Commonwealth of Pennsylvania
Department of Environmental Protection
Hazardous Sites Cleanup Program

Bishop Tube
East Whiteland Township
Chester County

ANALYSIS OF ALTERNATIVES AND PROPOSED RESPONSE

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ANALYSIS OF ALTERNATIVES AND PROPOSED RESPONSE

I. INTRODUCTION

This Analysis of Alternatives and Proposed Response document presents the decision-making process and description of the proposed response for the Bishop Tube Site. This document will be included in the Administrative Record which will be compiled for this response pursuant to Section 506 of the Pennsylvania Hazardous Sites Cleanup Act, Act of October 18, 1988, P.L. 756 No. 108 ("HSCA"), 35 P.S. § 6020.506.

The Bishop Tube Site ("Site") consists of areas of groundwater, soil, and surface water contamination located in East Whiteland Township, Chester County. In September 2010, the Department of Environmental Protection ("DEP") added this Site to Pennsylvania's Priority List of Hazardous Sites for Remedial Response ("PAPL"). DEP is proposing a remedial response action at the Site to address soil, groundwater, surface water, and a residential drinking water supply that have been contaminated by chlorinated solvents and/or inorganic contaminants of concern ("COCs"). DEP proposes to address contaminant source areas within unsaturated and saturated soils through addition of treatment reagents, coupled with in situ mixing; groundwater and surface water through in situ injection of reagent designed to chemically or biologically treat Site-related COCs, coupled with monitored natural attenuation, engineering controls, and institutional controls ("ICs"); and an impacted residential water supply through the connection to the existing public water supply waterline, combined with restrictions on the use of groundwater. This action is taken to protect human health, safety, and the environment.

II. SITE INFORMATION

A. SITE LOCATION AND DESCRIPTION

The Site is located in an area known as Frazer, East Whiteland Township, Chester County. Groundwater contamination at the Site affects properties located along South Malin Road, Lancaster Avenue (US Rt. 30), Conestoga Road (PA Rt. 401), Morehall Road (PA Rt. 29), and Village Way. The sources of the contaminated groundwater and surface water and areas of contaminated soil are located on the 13.7-acre former Bishop Tube property ("Source Property"), currently owned by Constitution Drive Partners, L.P. ("CDP"). The Source Property's address is listed as 1 South Malin Road, Malvern, PA. The tax parcel is 42-4-321.2.

The US Census estimated the population of East Whiteland Township to be 12,832 as of July 2019. According to East Whiteland Township's website, the transient worker population in the Township is greater than the resident population. Land use in the area comprising the Site includes residential, recreational, commercial, and industrial (active and abandoned) activities. In 2014, East Whiteland Township rezoned the Source Property from industrial to residential use.

The Source Property is located near the base of the South Valley Hill, which rises to the south from Lancaster Avenue (Figure 1). Site elevation varies from 375 ft. mean sea level ("ft msl") at the northeast corner to 450 ft msl at the southwest corner of the Source Property. The Source

Property is bordered by a vacant wooded lot and an active AMTRAK rail line to the south and by a Norfolk Southern freight rail line to the immediate north; a bulk petroleum storage facility is located across Malin Road to the west, and a residential area (General Warren Village) and undeveloped wooded area border the Source Property east of Little Valley Creek ("LVC"). In some reports this area of LVC is referred to as a "tributary" to LVC; Maps prepared by the United States Geological Survey ("USGS") depict it to be the headwaters of LVC.

During construction of the former Bishop Tube industrial facilities on the Source Property, primarily in the 1950s, significant cutting and filling apparently occurred, resulting in three relatively level areas, occupied by parking areas, and two former manufacturing buildings (Plant 5 and Plant 8), separated by two man-made steep slopes. Driveways, parking lots, and loading areas consisted of asphalt or concrete[1] (Figure 2). An additional steep slope is located between the developed portion of the Source Property and LVC to the east.

LVC, which has an Exceptional Value water quality designation, passes through the affected area and forms the northern boundary of the Site from Lancaster Avenue to Morehall Road. LVC is a tributary to Valley Creek, which is a tributary to the Schuylkill River; a regional tributary river that flows into the Delaware River. Within the Site, LVC is shallow and flows through a populated, mixed commercial and residential area. Recreation is the most probable use of LVC.

LVC's floodplain, riparian buffer areas, and adjacent wetlands are considered sensitive environments. These wetlands are also designated as Exceptional Value and warrant special protection under DEP regulations. A Pennsylvania Natural Diversity Inventory ("PNDI") identified no habitats for endangered or threatened species on the Source Property.

The Site is located within the Piedmont Physiographic Province, which in southeast Pennsylvania is represented by a northeast-southwest trending belt of rounded hills and relatively narrow valleys. The Site is situated along the southern side of one of these valleys, locally known as the Chester Valley, which is primarily comprised of Cambrian-Ordovician age carbonate rocks.

At the Site, groundwater moves in the bedrock through a network of naturally-occurring, interconnected, open channels known as fractures. Some of these fractures may be enlarged by naturally acidic groundwater moving through the bedrock. Where this process has been active in the fractured bedrock, the rate of groundwater movement may be high; elsewhere, the same rock type may exhibit lower rates of groundwater movement where there are smaller or fewer sets of fractures. At the Site, water in the fractured bedrock is generally under water-table conditions, but, under certain local conditions, may be confined (under pressure), causing springs to form.

According to Baker Environmental Inc, ("Baker"), who investigated the Site on behalf of DEP, between 2000 and 2008, the geologic horizons underlying the eastern section of the Source Property can be segregated into three categories: 1) a shallow soil/overburden interval; 2) a weathered bedrock interval; and 3) a deeper unweathered bedrock interval. The Conestoga

[1] These paved areas have experienced varying degrees of deterioration and disturbance over time.

Formation makes up the bedrock underlying the Site. The formation is composed of rocks known as calcium-rich phyllite and schist.

Wells drilled during the Site characterization activities revealed that the amount of calcium-rich material increases from south to north across the Site. Baker reported that the depth to bedrock varies from 3 to 24 feet spatially across the Source Property. In general, the depth to bedrock along the south sides of Plants 5 and 8 was found to be deeper than in the borings drilled within and along the north side of Plant 8. Baker attributed the variations to the grading activities associated with the construction of the plant buildings, as well as the natural differential weathering of the underlying rock materials. Information obtained while drilling deep wells on the Source Property indicates that steeply-dipping (approximately 80 degrees), structural features, (e.g. differential rock layers and fractures) exist in the bedrock, underlying the Source Property. Collectively, soil and lithology data from the characterization suggest that dense non-aqueous phase liquids ("DNAPL") within the source areas have migrated from the overburden down into the bedrock, via these geological structures.

Water-bearing zones encountered during the investigation ranged in yield (estimated) from <1 gallon per minute (gpm) to >40 gpm. Generally, the number and productivity of water-bearing fractures were found to decrease with depth at the Site.

Baker reported that maps prepared by the Soil Conservation Service show that the Conestoga Series and the Manor Series occur on the Source Property. The Conestoga silt loam consists of level to gently sloping, deep and well-drained soils occurring in upland areas. The soils are believed to have formed from the weathering of calcareous schist/phyllite and micaceous limestone. At the Site, the soils belonging to the Conestoga silt loam series underlie areas adjacent to LVC along the eastern edge of the Source Property, and adjacent to the Norfolk Southern railroad tracks along the northern edge of the Source Property. The Manor loam consists of level to moderately sloping, shallow, and well-drained soils underlying upland areas. They are believed to have formed in materials weathered from schist and gneiss. Soils belonging to the Manor series underlie central portions of the Source Property, extending from Malin Road to the eastern edge of LVC and from the Amtrak Railroad tracks to the Norfolk Southern railroad tracks north of the Source Property.

Silty clay and weathered schist fragments were observed in soil borings collected in the western and northern edges of Plant 8 and the eastern and southern edges of Plant 5. Soils borings collected from beneath Plant 5 and Plant 8 revealed sandy silt and silt clay and weathered schist fragments.

DEP considers the aquifer in the vicinity of the Site to be a used aquifer. Public water is available. One home located within the vicinity of the Site is supplied by a private well and was impacted. In 1999, Christiana Metals, a former owner/operator of Bishop Tube, installed a point of entry treatment system ("POET") at this affected residence. There is no reported use of surface waters located at the Site as a source of drinking water.

B. SITE HISTORY

In 1951, J. Bishop Company started manufacturing operations involving precious metals processing in Plant 5. J. Bishop reportedly began using the Source Property for manufacturing steel tubes in the 1950s. The manufacture and processing of metal alloy tubes and associated equipment continued until 1999. Several companies conducted these operations at the Source Property during this period including Matthey Bishop, Incorporated, and Johnson Matthey, Inc. ("Johnson Matthey") (successors to J. Bishop) (1951-1969), Whittaker Corporation ("Whittaker") (1969 – 1974), Christiana Metals Corporation ("Christiana Metals") (1974 – 1988), Alloy Steel Corporation. (1988 – 1991), and Marcegaglia USA, Inc. ("Marcegaglia") (1991 – 1999).

Tube production at the Bishop Tube facility on the Source Property concentrated primarily on seamless stainless-steel products for much of the period of operation. The processes included acid treatment and degreasing of the tubing. Hazardous substances were employed in the manufacturing processes throughout the history of manufacturing. Most notably chlorinated solvents, including trichloroethene ("TCE"), was utilized in the Plant 5 and Plant 8 vapor degreasers, processed in distillation units, and stored in drums and an aboveground storage tank ("AST") which was not equipped with spill containment. During most periods of operation, Bishop Tube employed nitric and hydrofluoric acids to prepare and to remove impurities from the stainless-steel tubes for lubrication and redrawing after annealing, which involves using heat to increase the hardness and durability of the stainless steel. These steps were repeated with each successive redrawing until the desired tube diameter and wall thickness were achieved.

Johnson Matthey constructed Plant 5 in 1951. It consists of a one-story concrete block structure. Plant 5 was used for precious metals processing and stainless-steel tubing manufacturing. According to former Bishop Tube employees, large diameter stainless steel tubing manufacturing, including a large vapor degreaser, was relocated to Plant 8 after its construction, but small diameter tubing (capillary and hypodermic) manufacturing continued in Plant 5 until sometime in the 1980s. A smaller free-standing vapor degreaser (approximately 5' L x 5' W x 5' H) was also used in Plant 5. Raw TCE was supplied to the Plant 5 operation in 55-gallon drums. Prior to Johnson Matthey's construction of Plant 8, acid treatment occurred in a separate room, attached approximately at the center of the southern wall of Plant 5, known as the pickle house. Acid rinse wastes drained from the floor of the pickle house to a "cesspool" adjacent to and east of the Plant 5 pickle house.

A former metal frame storage shed (referred to as the ARMCO building in some reports), located east of Plant 5 and south of Plant 8 (when it was erected), believed to have been installed on the Source Property by Johnson Matthey in 1963, and used as a drum storage area ("DSA") from that time until the mid-1990s. The ARMCO building was used to store raw (unused) and waste materials and hazardous substances in drums. Bulk hydrofluoric and nitric acid were stored in large ASTs immediately east of the drum storage shed.

Plant 8 is a two-story steel frame structure built by Johnson Matthey in 1958. After its construction, larger diameter stainless steel tubing manufacturing was moved from Plant 5 to Plant 8 and increased in size. A 40-foot-long vapor degreaser (approximately 40' L x 4' W x 10'

H) was located within an unlined, concrete subfloor pit in the western portion of Plant 8. From 1958 to 1974, during Johnson Matthey's ownership and then during Whittaker's ownership, the Plant 8 vapor degreaser was supplied with chlorinated solvents from 55-gallon drums. Starting in approximately 1975, Christiana Metals supplied the Plant 8 degreaser with solvents from a 5,000-gallon AST through subfloor piping, which primarily contained TCE. 1,1,1-Trichloroethane ("1,1,1-TCA") was also reportedly used as a degreasing solvent for a period during Christiana Metals' operation. According to former Bishop Tube employees, solvent spills and leaks occurred in and near the Plant 8 vapor degreaser pit, at the AST, and waste solvents and materials were disposed of outside of the two buildings. All pickle house operations were relocated to the eastern portion of Plant 8 after its construction.

