Chevron Environmental Management Company

REMEDIAL INVESTIGATION REPORT

Former Texaco Research Center Beacon

Glenham, New York

Site ID#314004
NYSDEC ID#3-1330-48/16-0
EPA ID#091894899

Revision 2
April 2021

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ACRONYMS AND ABBREVIATIONS

ACM	Asbestos Containing Material
Arcadis	Arcadis U.S., Inc.
AST	Aboveground Storage Tank
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CB	Chlorobenzene
CEMC	Chevron Environmental Management Company
CFS	Cubic Feet Per Second
Chevron	Chevron U.S.A. Inc.
cis-1,2-DCE	cis-1,2-dichloroethene
cm/sec	centimeters per second
COC	Constituent of Concern
CP	Commissioner Policy
CSIA	Compound Specific Isotope Analysis
CT	Carbon Tetrachloride
DER	Division of Environmental Remediation
DER-10	DER Technical Guidance for Site Investigation and Remediation
DNAPL	Dense nonaqueous phase liquids
Dunn	Dunn Geoscience Corporation
DUSR	Data Usability Summary Report
EDR	Environmental Data Resources, Inc.
EIM	Environmental Information Management
ELAP	Environmental Laboratory Approval Program
ELLE	Eurofins-Lancaster Laboratories, Environmental
EQUIS	Environmental Quality Information System
ESA	Environmental Site Assessment
^{o}F	degrees Fahrenheit
FEMA	Federal Emergency Management Agencyft^{2} Square Feet
ft bgs	Feet Below Ground Surface
FWRIA	Fish and Wildlife Resource Impact Analysis

GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographical Information System
GSC	Groundwater Sciences Corporation
HCBD	Hexachlorobutadiene
HHEA	Human Health Exposure Assessment
ICM	Interim Corrective Measure
ISS	Industrial Sewer System
kW	kilowatt
LNAPL	Light Non-Aqueous Phase Liquid
mg	milligram
mg/L	milligram per liter
mL	milliliter
MOSF	Major Oil Storage Facility
NFA	No Further Action
ng/L	nanograms per liter
NIOSH	National Institute for Occupational Safety and Health
6 NYCRR	Title 6 of the Official Compilation of New York Codes of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OU	Operable Unit
%	Percent
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PDMS	Polydimethylsiloxane
PE	Professional Engineer
PER	Protection of Ecological Resources
PFAS	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid

PID	Photoionization detector
POG	Protection of Groundwater
ppb	part per billion
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RIR	Remedial Investigation Report
RSL	Regional Screening Level
SCO	Soil Cleanup Objective
SGV	Sediment Guidance Values
SPDES	State Pollution Discharge Elimination System
SRFI	Supplemental RFI Facility Investigation
SV	Screening Value
SVI	Soil Vapor Intrusion
SVOC	Semi-volatile organic compound
SWQS	Surface Water Quality Standards
TAL	Target Analyte List
TCE	Trichloroethylene
TOGS	Technical and Operational Guidance Series
TRCB	Texaco Research Center Beacon
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VI	Vapor Intrusion
VOC	Volatile organic compound
WATF	Washington Avenue Tank Farm
WMS	Waterloo Membrane Sampler
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant
95% UCL	95 percent upper confidence limit on the mean

1,1-DCA	1,1-Dichloroethane
1,1,1-TCA	1,1,1-Trichloroethane
1,2-DCA	1,2-Dichloroethane
1,2-DCE	1,2-Dichloroethene
3D	Three-dimensional
4,4-DDD	4,4-dichlorodiphenyldichloroethane
4,4-DDE	4,4-dichlorodiphenyldichloroethylene
4,4-DDT	4,4-dichlorodiphenyltrichloroethane

QUALIFIED ENVIRONMENTAL PROFESSIONAL CERTIFICATION

I, Krista Mastracola, certify that I am currently a NYS registered professional engineer and that this Remedial Investigation Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications (DER-10, Section 1.5(b)2).

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EXECUTIVE SUMMARY

On behalf of Chevron Environmental Management Company (CEMC), Arcadis U.S., Inc., prepared this Remedial Investigation Report (RIR) to document the historical completion of remedial investigation activities at the former Texaco Research Center Beacon (TRCB) (the Site), located in the Hamlet of Glenham, New York. This revision includes all of the amendments submitted in the November 2, 2020 Remedial Investigation Report Addendum 1 as detailed in the March 1, 2021 letter and NYSDEC acceptance latter dated March 17, 2021. Remedial investigation activities have been conducted at the facility and surrounding properties from as early as 1981 through April 2020.

Investigations have been conducted on site to identify concerns associated with soil, groundwater, surface water, and sediment, as well as soil vapor intrusion (SVI). Analytical results have been compared to applicable New York State Department of Environmental Conservation (NYSDEC) 6NYCRR Part 375 Soil Cleanup Objectives (SCOs) criteria, NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Class GA Groundwater Quality Standards, NYSDEC Sediment Guidance Values (SGVs), NYSDEC Part 703 Class “C” water quality standards, and 2006 New York State Department of Health (NYSDOH) Final Guidance for Evaluating Soil Vapor Intrusion in New York State (SVI Guidance). The results of the investigations indicate several constituents of concern (COCs) present on site above the various criteria.

The Site is divided into nine distinct Operable Units (OUs) for investigation purposes. The Site previously consisted of a mixture of industrial buildings, aboveground and underground storage tanks, and other infrastructure that has since been mostly decommissioned, abated, and demolished. Only slabs, retaining walls, and approximately 12 permanent structures remain on site. Interim corrective measures have been completed at the Site, including former source area excavations; however, potential sources of impacts remain in various locations on site, including but not limited to historic fill, potential suspect piping, and residual impacts from historic site operations.

The objectives of the various investigation efforts performed on and around the Site were to:

- Identify and estimate the extent of impacted soil, groundwater, surface water, and sediment and the potential for SVI concerns at the Site;
- Evaluate changes in COC levels in groundwater through time; and
- Provide a basis for selecting and implementing appropriate remedies for the environmental impacts at the Site.

The main COCs on site include volatile organic compounds (VOCs), Target Analyte List (TAL) Metals, and semi-volatile organic compounds (SVOCs) in soil, and VOCs, SVOCs, and TAL Metals in groundwater.

Based on the results and findings of the investigations, the primary sources of potential impacts that remain at the Site include:

Soil

COCs that exceed SCOs in soil include:

- VOCs. Acetone is the most commonly detected VOC at concentrations above the Land Use Unrestricted SCO, but concentrations of acetone only exceed the lowest SCO and are not found beyond the Restricted-Residential SCO or higher SCOs. Isolated areas of additional VOCs (benzene, toluene, ethylbenzene, and xylenes [collectively, BTEX, 1,1-dichloroethene, 1,1,1-trichloroethane, 1,2-dichloroethane, chlorobenzene, and dichlorobenzenes among others) are also detected exceeding SCOs on OU-1A, OU-1C, and/or OU-1E and are generally found to be co-located with other COCs.
- (SVOCs. SVOCs, primarily polycyclic aromatic hydrocarbons (PAHs) (such as 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, indeno(1,2,3-cd)pyrene, and naphthalene among others) are infrequently detected at all OUs at concentrations greater than the Unrestricted SCOs.
- TAL Metals. TAL Metals, including arsenic, lead, and mercury, are the most commonly detected potentially site-related metals in soil, but arsenic and occasionally mercury are generally the only metals exceeding Industrial SCOs. Other TAL Metals detected above the SCOs at the Site, though unlikely to be related to site sources, include aluminum, barium, chromium, copper, iron, manganese, nickel, sodium, and zinc.

Groundwater

Primary COCs that occur in groundwater, either overburden or bedrock, and have been detected above the respective NYSDEC TOGS Class GA Groundwater and /or United States Environmental Protection Agency Tap Water Regional Screening Levels criteria are:

- Chlorinated VOCs. 1,1,1-Trichloroethane (1,1,1-TCA), trichloroethylene (TCE), and chlorobenzene are the primary COCs exceeding the Class GA TOGS, and other chlorinated VOCs tend to be co-located with areas impacted by TCE and/or chlorobenzene. In addition, due to natural degradation, breakdown products of these compounds, such as 1,1-dichloroethane (1,1-DCA), chloroethane, cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride, have been detected in groundwater exceeding the Class GA TOGS.
- Aromatic (primarily petroleum-related) VOCs. The compound in this class of compounds that is detected most frequently above its criterion is benzene, although ethylbenzene, toluene, and xylenes are also detected above their criteria.
- SVOCs. Groundwater containing PAHs (such as 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, indeno(1,2,3-cd)pyrene, hexachlorobutadiene (HCBD), and naphthalene) at concentrations exceeding criteria is limited in extent and is also impacted by VOCs; that is, there are no significant regions of groundwater impacted only by PAHs.
- TAL Metals. Arsenic, mercury, and lead have been identified as the primary inorganic COCs. Regions of groundwater containing inorganics at concentrations exceeding the NYSDEC TOGS Class GA criteria tend to be the same regions that have been impacted by the above three classes of organic compounds. Other TAL Metals detected above the NYSDEC TOGS at the Site, though unlikely to be related to site sources, include aluminum, barium, chromium, copper, iron, manganese, nickel, sodium, and zinc. In many samples, aluminum was detected at concentrations above its solubility

limit, suggesting that the groundwater samples contained particulate matter that was not otherwise expected to be migrating with the groundwater. The possible entrainment of particulate matter in the groundwater samples during collection may bias the inorganic analytical results high for those samples.

Surface Water and Sediment

- Overall, Fishkill Creek conditions along the former TRCB facility indicated unimpacted surface water quality. No organic compounds were found at detectable concentrations in surface water samples, while metals were detected at concentrations that were either below NYSDEC Class "C" Surface Water Quality Standards or lower than upstream concentrations.
- Sediment quality was found to be reflective of historical upstream conditions and was characterized at most sampling locations as having a minimum potential for adverse effects on sediment-associated organisms. Organic compounds, in general, were not a potential concern for exposure of sediment-associated organisms. Concentrations of VOCs, polychlorinated biphenyls (PCBs), and total PAHs were generally lower than analytical detection limits and/or the NYSDEC SGVs for Class A sediment. The concentration of metals in nearly 85 percent of the samples analyzed characterized the sediment quality as Class A, indicative of a low potential for impacts on sediment-associated organisms. Most of the remaining samples (13 percent of analyzed samples) had concentrations of one or more TAL Metals (chromium, copper, lead, nickel, zinc, and/or mercury) that characterized the sediment as Class B (higher than the no effects threshold but below the likely-effects threshold).

Soil Vapor Intrusion

- SVI investigations have been performed on site in the Mill Buildings 2, 3, 4, and 5 as well as in the Back 93 Acre OU1-E parcel. None of the VOC detections identified in the OU1-E parcel were detected in excess of the NYSDOH SVI Guidance minimum sub-slab soil vapor concentration range and thus are unlikely to correlate with indoor air samples exceeding the minimum value for requiring additional assessment if collected in the adjacent residential unit. SVI samples were collected within the Mill Buildings and indicated no further action was necessary for VOCs in Buildings 2, 3, and 4. TCE and carbon tetrachloride were detected in Building 5 sub-slab samples and, when compared to the NYSDOH SVI Guidance decision matrix, the recommendation was for mitigation of TCE and monitoring for carbon tetrachloride.

Ecological Resources Impact Analysis

- Concentrations of COCs measured in applicable media (i.e., surface soil, groundwater, surface water, and sediment) were compared to available toxicological screening benchmarks protective of ecological resources. In addition, an analysis of the potential ecological exposure pathways was performed. The primary ecological exposure pathways are associated with surface soil as well as surface water and sediments in Fishkill Creek and several small wetland areas located on OU-1E. These pathways have been addressed by evaluating available soil, sediment, and surface water data, as well as consideration of groundwater concentrations that could be discharging to Fishkill Creek and the wetland areas. Based on this evaluation, potential ecological exposures to groundwater, surface water, and sediment are minimal and do not require further evaluation. Exceedances of sediment benchmarks are generally limited spatially within the creek, suggesting that potential risks are localized and isolated. In addition, COCs that exhibit exceedances in groundwater are not reflected in surface water concentrations, suggesting that site groundwater is not adversely impacting ecological resources and that exceedances in the creek are likely associated with other sources.

- With respect to surface soil, OU-1A, OU-1B, OU-1C, OU-1D, OU-2, and OU-3 were eliminated due to limited availability of quality habitat. These areas either lack vegetation or are disturbed through routine maintenance or residential development. Parcel OU-1E was removed from consideration because, while a few scattered exceedances of protection of ecological resources SCOs (PER SCOs) were observed, surface soil concentrations are generally within the range of concentrations established as representing local background conditions. Based on evaluation of surface soil concentrations, potential risk associated with OU-4 may require further evaluation. Eight metals (arsenic, copper, lead, manganese, mercury, nickel, selenium, and zinc) were found to exceed the PER SCO in at least one sample and 95 percent upper confidence limit on the mean concentrations of copper, lead, and mercury are also above the PER SCO and estimates of background.
- As summarized above, the current data are adequate to consider, select, and initiate implementation of the remedial actions for the Site. When this RIR is deemed complete, CEMC will prepare a Feasibility Study and propose the most appropriate remedies for the Site.

1 INTRODUCTION

On behalf of Chevron Environmental Management Company (CEMC), Arcadis U.S., Inc. (Arcadis) has prepared this Remedial Investigation Report (RIR) at the request of the New York State Department of Environmental Conservation (NYSDEC) in its January 14, 2020 Report Comments letter (NYSDEC 2020). This report is a revision of the Remedial Investigation Report submitted to the NYSDEC by Parsons on August 29, 2019 (Parsons 2019b) and includes additional information and clarifications requested by the NYSDEC.

1.1 Objectives

The purpose of this RIR is to present soil, groundwater, surface water, sediment, and soil vapor investigations data collected through 2020 at the former Texaco Research Center, Beacon (TRCB) facility (the Site) (Figure 1-1) located in the Hamlet of Glenham, New York. The RIR includes screening of available environmental data against applicable regulatory criteria and an Ecological Resources Impact Analysis that supplements Part 1 of the Fish and Wildlife Resource Impact Analysis (FWRIA) submitted in 2015 to the NYSDEC (Parsons 2015c). Potential migration pathways, sources of impacts, and receptors are identified and evaluated to assess additional future remedial activities. All environmental investigations performed at the former TRCB facility were completed to evaluate the nature and extent of potential impacts on site through the development of conceptual site models and to assess potential exposure of humans and ecological receptors to site-related constituents of concern (COCs).

1.2 Description and Background

Texaco (a subsidiary of Chevron U.S.A. Inc. (Chevron)) operated the TRCB, located in the Hamlet of Glenham, Town of Fishkill, Dutchess County, New York (Figure 1-1) from 1931 until its closure in 2003. Glenham is a small residential community with churches, businesses, and a fire hall near the Site. The Site is currently owned by Chevron. CEMC manages environmental projects for Chevron affiliates.

1.2.1 Site History

The site history includes the following:

- 1811 – Constructed as a textile mill by The Glenham Co.
- 1917 – Stone buildings were demolished, and new buildings were built by Braeburn Woolen Co.
- 1929 – The facility closed and became the possession of Mechanic's Savings Bank.
- 1931 – Texaco purchased the property and renovated the former mill to become a crude oil refining research facility.
- 1930s-1980 – Many structures were added to the property, including a Major Oil Storage Facility (MOSF) "tank farm" with several aboveground storage tanks (ASTs). The main facility parcel was used for research and development of fuels, lubricants, additives, and oils.
- Mid 1980s – Small structures were built.

- 2001 – Chevron / Texaco acquisition was approved by shareholders of both companies.
- 2003 – A steady decrease in the size and scope of research activities led to the closure of the facility. Most of the facility was decommissioned by Chevron. The MOSF tank farm was demolished in late 2003.
- 2011 – Sitewide asbestos abatement and demolition project was performed at 46 facility buildings.

1.2.2 General Site Description

The Site is located on approximately 153 acres of land bisected by Fishkill Creek. A dam (approximately 22 feet high) used for generating hydroelectric power spans the creek within the boundaries of the Site. The Site is divided into distinct Operable Units (OUs) for investigation purposes (Figures 1-2 and 1-3). General site topography is detailed on Figures 1-4 and 1-5. The Main Facility (OU-1A) parcel and the Church Property (OU-1B) parcel are both located north of Fishkill Creek. The former Washington Avenue Tank Farm (WATF) (OU-1C) is located south of Fishkill Creek, and on the eastern edge of the Site. Two parcels (OU-1D and OU-3) that are currently zoned as planned industrial lots and do not have any TRCB structures, exist along the northern side of Washington Avenue and south of Fishkill Creek. These parcels are expected to become residential properties, and the nearby properties are currently residential; therefore, these properties have become known both internally and externally as the “Residential Property” parcels. A 4.96-acre parcel, the Hydroelectric Facility and Dam Parcel (OU-4), encompasses the hydroelectric power buildings and dam. OU-2 is the Road Parcel, located along Washington Avenue. The Back 93 Acre (OU-1E) parcel comprises most of the site area south of the creek. General descriptions of site activities and features that may have been potential sources of release are detailed in Table 1-1. Each OU is described in greater detail below.

1.2.2.1 Main Facility Parcel, OU-1A

The Main Facility (OU-1A) consists of 33 acres of land and includes most of the developed areas located north of Fishkill Creek (except for a portion of OU-4). OU-1A is bounded to the south by Fishkill Creek, to the north by Old Glenham Road, to the west by the Metro-North Railroad line and the former Church Property, and to the east by private property including parking, residential housing, and businesses. From 1811 until 1930, the Site was the location of textile mills. The mills were powered by water wheels and steam engines. Blacksmith and carpentry shops operated in support of the mills. More recently, OU-1A has been used as a non-production, non-transportation laboratory complex engaged in research, development, and technical services related to petroleum products and energy. OU-1A contained parking areas, offices and laboratory buildings, ASTs, underground storage tanks (USTs), roads, a wastewater treatment plant (WWTP), and storage areas (see historical maps in Appendix A for locations of features). The following buildings currently remain on site:

Table 1-2. Existing Structures On Site

Building Identification	Former Usage	Current Usage
Building 2	AT&T Laboratory Building	Inactive/Storage for Dam Operations
Building 3	Mechanical and Lubricant Laboratories	Inactive/Storage for Dam Operations
Building 4	Boiler House (until 1939) Water Cooling Pumps	Inactive/Storage for Dam Operations
Building 5	Hydro Generator and Pump Building	Inactive/Storage for Dam Operations
Building 31	Credit Union	Historical Document Storage/Bathrooms
Building 58	Drum Storage Area	Landscape Contractor Equipment Storage
Building 82	General Storage Area	Landscape Contractor Equipment Storage/Historical Document Storage
Building 83	Drum Storage Area	Landscape Contractor Equipment Storage
Building 85	Wastewater Treatment Plant	Wastewater Treatment Plant
Building 87	Fleet Test Area	Utility Company Office/Administration Support
Building 88	Fleet Test Area	Utility Company Office/Administration Support
Building 91	General Storage	Landscape Contractor Equipment Storage
Potter Brothers Building	Ski Equipment Store	Vacant
Water Reservoir	Drinking Water Storage	Inactive
Construction Trailer	--	Construction Support Offices

Petroleum, coal products, chemicals that were tested as potential additives, and solvents have been used at OU-1A in connection with research operations. During the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) performed by IT Corporation in the early 2000s, four soil samples (ITSB-5, ITSB-6, ITSB-7, and ITSB-18) were collected near Building 51. One of the sample analyses (ITSB-18) detected concentrations of volatile organic compounds (VOCs; primarily benzene, toluene, ethylbenzene, and xylenes [collectively, BTEX]) and metals (arsenic, beryllium, chromium, nickel, and zinc) above the NYSDEC’s guidance values. A 20-foot by 45-foot area was excavated at the edge of Building 51, to a depth of 12 feet below ground surface (ft bgs) to remove contamination in the area of

ITSB-18. Areas directly next to the building edge were excavated at a one-to-one slope for the first 6 feet from the building. A total 930.62 tons of soil were excavated from this parcel. Post-excavation samples were collected from the border of the excavation area, and all detected concentrations were below the 1994 NYSDEC’s Recommended Soil Cleanup Objectives (SCOs) presented in Technical Administrative Guidance Memorandum 4046 (NYSDEC 1994b). Data have been presented in the Environmental Site Assessment Report – Results of Building 51 Excavation (IT Corporation 2001b). Sanitary wastewater and industrial wastewater generated at TRCB were treated in the on-site WWTP, located to the west of the former Mill Buildings still on site. The industrial wastewater conveyance and treatment system was discontinued following closure of the Industrial Sewer System in 2006; however, the sanitary wastewater system and the on-site WWTP remain active and continue to discharge to Fishkill Creek under a State Pollution Discharge Elimination System (SPDES) permit. Most utilities located in the Main Facility (OU-1A) are underground. These include potable and fire-suppression water, electrical, communication, sanitary sewer, storm sewer, industrial sewer (closed), natural gas, and fuel product lines. As described in previous reports, investigations have been completed proximal to these utilities. There is one set of aboveground electrical lines located in the central western part of the Main Facility (OU-1A). Central Hudson maintains a high-pressure gas metering station in the Building 50 parking lot. In 2011 and 2012, Chevron conducted a Sitewide Asbestos Containing Material (ACM) Abatement and Building Demolition project. This project resulted in the demolition of most of the buildings on site to the basement or slab level, and currently no structures exist on OU-1A apart from a few administrative and/or support buildings. The remaining buildings are shown on Figure 1-6. The only activities that currently take place on this parcel are:

- General landscaping and site maintenance activities performed by a local contractor.
- General field activities performed by a CEMC contractor (such as water sampling, erosion, and sediment control inspections, etc.) based out of the site trailer located near Building 31.
- Sampling at the WWTP by a Chevron contractor to support SPDES requirements.
- The local landscaping contractor uses an area of the Site near Buildings 58 and 83 as a base of operations (such as landscaping material storage, vehicle and equipment storage, maintenance on equipment, etc.).
- Storage for site-related documents (Building 83).
- A local utility company performs field efforts off site based out of a laydown and field trailer located on site (near Buildings 87 and 88).

Investigations of different media mentioned in this RIR were performed to characterize potential releases from on-site laboratories (Buildings 41, 42, 51, 65, 68, 70), on-site USTs and ASTs, and tank farm underground piping that extended from the former tank farm located south of Fishkill Creek.

1.2.2.2 Former Church Property, OU-1B

The former Church Property (OU-1B) (see Figure 1-2) is a 15-acre undeveloped parcel located to the northwest of the Main Facility (OU-1A) that once included a local church that was relocated in the 1950s. No TRCB activities were conducted on this property. No structures or occupants are present on OU-1B, and no known activities take place on this parcel.

Investigations discussed in this RIR were performed on this parcel to assess the general quality of the environmental media. No potential sources of releases have been identified.

1.2.2.3 Washington Avenue Tank Farm, OU-1C

The WATF (OU-1C) (see Figure 1-2) consists of 5 acres of land located south of Fishkill Creek, and is bounded by Fishkill Creek to the north, Washington Avenue to the east, and the Metro-North Railroad line to the south and west. The WATF (OU-1C) is surrounded by a chain link fence. This OU formerly included approximately 30 ASTs and associated facilities. All tanks were decommissioned from late 2002 to 2003, and no environmental samples were collected at the time of decommissioning because all of the ASTs were located on concrete containment structures. Currently no structures exist on the OU and the area is an open lot with the remains of piping structures and a previously operated groundwater recovery system. The following activities are taking place on the parcel:

- General landscaping activities performed by a local contractor on a semi-annual basis (e.g., mowing).
- General field activities performed by a CEMC contractor (such as water sampling, erosion, and sediment control inspections, etc.) on an “as needed” basis.

Investigations of different media mentioned in this RIR were performed to characterize potential releases from a former tank farm and associated piping that existed on the parcel. The tank farm consisted of ASTs and a pump house that supplied chemicals from the tanks to the Main Facility (OU-1A).

1.2.2.4 Residential Property and Rail Siding Area Property, OU-1D

The Residential Property Parcel (OU-1D) is a 2.06-acre vacant parcel on Washington Avenue (Figure 1--2). Previously, OU-1D was an off-load point for rail cars delivering materials to the WATF. Previous reports have referred to this general area as the Rail Siding Area. The Rail Siding Area appurtenances are detailed in the Supplemental RCRA Facility Investigation (SRFI; Parsons 2009b). Equipment for pumping from train cars and underground piping to the tank farm are still in place. Currently no activities take place on this OU.

Investigations discussed in this RIR were performed on this parcel to assess the general quality of the environmental media.

1.2.2.5 Back 93 Acre Parcel, OU-1E

The Back 93 Acre Parcel (OU-1E) is an undeveloped property located south of Washington Avenue and Fishkill Creek. A portion of the Back 93 Acre Parcel is listed on New York State’s registry of Inactive Hazardous Waste Disposal Sites due to its former use as a disposal site for regular facility wastes and small quantities of laboratory waste (O.H. Materials Co. 1985). The Site was classified as a Class 2 hazardous waste site under the initial NYSDEC Part 373 Hazardous Waste Management Permit until the permit expired on March 29, 1996. The Site was reclassified as a Class 4 site[1] in 1996 under a New York State Administrative Procedures Act extension, and monitoring activities have been ongoing as part of

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[1] “Class 4” is defined as an inactive waste disposal site that has been properly closed and requires continued management.

Class 4 requirements. Areas of interest at the Back 93 Acre Parcel consisted of an “old” sludge lagoon and a “new” sludge lagoon[2] (the two sludge lagoons are separate locations approximately 550 feet apart), three chemical burial sites, a disposal pit, and a container disposal site. Additionally, four areas were identified that were referred to as Trash Piles “A” through “D” (Figure 1-3). These four separate areas were used for the disposal of non-hazardous materials during the history of the facility. Materials disposed of in these locations primarily consisted of wood and metal debris, grass clippings, old empty drums, and general trash. Initial remediation began in 1985 and lasted through 1986 to remove trash from Trash Piles “A” and “B” and to excavate the container disposal site, three chemical burial sites, old sludge lagoon, and disposal pit. Initial remediation also identified an area between several of these locations that required remediation, and this area was excavated under the identification ‘open dig area.’ Approximately 26,300 tons of material had been removed as part of these remedial actions. Closure of the ‘new’ sludge lagoon was completed in 1986 following excavation. These excavations are presented in the certification of closure report, submitted on July 23, 1986 (Texaco 1986, 1987). Additional excavation pits were dug in the Trash Pile “C” area to address aesthetic concerns by removing visible trash in 2000. Interim Corrective Measures (ICMs) were performed on OU-1E between November 2005 and April 2006 to excavate and remove impacts from a hotspot at “Trash Pile “D” near the former Open Dig Area identified in 2001, as well as surface soils from Chemical Burial Sites 1 and 3. In total an estimated 4,900 cubic yards or 10,600 tons were excavated to address VOC and semi-volatile organic compound (SVOC) (polycyclic aromatic hydrocarbon [PAH]) exceedances to the NYSDEC recommended SCOs . A “No Further Action” (NFA) letter was received from NYSDEC in 2006 for these ICM activities.

The property formerly included four structures (a washroom, storage shed, tennis court, and picnic shelter). Structures were removed during the sitewide building demolition project that took place in 2011 through 2012. Currently no structures exist on OU-1E except for remnants of the tennis court, a pump house that houses an inactive potable well system, and an associated concrete reservoir.

Activities currently performed at the parcel consist of:

- General landscaping performed by a local contractor.
- Routine monitoring performed by a CEMC contractor, including water sampling and erosion and sediment control inspections.

A portion of the parcel is also used by a local landscaping contractor for storage of landscaping materials (e.g., landscaping stones).

Investigations of different media mentioned in this RIR were performed to characterize potential releases from on-site disposal chemical and drum burial pits and past agriculture usage by former landowners.

1.2.2.6 Fishkill Creek, OU-1F

Fishkill Creek (OU-1F) (Figure 1-2) is a surface water body located south of the Main Facility (OU-1A) and north of the WATF (OU-1C). The creek was used as a hydropower source for the Site in the past and receives site stormwater and WWTP discharges. More in-depth descriptions of the creek can be found in Section 5 of this RIR. Access to Fishkill Creek for recreational boating and/or fishing is difficult due to cliffs

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[2] Both lagoons were permitted under RCRA Part B.

(approximately 80 to 100 feet high from Fishkill Creek), fencing, and dams within the Site and adjacent properties.

The quality of surface water and sediment in Fishkill Creek have been investigated to assess whether they are impacted by former operations at the Site. Results of past investigations are discussed in Section 5 of this RIR.

1.2.2.7 Road Parcel, OU-2

The Road Parcel (OU-2) (Figure 1-2) is a 0.23-acre parcel along and underneath Washington Avenue that has been utilized by Dutchess County. This parcel is located outside of the fence line of the main property and is maintained by the Town of Fishkill. No TRCB activities were conducted on this property. Currently no TRCB structures or activities exist on OU-2.

No investigations were conducted on this parcel because no potential sources of releases ever existed on this parcel.

1.2.2.8 Residential Property Parcel, OU-3

The Residential Property Parcel (OU-3) is a 0.67-acre vacant parcel on Washington Avenue (Figure 1-2). No TRCB activities were conducted on this property. Currently no structures or activities exist on this OU. A trash burning area was observed at a neighboring property to the east of OU-3 during a site visit.

Investigations discussed in this RIR were performed on this parcel to assess the general quality of the environmental media. No potential sources of releases existed on this parcel, but the nearby off-site trash burning area may be a source of surface soil impacts.

1.2.2.9 Hydroelectric Dam and Facilities, OU-4

Hydroelectric Dam and Facilities (OU-4) is a small parcel (4.96 acres) that includes the Texaco Research Center Dam (also called the Hydroelectric Dam, the Chevron Dam, or the Texaco Dam; hereafter called the Texaco Dam) and associated facilities. The Texaco Dam (state identification number 212-5185 and federal identification number NY 14845) is a hydroelectric dam that spans Fishkill Creek between the powerhouse (Building 5) on the northern bank to a level control structure on the southern side (Figure 1-2). This dam was constructed prior to the start of operations at the Site. The dam was refurbished by Chevron in 2005 and reinforced in 2012.

This OU includes the hydroelectric building and the dam itself with access on the northern side via an easement to Old Glenham Road, and on the southern side via an easement to Washington Avenue. The remaining structures on OU-4 include Building 5 (which contains the dam controls) and Buildings 3, 4, and a portion of Building 2, which are currently used for storage. The following activities take place on OU-4:

- General maintenance performed by a local hydroelectric contractor.
- Dam inspections performed by a Chevron consultant and state regulatory agencies.
- General field activities performed by a CEMC contractor (e.g., water sampling, erosion, and sediment control inspections).

Investigations discussed in this RIR were performed on this parcel to assess the general quality of the environmental media and to assess whether they are impacted by former operations at the Site.

1.3 Data Validation and Database Management

Investigation-related samples were collected by either Parsons or Arcadis and analyzed by Eurofins-Lancaster Laboratories, Environmental (ELLE) (Lancaster, Pennsylvania), Eurofins-Frontier Global Sciences (Bothell, Washington), Eurofins-Air Toxics (Folsom, California), EMSL Analytical (Cinnaminson, New Jersey), TestAmerica – Buffalo (Buffalo, New York), TestAmerica Edison (Edison, New Jersey), and TestAmerica Sacramento (Sacramento, California) following the procedures outlined in the Quality Assurance Project Plan.

During the processing of the soil samples collected in 2017 by ELLE, Parsons was notified by ELLE that the metals data using the United States Environmental Protection Agency (USEPA) SW-846 6020 analytical method were manipulated and falsely reported by an ELLE analyst. This manipulation occurred off-line from the instrument where compliant initial and continuing calibration verifications, laboratory control samples, low level check standards, and interference check standards were imported into the instrument to avoid a tedious and time-consuming instrument recalibration. As a result, some of the data were reported by ELLE in error. ELLE salvaged the correct files, imported the correct laboratory quality control into the instrument, and reissued the corrected metals data. Parsons reviewed a subset of these data and determined that the data were usable with certain data considered estimated based upon the corrected noncompliant quality control mentioned above. None of the corrected metals concentrations resulted in changes from detectable to non-detectable concentrations and vice versa. Chevron Energy Technology Company also had an independent verification firm, Environmental Standards, Incorporated, review the procedure that ELLE performed to verify ELLE’s revised results. Environmental Standards, Incorporated concurred with Parsons conclusions that the revised metals data were valid and usable.

All investigation-related analytical data were found to be acceptable in terms of deliverable completeness, accuracy, precision, representativeness, completeness, and comparability. A copy of the corresponding investigation Data Usability Summary Report (DUSR) was included with each investigation report.

The data generated during the sampling activities were stored and managed using Locus Focus Environmental Information Management (Locus EIM™) database software. The Locus EIM™ database was updated to reflect any changes following data validation. These changes included concentration changes, where appropriate, and removal, addition, and/or changes to data qualifiers. The data used in reports were taken from the updated master database to ensure that only current, validated analytical results were used.

In addition, all analytical data were submitted separately to the NYSDEC Project Managers (Mr. Paul Patel, P.E. and Mr. William Bennett, P.E.) in the required Environmental Quality Information System (EQUIS) format in the form of an e-mail and signed in accordance with Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10) Sections 1.2 and 1.5.

1.4 Report Organization

The sections of this RIR present information as described below:

- Section 2 –Includes a discussion of the physical characteristics of the facility (climate, surface water hydrology, geology, and groundwater hydrology)
- Section 3 – Summary of all soil investigations performed from 2005 through 2018
- Section 4 – Summary of groundwater investigations performed from 2006 through 2018 and current groundwater conditions
- Section 5 – Summary of surface water and sediment investigations performed in 1997 and 2014
- Section 6 – Summary of soil vapor investigations performed in 2016, 2018, and 2020
- Section 7 – Ecological Resources Impact Analysis
- Section 8 – Conclusions from the report
- Section 9 – References used in the report.

Table 1-1 presents a summary of major COCs in each OU.

2 CONCEPTUAL SITE MODEL

The following section identifies and models the pathways of impacts at the Site and describes physical conditions at the Site.

2.1 Constituents of Concern

Remedial investigations completed at the Site have identified parameters in excess of the applicable criteria including SCOs, NYSDEC Technical and Operational Guidance Series (TOGS[3]) 1.1.1, Groundwater Quality Standards, Sediment Guidance Values (SGVs), and Freshwater Criteria. The following compounds have been identified as COCs at the Site and are present at concentrations that may be attributable to former site operations:

- Petroleum organics: BTEX
- Chlorinated solvents and breakdown products:
  - 1,1,1-trichloroethane (1,1,1-TCA; breakdown – 1,1-dichloroethane [1,1-DCA]; chloroethane[4]; stabilizer – 1,4-dioxane)
  - Tetrachloroethane[4], trichloroethylene[4] (TCE; breakdown – cis-1,2-dichloroethene[4] [cis-1,2-DCE], vinyl chloride[4])
  - Chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene[4], 1,4-dichlorobenzene.
- SVOCs, which include PAHs): 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, hexachlorobutadiene[4] (HCBD), indeno(1,2,3-cd)pyrene, naphthalene
- Metals: arsenic, mercury, lead

These COCs were selected based on the spatial frequency of their detections above environmental standards or their identity as causing probable impact due to site sources. Certain VOCs, SVOCs, or metals have been detected above the soil and groundwater criteria, but in few borings or monitoring wells, and most often coincide with other exceedances. Therefore, these compounds have not been retained as COCs as they will be remediated with other compounds and are not detected frequently enough to describe above. Additional evaluation of background conditions in comparison to detected site concentrations will be completed in a separate evaluation following submittal of the RIR to assess potential background contributions. This evaluation will be submitted prior to the Feasibility Study.

2.2 Affected Media

The media reviewed in the investigations to date are as follows:

- Surface soils – soils within the first 2 inches bgs

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[3] A standard is a value that that has been promulgated and placed in regulation. Guidance values may be used where a standard for a substance has not been established.

[4] Identified COC has been detected in groundwater, but not in soil analytical data.

- Near-surface soils – soils between 2 inches and 2 ft bgs
- Subsurface soils – soils more than 2 ft bgs
- Overburden groundwater – groundwater present in unconsolidated deposits at the Site
- Bedrock groundwater – groundwater present in the fractures of consolidated bedrock
- Sediment – material at the bottom of Fishkill Creek and the wetland areas and intermittent stream located on OU-1E
- Surface water – water present in Fishkill Creek and the wetland areas and intermittent stream located on OU-1E
- Soil vapor – air impacted by the volatilization of compounds in soils or groundwater.

The investigations into the above media are described in Sections 3 through 6 of this RIR.

2.3 Potential Sources

The locations of former piping, tanks, and drum storage areas at the former TRCB facility are detailed on Figure 1-2, and tables describing these potential sources are provided in Tables 2-1A through 2-1D. During demolition activities taking place onsite from 2010 through 2012, most of the remaining aboveground storage tanks were closed and demolished. The remaining currently in place tanks are actively used and are related to the mill buildings and industrial wastewater treatment plant. Underground storage tanks onsite have all been closed in place or removed through the numerous remedial activities on site. Remaining underground storage tanks onsite will be further evaluated and remediated appropriately during future site efforts..

2.3.1 OU-1A

The primary sources at the Main Facility (OU-1A) include the laboratories across the Site, former drum storage areas, both ASTs and USTs, as well as the underground product piping across the Site. The locations of former piping, tanks, and drum storage areas are detailed on Figure 1-2, and tables that describe these potential sources are provided as Tables 2-1A through 2-1D. The locations of these potential source areas are further described in the Groundwater Sciences Corporation (GSC) 2005 Phase II Environmental Site Assessment (ESA) (GSC 2005). USTs and ASTs have since been removed (Parsons 2004a, 2004b), most of the buildings on site have been demolished, and drums have been removed from their former storage locations. The main laboratories on the Site included Buildings 41, 42, 51, 65, 68, and 70. USTs and ASTs were located across the Site, near the former laboratories, to supply a variety of materials, including heating oil, fuel, gasoline, and assorted lubricants and solvents. In addition, drums with these same materials were stored in the areas of Buildings 51, 58, 79, 83, and the south of Building 41. In one of these drum areas, free product has been documented in monitoring well ITMW-14. The light non-aqueous phase liquid (LNAPL) present on groundwater at this location is identified as a continuing source of groundwater impacts.

Former sources, including USTs, ASTs, process line piping, drum storage areas, and laboratory buildings, have been removed from the Site. However, soil impacts greater than the NYSDEC's Protection of Groundwater Soil Cleanup Objective are present on site. The locations where parameters exceed these criteria are retained as source locations that may impact groundwater. These objectives are discussed in Section 3.4. Additionally, groundwater at the Site generally flows toward Fishkill Creek. While sampling of both the sediment and surface water in Fishkill Creek does not identify any major impacts, groundwater is retained as a potential source of impacts to surface water receptors.

Potential sources at OU-1A have been identified and investigated through sampling events discussed in Sections 3 through 6.

2.3.2 OU-1B

No TRCB activities were conducted on this property. No structures or occupants are currently present on OU-1B, and no known activities take place on this parcel. Historical use of the parcel included an access road that may be a source for multiple identified PAH exceedances.

Potential sources at OU-1B have been identified and investigated through sampling events discussed in Sections 3 through 6.

2.3.3 OU-1C

During initial site closure activities, the tank farm was identified as a likely source of groundwater and soil impacts due to leaks from the ASTs that have since been removed from the Site. Approximately 30 ASTs were present at this parcel and were demolished along with removal of associated piping (Parsons 2004b). Historic remediation completed prior to the demolition and removal was conducted from the 1980s through 2003. The containment area for the tank farm was upgraded in 1990, and this upgrade generated soil that was bioremediated via soil venting and treatment in an on-site biocell system. Other remedial measures implemented at the tank farm included a petroleum containment trench and recovery system, and an air sparge system implemented in the late 1980s through 1999. While no major spills or releases have been documented, free product was detected in initial investigations at the parcel. However, the petroleum containment trench and recovery well/sump did not recover any LNAPL. Following upgrades to the air sparging system and piping in 1996, the system operated until the blower broke down in 1999. The system was not repaired due to the minimal extraction in previous years (IT Corporation 2001). Following remediation completed at OU-1C, the extent of free product has been limited to only one monitoring well (SWMW-21). The LNAPL present on groundwater at the tank farm is identified as a potential continuing source of groundwater impacts. In addition, underground piping at the tank farm extends south to the former Rail Siding Area.

Potential sources at OU-1C have been identified and investigated through sampling events discussed in Sections 3 through 6.

2.3.4 OU-1D

To the south of the tank farm, the Rail Siding Area acted as a drop-off point for product being transferred by rail car. This is also referred to as Residential Property Parcel. Piping underneath the Metro North Railroad line was used to transfer product between OU-1D and the tank farm. Additional pumping equipment and catch basins have been reported on this OU but the exact locations are unknown. Borings SWSL-74 through 77 were reportedly taken near the catch basin and fill ports to the north and SWMW-63 was also referenced to be slightly to the west of the fill ports (Parsons 2007). Potential sources at OU-1D have been identified and investigated through sampling events discussed in Sections 3 through 6.

2.3.5 OU-1E

Initial investigations into the former TRCB facility identified multiple disposal areas on the Back 93-Acre parcel that represented potential source areas and classified the Site as a Hazardous Waste Site. At OU-1E, these source areas included the former Trash Piles “A” through “D,” three Chemical Burial Sites, a Container Disposal Area, a disposal pit, and two sludge lagoons – one ‘old’ and one ‘new’.

The disposal areas represent the main potential sources at OU-1E. These areas were used for facility waste disposal. Initial remedial actions that took place from 1985 through 2006 included the excavation of these areas to address both regulatory requirements and aesthetic concerns (O.H. Materials Co. 1986; IT Corporation 2001; Parsons 2006a). These disposal areas no longer remain at the Site.

Potential sources at OU-1E have been identified and investigated through sampling events discussed in Sections 3 through 6.

2.3.6 OU-3

No TRCB activities have been conducted at this parcel. The parcel is vacant and is surrounded by residential properties to the east and west. A trash burning area located off site at the eastern residential property is suspected to be a potential source of PAH impacts in this area, specifically at location OU3SB02. Mercury and pesticide detections are isolated and likely not related to TRCB operations.

