX Hydraulic Pumping Trench
- Proposed PRB Location
- Stream
- Parcel Boundary
- Approximate OU4 Boundary
- Approximate Outline of 100 ug/L Total VOC Plume

N

0 25 50 Meters

0 100 200 Feet

Data Source: Cattaraugus County 2016; Ecology and Environment, Inc. 2019; ESRI 2017.

Document Path: L:\PROJECTS\Olean_Wells\Maps\MXD\Report\2022_05_23\4-3_Alt4.mxd

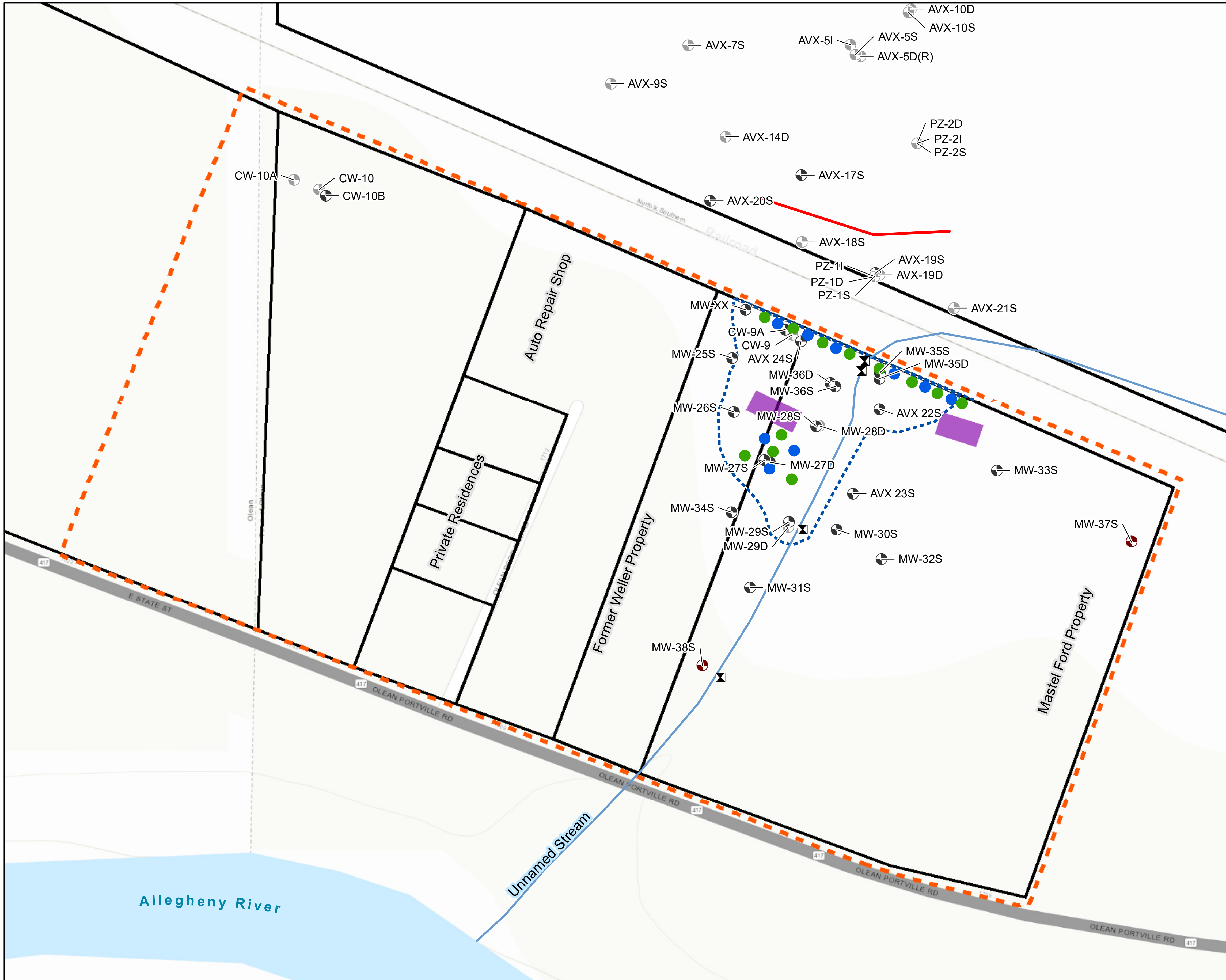

Figure 4-3
Olean Well Field OU4
Alternative 4:
Air Sparging, Soil Vapor Extraction, Long-term Monitoring and ICs
Cattaraugus County, NY

Legend

- Proposed New Monitoring Network Wells
- Monitoring Well Network
- Existing Wells/Piezometers
- Staff gauge
- Proposed Air Sparging wells
- Proposed Soil Vapor Extraction wells
- Proposed AVX Hydraulic Pumping Trench
- Stream
- Proposed Treatment Trailer Locations
- Parcel Boundary
- Approximate OU4 Boundary
- Approximate Outline of 100 ug/L Total VOC Plume

0 25 50 Meters

0 100 200 Feet

Data Source: Cattaraugus County 2016; Ecology and Environment, Inc. 2019; ESRI 2017.