Acid rinse water handling and disposal areas include the transfer pit and associated spill area immediately east of Plant 8 and the cesspool area located adjacent to Plant 5. Acid rinse wastes were transferred from the Plant 8 pickle house via a series of pits and pumps to the cesspool for subsurface disposal until the mid-1970s. According to former Bishop Tube employees and inspection reports, prepared by the Pennsylvania Department of Environmental Resources ("PADER"), now DEP, acid rinse wastes were discharged from a transfer pit located immediately east of Plant 8 across the ground surface into LVC.

PADER detected fluoride in surface water samples collected from LVC in the early-1970s. Fluoride was traced to a 12-inch diameter pipe leading from the Bishop Tube facility. The source of the elevated fluoride was determined to be non-contact cooling water obtained from two wells on the Source Property. The two production wells were located east and west of the cesspool. Water was pumped from the production wells to a storage reservoir on the hillside, south of the employee parking area. Water pumped from the wells and stored in the reservoir was held for emergency fire suppression and used to supply acid rinse baths and non-contact cooling water. Samples from the non-contact cooling water source (i.e., reservoir) contained elevated concentrations of fluoride. PADER's Bureau of Water Quality prompted, then operator, Christiana Metals to close the transfer pit and cesspool and to initiate a hydrogeologic investigation. In 1983, PADER noted violations of waste management regulations involving containment and housekeeping practices. Floor drains were also observed during PADER and DEP inspections in both Plants. Marcegaglia closed the final floor drain (in Plant 5) in 1999.

A June 1981, leak of nitric and hydrofluoric acid from ASTs caused the evacuation of approximately 500 residents from the nearby General Warren Village.

In June 1984, NUS Corporation performed a site inspection at the Source Property on behalf of the United States Environmental Protection Agency ("EPA"). The investigation included the sampling of four monitoring wells that were installed in 1981 as part of a hydrogeologic study conducted at the Source Property by Betz, Converse, Murdock Inc. on behalf of Christiana Metals. TCE ranging from 4,800 - 20,120 micrograms per liter ("µg/l") or parts per billion ("ppb") was found in three of the four monitoring wells. TCE was found in a surface water swale at 2,026 ppb. Other contaminants detected in the monitoring wells and the swale include 1,1,1-TCA, 1,1-dichloroethane ("1,1-DCA"), 1,1-dichloroethene ("1,1-DCE"), trans-dichloroethylene ("trans-1,2-DCE"), and tetrachloroethene ("PCE"). This was the first sample event known to DEP that included any analysis of Volatile Organic Compounds ("VOC").

In 1987, manufacturing operations temporarily ceased. Comments from a PADER inspection, performed under the federal Resource Conservation and Recovery Act ("RCRA") on June 15, 1988, indicated that RCRA closure actions had been completed. In 1991, the New Bishop Tube Company, formed by Marcegaglia, purchased machinery and equipment from Christiana Metals, and, under a lease arrangement, began its renovations and retrofitting of the facility, including disturbance and relocation of soils at the Source Property, and resumed operations of the facility for tube fabrication. While initiating operation of the facility, Marcegaglia arranged for removal of the TCE AST in July 1992. and later disposal of drums (including some that were reportedly leaking) found in the DSA between 1994-1995. In 1993, Marcegaglia purchased at least one 55-gallon drum of TCE, which it used in its operations. In 1994, a break in a water line in Plant 8 caused tens of thousands of gallons of water to flood inside and around Plant 8, in areas impacted by releases of hazardous substances in soils and groundwater. The New Bishop Company later changed its name to Damascus-Bishop Tube Company. Christiana Metals continued its investigation activities after operations transitioned to Marcegaglia.

In 1999, Marcegaglia ceased operations at the Source Property, and, at the same time, Christiana Metals informed DEP that voluntary actions to investigate and remediate the Site would cease. At this time, the Source Property was abandoned. The Source Property was subsequently acquired by the Central and Western Chester County Industrial Development Authority for potential redevelopment and sold the Source Property to CDP in 2005 for purposes of redevelopment.

In March 2000, DEP signed the Response Justification Document for the Site. DEP hired Baker to perform site investigations, utilizing a phased approach. Between 2000 and 2008, their activities revealed the following:

- Three soil hotspots;
- Source Property groundwater was contaminated by TCE and other chlorinated solvents in deep and shallow aquifers;
- Evidence of free product in groundwater on the Source Property;
- Source Property stream discharge of contaminated groundwater;
- Confirmed off-site migration of contaminated groundwater; and
- Full extent of the contamination was not known.

Under the terms of a 2005 Prospective Purchaser Agreement ("PPA") which DEP and CDP executed prior to the recordation of the deed transfer of the Source Property to CDP, CDP agreed, in part, to (1) assess and/or clean up soil contamination at the Source Property to a non-residential Statewide health standard or a site-specific standard, as set forth in the Land Recycling and Environmental Remediation Standards Act ("Act 2"), in accordance with a work plan created by CDP; (2) not to exacerbate any existing contamination at the Source Property; (3) not to interfere with or impair any response action taken by DEP; and (4) to provide access and right of entry to DEP for potential response actions in exchange, in part, for a covenant not to sue and contribution protection from DEP.

In 2006, DEP selected a Prompt Interim Response of installing an air sparging and soil vapor extraction remedial system ("AS/SVE System") to address TCE contaminated soil (unsaturated) in three source areas on the Source Property. DEP issued the Statement of Decision for the Prompt Interim Response in September 2007. In 2007, CDP designed and provided mechanical equipment for the installation and operation of the AS/SVE system. DEP's contractor (Weston Solutions) completed system installation in October 2007. CDP undertook the system performance demonstration from February to April 2008. While the system removed some COCs, primarily VOCs, it failed to meet some of the performance requirements.

In October 2008, DEP entered into a Consent Order and Agreement ("COA") with Johnson Matthey. Pursuant to the terms of the COA, Johnson Matthey would conduct an environmental investigation, intended to (1) characterize the following: (a) groundwater contamination contained within the bedrock originating from the Source Property; (b) contaminated groundwater contained within the overburden (i.e. above the bedrock zone) originating from the Source Property and occurring on properties down-gradient from the Source Property; (c) potential vapor intrusion ("VI") pathways resulting from migration of contaminants from the Source Property; and (d) potential groundwater to surface water pathways to determine whether, and, if so, where contaminated groundwater, resulting from the Source Property, may be entering LVC or other surface water features; (2) perform a Risk Assessment; and (3) develop a Feasibility Study (if necessary). Johnson Matthey hired Roux Associates, Inc. ("Roux") to perform the remedial investigation activities. On August 4, 2009, DEP, Johnson Matthey, and Whittaker amended the COA to include Whittaker (another former owner/operator) to the agreement.

DEP facilitated future remedial response action(s), as defined in Section 103 of HSCA, 35 P.S. § 6020.103, by placing the Site on the PAPL on September 11, 2010. The PAPL listing allowed DEP to consider response actions which would cost more than $2M and/or take longer than one year to complete and provided the local municipality, East Whiteland Township, with the opportunity to seek a technical evaluation grant ("TEG") to evaluate DEP's proposed remedial response action. DEP formally entered into a TEG agreement with East Whiteland Township authorizing expenditure of up to $50,000 on July 12, 2018. TEG funding for the purpose of evaluating DEP's proposed remedial response action will be available to the Township when the Administrative Record for this response action is opened.

From 2009 to the present, on behalf of Johnson Matthey and Whittaker, Roux has performed a multi-phased Remedial Investigation ("RI"), a Treatability Study ("TS"), and a Feasibility Study ("FS") for groundwater contamination at the Site. The RI focused on defining the full extent of groundwater contamination northeast of the Source Property; evaluating current and potential risks resulting from Site-related COCs identified in surface water; characterizing current and potential future VI into occupied structures within the Site (including associated human health risks); and supplementing prior Source Property investigations performed by DEP. Roux reported results of the RI work in three RI Reports dated December 2010, August 2015, and January 2021 ("2021 RI"). The 2021 RI conclusions included the following: (1) no current, unacceptable risks result from conditions at the Site; (2) potential future risks to human health may result from future groundwater use and/or construction of new or modification of existing structures within the Site (as delineated in the RI); (3) soils at the Source Property contain inorganic and organic COCs at levels exceeding DEP's numeric cleanup standards; and (4) surface water within the exceptional value LVC contains Site-related COCs, resulting from diffuse groundwater discharge.

The TS was initiated with a bench-scale test in 2012, followed by a field-scale test to evaluate the efficacy of enhanced reductive dechlorination/in situ bioremediation. The TS Completion Report, dated October 2015, concluded that amendments introduced into the target zone were not well distributed to the compacted saturated soils, but were distributed primarily to the weathered/shallow bedrock zone. Additionally, favorable geochemical conditions and sufficient populations of dechlorinating bacteria were not present in baseline samples or sustained in the target treatment zone during the field-scale test. A hydraulic evaluation performed during injection activities revealed downward transport of amendments from the overburden (target zone) into weathered/shallow and competent (deeper) bedrock zones.

DEP formally requested preparation of an FS in a letter dated May 31, 2016. The resulting FS Report, submitted by Roux in January 2021, screened and evaluated remedial options and technologies for addressing Site-related impacts to shallow, intermediate, and deep groundwater beneath the Site, DNAPL, and LVC. After the initial screening, retained options were evaluated with respect to short-term and long-term effectiveness, compliance with Applicable, or Relevant and Appropriate Requirements ("ARARs"), implementability, and cost effectiveness. The FS report did not evaluate options for addressing Site-related contamination in soils on the Source Property.

Initially, to evaluate options for addressing only unsaturated soils, DEP tasked Groundwater and Environmental Services, Inc. ("GES") with preparing a Remedial Alternatives Analysis ("2020 RAA") for unsaturated soils. The 2020 RAA, dated August 2020, evaluated excavation with offsite disposal, excavation with onsite treatment, in situ stabilization, in situ chemical oxidation or reduction via soil mixing, surface barrier (capping), and engineering/ICs. At DEP's request, GES supplemented the 2020 RAA with a November 2020 Technical Memorandum ("2020 Tech Memo") to evaluate four technologies capable of simultaneously addressing contaminated unsaturated and saturated soils on the Source Property.

In December 2020, Roux provided a report, summarizing additional, limited soil investigation activities in Plant 5. The objectives of the investigation were to assess the horizontal and vertical extent of VOCs and to assess whether hexavalent chromium is present in a railing spill area located in a courtyard between Plants 5 and 8. Roux also provided DEP with an FS Addendum, in which it, on behalf of Johnson Matthey and Whittaker, evaluated an eighth remedial alternative to integrate a remedial alternative for soil and groundwater source area mitigation with the FS alternatives for groundwater.

C. RELEASE OF HAZARDOUS SUBSTANCES

IDENTIFIED COCS/HAZARDOUS SUBSTANCES

Table 1 below summarizes the COCs identified in the 2021 RI. The COCs identified are "hazardous substances," pursuant to Section 103 of the HSCA, 35 P.S. §6020.103. All are designated as a hazardous substance pursuant to the Federal Superfund Act, officially titled the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"), 42 U.S.C. § 9601 et seq. The presence of these hazardous substances in soil, groundwater, and surface water constitute a "release" and "threatened release" of hazardous substances at the Site, as those terms are used in Section 505 of HSCA, 35 P.S. §6020.505.