Environmental impacts at OU-3 have been identified and investigated through sampling events discussed in Sections 3 through 6.

2.3.7 OU-4

The portion of OU-4 to the north of Fishkill Creek has been investigated along with OU-1A. Potential sources of impacts include the WWTP, drum storage at the former Mill Buildings, additives storage, and assorted laboratories and storage areas upgradient at the Main Facility. The soil vapor and indoor air have been investigated in the Mill Buildings and are described in Section 6.

To the south of Fishkill Creek, OU-4 includes the Undeveloped Parcel and access route between OU-1D and OU-1C. Investigations into these areas were conducted following unsubstantiated reports of a potential former disposal area at this parcel, although the investigations did not identify the bounds of any such area. One of the test pits encountered debris within the first 6 inches of soil, but no other evidence of a dump area was found. Soil borings completed in the purported dump area likewise did not exhibit evidence of a disposal area.

All potential sources at OU-4 have been identified and investigated through numerous sampling events discussed in Sections 3 through 6.

2.4 Physical Characteristics of Study Area

2.4.1 Climate and Meteorology

The Site is in the eastern part of New York State in the lower Hudson Valley. The climate in the region consists of moderately cold, snowy winters and warm, humid summers. The highest average daily mean temperature of 75 degrees Fahrenheit (°F) occurs in July. During the winter, the temperature averages near 26°F (-3.3°Celsius). Temperatures of 90°F or higher occur from 8 to 12 days per year between early June and late August (United States Geological Survey [USGS] 1980).

Normal annual precipitation is 43.1 inches based on the 30-year period from 1951 through 1980 as recorded at the Glenham weather station, formerly located on the Texaco property. The average annual potential evapotranspiration is 28.7 inches. Snowfall typically occurs between mid-December and mid-March. The lower Hudson Valley receives an average annual snowfall of 40 to 60 inches. Snow cover persists from mid-December through early March with maximum depths recorded in February of most years.

Winds are predominantly from the northwest and southwest at average speeds from 8 to 15 miles per hour. The winds are predominantly from the northwest during early fall to midwinter and predominantly from the southwest during spring to late summer.

2.4.2 Surface Water Hydrology

Fishkill Creek is the dominant surface water body near the Site, with a watershed of approximately 190 square miles. Fishkill Creek originates approximately 15 miles northeast of the Site and exhibits a fall of approximately 23 feet per mile. The USGS maintained a stream gauging station on Fishkill Creek at Beacon from 1944 to 1968, which was located about 0.7 mile downriver from the Texaco Dam (described below). The stream flow recorded at that station ranged from 0.4 cubic feet per second (cfs), to 8,800 cfs with an average of 279 cfs. The flow duration curve of daily flow for Fishkill Creek at Beacon indicates that the creek exceeded 170 cfs 50 percent (%) of the time and equaled or exceeded 8.8 cfs 99% of the time (Dunn Geoscience Corporation [Dunn] 1989).

The level of Fishkill Creek is controlled by dams. The Texaco Dam is located on the Site near Building 5 in OU-4 (Figure 1-2). The elevation of the top of the dam is reported to be 196.0 feet relative to the Texaco Site Datum[5] (Texaco 1998). The height of the dam is approximately 22 feet. A second dam is located approximately 2,500 feet downstream from the Texaco Dam, and three more dams are located farther downstream before Fishkill Creek joins the Hudson River, about 5 miles downstream from the Site.

Fishkill Creek above the Texaco Dam near the Site is wide and generally quiescent. Below the Texaco Dam, the creek narrows significantly and flows through a steep-sided channel.

Based on maps prepared by the Federal Emergency Management Agency (FEMA 2012), most of the Main Facility and the Back 93 Acre Parcel are located within a Zone X area (minimal potential for flooding). The lower section of the Main Facility, near the WWTP, is within the 100-year floodplain,

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[5] Unless noted otherwise, all elevations presented in this report are referenced to the Texaco Site Datum, which is 1.07’ below the North American Vertical Datum of 1988 (Parsons 2007).

classified as Zone AE. The tank farm is mainly located within Zone AE as well. Floodplain maps are provided as Figure 2-1.

Historical records indicate that flooding of the Site has occurred. Most notable among these was a 1955 flood event when lower sections of the Site, near the WWTP, were under water.

2.4.3 Geology

2.4.3.1 Regional Geology

The Site is in the Hudson-Mohawk Lowlands physiographic province of New York State (New York State Museum 2020). The province is characterized by generally low-lying lands of slight relief mantled by glacial deposits. Topographic relief in the region ranges from near sea level at the Hudson River (about 2.3 miles west of the Site) to about 400 feet at the tops of hills scattered across the lowlands. Beacon Mountain (locally known as “Mount Beacon”), which marks the edge of the adjacent Hudson Highlands physiographic province, begins to rise about 1 mile south of the Main Facility, reaching a maximum elevation of over 1,500 feet above sea level.

The region has a long and complex geologic history as it has been subject to several mountain-building and rifting episodes starting approximately a billion years ago. Folding and faulting of the rocks accompanied the mountain building, though the faults in the region are very old and considered to be inactive (Budnick et al. 2010). Sedimentary rocks deposited in shallow seas (e.g., limestones, dolomites, and sandstones) and deep ocean basins (e.g., shales) are present in the region. Some of these rocks were heated, deformed, and changed into gneisses and marbles. In places, the rocks were heated to the point of melting, forming granites. Granites and gneisses are resistant to erosion and comprise the bedrock of the Hudson Highlands.

The distribution of rock units generally forms a northeast to southwest pattern across the county. Areas of similar bedrock types are inferred to be bounded by faults that separate them from areas of differing bedrock types. It is likely that many faults have gone unmapped because most of the bedrock is covered by glacial deposits and vegetation and is not exposed (Budnick et al. 2010).

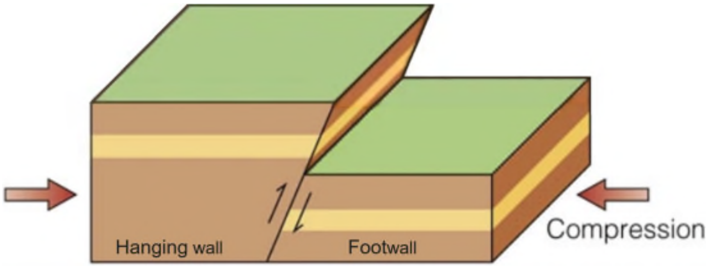
Pleistocene glaciers have excavated the surface and deposited great quantities of gravels, sands, silts, and clays in the Hudson Valley. Most of the unconsolidated deposits in the region are of glacial origin (Snavely 1980). During the most recent glacial epoch, the Laurentide ice sheet advanced southward from Canada, extending as far south as Long Island approximately 20,000 years ago. Till, an unsorted mixture of fine material, sand, gravel, cobbles, and boulders deposited at the base of the glacier, blankets the hills in the region and underlies other glacial deposits in the valleys. Sands and gravels occur as outwash deposited by glacial meltwaters in lowlands. In some areas, glacial lakes formed, beneath which lacustrine (lake) silts and clays were deposited.

The area also contains alluvial deposits that were laid down after the glacier retreated. Coarse sands and gravels are present in alluvial fans deposited where streams flowing off the Hudson Highlands meet valley floors. Finer grained sands and silts are found in the floodplains along present-day drainages such as Fishkill Creek.

2.4.3.2 Site Geology

To evaluate site geology, Arcadis consulted regional geologic literature and previously published reports for the Site (Dunn 1984, 1989; Parsons 2007, 2009b, 2019a; IT Corporation 2000a, 2000b), and reviewed site boring logs. To further evaluate site geology Arcadis prepared multiple cross-sections with key features presented on Figures 2-1 through 2-4.

2.4.3.3 Bedrock



Depiction of a reverse fault.

Two bedrock formations underly the Site and are separated by an ancient reverse fault. The approximate location of the fault, based on geologic information collected at the Site, is shown in plan view on Figure 2-2. This location agrees reasonably well with a fault mapped in the area by Fisher et al. (1970). A reverse fault is formed by compressional forces, where two blocks of rock are forced together and one block (termed the hanging wall) rises above the other (termed the footwall). The rock formations are interpreted to be a Proterozoic-aged[6] granitic gneiss[7], which comprises the footwall and the late Cambrian to early Ordovician aged limestones and dolomites of the Wappinger Group (Fisher and Warthin 1976). The relationship of these rock formations to one another, including the fault, as well as the overburden that mantles them, is depicted on four cross sections. As shown on Figure 2-2, three section lines focus on the main facility; the corresponding cross sections are shown on Figures 2-2A through 2-2C. A fourth transect traverses the Back 93 Acre Parcel, as shown on Figure 2-3. The associated cross section is included as Figure 2-3A.

The Wappinger Group is divided into six formations, each consisting of a limestone or dolomite; however, there appear to be no essential differences in the water-bearing properties between the formations and they are poorly mapped in the area. For this reason, the rocks of the Wappinger Group are hereafter referred to as “dolomite,” consistent with the terminology used in previous site reports. The dolomite was thrust above the granitic gneiss during mountain-building episodes that occurred hundreds of millions of years ago. Because the dolomite comprises the hanging wall, the fault plane must dip toward the southeast; however, no published data on the dip angle are available. Review of site boring logs indicates that four monitoring wells reportedly penetrated both dolomite and granitic gneiss: SWMW-1, SWMW-9, SWMW-12, and SWMW-27. Arcadis analyzed this information to help better locate the fault and estimate its dip angle but found the information to be contradictory. Because dolomite comprises the hanging wall of the fault, it should be penetrated before the granitic gneiss; however, at two of the four borings (SWMW-12 and SWMW-27) granitic gneiss was reported to have been penetrated before the dolomite. In addition, the two borings that reportedly penetrated dolomite first are located in an area of the Site where

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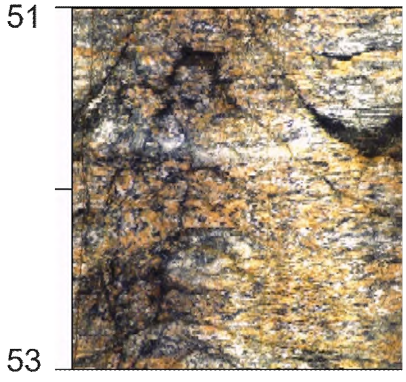
[6] The Proterozoic eon constitutes the later part of the Precambrian era, roughly spanning 600 million to 2.5 billion years ago. The Ordovician Period began about 485 million years ago.

[7] Previous site reports refer to this rock as granite. The physical and water-transmitting properties of both granite and granitic gneiss are essentially the same.

nearby boring data, including one boring where the borehole wall was imaged using an optical televiewer (SWMW-26, see Appendix B), indicate only granitic gneiss was penetrated. Because the observations made at these four borings were based solely on the descriptions of rock cuttings returned to the surface during air-rotary drilling, it is possible that the rock types were misinterpreted. It is also possible that the initial “bedrock” penetrated at these borings consisted of large boulders or detached rock slabs rather than true bedrock.

As noted above, information regarding the composition of the bedrock penetrated at the Site comes largely from observations of rock cuttings made during air-rotary drilling, supplemented with downhole optical and acoustic televiewing data collected at a subset of site monitoring wells. In total, approximately 520 feet of granitic gneiss from eight borings were logged with the optical and/or acoustic televiewers, compared to 321 feet of dolomite from a total of six borings (Appendix B).

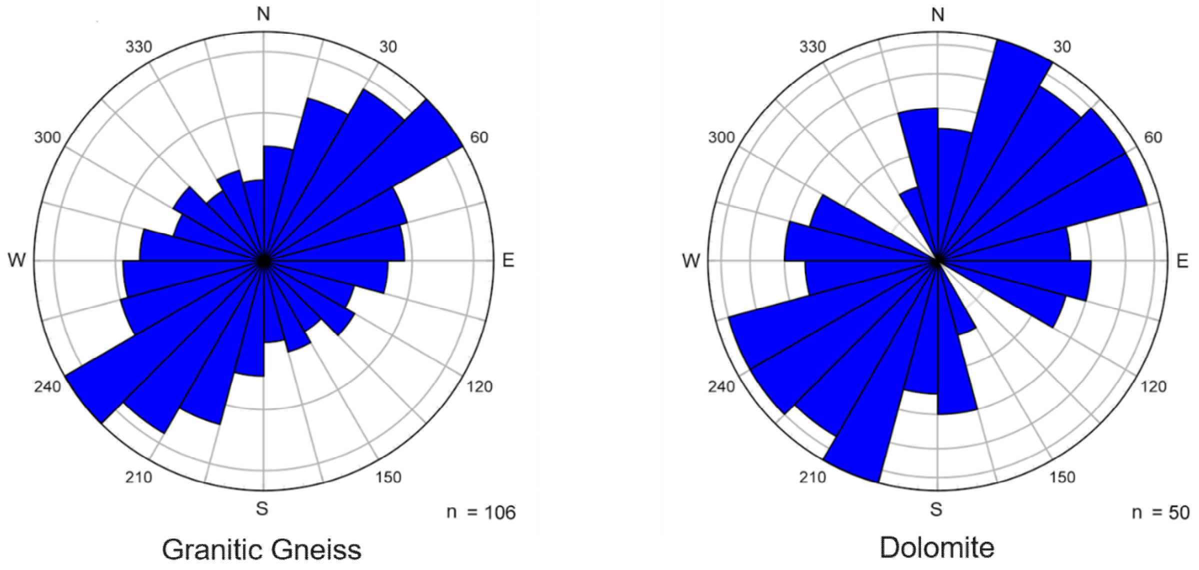
Based on the optical televiewer logs for boreholes drilled in the granitic gneiss, the rock is consistent with the quartz-feldspathic gneiss described by Fisher and Warthin (1976). No discernible patterns suggestive of structure (for example, relict bedding) are evident in the televiewer logs, suggesting that the rock was largely melted and recrystallized during metamorphism. Simmons et al. (1961) report that granites and gneisses in the region exhibit layers (foliation) that strike northeast and dip steeply to the southeast; and that, near reverse faults, the strike and dip of foliation parallel the faults. Rock of this type is relatively hard and resistant to weathering. This rock is present northwest of the fault line.



Granitic gneiss at SWMW-116B. Numbers represent feet below grade.

Structural data of interest for the gneiss consist of fractures interpreted from geophysical logging. For the 520 feet of borehole logged, 106 open fractures were interpreted, for an average of about two open fractures per every 10 feet of hole logged. While the planes of open fractures are oriented in all directions, the majority are oriented northeast-southwest, which is consistent with the orientation of rock types and faults in the region. Most of the open fractures are steeply dipping, with 73% dipping at angles between 45 and 80 degrees. Most open fractures (43%) dipped toward the northwest (dip azimuths between 90 and 180 degrees). A large percentage of open fractures (31%) dipped toward the southeast (dip azimuths between 270 and 360 degrees [i.e., due north]); with the remaining 26% dipping in various directions. Most fractures interpreted as open had no measurable aperture or measurable change in borehole diameter, indicating that they were relatively tight.

Based on review of the geophysical logs provided in Appendix B, the dolomite is light to dark gray in color and generally thickly bedded, though in some intervals the bedding is indistinct. Many of the interpreted fractures contained in the geophysical logs are aligned along bedding. Fifty open fractures were noted in 321 feet of borehole logged, or roughly 1.6 open fractures per each 10 feet of dolomite drilled. Like the granitic gneiss, the orientations of the fractures averaged northeast/southwest; however, there was slightly more variation, as shown in the following graphic:



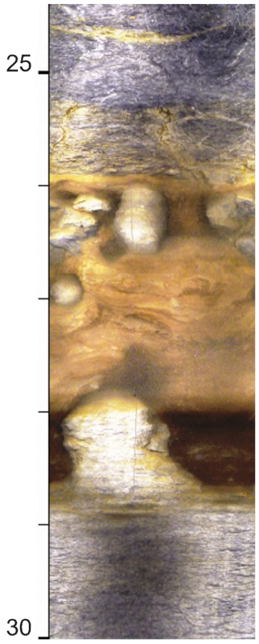
Granitic Gneiss

Dolomite

Equal area rose diagrams of open bedrock fractures showing that most fractures are oriented northeast-southwest.

Also like the granitic gneiss, most open fractures were steeply dipping, principally in two directions. Fifty-six percent of the open fractures dip toward the southeast (dip azimuths from 75 to 180 degrees) with an average dip angle of 64 degrees. Thirty percent of open fractures dipped toward the north-northwest (dip azimuths between 285 and 30 degrees) with an average dip angle of 46 degrees. The remaining 14% of open fractures generally dipped toward the west-southwest.

Unlike the granitic gneiss, the dolomite is relatively soluble, and its properties have been modified over geologic time as the rock has been dissolved by groundwater. The presence of solution-widened fractures and cavities is evidence of this. Fifteen such features were visible in the televiewer logs, including two greater than 8 feet in height. Other such features were noted in logs of borings in the dolomite that were not televiewed. Based on information available for site borings, some of the cavities were partially or wholly filled with a mixture of clay and pebbles while others were open. The first observation is consistent with Simmons et al. (1961) who note that, “in the Valley of Fishkill Creek, solution cavities [in the dolomite] filled with clay and sand have been reported.” Open solution-widened features are important because, if interconnected, they represent important pathways for groundwater moving though otherwise sparsely fractured rock and would



Cavity penetrated during drilling of well SWMW-118B. Data in feet below grade.

increase the bulk hydraulic conductivity and transmissivity of the rock appreciably.

In reviewing the geophysical logs, it was discovered that the boring for monitoring well SWMW-118B did not penetrate granitic gneiss, as indicated in the boring log, but rather was drilled entirely through dolomite. Additionally, three solutional cavities were penetrated ranging in height from 2.8 inches to over 11 feet; the well is screened across the smallest of these. The adjacent borehole televiewer image depicts a partially clay-filled, 3-foot-tall cavity penetrated while drilling the well.

The bedrock surface is shown on Figures 2-2 through 2-3A. Arcadis prepared the figure using site boring data and information for bedrock outcrops shown on a 2007 site survey map prepared by Badey & Watson (Appendix A). Several features are apparent on the figure:

- Fishkill Creek occupies a narrow bedrock valley.
- The elevation of the rock is greatest in the northwestern portion of OU-1B. Most of the mapped bedrock outcrops occur in this OU, which is underlain by granitic gneiss.
- There is a modest, north-northeast trending trough in OU-1A that generally aligns with the trace of the fault.
- Several localized closed depressions are evident on the figure. These occur more commonly in the portion of the Site underlain by dolomite and in areas where the bedrock elevation varies significantly (multiple feet) across short distances.

Closed depressions are relatively common in terranes underlain by soluble rock. This is caused by differential weathering – weathering and dissolution are focused at fractures and other features that allow greater circulation of groundwater. Comparing boring data from monitoring wells SWMW-112 and SWMW-113, located approximately 50 feet apart, provides evidence of this. The elevation of the bedrock surface at SWMW-112 is approximately 192 feet above the Texaco Datum while bedrock was never penetrated at monitoring well SWMW-113, which was drilled to an elevation of approximately 177 feet.

At the Back 93 Acre Parcel (OU-1E), a “karst feature” discovered at the bedrock surface was investigated (IT Corporation 2000a). A backhoe was used to excavate to the top of bedrock adjacent to former monitoring well DB-6A to investigate a void penetrated from 7.5 to 12 feet during drilling of the well. The excavation uncovered a 6-inch by 18-inch opening in the bedrock at a depth 7.5 feet with an open cavity beneath extending to 11.5 feet. The dolomite only crops out near the foot of the Texaco Dam, on the southern bank of the creek.

2.4.3.4 Overburden

The unconsolidated (overburden) deposits at the Site consist of lodgement till, glaciolacustrine silt and clay[8], alluvial sand and gravel, and fill. The general distribution of these deposits is depicted on the four cross sections included for the Site (Figures 2-2A through 2-2C and Figure 2-3A).

The most common deposit at the Site is lodgement till, which is a type of till that is deposited at the base of a glacier and is therefore very dense. The till at the Site consists of an unsorted mixture of sand, gravel, cobbles, and boulders in a matrix of fine sand, silt, and clay. Till generally directly overlies the

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[8] i.e., silt and clay deposited in a glacial lake.

bedrock beneath the Site. The thickness of till penetrated by borings drilled at the Site ranged from a few feet to over 20 feet. The till is absent in scattered areas across OU-1B and at the bluff along the north shore of Fishkill Creek downstream from the Texaco Dam, where bedrock is exposed at the surface.

Overburden tends to be thicker in areas underlain by dolomite. This is interpreted to be the result of two factors. First, the dolomite weathers more readily than the granitic gneiss; therefore, areas underlain by dolomite are topographically lower than those underlain by gneiss. Low-lying areas may have accumulated a greater thickness of till during glaciation and, following glaciation, received deposits of alluvial material (e.g., floodplain deposits). Second, the dolomite surface beneath the Site has been shown to be irregular. The cause of this irregularity is interpreted to be the result of preferential weathering along steeply dipping joints, where groundwater movement into the bedrock is focused.

The glaciolacustrine silt and clay occur above the till beneath most of OU-1C. Based on the available data, it is not anticipated to greatly exceed 5 to 6 feet in thickness. This deposit is overlain by a deposit of alluvial sand and gravel, which is about 10 feet thick near the edge of Fishkill Creek and thins to about 2 feet near the southern edge of OU-1C (Dunn 1984). Development of the Site resulted in a deposit of fill of variable thickness being placed across much of the Site.

A deposit of brown silt and sand with some gravel is present in the southeastern portion of OU-1E (Figure 2-3A). This material is interpreted to represent alluvial material as mapped by Reynolds and Calef (2010).

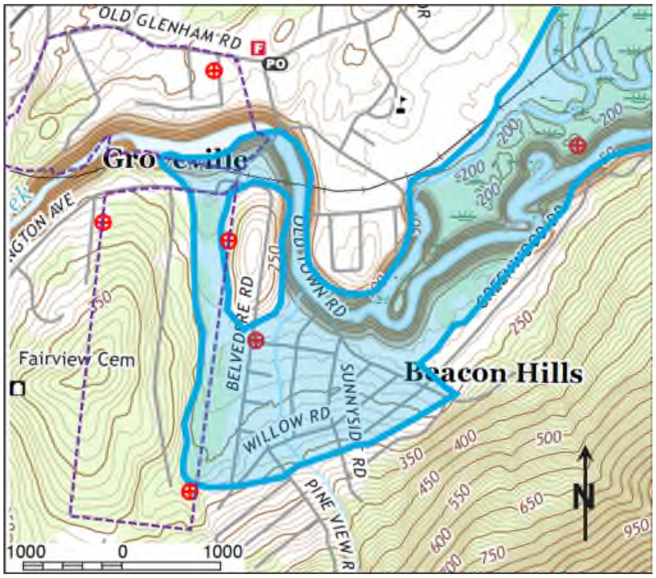
Much of the developed areas of the Site are mantled by a layer of fill. The fill is typically comprised of sand and silt and often contains building debris, asphalt, coal fragments, cinders, and/or ash. Fill is more widespread at OU-1A, which had more extensive industrial use. In this area, fill is generally thicker in areas underlain by dolomite, where up to 15 feet have been penetrated. In areas underlain by granitic gneiss, the thickness of the fill tends to be thinner, typically less than 5 feet. Previous investigations have concluded that much of the fill was placed before Texaco developed the property (GSC 2005). A portion of the fill is interpreted to consist of demolition debris from preexisting structures as well as coal, ash, and cinders from the former nineteenth century steam powerhouse (GSC 2005). In areas outside of the Main Facility, fill is associated with development of the former tank farm (OU-1C) and former disposal areas in OU-1E. Remedial excavations conducted at the latter were backfilled with clean fill.

2.4.4 Hydrogeology

2.4.4.1 Regional Hydrogeology

Groundwater occurs in all the consolidated (i.e., bedrock) and unconsolidated (i.e., overburden) deposits in the region. Practically all this groundwater is derived from infiltration of local precipitation. Groundwater levels fluctuate seasonally. The largest fluctuations, ranging from 10 to 20 feet, generally occur in monitoring wells screening poorly permeable deposits, such as till, and in bedrock monitoring wells underlying hills. The smallest fluctuations, ranging from 5 to 10 feet, generally occur in wells screening the more permeable unconsolidated deposits, such as sand and gravel, and in wells in bedrock in the valleys (Simmons et al. 1961).

The most productive unconsolidated deposits are comprised of glacial outwash – stratified deposits of sand and gravel. Recent alluvium deposited along present-day rivers and streams, such as Fishkill Creek, were comprised chiefly of sand, also provide appreciable quantities of water. Till and glacial lake deposits are poorly permeable and consequently are poor sources of water. The Fishkill-Sprout Creek Aquifer is the primary unconsolidated aquifer in the region (Snavely 1980; Reynolds and Calef 2010). As shown on the adjacent figure, the southeastern end of the mapped aquifer is shown to underly OU-1C (Washington Avenue Tank Farm) and the eastern edge of OU-1E (Back 93 Acre Parcel). Dunn (1984) concluded that the sand and gravel deposit that occurs beneath OU-1C should not be considered part of the aquifer because the deposit is too thin and limited in areal extent to support a production well capable of yielding a substantial quantity of water.



Extent of Fishkill-Sprout Creek Aquifer near the Site. Red circles denote boring data used by the USGS to perform the mapping. Site limits represented by dashed purple lines; scale is in feet. Modified from Reynolds and Calef (2010).

Bedrock formations in the region that are of interest to this RIR are the granitic gneiss and carbonates (i.e., limestone and dolomite) of the Wappinger Group. The carbonate rocks are the highest yielding bedrock aquifers, with yields averaging about 22 gallons per minute (Simmons et al. 1961; Snavely 1980). Texaco formerly operated two supply wells located in OU-1E identified as Well No. 1 and Well No. 2 (Figure 1-3). Well No. 1 is a 367-foot-deep bedrock well (IT Corporation 2000c[9]). Based on available information, the bedrock is inferred to be the Wappinger Group limestone and dolomite. IT Corporation (2000b) notes, “this well is not used for water supply because it does not produce a sufficient water yield (20 gallons per minute).” Well No. 2 is 463 feet deep and formerly supplied the TRCB facility with water. It was drilled in 1944 and was reported as “in service” in 1950 (Appendix C). The well reportedly produced approximately 300 gallons per minute (Snavely 1980; IT Corporation 2000c). Use of this well was discontinued following site closure. The open interval of the well consists of 59 feet of 8-inch-diameter open hole, from approximately -131.7 to -190.7 feet Texaco Datum. Although the available information suggests it is screened in shale, this rock type tends to be poorly permeable and it is highly unlikely that it could support the reported yield. Most likely the well is screened in the Wappinger Group. The wide range in yield between the two Texaco wells highlights the heterogeneity of karst aquifers – the yield of a given well is highly dependent on which transmissive features are (or are not) intercepted by its screen.

The high yield of the carbonate rocks is interpreted to be due to solution channels – joints and other openings in the bedrock that have been enlarged by solution (Simmons et al. 1961; Snavely 1980).

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[9] In this report, Well No. 1 is referred-to as TRCB-1 and Well No. 2 is referred-to as TRCB-2.

The granite and granitic gneiss rocks yield the least water of all the formations in the region because these dense, crystalline rocks are generally poorly permeable; joints and fractures provide the only permeability.

2.4.4.2 Site Hydrogeology

2.4.4.2.1 Overburden

The water table occurs in the overburden across most of the Site and fluctuates an average of approximately 3 feet seasonally. There are sizable areas in OU-1A and OU-1B, however, where the water table occurs in the bedrock. Figure 2-4 depicts the potentiometric surface of the overburden at OU-1A, OU-1B, OU-1C, and OU-4. This figure represents a revised version of the potentiometric surface presented in Parsons (2019b) and was prepared using the available overburden potentiometric data, soil moisture descriptions from soil boring logs, and the bedrock surface map (Figure 2-4). As shown on the figure, there are three regions of saturated overburden. The easternmost region consists of a 150- to 250-foot-wide strip that parallels Fishkill Creek. Near the Texaco Dam, a narrow ridge of bedrock further limits the extent of saturated overburden in this area. In the west-central portion of OU-1A, another region of saturated overburden is generally aligned along the fault. Based on the data shown on Figure 2-4, the saturated thickness in the northern portion of this area is small, approximately 2 feet or less. The third region occurs at the southwestern portion of OU-1A where there is a bowl-shaped depression in the rock surface. Groundwater in the overburden in this area is derived from recharge of precipitation, and possibly some lateral seepage of groundwater from the bedrock hill immediately to the northwest.

The ability for overburden deposits to transmit water depends on their hydraulic conductivity. The saturated deposits that are most extensive across the Site are the fill and till. Arcadis examined available hydraulic conductivity data for the Site (Parsons 2007, 2009b), which consist of rising head and falling head slug tests conducted in the site monitoring wells and determined that the results from six tests are representative of the hydraulic conductivity of the fill[10]. The average (geometric mean) of those test results is 4×10^{-3} centimeters per second (cm/sec). Our review of the data also concluded that there are no monitoring wells screened entirely in the till and consequently the data are not representative of the hydraulic conductivity of the till alone. The hydraulic properties of tills in southern New England were studied by Melvin et al. (1992). They report horizontal hydraulic conductivity test results for 16 wells screened in the till at four sites in western Massachusetts and Connecticut. The geometric mean of hydraulic conductivity from those tests is 1.9×10^{-4} cm/sec and is considered to be a reasonable estimate for the horizontal hydraulic conductivity of the till at the Site. Rising head slug tests were conducted in five monitoring wells that are screened across the alluvial sand and gravel (SWMW-18, SWMW-29, SWMW-30, SWMW-35, and TF-26). The geometric mean of these test results was 2×10^{-2} cm/sec. Similar to the till, no monitoring wells are screened entirely in the glaciolacustrine deposit; therefore, site-derived hydraulic conductivity data specifically targeting these deposits are not available. Freeze and Cherry (1979) noted that, along with dense, fine-grained till, glaciolacustrine deposits were the most common aquitards[11] in most of the northern United States. Deposits of clayey till or glaciolacustrine clay can isolate

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[10] ITMW-5 (rising head test), SWMW-52 (rising head and falling head tests), SWMW-60 (rising head and falling head tests), and SWMW-62 (rising head test).

[11] An aquitard is a geological material that restricts the flow of groundwater from one aquifer to another.

buried aquifers from near surface groundwater flow (Freeze and Cherry 1979). The glaciolacustrine deposit consists of alternating layers of fine sand, silt, and clay. This layered structure imparts anisotropy to the deposit; specifically, the vertical hydraulic conductivity (K_v) will be less than the horizontal hydraulic conductivity (K_h). When simulating groundwater movement in an area containing glaciolacustrine deposits, Ely and Kahle (2004) assigned an anisotropy ratio ($K_h : K_v$) of 1:100, meaning that the K_v of the glaciolacustrine deposit was 100 times lower than its K_h. Based on this information, when compared to the alluvial sand and gravel, the fill is moderately permeable, and the till and glaciolacustrine deposits are poorly permeable, particularly vertically (for the glaciolacustrine deposit).

Across OU1A, OU-1B, OU-1C, and OU-4, groundwater in the fill and alluvial sand and gravel moves predominantly horizontally toward Fishkill Creek. Horizontal movement is favored due to the relatively low hydraulic conductivity of the underlying till and the glaciolacustrine deposit, where present. For those OUs north of Fishkill Creek underlain by dolomite, there is generally a strong downward hydraulic gradient between the overburden and bedrock, except very near the creek, where the gradient is slightly upward. The strong downward gradient indicates that the degree of hydraulic connectivity between the overburden and bedrock is limited; otherwise, the strength of the vertical gradient would be less. This observed relationship is inferred to be due to relatively poor vertical hydraulic conductivity of the till and the relatively high bulk hydraulic conductivity of the dolomite. In terms of groundwater movement, this means that the till restricts, but does not prevent, movement of groundwater through it. For the OUs underlain by granitic gneiss, the direction of the vertical hydraulic gradient varies from upward to downward across the area. As discussed in Section 3, certain regions of bedrock groundwater have been impacted by releases to the overburden, demonstrating that the overburden does not serve as a barrier to COC migration in these areas.

In an area near the Texaco Dam within OU-1A and OU-4, the groundwater in the overburden does not appear to move toward and discharge into Fishkill Creek (Figure 2-4). In this area, near the top of the dam, Fishkill Creek loses water to the overburden. The overburden groundwater then moves around the dam, discharging to the creek below the dam. This phenomenon is caused by the large hydraulic head difference imposed by the dam (approximately 22 feet in this case) and is a common occurrence near dams.

Historically, over 30 monitoring wells were installed at OU-1E; however, many were decommissioned once remedial actions were completed (IT Corporation 2000a). Consequently, the configuration of the water table in this OU is best represented by historical water-level data collected before the monitoring wells were decommissioned. Figure 2-5 depicts the configuration of the water table for June 21, 1984 using data contained in O.H. Materials Co. (1985).

The shape of the water table depicted on Figure 2-6 represents a subdued replica of the topography. Groundwater moves from areas of higher elevation in the east and west toward a small valley where former disposal activities occurred. There is a groundwater divide in this valley that aligns with a topographic divide, which is approximately 1,600 feet south of Fishkill Creek. Groundwater north of the divide moves northward toward Fishkill Creek. Groundwater south of the divide moves south-southeast toward an unnamed tributary to Fishkill Creek that originates near the southeastern corner of the OU. In this area, a small closed depression in the water table is evident. This aligns with a local bedrock topographic high (Figure 2-6). In this immediate area, the overburden is dry, and the water table occurs in the bedrock.

Arcadis is unaware of any current conditions in the area that would serve to significantly alter the groundwater flow patterns observed in 1984.

2.4.4.2.2 Bedrock

(i) Granitic Gneiss

Most of the granitic gneiss studied during the remedial investigation is saturated, except, as noted previously, in areas where the bedrock crops out at or is very close to the surface. The primary porosity of rocks of this type is typically very low. Consequently, essentially all groundwater moves through secondary porosity consisting of relatively sparse open fractures, and potentially the fault. As discussed in Section 2.3.2.1, most open fractures in the granitic gneiss are oriented northeastward and dip steeply, predominantly toward the northwest, with a second fracture set that dips steeply toward the southeast. The apertures of most of the open fractures identified in the geophysical logging were too small to measure.

The hydraulic conductivity of the granitic gneiss was estimated from 66 slug tests conducted in 32 monitoring wells by Parsons (2007, 2009b). The geometric mean hydraulic conductivity is 3.6×10^{-4} cm/sec. To obtain another estimate of hydraulic conductivity, Arcadis analyzed data collected during a 7-hour pumping test conducted at monitoring well SWMW-114 (Parsons 2009b). That analysis yielded a similar hydraulic conductivity estimate of 3.5×10^{-4} cm/sec. Details regarding the pumping-test analysis are contained in Appendix D. The estimated hydraulic conductivity values are likely biased high because well screens specifically targeted higher-yielding intervals penetrated during drilling. Evidence that the transmissivity of the granitic gneiss is relatively low can be seen in the bedrock potentiometric surface (Figure 2-6). The horizontal hydraulic gradient in the granitic gneiss is relatively steep, and then steepens dramatically as the fault and the river are approached. The horizontal gradient from monitoring well SWMW-06(B) to the fault line near SWMW-27(B) is 0.167 foot per foot. Across most of the granitic gneiss, the potentiometric surface is 40 feet or more above the level of Fishkill Creek below the dam. If the rock were more transmissive, the potentiometric surface would likely be flatter (i.e., the hydraulic gradient would be less steep) and would be closer to the level of Fishkill Creek. These observations also suggest that the fracture networks in the rock are poorly integrated and therefore that migration pathways are sporadic.

Based on the potentiometry, the hydraulic gradient slopes toward the fault and, where the fault underlies Fishkill Creek, toward the creek itself. However, as noted in Section 2.3.2.1, most open fractures measured in the granitic gneiss strike to the northeast and dip steeply toward the northwest (away from the river). A second fracture set is oriented similarly but dips steeply in the opposite direction (toward the southeast). This geometry would tend to favor groundwater movement along strike toward the southwest. The steep hydraulic gradient in the granitic gneiss along the fault and its abrupt change in slope in the dolomite suggest that either the fault is highly transmissive and acting as a preferential pathway for groundwater flow, or that the bulk hydraulic conductivity of the dolomite is much higher than that of the granitic gneiss and can easily accommodate any seepage of groundwater from the granitic gneiss across the fault (or both). It is difficult to anticipate the effect of faults on groundwater movement. Some faults are transmissive while others are filled with gouge and clay weathered from the rock and are effectively impermeable.

There are few clustered monitoring wells in the granitic gneiss. Potentiometric data from June 2013 at the ITMW-29(B)/SWMW-116(B) cluster indicate a downward gradient in this area. Based on experience in similar settings, the hydraulic gradient must reverse toward Fishkill Creek; but the reversal may occur quite close to the creek's edge. Fishkill Creek is a regional groundwater discharge boundary; therefore, all of the groundwater investigated during the remedial investigation ultimately discharges to it.

(ii) Dolomite

Information contained in the regional literature coupled with data from bedrock borings and monitoring wells in the dolomite demonstrate that the dolomite is a karst aquifer. The ways by which groundwater is stored and moves through karst aquifers is different than in most other geologic terranes. Karst aquifers represent triple-porosity media: primary (matrix) porosity, secondary (fracture) porosity, and tertiary (solution conduit or "channel") porosity. Most of the groundwater in karst aquifers is stored in the primary porosity of the rock (Worthington 1999), even though that porosity is fairly low for crystalline limestones and dolomites of the type that underly the Site. Conversely, most of the groundwater, on the order of 90+%, moves through the tertiary porosity (Worthington 1999). Solution enlarged pathways will form dendritic, convergent networks (often called "conduit networks") in most karst aquifers (Worthington and Ford 2009); however, these networks typically occupy only a small volume of the rock and therefore are not frequently intercepted by wells. Groundwater flow is focused in the downgradient direction and typically discharges at springs, which may discharge beneath standing bodies of water. Groundwater velocities in the conduit networks are typically high – several hundred feet per day are common.

The dolomite beneath the Site appears to be perennially saturated. Groundwater in the dolomite is recharged by seepage from the overlying overburden. While at the Site that seepage occurs largely through till, Snavely (1980) notes that much of the limestone and dolomite in the Fishkill-Beacon area is overlain by permeable sand and gravel that readily transmits water to these rocks.

The hydraulic conductivity of the dolomite was estimated from 63 slug tests conducted in 27 monitoring wells by Parsons (2007, 2009b). The geometric mean hydraulic conductivity is 2.3×10^{-4} cm/sec. To provide additional estimates of hydraulic conductivity, Arcadis analyzed data collected during pumping tests conducted at monitoring wells SWMW-118 and SWMW-126 (Parsons 2009b). That analysis yielded estimated hydraulic conductivity values that varied considerably between the wells. At monitoring well SWMW-118, where downhole geophysics show that it screens a solution-widened fracture with an aperture of about 1.4 inches, the estimated hydraulic conductivity of the dolomite is estimated to be 2.2×10^{-3} cm/sec. At monitoring well SWMW-126, whose boring log describes the screened interval simply as "fracture at ~48 feet below ground surface," the estimated hydraulic conductivity of the dolomite is estimated to be 2.5×10^{-5} cm/sec – approximately 100 times less than at monitoring well SWMW-118. Details regarding the pumping-test analysis are provided in Appendix D.

Unlike the granitic gneiss, where conductivity values are likely biased high, the hydraulic conductivity values noted above for the dolomite are almost certainly biased low for several reasons:

- According to Ewers (2006), slug tests typically underestimate the hydraulic conductivity of karst aquifers by several orders of magnitude.
- Wide ranges of hydraulic conductivity values are common in karst aquifers. Because the various methods of conductivity measurement (e.g., core tests, slug tests, pumping tests) measure different portions of the aquifer permeability, they produce widely differing numbers in karst terranes. Apparent

values of hydraulic conductivity have been shown to range across 6 orders of magnitude in one aquifer when these different types of tests are applied (Ewers 2006).

- Many monitoring wells do not appear to have intercepted or been screened across solution features, the most transmissive elements of the aquifer permeability structure.
- In contrast to the granitic gneiss, the potentiometric surface is considerably less steep. The horizontal hydraulic gradient of the dolomite, as measured from monitoring well ITMW-03(B) to monitoring well SWMW-64(B) (Figure 2-6), is 0.025 foot per foot, nearly seven times less than measured for the granitic gneiss. Increased transmissivity (and hydraulic conductivity) tends to reduce the hydraulic gradient and “flatten” potentiometric surfaces.

Estimating the direction of groundwater movement in karst aquifers is extremely challenging. Flow directions at the site scale cannot be reliably inferred from potentiometric maps. Such inferences rely on the assumption that there is continuity of flow between all the monitoring wells used to draw the map. This assumption is not valid in karst aquifers (Ewers 2006). Groundwater movement occurs through the interconnected solution porosity (conduit network); therefore, knowledge of the geometry of the network would be required to accurately estimate groundwater flow directions. While remotely sensing or mapping the conduit network at most karst sites is technically impracticable, some useful inferences can be made:

- Conduits often form along geologic strike, which for the open fractures measured through borehole geophysics is aligned northeast-southwest, parallel to the fault.
- A trough in a potentiometric surface can indicate the presence and orientation of significant karst drainage features below.
- Dissolution is often enhanced at geologic contacts between soluble and insoluble rocks (e.g., the fault).

These observations suggest that movement of water in the dolomite will be favored toward the southwest, hydraulically down strike and will be constrained by the fault. Review of Figure 2-6 reveals a trough in the apparent potentiometric surface of the dolomite that parallels the fault. This feature may be somewhat enhanced by the presence of the Texaco Dam. Regardless, it is reasonable to infer that flow may be focused in this area.

Even though flow directions in the dolomite may not be exactly interpreted as reliably as in other (non-karst) settings, the fact that the Site lies directly along a regional groundwater discharge boundary (Fishkill Creek) and that the extent of the dolomite is constrained by the fault means that impacted groundwater in the dolomite is unlikely to travel far before it discharges into the creek. Much of that discharge may occur through subaqueous springs. As can also be seen on Figure 2-6, the potentiometric elevations in the dolomite on both sides of the creek are higher than the estimated creek elevation, demonstrating that Fishkill Creek is a groundwater discharge boundary. As discussed later in the report, this is consistent with available groundwater quality data that show that chlorinated solvents present in dolomite groundwater north of the creek are generally absent south of the creek.