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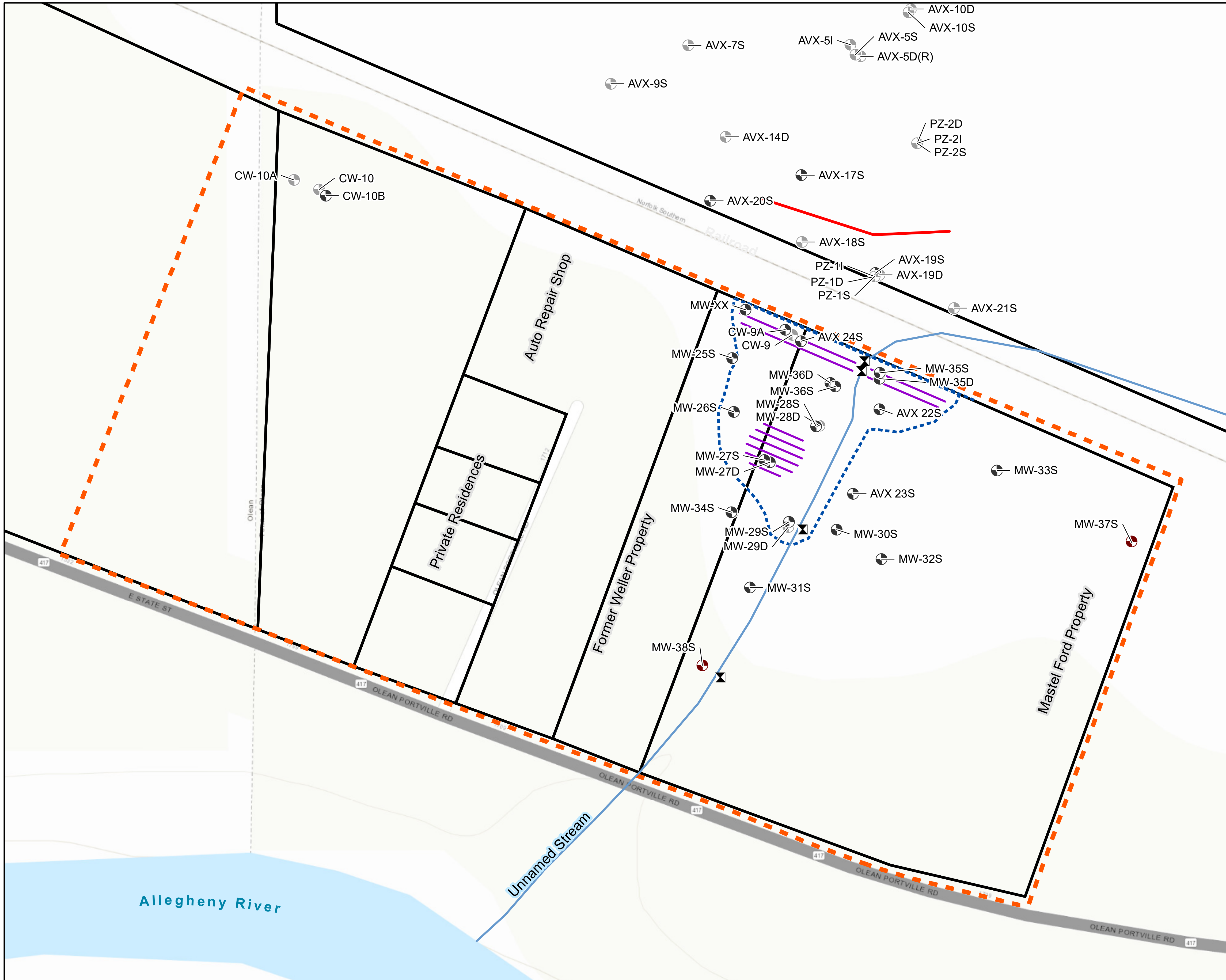

Figure 4-4
Olean Well Field OU4
Alternative 5:
In-situ Chemical/Biological Treatment, Long-term Monitoring and ICs
Cattaraugus County, NY

Legend

- Proposed New Monitoring Network Wells
- Monitoring Well Network
- Existing Wells/Piezometers
- Staff gauge
- Proposed AVX Hydraulic Pumping Trench
- Proposed Injection Lines
- Stream
- Approximate Outline of 100 ug/L Total VOC Plume
- Parcel Boundary
- Approximate OU4 Boundary

0 25 50 Meters

0 100 200 Feet

Data Source: Cattaraugus County 2016; Ecology and Environment, Inc. 2019; ESRI 2017.