Table 1: COCs that are Hazardous Substances

COC	Affected Media
Chlorinated Volatile Organic Compounds ("CVOCs")	
TCE	Soil, Groundwater, Surface water
1,1,1-TCA	Soil, Groundwater, Surface water
1,1,2-Trichloroethane ("1,1,2-TCA")	Soil, *Groundwater*[2]
1,1-DCA	*Groundwater*
1,1-DCE	Soil
1,2-Dichloroethane ("1,2-DCA")	*Groundwater*
Carbon Tetrachloride	*Groundwater*
Chloromethane	*Groundwater*
cis-1,2-Dichloroethene ("cis-1,2-DCE")	Soil, Groundwater, Surface water
Methylene Chloride	*Groundwater*
PCE	Soil, Groundwater
trans-1,2-DCE	*Groundwater*
Vinyl Chloride	Soil, Groundwater
Other Organic Compounds	
1,2,4-Trimethylbenzene ("1,2,4-TMB")	*Groundwater*
1,4-Dioxane	*Groundwater*
Benzene	*Groundwater*
Bromomethane	*Groundwater*
Methyl tert-butyl ether ("MTBE")	*Groundwater*
Inorganics	
Antimony	Soil
Arsenic	Soil
Cobalt	Soil
Hexavalent Chromium [3]	Soil, Groundwater, Surface water
Lead	Soil
Manganese	Soil, Groundwater
Nickel	Soil, Groundwater, Surface water
Thallium	Soil
Total Chromium	Soil, Groundwater, Surface water
Vanadium	Soil

[2] 'Groundwater' is italicized for certain CVOCs and other organic compounds, above, that Roux has disputed that their detections in groundwater samples are related to releases at the Site.
[3] Total chromium detections were compared to hexavalent chromium standards for soil in the RI. Additional soils analysis will be required during pre-design characterization to evaluate the presence and distribution of hexavalent chromium in soil

Fluoride is a "contaminant" as that term is defined by Section 103 of HSCA, 35 P.S. § 6021.103, and Section 9601 of CERCLA, 42 U.S.C.A. § 9601. Fluoride is a component of hydrofluoric acid, which was used in the tube-making process and released at the Site. Hydrofluoric acid is a hazardous substance. Fluoride is also identified as a COC in groundwater and surface water, as it was detected above Act 2 Residential Used Aquifer ("RUA") Standards for Medium-Specific Concentrations ("MSC") in Groundwater ("DEP Act 2 Standards"). During periods of manufacturing operations at the Source Property, fluoride was detected in LVC above Chapter 93 water quality standards. More recent surface water and monitoring well sample analysis demonstrates that the highest fluoride concentrations in LVC and in groundwater occur near areas where documented spills of raw acids and acid rinse water occurred on the Source Property.

IMPACTED MEDIA: SOILS

The source areas on the Source Property for CVOCs and inorganic hazardous substances are detailed below and depicted in Figure 3. The hazardous substances that were detected in soil were compared to DEP's Act 2 Standards as follows:

- Residential Direct Contact ("RDC") MSCs for soil (0-15 feet)
- RUA (total dissolved solids <2500 milligrams per liter) Soil-to-Groundwater MSCs for soil.

Soil source areas (CVOCs)
CVOC soil contamination has been identified in three main areas of concern ("AOCs"), associated with specific historic manufacturing operations of Bishop Tube. Chlorinated solvents were used for degreasing metals in Plants 5 and 8 and were stored in an AST located along the north wall outside of Plant 8. Hazardous substances detected above DEP's Act 2 Standards for soil in these areas include TCE, PCE, 1,1,2-TCA, 1,1,1-TCA, cis-1,2-DCE, 1,1-DCE, and vinyl chloride. Chlorinated solvents have also been identified in soils underlying the DSA, described above. Based on its extent within each of the three main source areas, TCE is considered the primary CVOC in soil and may be used to define the extent of CVOCs in each area. Maximum TCE concentrations in each area are 35.2, 10,754, and 4,179 mg/kg in the Plant 5, Plant 8 and DSA source areas respectively. The more stringent Act 2 Standard for TCE is 0.5 mg/kg (RUA Soil-to-Groundwater MSC).

In addition to the three main AOCs, chlorinated solvents were detected at levels exceeding Act 2 Standards in soils in other isolated areas of the Source Property. Based on information from former Bishop Tube employees, small quantities of chlorinated solvents were routinely discarded outside of the buildings. Figure 3 depicts the three main source areas and isolated areas of CVOC soil contamination which exceed the Act 2 Soil-to-Groundwater MSC.

Soil source areas (Inorganics)
Inorganic contaminants, including total chromium and nickel, have been detected in soil at levels, exceeding Act 2 Standards, in known acid rinse water handling AOCs. In addition, total chromium levels, exceeding DEP's soil cleanup standard for hexavalent chromium, are

widespread across the Source Property but are markedly higher in the acid rinse water handling AOCs and in a drainage area located between Plant 5 and Plant 8. To assure that cleanup actions to address chromium will be protective of human health and the environment (by addressing the more toxic hexavalent chromium), pre-remedial design phase sampling and soil analysis will be needed to determine the nature of the chromium detected (hexavalent vs. trivalent chromium). As noted above in Section B, Roux reported results of limited supplemental soil sampling from the drainage swale located between Plants 5 and 8 in a memorandum, dated December 16, 2020. Roux did not detect hexavalent chromium in samples it collected in this specific AOC. However additional pre-design sampling from additional AOCs will be needed to identify the source(s) of hexavalent chromium detected in shallow groundwater and LVC.

In addition to nickel and total chromium in acid rinse water handling AOCs, cobalt, manganese, thallium, and lead, exceeding DEP Act 2 Standards, have been identified in isolated areas of the Source Property. Fluoride concentrations in soil are not known, but, due to its presence in groundwater and surface water, fluoride analysis will also be incorporated into the pre-design soil investigation.

Other inorganic contaminants, including total chromium, arsenic, and vanadium are more widespread in soils but are likely attributable to natural occurring conditions. Pre-remedial design phase sampling may be performed to confirm whether this naturally occurring condition exists for any of these contaminants, which, if confirmed, would not be subject to remediation under HSCA.

IMPACTED MEDIA: GROUNDWATER

The source areas for CVOCs, other organic compounds, and inorganic hazardous substances in groundwater are detailed, below. The hazardous substances that were detected in groundwater were compared to DEP's Act 2 Standards -- specifically the RUA MSCs for groundwater.

Source area groundwater (CVOCs)
Groundwater within the saturated soils and bedrock below and downgradient from the vapor degreaser areas in Plant 5 and Plant 8 and the DSA contains the chlorinated solvents TCE, PCE, and 1,1,1-TCA which were used at the facility and breakdown products, including cis-1,2-DCE, 1,1-DCE, 1,2-DCA, and vinyl chloride, exceeding DEP's Act 2 Standards for groundwater. Upgradient wells located south and west of the manufacturing areas do not contain these compounds. Samples collected in 2018 from bedrock monitoring wells on and immediately downgradient from the Source Property contained TCE at levels exceeding 150,000 µg/l. Groundwater samples collected from overburden and bedrock monitoring wells located within the Plant 8 AOC contained TCE in excess of 200,000 µg/l. A bedrock monitoring well sample from within the DSA contained TCE exceeding 90,000 µg/l. Groundwater samples from wells within the Plant 5 AOC contained much lower TCE concentrations, ranging up to approximately 50 µg/l and suggesting that the saturated soil and bedrock in this AOC are not currently major contributors to the dissolved CVOC plume. DEP's Act 2 Standard for TCE is 5 µg/l. Based on its extent and concentration in groundwater, DEP considers TCE to define the limits of chlorinated solvent contamination in Site groundwater (including on the Source Property).

Groundwater contamination beyond the Source Property and the interaction of contaminated groundwater with LVC are discussed, below.

In the 2021 RI, Roux disputes the inclusion of certain CVOCs as groundwater COCs: 1,1,2-TCA, 1.2-DCA, carbon tetrachloride, chloromethane, and trans-1,2-DCE. The bases for its disputes are (1) that those COCs exceeded the Act 2 Standard in two or fewer monitoring wells and (2) Methylene chloride detections are thought to be (and commonly is) related to laboratory contamination. DEP considers these compounds to be COCs at the Site and will evaluate pre-design investigation results to determine if specific design components are needed to address these COCs.

Source area groundwater (Other Organic Compounds)
Five other organic compounds are listed, above, as groundwater COCs at the Site. Roux disputes the inclusion of the following organic compounds in the 2021 RI: 1,2,4-TMB, benzene, 1,4-dioxane, bromomethane and MTBE. The justifications for this dispute are that (1) Roux detected these organic COCs above their respective Act 2 Standards in two or fewer wells and (2) Roux considers an upgradient source (i.e., bulk fuel storage facility) to be responsible for the MTBE detections. Consistent with the CVOCs COCs disputed in the 2021 RI, DEP considers these compounds to be COCs. Pre-design sampling may be needed.

Source area groundwater (inorganics) on the Source Property
Total chromium and nickel concentrations, exceeding DEP's Act 2 Standards (100 µg/l in both cases), have been detected in overburden and shallow bedrock monitoring well samples within and/or downgradient from acid rinse water handling AOCs. Fluoride has also been detected above DEP's Act 2 Standards in similar areas associated with acid use at the Source Property. The presence of fluoride in Site groundwater is attributed to Bishop Tube's use of hydrofluoric acid to remove surface impurities (scale) during stainless steel tube processing.

Sulfide exceeded its groundwater MSC in seven wells sampled by Roux during the RI activities. Sulfide can be produced by a bacterial transformation of naturally occurring sulfate under certain anaerobic conditions. In the 2021 RI, Roux disputed inclusion of sulfide as a COC, arguing that it was only detected at these locations in a single sampling event. Pre-design investigation activities will include sulfide analysis to determine its presence and the need to address it in the remedial design.

These inorganic contaminants in groundwater appear to be confined within the Source Property, but some additional pre-remedial design phase monitoring well sampling will be necessary to confirm. The interaction of contaminated groundwater with LVC is discussed, below.

Downgradient groundwater (Offsite Plume)
CVOC contamination in groundwater as defined by TCE concentrations exceeding DEP's Act 2 Standard (5 µg/l) has been characterized through a combination of groundwater monitoring data and fate and transport modelling presented in the 2021 RI. As noted, above, inorganic COCs appear to be limited to areas within the Source Property; however, additional groundwater monitoring and analysis will be necessary to confirm current concentrations.

1,1,1-TCA, PCE, and TCE used and released at the Source Property and daughter/breakdown products associated with these parent compounds are present at levels exceeding DEP's Act 2 Standards north and east of the Source Property. Groundwater flow and contaminant transport at the Site are controlled by the orientation of bedrock fractures and joints. An apparent cross cutting fracture which is believed to account for the location of LVC on the Source Property acts as a discharge zone and appears to direct contaminant transport to the north across Lancaster Avenue, where the stream and groundwater flow turn in a more easterly direction. It should be noted that the cross-cutting fracture zone may not intercept all contaminants transported to the east, and additional groundwater delineation is necessary to evaluate contaminant transport in the northeast portion of the Source Property. Beyond Lancaster Avenue, monitoring wells installed north of LVC do not contain Site-related COCs above DEP's Act 2 Standards. This suggests that in this downgradient area, LVC acts as the northern Site boundary. Empirical data and contaminant fate and transport modeling show that TCE at levels exceeding DEP's Act 2 Standards has migrated approximately 3,500 ft. east northeast of the Source Property, beyond monitoring well MW-84 located on a commercial property on the west side of Morehall Road (PA Route 29). The extent of the Site, as defined by the TCE contaminant plume, is shown on Figure 4.