Like the granitic gneiss, there are a few bedrock monitoring well clusters where vertical hydraulic gradients in the rock can be estimated. From that information, a downward hydraulic gradient from shallow to deeper bedrock is inferred to exist across most of the dolomite. An upward gradient must exist near and beneath the creek.

2.5 Human and Environmental Receptors

2.5.1 Current Receptors

All parcels are currently zoned under “PI - Planned Industrial” by the Dutchess County Department of Planning and Development. Surrounding properties are mostly zoned residential: R-15 and R-20 and Beacon Hills District, which is located to the southeast of the Back 93 Acre Parcel. The properties OU-1D and OU-3 are also designated as planned industrial; however, due to the surrounding land use and the current anticipated end land use, these properties are referred to in this RIR as “Residential Property” Parcels.

Much of the Site consists of undeveloped, vacant land. Most of the former TRCB buildings have been demolished. Currently, portions of the Main Facility (OU-1A) are used by the local landscaping contractor as a base of operations (e.g., landscaping material storage, vehicle storage, maintenance on equipment, etc.) near Buildings 58 and 83. A local utility company performs field efforts off site based out of a laydown and field trailer located on site (parking lot west of Building 50). In addition, regulatory agency personnel and Chevron contractors performing general field activities may be present on site. Based on the current land use, current receptors include occasional workers or potential trespassers.

2.5.1.1 Surrounding Land Use

Areas surrounding the Site consist of primarily residential properties and a few commercial properties to the northeast of the Site. These commercial properties include the Slater Chemical Fire Company and the Beacon Church of God, as well as several restaurants. These locations are considered upgradient from site sources and unlikely to be impacted by the TRCB operations.

A utility right-of-way property owned by Central Hudson Gas and Electric exists between the border of OU-1E and residential properties to the east. Residential properties exist immediately around the site OUs and primarily consist of single-family homes.

2.5.1.2 Surrounding Well Search Survey

This section presents two of the most recent well search surveys conducted at or near the Site. One of the surveys was conducted by Environmental Data Resources, Inc. (EDR 2010) and the second was conducted by Arcadis (Appendix E) in March 2020. The EDR survey was performed as part of a Phase I ESA for the Potter Brothers Property located immediately north of the Main Facility (OU-1A). Arcadis conducted a survey in 2020 as part of this RI.

The findings of both surveys were similar. The EDR survey identified 15 USGS water wells located within a 1-mile radius of the Potter Brothers property. The Main Facility (OU-1A) fell within the search radius. The closest well to the Site was less than 1/8 mile east of the Site. The well was installed by the USGS in 1959 and was reported to be approximately 81 feet deep. No other information was provided. Sixteen inactive USGS wells and seven New York State water wells were identified within a 1-mile radius of the site boundary.

Arcadis conducted a survey using the National Water Information System Mapper and by searching the New York State water well completion database. Results are provided in Appendix E. The survey identified 16 inactive USGS wells and seven New York State water wells within a 1-mile radius of the site limits. The additional USGS well identified in Arcadis' survey as compared to the EDR survey is attributed to the fact that the search areas were not identical; specifically, Arcadis' search radius was conducted from the perimeter of the entire Site whereas the EDR survey area was a 1-mile radius from a single point (the center of the Potter Brothers property), which resulted in a larger search area.

Based on the results of the surveys, the interpretation of groundwater flow presented in Section 2.4.2, and the fact that the Town of Fishkill has an ordinance that disallows any private wells within their municipality, impacted groundwater at the Site does not impact or pose a risk to the wells identified in the surveys.

2.5.2 Potential Future Receptors

Future land use differs depending on site topography, and unique environmental features of each parcel. All portions of the Site are being considered for potential reuse and/or development, except for OU-1F and OU-2. Currently exact future uses are unknown. Potential future receptors may include residents, commercial/industrial workers, recreational users, and trespassers.

3 SOIL INVESTIGATIONS AND DATA SUMMARY

This section identifies the criteria selected to screen soil analytical results, summarizes the various soil investigations performed at the former TRCB facility, and discusses the nature and extent of impacts to soils. All soil data collected on site have been compared to the Unrestricted Land Use SCO as required by NYSDEC DER-10 regulations within Section 3. Additional reference is included in the subsections to follow to indicate exceedances occurring above the Unrestricted Land Use SCOs. The highest applicable SCO criteria: Residential, Restricted-Residential, Commercial, or Industrial, are referenced if exceedances beyond Unrestricted SCOs are present. Table 1-1 describes the major COCs present at each OU in this medium. Logs of soil borings are provided in Appendix F. Analytical data tables are provided in Appendices G and H, with summary tables provided as Tables 3-1 through 3-14. Monitoring well boring logs are provided in Appendix B. When describing sampling locations in this section, location names will be followed with depth intervals in feet. For example: OU1ASB01 (0.17 to 0.5 ft bgs).

3.1 Selection of Screening Criteria

NYSDEC has issued guidance for screening of soil analytical results in the NYSDEC Title 6 of the Official Compilation of New York Codes of Rules and Regulations (6 NYCRR) Part 375, Environmental Remediation Programs, Subparts 375-1 to 375-4 and 375-6, as well as the NYSDEC Commissioner Policy-51 CP-51/Soil Cleanup Guidance DEC Policy (NYSDEC 2010b). Analytical data at the TRCB facility are compared to these cleanup criteria to identify which areas of the facility may exhibit potential environmental impacts. Land Use screening criteria are used to evaluate the potential risk to human health from soil impacts and determine what Land Use Restrictions may be needed following remedial action. The Unrestricted Land Use SCO represents concentration levels that require no Land Use restrictions and that are the most conservative levels. From most conservative to least, the restricted SCOs are as follows: Residential, Restricted-Residential, Commercial, and Industrial. Protection of Groundwater (POG) screening criteria are used to evaluate potential soil sources of impacts to groundwater. Protection of Ecological Resources (PER) screening criteria are considered when any ecological resources are present or will be present during future use and soil impacts at the Site may threaten these resources. The soil analytical data are compared to all possible SCOs in this RIR for clarity.

The criteria for each OU based on anticipated future use are presented in Table 1-1 and below:

Operable Unit	Applicable Soil Cleanup Objective Criteria Exceedances
OU-1A – Main Facility	Unrestricted, Residential, Restricted-Residential, Commercial, Industrial, POG
OU-1B – Church Property	Unrestricted, Residential, Restricted-Residential, Commercial, Industrial
OU-1C – WATF	Unrestricted, Residential, Restricted-Residential, Commercial, Industrial, POG
OU-1D – Rail Siding Area / Residential Property	Unrestricted, Residential, Restricted-Residential, Commercial, Industrial, POG
OU-1E – Back 93 Acre Recreation Area	Unrestricted, Residential, Restricted-Residential, Commercial, Industrial, POG
OU-3 – Residential Property	Unrestricted, Residential, Restricted-Residential, Commercial, Industrial, POG
OU-4 – Dam Facilities Parcel	Unrestricted, Residential, Restricted Residential, Commercial, Industrial, POG

3.2 Previous Investigations and Interim Corrective Measures

The following subsections briefly detail soil investigations that have taken place at the Site across all OUs and the ICM previously implemented. Section 3.3 details the results of these investigations with summaries of the data collected. Soil boring locations to be discussed are presented on Figures 3-1 and 3-2.

3.2.1 Interim Corrective Measure: Soil Excavation Area (2005 Through 2006)

An ICM was performed on the Back 93 Acre Parcel (OU-1E), in which impacted soil (primarily VOCs and SVOCs) and debris were excavated and properly disposed of offsite. Soil was excavated from former Trash Pile D and Chemical Burial Sites 1 and 3. Excavation bounds, post-excavation samples, and delineation samples are shown by the ITSS, ITSB, CBS, and SS borings on Figure 3-2. Confirmation soil sampling indicated all impacted materials were removed from the subsurface, except for some excavation sidewall locations within the Chemical Burial Site Number 3 area. The remedial objectives for this area were met in that the detected compounds left in place were restricted to a very limited area and were completed with a minimum 2 feet of soil cover. This area was acceptable to the NYSDEC and an NFA letter was issued for the project. Results of this investigation are presented in the Interim Corrective Measure: Soil Excavation Recreation Area Report (Parsons 2006a).

3.2.2 Interim Corrective Measure: Industrial Sewer System Line Abatement (2006)

Industrial Sewer System (ISS) subsurface piping located on the Main Facility (OU-1A) was abandoned by grouting piping in-place. As part of the ISS closure activities, soil samples were collected adjacent to piping to determine if piping may be left in place for closure. Analytical samples identified excessive PAH and mercury impacts, but no VOCs were detected. Results of this investigation are presented in the Interim Corrective Measure: Inactive Line Abandonment Report (Parsons 2006b). Following the completion and reporting efforts, NYSDEC issued an NFA letter for this line abandonment effort in 2006.

3.2.3 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) (2006 Through 2007)

Ninety-one soil borings were completed among the Main Facility (OU-1A), former WATF parcel (OU-1C), and a section (service road) of OU-4. SWSL/SWMW borings related to the RFI are shown on Figure 3-1. Borings were completed to depths ranging from 1.5 to 16 ft bgs. Results of this investigation are presented in the Sitewide RFI Report (Parsons 2007).

3.2.4 RCRA Supplemental RFI Facility Investigation (RFI) (2008 Through 2009)

Seventeen soil borings were completed on the Church Property (OU-1B) and 31 soil borings were completed within the Main Facility (OU-1A), former WATF parcel (OU-1C), and a section (service road) of OU-4. The Supplemental RFI Borings are denoted by the “CPGP” prefix and additional SWSL/SWMW borings on Figure 3-1. Borings were completed to depths ranging from 0.75 to 7.5 ft bgs at the Church Property (OU-1B), while borings were completed to depths ranging from 10 to 101 ft bgs among the Main Facility (OU-1A), former WATF parcel (OU-1C), and OU-4. Results of this investigation are presented in the Supplemental Sitewide RFI Report (Parsons 2009b).

3.2.5 Phase II Environmental Site Assessment (ESA) of the Potter Brothers Property (2010)

Eleven soil borings were completed on a parcel known as the “Potter Brothers Property,” which was located along the northern parcel boundary of the Main Facility (OU-1A) (see Figure 3-1, PBSB borings). The soil borings were installed to evaluate the conditions identified in the Phase I ESA. Results of this investigation are presented in the Phase I and II ESA, Potter Brothers Property Report (Parsons 2010a).

3.2.6 Sitewide Soil Boring Investigation (2010)

Forty-eight soil borings were advanced on the Main Facility (OU-1A). The soil borings were completed to collect soil samples in areas on site where no soil sampling had been performed during previous subsurface investigations, assist in the development of conceptual site models, and assist in identifying potential remedial alternatives for the Site. These soil borings are depicted on Figure 3-1 as PGSB boring locations. Results of this investigation are presented in the Sitewide Soil Sampling Event Report (Parsons 2010b).

3.2.7 Environmental and Geotechnical Investigation (2010)

Seven soil borings were completed underneath the former Mill Buildings (OU-4) to evaluate the general soil quality. Results of this investigation are presented in the Environmental and Geotechnical Investigation Report, Former Mill Buildings 3 through 6 (Parsons 2011).

3.2.8 Undeveloped Property Area Subsurface Investigation (2012)

Sixteen soil borings were completed on an area known as the “Undeveloped Property Area.” The area was located on the southern side of Fishkill Creek on OU-4 and west of the former WATF. The soil locations are described on Figure 3-1 by the UDPSB borings. The soil borings were installed and sampled to characterize subsurface soil conditions that exist at the “Undeveloped Property Area.” Results of this investigation are presented in the Undeveloped Property Area, Subsurface Investigation Report (Parsons 2012).

3.2.9 Concrete Foundation Drilling Investigation (2012)

One hundred twenty-seven soil borings were completed on the Main Facility (OU-1A) to characterize subsurface soil conditions that existed underneath concrete foundations or basement slabs of former building structures that were demolished in 2011. Boring locations are denoted on Figure 3-1 by the PCFSB locations. Results of this investigation are presented in the Concrete Foundation Drilling Investigation Report (Parsons 2013b).

3.2.10 Additional Well Installation Investigation (Soil) (2013)

Six soil borings were completed on the Main Facility (OU-1A) to delineate VOC impacts at former Buildings 28/29, 42, and 52 following the Concrete Foundation Drilling Program, and delineate the groundwater impacts north of former Building 58. Results of this investigation are presented in the Groundwater Monitoring Well Installations Report (Parsons 2014b).

3.2.11 Data Gap Investigations (2017 and 2018)

In 2017, an initial soil investigation to address data gaps was conducted across all OUs on the Site. Identified data gaps in the 2017 field activities were covered during subsurface sampling in 2018. Borings are shown on Figures 3-1 and 3-2 by the OU-SB boring locations. Mercury speciation sampling was completed in conjunction with the Data Gap Investigations. Results of these investigations are presented in the Data Gap Investigation Report (Parsons 2019a)

3.2.11.1 Surface and Near-Surface Soil Sampling (2017-2018)

One hundred twenty-six soil borings were hand-augered at OU-1A, OU-1B, OU-1C, OU-1D, OU-1E, and OU-3, and 50 soil borings were hand-augered at designated background parcel locations (BG-1 through BG-5) during 2017 field investigation activities (Parsons 2018). Forty-two soil borings were completed utilizing direct-push drilling methods (Geoprobe^{TM}) at OU-1A during 2018 field investigation activities. Surface soil samples were collected from on-site and background properties to address data gaps in the nature and extent of potential soil impacts on and off site, and to assess potential exposure of humans and ecological receptors to site-related constituents, per the 2017 Data Gap Investigation (Soil and Surface Water) Work Plan (Parsons 2017c).

3.2.11.2 Subsurface Soil Sampling (2018)

Twelve soil borings were completed at OU-1D, OU-1E, and OU-3 to address data gaps in vertical delineation that were identified after examination of data from 2017 field activities. Soil borings were installed to collect subsurface soil samples (samples collected between 2 to 15 ft bgs).

3.2.11.3 Mercury Speciation Sampling

Mercury toxicity is linked to its total concentration and is also dependent on the species. A mercury speciation analysis was completed to evaluate the species of mercury present at the facility (see Section 8 for more details). Seven soil borings were completed at OU-4 and six soil borings were completed at OU-1B at previous sampling locations to submit to the laboratory for mercury speciation analysis, where elevated total mercury concentrations were detected. Three soil borings were also advanced at each background parcel to submit to the laboratory for mercury speciation analysis.

3.3 Soil Analytical Data Summaries

Applicable screening values consist of the Unrestricted, Residential, Restricted-Residential, Commercial, and Industrial land use as well as POG SCOs presented in 6 NYCRR Part 375 (effective December 14, 2006) and the supplemental SCOs presented in the CP-51 Soil Cleanup Guidance (NYSDEC 2010b). An evaluation of the PRT SCOs is provided in Section 7.

Per the NYCRR guidance, the screening considered surface (0 to 2 inches bgs), near-surface (2 inches bgs to 2 ft bgs), and subsurface soils (greater than 2 ft bgs). The following sections provide a summary of COCs detected in soil at concentrations greater than the land use SCOs during the soil investigations conducted at the former TRCB facility.

Acetone was reported over a range of concentrations in environmental samples collected from eight of the OUs at the TRCB (all except OU-2). The reported results were validated, and the validations were discussed in previously submitted DUSRs. Most of the data met quality requirements; however, there were instances where laboratory analyses of acetone were qualified due to poor relative standard deviation values calculated for initial calibrations (negative impact on accuracy and precision), elevated laboratory control sample recoveries (high bias on reported results), and unacceptable precision on field duplicates (negative impact on precision). These observations are present within the 2018 Data Gap Investigation soil results data (Parsons 2019a).

In addition, given site history, the acetone detections reported at some locations, for example the former operations area (OU-1A), are potentially consistent with the use of acetone and may require further remedy. However, reported acetone concentrations for the majority of the undeveloped property south and west of the operations area (OU-1B, OU-1D, OU-1E, OU-3, and the southern portion of OU-4) are not consistent with the use of acetone. Therefore, Chevron is prepared to complete an additional evaluation and analysis during the Feasibility Study remediation phase.

Summaries of screening results are presented in Tables 3-1A through 3-1K. Analytical data are provided in Appendix G, and soil boring locations are shown on Figures 3-1 and 3-2. Soil exceedances for specific analytes are provided on Figures 3-3(A-K) through 3-9.

3.3.1 OU-1A Parcel (Main Facility)

Stratigraphy at OU-1A is generally composed of fill and glacial till. These unconsolidated deposits are typically silts and fine- to medium-grained sands with varying minor amounts of fine gravels and clay. As previously noted, the fill often contains building debris, asphalt, coal fragments, cinders, and/or ash. Summaries of screening results are presented in Tables 3-1A through 3-1C. Analytical data are provided in Appendix G-1, and soil boring locations are shown on Figure 3-1. Soil exceedance areas for specific analytes described in this section are provided on Figures 3-3A through 3-3K and Figures 3-10A through 3-10GG.

3.3.1.1 Surface Soil (0-2”)

A summary of soil concentrations in OU-1A surface soil compared to the SCOs is presented in Table 3-1A. COCs detected in surface soil at OU-1A at concentrations greater than the Unrestricted SCO include SVOCs, pesticides, polychlorinated biphenyls (PCBs), and metals.

SVOCs are not detected or are detected at concentrations less than the Unrestricted SCO in over 80% of the surface soil samples. SVOCs, primarily PAHs, detected across OU-1A in surface soil at concentrations greater than the land use SCOs are shown on Figure 3-3D. Areas showingseveral of the most prevalent PAHs are presented on Figures 3-10X and 3-10Y (dibenz(a,h)anthracene), 3-10CC and 3-10DD (benzo(a)pyrene), and 3-10EE and 3-10GG (benzo(b)fluoranthene). PAHs are present in soil at concentrations greater than the Commercial and Industrial SCOs in isolated areas of the Site.

Pesticides (4,4-dichlorodiphenyldichloroethylene [4,4-DDE], 4,4-dichlorodiphenyltrichloroethane [4,4-DDT]) were detected at concentrations above Unrestricted SCOs at three soil borings (OU1ASB04, OU1ASB11, and OUSB032) as shown on Figure 3-3G. 4,4-DDT and 4,4-DDE distributions are depicted on Figures 3-10T through 3-10W. Pesticides were not detected at concentrations greater than other land use SCOs in surface soil at OU-1A.

PCBs have been detected at OU1ASB04. Aroclor 1248 was detected at a depth interval of 0.0 to 0.17 feet. Aroclor 1254 was detected at a depth interval of 0.0 to 0.17 feet. PCBs were only detected greater than the Unrestricted SCO and did not exceed any of the other land use SCOs.

Arsenic is the most commonly detected potentially site-related metal COC at concentrations above the land use SCOs at 15 of 43 surface soil borings isolated throughout the eastern, western, and northern borders of parcel OU-1A and a few spots near Building 30 and Building 37 (center of OU-1A). Arsenic results are presented on Figure 3-3H. Arsenic distribution is illustrated on Figure 3-10P and 3-10S. Lead and mercury were detected at concentrations above the Unrestricted SCO at soil borings located on the eastern and western sides of the parcel. There were a few isolated detections around the southern part of OU-1A near the border of OU-4 and the Mill Buildings, but concentrations were infrequently greater than Industrial l SCOs. Lead and mercury results are presented on Figure 3-3J and the distribution of each is illustrated on Figures 3-10B and 3-10C (lead) and Figure 3-10A (mercury). Zinc was detected at concentrations above the Unrestricted SCOs at approximately 50% of soil borings throughout parcel OU-1A but was not detected in any borings greater than the Residential SCOs. Zinc distribution on site is depicted on Figures 3-10M and 3-10O. Iron was detected at every surface soil sample greater than the supplemental Residential SCO. Barium and lead are detected at concentrations greater than the Commercial SCOs. Arsenic and mercury are detected at concentrations greater than the Industrial SCOs.

COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	0.04 - 22	Industrial	6/43
Benzo(a)pyrene	**1**	0.009 - 23	Industrial	6/43
Benzo(b)fluoranthene	**1**	0.062 - 30	Industrial	8/43
Benzo(k)fluoranthene	**0.8**	0.027 - 12	Restricted-Residential	6/43
Chrysene	**1**	0.068 - 24	Restricted-Residential	7/43
Dibenz(a,h)anthracene	**0.33**	0.019 - 3.4	Industrial	5/43
Indeno(1,2,3-cd)pyrene	**0.5**	0.036 - 14	Industrial	8/43
Polychlorinated Biphenyls				
Aroclor 1248	**0.1**	0.15 - 0.15	Unrestricted	1/4
Aroclor 1254	**0.1**	0.0063 - 0.21	Unrestricted	1/4
Pesticides				
4,4-DDE	**0.0033**	0.00078 - 1.3	Unrestricted	2/4
4,4-DDT	**0.0033**	0.00091 - 0.23	Unrestricted	3/4
ENDRIN	**0.014**	0.032 - 0.032	Unrestricted	1/12
Metals				
Arsenic	**13**	5.37 - 218	Industrial	20/43
Barium	**350**	3.31 - 410	Commercial	1/43
Chromium	**30**	2.89 - 52.1	Residential	5/43
Copper	**50**	1.86 - 77.6	Unrestricted	3/43
Iron	**2000***	3020 - 30800	Residential	43/43
Lead	**63**	6.45 - 1300	Commercial	19/43
Manganese	**1600**	125 - 2380	Restricted-Residential	1/43
Nickel	**30**	1.63 - 143	Residential	4/43
Vanadium	**100***	4.16 - 222	Residential	1/43
Zinc	**109**	2.06 - 597	Unrestricted	20/43
Mercury	**0.18**	0.0392 - 18.2	Industrial	17/43

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria
SCO units in mg/kg

3.3.1.2 Near-Surface Soil (2”-24”)

A summary of soil concentrations in OU-1A near-surface soil compared to the SCOs is presented in Table 3-1B. COCs detected in near-surface soil at OU-1A at concentrations greater than the Unrestricted SCO include VOCs, SVOCs, pesticides, PCBs, and metals.

VOCs were typically not detected in near-surface soil samples, except for acetone, which has been detected nearly everywhere on site (Figure 3-10Z and 3-10BB). Benzene and carbon tetrachloride (CT) were the only VOCs detected at concentrations greater than the Residential SCO and were each detected in only one out of 187 samples.

PAH SVOCs were frequently detected in near-surface soil, but only at concentrations greater than Unrestricted SCOs in approximately 10% of samples. Benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were also detected at concentrations greater than the Industrial SCOs. These borings are located through the northern border of the parcel, isolated spots near former buildings B-38, B-45, B-68, and near School Street. PAH detections greater than SCOs are presented on Figure 3-3E. Figures 3-10X and 3-10Y (dibenz(a,h)anthracene), 3-10CC and 3-10DD (benzo(a)pyrene), and 3-10EE and 3-10GG (benzo(b)fluoranthene).

Pesticides (4,4-dichlorodiphenyldichloroethane [4,4-DDD], 4,4-DDE, and 4,4-DDT) were detected at concentrations above Unrestricted SCOs at multiple soil borings as shown on Figure 3-3G. 4,4-DDT and 4,4-DDE distributions are depicted on Figures 3-10T through 3-10W. Pesticides were detected at concentrations less than Residential SCOs in near-surface soil at OU-1A.

PCBs were detected in one sample out of 20 at a concentration greater than the Unrestricted SCO but less than Residential SCOs.

Arsenic, lead, and mercury were the most commonly detected potentially site-related metal COCs at concentrations above the land use SCOs. Arsenic results are presented on Figure 3-3H and lead and mercury results are presented on Figure 3-3J. The distribution of arsenic, lead and mercury is illustrated on Figures 3-10P and 3-10S (arsenic), 3-10B and 3-10C (lead), and 3-10A (mercury). Arsenic has been detected at this OU above the Industrial SCO. Lead and mercury were detected at concentrations above the Unrestricted SCOs at soil borings located at the eastern and western sides of the parcel and a few isolated around the southern part of OU-1A near the border of OU-4 near the Mill Buildings but infrequently detected greater than Commercial (lead) or Industrial (mercury) SCOs. Zinc was detected at concentrations above the Unrestricted SCOs at approximately 30% of near-surface soil samples throughout parcel OU-1A but was not detected in any borings greater than the Residential SCOs. Zinc distribution is depicted on Figures 3-10M and 3-10O. Iron was detected at every surface soil sample greater than the supplemental Residential SCO. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
1,1,1-Trichloroethane	**0.68**	0.0006 - 1.5	Unrestricted	1/187
1,2-Dichloroethane	**0.02**	0.0006 - 0.11	Unrestricted	2/187
Acetone	**0.05**	0.009 - 0.39	Unrestricted	106/177
Benzene	**0.06**	0.0005 - 9.2	Restricted-Residential	5/187
Carbon Tetrachloride	**0.76**	0.0008 - 61	Industrial	1/187
Chloroform	**0.37**	0.0007 - 5.1	Unrestricted	2/187
Ethylbenzene	**1**	0.0006 - 2.3	Unrestricted	2/187
Toluene	**0.7**	0.0006 - 11	Unrestricted	4/187
Xylene (total)	**0.26**	0.003 - 30	Unrestricted	7/187
Semi-volatile Organic Compounds				
4-Methylphenol (p-Cresol)	**0.33**	0.024 - 0.47	Unrestricted	4/168
Benzo(a)anthracene	**1**	0.004 - 40	Industrial	17/190
Benzo(a)pyrene	**1**	0.004 - 38	Industrial	17/190
Benzo(b)fluoranthene	**1**	0.006 - 48	Industrial	20/190
Benzo(k)fluoranthene	**0.8**	0.004 - 18	Restricted-Residential	15/190
Chrysene	**1**	0.005 - 42	Restricted-Residential	19/190
Dibenz(a,h)anthracene	**0.33**	0.004 - 6.7	Industrial	13/189
Indeno(1,2,3-cd)pyrene	**0.5**	0.004 - 21	Industrial	21/190
Polychlorinated Biphenyls				
Aroclor 1248	**0.1**	0.29 - 0.29	Unrestricted	1/20
Aroclor 1254	**0.1**	0.0058 - 0.38	Unrestricted	1/20
Pesticides				
4,4-DDD*	**0.0033**	0.0043 - 0.0043	Unrestricted	1/13
4,4-DDE	**0.0033**	0.00047 - 1.4	Unrestricted	5/13
4,4-DDT	**0.0033**	0.0011 - 0.23	Unrestricted	5/13
Metals				
Arsenic	**13**	1.87 - 527	Industrial	62/172
Barium	**350**	13.2 - 423	Commercial	1/172
Chromium	**30**	5.72 - 440	Restricted-Residential	24/172
Cobalt	**30***	2.24 - 37.6	Residential	1/172
Copper	**50**	4.11 - 171	Unrestricted	15/172
Iron	**2000***	5490 - 103000	Residential	172/172
Lead	**63**	3.79 - 1100	Commercial	80/172
Manganese	**1600**	180 - 4630	Restricted-Residential	3/172
Nickel	**30**	1.97 - 53.2	Unrestricted	4/172
Vanadium	**100***	8.49 - 134	Residential	1/172

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Zinc	**109**	21.7 - 569	Unrestricted	54/172
Mercury	**0.18**	0.0144 - 7.98	Industrial	78/172

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.1.3 Subsurface Soil (>2')

A summary of soil concentrations in OU-1A subsurface soil compared to the SCOs is presented in Table 3-1C. COCs detected in subsurface soil at OU-1A at concentrations greater than the Unrestricted SCO include VOCs, SVOCs, and metals.

VOCs were typically not detected in subsurface soil samples. VOC concentrations detected greater than the Unrestricted SCO in subsurface soil are presented on Figures 3-3A and 3-3C. No VOCs were detected at concentrations less than Residential SCOs.

PAH SVOCs were also frequently detected in subsurface soil but at concentrations greater than Unrestricted SCOs in only approximately 10% of samples. Benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were also detected at concentrations greater than the Industrial SCOs. These borings are located through the northern border of the parcel, isolated spots near former buildings B-38, B-45, B-68, and near School Street. PAH detections greater than SCOs are presented on Figure 3-3F. Dibenz(a,h)anthracene distribution is illustrated on Figures 3-10X and 3-10Y.

Arsenic, lead, zinc, and mercury were the most commonly detected potentially site-related metal COCs at concentrations above the land use SCOs. Arsenic results are presented on Figure 3-3I. Arsenic distribution is illustrated on Figures 3-10P and 3-10S. Lead and mercury were infrequently detected greater than Industrial land use SCOs. Lead and mercury results are presented on Figure 3-3K, and the distribution of each is illustrated on Figures 3-10B and 3-10C (lead) and 3-10A (mercury). Lead and mercury were detected at concentrations above Unrestricted, and Restricted-Residential SCOs at various depths from multiple soil borings located on the eastern side of the parcel (near former buildings B-58 through B-42), isolated spots located near School Street, near former buildings B-1, B-41, and B-50. Zinc distribution is illustrated on Figures 3-10M and 3-10O. Zinc was detected at concentrations above the Unrestricted SCOs at approximately 30% of subsurface soil samples throughout parcel OU-1A but was not detected in any borings greater than the Residential land use SCOs.

Iron was detected at every surface soil sample greater than the supplemental Residential SCO.

COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
1,1 Dichloroethene	**0.33**	0.002 - 0.98	Unrestricted	1/367
1,1,1-Trichloroethane	**0.68**	0.001 - 6.5	Unrestricted	1/368
1,2-Dichlorobenzene (o-Dichlorobenzene)	**1.1**	0.006 - 53	Unrestricted	2/368
1,4-Dichlorobenzene	**1.8**	0.006 - 3.1	Unrestricted	2/368
Acetone	**0.05**	0.008 - 0.44	Unrestricted	9/353
Chlorobenzene	**1.1**	0.001 - 49	Unrestricted	9/368
Ethylbenzene	**1**	0.001 - 3.6	Unrestricted	6/369
Methylene chloride (Dichloromethane)	**0.05**	0.001 - 0.21	Unrestricted	4/368
Xylene (total)	**0.26**	0.001 - 37	Unrestricted	8/369
Semi-volatile Organic Compounds				
2-Methylphenol (o-Cresol)	**0.33**	0.39 - 0.65	Unrestricted	2/335
4-Methylphenol (p-Cresol)	**0.33**	0.029 - 2.1	Unrestricted	3/335
Benzo(a)anthracene	**1**	0.004 - 55	Industrial	26/368
Benzo(a)pyrene	**1**	0.004 - 43	Industrial	26/368
Benzo(b)fluoranthene	**1**	0.004 - 53	Industrial	27/368
Benzo(k)fluoranthene	**0.8**	0.004 - 21	Restricted-Residential	18/368
Chrysene	**1**	0.004 - 52	Restricted-Residential	28/368
Dibenz(a,h)anthracene	**0.33**	0.003 - 7.2	Industrial	14/368
Dibenzofuran	**7**	0.022 - 22	Residential	3/359
Fluoranthene	**100**	0.004 - 130	Restricted-Residential	2/368
Indeno(1,2,3-cd)pyrene	**0.5**	0.004 - 32	Industrial	28/367
Naphthalene	**12**	0.004 - 46	Unrestricted	3/370
Phenanthrene	**100**	0.004 - 170	Restricted-Residential	2/368
Phenol	**0.33**	0.027 - 1.4	Unrestricted	2/335
Pyrene	**100**	0.004 - 130	Restricted-Residential	2/368
Metals				
Arsenic	**13**	1.01 - 201	Industrial	44/337
Barium	**350**	7.62 - 374	Residential	2/337
Chromium	**30**	3.26 - 160	Residential	30/337
Copper	**50**	2.82 - 369	Commercial	17/337
Iron	**2000***	6270 - 67700	Residential	337/337
Lead	**63**	1.21 - 34100	Industrial	74/337
Manganese	**1600**	107 - 3630	Restricted-Residential	9/337
Nickel	**30**	1.2 - 80.7	Unrestricted	14/337
Selenium	**3.9**	0.807 - 6.67	Unrestricted	1/337
Silver	**2**	0.177 - 13	Unrestricted	6/337

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Vanadium	**100***	4.22 - 156	Residential	2/337
Zinc	**109**	12.7 - 580	Unrestricted	46/337
Mercury	**0.18**	0.0113 - 45.1	Industrial	69/337

Notes:

SCO: Soil Cleanup Objective

* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.1.4 OU-1A Discussion

At the Main Facility (OU-1A), soil impacts are attributed to activities at the laboratory buildings, ASTs, USTs, research operations and storage areas. Petroleum, coal products, chemicals that were tested for additives, and solvents have been used at OU-1A in connection with research operations. The most frequently detected COCs in soil at OU-1A are PAHs and arsenic.

SVOC impacts in soil are present on the west end of the parcel, along the lower sections of the parcel adjacent to Fishkill Creek downstream from the dam, and at a few isolated spots with surface soil impacts near the northern border and central region of the parcel. These isolated spots are delineated by clean borings. Surface soil impacts can be correlated with historical coal ash and debris used as fill materials to level parking lot areas at former Building 50 and Building 38 (GSC 2005). The SVOC exceedances in near surface and subsurface soil can be correlated with the fill used in this parcel, the possible drum storage area near Building 83 prior to its construction, slop-oil tank, lift stations and the sanitary holding basin inside former Building 45, and the former Building 55 area which was used as laboratory for fuel/lubricant testing. Near surface and subsurface soil samples exhibit areas of soil impacts at two locations: one at the lower section of the parcel near former Building 6 adjacent to Fishkill Creek exhibits areas of soil impacts and another on the southern end of former Building 55.

TAL Metal exceedances in soil are widespread at the west end of the parcel and correspond with the former Building 58/83 area operations, on the northern end of the parcel near the former Building 50 parking lot, on the northeastern side of former Building 26 and along the lower sections of the parcel along the Fishkill Creek downstream from the dam. A cluster of metals (lead and mercury) exceedances near the former Building 50 parking lot are related to the fill material in the area. Container Storage Building (Building 58/83 area) was permitted for the storage of hazardous waste, drummed wastes, spent solvents, and transfer of waste solvents to drums. A group of soil borings along Fishkill Creek near former Building 51 area exhibits exceedances near the groundwater plume in this area. Multiple soil borings clustered near the former Building 45/55 area exhibit exceedances near the groundwater plume. Mercury has been detected above Commercial and Industrial criteria at several soil borings and is likely due to liquid mercury used in instrumentation that was periodically disposed of in sinks and found in drain traps and piping connected to the Industrial Sewer System. Some of the metals detected in soil at the Site may be attributable to background concentrations. Additional evaluation of background conditions in comparison to detected site concentrations will be completed in a separate evaluation following submittal of the RIR to assess potential background contributions. This evaluation will be submitted prior to the Feasibility Study.

3.3.2 OU-1B Parcel (Church Property)

Stratigraphy at OU-1B generally consists of silt and a small amount of clay. Cinders, which is associated with fill, was also observed across OU-1B. Summaries of screening results are presented in Table 3-2A through 3-2C. Analytical data are provided in Appendix G-2, and soil boring locations are shown on Figure 3-1. Soil samples from the Church Parcel Investigation portion of the Supplemental RCRA Facility Investigation (CPGP) were taken prior to the separation of surface and near-surface soil, and so do not separate the first 6 inches of soil into intervals of 0 to 2 inches and 2 to 6 inches. Due to this, CPGP samples to be discussed will only be attributed to near-surface soil. Soil exceedance areas for specific analytes described in this section are provided on Figures 3-4A and 3-4B and Figures 3-10A through 3-10GG.

3.3.2.1 Surface Soil (0-2")

A summary of soil concentrations in OU-1B surface soil compared to the SCOs is presented in Table 3-2A. COCs detected in surface soil at OU-1B at concentrations greater than the Unrestricted SCO include SVOCs, pesticides, and metals.

SVOCs detected in OU-1B surface soil (benzo(b)fluoranthene and Indeno(1,2,3-cd)pyrene) were detected at only one location (OU1BSB11) at concentrations greater than the Unrestricted SCOs are shown on Figure 3-4A. SVOCs were not detected at concentrations greater than Industrial SCOs.

Pesticides (4,4-DDE, 4,4-DDT) were detected at concentrations above Unrestricted SCOs at all five soil borings. Pesticides were not detected at concentrations less than Residential SCOs in surface soil at OU-1B. 4,4-DDT, and 4,4-DDE distributions are depicted on Figures 3-10T through 3-10W.

Metals detected across OU-1B in surface soil at concentrations greater than the land use SCOs are shown on Figure 3-4B. Arsenic, lead, and mercury were the most commonly detected metals at concentrations above the Unrestricted SCOs. Metals results are presented on Figure 3-4B. The distribution of arsenic, lead and mercury is illustrated on Figures 3-10P and 3-10S (arsenic), 3-10B and 3-10C (lead), and 3-10A (mercury). Arsenic and manganese were the only metals detected at concentrations greater than the Restricted-Residential SCO, COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Semi-volatile Organic Compounds				
Benzo(b)fluoranthene	**1**	0.073 - 1.5	Restricted-Residential	1/13
Indeno(1,2,3-cd)pyrene	**0.5**	0.031 - 0.59	Restricted-Residential	1/13
Pesticides				
4,4-DDE	**0.0033**	0.0038 - 0.024	Unrestricted	5/5

4,4-DDT	**0.0033**	0.0048 - 0.018	Unrestricted	5/5
Metals				
Arsenic	**13**	7.91 - 21.8	Industrial	5/13
Iron	**2000***	13300 - 47700	Residential	13/13
Lead	**63**	57.5 - 263	Unrestricted	11/13
Manganese	**1600**	111 - 3170	Restricted-Residential	2/13
Nickel	**30**	17.4 - 32.6	Unrestricted	2/13
Vanadium	**100***	41.5 - 145	Residential	6/13
Zinc	**109**	40.8 - 236	Unrestricted	3/13
Mercury	**0.18**	0.123 - 0.544	Unrestricted	9/13

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.2.2 Near-Surface Soil (2”-24”)

A summary of soil concentrations in OU-1B near-surface soil compared to the SCOs is presented in Table 3-2B. COCs detected in surface soil at OU-1B at concentrations greater than the Unrestricted SCO include VOCs, SVOCs, pesticides, and metals.

VOCs (acetone and methylene chloride) were detected above the Unrestricted SCOs but did not exceed other land use SCOs. Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

SVOCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) detected in OU-1B near-surface soil at concentrations greater than the Unrestricted SCOs are shown on Figure 3-4A. SVOCs, other than benzo(a)pyrene, were not detected at concentrations greater than Commercial or Industrial SCOs.

Pesticides (4,4-DDD, 4,4-DDE, and 4,4-DDT) have been detected above Unrestricted SCOs at numerous borings on OU-1B. Pesticides were detected at concentrations less than Residential SCOs in surface soil at OU-1B. 4,4-DDT and 4,4-DDE distributions are depicted on Figures 3-10T through 3-10W.

Metals detected across OU-1B in surface soil at concentrations greater than the land use SCOs are shown on Figure 3-4B. Arsenic, lead, and mercury were the most commonly detected metals at concentrations above the Unrestricted SCOs. Metals results are presented on Figure 3-4B. The distribution of arsenic, lead, manganese, and mercury is illustrated on Figures 3-10P and 3-10S (arsenic), 3-10B and 3-10C (lead), 3-10J and 3-10L (manganese), and 3-10A (mercury). COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.008 - 0.25	Unrestricted	12/48
Methylene chloride (Dichloromethane)	**0.05**	0.012 - 0.092	Unrestricted	2/48
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	0.004 - 2.3	Restricted-Residential	3/76
Benzo(a)pyrene	**1**	0.004 - 2.2	Industrial	3/76
Benzo(b)fluoranthene	**1**	0.005 - 3.2	Restricted-Residential	4/76
Benzo(k)fluoranthene	**0.8**	0.004 - 1.1	Residential	2/76
Chrysene	**1**	0.004 - 2.4	Residential	3/76
Dibenz(a,h)anthracene	**0.33**	0.005 - 0.39	Restricted-Residential	1/76
Indeno(1,2,3-cd)pyrene	**0.5**	0.004 - 1.5	Restricted-Residential	5/76
Pesticides				
4,4-DDD	**0.0033**	0.00064 - 0.0061	Unrestricted	2/49
4,4-DDE	**0.0033**	0.00049 - 0.059	Unrestricted	28/49
4,4-DDT	**0.0033**	0.00045 - 0.073	Unrestricted	23/49
Metals				
Arsenic	**13**	3.8 - 34	Industrial	12/76
Chromium	**30**	11.3 - 61.7	Residential	4/76
Copper	**50**	11.3 - 112	Unrestricted	12/76
Iron	**2000***	10300 - 95300	Residential	76/76
Lead	**63**	13.1 - 564	Restricted-Residential	31/76
Manganese	**1600**	121 - 5270	Restricted-Residential	9/76
Nickel	**30**	13.1 - 89.9	Unrestricted	6/76
Selenium	**3.9**	0.291 - 5.04	Unrestricted	1/76
Silver	**2**	0.0305 - 2.93	Unrestricted	1/76
Vanadium	**100***	14 - 135	Residential	3/76
Zinc	**109**	32.9 - 804	Residential	13/76
Mercury	**0.18**	0.0293 - 0.734	Unrestricted	39/94

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.2.3 OU-1B Discussion

There is no clear evidence of the source of impacts at the OU-1B parcel and analyte exceedances appear not to be related to TRCB operations at the main facility.

According to historical investigations, the Site was the location of textile and woolen mills from 1811 until 1930. The mills were powered by water wheels and steam engines and the textile operations maintained their own coal to gas production facility requiring more than 3,000 tons of coal annually (Parsons 2007).

The identified PAH compounds are those that are expected to be found where fossil fuel burning has historically taken place or coal cinders and ash have been disposed of. In addition, coal related substances have been identified in boring logs at soil locations CPGP-01, CPGP-02 and CPGP-03. These borings are located to the southern portion of the parcel bounding to the Metro-North Railroad and parcel OU-1A where PAH containing historical fill was possibly used for an access road construction in that area.

Concentrations of lead, mercury, and arsenic are generally uniformly distributed at the parcel. Some of the metals detected in soil at the Site may be attributable to background concentrations. A comparison of OU soil data to background conditions will be completed prior to the Feasibility Study.