Document Path: L:\PROJECTS\Olean_Wells\Maps\MXD\Report\2022_05_23\4-5_Alt6.mxd

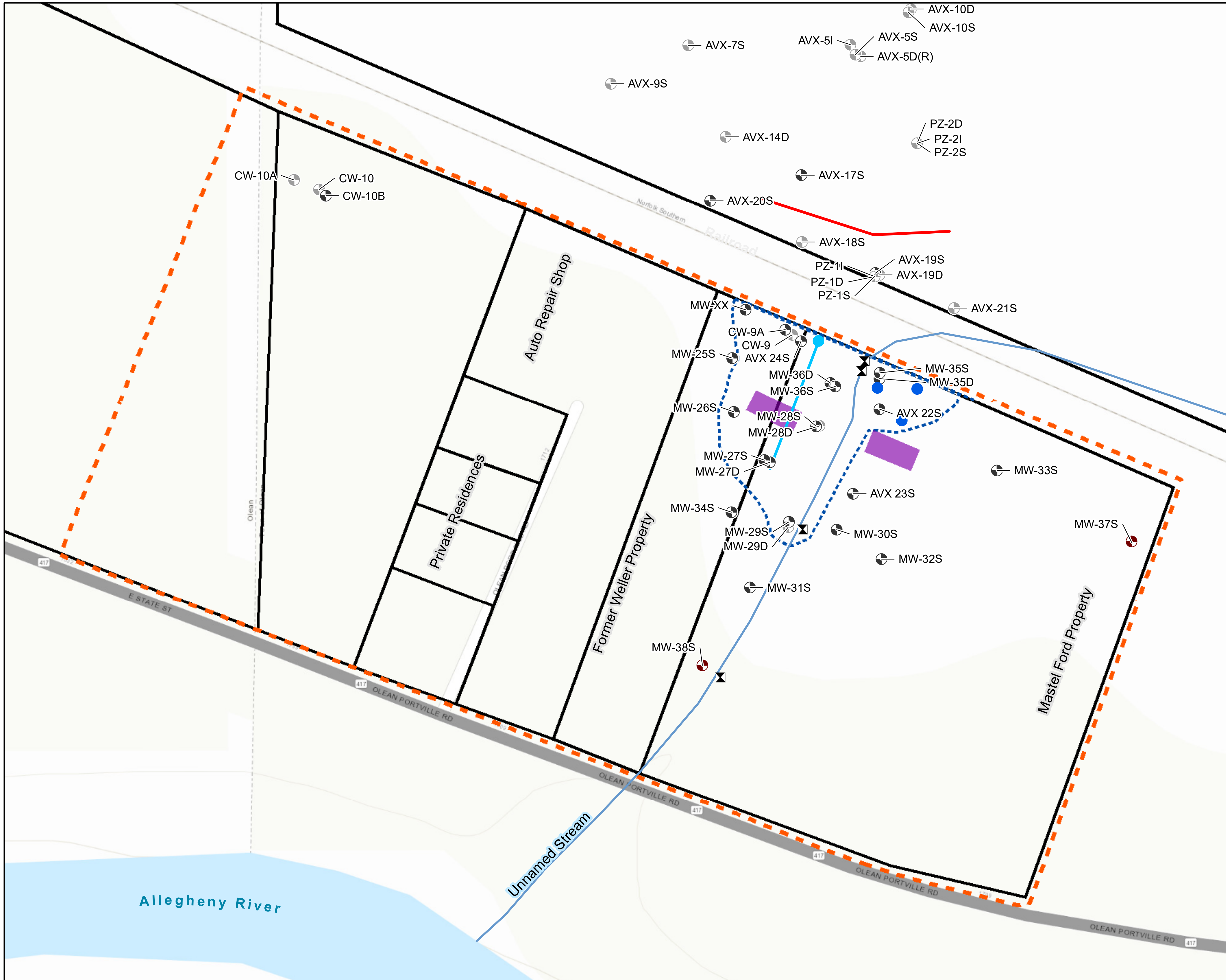

Figure 4-5
Olean Well Field OU4
Alternative 6:
Pump and Treat, Long-term Monitoring and ICs
Cattaraugus County, NY

Legend

- Proposed New Monitoring Network Wells
- Monitoring Well Network
- Existing Wells/Piezometers
- Staff gauge
- Vertical Groundwater Extraction Wells
- Extraction Well Riser
- Proposed AVX Hydraulic Pumping Trench
- Horizontal Groundwater Extraction Well
- Stream
- Proposed Treatment Trailer Locations
- Parcel Boundary
- Approximate OU4 Boundary
- Approximate Outline of 100 ug/L Total VOC Plume

N

0 25 50 Meters

0 100 200 Feet

Data Source: Cattaraugus County 2016; Ecology and Environment, Inc. 2019; ESRI 2017.