In 1999, at the request of DEP, Christiana Metals installed a POET on the water supply of a contaminated home well, which contained TCE at a concentration of 53 µg/l. The POET consists of a dual canister whole-house granulated activated carbon ("GAC") filter system and is equipped with an ultraviolet light for disinfection. Sampling performed by a consultant working for Christiana Metals confirmed the effectiveness of the treatment system. DEP has periodically sampled and maintained the GAC filter, sometimes with the assistance of two former owners/operators of Bishop Tube (Johnson Matthey and Whittaker). Pre-treatment samples collected in 2017 contained TCE at 5.88 µg/l. Subsequent to the 2017 sampling, the property had been unoccupied, but in 2019 it was purchased. DEP has identified the existence of the POET with the new owner, while trying to arrange for the sampling of that well. The new owner has indicated an intention to use the home as a residence after renovations are completed.

IMPACTED MEDIA: SURFACE WATER/STREAM

LVC flows in a northerly direction across the eastern portion of the source property. This headwater stretch of LVC is a small stream. Baseflow measurements collected by Roux during their RI activities ranged from 49 to 354 gallons per minute as measured upstream (near the AMTRAK railroad crossing) and downstream (just north of Lancaster Avenue), respectively. Based upon these measurements LVC is considered to be a gaining stream on the Source Property. This means that groundwater is discharging to the stream in this stretch. Concurrent monitoring well and stream sampling data suggest that 1,1,1-TCA, TCE, cis-1,2-DCE, total chromium, hexavalent chromium, nickel, and fluoride are entering LVC via diffuse discharge of contaminated groundwater from the Source Property to the stream in the same stretch. In addition, any ongoing discharge to the waters of the Commonwealth would be a public nuisance, pursuant to Section 401 of the Clean Streams Law, 35 P.S. § 691.401.

The following table summarizes results of an evaluation of the groundwater discharge to surface water presented in the 2021 RI. Sample results presented in the table were collected during dry weather conditions in an effort to avoid collecting stream samples comprised of surface runoff from precipitation. Roux collected 5 samples from LVC between the Amtrak rail line south, upstream of the Source Property and a location just north of the Norfolk Southern rail line, downstream of the Source Property, see Figure 5.

Table 2: Summary of LVC Sample Results for Surface Water COCs

	Upstream Result *(from SW-1 or SW-2)*	**Maximum Result** (from SW-3, 4, or 5)	**Chapter 93 Standard**
TCE	**ND (<1)**	**7.3**	0.6
1,1,1-TCA	ND (<1)	1.2	610
cis-1,2-DCE	ND (<1)	4.7	12
Fluoride	51	1200	2000
Hexavalent Chromium	0.1	**22.5**	11
Nickel*	ND (<2)	38.16	52
Total Chromium	7.4	22.7	None

All samples are reported in µg/l
All maximum results are from locations proximate to/or downstream from source areas
Metals results are for dissolved metals
Bold indicates Chapter 93 exceedance
**at Hardness of 100*

The 2021 RI evaluated COCs detected in LVC by presenting concurrently collected groundwater analytical data. The surface water COCs in Table 2 were detected in groundwater samples near LVC and increased along and just downstream of soil source areas on the Source Property. The 2021 RI concludes that this stretch of LVC is a gaining stream, meaning that groundwater is discharging along and just downstream from these source areas. The increasing COC concentrations identified along and just downstream from the source areas are attributed to groundwater discharge to LVC. A human health and an ecological risk assessment are presented in the 2021 RI and conclude that no unacceptable risks currently result from the COC concentrations identified in LVC, based on current human and ecological exposure pathways.

As noted, above, LVC is classified as an Exceptional Value stream by DEP. This designation subjects LVC to special protections, including anti-degradation requirements discussed in Section V, below.

RISK EVALUATION

In 2008, the Agency for Toxic Substances and Disease Registry ("ATSDR") completed a Health Consultation for the Site. At that time, ATSDR identified three completed exposure pathways and three potential exposure pathways. The potential exposure pathways included "incidental ingestion of groundwater from residential taps," "inhalation of vapors from contaminated spring water inside a residential dwelling and a spring house," and "inhalation of vapors migrating into dwellings from underlying contaminated groundwater or soils."

The Human Health Risk Assessment ("HHRA") presented in the 2021 RI evaluated current and potential future exposure risks at the Site. The HHRA concludes that there are no current unacceptable exposure risks at the Site, based on the results of the surface water risk assessment and a lack of open exposure pathways, such as untreated drinking water supplies and VI into occupied structures (based on evaluation of indoor air quality data collected during the RI).

Potential future risks exceeding cancer and noncancer risk criteria were identified in the 2021 RI, related to consumption of groundwater and VI associated with Site groundwater. Risks associated with consumption of groundwater could occur in the future if any drinking water supply wells are installed within the Site boundary. Calculated risks associated with VI resulting from groundwater presented in the 2021 RI are largely driven by the TCE concentrations identified in monitoring wells. Additionally, evaluation of groundwater analytical data from Site monitoring wells revealed potential future VI risks if existing structures are modified or if new structures are constructed within the Site boundary as identified in Figure 4.

ATSDR's Toxic Substance Portal was referenced for information related to the threat to human health posed by each COC, if there is human exposure. This information is summarized in Appendix A.

PRIMARY COC

In summary, TCE is considered the primary Site-related COC because its concentrations within soil, groundwater, and surface water are generally higher than other CVOCs. Additionally, TCE has migrated further in groundwater than the other CVOCs released at the Site. The 2021 RI establishes the Site boundary based on TCE concentrations in groundwater. Since a public water supply is available within the entire Site boundary, VI is anticipated to be the most significant exposure pathway. Calculated risks associated with VI resulting from groundwater presented in the 2021 RI are largely driven by the TCE concentrations identified in monitoring wells. Potential routes of exposure on the Source Property include trespasser and construction worker direct contact to soil and surface water, and construction worker inhalation during excavation. Potential exposure routes for a future redevelopment scenario may include inhalation from VI and drinking from wells, if installed. Potential routes of exposure for downgradient properties may include the VI pathway if new construction occurs and/or occupied buildings are modified and potential use of untreated groundwater.

III. RESPONSE CATEGORY

On September 11, 2010, DEP published the Notice of Listing on the PAPL. DEP has the discretion to place sites on the PAPL when it has determined through investigation that there are releases or threatened releases of hazardous substances, or releases or threatened releases of contaminants that present a substantial danger such that placement on the PAPL is warranted. In accordance with the requirements of Section 502(a) of HSCA, the Hazard Ranking System (HRS; 40 CFR Part 300, Appendix A), established under the Federal Superfund Act, is utilized to rank the sites for placement on the PAPL. Placement of a site on the PAPL is used to identify and prioritize sites that require a remedial response to address threats to the public health, safety, or the environment. Remedial responses are expected to cost more than $2 million or to take more than one year to implement.

IV. CLEANUP STANDARDS

Section 106 of Act 2 states that environmental remediation standards established under that statute shall be applicable to remediation conducted under HSCA. This Site will be remediated to a combination of the Act 2 standards, including background, Statewide health, and site-specific. DEP maintains discretion under HSCA to select remedies that meet any one or a combination of cleanup standards under Act 2.

A background standard may be applied to certain inorganic contaminants or other organic compounds if the contaminant is determined to be present because it is a natural component of soil or because it has been released from an off-site facility and migrated onto the Site.

A Statewide health standard may be applied to COCs based upon post-remediation sample analysis. Under the Statewide health standard, the regulations in Chapter 250 establish a list of cleanup levels for certain contaminants. The MSCs are the concentrations of contaminants in soil or groundwater for residential and non-residential exposures. The standard may be met by using treatment and removal technologies.

A site-specific standard may be applied to COCs, including TCE, where the DEP has determined that achieving a Statewide health standard may not be practical. Under the site-specific standard, cleanup levels can be developed specifically for a site based on the contaminants, exposures, and conditions unique to that site. The following
considerations apply:

- For carcinogens, the cleanup levels for soil and groundwater are established at levels that represent a cumulative excess cancer risk of between one in 10,000 to one in 1,000,000.
- For toxic chemicals other than carcinogens, soil and groundwater must be cleaned up to a level that prevents deleterious effects to the exposed population.
- Current and probable future uses of groundwater in aquifers must be identified and protected.
- Concentrations of contaminants in soil must protect against carcinogenic and other toxic effects based on direct contact with the soil. Soil cleanup standards must also be protective of groundwater uses.
- The cleanup standards may be attained through a combination of remediation activities that can include treatment, removal, engineering controls, or ICs and can include innovative or other demonstrated measures.

V. APPLICABLE, OR RELEVANT AND APPROPRIATE REQUIREMENTS ("ARARs")

Section 504 of HSCA requires that final remedial responses must meet (or waive or modify) all ARARs and be cost effective. The table in Appendix B lists standards, requirements, criteria, or limitations that are legally applicable, or relevant and appropriate under the circumstances presented by the Site.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law, that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a state Site. The "applicability" determination is a legal one and implies that the remedial action or the circumstances at the site satisfy all of the jurisdictional prerequisites of a requirement.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a state site, address problems or situations sufficiently similar to those encountered and their use is well suited to the particular site.

The determination of relevant and appropriate relies on professional judgment. A requirement can be judged by comparing a number of factors, including the characteristics of the remedial action, the hazardous substances in question, or the physical circumstances of the site, with those addressed in the requirement. It is also helpful to look at the objective and origin of the requirement.

A requirement that is determined to be relevant and appropriate must be complied with to the same degree as if it were applicable. However, there is more discretion by DEP in this determination. It is possible for only part of a requirement to be considered relevant and appropriate, the rest being dismissed, if judged not to be relevant and appropriate in a given case.

Non-promulgated or non-regulatory documents (health advisories, guidance, proposed regulations), issued by the state or Federal government, are not considered ARARs and are referred to as "to be considered" requirements or TBCs. TBCs are evaluated along with ARARs and are considered appropriate in the absence of a specific ARAR or where ARARs are not sufficiently protective in developing cleanup goals. A TBC identified for the action must be complied with to the same degree as if it were applicable.

VI. ANALYSIS OF ALTERNATIVES

In 2017, prior to completion of the FS, Roux prepared a Preliminary FS Screening Memorandum ('FS Screening Memo") to address groundwater impacts at the Site, groundwater impacts to surface water and sediment at the Site, and the potential for VI off of the Source Property. The purpose of the FS Screening Memo was to identify remedial alternative technologies ("RAs"), which would be retained for further consideration in the FS. The RAs were evaluated for implementability, effectiveness, and relative cost. The seven retained RAs were evaluated further in the FS. The 2020 RAA addressed unsaturated soil on the Source Property. The 2020 Tech Memo evaluated four technologies capable of simultaneously addressing contaminated unsaturated and saturated soils on the Source Property. After reviewing the 2020 Tech Memo, Roux submitted a FS Addendum in December 2020. The FS Addendum evaluated an eighth RA to integrate a RA for soil and groundwater source area mitigation with the FS.

DEP is proposing to divide the Site into three operable units ("OU") to address the contamination at the Site.

- OU1 would address soil contamination on the Source Property.
- OU2 would address Site groundwater.
- OU3 would address drinking water impacts.

Based on requirements of HSCA, the RAs were analyzed to determine: 1) the extent to which each alternative protects public health and the environment; 2) the extent to which each alternative complies with or otherwise addresses ARARs; 3) the extent to which each alternative is feasible, effective, implementable, and permanent, and 4) the relative cost effectiveness of each alternative. A summary of costs for each alternative considered is presented in Appendix C. DEP considered the most viable alternatives described, below.