Since there is no record of pesticide manufacturing or handling at the main facility or at the parcel, pesticide exceedances are potentially remnant of past use in the area and not related to former site operations.

3.3.3 OU-1C Parcel (Former Washington Avenue Tank Farm)

Stratigraphy at OU-1C consists of till overlain by a discontinuous layer of glaciolacustrine silt and clay. Fluvial and alluvial sediments associated with Fishkill Creek overlay the till or glaciolacustrine silt and clay. Additionally, fill is commonly found across the parcel. The fill, till, and alluvium are comprised of silts and sands with varying minor amounts of fine gravels and clay. Summaries of screening results are presented in Tables 3-3A through 3-3D. Analytical data are provided in Appendix G-3, and soil boring locations are shown on Figure 3-1. Soil exceedance areas for specific analytes described in this section are provided on Figures 3-5A through 3-5D and Figures 3-10A through 3-10GG.

3.3.3.1 Surface Soil (0-2”)

A summary of soil concentrations in OU-1C surface soil compared to the SCOs is presented in Table 3-3A. COCs detected in surface soil at OU-1C at concentrations greater than the Unrestricted SCO include SVOCs, pesticides, and metals.

One SVOC (phenol) was detected in surface soil above the Unrestricted SCOs but less than Residential SCOs at one surface sample (OU1CSB16).

One pesticide (4,4-DDT) was detected in surface soil above the Unrestricted SCOs at one boring (OU1CSB01) and were detected at concentrations less than Residential SCOs in surface soil at OU-1C. 4,4-DDT distribution is depicted on Figures 3-10T and 3-10W.

TAL Metals (arsenic, chromium, copper, iron, lead, mercury, nickel, selenium, and zinc) were detected at concentrations in exceedance of the NYSDEC 6 NYCRR Unrestricted SCOs at 16 soil borings at OU-1C as presented on Figure 3-5C. Arsenic was the only metal detected above Commercial or Industrial SCOs. Arsenic distribution is illustrated on Figures 3-10P and 3-10S. Lead and mercury concentrations are illustrated on Figures 3-10B and 3-10C (lead) and 3-10A (mercury). COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Semi-volatile Organic Compounds				
Phenol	**0.33**	0.4 - 0.4	Unrestricted	1/16
Pesticides				
4,4-DDT	**0.0033**	0.00076 - 0.0042	Unrestricted	1/2
Metals				
Arsenic	**13**	7.67 - 426	Industrial	12/16
Chromium	**30**	12.3 - 89.4	Residential	5/16
Copper	**50**	21.1 - 73.3	Unrestricted	3/16
Iron	**2000***	15900 - 33800	Residential	16/16
Lead	**63**	37.7 - 645	Restricted-Residential	9/16
Nickel	**30**	14.7 - 40.3	Unrestricted	6/16
Zinc	**109**	82.3 - 437	Unrestricted	13/16
Mercury	**0.18**	0.1 - 1.23	Restricted-Residential	11/16

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.3.2 Near-Surface Soil (2”-24”)

A summary of soil concentrations in OU-1C near-surface soil compared to the SCOs is presented in Table 3-3B. COCs detected in surface soil at OU-1C at concentrations greater than the Unrestricted SCO include VOCs and metals.

One VOC (acetone) was detected in near-surface soil above the Unrestricted SCO. Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

One pesticide (4,4-DDT) was detected in near-surface soil above the Unrestricted SCOs at one boring (OU1CSB01, 0.17 to 0.5 ft bgs). Pesticides did not expand beyond this solitary boring, so this may be considered an isolated hotspot. 4,4-DDT distribution is depicted on Figures 3-10T and 3-10U.

TAL Metals (arsenic, chromium, copper, iron, lead, mercury, nickel, selenium, and zinc) were detected at concentrations in exceedance of the Unrestricted SCOs. Arsenic was the only metal detected at concentrations greater than the Commercial or Industrial SCO. The distribution of arsenic, lead and mercury is illustrated on Figures 3-10P and 3-10S (arsenic), 3-10B and 3-10C (lead), and 3-10A (mercury). COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.022 - 0.29	Unrestricted	42/51
Pesticides				
4,4-DDT	**0.0033**	0.00048 - 0.0035	Unrestricted	1/6
Metals				
Arsenic	**13**	3.3 - 506	Industrial	36/51
Chromium	**30**	14.6 - 189	Restricted-Residential	8/51
Copper	**50**	13 - 137	Unrestricted	8/51
Lead	**63**	13.6 - 665	Restricted-Residential	19/51
Manganese	**1600**	280 - 2730	Restricted-Residential	1/51
Nickel	**30**	12.7 - 70.4	Unrestricted	10/51
Selenium	**3.9**	0.131 - 30.9	Unrestricted	1/51
Zinc	**109**	43.8 - 659	Unrestricted	26/51
Mercury	**0.18**	0.0261 - 1.47	Restricted-Residential	21/51

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.3.3 Subsurface Soil (>2')

A summary of soil concentrations in OU-1C subsurface soil compared to the SCOs is presented in Table 3-3C. COCs detected in surface soil at OU-1C at concentrations greater than the Unrestricted SCO include VOCs and metals.

Five VOCs (acetone, benzene toluene, ethylbenzene, and xylene) were detected exceeding the Unrestricted SCOs in less than 25% of subsurface soil samples. Only ethylbenzene and xylene exceed the Residential or Restricted-Residential SCOs and only at one soil boring. VOC subsurface soil exceedances are presented on Figure 3-5A. No VOCs were detected greater than Commercial or Industrial SCOs.

Three SVOCs (2-methylnaphthalene, benzo(b)fluoranthene, and naphthalene) were detected in subsurface soil above Unrestricted or supplemental Residential SCOs. SVOC subsurface soil exceedances are presented on Figure 3-5B. No SVOCs were detected greater than Commercial or Industrial SCOs.

TAL Metals (arsenic, copper, iron, lead, manganese, nickel, zinc, and mercury) have been infrequently detected at various points in subsurface soil above Unrestricted SCOs. Metals subsurface soil exceedances are presented on Figure 3-5D. Arsenic was the only metal detected at concentrations greater than the Commercial or Industrial SCOs. Arsenic distribution is illustrated on Figure 3-10P and 10S. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.038 - 5.7	Unrestricted	5/23
Benzene	**0.06**	0.002 - 0.98	Unrestricted	2/23
Ethylbenzene	**1**	0.002 - 63	Restricted-Residential	3/23
Toluene	**0.7**	0.002 - 1.7	Unrestricted	1/23
Xylene (total)	**0.26**	0.002 - 230	Restricted-Residential	5/23
Semi-volatile Organic Compounds				
2-Methylnaphthalene	**0.41***	0.039 - 26	Residential	23-Apr
Benzo(b)fluoranthene	**1**	0.19 - 1.2	Restricted-Residential	1/23
Naphthalene	**12**	0.042 - 13	Unrestricted	1/23
Metals				
Arsenic	**13**	2.97 - 48.8	Industrial	3/23
Chromium	**30**	12 - 47.4	Residential	1/23
Copper	**50**	15.5 - 104	Unrestricted	2/23
Lead	**63**	7.8 - 87.4	Unrestricted	4/23
Manganese	**1600**	173 - 2040	Restricted-Residential	1/23
Nickel	**30**	14.5 - 33.1	Unrestricted	1/23
Zinc	**109**	55.1 - 318	Unrestricted	1/23
Mercury	**0.18**	0.0143 - 0.203	Unrestricted	2/23

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.3.4 OU-1C Discussion

At the WATF parcel, impacts were primarily caused by leaks from the underground piping and ASTs. These tanks have since been decommissioned and removed, along with the piping.

As part of the tank removal and remediation, impacted soils have been excavated and remediated via soil cell bioremediation. Trenching for the groundwater remediation system and pipeline excavations also worked to remediate surface and near-surface soils on site (IT Corporation 2000b). LNAPL has been detected in groundwater at SWMW-21 and has historically been remediated in the area of the WATF. Therefore, exceedances of VOCs and SVOCs are likely related to the LNAPL detections and leakages from the former tank farm.

Arsenic is present at this OU, and other TAL Metals have been detected above SCOs. Other parameters in surface and near surface soils are limited and do not exceed Land Use SCOs other than Unrestricted SCOs. Some of the metals detected in soil at the Site may be attributable to background concentrations. A comparison of OU soil data to background conditions will be completed prior to the Feasibility Study.

Additionally, pesticide exceedances are likely a remnant of pesticide use near the Site, as there is no record of pesticides having been used, manufactured, or studied at the facility.

3.3.4 OU-1D Parcel (Residential Property and Rail Siding Area)

Stratigraphy generally consists of silts and fine to medium grained sands with minor amounts of coarse-grained sand, fine to coarse gravels, and clay. Summaries of screening results are presented in Tables 3-4A through 3-4C. Analytical data are detailed in Appendix G-4, and soil boring locations are shown on Figure 3-1. Soil exceedance areas for specific analytes described in this section are provided on Figures 3-6A and 3-6B and Figures 3-10A through 3-10GG.

3.3.4.1 Surface Soil (0-2”)

A summary of soil concentrations in OU-1D surface soil compared to the SCOs is presented in Table 3-4A. COCs detected in surface soil at OU-1D at concentrations greater than the Unrestricted SCO include SVOCs and metals.

PAHs (benzo(a)anthracene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene) were detected above Unrestricted SCOs at surface samples OU1DSB04 and OU1DSB06. These samples also had concentrations above the Residential and Restricted-Residential SCOs but there were no exceedances of the Commercial or Industrial SCOs. SVOC exceedances at OU-1D are presented on Figure 3-6A.

TAL Metals (arsenic, chromium, copper, iron, lead, mercury, nickel, and zinc) were detected at levels above the Unrestricted SCOs in eight borings in surface soil. Only arsenic was detected at concentrations greater than the Restricted-Residential, Commercial, and Industrial SCOs. Metals exceedances at OU-1D are presented on Figure 3-6B. Arsenic distribution is illustrated on Figures 3-10P and 3-10S. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	0.025 - 1.3	Restricted-Residential	1/11
Benzo(b)fluoranthene	**1**	0.036 - 1.9	Restricted-Residential	2/11
Chrysene	**1**	0.037 - 1.2	Residential	2/11

Indeno(1,2,3-cd)pyrene	**0.5**	0.016 - 0.75	Restricted-Residential	2/11
Metals				
Arsenic	**13**	5.99 - 96.4	Industrial	7/11
Chromium	**30**	14.8 - 54.6	Residential	1/11
Copper	**50**	23.4 - 51.6	Unrestricted	1/11
Lead	**63**	17.9 - 86.7	Unrestricted	5/11
Nickel	**30**	19.4 - 53.6	Unrestricted	3/11
Vanadium	**100***	21.5 - 237	Residential	1/11
Zinc	**109**	78.3 - 165	Unrestricted	4/11
Mercury	**0.18**	0.0572 - 0.592	Unrestricted	7/11

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.4.2 Near-Surface Soil (2”-24”)

A summary of soil concentrations in OU-1D near-surface soil compared to the SCOs is presented in Table 3-4B. COCs detected in near-surface soil at OU-1D at concentrations greater than the Unrestricted SCO include VOC, SVOCs, pesticides, and metals.

One VOC (acetone) was detected above the Unrestricted SCOs at three borings at OU1D.

PAHs (2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) at soil borings completed on OU-1D were infrequently detected at concentrations in exceedance of the Unrestricted SCOs at no more than five out of 35 samples. Benzo(a)pyrene was the only SVOC detected at concentrations greater than the Commercial or Industrial SCOs. SVOC exceedances at OU-1D are presented on Figure 3-6A.

Pesticides were detected infrequently in near-surface soil at concentrations greater than the Unrestricted SCOs and were detected less than Residential SCOs. 4,4-DDT and 4,4-DDE distributions are depicted on Figures 3-10T through 3-10W.

TAL Metals (arsenic, chromium, iron, lead, manganese, mercury, nickel, and zinc) were detected above the Unrestricted SCOs. Arsenic is the only metal detected at concentrations greater than the Commercial or Industrial SCOs. Metals exceedances at OU-1D are presented on Figure 3-6B. Arsenic distribution is illustrated on Figures 3-10P and 3-10S. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.045 - 0.13	Unrestricted	7/10
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	0.006 - 3	Restricted-Residential	3/35
Benzo(a)pyrene	**1**	0.007 - 2.4	Industrial	3/35
Benzo(b)fluoranthene	**1**	0.005 - 3.5	Restricted-Residential	5/35
Benzo(k)fluoranthene	**0.8**	0.005 - 1.6	Residential	3/35
Chrysene	**1**	0.008 - 3.3	Residential	3/35
Dibenz(a,h)anthracene	**0.33**	0.007 - 0.4	Restricted-Residential	3/35
Indeno(1,2,3-cd)pyrene	**0.5**	0.007 - 1.3	Restricted-Residential	5/35
Pesticides				
4,4-DDD	**0.0033**	0.0005 - 0.0039	Unrestricted	1/7
4,4-DDE	**0.0033**	0.0021 - 0.2	Unrestricted	3/7
4,4-DDT	**0.0033**	0.007 - 0.096	Unrestricted	7/7
Metals				
Arsenic	**13**	4.68 - 149	Industrial	20/35
Chromium	**30**	10.9 - 33.4	Unrestricted	1/35
Iron	**2000***	19000 - 47100	Residential	35/35
Lead	**63**	9.48 - 107	Unrestricted	7/35
Manganese	**1600**	385 - 2790	Restricted-Residential	1/35
Nickel	**30**	12.8 - 62.1	Unrestricted	3/35
Vanadium	**100***	14.1 - 508	Residential	3/35
Zinc	**109**	52.1 - 173	Unrestricted	3/35
Mercury	**0.18**	0.027 - 2.66	Restricted-Residential	18/35

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.4.3 Subsurface Soil (>2')

A summary of soil concentrations in OU-1D subsurface soil compared to the SCOs is presented in Table 3-4C. COCs detected in subsurface soil at OU-1D at concentrations greater than the Unrestricted SCO include VOCs, SVOCs and metals.

One VOC (Acetone) was detected at two soil borings on OU-1D above the Unrestricted SCOs. Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

PAHs (2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were detected infrequently at concentrations in exceedance of the Unrestricted SCOs in one to three soil samples. Only benzo(a)pyrene was detected at concentrations greater than the Commercial or Industrial SCOs, and only in one sample. SVOC exceedances at OU-1D are presented on Figure 3-6A.

TAL Metals (arsenic, iron, lead, mercury, and nickel) have been detected above Unrestricted or CP-51 Residential SCOs. Arsenic is the only metal with concentrations greater than the Industrial SCOs. Arsenic distribution is illustrated on Figures 3-10P and 3-10S. Iron has been detected above the Residential SCOs across the parcel. Metals exceedances at OU-1D are presented on Figure 3-6B. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	85 - 0.013	Unrestricted	2/13
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	32 - 0.005	Restricted-Residential	1/25
Benzo(a)pyrene	**1**	32 - 0.008	Industrial	1/25
Benzo(b)fluoranthene	**1**	36 - 0.004	Restricted-Residential	1/25
Benzo(k)fluoranthene	**0.8**	28 - 0.005	Residential	1/25
Chrysene	**1**	32 - 0.01	Restricted-Residential	2/25
Dibenz(a,h)anthracene	**0.33**	16 - 0.037	Restricted-Residential	1/25
Indeno(1,2,3-cd)pyrene	**0.5**	28 - 0.012	Restricted-Residential	1/25
Metals				
Arsenic	**13**	100 - 4.39	Industrial	3/25
Iron	**2000***	100 - 20000	Residential	25/25
Lead	**63**	100 - 8.5	Unrestricted	1/25
Nickel	**30**	100 - 13.8	Unrestricted	1/25
Mercury	**0.18**	28 - 0.0225	Unrestricted	2/25

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

SCO units in mg/kg

3.3.4.4 OU-1D Discussion

OU-1D lies to the south of a railroad line owned by the Metro-North Railroad. This parcel contains a rail siding area, which acted as an offload point for rail cars delivering petroleum products to the TRCB. Underground piping reportedly sent these materials to OU-1C and the main facility beneath the Metro-North Railroad. Additional structures included a spill containment basin, two fill ports, and a hose box. Impacts at OU-1D may be due to these operations.

Detections at the northern part of the parcel (OU1DSB03, OU1DSB04, and OU1DSB06) correspond with the locations of the fill ports and underground pipelines heading toward OU-1C. Subsurface PAH exceedances are likely an isolated hotspot, as there are no other subsurface impacts detected, and these impacts do not extend beyond the detected interval.

Metals exceedances are more widespread at OU-1D. Arsenic has been detected in surface, near-surface, and subsurface soil above the Industrial SCO at seven of the 11 borings present at OU-1D, and resemble similar concentrations as those at OU-1C and the northern portion of OU-1E. Some of the metals detected in soil at the Site may be attributable to background concentrations. A comparison of OU soil data to background conditions will be completed prior to the Feasibility Study.

3.3.5 OU-1E Parcel (Back 93 Acre)

Overburden at OU-1E is generally composed of till. The till is comprised of silts and fine to medium grained sands with minor amounts of coarse-grained sand, fine to coarse gravels, and/or clay. Additionally, clean fill was utilized to backfill areas that were excavated as part of past remediation activities. Summaries of screening results are presented in Tables 3-5A through 3-5C. Analytical data are detailed in Appendix G-5, and soil boring locations are shown on Figure 3-2. Soil exceedance areas for specific analytes described in this section are provided on Figures 3-7A and 3-7B and Figures 3-10A through 3-10GG.

3.3.5.1 Surface Soil (0-2”)

A summary of soil concentrations in OU-1E surface soil compared to the SCOs is presented in Table 3-5A. COCs detected in surface soil at OU-1E at concentrations greater than the Unrestricted SCO include SVOCs, pesticides, and metals.

SVOCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were detected above the Unrestricted SCOs in two out of 81 samples. SVOC concentrations in those two samples also exceed the Restricted Residential, Commercial, and Industrial SCOs. SVOC exceedances in soil at OU-1E are presented on Figure 3-7A.

4,4-DDE was detected above the Unrestricted SCOs at three borings but there were no exceedances of other land use SCOs for pesticides. 4,4-DDE distribution is depicted on Figures 3-10V and 3-10W.

TAL Metals (arsenic, chromium, iron, lead, manganese, mercury, nickel, vanadium, and zinc) have been detected above the Unrestricted SCOs at 22 surface samples across OU-1E. Most of these borings do not represent any areas of soil impacts. Exceedances vary based on parameter and may be considered representative of background. Arsenic at the north end of this OU may be related to arsenic detections at similar levels found in OU-1D and OU-1C exceedances. Mercury at OU1EFSB02 is isolated but may be related to the location of the former “New Sludge Lagoon.” Only arsenic was detected at concentrations greater than the Commercial or Industrial SCOs, and only manganese, vanadium and mercury were detected greater than the Residential or Restricted Residential SCOs, and those were only detected in one or two out of 81 samples. Metals exceedances in soil at OU-1E are limited and are presented on Figure 3-7B. The distribution of arsenic and mercury is illustrated on Figures 3-10P and 3-10S (arsenic) and 3-10A (mercury). COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	0.004 - 6.1	Commercial	2/81
Benzo(a)pyrene	**1**	0.006 - 7.3	Industrial	2/81
Benzo(b)fluoranthene	**1**	0.008 - 9.8	Commercial	2/81
Benzo(k)fluoranthene	**0.8**	0.004 - 4.5	Restricted-Residential	2/81
Chrysene	**1**	0.006 - 6.8	Restricted-Residential	2/81
Dibenz(a,h)anthracene	**0.33**	0.005 - 1.3	Industrial	2/81
Indeno(1,2,3-cd)pyrene	**0.5**	0.005 - 4.3	Restricted-Residential	2/81
Pesticides				
4,4-DDE	**0.0033**	0.00081 - 0.0039	Unrestricted	3/19
Metals				
Arsenic	**13**	4.56 - 84.4	Industrial	3/81
Chromium	**30**	9.65 - 34.7	Unrestricted	3/81
Iron	**2000***	13500 - 37900	Residential	81/81
Lead	**63**	11.4 - 65.2	Unrestricted	2/81
Manganese	**1600**	219 - 2620	Restricted-Residential	4/81
Nickel	**30**	12.9 - 52.2	Unrestricted	6/81
Vanadium	**100***	13.7 - 126	Residential	31/81
Zinc	**109**	55.9 - 196	Unrestricted	11/81
Mercury	**0.18**	0.028 - 1.28	Restricted-Residential	9/81

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.5.2 Near-Surface Soil (2”-24”)

A summary of soil concentrations in OU-1E near-surface soil compared to the SCOs is presented in Table 3-5B. COCs detected in near-surface soil at OU-1E at concentrations greater than the Unrestricted SCO include VOCs, SVOCs, pesticides, and metals.

Acetone was detected above the Unrestricted SCOs in most of the near-surface soil samples. Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and phenol) were only detected at concentrations greater than Unrestricted SCOs at in three samples out of 253 (locations OU1EESB01 and OU1EESB20). PAHs at this OU were not detected beyond 1 ft bgs. OU1EESB01 and OU1EESB20 are not located near each other and are representative of isolated detections. SVOC exceedances in soil at OU-1E are presented on Figure 3-7A.

4,4-DDE was detected above the Unrestricted SCOs at two borings out of 59. Pesticide detections did not extend beyond 0.5 ft bgs in this OU and were not detected above any other land use SCO. 4,4-DDE distribution is depicted on Figures 3-10V and 3-10W.

TAL Metals (arsenic, chromium, iron, lead, manganese, mercury, nickel, and zinc) have been infrequently detected above the Unrestricted SCOs across OU-1E, except for iron. Only arsenic is detected at concentrations greater than the Commercial or Industrial SCOs. Arsenic at the north end of this OU may be related to arsenic detections at similar levels found in OU-1D and OU-1C exceedances. Arsenic distribution is illustrated on Figures 3-10P and 3-10S. Mercury at OU1EFSB02 is isolated but may be related to the location of the former “New Sludge Lagoon.” Metals exceedances in soil at OU-1E are presented on Figure 3-7B. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.021 - 0.36	Unrestricted	70/87
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	0.004 - 6.2	Commercial	3/253
Benzo(a)pyrene	**1**	0.004 - 7	Industrial	3/253
Benzo(b)fluoranthene	**1**	0.004 - 9.4	Commercial	3/253
Benzo(k)fluoranthene	**0.8**	0.004 - 4	Restricted-Residential	3/253
Chrysene	**1**	0.004 - 6.6	Restricted-Residential	3/253
Dibenz(a,h)anthracene	**0.33**	0.004 - 1.1	Commercial	3/253
Indeno(1,2,3-cd)pyrene	**0.5**	0.004 - 4	Restricted-Residential	3/253
Phenol	**0.33**	0.034 - 0.65	Unrestricted	1/253
Pesticides				
4,4-DDE	**0.0033**	0.00043 - 0.0045	Unrestricted	2/59
Metals				
Arsenic	**13**	3.62 - 88.5	Industrial	6/253
Chromium	**30**	8.85 - 101	Residential	8/253
Iron	**2000***	13800 - 43600	Residential	253/253
Manganese	**1600**	193 - 4060	Restricted-Residential	2/253
Nickel	**30**	10.2 - 53.1	Unrestricted	14/253

Zinc	**109**	38.6 - 161	Unrestricted	7/253
Mercury	**0.18**	0.0207 - 0.886	Restricted-Residential	5/253

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.5.3 Subsurface Soil (>2')

A summary of soil concentrations in OU-1E subsurface soil compared to the SCOs is presented in Table 3-5C. COCs detected in subsurface soil at OU-1E at concentrations greater than the Unrestricted SCO include SVOCs and metals.

PAHs including 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene have been infrequently detected in Chemical Burial Site 3 post-excavation samples above the Unrestricted SCOs. Benzo(a)anthracene, benzo(a)pyrene, and dibenz(a,h)anthracene were detected in one sample greater than the Commercial and Industrial SCOs. SVOC exceedances in soil at OU-1E are presented on Figure 3-7A.

Chromium and iron were detected above the Unrestricted/CP-51 Residential SCOs. Metals exceedances in soil at OU-1E are presented on Figure 3-7B. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	0.006 - 12	Industrial	4/41
Benzo(a)pyrene	**1**	0.043 - 8.6	Industrial	1/41
Benzo(b)fluoranthene	**1**	0.01 - 11	Commercial	3/41
Benzo(k)fluoranthene	**0.8**	0.005 - 4.1	Restricted-Residential	1/41
Chrysene	**1**	0.004 - 11	Restricted-Residential	4/41
Dibenz(a,h)anthracene	**0.33**	0.014 - 2.1	Industrial	1/41
Indeno(1,2,3-cd)pyrene	**0.5**	0.038 - 5	Restricted-Residential	2/41
Metals				
Chromium	**30**	14.1 - 48.6	Residential	1/9

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.5.4 OU-1E Discussion

At the Back 93 Acre parcel, previous investigations and remedial actions have been undertaken to address the majority of the previous impacts. Former Sludge lagoons were closed and excavated, Chemical Burial sites were removed and excavated, and former trash piles were removed for both regulatory and aesthetic purposes.

Most current soil exceedances are unrelated to the former operations at the OU-1E parcel. One parameter (mercury) has been detected nearby a former sludge lagoon. Soil concentrations of arsenic and some PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Chrysene, Dibenz(a,h)anthracene, Indeno(1,2,3-cd)pyrene, and Phenol) on the northern end of OU-1E are similar to soil concentrations at OU-1C and OU-1D and may be related to the activities at these parcels.

3.3.6 OU-3 Parcel (Residential Property)

Overburden at OU-3 is generally composed of the same material present at OU-1D which is also located to the south of Fishkill Creek. The unconsolidated sediments were described as silts and fine to medium grained sands with minor amounts of coarse-grained sand, fine to coarse gravels, and/or clay Summaries of screening results are presented in Table 3-6A through 3-6C. Analytical data are detailed in Appendix G-6, and soil boring locations are shown on Figure 3-1. Soil exceedance areas for specific analytes described in this section are provided on Figure 3-8 and Figures 3-10A through 3-10GG.

Some of the metals detected in soil at the Site may be attributable to background concentrations. A comparison of OU soil data to background conditions will be completed prior to the Feasibility Study.

3.3.6.1 Surface Soil (0-2”)

A summary of soil concentrations in OU-3 surface soil compared to the SCOs is presented in Table 3-6A. COCs detected in surface soil at OU-3 at concentrations greater than the Unrestricted SCO include SVOCs, pesticides, and metals.

SVOCs (2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene) were detected above Unrestricted SCOs at one boring (OU3SB02). Benzo(a)pyrene concentration in this sample exceeds the Commercial and Industrial SCOs.

Two pesticides (4,4-DDE and 4,4-DDT) have been detected above Unrestricted SCOs at one soil boring (OU3SB04). 4,4-DDT was detected only in surface soil at OU-3. Pesticide concentrations do not exceed any other land use SCOs. 4,4-DDT and 4,4-DDE distributions are depicted on Figures 3-10T through 3-10W.

Mercury was detected in surface soil at OU-3 above the Unrestricted SCOs but no other land use SCOs at soil boring OU3SB03. Iron exceedances above Unrestricted SCOs occur across the parcel. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**1**	0.063 - 2.7	Restricted-Residential	1/5
Benzo(a)pyrene	**1**	0.071 - 1.9	Industrial	1/5
Benzo(b)fluoranthene	**1**	0.1 - 2.6	Restricted-Residential	1/5
Benzo(k)fluoranthene	**0.8**	0.037 - 1.1	Residential	1/5
Chrysene	**1**	0.088 - 2.4	Residential	1/5
Indeno(1,2,3-cd)pyrene	**0.5**	0.047 - 0.87	Restricted-Residential	1/5
Pesticides				
4,4-DDE	**0.0033**	0.011 - 0.011	Unrestricted	1/1
4,4-DDT	**0.0033**	0.004 - 0.004	Unrestricted	1/1
Metals				
Iron	**2000***	19300 - 24000	Residential	5/5
Mercury	**0.18**	0.113 - 0.217	Unrestricted	1/5

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.6.2 Near-Surface Soil (2”-24”)

A summary of soil concentrations in OU-3 near-surface soil compared to the SCOs is presented in Table 3-6B. COCs detected in near-surface soil at OU-3 at concentrations greater than the Unrestricted SCO include VOCs, pesticides, and metals.

Acetone was detected above Unrestricted SCOs at one soil boring, OUSB03. Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

One pesticide (4,4-DDE) has been detected above the Unrestricted SCOs at one soil boring: OU3SB04. Impacts did not extend beyond 1 ft bgs. 4,4-DDE distribution is depicted on Figures 3-10V and 3-10W.

Nickel has been detected above only the Unrestricted SCOs in one near-surface soil boring on OU-3: OU3SB05 (0.5 to 1, 1 to 2 ft bgs). Iron exceedances above Unrestricted SCOs occur across the parcel. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.047 - 0.053	Unrestricted	2/3
Pesticides				

4,4-DDE	**0.0033**	0.0019 - 0.0083	Unrestricted	3/4
Metals				
Iron	**2000***	17500 - 34900	Residential	16/16
Nickel	**30**	14.9 - 32.8	Unrestricted	2/16

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.6.3 Subsurface Soil (>2')

A summary of soil concentrations in OU-3 subsurface soil compared to the SCOs is presented in Table 3-6C. COCs detected in subsurface soil at OU-3 at concentrations greater than the Unrestricted SCO include VOCs and metals.

Acetone was detected above Unrestricted SCOs at one soil boring, OUSB02 (2 to 4 ft bgs). Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

Nickel has been detected above only the Unrestricted SCOs at two subsurface soil samples on OU-3: OU3SB05 (6 to 8, 12 to 14 ft bgs) and OU3SB02 (10 to 12, 14 to 16 ft bgs). Iron exceedances above Unrestricted SCOs occur across the parcel. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.013 - 0.079	Unrestricted	1/5
Metals				
Iron	**2000***	30900 - 34000	Residential	5/5
Nickel	**30**	29.5 - 32.4	Unrestricted	4/5

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.6.4 OU-3 Discussion

No TRCB operations took place on OU-3, and no current structures exist on this parcel. Previous investigations into this parcel did not reveal any potential sources derived from the TRCB; however, the eastern neighboring property reportedly had a pit for burning trash near the edge of their property, close to the OU3SB02 boring location. It is likely that the surface level PAHs present at OU3SB02 are due to this burn pit rather than TRCB operations.

The pesticide detections at OU3SB04 are not related to activities at the TRCB, and iron exceedances at all points are at similar levels to background concentrations.

Some of the metals detected in soil at the Site may be attributable to background concentrations. A comparison of OU soil data to background conditions will be completed prior to the Feasibility Study.

3.3.7 OU-4 Parcel (Hydroelectric Dam Property)

The overburden at OU-4 varies from the northern side of Fishkill Creek to the southern side of the creek. As described in Section 1.2.2.9, the boundary of OU-4 includes the hydroelectric building and the dam itself with access on the northern side via an easement to Old Glenham Road, and on the southern side via an access route to Washington Avenue. On the southern side of the creek and toward the west, the overburden at OU-4 is generally composed of approximately 6 inches of organic soil (roots) at the surface, underlain by silt with various amounts of clay with minor amounts of fine sand and fine to coarse gravel. On the northern side of the creek, the stratigraphy is the same as OU-1A (fill, silts and fine to medium grained sands with varying minor amounts of fine gravels and clay). Along the Washington Avenue easement, the overburden consists of fill, silts, and sands with minor amounts of gravel and clay. Summaries of screening results are presented in Tables 3-7A through 3-7C. Analytical data are presented in Appendix G-7, and soil boring locations are shown on Figure 3-1. Soil exceedance areas for specific analytes described in this section are provided on Figures 3-9A, 3-9B and Figures 3-10A through 3-10GG.

3.3.7.1 Surface Soil (0-2”)

A summary of soil concentrations in OU-4 surface soil compared to the SCOs is presented in Table 3-7A. COCs detected in surface soil at OU-4 at concentrations greater than the Unrestricted SCO include VOCs and metals.

Acetone in surface soil has been detected above the Unrestricted SCOs at six borings. Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

TAL Metals (arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, and zinc) have been detected above the Unrestricted SCOs at multiple borings across OU-4. The distribution of arsenic, lead and mercury is illustrated on Figures 3-10P and 3-10S (arsenic), 3-10B and 3-10C (lead), and 3-10A (mercury). Mercury detections occur at most surface borings at OU-4 above Unrestricted SCOs, but only three samples had concentrations greater than Residential/Restricted Residential SCOs and no samples exceeded Commercial or Industrial SCOs. One arsenic sample exceeded Commercial and Industrial SCOs. Metals exceedances at OU-4 are presented on Figure 3-9B. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.011 - 0.13	Unrestricted	6/16
Metals				
Arsenic	**13**	4.74 - 21	Industrial	1/16
Cadmium	**2.5**	0.16 - 3.36	Restricted-Residential	1/16
Chromium	**30**	10.3 - 5410	Commercial	3/16
Copper	**50**	14.7 - 1340	Commercial	2/16
Iron	**2000***	15800 - 60000	Residential	16/16
Lead	**63**	25.3 - 514	Restricted-Residential	3/16
Nickel	**30**	11.1 - 50.4	Unrestricted	8/16
Selenium	**3.9**	1.12 - 4.19	Unrestricted	1/16
Zinc	**109**	73.7 - 331	Unrestricted	7/16
Mercury	**0.18**	0.132 - 1.72	Restricted-Residential	13/16

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.7.2 Near-Surface Soil (2”-24”)

A summary of soil concentrations in OU-4 near-surface soil compared to the SCOs is presented in Table 3-7B. COCs detected in near-surface soil at OU-4 at concentrations greater than the Unrestricted SCO include VOCs, SVOCs, and metals.

Acetone has been detected above the Unrestricted SCO in near-surface soil in five samples and methylene chloride has also been detected in one sample. Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

SVOCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene) have been infrequently detected above the Unrestricted SCOs at one boring, UDPSB-16 (0.5 to 1 ft bgs). Benzo(a)pyrene exceeds the Industrial SCO at this location. SVOCs are not detected at concentrations greater than the Residential SCOs at other locations on this parcel. SVOC exceedances at OU-4 are presented on Figure 3-9A.

TAL Metals (primarily nickel and mercury) were detected at concentrations exceeding the Unrestricted SCOs in near-surface soil at multiple borings. Additionally, mercury has been detected in some of these borings exceeding the Restricted Residential SCOs. Metals exceedances at OU-4 are presented on Figure 3-9B. The distribution of nickel and mercury is illustrated on Figures 3-10D and 3-10I (nickel) and Figure 3-10A (mercury). COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.01 - 0.2	Unrestricted	5/43
Methylene chloride (Dichloromethane)	**0.05**	0.002 - 0.64	Unrestricted	1/43
Benzo(a)anthracene	**1**	0.005 - 1.5	Restricted-Residential	1/43
Benzo(a)pyrene	**1**	0.005 - 1.3	Industrial	1/43
Benzo(b)fluoranthene	**1**	0.005 - 1.4	Restricted-Residential	1/43
Chrysene	**1**	0.005 - 1.4	Residential	1/43
Indeno(1,2,3-cd)pyrene	**0.5**	0.004 - 0.67	Restricted-Residential	1/43
Phenol	**0.33**	0.03 - 0.6	Unrestricted	1/43
Metals				
Arsenic	**13**	1.5 - 15.4	Industrial	1/43
Chromium	**30**	14.7 - 413	Restricted-Residential	3/43
Copper	**50**	11.8 - 212	Unrestricted	2/43
Iron	**2000***	17800 - 57300	Residential	43/43
Lead	**63**	11.9 - 373	Unrestricted	3/43
Manganese	**1600**	266 - 1760	Unrestricted	1/43
Nickel	**30**	16.9 - 46	Unrestricted	14/43
Zinc	**109**	58.9 - 155	Unrestricted	3/43
Mercury	**0.18**	0.0151 - 1.75	Restricted-Residential	33/66

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.7.3 Subsurface Soil (>2')

A summary of soil concentrations in OU-4 subsurface soil compared to the SCOs is presented in Table 3-7C. COCs detected in subsurface soil at OU-4 at concentrations greater than the Unrestricted SCO include VOCs and metals.

Acetone has been detected above the Unrestricted SCOs in subsurface soil at one boring – UDPSB-09 (4 to 6 ft bgs). Acetone distribution is depicted on Figures 3-10Z and 3-10BB.

TAL Metals were detected infrequently in subsurface soil at OU-4 at concentrations greater than Unrestricted SCOs. Iron exceedances above Unrestricted SCOs occur across the parcel. Metals exceedances at OU-4 are presented on Figure 3-9B. COCs exceeding the Unrestricted SCOs are provided in the table below. In addition, this table provides the most restrictive land use SCO exceeded and a range of detections.

Parameter Name	Unrestricted Use Soil Cleanup Objectives	Detection Range	Most Restrictive SCO Exceeded	Unrestricted Exceedance Frequency
Volatile Organic Compounds				
Acetone	**0.05**	0.009 - 0.067	Unrestricted	1/19
Metals				
Chromium	**30**	5.7 - 293	Restricted-Residential	2/19
Copper	**50**	4.38 - 109	Unrestricted	1/19
Iron	**2000**	8740 - 52100	Residential	19/19
Lead	**63**	3.5 - 73.9	Unrestricted	1/19
Nickel	**30**	5.29 - 32.7	Unrestricted	3/19

Notes:

SCO: Soil Cleanup Objective
* Value taken from CP-51 Residential Criteria

All units in mg/kg

3.3.7.4 OU-4 Discussion

The OU-4 Parcel primarily includes the Mill Buildings within the area of the Main Facility parcel OU-1A, as well as an undeveloped parcel to the south of Fishkill Creek and an access route running between OU-1C and OU-1D. Soil investigations have been completed at the northern and southern portions of OU-4, and investigations of OU-1D and OU-1C have fulfilled investigations along the access route portion of OU-4. The Mill Buildings have been examined through Soil Vapor Investigations and are discussed in Section 6.

Soil impacts on OU-4 may be related to nearby activities on OU-1C and OU-1D as well as use and maintenance of the Texaco Dam. The investigation at the undeveloped parcel was prompted by limited accounts that may have suggested a former disposal site at this parcel.

One near-surface sample boring interval indicates PAH exceedances, though this is an isolated hotspot since no other sample locations in the horizontal or vertical area exhibit similar concentrations.

Mercury detections at OU-4 above the Unrestricted SCOs are found across the OU and some exceed Residential and Restricted-Residential SCOs. This may be related to the potential disposal site, but there are limited records of this area or what was disposed of if the disposal area existed. Some of the metals detected in soil at the Site may be attributable to background concentrations. A comparison of OU soil data to background conditions will be completed prior to the Feasibility Study.

3.3.8 Background Soil Samples

Background investigations took place on five background parcels (BG01 through BG05) for different soil types at locations near the Site. No groundwater was encountered to the depth of the investigation (2 ft bgs), and overburden was generally composed of the same material as present at the corresponding OU. Results indicated concentrations of PAHs, Pesticides and TAL Metals. Compounds exceeding the Unrestricted SCOs included 4-methylphenol, pesticides (4,4-DDE, 4,4-DDT, alpha chlordane), and TAL Metals (arsenic, chromium, copper, lead, manganese, nickel, zinc, mercury). A summary of background soil data is presented in Tables 3-8A and 3-8B and complete results are presented in Appendix G-8.

3.4 Protection of Groundwater Analysis and Soil Sources

The 6 NYCRR Part 375-6.8(b) and CP-51 SCOs include criteria for the POG. POG SCOs are compared to soil data when parameters in groundwater exceed the groundwater criteria to evaluate whether sources exist in soil that may impact groundwater. Further information on groundwater quality is presented in Section 4; a brief discussion of the class of chemicals that exceeds groundwater criteria at each OU is provided for additional detail to supplement the POG SCO discussions. Analytical data screening tables are provided in Appendix H. Parameters that exceed TOGS groundwater standards are compared to POG SCOs below and are also depicted on Figures 3-11 through 3-16. Note that, because no soil sources threatening groundwater quality were identified in OU-1B, this parcel was not evaluated herein.

3.4.1 OU-1A Parcel (Main Facility)

Groundwater concentrations at OU-1A indicate exceedances of VOCs, SVOCs, and metals. Soil data for these parameters are compared to the POG SCOs in Appendix H-1. A summary of screening exceedances is provided in Table 3-9 and exceedances of 6 NYCRR Part 375-6.8(b) SCOs are presented on Figures 3-11A (VOCs), 3-11B (SVOCs), and 3-11C (Metals).

TAL Metals, VOCs, and SVOCs have been detected at levels exceeding POG criteria in multiple near surface and subsurface soil sampling locations. These detections can be considered a potential source of groundwater impacts and may be related to the historical site operations, including the Former Fleet Test Area in the northeastern portion of the parcel, the drum storage area near former Buildings 58/83, tanks and laboratory near the former Building 50 parking lot, former Building 51 in the southeastern portion of the parcel, and laboratory buildings. VOCs and PAHs exceeding POG criteria are detected at various points near the Former Fleet Test Area in the northeastern portion of the parcel. SVOCs exceeding POG criteria are detected at various isolated spots near the lower section of the parcel along Fishkill Creek, and in the northern, southeastern, and central regions of the parcel. Arsenic and mercury exceed POG criteria for a group of soil borings located near the former Building 58/83 area, near former Building 51, and the Building B-6 area in the eastern region of the parcel. COCs exceeding the POG SCOs are provided in the table below. In addition, this table provides a range of detections and the frequency of samples that exceeded each POG SCO.

Parameter Name	375-6.8(b) & CP-51 POG	Detection Range	POG Exceedance Frequency
Volatile Organic Compounds			
1,1 Dichloroethene	**0.33**	0.0006 - 0.98	1/555
1,1,1-Trichloroethane	**0.68**	0.0006 - 6.5	2/556
1,2-Dichlorobenzene (o-Dichlorobenzene)	**1.1**	0.0006 - 53	2/559

Parameter Name	375-6.8(b) & CP-51 POG	Detection Range	POG Exceedance Frequency
1,2-Dichloroethane	**0.02**	0.0006 - 0.11	2/556
1,4-Dichlorobenzene	**1.8**	0.0008 - 3.1	2/559
Acetone	**0.05**	0.008 - 0.44	115/531
Benzene	**0.06**	0.0005 - 9.2	5/557
Carbon Tetrachloride	**0.76**	0.0008 - 61	1/556
Chlorobenzene	**1.1**	0.001 - 49	9/556
Chloroform	**0.37**	0.0007 - 5.1	2/556
Ethylbenzene	**1**	0.0006 - 3.6	8/557
Methylene chloride (Dichloromethane)	**0.05**	0.001 - 0.21	4/556
Toluene	**0.7**	0.0006 - 11	4/557
Xylene (total)	**1.6**	0.001 - 37	10/557
Semi-volatile Organic Compounds			
2-Methylphenol (o-Cresol)	**0.33**	0.033 - 0.65	2/546
4-Methylphenol (p-Cresol)	**0.33**	0.024 - 2.1	7/546
Benzo(a)anthracene	**1**	0.004 - 55	49/601
Benzo(a)pyrene	**22**	0.004 - 43	5/601
Benzo(b)fluoranthene	**1.7**	0.004 - 53	36/601
Benzo(k)fluoranthene	**1.7**	0.004 - 21	13/601
Chrysene	**1**	0.004 - 52	54/601
Dibenzofuran	**6.2**	0.02 - 22	4/584
Indeno(1,2,3-cd)pyrene	**8.2**	0.004 - 32	8/600
Naphthalene	**12**	0.004 - 46	4/603
Nitrobenzene	**0.17**	0.02 - 4.4	1/600
Phenol	**0.33**	0.027 - 1.4	2/546
Metals			
Arsenic	**16**	1.01 - 527	103/552
Lead	**450**	1.21 - 34100	13/552
Manganese	**2000**	107 - 4630	9/552
Nickel	**130**	1.2 - 143	1/552
Selenium	**4**	0.116 - 6.67	1/552
Silver	**8.3**	0.0321 - 13	2/552
Mercury	**0.73**	0.0113 - 45.1	55/552

Notes:
All values are provided in mg/kg
POG: Protection of Groundwater

3.4.2 OU-1C Parcel (Former Washington Avenue Tank Farm)

Groundwater concentrations at OU-1C indicate exceedances of VOCs, SVOCs, and metals. Soil data for these parameters are compared to the POG SCOs in Appendix H-2. A summary of screening exceedances is provided in Table 3-10 and also presented on Figure 3-12. Results indicate that acetone and arsenic are the primary COCs found in various surface and near-surface soil samples at concentrations above the protection of groundwater SCO. Other parameters have very infrequent detections greater than the POG SCO.

Previous LNAPL removal efforts have been undertaken to control the groundwater concentrations. In 2001, the system was abandoned since the groundwater monitoring results had reached asymptotic concentrations of BTEX (IT Corporation 2001). Therefore, it is likely that soils at the Site no longer act as a source of groundwater impacts. However, LNAPL has recently been detected in SWMW-21 and has been reported to be present in SWMW-72, though Arcadis has not yet confirmed this. Due to the detections of LNAPL, it is possible that source material may remain at OU-1C. COCs exceeding the POG SCOs are provided in the table below. In addition, this table provides a range of detections and the frequency of samples that exceeded each POG SCO.

Parameter Name	375-6.8(b) & CP-51 POG	Detection Range	POG Exceedance Frequency
Volatile Organic Compounds			
Acetone	**0.05**	0.022 - 5.7	47/74
Benzene	**0.06**	0.0005 - 0.98	2/74
Xylene (total)	**1.6**	0.001 - 230	2/74
Semi-volatile Organic Compounds			
Naphthalene	**12**	0.004 - 13	1/74
Phenol	**0.33**	0.029 - 0.4	1/74
Metals			
Arsenic	**16**	2.97 - 506	49/74
Lead	**450**	7.8 - 665	3/74
Manganese	**2000**	173 - 2730	2/74
Selenium	**4**	0.131 - 30.9	1/74

Notes:
All values are provided in mg/kg
POG: Protection of Groundwater

3.4.3 OU-1D Parcel (Residential Property and Rail Siding Area)

Groundwater concentrations at OU-1D indicate exceedances of several total and/or dissolved metals. Soil data for these parameters are compared to the POG SCOs in Appendix H-3. A summary of screening exceedances is provided in Table 3-11 and also presented on Figure 3-13. Results indicate that acetone, PAHs, and metals exceed POG SCO in soil at OU-1D. Arsenic is most frequently found above the protection of groundwater SCOs at various points on OU-1D in surface and near-surface sampling intervals. COCs exceeding the POG SCOs are provided in the table below. In addition, this table provides a range of detections and the frequency of samples that exceeded each POG SCO.

Parameter Name	375-6.8(b) & CP-51 POG	Detection Range	POG Exceedance Frequency
Metals			
Arsenic	**16**	4.39 - 149	27/71
Manganese	**2000**	215 - 2790	1/71
Mercury	**0.73**	0.0225 - 2.66	7/71

Notes:

All values are provided in mg/kg

POG: Protection of Groundwater

3.4.4 OU-1E Parcel (Back 93 Acre)

Groundwater concentrations indicate exceedances of select VOC, SVOCs, and metals. Soil data for these parameter groups are compared to the POG SCOs in Appendix H-4. A summary of screening exceedances is provided in Table 3-12 and also presented on Figure 3-14. Results indicate very infrequent detections in surface and near-surface intervals above the POG SCOs. COCs exceeding the POG SCOs are provided in the table below. In addition, this table provides a range of detections and the frequency of samples that exceeded each POG SCO.

Parameter Name	375-6.8(b) & CP-51 POG	Detection Range	POG Frequency
Semi-volatile Organic Compounds			
Benzo(a)anthracene	**1**	0.004 - 12	9/375
Benzo(b)fluoranthene	**1.7**	0.004 - 11	6/375
Benzo(k)fluoranthene	**1.7**	0.004 - 4.5	3/375
Chrysene	**1**	0.004 - 11	9/375
Metals			
Manganese	**2000**	193 - 4060	3/343

Notes:

All values are provided in mg/kg

POG: Protection of Groundwater

3.4.5 OU-3 Parcel (Residential Property)

Groundwater concentrations indicate exceedances of one VOC, select SVOCs, and dissolved and/or total metals. Soil data for these parameter groups are compared to the POG SCOs in Appendix H-5. A summary of screening exceedances is provided in Table 3-13 and also presented on Figure 3-15. Results indicate benzo(a)anthracene, benzo(b)fluoranthene, and chrysene have been detected at concentrations above the POG SCOs at only one surface sampling location OU3SB02. Acetone has been detected in near and sub-surface soil above the POG SCO. COCs exceeding the POG SCOs are provided in the table below. In addition, this table provides a range of detections and the frequency of samples that exceeded each POG SCO.

Parameter Name	375-6.8(b) & CP-51 POG	Detection Frequency	POG Exceedance Frequency
Volatile Organic Compounds			
Acetone	**0.05**	0.013 - 0.079	3/8
Semi-Volatile Organic Compounds			
Benzo(a)anthracene	**1**	0.007 - 2.7	1/26
Benzo(b)fluoranthene	**1.7**	0.005 - 2.6	1/26
Chrysene	**1**	0.005 - 2.4	1/26

Notes:
All values are provided in mg/kg
POG: Protection of Groundwater

3.4.6 OU-4 Parcel (Hydroelectric Dam Property)

Groundwater concentrations indicate exceedances of five total and/or dissolved metals. Soil data for these parameter groups are compared to the POG SCOs in Appendix H-6. A summary of screening exceedances is provided in Table 3-13 and also presented on Figure 3-16. Acetone and mercury were detected at concentrations greater than the POG SCOs. Several other parameters are detected in one sample out of 78 at concentrations greater than the POG SCOs. COCs exceeding the POG SCOs are provided in the table below. In addition, this table provides a range of detections and the frequency of samples that exceeded each POG SCO.

Parameter Name	375-6.8(b) & CP-51 POG	Detection Range	POG Exceedance Frequency
Semi-volatile Organic Compounds			
Benzo(a)anthracene	**1**	0.005- 1.5	1/78
Chrysene	**1**	0.005- 1.4	1/78
Metals			
Arsenic	**16**	1.27- 21	1/78
Lead	**450**	3.5- 514	1/78

Notes:

All values are provided in mg/kg

POG: Protection of Groundwater

3.5 Protection of Ecological Resources

The 6 NYCRR Part 375 and CP-51 Soil Cleanup Objectives include criteria for the protection of ecological resources (PER). The PER SCOs are compared to soils in the first 6 inches below ground and down to 24 inches bgs. PER SCOs are applicable where ecological resources are present or will be present, are important components of the environment, or where there is a defined threat to these ecological resources. Section 8 of this report identifies areas of the Site where the PER SCOs apply and compares analytical results to these SCOs.

3.6 Soil Investigation Summary

The distribution of COCs detected most frequently in soil at concentrations greater than the Unrestricted SCOs are presented on Figures 3-10A through 3-10X. As discussed in Section 2.1, primary COCs in soil are acetone, PAHs, and metals (arsenic, lead, and mercury). The selection of these compounds is based on the frequency of detections above the SCOs.

As discussed at the start of Section 3.3, acetone in at least some of the detections from certain investigations may be attributed to laboratory error, especially at the undeveloped parcels (OU-1B, OU-1D, OU-1E, OU-3, and the southern portion of OU-4) where acetone was unlikely to be actively used. While evaluating COCs requiring remedial action in the Feasibility Study, further evaluation of the accuracy of acetone data should be completed.

As the next step after completing the RIR requirements, Arcadis, on behalf of CEMC, will prepare an additional evaluation of background conditions in comparison to detected site concentrations in a separate evaluation following submittal of the RIR to assess potential background contributions. This evaluation will be submitted prior to the Feasibility Study. It will include a statistical background comparison and evaluation to determine exposure point concentrations and ultimately estimates of the amount of human intake.

4 GROUNDWATER INVESTIGATIONS AND DATA SUMMARY

This section briefly summarizes all the groundwater investigations performed at the former TRCB facility and adjacent properties. Monitoring well boring logs are contained in Appendix B. A summary of groundwater sample results taken at the OUs is provided in Tables 4-1 through 4-7. Additionally, Table 2-2 provides the construction information for all monitoring wells currently present on-site. This table was developed using site investigation findings and review of construction logs from installed monitoring well records. Monitoring well boring logs are included in Appendix B and full analytical tables are provided in Appendix Is.

4.1 Selection of Screening Criteria

To evaluate groundwater quality, analytical results are compared to the ambient water quality guidance values and groundwater effluent limitations contained in TOGS 1.1.1 (hereafter referred to as TOGS standards). For substances not included in TOGS 1.1.1, the USEPA Tap Water Regional Screening Levels (RSLs) are used for comparison. For data comparison discussions, TOGS standards and RSLs will collectively be referred to as applicable screening values here within. Groundwater at the former TRCB facility is classified as Class GA. Class GA represents groundwater that may be used as a source of drinking water (NYSDEC 2014b; USEPA 2019).

4.2 Previous Investigations

The following subsections briefly detail the scope of groundwater investigations that have taken place at the Site across all OUs. Section 4.5 details the results of these investigations with summaries of the data presented. All active groundwater monitoring wells and former temporary well points are shown on Figures 4-1 and 4-2.

4.2.1 Sitewide Soil Gas Survey and Groundwater Monitoring Well Installations Performed by Prior Texaco and CEMC Consultants (1980s to early 2000s)

Approximately 70 groundwater monitoring wells (both overburden and bedrock) were installed and soil gas surveys were conducted throughout the Main Facility (OU-1A), the Washington Avenue Tank Farm (OU-1C), and the Back 93 Acre Parcel (OU-1E). These investigations were performed as preliminary investigations into the groundwater quality at the main Site and initial remedial actions taken at OU-1C and OU-1E. Installed monitoring wells include the Groundwater Technology (GT and BR) monitoring wells, the tank farm investigation (TF) monitoring wells, the IT Corporation (ITMW) monitoring wells, the recreation area monitoring wells, and the unknown monitoring wells,. The monitoring wells from these investigations that still exist are shown on Figures 4-1 and 4-2.

4.2.2 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) (2006 Through 2007)

The groundwater investigation consisted of installing 74 monitoring wells in the overburden and bedrock at the Main Facility (OU-1A) and former WATF parcel (OU-1C). Samples were analyzed for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and TAL Metals. Results of this investigation are presented in the RFI Report (Parsons 2007).

4.2.3 RCRA Supplemental RFI Facility Investigation (2008 Through 2009)

An additional 27 groundwater monitoring wells were installed in both overburden and bedrock on the Main Facility (OU-1A) and former WATF parcel (OU-1C) to provide information at select areas of the Site. Monitoring wells related to the RFI and SRFI are designated with the prefix “SWMW” on Figure 4-1. Samples were analyzed for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and total TAL Metals. Results of this investigation are presented in the Supplemental RFI Report (Parsons 2009b).

4.2.4 Undeveloped Property Investigation (2012)

Three overburden and two bedrock monitoring wells were installed to characterize subsurface conditions at an undeveloped area located west of the former WATF parcel (OU-1C) and to characterize groundwater conditions at the Hydroelectric Facility and Dam Parcel (OU-4). Four temporary well points are shown on Figure 4-1 as the UDPSB temporary well points. Samples were analyzed for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and Total and dissolved TAL Metals. Results of this investigation are presented in the Undeveloped Property Subsurface Investigation Report (Parsons 2012).

4.2.5 Concrete Foundation Drilling and Groundwater Investigation (2012)

Following the completion of the Sitewide ACM Abatement and Building Demolition project, 14 temporary well points were installed through the concrete foundations of certain buildings located on the Main Facility (OU-1A). Temporary well points are identified by the prefix “PCFGW” on Figure 4-1. Samples were analyzed for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and Total TAL Metals. Results of this investigation are presented in the Concrete Foundation Drilling Investigation Report (Parsons 2013b).

4.2.6 Additional Well Installation Investigation (2013)

Six groundwater monitoring wells were installed in three building areas located at the Main Facility, three in the overburden and three in the bedrock. These monitoring wells include SWMW-135, SWMW-136, SWMW-137, SWMW-138, SWMW-139, and SWMW-140 shown on Figure 4-1. The monitoring wells were installed to provide additional data to validate existing Geographical Information System (GIS) groundwater plume contours, to complete delineation of the three VOC plumes identified during the Concrete Foundation Drilling program that took place in fall 2012, and to delineate the plume boundary north of the Building 58 area. Parsons analyzed samples for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and Total TAL Metals. Results of this investigation are presented in the Groundwater Monitoring Well Installations Report (Parsons 2014b).

4.2.7 Sitewide Groundwater Monitoring Well Sampling Events (2008, 2010, 2012, and 2013)

These four sitewide groundwater sampling events were conducted to provide additional data to compare to data collected by previous investigations. Between 74 to 144 groundwater monitoring wells located on the Main Facility (OU-1A) and former WATF parcel (OU-1C) were sampled at various frequencies over this 5-year period. Samples were analyzed for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and Total TAL Metals. Result of these investigations are presented in the Sitewide Groundwater Sampling Event reports (Parsons 2009a, 2010d, 2013a, 2014c).

4.2.8 Quarterly Natural Attenuation Groundwater Monitoring Well Sampling Investigation (2014 Through 2016)

Forty-three groundwater monitoring wells located on the Main Facility (OU-1A) and former WATF parcel (OU-1C) were sampled on a quarterly basis (Parsons 2015d, 2016, 2017b) to assess COC degradation within the subsurface by analyzing and reviewing parameters associated with natural attenuation. Only selected monitoring wells were sampled that exhibited parameters of concern in exceedance of NYSDEC TOGS standards. COCs consisted of benzene, chlorobenzene, cis-1,2-DCE, TCE, vinyl chloride, and manganese.

The results from that evaluation indicated natural attenuation of certain organic parameters through chemical transformation including biodegradation was occurring. Observation of natural attenuation of benzene, chlorobenzene, vinyl chloride, and TCE were supported by the observed fluctuations of the VOC concentrations and observed plume extents (boundaries) from 2008 through 2016 (e.g., plume extents either stayed the same or shrank slightly). To assess the role of COC degradation in natural attenuation, Compound Specific Isotope Analysis (CSIA) was also performed on select monitoring wells in 2015 and 2016. This sampling was performed to assess degradation of select COCs (including 1,2-dichlorobenzene, chlorobenzene, TCE, and vinyl chloride) in groundwater. CSIA results also supported the conclusion that degradation was contributing to the natural attenuation of these COCs at the TRCB facility. Further analysis of the results of the CSIA are provided in Section 4.4.1.1.

4.2.9 Former RCRA Well Permit/Consent Order Groundwater Investigation (1980s to Present Day)

The original groundwater monitoring well network in the Back 93 Acre Parcel (OU-1E) consisted of over 30 monitoring wells. Over the years, as some of these monitoring wells consistently indicated COC concentrations below regulatory limits, the NYSDEC granted approvals for monitoring well closures. Currently, 10 groundwater monitoring wells are sampled on a semi-annual basis to monitor the general groundwater quality of the Back 93 Acre Parcel (OU-1E). Samples are analyzed for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and Total TAL Metals. Groundwater analytical data results from these monitoring wells indicate the presence of VOCs (TCE, 1,1-DCA, and 1,2-dichloroethene [1,2-DCE]) at concentrations just exceeding the NYSDEC TOGS standards (Parsons 1980 through 2018). Two of the 10 monitoring wells sampled are located on the former WATF parcel (OU-1C), two are located on the Back 93 Acre Parcel (OU-1E), two are located on the Central Hudson

Electric and Gas Right of Way to the East of OU-1E, and the remaining four monitoring wells are located along a road (Belvedere Road) that is east of the Back 93 Acre Parcel (OU-1E).

CEMC entered into a Consent Order with the NYSDEC to transition the investigation program from a RCRA Permit sampling program to a Consent Order sampling program in 2013.

4.2.10 Data Gap Investigation at OU-1D, OU-1E, and OU-3 (2018)

Twelve temporary well points were installed during field activities. These temporary well points are shown on Figures 4-3 and 4-4: seven at OU-1D, three at OU-1E, and two at OU-3. The temporary well points were installed to determine the general groundwater quality within the subsurface at each OU. Samples are analyzed for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and Total and dissolved TAL Metals. Results are presented in the Data Gap Investigation Report (Parsons 2019a).

4.2.11 Adjacent Property Investigation (ReCommunity Recycling Center Groundwater Investigation Program) (2010, 2013, 2015, and 2016)

Five bedrock groundwater monitoring wells were installed in 2010 by Paratt-Wolff, Inc., for Chevron on an adjacent property located to the west of the Main Facility (OU-1A). These monitoring wells are shown on Figure 4-1 as SWMW-130(S/D) through 132. The monitoring wells were installed to ascertain if groundwater impacts and LNAPL, which was detected along the farthest western property of the former TRCB facility, had migrated off site. Samples are analyzed for VOCs by USEPA Method 8260, SVOCs via USEPA Method 8270, and Total TAL Metals. Groundwater analytical data results indicated only TAL Metals representative of background (aluminum, iron, beryllium, cobalt, manganese, sodium, and thallium), at concentrations exceeding the NYSDEC groundwater criteria, but no COCs related to plumes at OU-1A to the east (benzene, TCE, vinyl chloride, and chlorobenzene) were detected (Parsons 2010c, 2014a, 2015e, 2017a). Based on physical observations during field activities and analytical results, no evidence of LNAPL, petroleum hydrocarbon VOCs, or chlorinated VOCs was present, demonstrating that no migration of COCs present within the Building 58 area of the former TRCB facility had occurred beyond the most southwestern property boundary (Building 58 area) onto the ReCommunity Recycling Center Property.

4.2.12 Emerging Contaminant Investigation (2019)

Seven monitoring wells located on parcels OU-1A, OU-1C, and OU-1E were sampled to address a request by the NYSDEC for 1,4-dioxane and per- and polyfluoroalkyl substances (PFAS). The sampling locations for 1,4-dioxane were selected in areas of historical 1,1,1-TCA and/or TCE detections in monitoring wells located on parcels OU-1A and OU-1E. Monitoring wells with 1,1,1-TCA or TCE exceedances were selected for 1,4-dioxane sampling. Additional monitoring wells were investigated at the request of the NYSDEC. PFAS sampling locations were selected based on the potential storage areas of firefighting equipment that could have included firefighting foam on and near the Site. In addition, two additional overburden monitoring wells within historical VOC plumes in OU-1C and OU-1E were selected for PFAS sampling. Results of this investigation are discussed in the Emerging Contaminant Summary Report (Arcadis 2020b).

4.3 Groundwater Analytical Data Summary

The following groundwater analytical data summary section has been prepared based on groundwater investigations conducted at the former TRCB facility. The most recent 2 to 3 years of groundwater analytical data available are used to identify primary COCs. During the 2015 and 2016 groundwater investigations, a limited number of compounds were analyzed in groundwater samples in an effort to define natural attenuation of certain compounds more clearly. These compounds include benzene, chlorobenzene, cis-1,2-DCE, TCE, vinyl chloride, and manganese. However, additional COCs at the site have been identified that were not sampled during these events. For these COC compounds not analyzed, prior historical data was reviewed to summarize their status and to identify the primary COCs.

As stated in Section 4.1, the NYSDEC TOGS standards and the USEPA Tap Water RSLs were used as the applicable screening values. The screening was performed on a point-by-point basis, meaning no statistical evaluations or calculations of representative concentrations were performed. Groundwater concentrations exceeding criteria for specific analytes described in this section are depicted on single frame aerial photograph views captured in Figures 4-4A through 4-4AAA. Several TAL Metals (aluminum, iron, magnesium, manganese, and sodium) have been identified in groundwater from monitoring wells located upgradient on site and are considered to be representative of background concentrations and/or the total suspended solids inherent to the sampling method used (i.e., three volume purging). For example, the concentrations of aluminum are frequently above the maximum solubility limit (1,000 micrograms per liter [µg/L]) and it is likely that these aluminum concentrations are indicative of particulate matter in groundwater samples resulting from the sampling method. As there has been limited dissolved metals sampling conducted at the Site, it is difficult to confirm actual concentrations of metals in groundwater. Since these metals are frequently detected at monitoring wells (including unimpacted monitoring wells) on site, they have been classified as background metals and will not be retained for additional assessment.

The following sections summarize observations regarding groundwater conditions at the facility.

4.3.1 OU-1A Parcel (Main Facility)

Groundwater impacts at OU-1A are split into four main areas of impact: The Building 51 area, Building 45/55 area, Building 36 area, and Building 58/83 area are depicted on Figure 4-1. Metals, including aluminum, iron, manganese, and sodium, have been detected above regulations across OU-1A. Additionally, magnesium is detected along with these metals at the eastern portion of the parcel. It is likely that these metals are present in the background since they are also detected in upgradient monitoring wells and areas with no known sources. COCs exceeding the NYSDEC TOGS in overburden groundwater are provided in the table below. In addition, this table provides a range of detections, the number of different monitoring wells investigated, and the number of samples collected.

Overburden Groundwater Summary

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples
Volatile Organic Compounds				

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples
1,1 Dichloroethene	**5**	0.9 - 240	60	158
1,1,1-Trichloroethane	**5**	0.9 - 900	60	158
1,1-Dichloroethane	**5**	1 - 220	60	158
1,2-Dibromo-3-chloropropane (DBCP)*	**0.00033**	4 - 4	4	5
1,2-Dichlorobenzene (o-Dichlorobenzene)	**3**	0.5 - 160	60	164
1,2-Dichloroethane*	**0.6**	1 - 1	60	158
1,3-Dichlorobenzene	**3**	0.5 - 91	60	164
1,4-Dichlorobenzene	**3**	0.7 - 160	60	164
2-Butanone (Methyl ethyl ketone)	**50**	3 - 55	60	153
Acetone	**50**	3 - 5800	59	148
Benzene	**1**	0.5 - 850	60	295
Chlorobenzene	**5**	0.8 - 1300	60	293
Chloroethane	**5**	2 - 610	60	158
Chloroform	**7**	0.8 - 9	60	158
cis-1,2-Dichloroethene	**5**	0.6 - 110	60	288
Ethylbenzene	**5**	1 - 101	60	164
Methylene chloride (Dichloromethane)	**5**	3 - 17.9	60	158
Tetrachloroethene	**5**	0.8 - 15	60	157
Toluene	**5**	0.9 - 46	60	164
Trichloroethene (Trichloroethylene)	**5**	0.5 - 300	60	293
Vinyl chloride (Chloroethene)	**2**	0.6 - 12	60	293
Xylene (total)	**5**	0.9 - 160	60	164
Semi-volatile Organic Compounds				
2-Chlorophenol (o-Chlorophenol)	**1**	0.7 - 12	60	149
2-Methylnaphthalene	**36**	0.1 - 8400	60	156
2-Methylphenol (o-Cresol)	**1**	1 - 2	60	149
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	**1**	8 - 8	60	149
4-Methylphenol (p-Cresol)	**1**	3 - 97	60	149
Acenaphthene	**20**	0.2 - 63	60	159
Benzo(a)anthracene	**0.002**	0.1 - 26	60	159
Benzo(a)pyrene	**0.025**	0.1 - 27	60	159
Benzo(b)fluoranthene	**0.002**	0.1 - 37	60	159
Benzo(k)fluoranthene	**0.002**	0.1 - 13	60	159
bis(2-Chloroethyl) ether	**1**	0.8 - 2	60	159
bis(2-chloroisopropyl) ether	**5**	35.1 - 35.1	60	159
bis(2-Ethylhexyl)phthalate	**5**	1.1 - 2800	60	159
Chrysene	**0.002**	0.1 - 26	60	159
Di-n-octylphthalate	**50**	6 - 66	60	159

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples
Dibenz(a,h)anthracene	**0.025**	0.1 - 5	60	159
Dibenzofuran	**7.9**	0.5 - 180	60	156
Fluoranthene	**50**	0.2 - 53	60	159
Fluorene	**50**	0.2 - 210	60	159
Hexachloroethane	**5**	17.7 - 17.7	60	159
Indeno(1,2,3-cd)pyrene	**0.002**	0.1 - 13	60	159
Naphthalene	**10**	0.1 - 1500	60	159
Nitrobenzene*	**0.4**	1.6 - 1.6	60	159
Pentachlorophenol*	**1**	2 - 2	60	149
Phenanthrene	**50**	0.1 - 340	60	159
Phenol	**1**	1 - 18	60	149
Metals				
Aluminum	**100**	8.5 - 1020000	60	153
Antimony	**3**	3.6 - 49.9	60	153
Arsenic	**25**	7 - 704	60	156
Barium	**1000**	0.091 - 4790	60	156
Beryllium	**3**	0.68 - 215	60	153
Cadmium	**5**	0.4 - 20.3	60	156
Chromium	**50**	0.024 - 3740	60	156
Cobalt	**5**	1.4 - 740	60	153
Copper	**200**	0.021 - 1930	60	153
Iron	**300**	17.4 - 3050000	60	153
Lead	**25**	0.01 - 7400	60	156
Magnesium	**35000**	22.7 - 501000	60	153
Manganese	**300**	0.54 - 44300	60	285
Nickel	**100**	1.3 - 748	60	153
Selenium	**10**	7.8 - 43.3	60	156
Silver	**50**	1.6 - 75.4	60	156
Sodium	**20000**	29.9 - 625000	60	153
Thallium	**0.5**	5.8 - 117	60	153
Vanadium	**86**	1.5 - 1730	60	153
Zinc	**2000**	0.058 - 5700	60	153
Mercury	**0.7**	0.06 - 89.6	60	156

Notes:

All values are provided in micrograms per liter (ug/L)

NYSDEC TOGS: New York Technical and Operational Guidance Series

USEPA: United States Environmental Protection Agency

RSL: Regional Screening Levels

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples

--: Not applicable

COCs exceeding the NYSDEC TOGS in bedrock groundwater are provided in the table below. In addition, this table provides a range of detections, the number of different monitoring wells investigated, and the number of samples collected.

Bedrock Groundwater Summary

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Monitoring Well Locations	Monitoring Well Locations	Number of Samples
Volatile Organic Compounds				
1,1 Dichloroethene	**5**	0.8 - 680	83	380
1,1,1-Trichloroethane	**5**	0.8 - 29000	83	380
1,1-Dichloroethane	**5**	1 - 150	83	380
1,2-Dichlorobenzene (o-Dichlorobenzene)	**3**	0.5 - 730	82	369
1,2-Dichloroethane	**0.6**	2 - 2	83	380
1,2-Dichloroethene	**5**	26 - 85	18	21
1,3-Dichlorobenzene	**3**	0.6 - 7	82	369
1,4-Dichlorobenzene	**3**	0.5 - 43	82	369
2-Butanone (Methyl ethyl ketone)	**50**	3 - 55	83	353
Acetone	**50**	3 - 400	82	328
Benzene	**1**	0.5 - 560	83	595
Carbon Tetrachloride	**5**	1 - 48	83	380
Chlorobenzene	**5**	0.6 - 3100	83	595
Chloroethane	**5**	1 - 110	83	380
Chloroform	**7**	0.8 - 55	83	380
Chloromethane (Methyl chloride)	**5**	18 - 18	83	380
cis-1,2-Dichloroethene	**5**	0.6 - 1000	83	574
Ethylbenzene	**5**	0.8 - 580	83	389
Methyl-t-butyl ether	**10**	0.5 - 110	83	358
Methylene chloride (Dichloromethane)	**5**	0.8 - 24	83	380
o-Xylene	**190**	0.5 - 250	14	15
Tetrachloroethene	**5**	0.8 - 43	83	379
Toluene	**5**	0.7 - 340	83	389
trans-1,2-Dichloroethene	**5**	0.8 - 91	83	354
Trichloroethene (Trichloroethylene)	**5**	0.5 - 1200	83	594
Vinyl chloride (Chloroethene)	**2**	0.6 - 130	83	595
Xylene (total)	**5**	0.8 - 980	83	389

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Monitoring Well Locations	Monitoring Well Locations	Number of Samples
Semi-volatile Organic Compounds				
1,4-Dioxane	**0.46**	5.6 - 5.6	3	3
2-Chlorophenol (o-Chlorophenol)	**1**	0.7 - 17	82	326
2-Methylnaphthalene	**36**	0.1 - 1200	82	347
2-Methylphenol (o-Cresol)	**1**	0.5 - 3	82	326
4-Methylphenol (p-Cresol)	**1**	7 - 430	82	326
Acenaphthene	**20**	0.1 - 31	82	352
Benzo(a)anthracene	**0.002**	0.2 - 1.2	82	352
Benzo(a)pyrene	**0.025**	0.1 - 0.8	82	352
Benzo(b)fluoranthene	**0.002**	0.2 - 1	82	352
Benzo(k)fluoranthene	**0.002**	0.1 - 0.5	82	352
bis(2-Chloroethyl) ether	**1**	1 - 160	82	351
bis(2-Ethylhexyl)phthalate	**5**	1 - 360	82	352
Chrysene	**0.002**	0.1 - 1.1	82	352
Dibenz(a,h)anthracene	**0.025**	0.1 - 0.2	82	352
Dibenzofuran	**7.9**	0.6 - 17	82	347
Indeno(1,2,3-cd)pyrene	**0.002**	0.1 - 0.8	82	352
Naphthalene	**10**	0.1 - 130	82	358
Phenol	**1**	0.5 - 1200	82	326
Metals				
Aluminum	**100**	0.32 - 71500	82	335
Antimony	**3**	4 - 15.6	82	335
Arsenic	**25**	0.019 - 43.2	82	335
Beryllium	**3**	0.012 - 7.8	82	335
Cadmium	**5**	0.009 - 8.6	82	335
Chromium	**50**	0.01 - 230	82	334
Cobalt	**5**	0.072 - 25.9	82	335
Iron	**300**	0.85 - 80700	82	335
Lead	**25**	0.082 - 844	82	335
Magnesium	**35000**	20 - 152000	82	335
Manganese	**300**	0.55 - 14800	82	547
Selenium	**10**	0.005 - 11.8	82	335
Sodium	**20000**	5.9 - 912000	82	334
Thallium	**0.5**	6.1 - 21.4	82	335
Mercury	**0.7**	0.0004 - 33	82	335

Notes:

All values are provided in micrograms per liter (ug/L)

NYSDEC TOGS: New York Technical and Operational Guidance Series

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Monitoring Well Locations	Monitoring Well Locations	Number of Samples

USEPA: United States Environmental Protection Agency

RSL: Regional Screening Levels

4.3.1.1 Overburden

Overburden groundwater sampling data from 2000 to 2020 has been summarized in Table 4-1. This table identifies the total number of detections and the amount of detections greater than the screening values in overburden groundwater. The complete analytical data are provided in Appendix I-1.

4.3.1.1.1 Building 51

In overburden groundwater, a chlorinated VOC plume is positioned south of the former Building 51 area. The concentrations of TCE and daughter products were elevated in the area of SWMW-58 and SWMW-67. This plume is well bounded to the area surrounding former Building 51 and former Building 41 by temporary well points PCFGW-53, PCFGW-54, PCFGW-75, PCFGW-85, PCFGW-89, and PCFGW-56. TCE or daughter products were not detected at these temporary well points during their sampling event.

Aromatic VOCs (BTEX) have been detected exceeding TOGS standards at monitoring well SWMW-15, but other overburden monitoring wells in the area do not exhibit BTEX exceedances.

SVOCs such as benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and bis(2-ethylhexyl)phthalate have been detected above criteria at ITMW-5, PCFGW-53, PCFGW-57, PCFGW-85, PCFGW-89, SWMW-15, and SWMW-62, but other overburden monitoring wells do not exhibit these SVOC exceedances. Similar exceedances have been detected near Building 38 in one temporary well point PCFGW-36, leaving it as an isolated spot.

Arsenic and lead have been detected above NYSDEC TOGS criteria at SWMW-62, SWMW-15, PCFGW-90, PCFGW-89, PCFGW-53-57, PCFGW-72, PCFGW-74, PCFGW-85, and ITMW-5. Mercury has been detected above criteria at ITMW-5, PCFGW-53, PCFGW-54, PCFGW-56, PCFGW-57, PCFGW-85, PCFGW-89, PCFGW-90, SWMW-15, and SWMW-62. Concentrations of arsenic and lead do not appreciably change during the recent sampling events, indicating the groundwater plume in this area has stabilized. These exceedances may be related to the anoxic conditions and will be expanded upon in Section 4.4.3. The majority of detected exceedances occur in the areas surrounding Building 51, however the concrete foundation samples taken at Building 68 indicate arsenic and lead exceedances as well. This may represent an additional mobilization of metals, but the lack of VOC and SVOC exceedances at these locations makes suspended solids in the sample a more likely explanation. The metals aluminum, iron, manganese, and sodium are detected in this area and attributed to background conditions.

4.3.1.1.2 Building 58/83, Building 36

Benzene, chlorobenzene, and dichlorobenzenes make up most of the exceedances in the Building 58/83 and Building 36 area. Detections in overburden in this area greater than the NYSDEC TOGS standards include Unknown Wells 1, 2, and 3, GT-2, and temporary well points PCFGW-2 and -122. GT-2 has the highest concentration of benzene and chlorobenzene.

TCE was detected only at PCFGW-001. Breakdown products of chlorinated VOCs, such as chloroethane and 1,1-DCA, have been detected only at Unknown Well 1.

In an isolated incident, methyl ethyl ketone and acetone were detected during the only sampling (2013) for SWMW-135. No other monitoring wells in the area exhibited these compounds and therefore these detections may be a laboratory artifact.

PAH concentrations have been detected above screening levels at PCFGW-122 and in one sample at PCFGW-123. However, these PAH SVOCs were not detected in the duplicate. PAH exceedances seem to be generally limited to these PCFGW temporary well points.

Lead has been detected above screening levels at SWMW-59, but no other metal COCs have been detected there. The background metals aluminum, iron, manganese, and sodium are consistently present. Other TAL Metals, including lead, have been detected in samples taken from PCFGW-1, PCFGW-2, PCFGW-121, PCFGW-122, and PCFGW-123. These metals are only infrequently detected above applicable screening values and may be a result of suspended solids in the samples and/or background concentrations.

4.3.1.1.3 Building 45/55

In overburden groundwater, the impacted area around Building 45/55 is characterized by three main compound categories: chlorinated VOCs, aromatic VOCs, and PAH SVOCs. The compounds detected in the overburden have also been identified in bedrock monitoring wells.

Aromatic VOC and chlorinated VOC exceedances in the Building 45/55 area include: 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, chlorobenzene, chloroethene, TCE, and BTEX.

The highest concentrations of aromatic VOCs and chlorinated VOCs occur at monitoring wells SWMW-10 and ITMW-25, both located in the vicinity of Building 55. Monitoring well ITMW-25 exhibits the largest number of VOC exceedances compared to other impacted monitoring wells in the Building 45/55 area. TCE has been observed exceeding applicable groundwater criteria only at monitoring well ITMW-25. Other overburden monitoring wells exhibiting exceedances are SWMW-24, SWMW-10, SWMW-25, SWMW-48, ITMW-25, and SWMW-28.

PAH SVOC exceedances such as benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and naphthalene have been detected at monitoring wells SWMW-24, SWMW-10, SWMW-25, SWMW-48, ITMW-25, SB35-3R, SWMW-28, and SB35-4R. The highest concentrations of PAH SVOCs occur at overburden monitoring wells SWMW-25 and ITMW-25. Generally, SVOC exceedances occur mainly in the area of Building 55 and are limited in extent compared to other compounds. Exceedances to the south near Building 45 are likely related to different sources and do not represent an extension of this same plume.

Other SVOCs detected exceeding applicable criteria are: acenaphthene, 2-chlorophenol, phenol, and bis(2-2-ethylhexyl) phthalate. These compounds have been detected at overburden monitoring wells

SWMW-10, ITMW-25, and SB35-3R; this indicates a more limited range of exceedances for these compounds. However, these limited compounds are collocated with other detected exceedances.

Aromatic VOCs and PAH SVOCs are detected in an area bounded by overburden monitoring wells SB35-3R, SB35-1R, and SB35-4R toward the east. The extent of the impacted area has not been defined toward the northern and western portions of the parcel due to lack of analytical data in those areas.

TCE and daughter products have been detected in overburden monitoring well SWMW-24. 1,1-DCA has also been infrequently detected at monitoring well SWMW-65. Overburden monitoring wells in the vicinity of SWMW-24 have not exhibited TCE and daughter products.

TAL Metals have also been detected above applicable groundwater criteria in overburden groundwater. Overburden monitoring well SWMW-10 exhibits the largest number of exceedances of the applicable screening values for TAL metals, including arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, and nickel. Additional monitoring wells exhibiting aluminum, manganese, and sodium exceedances are SWMW-24 and SWMW-25 but may be indicative of background. Arsenic and lead were detected at monitoring wells exhibiting BTEX-related compounds, indicating a relationship between the anoxic conditions caused by BTEX compounds and the concentrations of lead and arsenic. Other metal detections described above may also be due to the conditions of the groundwater, which will be described in Section 4.4.3.

4.3.1.2 Bedrock (Dolostone)

Bedrock groundwater sampling has been summarized in Table 4-2. This table identifies the total number of detections and the amount of detections over the standard in bedrock groundwater. The complete analytical data are provided in Appendix I-2. Primary COCs that exceed the NYSDEC TOGS are provided in the table below. In addition, this table provides a range of detections, and a comparison of number of monitoring wells reviewed versus sample numbers.

4.3.1.2.1 Building 51

In bedrock groundwater, aromatic VOC impacts mainly occur near Building41. Monitoring wells having no aromatic VOC exceedances include SWMW-110, SWMW-109, SWMW-122, SWMW-14, SWMW-107, SWMW-111, SWMW-68, and SWMW-119. The highest concentrations of BTEX compounds occur at SWMW-41, located along Fishkill Creek.

The chlorinated VOC impacts cover the area of former Buildings 51, 32, and 41 and are bounded by SWMW-104, SWMW-122, ITMW-08, and SWMW-108, all of which present no detections during sampling investigations. The highest concentrations of chlorinated VOCs (cis-1,2-DCE, TCE, and vinyl chloride) occur at SMWW-112, SWMW-56, and SWMW-68. Concentrations of TCE and cis-1,2-DCE have been detected above the criteria in bedrock monitoring well SWMW-41 along Fishkill Creek.

Farther to the northwest of former Building 51, monitoring well SWMW-105 has exhibited exceedances of TCE and is bounded by monitoring wells SWMW-104, SWMW-12, and SWMW-108.

PAH SVOCs such as benzo(a)anthracene, benzo(a)pyrene, bis(2-Ethylhexyl) phthalate, indeno(1,2,3-cd)pyrene, and chrysene have been detected above the criteria at SWMW-14 and ITMW-06, but other bedrock monitoring wells in the area do not exhibit SVOC detections during these sampling events.

ITMW-06, SWMW-56, and SWMW-41 exhibit the highest concentration of PAH SVOCs such as bis(2-Chloroethyl) ether.

Mercury is the only TAL Metal – besides the background metals (aluminum, iron, manganese, and sodium) – that has been detected above the criteria in bedrock at the Building 51 area. Mercury exceeded screening levels in bedrock monitoring wells ITMW-06, SWMW-111, and SWMW-14 during the 2012 sampling; however, the 2011 and 2013 sampling events do not exhibit mercury.

4.3.1.2.2 Building 45

COC groups identified in the area are aromatic and chlorinated VOCs, PAHs, SVOCs, and TAL Metals. Impacted monitoring wells in the area appear to be limited to one bedrock monitoring well (SWMW-27). Upgradient monitoring wells SWMW-118 and SWMW-64, located at the boundary with OU-4, do not exhibit exceedances.

Aromatics and chlorinated VOC exceedances in the Building 45 area include: 1,1-DCA, 1,2--dichloroethane (1,2-DCA), 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, , cis-1,2-DCE, tetrachloroethene (PCE), and TCE.

PAH SVOCs exceedances detected at monitoring well SWMW-27 include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and naphthalene. These exceedances have only been identified during the 2013 sampling event, except for naphthalene, which was detected in 2007 and 2010 but has not been detected above criteria during recent sampling events.

Bedrock monitoring well SWMW-27 has also exhibited exceedances for TAL Metal including aluminum and sodium. These exceedances have also been identified in upgradient monitoring wells SWMW-118 and SWMW-64 and are likely related to background groundwater concentrations at the Site.