OU1: SOILS

OU 1 consists of the soil source areas, as shown in Figure 3, described in Section C, above, and includes unsaturated soils. Saturated soils are defined as the solid media located below the groundwater table and above the bedrock. Remedial alternatives for addressing saturated soils are evaluated as part of either OU1 or OU2 Groundwater depending on the nature of the remediation involved. The Remedial Action Objectives ("RAOs") are 1) assuring that exposure pathways are eliminated or remain closed in accordance with an Act 2 Standard; 2) reducing contaminant transfer and migration from the soil into groundwater; and 3) preventing movement of contaminated soils by water or wind. DEP evaluated the following remedial alternatives as they apply to each area of impact:

- OU1: Alternative 1 - No Action
- OU1: Alternative 2 - Engineering Controls, Coupled with ICs
- OU1: Alternative 3 - Excavation with Offsite Treatment and/or Disposal
- OU1: Alternative 4 - Excavation with Onsite Treatment
- OU1: Alternative 5 - In Situ Chemical Oxidation/In Situ Chemical Reduction ("ISCO/ISCR"), Coupled with Soil Mixing

More specific information concerning each alternative, including further breakdown of costs, is provided in the 2020 Tech Memo.

OU1: ALTERNATIVE 1 - No Action

Description of the Alternative
Under this alternative, DEP would require no further action be taken to mitigate the threat of Site-related contamination. This alternative serves as a baseline to compare against other response actions. This alternative would be feasible and implementable because no action is being taken but would not be effective in addressing the health threats to the public and does not offer a permanent solution.

Compliance with ARARs
This alternative would not comply with ARARs because it would not meet Act 2 standards or antidegradation requirements listed in Chapter 93 that protect LVC from diffuse COC discharges originating from the soil source areas.

Costs and Cost Effectiveness
There is no cost associated with this alternative.

OU1: Common Elements of Alternatives 2 through 5

Certain common elements are incorporated into all OU1 alternatives except for No Action. The degree to which these common elements apply may differ among the alternatives and may depend on the concentrations of COCs that remain after implementation. The following common elements apply to OU1 Alternatives 2 through 5:

- Pre-Design Investigation will establish and verify areas to be targeted for attainment of one or more standards. For example, the nature of chromium detected in soil in previous investigations is not fully defined, and additional analysis will be needed to determine its toxicity and/or attribution to naturally occurring/background conditions.
- Engineering controls are described in the FS as remedial actions designed to contain or control physical contact with or migration of COCs. Engineering controls are also described as best management practices ("BMPs").
- ICs are measures taken to limit or prohibit certain activities that may interfere with the integrity of a remedial action or result in exposure to regulated substances at a site and typically involve activity and use limitations ("AULs"). AULs are established to prevent exposure to COCs and protect the remedy. The ICs developed for soil would be integrated with engineering controls described in the OU2 Groundwater analysis of alternatives below, including surface barriers, stormwater management structures and targeted plantings to protect LVC from stormwater runoff and mitigate diffuse discharge of COCs. Environmental Covenants ("ECs") on the Source Property would be drafted and recorded to implement the AULs in accordance with the Uniform Environmental Covenants Act ("UECA"). Pursuant to Section 512 of HSCA, DEP could issue an Administrative Order ("HSCA 512 Order") to a property owner who refuses to sign and record an EC. Such an EC or HSCA 512 Order would be attached to the deed of the property and be permanent, running with the land. A common IC applied to soil is a prohibition or limitation on future excavation or movement of contaminated soil to prevent human or ecological exposure.
- Post-remedial care and monitoring would include a periodic review of ICs and any engineering controls that are incorporated into the remedy. The outcome of this monitoring would be documented to verify that the RAOs continue to be met. If engineering controls (e.g., vapor mitigation systems) require maintenance, maintenance plans would be included.

OU1: ALTERNATIVE 2 - Engineering Controls, Coupled with ICs

Description of the Alternative
Implementation of this alternative would involve characterization and evaluation of current and potential exposure pathways and risk levels associated with COCs during the design phase to determine the exact areas and COC concentrations. Engineering controls for source area soils may include surface barrier(s), aimed at addressing direct contact to COCs and preventing the transfer of COCs from unsaturated soils to groundwater, as rainfall infiltrates and passes through contaminated soils (known as the soil-to-groundwater pathway).

Saturated soils are impacted by contaminated groundwater and can hold COCs, acting as a continuing source to groundwater contamination. Under this alternative, no steps would be taken to address these existing sources of contamination in saturated soils.

To address the VI pathway, engineering controls may consist of the installation of vapor barriers or VI mitigation systems for any buildings constructed and intended for occupancy on the Source Property.

ICs, in the form of an EC or a HSCA 512 Order, would be recorded on the deed of the Source Property and be permanent, running with the land. AULs would ensure that barriers and/or mitigation systems are installed when development occurs and properly operated and maintained in the future. Restrictions on the excavation and/or disturbance and/or relocation of soils would also be included.

Installation, operation and maintenance of engineering controls associated with redevelopment of the property would be the responsibility of the property owner/operator/developer, while DEP would be responsible for ensuring ICs are implemented and for monitoring IC compliance.

Engineering controls and ICs specific to Source Property soils would be protective of human health, feasible, effective, and implementable but would not address saturated soils as an ongoing source of groundwater contamination.

Compliance with ARARs
Alternative 2 would meet the requirements of Act 2 under the site-specific standard with respect to direct contact. However, Act 2 soil-to-groundwater MSCs and antidegradation requirements listed in Chapter 93 that protect LVC from diffuse COC discharges would not be met solely through engineering controls and ICs.

Engineering controls would be required to comply with ARARs related to Storm Water Management BMPs.

ICs would be prepared as described, above, in accordance with UECA and/or HSCA Section 512.

Cost Effectiveness
A detailed cost breakdown for this alternative is presented in the 2020 RAA prepared for DEP by GES. Implementation costs, including design, planning, fence construction, EC filing fees, and documentation/reporting are estimated at $156,345. This does not include costs related to the construction of a surface barrier. Annual maintenance and reporting costs are estimated to be $12,000. Over a 30-year lifespan the total cost associated with Alternative 2 (including contingency - 30% and inflation - 3%) is $796,257.

OU1: Common Elements of Alternatives 3 through 5

- Process monitoring would be applicable to the active remedial alternatives that involve construction work to remove and/or treat COCs in soils and may include interim soil sampling to evaluate the status of the remediation, monitoring for potential stream impacts resulting from remediation activities, and air monitoring to ensure that workers and the community are not exposed to COCs.
- Post-remediation performance verification is intended to assure that the active remediation has been completed successfully. It could include post-excavation/post-treatment soil sampling, sampling of backfill (treated soil or imported fill), and physical testing of remediated areas for compaction and/or permeability.
- Restoration of certain areas subjected to soil remediation including grading may be necessary to prevent erosion and/or infiltration after work has been completed.

OU1: ALTERNATIVE 3 - Excavation with Offsite Treatment and/or Disposal

Description of the Alternative
This alternative involves the use of earth moving equipment to excavate then remove contaminated soils from the Source Property. Soils may be stockpiled onsite or loaded directly into trucks prior to shipment to a treatment and/or disposal facility. Excavation within Plant 5 and Plant 8 would require building demolition. This alternative is applicable to both unsaturated and/or saturated soils. However, excavation of saturated soils would require dewatering, including handling, treatment, and disposal of contaminated water. This alternative may be used in combination with one or more other alternatives to address contaminated saturated soil on the Source Property.

Excavation followed by offsite disposal would permanently remove contaminated soil from the Source Property and address direct contact and the soil-to-groundwater pathway. If applied to saturated soil, the contaminants within the soil media would be removed. Completion of the excavation would involve sampling and analysis to document that excavation goals have been met. Backfill would be imported to restore excavated areas to their pre-construction grade.

This alternative may require less engineering controls and/or less restrictive ICs than Alternative 2, which provides for no active remediation of contaminated soil. (Source Property ICs would be required for OU2 Groundwater). After backfilling and restoration is completed, long-term operation and maintenance would not be necessary.

This alternative would be feasible, effective, and protective of human health. It would be difficult to implement due to the shallow groundwater table in certain areas of the Source Property. The shallow depth of the groundwater in some areas would cause saturation of soils during excavation and a greater need for dewatering and to contain increasing contaminated saturated soils on the Source Property. Additionally, the low bridge clearance on S. Malin Road may require smaller equipment and trucks to be used than for standard excavation projects. Increased truck traffic would result from offsite transport and backfill importation activities and could result in community concerns.

Compliance with ARARs
Soil excavation with offsite disposal would comply with Act 2 direct contact and soil-to-groundwater standards. Implementation of this alternative would require stormwater management plans and plans for addressing fugitive emissions of dust and vapors. Building demolition would be performed in accordance with asbestos abatement regulations and notification requirements. Upon analytical waste classification and excavation, soils would be handled as residual or hazardous wastes in accordance with solid waste regulations. Prior to offsite transport of contaminated soils, additional laboratory analysis of soils would be required under state and Federal waste management regulations and to facilitate selection of one or more appropriate treatment and/or disposal facilities permitted to accept hazardous or residual waste.

Where applied to the saturated zone, this alternative would necessitate pumping of groundwater that would need to be treated and discharged or disposed in accordance with pretreatment requirements or waste management regulations. Because of the exceptional value designation of LVC, discharge to surface water is not considered feasible.

Cost Effectiveness
Costs associated with the excavation and offsite disposal alternative include building demolition, transportation, and offsite treatment/disposal. More detailed cost information is provided in the 2020 Tech Memo prepared by GES. When applied to saturated and unsaturated soil, Alternative 3 is estimated to cost $7.3M. Implementation of this alternative would reduce costs associated with addressing groundwater (OU2) in the unconsolidated zone (i.e., above bedrock). Selection of backfill materials may enhance cost effectiveness of certain OU2 alternatives described, below.

This alternative would not require expenditure for long-term operation and maintenance because contaminated soils would be permanently removed.

OU1: ALTERNATIVE 4 - Excavation with Onsite Treatment

Description of the Alternative
Like Alternative 3, this alternative involves use of earth moving equipment to excavate contaminated soils. The contaminated soils would be stockpiled on the Source Property. Then one or more treatment technologies would be used to treat the excavated soils. Treatment technologies could include ex situ soil vapor extraction or thermal treatment to address VOCs and/or equipment to stabilize COCs with a binding additive such as Portland cement to address direct contact and the soil-to-groundwater pathway. Post treatment soil samples would be

collected and analyzed to verify that Act 2 standards have been achieved before treated soils are used for backfill. Excavation within Plant 5 and Plant 8 would require building demolition. This alternative is applicable to both unsaturated and saturated soils. However, excavation of saturated soils would require dewatering, including handling, treatment, and disposal of contaminated water.

Excavation followed by onsite treatment would effectively address COCs in soil by removal from soil (if thermal treatment is used to address VOCs) and/or by preventing transfer of COCs to groundwater (where binding agents are used) through stabilization. Treatment equipment deployed on the Source Property would be designed to capture or mitigate fugitive emissions. Completion of the excavation would involve sampling and analysis to document that cleanup standards have been met. Treated soil would be used to restore excavated areas to their pre-construction grade.

Limited offsite disposal, engineering controls and/or ICs may be needed in combination with this alternative to eliminate direct contact with soils containing COCs exceeding the Act 2 direct contact standards if COC concentrations cannot be adequately addressed by the selected treatment technology. After excavation restoration is completed, long-term operation and maintenance would not be necessary. ICs may require monitoring of groundwater and surface water.

This alternative would be feasible, effective, and protective of human health. It would be difficult to implement due to the shallow groundwater table in certain areas of the Source Property. Access limitations resulting from the low-clearance bridge on South Malin Road may complicate remedy implementation due to the size of standard soil excavation and treatment equipment.

Compliance with ARARs
Soil excavation with onsite treatment would comply with Act 2 soil-to-groundwater and direct contact standards. Implementation of this alternative would require stormwater management plans and plans for addressing fugitive emissions of dust and vapors during the excavation work and from treatment equipment. Building demolition would be performed in accordance with asbestos abatement regulations and notification requirements. Where applied to the saturated zone, groundwater resulting from dewatering would need to be treated and discharged or disposed in accordance with pretreatment requirements or waste management regulations. Because of the exceptional value designation of LVC, discharge to surface water is not considered feasible.

To comply with post construction stormwater management requirements, restoration of remediated areas would be incorporated into the BMPs described as a common element in the OU2 Groundwater alternatives (except for No Action).

Cost Effectiveness
Costs associated with the excavation with the onsite treatment alternative are detailed in the GES 2020 Tech Memo and include building demolition and onsite treatment. When applied to saturated and unsaturated soil, Alternative 4 is estimated to cost \$6.0M. Implementation of this

alternative would reduce costs associated with addressing groundwater (OU2 – Groundwater) in the unconsolidated zone (i.e., above bedrock). Coordination of OU1 and OU2 design and implementation may enhance cost effectiveness of the overall remedy.

OU1: ALTERNATIVE 5 – ISCO/ISCR, Coupled with Soil Mixing

Description of the Alternative
In situ chemical oxidation ("ISCO") and/or in situ chemical reduction ("ISCR"), coupled with soil mixing/homogenization, are capable of destroying organic compounds including CVOCs found at the Site. Some varieties of ISCR amendments are capable of transforming and precipitating inorganic (e.g., heavy metals) contaminants, reducing mobility and impacts to groundwater via the soil-to-groundwater pathway. In some circumstances, soil amendments may be added to reduce the movement of groundwater through treated soil.

Amendment selection and dosing would be determined through pre-design investigation to maximize effectiveness and minimize negative effects such as impacts to LVC or on-going natural attenuation of groundwater contamination. Selection of amendments could be tailored to address COCs present in different areas of soil contamination as depicted in Figure 3. Since mechanical augers would be utilized in a grid pattern for mixing, soil excavation would not be required. Contaminated areas are treated as smaller units (cells) to optimize reagent dosing, ensure thorough mixing, and facilitate attainment evaluation. Building demolition would be necessary to facilitate access for the soil mixing. Alternative 5 can also be applied to saturated zone soils to address dissolved and adsorbed COCs which act as a source of groundwater contamination. Implementation of this technology would potentially hinder future development in areas where soil mixing is applied by compromising the soil structure and strength. The property owner/redeveloper may need to take additional steps to stabilize the treated soils to facilitate property development and reuse of the Source Property.

ICs including limits on excavation or a requirement for a soil management plan may be necessary to address potential direct contact exposure to inorganic COCs in treated soils for protection of human health and to ensure permanence. The need for ICs would be evaluated based on post-remediation sampling and analysis.

This alternative would be feasible, implementable, effective, and protective of human health.

Compliance with ARARs
In situ ISCO/ISCR treatment, coupled with soil mixing, would comply with Act 2 soil-to-groundwater standards. Though less intrusive than excavation remedies, implementation of this alternative would still require stormwater management plans. The subsurface dosing of fluids may be regulated by the Safe Drinking Water Underground Injection Control ("UIC") Program. Other potential impacts to surface water resulting from amendment injection would need to be assessed during a pre-design evaluation. Plans would be required for addressing fugitive emissions of dust and vapors during the mixing process. Building demolition would be performed in accordance with asbestos abatement regulations and notification requirements.

Cost Effectiveness
Costs associated with the in situ ISCO/ISCR, coupled with soil mixing alternative include building demolition, treatment reagent, and specialized equipment used for soil mixing. A more detailed cost breakdown is presented in the 2020 Tech Memo. When applied to saturated and unsaturated soil, Alternative 5 is estimated to cost $2.8M. As with other active approaches, implementation of this alternative would reduce costs associated with addressing groundwater (OU2) in the unconsolidated zone (i.e., above bedrock).

OU2: GROUNDWATER

OU2 consists of contaminated groundwater originating from the Source Property and extending to the east northeast as described in Section C, above, and shown on Figure 4. RAOs for groundwater include: 1) assuring that potential future exposure pathways resulting from groundwater contamination remain closed in accordance with Act 2; 2) reducing contaminant migration across the Source Property Boundary; 3) reducing COC discharge to LVC; and 4) hastening retraction of the groundwater contaminant plume.

DEP evaluated the following remedial alternatives:
- OU2: Alternative 1 – No Action
- OU2: Alternative 2 – Monitored Natural Attenuation (“MNA”)
- OU2: Alternative 3 – In Situ Injection (ISCO/ISCR/Bioremediation)
- OU2: Alternative 4 – In Situ Thermal Treatment (“ISTT”)
- OU2: Alternative 5 – Hydraulic Control (“HC”)

OU2: ALTERNATIVE 1 – No Action

Description of the Alternative
Under this alternative, DEP would require no further action be taken to mitigate the threat of Site-related contamination. This alternative serves as a baseline to compare against other response actions. This alternative would be feasible and implementable because no action is being taken but would not be effective in addressing the threats to the public health or the environment and does not offer a permanent solution.

Compliance with ARARs
This alternative would not comply with ARARs because it would not meet Act 2 standards or antidegradation requirements listed in Chapter 93 that protect LVC from diffuse COC discharges originating from the source areas.

Cost Effectiveness
There is no cost associated with this alternative.

OU2: Common Elements of Alternatives 2 through 5

Certain common elements are incorporated into all OU2 alternatives except for No Action. The degree to which these common elements apply may differ among the alternatives and may depend on the concentrations of COCs that remain after implementation. The following common elements apply to OU2 Alternatives 2 through 5:

- Pre-Design Investigation – These investigations may include a groundwater investigation in the northeast corner of the Source Property[4]: offsite inorganics analysis; chemical speciation; sampling and analysis to determine background conditions; and/or evaluation and pilot testing needed to implement active remedial strategies.
- Engineering controls would include stormwater control measures, capping in selected areas, and plantings to reduce COC migration and discharge to LVC; any necessary VI mitigation measures needed to prevent human exposure in modified or new occupied structures within the Site boundary; and may also include treatment equipment to treat the private water supply located within the affected area and specifically addressed as OU3 (Drinking Water).
- ICs will be necessary on the Source Property and select downgradient properties. ICs may include local or county rules and requirements, HSCA 512 Orders or ECs to document and ensure compliance with AULs. To prevent installation of new wells for potable use, any potential new potable well within the area of the Site would need to comply with Chester County Health Department ("CCHD") regulations that require a permit for any new supply wells prior to installation. CCHD considers known areas of groundwater contamination when issuing these permits. In addition, the CCHD regulations require sampling of any new well installed in the vicinity of the Site to demonstrate that it meets the drinking water standards before permission from the CCHD is granted to use the new well for drinking purposes. The VI pathway would require ECs or HSCA 512 Orders, mandating evaluation of the VI pathway prior to new construction and to assure maintenance and proper operation of necessary VI mitigation measures. ECs or HSCA 512 Orders would also be used to protect engineering controls intended to address diffuse COC discharges to LVC. Such an EC or HSCA 512 Order would be attached to the deed of the property and be permanent, running with the land.
- A post-remedial care plan will be prepared and implemented to assure ICs and engineering controls are maintained and long-term groundwater sampling is focused on monitoring continued natural attenuation; reduced migration of COCs across the Source Property boundary; retraction of the contaminant plume; and the remedy's effect upon diffuse discharge of contaminated groundwater to LVC. Routine groundwater monitoring could justify removal of ICs from affected properties as the size of the contaminant plume is reduced over time. Effective monitoring would require evaluation and potentially enhancement of the existing monitoring well network.

OU2: ALTERNATIVE 2 – MNA

Description of the Alternative
Monitored Natural Attenuation ("MNA") involves allowing multiple natural processes including dispersion, dilution, diffusion, abiotic, and biotic degradation to eventually meet groundwater RAOs. Alternative 2 would incorporate engineering controls and ICs to assure exposure

[4] Costs for performing the groundwater investigation in the northeast corner of the Source Property were not included in the 2021 FS prepared by Roux. Based on prior experience, DEP included an estimate cost of $50,000 to complete the groundwater investigation in the northeast corner of the Source Property.

pathways are addressed and eliminated. Implementing this alternative would not require demolition of Source Property buildings, but if buildings and building slabs are removed as part of the OU1 remedy, additional engineering controls (i.e., impermeable surface barriers) may be needed to prevent surface water infiltration and increased contaminant migration and/or discharge to LVC. Alternative 2 would include routine groundwater monitoring to assess and document the ongoing attenuation of the groundwater contamination at the Site. Data summarized in the 2021 RI suggests that, over time, natural attenuation processes have been resulting in reduced groundwater contamination and retraction of the contaminant plume associated with the Site, although the rate of reduction has not been demonstrated.

Selection of an active remedy to address OU1 may shorten the timeframe required to reduce the size of the contaminant plume, reduce offsite contaminant migration, and discharge to LVC. Selection of an appropriate OU1 remedy could also help create conditions favorable for biological degradation of CVOCs, a key component of natural attenuation. However, because of the high CVOC concentrations within the bedrock aquifer and the likelihood that CVOCs have been diffused into the bedrock matrix, regardless of which alternative is selected to address OU1, MNA is expected to take many decades to allow for removal of ICs on all properties downgradient from the Source Property.

MNA, along with engineering controls and ICs, would be protective of human health, feasible, and effective, but it would take many decades to implement and not address CVOCs trapped in the bedrock as an ongoing source of groundwater contamination.

Compliance with ARARs
Alternative 2 would meet the requirements of Act 2 under the site-specific standard with respect to eliminating exposure pathways. However, attainment of water quality and anti-degradation ARARs would likely take decades or more due to the high COC concentrations in groundwater and likely diffused in bedrock. Engineering controls would be required to comply with ARARs related to storm water management BMPs. ICs would be prepared as required by UECA and/or HSCA Section 512. Monitoring under this alternative would be performed in accordance with the Land Recycling Program Technical Guidance Manual and other technical guidance documents, which are considered TBCs.

Cost Effectiveness
Pre-implementation costs associated with the MNA alternative would include pre-design investigation, design of LVC engineering controls, planning, and IC costs estimated at $215,000. Construction costs for this alternative are limited to the engineering controls for addressing the LVC discharge estimated at $358,530. Operation and maintenance costs would accrue over a 30-year period and are estimated to be $2. 4M on a present value ("PV") basis. The total estimated cost of the MNA alternative is $3.0M.

A detailed breakdown of Alternative 2 costs is provided in the 2021 FS, prepared by Roux.

OU2: Common Element of Alternatives 3 through 5

- Process and performance monitoring would take place during active remedy implementation and could be used to optimize remedy implementation and/or to justify transition to MNA. Performance monitoring would also be used to assure that remedy implementation is not causing contaminant migrations or emissions across the Source Property boundary or negatively affecting LVC.

OU2: ALTERNATIVE 3 – In Situ Injection (ISCO/ISCR/Bioremediation)

Description of the Alternative
In situ injection remedies involve introducing amendments directly into the contaminated aquifer to treat contaminated groundwater. Potential amendments that might be injected include various chemical oxidants (known as in situ chemical oxidation – ISCO), reducing substances such as zero valent iron, or ZVI, capable of chemically reducing or destroying dissolved contaminants (known as in situ chemical reduction – ISCR), or nutrients like emulsified vegetable oil, sodium lactate, or molasses, and/or cultured bacteria to facilitate or enhance biological degradation of CVOCs (known as bioremediation). Certain types of ISCR amendments are capable of directly destroying CVOCs and providing a long-term nutrient source for continued biological degradation of CVOCs. The FS Addendum assumed that ISCR would be used as an amendment. Under this alternative, amendment selection will be based on pre-design investigations and may be modified during phased implementation.