4.3.1.3 Bedrock (Granitic Gneiss)

Bedrock groundwater sampling is summarized in Table 4-2. This table identifies the total number of detections and the number of detections over the applicable screening values in bedrock groundwater. The full analytical data are provided in Appendix I-2.

4.3.1.3.1 Building 58/83, Building 36

In bedrock groundwater, the plume in the Building 58 area is well defined and consists of both aromatics and chlorinated VOCs, as well as PAHs. The highest concentrations of BTEX and chlorinated VOCs occur at SWMW-125. TCE and its daughter products are detected. This plume is bounded to the north by upgradient bedrock monitoring wells SWMW-124/47, SWMW-51, SWMW-42, SWMW-136, and ITMW-28. SWMW-49, downgradient from SWMW-125, does not exhibit any COC detections other than background metals, but is screened shallower than 125 feet. This indicates chlorinated VOC COCs may only be present in deeper bedrock fractures, and not present at shallower bedrock depths. All of these monitoring wells present no detections within their recent sampling events. PAHs are present only at ITMW-14 and SWMW-125. During several recent sampling events at ITMW-14, a variable LNAPL thickness has been observed ranging from no observation (0.0 ft) to 0.27ft.

The area of likely aromatic VOC impacts may connect along the fault with the Building 36 plume, and includes monitoring wells SWMW-45, SWW-55, SWMW-123, ITMW-31, and ITMW-22, which exhibit similar compound exceedances of benzene, chlorobenzene, and dichlorobenzenes. The highest concentrations of benzene and chlorobenzene have been detected at SWMW-55, BR-2, ITMW-12, and ITMW-30; however, detections of these aromatic VOCs were not observed during the most recent sampling events.

Concentrations of chlorinated VOCs in the Building 36 area, such as 1,1-DCE and 1,1,1-TCA, have been detected in the bedrock monitoring wells along Fishkill Creek in ITMW-22 and SWMW-123.

PAH SVOCs such as benzo(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl) phthalate, and indeno(1,2,3-cd)pyrene have been detected above criteria at monitoring well SWMW-45, but other bedrock monitoring wells in the area do not exhibit this exceedance. Additionally, naphthalene has been detected at monitoring wells ITMW-22 and ITMW-31 and has previously been detected at SWMW-55.

There are no TAL Metals exceedances besides the likely background metals (aluminum, iron, manganese, and sodium) in bedrock groundwater in this area.

4.3.1.3.2 Building 55

The bedrock groundwater in the Building 55 area exhibits similar COC exceedances as the Building 45 area discussed in Section 4.3.1.2.2. The bedrock groundwater in the Building 55 area is characterized by the presence of two main COC groups, one consisting of aromatic and chlorinated VOCs, and the other PAH SVOCs. TAL Metals exceedances have also been identified; however, these exceedances are likely due to natural site conditions (background concentrations) and not related to activities performed in the facility.

Aromatics and chlorinated VOC exceedances in the Building 55 area occur at bedrock monitoring wells SWMW-9, SWMW-44, and ITMW-28 and include: 1,1-dichloroethene, 1,2-dichloroethene, 1,1-DCA, 1,1,1-TCA, chloroethene, cis-1,2-DCE, TCE, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, chlorobenzene, benzene, and toluene. Most of these exceedances have been detected at monitoring wells SWMW-44 and ITMW-28, with the latter exhibiting the largest number of exceedances. The highest concentrations of benzene and chlorinated VOCs occur at monitoring well ITMW-28, located to the south of Building 55. Bedrock monitoring well SWMW-44, bounding Building 55 to the north, has also exhibited high concentrations of chlorobenzene. TCE and daughter products have also been detected in both monitoring wells SWMW-44 and ITMW-28.

The aromatic and chlorinated VOCs impacted area is bounded to the north by bedrock monitoring wells SWMW-57, ITMW-9, and SWMW-26 and to the east by bedrock monitoring well SWMW-1. There are not sufficient analytical data to define a boundary to the west since bedrock monitoring wells SWMW-06 and SWMW-07 have been dry. Similarities in aromatic and chlorinated VOC exceedances have been detected near the Building 36 area; however, available analytical data are insufficient to determine if these two plumes are interconnected. No exceedances of VOCs in surface water samples from Fishkill Creek were noted.

PAH SVOC exceedances have occurred at monitoring well ITMW-28 and include benzo(a)anthracene and chrysene. Exceedances have not been detected in recent sampling events.

TAL Metal exceedances, including aluminum, iron, manganese, and sodium, have been detected at monitoring wells SWMW-44, SWMW-9, SWMW-117, and ITMW-28. These exceedances have been detected in upgradient monitoring wells at the Site and are likely related to background concentrations.

4.3.2 OU-1C Parcel (Former Washington Avenue Tank Farm)

Table 4-3 summarizes the results for OU-1C. Analytical data are provided in Appendix I-3. Groundwater exceedances at OU-1C include BTEX compounds and other VOCs, including 1,2-dichlorobenzene, acetone, and methyl tertiary-butyl ether, as well as related SVOCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene). Additional SVOCs detected in assorted monitoring wells include 2-methylnaphthalene, 2-methylphenol, 4-methylphenol, bis(2-ethylhexyl) phthalate, naphthalene, and phenol. COCs exceeding the NYSDEC TOGS are provided in the table below. In addition, this table provides a range of detections, the number of different monitoring wells investigated, and the number of samples collected.

Parameters	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples
Volatile Organic Compounds				
1,2-Dichlorobenzene (o-Dichlorobenzene)	**3**	0.7 - 7	38	287
Acetone	**50**	8 - 110	38	149
Benzene	**1**	0.5 - 550	38	258
Methyl-t-butyl ether	**10**	0.6 - 110	38	214
Toluene	**5**	0.8 - 55	38	225
Xylene (total)	**5**	0.9 - 1500	38	220
Semi-volatile Organic Compounds				
2-Methylnaphthalene	**36**	0.1 - 170	38	209
2-Methylphenol (o-Cresol)	**1**	1 - 2	38	205
4-Methylphenol (p-Cresol)	**1**	2 - 4	38	205
Benzo(a)anthracene	**0.002**	0.1 - 0.4	38	216
Benzo(a)pyrene	**0.025**	0.1 - 0.4	38	216
Benzo(b)fluoranthene	**0.002**	0.1 - 0.5	38	216
Benzo(k)fluoranthene	**0.002**	0.2 - 0.2	38	216
bis(2-Ethylhexyl)phthalate	**5**	2 - 14	38	214
Chrysene	**0.002**	0.1 - 0.8	38	216
Indeno(1,2,3-cd)pyrene	**0.002**	0.1 - 0.3	38	216
Naphthalene	**10**	0.1 - 260	38	225
Phenol	**1**	0.6 - 36	38	205
Metals				
Aluminum	**100**	87.4 - 30200	38	143
Antimony	**3**	10.1 - 33	38	143
Arsenic	**25**	8.4 - 233	38	143

Parameters	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples
Cadmium	**5**	0.43 - 9	38	143
Chromium	**50**	1.1 - 968	38	143
Cobalt	**5**	0.71 - 33.6	38	143
Iron	**300**	55.2 - 66200	38	143
Lead	**25**	3 - 131	38	170
Magnesium	**35000**	4190 - 44100	38	143
Manganese	**300**	1.6 - 17900	38	176
Nickel	**100**	1.1 - 189	38	143
Selenium	**10**	7.7 - 12.3	38	143
Sodium	**20000**	5380 - 435000	38	143
Thallium	**0.5**	7.4 - 8.5	38	143

Notes:

All values are provided in micrograms per liter (ug/L)

NYSDEC TOGS: New York Technical and Operational Guidance Series

USEPA: United States Environmental Protection Agency

RSL: Regional Screening Levels

--: Not applicable

4.3.2.1 Overburden

The VOC impacts at OU-1C are limited to a central location, with the maximum concentrations detected at SWMW-21, where LNAPL has also been detected. Centrally located monitoring wells with VOC exceedances include SWMW-50, SWMW-60, SWMW-61, and SWMW-71. Monitoring wells SWMW-30 through SWMW-33 along Fishkill Creek have had detections of both VOCs and SVOCs. PAHs extend slightly to the south and are detected at SWMW-72, SWMW-102, SWMW-127, and SWMW-20, as well as some of the monitoring wells with VOC exceedances (SWMW-21 and SWMW-60). Bis(2-ethylhexyl) phthalate and acetone have been infrequently detected at TF-5, TF-26, SWMW-34, and SWMW-38.

TAL Metals, including aluminum, antimony, arsenic, cadmium, chromium, iron, lead, magnesium, manganese, nickel, selenium and sodium, and thallium, have been detected in multiple monitoring wells above the TOGS standards. Since upgradient, unimpacted monitoring wells exhibit detections of aluminum, iron, magnesium, manganese, and sodium, these metals are likely naturally occurring in groundwater and / or are a result of sampling methodology.

Arsenic has been detected at monitoring wells that have detections of BTEX including near-creek monitoring wells SWMW-30 through SWMW-32, the LNAPL impacted monitoring well SWMW-21, and central monitoring wells SWMW-50, SWMW-60, SWMW-61, and SWMW-71. Additionally, arsenic has been detected at SWMW-29 and has been infrequently detected at TF-15, TF-26, SWMW-22, SWMW-35, SWMW-74, and SWMW-102.

Lead has been detected at SWMW-20 and infrequently detected at SWMW-19, SWMW-21, SWMW-29, SWMW-35, SWMW-73, SWMW-102, TF-05, TF-06, and TF-23.

4.3.2.2 Bedrock

Groundwater in the bedrock of OU-1C has not been investigated. Due to the presence of layers of silt and clay, as discussed in Section 2.4.4.2.1, the low permeability of these layers suggests that impacts to the overburden would not migrate to the bedrock aquifer. Due to this determination, bedrock has not been investigated. This choice was made to prevent any impact to the bedrock aquifer occurring due to drilling operations.

4.3.3 OU-1D Parcel (Residential Property and Rail Siding Area)

OU-1D results are summarized in Table 4-4. Analytical data are provided in Appendix I-4. No VOCs or SVOCs were detected in groundwater at OU-1D. COCs exceeding the NYSDEC TOGS are provided in the table below. In addition, this table provides a range of detections, the number of different monitoring wells investigated, and the number of samples collected.

Parameter name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Sample Count
Metals				
Aluminum	**100**	1920 - 305000	7	8
Arsenic	**25**	2 - 169	7	8
Barium	**1000**	36.5 - 1630	7	8
Beryllium	**3**	0.12 - 16.8	7	8
Chromium	**50**	3 - 533	7	8
Cobalt	**5**	1.1 - 300	7	8
Copper	**200**	13.1 - 819	7	8
Iron	**300**	2810 - 674000	7	8
Lead	**25**	2 - 455	7	8
Magnesium	**35000**	14400 - 255000	7	8
Manganese	**300**	63.9 - 29500	7	8
Manganese (Dissolved)	**300**	17.7 - 1030	7	8
Nickel	**100**	2.7 - 580	7	8
Sodium	**20000**	37600 - 404000	7	8
Sodium (Dissolved)	**20000**	32700 - 412000	7	8
Thallium	**0.5**	0.41 - 1.5	7	8

Parameter name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Sample Count
Vanadium	**86**	2.9 - 584	7	8
Mercury	**0.7**	0.37 - 2.4	7	8

Notes:

All values are provided in micrograms per liter (ug/L)

NYSDEC TOGS: New York Technical and Operational Guidance Series

USEPA: United States Environmental Protection Agency

RSL: Regional Screening Levels

--: Not applicable

4.3.3.1 Overburden

TAL Metals that have been detected above the NYSDEC TOGS standards include, arsenic, barium, beryllium, chromium, cobalt, copper, lead, magnesium, manganese, nickel, sodium, thallium, vanadium, and mercury. Additionally, dissolved concentrations of aluminum, iron, manganese, and sodium were detected above screening levels. Most of the temporary well points at OU-1D only exhibit exceedances of total aluminum, total iron, total and dissolved manganese, and total and dissolved sodium, likely indicating that these compounds are present in background conditions. The temporary well points with additional metal exceedances include OU1DSB03, OU1DSB08, OU1DSB10, and OU1DSB11. Those exceedances include compounds such as arsenic, lead, and mercury, which are considered major COCs. The overburden groundwater does not appear impacted by VOCs or SVOCs, which may indicate these metals impacts are related to suspended solids in the sample. An additional analysis of possible TAL Metal exceedance sources is provided in section 4.4.3.

4.3.3.2 Bedrock

Only temporary well points have been drilled in the overburden as part of an initial ESA. The bedrock groundwater at OU-1D has not been investigated.

4.3.4 OU-1E Parcel (Back 93 Acre)

The primary COCs at OU-1E are presented and covered in the yearly semi-annual sampling reports. These COCs include TCE, 1,1-DCA, 1,2-DCE, and HCBD. A summary of OU-1E groundwater sampling results is presented in Table 4-5. The analytical data are provided in Appendix I-5. Recent analytical data have been presented on Figure 4-3. COCs exceeding the NYSDEC TOGS are provided in the table below. In addition, this table provides a range of detections, the number of different monitoring wells investigated, and the number of samples collected.

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples
Volatile Organic Compounds				
1,2-Dichloroethene	**5**	0.7 - 18	9	225
Methyl-t-butyl ether	**10**	59 - 59	12	214
Trichloroethene (Trichloroethylene)	**5**	0.7 - 31	12	244
Semi-volatile Organic Compounds				
1,4-Dioxane	**0.46**	2.2 - 2.2	11	21
2,6-Dinitrotoluene	**5**	11 - 11	12	218
2-Methylphenol (o-Cresol)	**1**	2 - 2	12	218
Benzo(a)anthracene	**0.002**	0.1 - 4	12	218
Benzo(a)pyrene	**0.025**	0.2 - 5	12	218
Benzo(b)fluoranthene	**0.002**	0.1 - 8	12	218
Benzo(k)fluoranthene	**0.002**	0.1 - 3	12	218
Chrysene	**0.002**	0.1 - 6	12	218
Dibenz(a,h)anthracene	**0.025**	0.1 - 0.8	12	218
Hexachlorobutadiene	**0.5**	0.6 - 6	12	218
Indeno(1,2,3-cd)pyrene	**0.002**	0.1 - 4	12	218
Nitrobenzene	**0.4**	1 - 1	12	218
Metals				
Aluminum	**100**	12700 - 29800	3	3
Cobalt	**5**	8.2 - 31.8	3	3
Iron	**300**	30200 - 64600	3	3
Lead	**25**	0 - 53.5	12	85
Magnesium	**35000**	8770 - 61300	3	3
Manganese	**300**	758 - 2620	3	3

Notes:

All values are provided in micrograms per liter (ug/L)

NYSDEC TOGS: New York Technical and Operational Guidance Series

USEPA: United States Environmental Protection Agency

RSL: Regional Screening Levels

--: Not applicable

4.3.4.1 Overburden

Occasional detections of PAHs in OS-2 and OS-3 have been attributed to the road replacement that occurred close in time to these sampling events. During the Data Gap Investigation, one temporary well point (OU1EESB20) had detections of PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene) above the criteria. These compounds have not been detected in groundwater elsewhere at OU-1E. These results may be attributable to the temporary well point installation and sampling methods and may not be representative of groundwater conditions.

4.3.4.2 Bedrock

Karstic bedrock at OU-1E has been previously investigated during initial site investigation activities. No exceedances of COCs in bedrock groundwater were noted; the monitoring wells were abandoned in 2000. Currently, OR-2 and OR-3 are the only bedrock monitoring wells in place near OU-1E. These two monitoring wells have exhibited occasional detections of PAHs, as have been seen in the OS-2 and OS-3 monitoring wells. Similarly, these have been attributed to the road replacement.

4.3.5 OU-3 Parcel (Residential Property)

No monitoring wells were installed in OU-3 since there were no TRCB activities on the OU. However, temporary well points were installed to assess groundwater quality. A summary of sampling results is presented in Table 4-6. Analytical data are provided in Appendix I-6. COCs exceeding the NYSDEC TOGS are provided in the table below. In addition, this table provides a range of detections, the number of different monitoring wells investigated, and the number of samples collected.

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples
Volatile Organic Compounds				
Acetone	**50**	12 - 56	2	2
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**0.002**	0.3 - 0.3	2	2
Benzo(a)pyrene	**0.025**	0.4 - 0.4	2	2
Benzo(b)fluoranthene	**0.002**	0.5 - 0.5	2	2
Benzo(k)fluoranthene	**0.002**	0.2 - 0.2	2	2
Chrysene	**0.002**	0.4 - 0.4	2	2
Indeno(1,2,3-cd)pyrene	**0.002**	0.3 - 0.3	2	2
Metals				
Aluminum	**100**	180000 - 1730000	2	2
Aluminum (Dissolved)	**100**	1320 - 1320	2	2
Arsenic	**25**	43.1 - 61.1	2	2

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Number of Samples
Barium	**1000**	720 - 1330	2	2
Beryllium	**3**	6.8 - 12.7	2	2
Cadmium (Dissolved)	**5**	5.2 - 5.2	2	2
Chromium	**50**	289 - 511	2	2
Cobalt	**5**	106 - 199	2	2
Cobalt (Dissolved)	**5**	3.6 - 352	2	2
Copper	**200**	259 - 433	2	2
Iron	**300**	220000 - 2040000	2	2
Iron (Dissolved)	**300**	24.5 - 25600	2	2
Lead	**25**	137 - 272	2	2
Magnesium	**35000**	71500 - 594000	2	2
Magnesium (Dissolved)	**35000**	32300 - 113000	2	2
Manganese	**300**	14300 - 65700	2	2
Manganese (Dissolved)	**300**	4630 - 55100	2	2
Nickel	**100**	268 - 2490	2	2
Nickel (Dissolved)	**100**	5.7 - 233	2	2
Sodium	**20000**	19000 - 192000	2	2
Sodium (Dissolved)	**20000**	86500 - 295000	2	2
Thallium	**0.5**	1 - 1.5	2	2
Vanadium	**86**	191 - 312	2	2
Mercury	**0.7**	0.32 - 4.2	2	2

Notes:

All values are provided in micrograms per liter (ug/L)

NYSDEC TOGS: New York Technical and Operational Guidance Series

USEPA: United States Environmental Protection Agency

RSL: Regional Screening Levels

--: Not applicable

4.3.5.1 Overburden

During the Data Gap Investigation, the one temporary well point (OU3SB02) installed at OU-3 had detections of acetone and PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene) above the criteria. Additionally, sampling at this OU as a part of the Data

Gap Investigation indicated the presence of total and dissolved metals above the NYSDEC TOGS standards. The PAH and total metals results may be attributable to background concentrations in groundwater or temporary well point installation and sampling methods which may have allowed for a higher concentration of suspended particles.

4.3.5.2 Bedrock

Only temporary well points have been drilled in the overburden as part of an initial ESA. The bedrock groundwater at OU-3 has not been investigated.

4.3.6 OU-4 Parcel (Hydroelectric Dam Property)

Detections at the portion of OU-4 to the north of Fishkill Creek are generally equivalent to detections at OU-1A. All detections have been consolidated into Table 4-7, with full analytical data provided in Appendix I-7. COCs exceeding the NYSDEC TOGS are provided in the table below. In addition, this table provides a range of detections, the number of different monitoring wells investigated, and the number of samples collected.

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Sample Count
Volatile Organic Compounds				
1,2-Dibromo-3-chloropropane (DBCP)	**0.00033**	4 - 4	1	1
1,2-Dichlorobenzene (o-Dichlorobenzene)	**3**	0.8 - 4	14	46
1,4-Dichlorobenzene	**3**	1 - 9	14	46
Benzene	**1**	0.5 - 12	14	54
Chlorobenzene	**5**	1 - 44	14	53
Toluene	**5**	0.9 - 12	14	46
Semi-volatile Organic Compounds				
Benzo(a)anthracene	**0.002**	2 - 5	14	42
Benzo(a)pyrene	**0.025**	2 - 5	14	42
Benzo(b)fluoranthene	**0.002**	0.1 - 6	14	42
Benzo(k)fluoranthene	**0.002**	2 - 2	14	42
bis(2-Ethylhexyl)phthalate	**5**	3 - 19	14	42
Chrysene	**0.002**	0.1 - 6	14	42
Dibenz(a,h)anthracene	**0.025**	0.5 - 0.7	14	42
Indeno(1,2,3-cd)pyrene	**0.002**	1 - 3	14	42
Metals				
Aluminum	**100**	106 - 12900	10	36
Arsenic	**25**	6.9 - 31.5	10	38
Cadmium	**5**	0.44 - 8.6	10	38

Parameter Name	NYSDEC TOGS & USEPA Tap Water RSL	Detection Range	Monitoring Well Locations	Sample Count
Chromium	**50**	1.4 - 172	10	38
Cobalt	**5**	0.66 - 6.8	10	36
Iron	**300**	69 - 26000	10	36
Lead	**25**	6.3 - 46.8	10	38
Magnesium	**35000**	3220 - 68500	10	36
Magnesium (Dissolved)	**35000**	25200 - 68400	4	4
Manganese	**300**	5.7 - 7860	10	45
Sodium	**20000**	989 - 912000	10	36
Sodium (Dissolved)	**20000**	24200 - 69000	4	4

Notes:

All values are provided in micrograms per liter (ug/L)

NYSDEC TOGS: New York Technical and Operational Guidance Series

USEPA: United States Environmental Protection Agency

RSL: Regional Screening Levels

--: Not applicable

4.3.6.1 Overburden

VOCs (benzene, chlorobenzene, toluene, and 1,2- and 1,4-dichlorobenzene) and PAHs (benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) have been detected above the NYSDEC TOGS standards at the portion of OU-4 to the north of Fishkill Creek. In overburden water to the south of Fishkill Creek, the four temporary well points did not indicate exceedances or impacts above background concentrations.

4.3.6.2 Bedrock

Bedrock monitoring wells on the portion of OU-4 bounding the southern side of Fishkill Creek have not exhibited exceedances of organic compounds. TAL Metals, including chromium, and background metals have been detected in these monitoring wells.

4.3.7 Emerging Contaminant Investigation Results

Groundwater results from the Emerging Contaminant Investigation are detailed in Tables 4-8 and 4-9. The results of the 1,4-dioxane investigation are presented on Figures 4-5A and 4-5B. Results of the PFAS investigation are presented on Figures 4-6A and 4-6B.

Seven monitoring wells (SWMW-41, SWMW-62, SWMW-67, SWMW-125, SWMW-140, DC-2, and DB-8A) were sampled and analyzed for 1,4-dioxane, and seven monitoring wells (DB-8A, DC-2, ITMW-25, SWMW-21, SWMW-59, ITMW-2, and SWMW-140) were sampled and analyzed for 21 PFAS compounds. Only two monitoring wells identified 1,4-dioxane at detectable levels – DB-8A and SWMW-41. The concentration of 1,4-dioxane at DB-8A was 2.2 µg/L. The concentration of 1,4-dioxane at SWMW-41 was 5.6 µg/L.

Two monitoring wells (DC-2 and SWMW-140) were selected for inclusion as upgradient (background) locations. There were no perfluorooctanesulfonic acid (PFOS) or perfluorooctanoic acid (PFOA) detections in DC-2. Groundwater from SWMW-140 had concentrations of 15 nanograms per liter (ng/L) PFOS and 3.7 ng/L PFOA. PFOS and PFOA concentrations in DB-8A were 1.3 ng/L and 10 ng/L, respectively. Groundwater from SWMW-21 had a concentration of 5.9 ng/L PFOS and 3.6 ng/L PFOA. Groundwater from ITMW-02 had concentrations of 1.5 ng/L PFOS and 5 ng/L PFOA. ITMW-25 had concentrations of 10 ng/L PFOS and 10 ng/L PFOA. SWMW-59 had concentrations of 6.8 ng/L PFOS and 6 ng/L PFOA. PFAS compounds were detected in one equipment blank (EB-W-191031) and two field blanks (FB-W-191028 and FB-W-191031) at concentrations less than the laboratory reporting limit but above the method detection limit.

4.4 Fate and Transport

The discussion of fate and transport in groundwater focuses on the three primary classes of COCs: chlorinated VOCs, petroleum hydrocarbons, and inorganics as well as the movement of COCs in groundwater in the overburden and bedrock units.

4.4.1 Chlorinated VOCs

Chlorinated VOCs are present in groundwater at concentrations exceeding NYSDEC TOGS standards predominantly in OU-1A. The chlorinated VOCs that most often exceed criteria are TCE and chlorobenzene and their degradation products. TCE and its daughter products (including cis-1,2-DCE and vinyl chloride) predominantly occur in groundwater at concentrations above their respective standards east of the fault (near and downgradient from Building 51), most prominently in monitoring wells screened in dolomite. TCE is also present above its standard in selected monitoring wells west of the fault, notably granitic gneiss monitoring wells SWMW-44, SWMW-114, and SWMW-125. As is the case east of the fault, samples from monitoring wells where the TCE standard is exceeded west of the fault frequently contain daughter products cis-1,2-DCE and vinyl chloride, but at lower concentrations. Chlorobenzene occurs at concentrations exceeding its groundwater standard predominantly west of the fault. Chlorobenzene is detected at concentrations exceeding its standard at only two locations east of the fault, monitoring well SWMW-15 and temporary well point PCFGW-055, both screened in the overburden. Based on the available information, it is inferred that TCE and chlorobenzene were released at or near the land surface (e.g., from spills and leaks at the surface and/or leaks in near-surface piping and sewers) at multiple locations.

At OU-1E, TCE and another chlorinated VOC, HCBD, occur above their NYSDEC TOGS standards in samples from only two monitoring wells. These wells monitor former disposal areas that have been remediated and closed. Because TCE and HCBD are only detected in a few monitoring wells in this area and at low concentrations, their source is attributed to a small amount of residual impacts near the former disposal areas. HCBD analyses at OU-1A result in non-detect concentrations above the groundwater quality standard; therefore, HCBD contamination at OU-1A cannot be completely ruled out.

If released in their pure form, chlorinated VOCs, which do not dissolve appreciably in and are denser than water[12], would tend to migrate downward through the vadose zone to the water table. If released in sufficient quantity, these compounds could penetrate the water table and continue to migrate downward. During migration, a significant portion of the DNAPL is retained in porous media, thereby depleting, and eventually exhausting, the mobile DNAPL body. The analytical results for groundwater samples suggest that there is no DNAPL near any of the monitoring wells chlorinated VOCs are detected. Specifically, the maximum concentrations of these chemicals detected during recent sampling events are well below 1% of their solubilities in water; a threshold generally accepted to be indicative of DNAPL presence (USEPA 1993).

Transport of dissolved chlorinated VOCs in overburden groundwater is controlled by advection and dispersion through the mobile porosity (interconnected regions of higher hydraulic conductivity), diffusion into and back-diffusion from the relatively immobile pore water contained in low-permeability deposits (e.g., silt- and clay-rich materials such as till), volatilization into soil gas, and natural attenuation processes caused by degradation or retardation through sorption. Transport of dissolved COCs in the bedrock is controlled by advection and dispersion through fractures and, in the dolomite, solution porosity; diffusion into the relatively immobile pore water in the rock matrix; retardation processes caused by sorption; volatilization into unsaturated fractures and solution porosity; and other biophysical processes (Geyer et al. 2007; Padilla and Vesper 2018).

4.4.1.1 Trichloroethene

The primary area where TCE occurs in overburden groundwater is the area surrounding and downgradient (south) of Building 51. Groundwater exceedances are more widespread in the bedrock, and the highest concentrations occur here. In 2001, an excavation at Building 51 was performed to remove soil impacted with petroleum hydrocarbons and TAL Metals. Initial test-pit sampling indicated one sample with a level of TCE above the current Unrestricted/POG SCOs; however, this detection did not exceed the 1994 Recommended SCOs used at that time (NYSDEC 1994b). This location was removed during the follow-up excavation, and follow-up soil sampling in the area did not have any TCE detections. TCE exceeds criteria in essentially three other areas in OU-1A: near Building 55, near Building 58, and near the former WWTP (just below the Texaco Dam). At Building 55, groundwater samples collected from the overburden at two temporary well points slightly exceeded the NYSDEC TOGS standards, and samples collected from one bedrock monitoring well (SWMW-44) exceed the standard. This well screens the granitic gneiss and concentrations detected in recent samples collected from it average 135 µg/L. At Building 58, the TCE standard is exceeded only at two bedrock monitoring wells (SWMW-114 and SWMW-125), with concentrations ranging from 240 to 270 µg/L in recent samples. These monitoring wells are also screened in the granitic gneiss and the overburden is typically unsaturated nearby. The overburden saturated thickness beneath Building 58, as monitored by monitoring wells UKW-01 through UKW-03, is typically 3 feet or less. Groundwater in these monitoring wells has historically contained chlorobenzene but not TCE. Concentrations exceeding criteria near the former WWTP are limited to

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[12] The term used to describe such liquids is dense non-aqueous phase liquids (DNAPLs).

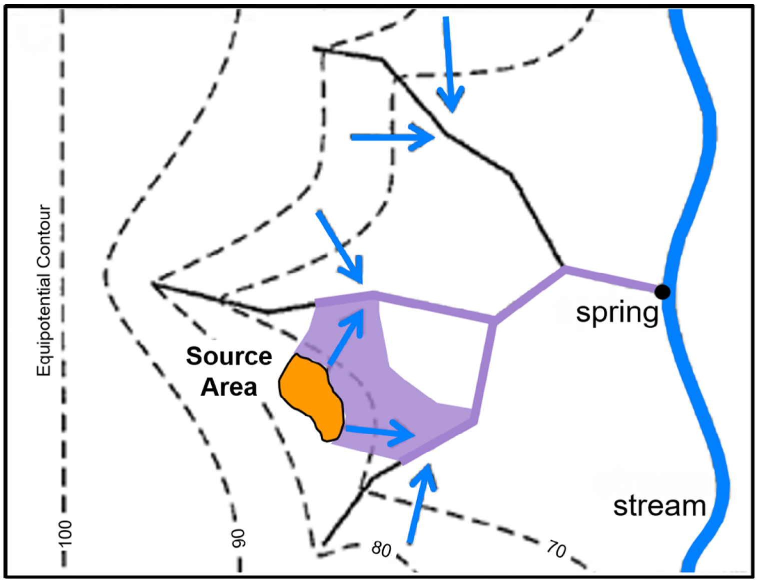
samples collected from two monitoring wells, overburden monitoring well SWMW-65 and dolomite bedrock monitoring well SWMW-27. Detected concentrations at both of these locations are only slightly above the NYSDEC TOGS standards. The number of monitoring wells exhibiting TCE exceedances has declined over time, and concentrations in monitoring wells currently exhibiting exceedances have either stabilized or gradually declined (Parsons 2019b).

The above observations indicate that:

- TCE was released at several discrete areas in OU-1A, with the largest apparent release area located around Building 51.
- The direction of migration of dissolved TCE through the overburden near Building 51 was predominantly downward to the bedrock. Dissolved TCE in overburden groundwater also moves laterally toward Fishkill Creek.
- The direction of migration of dissolved TCE through the overburden near Building 55 was also predominantly downward to the bedrock, as mappable plumes of TCE in the overburden in these areas do not exist.
- Overburden groundwater beneath Building 58 contains chlorobenzene but not TCE; therefore, the source of TCE to nearby bedrock monitoring wells SWMW-114 and SWMW-125 is uncertain.
- Concentrations of dissolved TCE have declined slowly over time, demonstrating that the extent of dissolved TCE in groundwater is shrinking.
- Historical TCE migration pathways through the till and in the bedrock were spatially sporadic, likely following preferential pathways (e.g., macropores and fractures).
- TCE migrating along these pathways has diffused into the soil and rock matrix and acts as a long-term, secondary source of dissolved TCE to groundwater.
- The localized, relatively low concentrations of TCE near the former WWTP are inferred to be due to localized spills/leaks of wastewater during plant operation.

Movement of COCs such as TCE through karst aquifers (in this case, the dolomite) is different than in most other geologic media. In the dolomite, most of the impacted groundwater moves relatively rapidly through the integrated network of solution porosity (i.e., the conduit network). Tracer studies conducted in karst aquifers demonstrate that significant dilution occurs along these networks, as tributary conduits containing clean water join downgradient. TCE stored in the overburden, the dolomite matrix, and unweathered fractures moves slowly toward and discharges into the nearest branch of the drainage network. Groundwater transported by the network is expected to discharge at focused points beneath the creek.

Due to the mode of transport described above, conventional plumes of impacted groundwater do not form in karst aquifers (Ewers et al. 2012; White 2018). This concept is depicted in the adjacent graphic. This transport behavior means that the extent of impacted groundwater in karst aquifers cannot be defined as precisely as in most other hydrogeologic settings. Given that the Site is located adjacent to Fishkill Creek, a local groundwater discharge boundary, and that the aquifer is bounded by the fault, impacted groundwater in the dolomite cannot migrate off site, but does migrate to the creek, although concentrations at discharge points are expected to be significantly attenuated.



Distribution of Dissolved Contamination Emanating from a Continuous Source.

The dissolved contamination is shown in purple. The semblance of a plume may form near the source area, but, with distance downgradient, impacted groundwater becomes confined to the portion of the conduit network draining the impacted groundwater.

A transport mode that is almost exclusively limited to karst aquifers is transport of suspended solids. This transport mechanism could be relevant if COCs such as TCE are adsorbed to the suspended solids. The large aperture size of the solution-porosity network in karst aquifers can accommodate turbulent flow, which can entrain and transport solid particles through the aquifer. This mode of transport most commonly occurs in karst aquifers that receive focused recharge – water entering the aquifer rapidly at discrete points such as sinkholes and disappearing streams. Due to glaciation, a layer of till covers the bedrock that serves as a cap over the aquifer and promotes diffuse, rather than focused, recharge to the aquifer. As such, transport of suspended solids in the dolomite is not considered to be a viable mechanism. While cavities wholly or partially filled with sediment have been penetrated at the Site, this sediment most likely represents material that migrated into the aquifer long ago, prior to or during glaciation.

Given the long time since releases occurred at the Site, and the relatively high groundwater velocities associated with the active flow system of karst aquifers, the maximum extent of dissolved impacts in the dolomite, including TCE, will have been attained relatively rapidly after releases occurred. Today, the extent of impacted groundwater is gradually shrinking, as TCE stored in low-permeability regions of the overburden and bedrock slowly dissolves.

The presence of TCE daughter products in groundwater indicates that TCE is degrading. Results of a CSIA study performed at the Site indicated TCE and its daughter products (i.e., cis-1,2-DCE and vinyl chloride) were degrading within impacted groundwater in the overburden and bedrock in the Building 51 area. This finding was based on TCE and its daughter products concentration trends along the interpreted groundwater flow path, carbon-13 (^{13}C) enrichment and isotopic mass balance of the chlorinated ethenes (Parsons 2017b).

Groundwater samples used in this study were collected from three overburden monitoring wells (SWMW-58, SWMW-67, and SWMW-113) and three dolomite bedrock monitoring wells (SWMW-66, SWMW-68, and SWMW-126).

The distribution of dissolved TCE west of the fault, where overburden is underlain by granitic gneiss, indicates that no significant source areas occur in the overburden. Consequently, lateral movement of dissolved TCE in the overburden is limited, as evidenced by low concentrations of TCE and the absence of mappable plumes. In the bedrock, concentrations are higher and generally isolated – the three monitoring wells yielding samples with elevated TCE concentrations are surrounded by bedrock monitoring wells where TCE is not detected above its standard. This observation demonstrates that impacted groundwater in the gneiss is relatively isolated, the fracture network through which impacted groundwater is moving is poorly integrated and the resulting migration pathways are sporadic. Impacted groundwater will be limited to discrete portions of the fracture network and is not expected to form traditional, mappable plumes. The concentration of TCE in groundwater moving through fractures is attenuated by dilution, dispersion, sorption, degradation, and diffusion into the rock matrix. Although no CSIA study has been performed in the gneiss, the presence of TCE daughter products in monitoring wells containing TCE demonstrates that degradation of TCE is also occurring, further decreasing TCE concentrations. Figures 4-4A and 4-4D represent the TCE exceedances detected at the Site at two different time intervals – sampling from 2012-2013 and 2016-2018.

4.4.1.2 Chlorobenzene

Groundwater containing chlorobenzene at concentrations exceeding the NYSDEC TOGS standard is present almost exclusively west of the fault in OU-1A. The exceptions are two overburden locations near Building 51, and two overburden locations and one bedrock monitoring well near the former WWTP. Both of these areas are also impacted by TCE. Like TCE, the chlorobenzene near the former WWTP is attributed to localized historical spills/leaks of wastewater during plant operation.

The fate and transport characteristics of chlorobenzene are similar to TCE. Chlorobenzene concentrations in the overburden are highest, and most frequently exceed its standard, near Buildings 55 and 56. The distribution of chlorobenzene in this area indicates that it was released at more than one location. Groundwater in the overburden here moves laterally toward the fault (southeastward), which is located less than 200 feet away. In areas where there is a downward hydraulic gradient, overburden groundwater also moves downward into the bedrock. Attenuation mechanisms for chlorobenzene in overburden groundwater are the same as for TCE. Also similar to TCE, overburden concentrations are either stable or declining, indicating that the extents of impacts are at steady state or are shrinking. Benzene is also an intermediate degradation product of chlorobenzene and is present in overburden groundwater above its NYSDEC TOGS standard. The distribution of benzene overlaps but does not precisely mirror that of chlorobenzene. As such, a fraction of the benzene in overburden groundwater west of the fault may represent degradation of chlorobenzene, but another source of benzene in this area likely exists.

Similar to TCE, a CSIA study was conducted in 2015 to assess natural attenuation through chemical transformation for chlorobenzene and for 1,2-dichlorobenzene to also assess its impact on isotopic changes in chlorobenzene. Significant enrichment in ^{13}C in monitoring wells located downgradient along the interpreted groundwater flow path in Buildings 45/55 overburden and bedrock groundwater plumes and Buildings 58/83/36 groundwater plumes was noted. This finding indicated chlorobenzene degradation was taking place within those plumes in the direction of decreasing chlorobenzene concentrations. The results also suggested further enrichment of chlorobenzene was suppressed likely due to degradation of 1,2-dichlorobenzene to chlorobenzene as an intermediate (Parsons 2016).

Chlorobenzene occurs at concentrations exceeding its standard in a small subset of monitoring wells screened in the granitic gneiss bedrock. Not surprisingly, some of these monitoring wells are located beneath impacted areas of overburden. Additionally, bedrock monitoring wells near Buildings B-79 (SWMW-55 and SWMW-123) and B-58 (ITMW-13, SWMW-114, and SWMW-125) also yield samples containing elevated concentrations of chlorobenzene. At these locations, the overburden is typically dry.

Dissolved chlorobenzene moves downward into the gneiss through open fractures, most of which are steeply dipping. Essentially all groundwater movement in the gneiss occurs through the fracture network. Geophysics performed in borings drilled through the gneiss demonstrate that open fractures are relatively sparse with small apertures, and generally parallel, and dip steeply away from the fault. Groundwater elevations in the gneiss are high; even near the creek they are 30 to 40 feet above the creek level, demonstrating that the rock is poorly drained. This fact combined with the steeply dipping nature of the fractures and the sporadic occurrence and distribution of chlorobenzene in bedrock monitoring wells demonstrates that transport pathways for dissolved impacts are poorly integrated. This conclusion is supported by the absence of mappable plumes in the rock. If the rocks were pervasively fractured, impacted groundwater would tend to be more widespread. Concentrations of chlorobenzene are attenuated by dilution, advection, dispersion, adsorption into the rock matrix, and likely biodegradation.

Bedrock groundwater containing chlorobenzene likely moves toward the fault, and, where the fault underlies Fishkill Creek, toward the creek itself. If the portion of the fault underlying OU-1A is permeable, this groundwater will move along the fault and discharge to Fishkill Creek. If the fault is impermeable, this groundwater will move parallel to the fault and discharge to Fishkill Creek. In either case, some groundwater may seep out of the steep bedrock bluff along the creek in this area. Figures 4-4H and 4-4I represent the chlorobenzene exceedances detected at the Site at two different time intervals – sampling from 2012-2013 and 2016-2018.

4.4.1.3 Other Chlorinated VOCs

Several other chlorinated VOCs occur in site groundwater above their respective criteria, though less frequently and in fewer monitoring wells than TCE and chlorobenzene. These chlorinated VOCs are TCA (and its associated daughter products 1,1-DCA and chloroethane), PCE, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1-4-dichlorobenzene. In general, where these compounds occur above applicable criteria in groundwater, they are co-located with groundwater impacted by TCE and/or chlorobenzene. The fate and transport of these compounds is expected to be similar to TCE and chlorobenzene. Figures 4-4J through 4-4M represent the exceedances of daughter products (cis-1,2-DCE and vinyl chloride) detected at the Site at two different time intervals –sampling from 2012-2013 and 2016-2018.

4.4.2 Petroleum Hydrocarbons

Petroleum compounds, including LNAPL, are only sporadically detected in groundwater at the Site considering the Site was a research facility for petroleum products for decades. The primary area where petroleum has been historically released and where groundwater impacts remain is OU-1C. In recent years, LNAPL detections have been limited and LNAPL thicknesses have been small. Some BTEX compounds – VOCs that are reasonable indicators of groundwater impacted by petroleum – have also been detected in groundwater at several locations in OU-1A at concentrations exceeding their respective NYSDEC TOGS standards. Groundwater quality data from other OUs do not suggest petroleum impacts.

Groundwater impacted by BTEX sometimes contains elevated concentrations of petroleum related SVOCs (mainly PAHs), notably naphthalene. Naphthalene tends to be more mobile in groundwater than other PAHs. Other, less mobile PAHs tend to be detected at concentrations exceeding their criteria infrequently and occur in those regions of groundwater that contain the highest concentrations of VOC impacts. This observation is consistent with the fact that these higher molecular weight PAHs tend to be poorly soluble and adsorb to aquifer materials. Figures 4-4E and 4-4G represent the benzene exceedances detected at the Site at two different time intervals –sampling from 2012-2013 and 2016-2018. In addition, SVOC exceedances for these date intervals are presented on Figure 4-4FF through 4-4VV.

4.4.2.1 OU-1C Parcel (Former Washington Avenue Tank Farm)

The quality of groundwater at this OU has been studied since the 1980s (Dunn 1984, 1989). That work and subsequent work determined that the groundwater in the area contained soluble petroleum components (principally BTEX) and that the chemical signature was consistent with weathered gasoline and diesel fuel (Dunn 1984). Historically, LNAPL had been detected in several monitoring wells at this OU, but over time the number of monitoring wells where LNAPL was present has declined. In 2016, LNAPL was detected in only one monitoring well, SWMW-21, with a measured thickness 0.28 foot (Parsons 2016). Historical results of groundwater samples collected from SWMW-21 show elevated BTEX and naphthalene, consistent with a petroleum source. Based on this information, and the fact that it has been decades since petroleum was handled at the facility, the bulk of LNAPL released during operations is inferred to be at or below residual saturation. It is likely trapped in pore spaces in the fill and alluvial sand and gravel in a smear zone created by historical, seasonal fluctuation of the water table. This material has slowly dissolved over time, creating a stable, dissolved plume of impacted groundwater.

Petroleum compounds dissolved in groundwater are predominantly benzene. During the 2016 sitewide groundwater sampling event (Parsons 2017b), when most of the monitoring wells in this OU were sampled, the concentration of benzene exceeded its NYSDEC TOGS standard in samples collected from five monitoring wells. Most impacted groundwater moves through the saturated fill and alluvial sands and gravels, discharging to Fishkill Creek. Horizontal movement is favored because the alluvium is underlain by glaciolacustrine silt and clay and/or dense till, both of which are much less permeable than the alluvium. As shown on Figure 2-2C, there is an upward gradient near the creek’s edge from the bedrock to the overburden, as would be expected hydrogeologically. This fact, coupled with the low hydraulic conductivity of the glaciolacustrine silt and clay and the till, indicates that impacted groundwater in the alluvium is unlikely to migrate into the bedrock in this area.

Petroleum compounds such as benzene biodegrade both aerobically and anaerobically (Essaid et al. 2011). Biodegradation is ongoing at the Site, as evidenced by elevated concentrations of methane and ferrous iron (Parsons 2017b) in the following table:

COC	SWMW-21	SWMW-30	SWMW-31	SWMW-71
Methane	7,000	2,200	2,600	3,900
Ferrous Iron	12,400	21,600	27,100	32,400

Notes: Concentrations reported in µg/L. Ferrous iron values are estimated.

These results demonstrate that an anoxic zone (iron-reducing to methanogenic conditions) has developed in response to the biodegradation. Based on the available information, the plume of impacted groundwater at OU-1C is stable and is naturally attenuating.

4.4.2.2 OU-1A Parcel

Evidence of petroleum-related impacts in groundwater includes the presence of elevated concentrations of one or more BTEX compounds in combination with naphthalene. Benzene alone is not a reliable indicator of petroleum-related impacts at the Site because benzene can be derived from the degradation of chlorobenzene. Using the above relationship, evidence of petroleum-related impacts to groundwater in the portion of OU-1A underlain by dolomite is limited to three monitoring wells, overburden monitoring well SWMW-15 and bedrock monitoring wells SWMW-27 and SWMW-41.

Overburden monitoring well SWMW-15 is located near Building 51; however, unlike some other monitoring wells in that area, samples from SWMW-15 do not contain TCE above its NYSDEC TOGS standard. Given its lone status, the source of the BTEX and naphthalene to this monitoring well must be localized and isolated from the B-51 TCE plume. These results are related to the contaminated soil removed near B-51 as discussed previously. Groundwater at monitoring well SWMW-27, located near the former WWTP, is also impacted by relatively low levels of chlorinated VOCs. Relatively low-level petroleum and chlorinated VOC impacts at this monitoring well are attributed to leaks and spills associated with former treatment plant operations. Monitoring well SWMW-41 is located near Building 41. Samples from this monitoring well have also contained TCE exceeding its NYSDEC TOGS standard.

In the portion of OU-1A underlain by granitic gneiss, evidence of petroleum-related impacts to overburden groundwater are limited to four sampling locations: monitoring wells ITMW-25 and SWMW-10 and temporary well points PCFGW- 011 and PCFGW-013. All four of these sampling points are located near Buildings 55 and 56, and samples collected from them also contain elevated concentrations of chlorobenzene. The transport of dissolved petroleum hydrocarbons will be similar to that described above for chlorobenzene.

For groundwater in the granitic gneiss, evidence of petroleum-related impacts is limited to four monitoring wells. At two of these monitoring wells, SWMW-114 and SWMW-125, which are located near Building 58, samples also contain elevated concentrations of TCE and chlorobenzene. The overburden in this area is thin and unsaturated. At the remaining two monitoring wells, ITMW-22, and ITMW-31, which are located near Building 36, neither TCE nor chlorobenzene are detected above NYSDEC TOGS standards. The overburden in this area is also thin and unsaturated. Impacts to these monitoring wells are attributed to localized, historical leaks or small spills. Groundwater in both these areas moves toward Fishkill Creek. The fate and transport of dissolved petroleum hydrocarbons will be similar to that described above for chlorobenzene.

LNAPL has been detected occasionally in monitoring well ITMW-14, located near Building 58. Most recently in 2016, a thickness of 0.27 foot was measured (Parsons 2017b). Historically, analytical results for this monitoring well show that BTEX was not detected and the only VOC detected above NYSDEC TOGS standards was chlorobenzene. Based on this information, it is unclear what the composition of the LNAPL may be, but it does not appear to be petroleum related.

4.4.3 TAL Metals

As described in Section 4.3, multiple TAL Metals were detected in groundwater above NYSDEC TOGS standards. Data from wells located upgradient of source areas and regions of impacted groundwater suggest that some TAL Metals may occur naturally in groundwater, sometimes at concentrations exceeding criteria. Review of groundwater TAL Metals data; however, suggests that concentrations may be biased high by the presence of particulates entrained in the samples. Evidence for this is clear when reviewing the results for aluminum. While aluminum is one of the most abundant metals in the earth's outer crust, it rarely occurs in groundwater samples in concentrations greater than a few tenths or hundredths of a milligram per liter (mg/L). Concentrations reported in excess of 1 mg/L (i.e., 1,000 µg/L) for water with a near-neutral pH (such as at the Site) likely represent particulate material entrained in the sample (Hem 1989). Because samples targeted for analysis are preserved with nitric acid, suspended matter can produce sampling artifacts (elevated concentrations of TAL Metals that are not dissolved in the groundwater and therefore not transported with the groundwater but were entrained in the sample as a result of sampling method); therefore, samples containing such matter should be filtered prior to analysis (Hem 1989; Appelo and Postma 1993). Some aluminum (and other metals) could also be contributed by colloids.[13]

Transport of TAL Metals in groundwater tends to be tied to the geochemical conditions, in particular oxidation-reduction (redox) conditions. At the typical pH range observed at the Site, TAL Metals tend to be mobile under anaerobic (reducing) conditions. As noted in Section 4.4.1.1, transport of suspended solids (i.e., particles that are larger than colloids) can occur in some karst aquifers, but this mode of transport is judged to be unlikely at the Site. Redox conditions are generally considered aerobic when dissolved oxygen concentrations are greater than about 1 mg/L. In impacted groundwaters where biodegradation is occurring, geochemical conditions are often reducing as dissolved oxygen is consumed during microbial activity. Historically, dissolved oxygen readings were typically obtained during groundwater sampling; however, the quality of those data is uncertain. This is because the data were not collected using a flow-through cell, which eliminates contact of the purged groundwater with air, but were collected using a bailer during monitoring well purging, where collected groundwater is in contact with air. As such, dissolved oxygen readings can be biased high. Regardless, it is reasonable to assume that regions of groundwater impacted by former site operations are likely under reducing conditions due to biodegradation.

In areas of the Site where degradation of organics, particularly petroleum hydrocarbons, has created anoxic (reducing) conditions in the groundwater, naturally occurring TAL Metals such as iron and arsenic may be mobilized (Cozzarelli et al. 2016). This has occurred at OU-1C, where the NYSDEC TOGS standard for arsenic was exceeded in samples collected from 12 monitoring wells in the most recent

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[13] Colloids are very small particles that can often move with groundwater.

sampling event (Parsons 2017b), and where methane and ferrous iron data clearly demonstrate anoxic conditions. Metals such as iron and arsenic that are mobilized due to the anoxic conditions are removed from groundwater at the leading edge of the plume, adsorbing to aquifer sediments (Cozzarelli et al. 2016) and/or precipitating from solution, thus becoming immobile. At OU-1C, the leading edge of the plume is at or near the groundwater-surface water interface near the creek; thus, the arsenic will bind to aquifer particles before the groundwater mixes with surface water, becoming immobilized. The primary, and in most instances, the only processes involved in the natural attenuation of inorganic COCs are sorption to aquifer minerals and precipitation (USEPA 2007).

In other areas of the Site where the concentrations of trace metals exceed NYSDEC TOGS standards (e.g., beryllium, cadmium, chromium, cobalt, lead, mercury, and thallium) and are not present at similar concentrations upgradient, the concentrations are inferred to be related to anoxic conditions in the groundwater at those locations. As noted previously, the extents of impacted regions of groundwater are either stable or shrinking. At the downgradient fringe of impacted groundwater, trace metals are naturally attenuated by sorption to aquifer materials. Evidence of this is the quality of surface water in Fishkill Creek, where site groundwater discharges. The concentrations of TAL Metals detected in surface water samples collected adjacent to and downstream from the Site were either less than the applicable Surface Water Quality Standards (SWQS) or less than measured upstream concentrations. Figures 4-4N through 4-4EE represent TAL Metals exceedances detected at the Site at two different time intervals –sampling from 2012-2013 and 2016-2018.

4.5 Groundwater Investigation Summary

Multiple individual groundwater investigations have been conducted at the Site during the past 37 years. These investigations have yielded an expansive set of groundwater elevation and quality data. In summary:

- Over 240 monitoring wells have been installed at the Site, including 77 in the bedrock. While some were determined to no longer be needed and have been decommissioned, 154 monitoring wells currently remain.
- Forty-seven temporary well points were installed.
- Thousands of individual water level measurements were taken and recorded.
- Over 1,200 groundwater samples have been collected and analyzed for one or more of the following: VOCs, SVOCs, pesticides, PCBs, inorganics, and most recently the emerging contaminants 1,4-dioxane and PFAS.

The quality of groundwater in both the overburden and bedrock has been investigated and the extent of impacts has been defined sufficiently for remedial decision making.

Primary COCs that occur in groundwater above their respective criteria are:

- Chlorinated VOCs. The compounds most frequently detected above criteria are TCE, chlorobenzene, and their degradation products. Other chlorinated VOCs that have occasionally been detected above criteria include PCE, 1,1,1-TCA, and various dichlorobenzenes. These tend to be co-located with areas impacted by TCE and/or chlorobenzene.

- Aromatic (primarily petroleum-related) VOCs. The compound in this class of compounds that is detected most frequently above its criterion is benzene, although ethylbenzene, toluene, and xylenes are also detected above their criteria.
- SVOCs. Most SVOCs detected above criteria in groundwater are PAHs. Except for naphthalene, which tends to be somewhat mobile in groundwater, groundwater containing PAHs at concentrations exceeding criteria is limited in extent and has also been impacted by VOCs; that is, there are no significant regions of groundwater impacted only by PAHs.
- Inorganics (specifically, TAL Metals). Arsenic, mercury, and lead have been identified as inorganic COCs. Regions of groundwater containing inorganics at concentrations exceeding their criteria tend to be the same regions that have been impacted by the above three classes of organic compounds. This is because elevated levels of inorganics are associated with regions of groundwater where redox conditions are reducing, and reducing conditions are created by biodegradation of organic compounds. At the fringes of impacted regions, groundwater becomes oxic, and inorganics are removed from the groundwater and immobilized. In many samples, aluminum was detected at concentrations above its solubility limit, indicating that the samples contained particulate matter that was not migrating with the groundwater, but was entrained in the samples during collection. This observation suggests that the concentrations of other inorganics reported for such samples may be biased high.
- Nonaqueous phase liquids (NAPLs) are not a concern at the Site. Recently, LNAPL has been detected in only two monitoring wells and at thicknesses of only a few tenths of a foot or less. While chlorinated VOCs such as TCE and chlorobenzene are DNAPLs, groundwater analytical results suggest that there is no DNAPL near any of the monitoring wells where these compounds are detected.
- In 2019, groundwater sampling was conducted to assess whether the emerging contaminants PFAS and 1,4-dioxane posed a concern at the Site. Low levels of either 1,4-dioxane or selected PFAS compounds were detected in several groundwater samples, including a sample collected upgradient from the Site. Based on these results, these compounds are not considered COCs.

The following groundwater conclusions have been made based on previous investigations:

- Zones of impacted groundwater are reasonably defined and are either shrinking or stable.
- The dolomite is a karst aquifer. Most of the groundwater moves through preferential pathways that cannot be reliably mapped. While the extent of impacts in the dolomite cannot be defined as precisely as in the overburden, the location of the Site along a groundwater discharge boundary (Fishkill Creek) and the location of the fault serve to prevent groundwater in the dolomite from leaving the Site, except where it discharges to the creek.
- In karst aquifers, dilution is a particularly potent attenuation mechanism.
- Transport pathways in the granitic gneiss are sporadic and poorly integrated; therefore large, mappable plumes of impacted groundwater have not formed.
- All impacted groundwater COCs that are not attenuated discharge into Fishkill Creek. Underflow of impacted water to the opposite side of the creek is not occurring.

- No significant sources were identified in soils at OU-1B, and this OU is upgradient from adjacent OU-1A; therefore, there is no evidence to suggest that groundwater beneath this OU would be impacted.
- At OU-1C, hydrogeologic and COC characteristics indicate that migration of impacted water in the permeable alluvial sand and gravel will be primarily horizontal. Primary releases in the area consisted of LNAPL, which is less dense than the water table, and floated on top of the water table. The till and glaciolacustrine silt and clay, where present, are aquitards that will prevent significant downward movement of impacted groundwater. Groundwater elevation data from a nearby bedrock monitoring well indicate an upward gradient from the bedrock to the overburden near the edge of Fishkill Creek.
- At OU-1E, the plume of impacted groundwater in the overburden has attenuated significantly over time, following remediation of the area. Concentrations of a few VOCs are currently only slightly above their respective NYSDEC TOGS standards. Some of this impacted groundwater moves northward, toward Fishkill Creek, and some moves southeastward toward an unnamed tributary to the creek.
- Groundwater beneath OU-1D, OU-3, and the portion of OU-4 south of the creek has not been significantly affected by historical site operations. No significant source areas were identified in soils, and overburden groundwater samples generally only contained inorganics above criteria. As noted previously, evidence suggests that detected concentrations of inorganics may be elevated due to entrainment of sediment in the samples. Groundwater in these areas is anticipated to be oxic, in which case inorganics will be immobile in groundwater (adsorbed to soil grains).

5 SURFACE WATER AND SEDIMENT INVESTIGATIONS DATA SUMMARY

This section summarizes results of a comprehensive evaluation of surface water and sediment quality of Fishkill Creek (OU-1F) conducted for Chevron in 2014. Findings of the survey were reported as Part 1 of an FWRIA submitted to the NYSDEC in April 2015 (Parsons 2015c). The scope and findings of the Fishkill Creek investigation are summarized below.

5.1 Selection of Screening Criteria

NYSDEC has issued guidance for screening of surface water analytical results in the NYSDEC TOGS standards and the 6 NYCRR Part 703: Surface Water and Groundwater Quality and Groundwater Effluent Limitations. Screening of sediment analytical results is outlined in the NYSDEC's document guidance Screening and Assessment of Contaminated Sediment. Analytical data at the TRCB facility are compared to these criteria to identify which areas of the facility may exhibit potential environmental impacts. Surface water at the TRCB facility has been classified as Class C waters to represent suitability for fish, shellfish, and wildlife propagation and survival as well as secondary contact recreation, and sediment is classified as Freshwater Sediment.

5.2 Previous Investigations

Surface water and sediment samples were collected from Fishkill Creek in May 1997 and from the vicinity of the former Hazardous Storage Area (Building 83 located on the Main Facility) to determine whether those media were impacted by COCs present in Building 83 (Fluor Daniel GTI 1997). Surface water and sediment samples were collected from eight locations, one near Building 83 and the remainder from upstream and downstream locations (four and three samples, respectively). The sample locations are shown on Figures 5-1 and 5-1A. Constituents detected above regulatory criteria were limited to a single VOC in surface water (acetone) and four SVOCs (phenanthrene, fluoranthene, pyrene, benzo(a)anthracene) in sediment and were not indicative of COCs used or stored at Building 83. The Hazardous Storage Area was ruled out as a potential COC source (Fluor Daniel GTI 1997).

5.3 Comprehensive 2014 Fishkill Creek Investigation

A sampling survey of sediment and surface water was conducted from August 11 through September 11, 2014 to provide a comprehensive characterization of the Fishkill Creek segment located along the former TRCB facility. More than one half of the segment is located upstream from the hydroelectric dam where a substantial sediment deposition has taken place. Sediment deposition downstream from the dam is very limited. Because most of the creek's watershed is located upstream from the dam, the creek's surface water and sediment quality were expected to largely reflect conditions associated with multiple upstream point and non-point sources unrelated to TRCB operations. For this reason, upstream locations were also sampled to document background conditions.

Samples were collected from 11 transects across Fishkill Creek, including three located upstream from the former TRCB facility. One surface water sample was collected from each transect. Three to five locations across each transect were initially targeted for sediment collection, depending on stream width. Lack of sediment precluded sampling at several locations. Ninety-four individual sediment samples were collected from 31 sediment coring locations subsampled by depth intervals (0 to 6 inches, 6 to 12 inches, 1 to 2 feet, and 2 to 3 feet). Both surface water and sediment samples were analyzed for metals and other inorganic substances, VOCs, PAHs, and PCBs. Sediment properties were also analyzed to assess bioavailability to sediment-associated organisms of organic compounds (organic carbon content) and metals (acid-volatile sulfide content). Summary tables for the 2014 surface water and sediment survey are presented in Tables 5-1 and 5-2. Full analytical data tables are provided in Appendices J and K. Refer to Figures 5-1 and 5-1A for sampling locations. Sampling logs for sediment are provided in Appendix L (Parsons 2015c).

5.3.1 Surface Water Quality

Detected concentrations were compared to chronic exposure, SWQS for Class “C” streams applicable to Fishkill Creek. A comparison was also made of concentrations in the three upstream sampling locations versus concentrations of eight samples collected from the creek’s segment along the former TRCB facility. No organic compounds were found at detectable concentrations in any of the surface water samples. Concentrations of metals within the TRCB segment were either less than the applicable SWQS or less than measured upstream concentrations. No evidence was found of impacts on surface water quality in the creek’s segment along the former TRCB facility.

5.3.2 Sediment Quality

Sediment guidance values (SGVs) from the NYSDEC were used as a reference for the sediment quality assessment. The agency guidance classifies sediments as Class A, Class B, or Class C based on threshold values for no-effect levels and probable adverse-effect levels applicable to each COC (NYSDEC 2014a):

- Class A sediments, those with COC concentrations less than a no-effect SGV threshold, are considered to have a minimum or no potential for impacts on sediment-associated organisms,
- Class C sediments, with COC concentrations greater than the probable adverse-effects SGV threshold, represent conditions likely to be toxic to aquatic life, and
- Class B sediments, those with concentrations of COCs that fall within the no-effect and probable-adverse effect threshold levels. The potential for adverse effects of the Class B sediments is undefined because the potential risk to aquatic life cannot be ascertained from COC concentrations alone.

Table 5-2 shows that organic substances, in general, were not a potential concern for exposure of sediment-associated organisms. Both VOCs and PCBs were found at concentrations less than SGVs and/or detection limits, while total PAH concentrations were less than the Class A concentration of 4 milligrams per kilogram in all but one sample.

Concentrations of metals were also less than the Class A sediment SGV threshold for 79 of 94 sediment samples analyzed. Twelve additional samples were characterized as Class B, having concentrations of one or more metals greater than the Class A threshold but less than the SGV threshold for Class C sediment. In most instances, metals concentrations in samples from upstream sampling locations were similar to or greater than concentrations measured in samples from the creek's segment along the former TRCB facility. The Class C characterization was limited to the three remaining samples, collected from disconnected locations, having elevated concentrations of nickel (two samples) or mercury (one sample). Further evaluation of Class B and C samples was made based on the sediment's acid-volatile sulfide content. The evaluation indicated that metals were predominantly present in chemical forms largely retained in the sediment matrix and, thus, unavailable for exposure of benthic organisms (Parsons 2015c).

5.4 Surface Water and Sediment Investigation Conclusions

The following conclusions were reached based on results of the 2014 survey of the Fishkill Creek segment adjacent to the former TRCB facility (OU-1F):

Surface Water Quality. There was no indication of potential adverse effects of former TRCB operations on the surface water quality of Fishkill Creek. No organic compounds were found at detectable concentrations in surface water samples while metals were detected at concentrations that were either below water quality standards or lower than upstream concentrations.

Organic Compounds in Sediment. Organic compounds, in general, were not a potential concern for exposure of sediment-associated organisms. Concentrations of VOCs, PCBs, and total PAHs were generally lower than analytical detection limits and/or the Class A threshold values.

Metals in Sediment. Sediment-associated organisms in the Fishkill Creek were not expected to be impacted at a population level from exposure to metals. The concentration of metals in nearly 85% of the samples analyzed characterized the sediment quality as Class A, indicative of a low potential for impacts on sediment-associated organisms. Most of the remaining samples (13% of analyzed samples) had concentrations of one or more metals that characterized the sediment as Class B (higher than the low potential effects threshold but below the likely-effects threshold). Sediments from the creek segment along the TRCB facility largely reflect those collected from upstream locations.

Overall, Fishkill Creek conditions along the former TRCB facility indicated an unimpacted surface water quality. Sediment quality, reflective of historical upstream conditions, was characterized at most sampling locations as having a minimum potential for adverse effects on sediment-associated organisms.

Based on the information presented above, sediment and surface water concentrations within Fishkill Creek of several COCs exceed certain classes of NYSDEC SGVs and have been evaluated through exposure assessment processes. Section 7 provides exposure assessment conclusions for sediment located in Fishkill Creek (OU-1F), along with details describing the exposure assessment process.

6 SOIL VAPOR INTRUSION INVESTIGATIONS AND DATA SUMMARY

This section summarizes the soil vapor intrusion (SVI) investigations performed at the former TRCB facility. Individual investigations performed and conclusions drawn are briefly described below.

6.1 Previous Investigations

The following subsections briefly detail SVI investigations that have been conducted at the Site across all OUs. Section 6.3 details the results of these investigations with summaries of the data presented.

6.1.1 Soil Vapor Intrusion Investigation at Former Mill Buildings 2, 3, 4, and 5 (2016)

Two separate rounds of sampling were performed in 2016 (Parsons 2017d). The first round was completed in June 2016 to evaluate the potential vapor intrusion pathway at the former Mill Buildings 2 through 5. The following activities were completed.

- Indoor air sampling at Buildings 2, 3, 4, and 5; sub-slab soil vapor sampling at Buildings 2, 4, and 5; crawlspace air sampling at Building 3; and sampling of outdoor ambient air.
- All locations were sampled for VOC analysis via Method TO-15.
- Since mercury was detected in the soil at concentrations exceeding soil screening criteria (boring location MB-1 within Building 3), Building 3 locations were also sampled for gaseous mercury using a sorbent trap apparatus for analysis via USEPA Modified Method 30B/1631.
- Building inspections were performed prior to sampling activities to document the building conditions and contents. Items observed inside the buildings included gasoline cans, a 5-gallon container of TCE (presumably used for parts cleaning), paints, oils, and solvents. Items were not removed before the first round of sampling activities.
- Photoionization detector (PID) (MiniRae 3000 with a 10.6 ionization potential electronvolt [eV] lamp) readings were taken from each building.

During August 2016, the second round of sampling was performed to ascertain if the TCE container in Building 5 was a potential source of the elevated analytical concentrations in Building 5. A summary of the second-round sampling activities is as follows:

- Various potential VOC-source items that were located adjacent to several first round sampling locations were removed approximately 2 weeks prior to the second round of sampling in Building 5.
- Sampling of sub-slab soil vapor and indoor air at Building 5, and analysis via TO-15 for the same suite of VOCs as the previous round.
- Field-screening for gaseous mercury using a portable Jerome 431 Mercury Analyzer at various locations throughout Buildings 3, 4, and 5. Locations included pipe elbows, pipe chases, cracks,

openings in floors, sinks, and any other potential pathway for vapors intrusion from the Building 3 crawlspace. Measurements were collected from floor level and breathing zone level.

Sampling locations for the 2016 SVI investigation are shown on Figure 6-1.

6.1.2 Gaseous Mercury Investigation (2016)

One gaseous mercury sample collected from the Building 3 crawlspace during the 2016 sampling exceeded the USEPA RSL for industrial indoor air. Mercury concentrations in samples collected within the Building 3 crawlspace and indoor air locations ranged from 0.372 to 2.28 micrograms per cubic meter (µg/m^3). The mercury concentration in the gaseous mercury sample collected from the eastern portion of the Building 3 crawlspace exceeded the USEPA RSL for industrial indoor air.

Parsons also performed a gaseous mercury survey using a portable Jerome 431 Mercury Analyzer at various locations throughout Building 3 (including the crawlspace), Building 4, and Building 5. Jerome Mercury Analyzer concentrations ranged from 3 to 16 µg/m^3. A summary table of measurement locations and mercury vapor results is provided in Table 6-1.

6.1.3 Soil Vapor Investigations at the Back 93 Acre Parcel (2018)

At OU-1E, soil vapor sampling was performed in 2018 to assess the potential for SVI to occur at the off-site residences along Belvedere Road to the east of the Site, and to evaluate the SVI potential for future buildings that may be constructed on the Site. Soil vapor sampling was performed using both passive and active sampling techniques. Passive sampling was performed to the east and west of the asphalt road located on OU-1E, while active sampling was performed near the eastern boundary, close to the former disposal areas (Parsons 2019a).

Six permanent active soil vapor monitoring points were installed using direct-push drilling methods and were constructed as a single depth/interval monitoring point due to shallow groundwater levels. Depths of the monitoring points varied between 3.5 to 6 ft bgs with the vapor probe installed approximately 0.5 to 1 foot above the existing groundwater table (3.5 to 7 ft bgs). The active soil vapor sampling was performed to determine if there is a potential SVI risk to the off-site residences along Belvedere Road to the east of the Site based on the groundwater concentrations of 1,1-DCA and TCE detected in groundwater monitoring well DB-8A.

A total of 128 passive soil vapor monitoring points were installed. The monitoring points were hand augered to approximately 2.5 to 3 ft bgs, and a glass capsule containing sorbent material was then placed inside each borehole. Each borehole was sealed with a rubber plug. The capsules remained in the subsurface for approximately 30 days prior to removal for analysis. The passive soil vapor sampling was performed as a “screening tool” only to identify areas with a significant potential for SVI to occur, should buildings be constructed in the future. A schematic showing how the passive soil vapor monitoring point is installed is provided in Appendix M.

The passive soil vapor samplers were used as a screening tool to determine soil gas hotspots in the area of the Back 93 Acre Parcel mentioned above by obtaining estimations of soil gas concentrations. The Waterloo Membrane Sampler [WMS]) used for data collection was a passive permeation sampler for monitoring time-weighted average concentrations of VOCs and is composed of a polydimethylsiloxane (PDMS) membrane across the face of a vial filled with a sorbent material. VOC vapors partition into and permeate through the membrane. The sorbent then traps the vapors, and the mass of each compound is determined by Gas Chromatography/Mass Spectrometry (GC/MS) analysis. The uptake rate has been experimentally measured for many common VOCs and can be easily calculated for compounds because it is directly proportional to the retention index.

The WMS was also chosen for passive soil gas collection due to the following advantages:

- Simpler sampling protocols compared to other soil gas screening technologies.
- Lower reporting limits.
- Longer time-integrated samples (less temporal variability).
- Predictable uptake rates for less common compounds.
- Minimal effect from moisture within the subsurface.
- Ability to modify uptake rate to avoid starvation effect for soil vapor monitoring.
- WMS analytical results compare very well to "conventional" sampling results (SUMMA® canisters, USEPA's Trace Atmospheric Gas Analysis unit, or active sorbent tubes) over at least six orders of magnitude. A flyer describing the WMS is provided in Appendix N.

Soil vapor sample locations from 2018 are shown on Figure 6-2.

6.1.4 Soil Vapor Intrusion Investigation at Former Mill Buildings 2, 3, 4, and 5 (2020)

Per the NYSDEC's letter dated April 23, 2019, CEMC was requested to provide a comparison of the 2016 SVI investigation data to the NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in New York State (SVI Guidance) criteria (NYSDOH 2006), specifically decision matrices A, B, and C (NYSDOH 2017). Additionally, NYSDEC/NYSDOH requested that a follow-up sampling event be performed during the designated heating season (November to March) to be consistent with the 2006 NYSDOH SVI Guidance criteria, which would include co-located indoor air and sub-slab soil vapor samples. During the week of February 17, 2020, an SVI investigation was performed in accordance with the Vapor Intrusion Investigation Work Plan (Arcadis 2020a) approved on January 14, 2020. The SVI investigation involved collecting indoor air and either sub-slab soil vapor or crawlspace air samples for Buildings 2, 3, 4, and 5 during the 2020 heating season.

6.1.4.1 Former Mill Buildings Construction Details

Construction details for the Mill Buildings include the following:

- Building 2 – one floor with slab-on-grade construction and a footprint of approximately 1,600 square feet (ft^2) is all that remains of Building 2 following demolition activities conducted during 2012.
- Building 3 – two floors with a crawlspace foundation and a footprint of approximately 7,000 ft^2. The northwestern portion of Building 3 is one floor plus a partial sub-floor pit/crawlspace and a footprint of approximately 800 ft^2.
- Building 4 – one floor with slab-on-grade construction and a footprint of approximately 1,300 ft^2.

- Building 5 – the northern portion consists of two floors with slab-on-grade construction and a footprint of approximately 800 ft^2, and the southern portion consists of an approximately 1,000 ft^2 concrete slab suspended over Fishkill Creek. The second floor of the northern portion includes a rarely used office.

6.1.4.2 Mill Buildings Inventory and Reconnaissance

Building reconnaissance was conducted to identify sample locations, visually assess the condition of the existing concrete slab, obtain information on building space use, and identify the type and locations of chemical products that could influence indoor air results. A 5-gas meter with PID equipped with an 11.7 electronvolt lamp and a portable Jerome J405 mercury analyzing meter were used to screen chemical products for VOCs and gaseous mercury, respectively. Products identified that were off-gassing detectable VOCs included used paint cans and construction products (e.g., caulk) located in a cabinet on the first floor of the northern portion of Building 5, as well as a used paint can in the Building 3 crawlspace. These products were removed before air sampling began. A completed building reconnaissance questionnaire is included in Appendix O. It should also be noted that an open-top bucket of used oil was identified on top of a refrigerator in Building 4 following completion of the air sampling.

6.1.4.3 Mill Buildings Heating

The former Mill Buildings do not include heating infrastructure. To simulate heating conditions, five 60-kilowatt (kW) electric heaters were placed throughout the Mill Buildings complex and began operating approximately 48 hours before SVI sampling commenced. A 320-kW tow-behind diesel generator was mobilized to the Site, staged over 100 feet from the former Mill Buildings and connected to the heaters via exterior-rated electrical cable. Two heaters were placed on the first floor of Building 3, and one heater each was placed in Buildings 2, 4, and 5. An indoor temperature of at least 15 °F greater than the outdoor temperature was achieved at all sampling locations. The indoor temperature achieved throughout the former Mill Buildings ranged from 70 to 82 °F, while the outdoor temperature during the sample collection period ranged from 18 to 34 °F.

6.1.4.4 SVI Sampling Procedure

The following locations were sampled:

- Two co-located indoor air and sub-slab soil vapor samples in Building 2.
- Two co-located indoor air and crawlspace air samples in Building 3.
- One co-located indoor air and sub-slab soil vapor sample in Building 4.
- One co-located indoor air and sub-slab soil gas sample in Building 5.
- Two outdoor ambient air samples: one downwind (west) and one upwind (east) of the former Mill Buildings.

One duplicate indoor air sample and one duplicate sub-slab soil vapor sample were also collected. Sample locations from the 2020 SVI investigation are shown on Figure 6-1.

New sub-slab soil vapor sampling points were installed prior to sampling. The new points were located within proximity to the pre-existing sub-slab soil vapor points installed for the 2016 SVI sampling.

Sub-slab soil vapor points were installed within the slabs using a hammer drill to provide a space below the slab in which a vapor sample could be collected. Sub-slab soil vapor points were constructed of dedicated stainless steel VaporPin® probes. Each point was leak tested via helium tracer test prior to sampling in accordance with the procedure detailed in the Chevron ETC Soil Vapor and Indoor Air Sampling Technical Toolkit included in Appendix P.

Sub-slab soil vapor, crawlspace air, indoor air, and ambient air were sampled concurrently with a target sample duration of approximately 8 hours. Indoor air samples were collected in the immediate area of the co-located sub-slab or crawlspace sampling location at an intake height of approximately 3 to 5 feet above the slab/ground surface.

At each location, sampling for VOCs was conducted using an individually certified, passivated 6-liter SUMMA® canister and flow regulator supplied by the laboratory (Eurofins-Air Toxics). Flow regulators were preset by the laboratory for a target sampling rate of approximately 12.5 milliliters (mL) per minute (i.e., 6 liters over 8 hours). Sub-slab soil vapor points were connected to SUMMA® canisters using a combination of flexible nylon tubing and stainless-steel tubing/fittings (i.e., Swagelok®). Sample trains also included fittings and valves as necessary to allow for leak-detection testing of the sub-slab soil vapor points. Once a canister was filled (i.e., approximately 5 inches of mercury vacuum remaining), the canister was closed and labeled with the sample identification number for the sampling location.

Each location was also sampled for gaseous mercury using a 200 milligram (mg) sorbent tube and sampling pump. Pumping rates were set based on the required sample volume to meet the target reporting limits and maintaining a sub-slab soil vapor sampling rate at 200 mL per minute or less. Sorbent tubes were analyzed for gaseous mercury via National Institute for Occupational Safety and Health (NIOSH) 6009.

6.1.4.5 Sample Analysis

SUMMA® canisters were analyzed by Eurofins-Air Toxics in Folsom, California, which is an Environmental Laboratory Approval Program (ELAP) and NYSDOH-certified laboratory, for VOCs using USEPA Method TO-15 and for helium and methane using ASTM International Method D-1946. Whole-air samples were analyzed for VOCs using a quadrupole or ion-trap GC/MS system to provide compound reporting limits at or below the NYSDOH guidance values when applicable. Sorbent tubes were analyzed for gaseous mercury using NIOSH Method 6009 by EMSL Analytical, Inc., in Cinnaminson, New Jersey (also an ELAP and NYSDOH -certified laboratory).

6.2 Soil Vapor Analytical Data Summary

This section summarizes the results of the previously described SVI Investigations. Soil vapor point installation logs from the 2018 OU-1E soil vapor sampling field event investigation are included in Appendix Q while sample logs for the 2020 SVI investigation sampling are included in Appendix R. Laboratory analytical reports and validated data DUSR for the 2020 SVI investigation sampling are included in Appendix S.

6.2.1 2016 – Soil Vapor Intrusion Investigation at Former Mill Buildings 2, 3, 4, 5

In sub-slab soil vapor samples, detected VOCs included CT, methylene chloride, 1,1,1-TCA, PCE, and TCE. Based on the sub-slab soil vapor screening criteria considered at the time of the 2016 SVI investigation (USEPA Commercial Vapor Intrusion Screening Level, target risk of 10^{-6} and hazard quotient of 1) sub-slab concentrations exceeded screening criteria for TCE in Building 5 for both the June 2016 (6,800 µg/m^3) and August 2016 (13,000 µg/m^3) sampling events.

In the Building 3 crawlspace air samples, detected VOCs included methylene chloride and TCE. Based on the screening criteria considered at the time for both crawlspace air and indoor air (USEPA Industrial RSLs, target risk of 10^{-6} and hazard quotient of 1, there were no exceedances for VOCs for crawlspace air samples.

For each sample location, indoor air was only analyzed if the corresponding co-located sub-slab soil vapor or crawlspace air sample exceeded screening criteria. As such, Building 5 indoor air samples were analyzed for VOCs (for both the June and August 2016 events). Detected VOCs in indoor air included benzene, methylene chloride, and TCE. Based on the indoor air screening criteria considered at the time (USEPA Industrial RSLs, target risk of 10^{-6} and hazard quotient of 1, Building 5 indoor air concentrations exceeded criteria for benzene for both the June (3.3 µg/m^3) and August 2016 (2.8 J µg/m^3) events. Building 5 indoor air screening criteria for TCE was exceeded for the June 2016 event (51 µg/m^3). The likely source of the TCE was a partially filled 5-gallon container of TCE that was stored inside the building at the time of the June 2016 sampling event. The TCE can was removed from the building approximately 2 weeks prior to the August 2016 sampling event. TCE was not detected in the Building 5 indoor air sample from the August 2016 event.

Based on the NYSDOH SVI Guidance decision matrices, the 2016 SVI data indicated a recommended response action of mitigation for Building 5 (due to sub-slab concentrations of TCE and methylene chloride), should the building ever be occupied. Comparison of the 2016 SVI data for each compound included in the NYSDOH SVI Guidance decision matrices is not achievable due to insufficient reporting limits.

In addition to sampling, abandoned piping and appurtenances in the Mill Building 3 crawlspace were removed to eliminate these items as potential ongoing sources of gaseous mercury. No free mercury was observed during the removal of these items.

Detectable VOC concentrations, as measured by a PID, were present in various locations of Building 2, Building 3, Building 4, and Building 5, varying from 0.0 part per billion (ppb) to 669 ppb in Building 5 in June 2016. Most of the detectable PID readings in Building 3 can be attributed to the presence of containers of building and grounds maintenance fluids (gasoline, solvents, batteries) and materials stored inside the building. These source items were removed over one month prior to the second round of sampling. Subsequent PID measurements were collected in August 2016 in Building 3 in areas where containers were previously stored. The second PID measurements were below detectable concentrations.

Gaseous mercury was detected in crawlspace air samples and indoor air samples in Building 3. The crawlspace and indoor air screening criteria of 1.3 µg/m^3 (based on the USEPA Industrial RSLs, target risk of 10^{-6} and hazard quotient of 1 were exceeded in one of the two crawlspace air samples. Mercury concentrations in the other Building 3 samples ranged from 0.372 to 0.571 µg/m^3. Additionally, mercury concentrations in outdoor ambient air samples were 0.016 and 0.003 µg/m^3. Jerome 431 Mercury Analyzer readings ranged from 3 to 16 µg/m^3.

2016 SVI investigation analytical data are included in Table 6-1.

6.2.2 2018 - Soil Vapor Investigations at the Back 93 Acre Parcel

Multiple VOCs have been detected at OU-1E passive and active soil vapor borings. VOC detections include acetone, benzene, toluene, and xylenes at the active soil vapor borings. In passive soil vapor samples, these parameters were accompanied by chlorinated solvent concentrations, including 1,1,1-TCA, chlorobenzenes, TCE, and daughter products of these compounds. Soil vapor data are presented in Tables 6-2 and 6-3. Additionally, Figure 6-3 presents the detections of constituents in soil vapor. The figure presents only detected concentrations of compounds present in the NYSDOH Vapor Intrusion Decision Matrices. All vapor sample locations without posted data on Figure 6-3 are nondetect for these compounds. Two locations of passive soil vapor sampling identified constituents at detectable concentrations, OU1EPSV014 and OU1EPSV095.

When compared to the NYSDOH SVI Guidance decision matrices, no compounds were detected in excess of the minimum sub-slab soil vapor concentration range. It is unlikely that SVI would be an issue for future buildings to be built above ground and therefore no additional vapor intrusion assessment is warranted in the sampled areas. Soil vapor samples near the residential properties likewise did not exhibit chemical concentrations at a level warranting additional investigation.

6.2.3 2020 - Soil Vapor Intrusion Investigation at Former Mill Buildings 2, 3, 4, and 5

Analytical results for indoor air, sub-slab soil gas, crawlspace air, and ambient air samples are provided in Table 6-4. Detected NYSDOH SVI Guidance decision matrix compounds for each sample location are shown on Figure 6-1. Laboratory analytical reports are included in Appendix S. Detected NYSDOH SVI Guidance decision matrix compounds include 1,1,1-TCA, CT, PCE, and TCE. A summary of detected NYSDOH SVI Guidance decision matrix compounds for each building (including outdoor air) is presented below.

- Ambient Air
    - CT was detected in the upwind outdoor ambient air sample (AA-02) at 0.41 µg/m^3 and in the downwind outdoor ambient air sample (AA-01) at 0.33 µg/m^3.
- Building 2
    - TCE was detected in both sub-slab soil gas samples (0.23 µg/m^3 at B2-SS-01 [0.23 µg/m^3 in the duplicate sample] and 2.6 µg/m^3 at B2-SS-02) but was not detected in either indoor air sample.
    - CT was detected in both sub-slab soil gas samples (0.84 µg/m^3 at B2-SS-01 [0.91 µg/m^3 in the duplicate sample] and 1.7 µg/m^3 at B2-SS-02) and in both indoor air samples (0.41 µg/m^3 at B2-IA-01 and 0.46 µg/m^3 at B2-IA-02).