Alternative 3 would be focused on limited hot spot areas of the Source Property, which continue to act as ongoing sources of groundwater contamination migrating beneath downgradient properties and resulting in the diffuse discharge of contaminated groundwater to LVC. These areas include the former vapor degreaser in Plant 8 and the DSA, where groundwater within the shallow bedrock interval (i.e., less than 120 ft. deep) contains the highest CVOC concentrations. This methodology, particularly ISCR, could also be used to reduce the toxicity of hexavalent chromium, which has been identified in Source Property groundwater and surface water. In situ injection may not be viable for hot spot areas (i.e., acid rinse spill area) in close proximity to LVC because of potential negative impacts to surface water.

Injection methods that would be used might include direct injection into deep soils within the target source zone, allowing for the amendment to migrate downward into the shallow bedrock aquifer along similar paths that the contaminant traveled when released. This approach, which is fully described in the Roux FS Addendum, may require supplemental bedrock injection to achieve effective amendment distribution. Demolition of Source Property buildings may not be required to implement this alternative for groundwater, but demolition could be part of an overall remedy, depending on how contaminated soils are addressed. This alternative would need to be coordinated with the OU1 soil remedy to avoid potential negative or contradictory effects (i.e., backfill materials used in an excavation and offsite disposal alternative could prevent adequate amendment distribution or ISCO used with soil mixing could counteract ISCR or biological amendments introduced to address groundwater). Some amendments are longer acting, which could address CVOCs currently diffused in the rock matrix and possibly migrate beyond the immediate target treatment area reducing downgradient concentrations.

It is anticipated that implementation of the active (injection) portion of this alternative would involve pre-design characterization, treatability testing, and closely monitored, phased implementation to maximize effectiveness and avoid negatives outcomes, such as negative impacts to LVC or to the ongoing natural attenuation processes, demonstrated during the RI. The effectiveness and performance of Alternative 3 would be assessed by monitoring amendment distribution throughout the target treatment zone and attainment of conditions that are conducive for meeting the overall objectives (i.e., hastened reduction of offsite migration/stream discharge and retraction of the contaminant plume). After these performance benchmarks have been met, MNA, combined with engineering controls and ICs, will be implemented through a long-term monitoring plan, coupled with a post-remediation care plan.

This alternative would be feasible, implementable, effective, and protective of human health.

Compliance with ARARs
OU2 Alternative 3 would comply with the cleanup standards established under Act 2. Antidegradation requirements for surface water would be achieved more quickly than through MNA alone. In addition, action and location specific ARARs, including storm water management plans for any earth disturbance and underground injection controls required under the Safe Drinking Water regulations (40 CFR Parts 144 and 146) and administered by US EPA, must be met during implementation.

Cost Effectiveness
Costs associated with the in situ injection alternative are detailed in the 2021 FS and 2021 FS Addendum and are based on ISCR treatment of the building 8 vapor degreaser and drum storage source areas. The estimate assumes that amendments injected into the deep soil interval will only partially move into the target treatment zone within shallow bedrock. Preconstruction/design costs for this alternative involve design, planning, and EC filing fees estimated at $415,000. To account for potential bedrock amendment injection, quantities and costs provided in the 2021 FS Addendum have been included. These contingent costs for bedrock injection are estimated to be $309,700. Capital costs associated with the active in situ injection implementation, including overburden and bedrock injections, and the engineering controls to reduce diffuse discharge to LVC are estimated at $2.3M. Long-term costs, associated with monitoring in situ treatment during a 7-year active period, followed by MNA and management of engineering/ICs (calculated on a PV basis) over a 23-year post-remedial care period, are estimated to be $2.5M. Over a 30-year lifespan, the total estimated cost associated with the in situ injection alternative is $5.2M.

OU2: ALTERNATIVE 4 – ISTT

Description of the Alternative
In situ thermal treatment (ISTT) is an alternative capable of addressing VOCs in both soil (saturated and unsaturated) and groundwater by heating the contaminated source area media to preferentially volatilize the VOCs. Temperatures required to achieve this are near the boiling point of water and would generate steam capable of removing VOCs from the impacted media in the source area. Steam and vapors would be captured for treatment through a separate vapor

extraction and treatment system. In addition to soil and water, ISTT is capable of removing VOCs diffused in the bedrock matrix. Practicality and cost considerations limit the depth at which ISTT can be implemented. For cost estimating purposes, the Source Property VOC areas shown in Figure 3 would be treated to a depth of 80 feet. Because of its applicability to groundwater and shallow bedrock, ISTT is evaluated as an OU2 groundwater alternative, though it would also address the VOC source areas in soils. ISTT is not applicable to the inorganic COCs at the Site, which would need to be addressed through expanded engineering controls and/or another OU1 remedial approach. Other potential implementability problems could be associated with collecting vapors in areas where shallow groundwater is present, but these potential problems could be resolved in the design phase. Water condensed from extracted vapor or generated due to system flooding would require treatment and/or offsite disposal or reinjection. If reinjection is necessary, careful design consideration will be needed to avoid interfering with the remedy and/or affecting LVC flow conditions.

To successfully implement ISTT, heater and extraction well spacing and placement would be based on predesign investigation and pilot testing. Like other remedies intended to address soils, implementation of ISTT would require demolition of the former manufacturing buildings to accommodate access for drilling and remediation equipment. Performance monitoring and demonstration would be centered on achieving the required groundwater temperature throughout the targeted treatment zone. Additionally, temperature monitoring would be required to assure that LVC is not impacted by the thermal effects of ISTT. Vapors captured for treatment would be monitored to track removal efficiency. Implementation of active ISTT would occur over a short timeframe (i.e., 1 – 2 years). Despite the shorter timeframe, a large amount of energy would be needed to heat the subsurface media, resulting in a large carbon footprint for this alternative. After extracted CVOC concentrations reach asymptotic conditions or other treatment goals are met, MNA combined with engineering controls and ICs would be implemented through a long-term monitoring plan, coupled with a post-remediation care plan. Additionally, completion of this alternative would include certain components associated with OU1 Soil alternatives, such as surface grading and restoration to prevent soil erosion.

Compliance with ARARs
Implementation of ISTT would comply with the cleanup standards established under Act 2 and make progress toward achieving antidegradation requirements for surface water. As indicated, above, careful implementation and monitoring would be necessary to avoid thermal impacts to LVC. Extracted vapors would be treated to comply with Air Quality regulations. Water collected by the vapor extraction system would be handled in accordance with Waste Management regulations, the Federal Safe Drinking Water Act, 42 U.S.C. § 300f *et seq.*, reinjection provisions, and/or pre-treatment requirements of the Valley Forge Sewer Authority, which serves East Whiteland Township. Depending on the amount of land disturbance required to implement ISTT, an erosion and sedimentation control plan may be needed to comply with stormwater management requirements.

Cost Effectiveness
A breakdown of costs for the ISTT alternative is presented in the 2020 Tech Memo, prepared for DEP by GES. Capital costs associated with the ISTT alternative include demolition of facility structures, installation of equipment needed to heat the subsurface media, treat recovered vapors,

and utility costs. Preconstruction/design costs for this alternative involve design, planning, and EC filing fees estimated at $324,200. Capital costs associated with the active ISTT implementation include engineering controls to protect LVC and are estimated at $14.3M. Long-term costs associated with MNA and management of engineering/institutional controls are calculated on a PV basis over a 27-year post-remedial care period and are estimated to be $2.3M. Over a 30-year lifespan, the total estimated cost associated with the ISTT alternative is $16.9M.

OU2: ALTERNATIVE 5 – HC

Description of the Alternative
Hydraulic Control ("HC") involves the targeted pumping of groundwater to address migration of COCs to downgradient areas and to LVC. Under this alternative extracted groundwater would require treatment to remove contaminants prior to reinjection on the Source Property. Reinjection would be necessary because of restrictions on discharges to LVC and limited capacity of the Valley Forge Sewer Authority to accept treated water based upon a 2008 email between DEP and the East Whiteland Township Public Works Director. Standard treatment technologies, including air stripping and carbon filtration, to address CVOCs, and chemical addition to facilitate removal of inorganic COCs would be employed to meet reinjection requirements. This treatment process would also generate air emissions requiring further treatment and wastes including sludges from metals treatment and spent carbon filter media requiring offsite treatment and/or disposal.

Alternative 5 would be capable of meeting the RAOs associated with reducing CVOC migration off the source property, reducing impacts to LVC via diffuse discharge of contaminated groundwater, and hastening retraction of the plume. However, the implementation of HC may also have certain negative effects, including altering the flow characteristics of LVC and changing the geochemistry and flow characteristics of groundwater in the source area, which could negatively impact ongoing natural attenuation processes. HC is not an effective technology for directly addressing contaminant source areas because groundwater is extracted from more permeable areas of the subsurface (i.e., fractures or sand layers), while much of the contaminant source remains in less permeable materials (i.e., rock or clay). This means that even after contaminant concentrations in extracted groundwater are reduced significantly, high COC concentrations may return quickly after groundwater extraction is terminated. The inability of HC to address the source of contamination means that it typically needs to be operated for decades, increasing this alternative's cost and energy usage (i.e., carbon footprint).

Pre-design investigations associated with HC would include hydraulic modelling and pilot testing to properly locate groundwater extraction and reinjection wells. Bench and field-scale testing of treatment technologies would also be employed prior to full-scale implementation to assure attainment of pre-injection requirements. The effectiveness of HC could be tracked through a combination of hydraulic monitoring and sampling to verify capture of contaminants migrating across the Source Property boundary and toward LVC. Groundwater contaminants which have already migrated away from the source property would be addressed through MNA, coupled with ICs, to prevent exposure resulting from installation of new wells and/or VI. These components of the response would be incorporated into a long-term monitoring plan.

Compliance with ARARs

Implementation of HC would be capable of meeting cleanup standards established under Act 2 at the Source Property boundary and make progress toward achieving antidegradation requirements for LVC. Design consideration and careful implementation and monitoring would be necessary to avoid altering the natural flow conditions of LVC. Extracted groundwater would be treated to comply with groundwater reinjection requirements. Air emitted by the groundwater treatment system would require treatment to meet air quality standards. Additionally, solid wastes, including sludges and spent carbon, would be handled in accordance with Waste Management regulations. Construction of a groundwater treatment system would need to comply with storm water management requirements.

Cost Effectiveness

A breakdown of costs associated with the HC alternative is presented in the 2021 FS. Preconstruction/design costs for this alternative include pre-design investigation and design of the extraction/treatment/reinjection system and are estimated at $615,000. Capital costs associated with the HC alternative include installation of extraction and injection wells, installation of pumps and piping to convey extracted contaminated and treated groundwater, and construction of a groundwater treatment plant. Capital costs associated with HC implementation are estimated at $8.7M. Long-term costs associated with HC over the 30-year active operation period are estimated to be $29.1M. The total estimated cost of HC is $38.5M.

OU3: DRINKING WATER

OU3 consists of the one contaminated potable drinking water supply, located within the Site area. As noted, above, in Section B, this well was equipped with a POET in 1999. Periodic sampling of well water prior to treatment has revealed declining concentrations of TCE, from 53 µg/l prior to installation to 5.88 µg/l in 2017. After 2017, the affected home was sold and is currently unoccupied. The new property owner plans to use the home as a residence after renovations are completed. DEP considered the following three potential alternatives:

- OU3: Alternative 1 - No Action.
- OU3: Alternative 2 - Continued Operation, Maintenance, and Monitoring of Whole House Carbon Filtration Systems, Combined with Restrictions on the Use of Groundwater.
- OU3: Alternative 3 - Connection to the Existing Public Water Supply Waterline, Combined with Restrictions on the Use of Groundwater.