  - PCE was detected in both sub-slab soil gas samples (0.35 µg/m^3 at B2-SS-01 [0.34 µg/m^3 in the duplicate sample] and 1.8 µg/m^3 at B2-SS-02) and in one of two indoor air samples (0.22 µg/m^3 at B2-IA-02).
  - 1,1,1-TCA was detected in both sub-slab soil gas samples (0.36 µg/m^3 at B2-SS-01 [0.35 µg/m^3 in the duplicate sample] and 1.8 µg/m^3 at B2-SS-02) but was not detected in either indoor air sample.
- Building 3
  - TCE was detected in one of two crawlspace samples (0.25 µg/m^3 at B3-CS-01) and was not detected in either indoor air sample.
  - CT was detected in both crawlspace samples (0.54 µg/m^3 at B3-CS-01 and 0.46 µg/m^3 at B3-CS-02) and in both indoor air samples (0.48 µg/m^3 at B3-IA-01 and 0.44 µg/m^3 at B3-IA-02).
  - PCE was detected in one of two crawlspace samples (0.32 µg/m^3 at B3-CS-01) and was not detected in either indoor air sample.
- Building 4
  - TCE was detected in the sub-slab soil gas sample at 0.41 µg/m^3 and was not detected in the indoor air sample.
  - CT was detected in the sub-slab soil gas sample at 0.8 µg/m^3 and in the indoor air sample at 0.4 µg/m^3.
  - PCE was detected in the sub-slab soil gas sample at 0.37 µg/m^3 and was not detected in the indoor air sample.
- Building 5
  - TCE was detected in the sub-slab soil gas sample at 1,500 µg/m^3 and was not detected in the indoor air sample.
  - CT was detected in the sub-slab soil gas sample at 7.1 µg/m^3 and in the indoor air sample at 0.41 µg/m^3 (0.47 µg/m^3 in the duplicate indoor air sample).
  - PCE was detected in the sub-slab soil gas sample at 6 µg/m^3 and was not detected in the indoor air sample.
  - 1,1,1-TCA was detected in the sub-slab soil gas sample at 2.3 µg/m^3 and was not detected in the indoor air sample.

Mercury was detected in all indoor air samples ranging from 0.21 µg/m^3 (B5-IA-01) to 0.92 µg/m^3 (B2-IA-01). Mercury was detected at 1.5 µg/m^3 in one of the two Building 2 sub-slab soil gas samples (B2-SS-01) and was not detected in any other sub-slab soil gas samples. In the Building 3 crawlspace samples, mercury was detected at 1.1 µg/m^3 (B3-CS-01) and 1.4 µg/m^3 (B3-CS-02) and was not detected in ambient outdoor air samples.

Indoor air and sub-slab soil gas sample results for each respective collocated sample location were plotted on the applicable NYSDOH SVI Guidance decision matrix. The recommended response actions for each location as per the NYSDOH SVI Guidance decision matrices, should the buildings become occupied, include the following:

- Building 2:
  - B2-IA/SS-01 – No further action is warranted based on the analytical results for soil gas, indoor air, and outdoor air data collected.
  - B2-IA/SS-02 – No further action is warranted based on the analytical results for soil gas, indoor air, and outdoor air data collected.
- Building 3:
  - The NYSDOH decision matrices are intended for use for buildings with a slab-on-grade construction and may not be appropriate for buildings with crawlspaces (since there may be little to no attenuation between crawlspace and indoor air). For Building 3, the lowest indoor air concentration range was exceeded for CT (for each crawlspace air locations) and TCE (at one of the two crawlspace air locations). It should be noted 1) indoor air TCE in Building 3 was not detected above the NYSDOH Matrix A screening value of 0.2 µg/m^3; 2) CT was also detected in both the upwind and downwind outdoor ambient air samples at concentrations greater than the lowest indoor air concentration range from the NYSDOH Matrix A, and therefore detections should be attributed to an ambient background source.
- Building 4:
  - B4-IA/SS-01 – No further action is warranted based on the analytical results for soil gas, indoor air, and outdoor air data collected.
- Building 5:
  - B5-IA/SS-01 – Based on the NYSDOH matrix, mitigation for TCE and monitoring for CT is not required. Under current use, no action is warranted in Building 5 because the indoor air TCE concentration was not detected above the NYSDOH Matrix A screening value of 0.2 µg/m^3. However, because the TCE sub-slab concentration is 1,500 µg/m^3, additional evaluation may be needed to verify the TCE indoor air is still below the screening value prior to changing the current use for Building 5.

6.3 Conclusions of Soil Vapor Intrusion Analytical Data

Based on the former Mill Buildings (OU-4 Parcel) current usage, and the results identified during the winter sampling event conducted in February 2020, no additional sampling or mitigation is proposed for the short term. As the former Mill Buildings are currently unoccupied and used solely for storage, there is no immediate need for continuous sampling/monitoring program or mitigation for worker/occupant exposures. With this said, if in the future these buildings are to be used for short-term or long-term occupancy, a follow-up sampling program will be proposed to NYSDEC/NYSDOH for approval. As was proposed in the February 2020 Vapor Intrusion Investigation Work Plan (Arcadis 2020a), if future results compared to NYSDOH Matrices identify follow-up measures such as continued monitoring or mitigation to be necessary, a subsequent work plan will also be submitted to the NYSDEC/NYSDOH for review and approval prior to implementation of such activities.

Multiple VOCs have been detected at low concentrations at the OU-1E parcel; however, these concentrations are lower than the applicable NYSDOH Matrices screening values for sub-slab and therefore indicate no further action is proposed. Active soil vapor points near the residential properties likewise did not exhibit parameters at a level requiring an additional investigation.

7 ECOLOGICAL RESOURCES IMPACT ANALYSIS

The following ecological resources impact analysis has been performed to identify any impacts that may affect ecological receptors. For this analysis, available habitat and potential exposure pathways are evaluated along with the appropriate criteria to determine if there are significant exposure risks in accordance with the Fish and Wildlife Impact Analysis for Inactive Hazardous Water Sites (FWIA) (NYSDEC 1994a).

A detailed evaluation of potential habitat types is provided in the FWRIA Part 1 (Parsons 2015c). Based on that analysis, available terrestrial habitat at the Site is primarily mature upland hardwood forest with intermixed open fields and areas of grass/green space (former recreational areas). The quality of the available habitat varies considerably depending on the parcel evaluated.

Fishkill Creek (OU-1F) bisects the Site and originates approximately 15 miles east of Beacon. Most of the watershed for Fishkill Creek is located upstream from the Site. There are some small springs and wetlands located along the eastern boundary of OU-1E, to the south of Fishkill Creek (Figures 1-1 and 1-2).

Based on the available habitats, the following exposure pathways were evaluated at each parcel:

- Exposure to COCs in surface water and sediment within Fishkill Creek
- Potential discharge of groundwater to Fishkill Creek as well as seeps and wetland areas in OU-1E
- Exposure to COCs in surface and near-surface soil (0 to 2 ft bgs).

This evaluation focused on identifying those parcels with available habitat where site related COCs are present at concentrations above relevant benchmarks.

7.1 Ecological Screening

Concentrations of COCs measured in applicable media (i.e., surface soil, groundwater, surface water, and sediment) were compared to available toxicological screening benchmarks protective of ecological resources. A summary of the benchmarks used is provided below.

7.1.1 Surface and Near Surface Soil

For this evaluation, surface soil was defined as the top 2 feet of the soil column. Surface soil data collected from the Site were compared to New York State SCOs for the Protection of Ecological Resources (i.e., Table 375-6.8(b): Restricted Use Soil Cleanup Objectives—Protection of Ecological Resources). Summary statistics for chemicals that exceed the PER SCOs in at least one sample are presented in Table 7-1.

7.1.2 Groundwater

There are no ecologically based groundwater screening criteria available from NYSDEC. In lieu of these, and as a conservative approach, available groundwater data were screened against Class C Ambient Water Quality Standards (WQS) for the protection of fish or wildlife. Summary statistics for chemicals that exceed the WQS in at least one sample are presented in Table 7-2. When both dissolved and total metals data were available, data for the fraction used to develop the WQS were presented in Table 7-2.

7.1.3 Sediment

Sediment data collected from Fishkill Creek were compared to two Freshwater Sediment Guidance Values: Class A screening values, which are considered to present little or no potential for risk to aquatic life, and Class C screening values, which are considered to have high potential for the sediments to be toxic to aquatic life (Appendix K). Summary statistics and comparisons to these screening values for those chemicals that exceed the Class A screening value in at least one sample are presented in Table 7-3.

7.1.4 Surface Water

Surface water data collected from Fishkill Creek were compared to Class C Ambient WQS for the protection of fish or wildlife. Summary statistics for chemicals that exceed the WQS in at least one sample are presented in Table 7-4.

7.2 Screening Results by Operable Unit

For the purpose of this analysis, all ecologically relevant analytical data were screened against the toxicological benchmarks described above to identify potential impacts to ecological resources likely to be present. Comparisons of individual sampling points to these benchmarks are provided in Appendix J, K, T, and U for surface water, sediment, soil, and groundwater, respectively, and discussed below. A summary of these comparisons is provided in Tables 7-1, 7-2, 7-3, and 7-4, including a list of all chemicals with at least one exceedance, the number of locations that exceed, the concentration range, and the 95% upper confidence limit on the mean (95% UCL) where sufficient detections were available to calculate.

7.2.1 Background Samples

As shown in Table 7-1, soil samples collected from background properties exhibit 11 metals (aluminum, arsenic, calcium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc) and two pesticides (4,4-DDE and 4,4-DDT) that exceed the PER SCO in at least one sample.

7.2.2 OU-1A Parcel (Main Facility)

The Main Facility (OU-1A) consists of 33 acres of land and has been used as an onshore, non-production, non-transportation laboratory complex engaged in research, development, and technical services related to petroleum products and energy for many years. The Main Facility is bounded to the south by Fishkill Creek, to the north by Old Glenham Road, to the west by the Metro-North Railroad line and the former Church Property (OU-1B), and to the east by private property including parking, residential housing, and businesses.

The Main Facility formerly included: parking areas, offices and laboratory buildings, ASTs and USTs, roads, and storage areas. In 2011 and 2012, Chevron conducted a building removal project that resulted in the demolition to the basement or slab level of the vast majority of buildings on site. Currently no structures exist on the OU except for a few support buildings, and all storage tanks have been removed. The predominantly developed areas include limited grass/green space habitat in the eastern section, as well as limited fringe upland forest adjacent to the Church Parcel (OU-1B) and along Fishkill Creek. No wetlands or other surface water features are located within the Main Facility. Virtually all of the facility has pavement, old foundations, and non-vegetated areas.

Soil samples collected from OU-1A exhibit 12 metals (aluminum, arsenic, calcium, cobalt, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc) and four pesticides (4,4-DDT, 4,4-DDE, 4,4-DDD, and endrin), as well as two SVOCs (benzo(a)pyrene and di-n-butylphthalate) and one VOC (xylene) that exceed the PER SCO in at least one sample (Table 7-1).

Groundwater samples collected from OU-1A were collected from both the bedrock and overburden aquifers. For the bedrock aquifer, four VOCs (benzene, ethylbenzene, toluene, and xylenes), six SVOCs (acenaphthene, benzo(a)anthracene, fluorene, naphthalene, phenanthrene, and pyrene), and 13 metals (aluminum, cadmium, chromium, cobalt, copper, iron, lead, mercury, selenium, silver, thallium, vanadium, and zinc) exceed the WQS in at least one sample (Table 7-2). For the overburden aquifer, three VOCs (benzene, ethylbenzene, and xylenes), seven SVOCs (acenaphthene, anthracene, benzo(a)anthracene, fluorene, naphthalene, phenanthrene, and pyrene), and 15 metals (aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc) were detected in at least one sample above the WQS (Table 7-2).

As described above, this parcel is primarily covered by impervious surfaces (concrete slabs and asphalt), prohibiting direct contact to soil by ecological receptors. The limited available vegetation is of low ecological quality, consisting primarily of fragmented, landscaped areas. Therefore, exposures to site-related COCs in surface soil in this area are very unlikely and this pathway is considered incomplete.

Because there are no surface water features in OU-1A, potential exposures to groundwater were addressed by evaluation of sediment and surface water in Fishkill Creek (OU-1F).OU-1B Parcel (Church Property)

The former Church Property (OU-1B) is a 15-acre undeveloped parcel located to the northwest of the Main Facility (OU-1A) that once contained a local church, which was relocated off the OU-1B parcel. Currently no structures exist on the OU and no activities or occupants currently exist on this parcel. Main areas that have been used are limited to the access road along the western side of the parcel and the southeastern corner where the church and parsonage were located. Parcel OU-1B was not used as an area of active operations or disposal during the TRCB operations. This parcel is bounded on the north by Old Glenham Road and residential properties, the east by the Main Facility, the west by residential properties, and the south by Fishkill Creek.

Mature upland forest has been identified as the predominant plant community throughout OU-1B. This community had a mixture of hardwood trees, including sugar maple, pignut hickory, shagbark hickory, black oak, and northern red oak. The shrub layer is variable and patchy in distribution due to the closed canopy of the mature trees. The mature upland hardwood forest in the Church Property parcel is relatively undisturbed. The soil layer is generally thin over much of the Church Property, and exposed rock areas are found throughout the central section of the parcel. No wetlands or surface water features are present within OU-1B.

Soil samples collected from OU-1B exhibit 14 metals (aluminum, arsenic, calcium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc) and three pesticides (4,4-DDD, 4,4-DDE, and 4,4-DDT) that exceed the PER SCO in at least one sample. (Table 7-1).

Groundwater data are not available for this parcel since no monitoring wells have been installed.

As discussed in Section 3.3.2.3, there is no clear evidence of the source of impacts at the OU-1B parcel and analyte exceedances appear not to be related to TRCB operations at the Main Facility. Other sources, including historical fill and textile and woolen mills, have potentially contributed to the presence of COCs in surface soil. In addition, some of the metals detected in soil at the Site may be attributable to background concentrations. Therefore, exposures to site-related COCs in surface soil in this area are very unlikely and this pathway is considered incomplete.

7.2.3 OU-1C Parcel (Former Washington Avenue Tank Farm)

Parcel OU-1C consists of 5 acres of land located south of Fishkill Creek and north of Washington Avenue. It was formerly the site of over 30 ASTs and associated facilities. The tanks and containment structures were removed in fall 2003 and winter 2004. Vegetation at OU-1C is sparse with mostly low grasses and woody stem weeds due to routine maintenance. A row of deciduous trees is located along the creek outside of the fence. No wetlands or surface water features are present within OU-1C.

Soil samples collected from OU-1C exhibited one pesticide (4,4-DDT) and 11 metals (aluminum, arsenic, calcium, copper, lead, manganese, mercury, nickel, selenium, vanadium, and zinc) that exceed the PER SCO in at least one sample (Table 7-1).

Groundwater samples collected from the overburden aquifer below OU-1C had three VOCs (benzene, ethylbenzene, and xylenes), four SVOCs (benzo(a)anthracene, fluorene, naphthalene, and phenanthrene), and 15 metals (aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc) exceed their WQS in at least one sample (Table 7-2).

As described above, this parcel was heavily developed and existing habitat continues to be disturbed due to routine maintenance. Therefore, exposures to site-related COCs in surface soil in this area are very unlikely and this pathway is considered incomplete.

Because there are no surface water features in OU-1C, potential exposures to groundwater were addressed by evaluation of sediment and surface water in Fishkill Creek (OU-1F).

7.2.4 OU-1D Parcel (Residential Property and Rail Siding Area)

Parcel OU-1D is an approximately 2.1-acre area adjacent to Washington Avenue, that was never used as part of the former TRCB operations. It is anticipated to be a future residential use parcel. Most of the land is wooded, primarily successional upland forest. No wetland or surface water features are present. There are no known contaminant sources on site.

Soil samples collected from OU-1D exhibit 10 metals (aluminum, arsenic, calcium, copper, lead, manganese, mercury, nickel, vanadium, and zinc) and three pesticides (4,4-DDD, 4,4-DDE, and 4,4-DDT) that exceed the PER SCO in at least one sample (Table 7-1).

Groundwater samples collected from the overburden aquifer below OU-1D only had iron exceedances of the WQS (Table 7-2).

As described above, Parcel OU-1D is anticipated to be a future residential use parcel. Its habitat value for ecological receptors is limited based on its proximity to both roads and adjacent developed residential properties Therefore, exposures to site-related COCs in surface soil in this area are very unlikely and this pathway is considered incomplete.

Because there are no surface water features in OU-1D, potential exposures to groundwater were addressed by evaluation of sediment and surface water in Fishkill Creek (OU-1F).

7.2.5 OU-1E Parcel (Back 93 Acre)

The Back 93 Acres (OU-1E) includes approximately 93 acres of undeveloped property located south of Washington Avenue and Fishkill Creek. The property formerly included four structures (pump house, washroom, storage shed, and picnic shelter). These structures have since been removed. It is primarily wooded; however, there are small wetland areas along the eastern boundary.

Soil samples collected from OU-1E exhibit one SVOC (benzo(a)pyrene), one pesticide (4,4-DDE), and 10 metals (aluminum, arsenic, calcium, cobalt, lead, manganese, mercury nickel, vanadium, and zinc) that exceed the PER SCO in at least one sample (Table 7-1). With the exception of aluminum, the number of samples with exceedances were a small percentage (i.e., <10 percent) of the total number of samples, suggesting that elevated concentrations are localized and not widespread throughout the parcel. Aluminum was the only chemical for which the 95% UCL exceeded the PER SCO (Table 7-1). In addition, the 95% UCL concentrations of these chemicals are lower than or comparable to those observed in surface soils collected as part of the background study establishing local surface soil conditions (Table 7-1).

Evaluation of groundwater collected from this area indicates there are two SVOCs (benzo(a)anthracene and pyrene) and one metal (iron) present at concentrations above the WQS (Table 7-2). It is important to note that these concentrations do not represent actual surface water concentrations; therefore, comparison to SWQS is a conservative estimate of potential risk. In addition, the monitoring wells closest to the wetland areas in OU-1E, which are most representative of the potential surface water exposure, have historically been non-detect for these SVOCs. Two of the three iron samples (OU1EESB01 and OU1EESB08) were collected near one wetland in OU-1E. However, the dissolved concentrations of iron collected from these two locations were non-detect, indicating the more bio-available fraction of this metal is far lower than the total fraction.

In summary, while a few scattered exceedances of PER SCO were observed, surface soil concentrations are generally within the range of concentrations established as representing local background conditions. Similarly, groundwater concentrations suggested no impact to nearby surface water bodies. Based on this assessment, ecological exposures in OU-1E do not appear to be associated with potential risk, and no further evaluation is warranted.

7.2.6 OU-1F (Fishkill Creek)

Fishkill Creek (OU-1F) is a surface water body located south of the Main Facility (OU-1A) and north of the WATF (OU-1C). The Creek was used as a hydropower source for the Site in the past. No additional

TRCB activities were conducted in or within the Creek. OU-1F represents the primary aquatic habitat in connection with the Site.

Fishkill Creek originates approximately fifteen miles east of the Site and traverses the area from east to west with a fall of approximately 23 ft per mile. The surface water elevations of the Creek are controlled by dams. The upper dam (Texaco Dam) is located on the Site, at the west end of the WATF parcel (See Figure 1.2). The height of the dam is approximately 22 ft. A second dam is located approximately 1,400 ft downstream from the Texaco Dam. A third dam is located just above East Main Street in Beacon downstream from the TRCB.

The Creek above the Texaco Dam is wide and generally quiescent with an accumulated thickness of sediment. Below the Texaco Dam, the river narrows significantly and the Creek flows through a steep-sided channel. Downstream from the Site, Fishkill Creek passes through the City of Beacon and discharges to the Hudson River.

Both upstream and on-site sources potentially may affect Fishkill Creek. Most of the creek’s watershed is located upstream of TRCB. Consequently, both surface water and sediment in the creek are expected to reflect conditions associated with multiple point and non-point contaminant sources unrelated to TRCB operations (e.g., municipal and industrial effluent discharges, contaminated runoff). Within OU-1F, soil and groundwater from three parcels adjacent to the creek are potential contaminant sources: Main Facility (OU-1A), WATF (OU-1C), and Hydroelectric Dam and Facilities parcel (OU-4).

In sediment data collected from Fishkill Creek, total PAHs and eight metals (arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc) have at least one sample concentration above the Class A Sediment Value (Table 7-3). Total PAHs, nickel, and mercury also each had one sample concentration above the Class C Values. Although these COCs were detected at all 80 locations, exceedances were typically associated with a small percentage of samples, 30% or less for all COC except nickel. Total PAHs and nickel were the only COC where the 95% UCL was above the Class A Values. For PAHs, all but two of the 80 samples collected were below the Class A Values, indicating that any potential impact of PAHs is very localized and not affecting the overall sediment quality of Fishkill creek (Table 7-3). With respect to nickel, it was observed to exceed the Class A Value in 75% of the samples; however, concentrations in sediment were comparable to those established as background in soil. In addition, although nickel was identified in groundwater at concentrations above the SWQS, there were no exceedances of nickel in the surface water of the Creek. These data suggest that the Site may not be the primary source of nickel to sediments of the creek.

Considering surface water data from Fishkill Creek, two metals had at least one exceedance of the WQS: total iron and dissolved mercury (Table 7-4). The 95% UCL for total iron data is below the Class C WQS, and the dissolved mercury was only detected in two of 12 samples with both detections exceeding the WQS.

Based on this assessment, sediment and surface water of Fishkill Creek do not appear to have been significantly impacted by the Site, and no further evaluation is warranted.

7.2.7 OU-2 Parcel (Washington Avenue Road)

Parcel OU-2 is a 0.23-acre parcel along and underneath Washington Avenue. This parcel is located outside of the fence line of the main property and is maintained by the Town of Fishkill as a major thoroughfare. No known TRCB activities were conducted on this property. The parcel is fully developed, containing the road and adjacent grass service areas. No surface water features, or other ecological resources are located within OU-2 and it presents no suitable ecological habitat. Therefore, exposures to site-related COCs in surface soil in this area are very unlikely and this pathway is considered incomplete.

7.2.8 OU-3 Parcel (Residential Property)

Parcel OU-3 is an approximately 0.67-acre area adjacent to Washington Avenue, that was never used as part of the former TRCB operations. It is designated for future residential use. Most of the land is wooded, primarily successional upland forest. No wetland or surface water features area present. There are no known contaminant sources on site.

Soil samples collected from OU-3 exhibit one SVOC (di-n-butylphthalate), two pesticides (4,4-DDE, 4,4-DDT), and five metals (aluminum, cobalt, mercury, nickel, and vanadium) that exceed the PER SCO in at least one sample (Table 7-1).

Groundwater samples collected from the overburden aquifer below OU-3 showed exceedances of one SVOC (benzo(a)anthracene) and seven metals (aluminum, cadmium, cobalt, copper, iron, nickel, and zinc) (Table 7-2).

As described above, Parcel OU-3 is anticipated for future residential use. Its habitat value for ecological receptors is limited based on its proximity to both roads and developed residential properties. Therefore, exposures to site-related COCs in surface soil in this area are very unlikely and this pathway is considered incomplete.

Because there are no surface water features in OU-3, potential exposures to groundwater were addressed by evaluation of sediment and surface water in Fishkill Creek (OU-1F).

7.2.9 OU-4 Parcel (Hydroelectric Dam Property)

Parcel OU-4 is described as the “Hydroelectric Facility & Dam.” The operable unit includes the hydroelectric buildings and the dam itself with access on the northern side via an easement to Old Glenham Road, and on the southern side via an easement to Washington Avenue (Figure 3.8). The parcel is approximately 4.96 acres. Most of the west and central sections of OU-4 contain upland hardwood forest adjacent to Fishkill Creek. The east section of the parcel, adjacent to the WATF, is sparse with mostly low grasses and woody stem weeds due to routine lawn maintenance. The hydroelectric facilities are located in a fully developed area north of Fishkill Creek, adjacent to the Main Facility. No wetlands or surface water features are present within Parcel OU-4.

Soil samples collected from OU-4 exhibit eight metals (arsenic, copper, lead, manganese, mercury, nickel, selenium, and zinc) that exceed the PER SCO in at least one sample (Table 7-1). The 95%UCL concentrations of copper, lead, and mercury are also above the PER SCO and estimates of background.

Overburden groundwater data collected from below the northern side of OU-4 show exceedances of one VOC (chlorobenzene), four SVOCs (benzo(a)anthracene, fluorene, phenanthrene, and pyrene) and three metals (iron, selenium, and mercury) in at least one sample (Table 7-2). In both bedrock and overburden groundwater south of the creek, only iron was detected above the WQS.

Because there are no surface water features in OU-4, potential exposures to groundwater were addressed by evaluation of sediment and surface water in Fishkill Creek (OU-1F).

Based on this evaluation, potential ecological exposures to surface soil from Parcel OU-4 will be further evaluated.

7.3 Ecological Resources Impact Analysis Conclusions

Considering available habitats at the Site, the primary ecological exposure pathways are associated with surface soil, as well as surface water and sediments in Fishkill Creek and several small wetland areas in OU-1E. These pathways were addressed by evaluating available soil, sediment, and surface water data, as well as consideration of groundwater concentrations that could be discharging to Fishkill Creek and the wetland areas. Based on this evaluation, potential ecological exposures to groundwater, surface water, and sediment are minimal and do not require further evaluation.

With respect to surface soil, OU-1A, OU1B, OU-1C, OU-1D, OU-3 and OU-2 were eliminated due to lack of suitable habitat. While a few scattered exceedances of PER SCO were observed at OU-1E, surface soil concentrations are generally within the range of concentrations established as representing local background conditions, therefore, this area was also removed from consideration. At OU-4, several metals, primarily copper, lead, and mercury, were identified at concentrations potentially associated with risk to ecological receptors. Those potential risks will be further evaluated.

8 CONCLUSIONS

This section summarizes conclusions for the former TRCB facility based on analytical data from the RIR and exposure evaluations.

8.1 Soil

The RI of soil impacts on site is complete. Site sources have been properly identified and investigations have been completed to identify impacts from these sources. The distribution of COCs detected most frequently in soil at concentrations greater than the Unrestricted SCOs is presented on Figures 3-10A through 3-10GG. Primary COCs (those parameters with the highest frequency or concerning concentrations) in soil are acetone, PAHs, and metals (arsenic, lead, and mercury). The following conclusions about site soil quality have been made:

8.1.1 OU-1A

At the Main Facility (OU-1A), soil impacts were primarily caused by releases from laboratory buildings, ASTs, USTs, research operations, and storage areas. Petroleum, coal products, and solvents have been used at OU-1A in connection with research operations.

Surface soil impacts can be linked with historical coal ash and debris used as fill materials to level parking lot areas at former Building 50 and Building 38 (GSC 2005).The SVOC exceedances in near-surface and subsurface soil can be linked with the fill used in this parcel, possible drum storage area near Building 83 prior to its construction, slop-oil tank, lift stations, and the sanitary holding basin inside former Building 45, and with former Building 55 area which was used as laboratory for fuel/lubricant testing.

TAL Metal exceedances in soil are widespread at the western end of the parcel and correspond with the former Building 58/83 area operations, on the northern end of the parcel near the former Building 50 parking lot, on the northeastern side of former Building 26, and along the lower sections of the parcel along Fishkill Creek downstream from the dam. A cluster of exceedances near the former Building 50 parking lot are related to the fill material in the area. A group of soil borings along Fishkill Creek near the former Building 51 area exhibits exceedances near the groundwater impacts in this area. Multiple soil borings clustered near the former Building 45/55 area exhibit exceedances near the groundwater impacts. Mercury has been detected above Commercial and Industrial criteria at several soil borings and may be due to liquid mercury used in instrumentation that was periodically disposed of in sinks and found in drain traps and piping connected to the Industrial Sewer System.

TAL Metals, VOCs, and SVOCs have been detected at levels exceeding POG criteria in near-surface and subsurface soil sampling locations. Due to the limited extent of these detections, soil is not considered to be a significant ongoing source of groundwater impacts.

8.1.2 OU-1B

No TRCB activities were conducted on this parcel. No structures currently exist on the OU and no activities or occupants exist on this parcel. There is no clear evidence of the source of impacts at the OU-1B parcel and exceedances appear not to be related to TRCB operations at the main facility.

The identified PAH compounds are those that are expected to be found where fossil fuel burning has historically taken place or coal cinders and ash have been disposed of. Historical investigations have reported that the textile operations maintained their own coal to gas production facility. The exact location of this facility is unknown, but it is suspected that it was located in OU-1A near Fishkill Creek. Sub products of coal to gas processes are coal ash and coal tar; PAH containing compounds. Impacted PAH areas might also be related to the use of historical fill, containing coal cinders, presumably used for an access road construction in the southern portion of the parcel bounding the Metro-North Railroad.

8.1.3 OU-1C

Impacts at OU-1C likely stem from leakages in the ASTs at the tank farm and in the underground piping that transported product between tanks and to the main facility. Previous remedial efforts have remediated surface and near-surface soils using a soil bioremediation cell. ASTs have been removed, pipelines have been excavated and a large amount of soil has been excavated and remediated. Currently, the primary driver of remediation is arsenic. Arsenic impacts have been detected above the Industrial SCOs across most of OU-1C from 0.0 to 2.0 ft bgs. In subsurface soil, samples taken from monitoring well installations have additionally identified BTEX impacts in soil. Locations that exhibit these impacts have historically exhibited LNAPL. There may be residual LNAPL in this area that continues to act as a source for groundwater impacts.

8.1.4 OU-1D

The impacts at OU-1D are likely related to the former Rail Siding Area that offloaded product from railcars and pumped materials to the tank farm. Soil borings that have been completed at OU-1D have identified PAH impacts near the location of the pumping appurtenances. In addition, the soil in this area exhibits similar arsenic exceedances to the tank farm surface and near-surface soils. The pumping equipment and pipeline may remain in place at OU-1D.

8.1.5 OU-1E

Following initial remediation activities at the Site, source areas at OU-1E have been excavated. The Data Gap Investigations in 2017 and 2018 served to identify any additional impacts at the Site as well as to provide confirmation that excavated areas did not exhibit additional exceedances (Parsons 2019a). The Data Gap investigation identified three soil borings with impacts that may warrant additional investigation. PAHs were identified at OU1EESB01 and OU1EESB20, and a mercury exceedance was identified at OU1EFSB02. The PAH and mercury exceedances may be related to the “new” sludge lagoon formerly in place at the sampling location. Other than these select areas, no additional concentrations of COCs have been detected above the SCOs that cannot be attributed to background concentrations or laboratory artifacts.

8.1.6 OU-3

No TRCB sources were identified during the investigations into OU-3. This parcel has remained a residential parcel and no TRCB activities have taken place at the OU. Surficial PAH impacts have been identified at OU-3; however, these impacts are attributable to a trash burning area located on the neighboring property. In addition, 4,4-DDE, 4,4-DDT, and mercury have been detected above the Unrestricted SCOs at OU-3, though it is unlikely that these are related to operation at the Site.

8.1.7 OU-4

The OU-4 Parcel primarily includes the Mill Buildings within the area of the main parcel OU-1A, as well as an undeveloped Parcel to the south of Fishkill creek and an access route running between OU-1C and OU-1D. Soil samples discussed as part of OU-4 include the Undeveloped Parcel investigation. Impacts on the Undeveloped Parcel may be related to nearby activities on OU-1C and OU-1D as well as use and maintenance of the Dam. The investigation at the undeveloped parcel was prompted by limited accounts that may have suggested a former disposal site at this parcel, but investigations have provided little evidence of this other than some debris.

Mercury detections at OU-4 are the most widespread, with detections above the Unrestricted SCOs across the OU and some above Residential and Restricted-Residential SCOs. This may be related to the potential disposal site, but there are limited records of this area or what was disposed of if the disposal area existed.

8.1.8 Path Forward

As discussed at the start of Section 3.3, acetone in at least some of the detections from certain investigations may be attributed to laboratory error, especially at the undeveloped parcels (OU-1B, OU-1D, OU-1E, OU-3, and the southern portion of OU-4) where acetone was unlikely to be actively used. An evaluation of the accuracy of acetone data will be performed as part of the remedial evaluation phase of the Feasibility Study.

A Qualitative Human Health Exposure Assessment (HHEA) will be prepared to evaluate constituents for potential ingestion pathways in accordance with DER-10 Appendix 3-B. The assessment will estimate potential human intake for the planned usage of the site during the upcoming remedial stages and for future use. An evaluation of background conditions in comparison to detected site concentrations will be prepared along with the qualitative HHEA following submittal of the RIR to assess potential background contributions. Using information in the HHEA and background evaluation, an additional evaluation of constituents onsite will be performed to evaluate which constituents, if any, should be retained as COCs. These evaluations will be submitted prior to the Feasibility Study.

An additional evaluation of background conditions in comparison to detected site concentrations will be prepared in a separate evaluation following submittal of the RIR to assess potential background contributions. This evaluation will be submitted prior to the Feasibility Study. It will include a statistical background comparison and evaluation.

8.2 Groundwater

Based on the work conducted to date, the following is concluded with respect to groundwater on site:

- Zones of impacted groundwater are reasonably defined and are either shrinking or stable.
- The dolomite is a karst aquifer. Most of the groundwater moves through preferential pathways that cannot be reliably mapped. While the extent of impacts in the dolomite cannot be defined as precisely

as in the overburden, the location of the Site along a groundwater discharge boundary (Fishkill Creek) and the location of the fault serve to prevent groundwater in the dolomite from leaving the Site, except where it discharges to the creek.

- In karst aquifers, dilution is a particularly potent attenuation mechanism.
- Transport pathways in the granitic gneiss are sporadic and poorly integrated; therefore large, mappable plumes of impacted groundwater have not formed.
- All impacted groundwater that is not attenuated discharges to Fishkill Creek. Underflow of impacted water to the opposite side of the creek is not occurring.
- No significant sources were identified in soils at OU-1B, and this OU is upgradient from adjacent OU-1A; therefore, there is no evidence to suggest that groundwater beneath this OU would be impacted.
- At OU-1C, hydrogeologic and COC characteristics indicate that migration of impacted water in the permeable alluvial sand and gravel will be primarily horizontal. Primary releases in the area consisted of LNAPL, which is less dense than the water table, and floated on top of the water table. The till and, where present, glaciolacustrine silt and clay are aquitards that will serve to prevent significant movement of impacted water downward through them. Groundwater elevation data from a nearby bedrock monitoring well indicates an upward gradient from the bedrock to the overburden near the edge of Fishkill Creek.
- At OU-1E, the area of impacted groundwater in the overburden has attenuated significantly over time, following remediation of the area. Concentrations of a few VOCs are currently only slightly above their respective NYSDEC TOGS standards. Some of this impacted groundwater moves northward, toward Fishkill Creek, and some moves southeastward toward an unnamed tributary to the creek.
- Groundwater beneath OU-1D, OU-3, and the portion of OU-4 south of the creek has not been significantly affected by historical site operations. No significant source areas were identified in soils, and overburden groundwater samples generally only contained inorganics above criteria. As noted previously, evidence suggests that detected concentrations of inorganics may be elevated due to entrainment of sediment in the samples. Groundwater in these areas is anticipated to be oxic, in which case inorganics will be immobile in groundwater (adsorbed to soil grains).

Additional detailed summaries are provided below for each of the individual parcels.

8.2.1 OU-1A

Groundwater contamination at OU-1A is split into four main areas of impact: The Building 51 area, Building 45/55 area, Building 36 area, and Building 58/83 area.

Chlorinated VOCs are present in Site groundwater at concentrations exceeding NYSDEC TOGS standards predominantly in OU-1A. The chlorinated VOCs that most often exceed criteria are TCE and chlorobenzene and their degradation products. TCE and its daughter products (including cis-1,2-DCE and vinyl chloride) predominantly occur in groundwater at concentrations above their respective standards east of the fault (near and downgradient from Building 51), most prominently in monitoring wells screening the dolomite. Chlorobenzene occurs at concentrations exceeding its groundwater standard predominantly west of the fault. Based on the available information, it is inferred that TCE and chlorobenzene were released at or near the land surface (e.g., from spills and leaks at the surface and/or leaks in near-surface piping and sewers) at multiple locations.

The primary area where TCE occurs in overburden groundwater is the area surrounding and downgradient (south) of Building 51. Groundwater exceedances are more widespread in the bedrock, and the highest concentrations occur here. Soil sampling in the area identified no significant source areas. TCE exceeds criteria in essentially three other areas in OU-1A: near Building 55, near Building 58, and near the former WWTP (just below the Texaco Dam).

Bedrock groundwater containing chlorobenzene likely moves toward the fault, and, where the fault underlies Fishkill Creek, toward the creek itself.

Aromatic VOCs (BTEX) have been detected exceeding NYSDEC TOGS standards at monitoring well SWMW-15, but other overburden monitoring wells in the area do not exhibit exceedances. Some BTEX compounds – VOCs that are reasonable indicators of groundwater impacted by petroleum – have also been detected in groundwater at several locations in OU-1A at concentrations exceeding their respective NYSDEC TOGS standards.

SVOCs have been detected above criteria at ITMW-5, PCFGW-53, PCFGW-57, PCFGW-85, PCFGW-89, SWMW-15, and SWMW-62, but other overburden monitoring wells do not exhibit exceedances.

Metals, including aluminum, iron, manganese, and sodium, have been detected above regulations across OU-1A. The concentration of metals has not changed over the course of all sampling events and there is no delineation of the impacted area. It is likely that these metals are present in the background as they are detected in upgradient background monitoring wells and areas with no known contamination.

8.2.2 OU-1C

OU-1C is the primary area of the Site where petroleum has been historically released and where groundwater impacts remain. As part of the semiannual Consent Order groundwater monitoring program, two monitoring wells are regularly monitored at OU-1C. VOC, petroleum related PAHs and metals impacts exist in the overburden groundwater aquifer. Based on the available information, the plume of impacted groundwater at OU-1C is stable and is naturally attenuating.

At OU-1C, hydrogeologic and COC characteristics indicate that migration of impacted groundwater in the permeable alluvial sand and gravel will be primarily horizontal. Primary releases in the area consisted of LNAPL, which is less dense than water, and floats on top of the water table. The till and, where present, glaciolacustrine silt and clay are aquitards that served to prevent significant movement of impacted groundwater downward through them. Groundwater elevation data from a nearby bedrock monitoring well indicates an upward gradient from the bedrock to the overburden near the edge of Fishkill Creek. As a result of the aforementioned information and to prevent a potential vertical migration pathway, a bedrock groundwater monitoring well has not been installed at OU-1C

8.2.3 OU-1D

Groundwater investigations at OU-1D began as part of the Data Gap Investigation. The overburden groundwater at the Rail Siding Area does not exhibit exceedances of any COCs, including dissolved metals. The groundwater at this parcel does not exhibit significant impacts and additional investigations are not warranted.

8.2.4 OU-1E

Groundwater investigations into the Back 93 Acre Parcel have continued since the initial investigations in the 1980s. Currently, eight monitoring wells are sampled semi-annually at OU-1E as part of the Consent Order monitoring at the Site. These groundwater samples have detected minimal concentrations of COCs related to the former disposal areas, and the concentrations have decreased to levels near the NYSDEC TOGS standards.

Extensive groundwater investigations into the Back 93 Acre Parcel have clearly identified the groundwater conditions at the Site. The data gap groundwater sample taken at OU1EESB20 identified PAH impacts. However, due to the high tendency for these specific PAHs to be adsorbed in soils, it is likely these results are a product of the turbidity of groundwater samples. Therefore, it is likely that impacts to groundwater in this area are not widespread or they are not related to site conditions.

8.2.5 OU-3

No TRCB operations took place on OU-3. One groundwater sample was identified that contained PAH impacts. However, the sampling method of using 3-volume sampling may have resulted in a high amount of particulate matter that contained adsorbed PAHs left over from the drilling. Since this exceedance has only been detected at this solitary point, it is unlikely that this exceedance is representative of groundwater at the Parcel as a whole.

8.2.6 OU-4

OU-4 groundwater to the north of Fishkill Creek is primarily impacted in a similar capacity to OU-1A, due to OU-1A surrounding OU-4's northern portion. The groundwater discussion at OU-1A may be attributable to groundwater at OU-4's northern section.

Overburden monitoring wells south of Fishkill Creek in the southern portion of OU-4 are attributed to OU-1C. Bedrock monitoring wells at OU-4 do not exhibit exceedances of VOCs or SVOCs. Undeveloped parcel sampling locations show a similar trend, with only background metals being detected above screening criteria. This evidence indicates the groundwater impacts at Building 51 are not migrating beneath Fishkill Creek, and there is not likely to be related impacts at OU-1C.

8.3 Surface Water and Sediment

The investigation into the surface water and sediment quality at the Site is complete. There was no indication of potential adverse effects of former TRCB operations on the surface water quality of Fishkill Creek. No organic compounds were found at detectable concentrations in surface water samples while metals were detected at concentrations that were either below water quality standards or lower than upstream concentrations.

Sediment from the creek segment along the TRCB facility largely also reflect those collected from upstream locations. Organic compounds, in general, were found not to be a potential concern for exposure of sediment-associated organisms. Concentrations of VOCs, PCBs, and total PAHs were generally lower than analytical detection limits and/or the Class A threshold values. Sediment-associated organisms in Fishkill Creek were not expected to be impacted at a population level from exposure to metals.

8.4 Soil Vapor

As noted in Section 6.3, based on the former Mill Buildings (OU-4 Parcel) current usage, and the results identified during the sampling event conducted in February 2020, no additional sampling or mitigation is proposed for the short term. As the former Mill Buildings are currently left unoccupied and used solely for storage, there is no immediate need for continuous sampling, a monitoring program or mitigation for worker/occupant exposures. With this said, if in the future these buildings are to be used for short or long-term occupancy, a follow-up notification and if necessary, sampling program proposal will be submitted to NYSDEC/NYSDOH for approval. As was proposed in the February 2020 - Vapor Intrusion Investigation Work Plan (Arcadis 2020a), if future results compared to NYSDOH Matrices identify follow-up measures such as continued monitoring or mitigation to be necessary, a subsequent work plan will also be submitted to the NYSDEC/NYSDOH for review and approval prior to implementation of such activities.

Multiple VOCs have been detected at low concentrations at the OU-1E parcel; however, these concentrations are lower than the applicable NYSDOH Matrices screening values for sub-slab and therefore indicate no further action is proposed. Active soil vapor points near the residential properties likewise did not exhibit parameters at a level requiring additional investigation.

8.5 Ecological Resources Impact Analysis

Exposure pathways to ecological receptors include surface soils, Fishkill Creek, and the wetland areas present at OU-1E. To determine the potential impacts to these receptors, Arcadis reviewed the surface soil, surface water, and sediment data. In addition, a review of groundwater was completed to determine its potential to discharge to Fishkill Creek. The ecological assessment determined the potential impact from surface water, sediment, and groundwater was minimal, and therefore does not require further investigation.

With respect to surface soil, OU-1A, OU1B, OU-1C, OU-1D, OU-3 and OU-2 were eliminated due to lack of suitable habitat, and OU-1E was removed from consideration because surface soil concentrations of COC’s are generally within the range of concentrations established as representing local background conditions. Potential risks associated with metals, primarily copper, lead, and mercury, will be further evaluated at OU-4.

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