OU3: ALTERNATIVE 1 - No Action

Description of the Alternative

Under this alternative, no further action would be taken to mitigate the threat posed by ingestion and inhalation of Site-related contamination. This alternative serves as a baseline to compare against other response actions. This alternative would be feasible and implementable because no action is being taken but would not be effective in addressing the health threats to the public and does not offer a permanent solution.

Compliance with ARARs
This alternative would not comply with ARARs because it fails to prevent the public's exposure to hazardous substances.

Cost Effectiveness
There is no cost associated with this alternative.

OU3: ALTERNATIVE 2 – Continued Operation, Maintenance, and Monitoring of a Whole-House Filtration System, Combined with Restrictions on the Use of Groundwater

Description of the Alternative
A POET in the form of dual-canister granulated activated carbon filter units is installed in the residence with levels of TCE that exceed the MCL in the well. A properly maintained carbon POET is effective in eliminating the ingestion, inhalation, and dermal pathways of TCE and its breakdown products within the affected home.

This alternative would provide a permanent solution to the potential for exposure to Site-related contamination, as long as the carbon filtration system is properly maintained. Operations, maintenance, and monitoring ("OM&M") would include routine sampling to ensure that the contamination does not break through the system. There are sample ports installed before, in-between, and after each filter. Carbon filters would be replaced as necessary, when sampling reveals concentrations of TCE or its breakdown products in samples collected in between or after the filter units. Typically, after sampling reveals breakthrough in-between filters, the first filter would be replaced and what was the second filter would become the first filter.

The OM&M of the system would continue until concentrations of TCE and its breakdown products are confirmed by DEP to be below applicable MCLs or Statewide health MSCs in the untreated drinking water. Eight consecutive quarters of sampling will be necessary to confirm results are below the standards.

This alternative would also be feasible and implementable but could be an inconvenience to the residents of this property due to sampling, periodic change outs of the carbon tanks, and scheduling.

An IC, in the form of an EC or HSCA 512 Order, would be utilized to document the need for continued OM&M of the POET and acknowledgment of contaminated groundwater on the property. The residents would be required to execute an EC in accordance with UECA or a HSCA 512 Order could be issued if the property owner refuses to sign a covenant. Such an EC or HSCA 512 Order would be attached to the deed of the property and be permanent, running with the land. The potential installation of new wells for potable use would be addressed as described above in OU2 Groundwater Alternatives.

Compliance with ARARs
This alternative would comply with ARARs. DEP would ensure that the treatment system components comply with standards established by the NSF International and the American National Standards Institute. Although private drinking wells are not regulated by the

Pennsylvania Safe Drinking Water Act, 35 P.S. §§ 721.1-721.17 ("Safe Drinking Water Act"), the MCLs established by the Safe Drinking Water Act are relevant and appropriate as well as the Statewide health MSCs established by 25 Pa. Code Chapter 250. Post treatment samples would meet applicable MCLs and/or MSCs.

Cost Effectiveness
Costs associated with OM&M of the existing POET are presented in the 2021 FS in the evaluation of alternatives for addressing groundwater contamination at the Site. Based on an evaluation of pre-treatment sample data, a ten-year OM&M period is conservatively assumed for the purposes of the cost evaluation.

The 2021 FS includes costs for preparing a POET OM&M Plan, estimated at $3,000. The costs assume that annual POET sampling (pre-, mid-, and post-treatment) would cost $2,500 and will be performed over 8-years, followed by eight quarterly sampling events to demonstrate attainment. Roux also estimates that the filter may need to be changed out three times during the 10-year period. The estimated cost to service the POET provided in the 2021 FS is $3,000.

Annual OM&M costs estimated in the 2021 FS are $4,900 and the total PV cost is estimated to be $37,420.

OU3: ALTERNATIVE 3 - Connection to the Existing Public Water Supply Waterline, Combined with Restrictions on the Use of Groundwater

Description of the Alternative
This alternative would consist of a lateral connection from the waterline main to the affected residential property, the connection of the lateral to the in-house plumbing, the repairs to all road surfaces or properties disturbed by the waterline lateral construction, and the required abandonment of the private water supply well.

This alternative would be protective of human health and safety by eliminating the threat of exposure to site contaminants through ingestion, dermal, and inhalation pathways. The future supply of water to the affected property will be provided by a water utility, which already has mandated monitoring requirements, to ensure the water meets human health standards for drinking water MCLs.

This alternative would be a feasible, effective, and a permanent solution. Implementation of this alternative would be completed in a short period of time. Water mains exist nearby.

Compliance with ARARs
This alternative would comply with ARARs. The utility responsible for providing the water would be required to comply with the Pennsylvania Safe Drinking Water Act and the requirements of 25 PA Code Chapter 109-Safe Drinking Water Regulations. The community water system would be required to be designed and constructed in accordance with the substantive requirements of the DEP’s Public Water Supply Manual, Part II relating to Community System Design Standards.

The required well abandonment would comply with CCHD's Rules and Regulations and PA Department of Conservation and Natural Resources ("DCNR")'s Water-Well Abandonment Guidelines established pursuant to the Water Well Drillers License Act.

Cost Effectiveness
Costs for connecting the existing affected residence were not evaluated in the 2021 FS. DEP contacted the local water utility and applied experience from other, similar projects to estimate costs for Alternative 3. All costs associated with this alternative would be preconstruction/design or construction costs, which include well abandonment.

Preconstruction costs are estimated to be $5,000 and construction costs, including $2,500 for well abandonment, are an estimated $19,000, resulting in a total estimated cost of $24,000 for this alternative.

VII. PROPOSED RESPONSE

OU1: SOILS

DEP proposes the selection of Alternative 5 - In Situ Chemical Oxidation and/or In Situ Chemical Reduction (ISCO/ISCR), Coupled with Soil Mixing to address areas of elevated COCs in unsaturated and saturated soils, as depicted on Figure 3. As described, above, implementation of this alternative would involve a pre-design investigation to accurately define the limits of the soils contaminated by CVOC/inorganic COCs to be treated, to select the amendment(s) in appropriate quantities, and to avoid potential negative impacts to ongoing natural attenuation in groundwater and to LVC; building demolition to facilitate access for the soil mixing equipment; soil mixing and blending with the selected amendments using auger equipment; and regrading/restoration.

The performance of the remedy would be assessed using post treatment sampling to verify amendment distribution and effectiveness at destroying and/or reducing the toxicity or mobility of the COCs.

The proposed alternative is more cost effective and provides unique benefits which are expected to compliment the preferred groundwater remediation approach discussed below. This alternative will comply with ARARs and is also expected to have a smaller carbon footprint and results in lower potential for erosion/sedimentation and fugitive air emissions than the other alternatives considered.

Engineering controls designed to protect LVC and reduce surface infiltration and contaminant migration would be evaluated upon completion of the soil remedy work and implemented as part of the groundwater remedy.

Completion of this alternative is expected to take four years and cost $2.8M. Long-term O&M costs associated with engineering and institutional controls are incorporated into the OU2 Groundwater remedy.

ISCO/ISCR, coupled with soil mixing would meet the previously described RAOs and be protective of public health and the environment by addressing soil exposure pathways, reducing contaminant transfer and migration to and by groundwater, and preventing erosion during construction and after regrading and/or restoration are completed.

OU2: GROUNDWATER

DEP proposes selecting Alternative 3 – In Situ Injection (ISCO/ISCR/Bioremediation) to address COCs in groundwater resulting from Areas 1 and 9 shown on Figure 3, which have been identified as the primary sources of COC contamination at the Site. Prior to implementation of this alternative, a pre-design investigation would be conducted to determine the appropriate types and quantities of ISCO, ISCR, and/or bioremediation amendment to be used; establish the boundaries of treatment zones; determine the number, design, spacing and depths of injection points; identify necessary measures to ensure protection of LVC from negative effects of remediation; characterize the concentration and potential migration of Site COCs in the northeast corner of the Source Property; evaluate the practicability of groundwater remediation in the deep bedrock zone; and establish the presence or absence of disputed COCs, related to releases at the Site, in groundwater. Implementation of this alternative would involve phased injection of amendments to treat the targeted groundwater source areas; engineering and/or ICs to mitigate Site impacts to LVC and address potential future human exposure to COCs in groundwater resulting from water well installation and/or VI; and long-term monitoring of engineering controls/ICs and ongoing natural attenuation.

Establishment of ICs as an initial step would immediately address the primary RAO to prevent potential future human exposure to Site-related COCs in accordance with an Act 2 site-specific standard. Over time, implementation of Alternative 3 would achieve the other RAOs including reducing COC migration in groundwater across the Source Property boundary; reducing the diffuse discharge of COCs to LVC through construction of BMPs to reduce COC migration and discharge and a reduction in COC concentrations; and hastening retraction of the contaminant plume. Completion of the active (i.e., injection) phase would be evaluated through monitoring of amendment distribution and attainment of conditions suitable for continued anaerobic biological degradation of CVOCs. After completion of the active phase of remediation, long-term monitoring would continue to assure exposure pathways are not opened due to changes in conditions (i.e., new construction) and to evaluate progress toward attaining RAOs.

DEP considers Alternative 3 to be more implementable than hydraulic control and ISTT because no extracted water will require discharge and/or additional pre-treatment before discharge. It is also more cost effective than these other alternatives and would provide for quicker attainment of RAOs than monitored natural attenuation alone. Preconstruction, construction, and active remedy implementation costs associated with the proposed alternative would be approximately \$2.8M. Long-term post remedial costs are estimated to be \$2.5M, based on a PV calculation, resulting in a total estimated PV cost of \$5.3M.

The in situ injection alternative would comply with ARARs and be protective of human health and the environment primarily through assuring exposure pathway elimination via engineering controls and ICs. This alternative would also achieve RAOs by addressing the primary sources of COCs contamination in groundwater.

OU3: DRINKING WATER

DEP proposes the selection of Alternative 3 - Connection to the Existing Public Water Supply Waterline, Combined with Restrictions on the Use of Groundwater. Under alternative 3, a lateral connection would be installed from the existing waterline main to the affected residential property and the private water supply well would be abandoned as set forth in the description of that alternative, above. The proposed alternative is a permanent solution that is protective of human health. The nearby existing public water infrastructure makes the proposed alternative relatively easy to implement. Once connected to the waterline, the private well will be abandoned, therefore additional sampling will not be required. The action will comply with ARARs relating to safe drinking water standards.

Connection of the home to the existing public water supply would cost approximately $24,000 and is more cost effective than continuing to operate, maintain, and monitor the existing POET.

Alternative 3 would protect public health by permanently eliminating exposure to Site-related COCs resulting from use of the impacted private well.

SUMMARY

In summary, DEP's proposed remedy includes ISCO/ISCR, coupled with soil mixing to address unsaturated and saturated soils impacted by Site COCs, in situ injection of ISCO, ISCR or bioremediation amendments in the two primary CVOC source areas to address contaminated groundwater, and connection of the residence with an impacted private well to the existing public waterline.

In combination, implementation of these proposed alternatives would protect public health and the environment and address potential exposure pathways by using engineering controls and ICs and connecting the affected home to the public waterline, reducing COC migration across the source property boundary, reducing migration and diffuse discharge of COCs to LVC, and hastening retraction of the groundwater contaminant plume by reducing source concentrations of COCs in soil and groundwater.

If selected, implementation of these alternatives would be designed and implemented in a complimentary manner to avoid potential negative interactions, comport with the protections afforded under Article 1, Section 27 of the Pennsylvania Constitution, comply with ARARs, and avoid negative impacts to LVC. The total estimated PV cost of the proposed final remedial response action is $ 8.1M. A summary of the proposed remedy costs is presented in Appendix D.

VIII. DEP APPROVALS

FOR THE COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

______________________________ 8/17/2021
Joseph Adams, P.E. Date
Deputy Secretary
Office of Field Operations

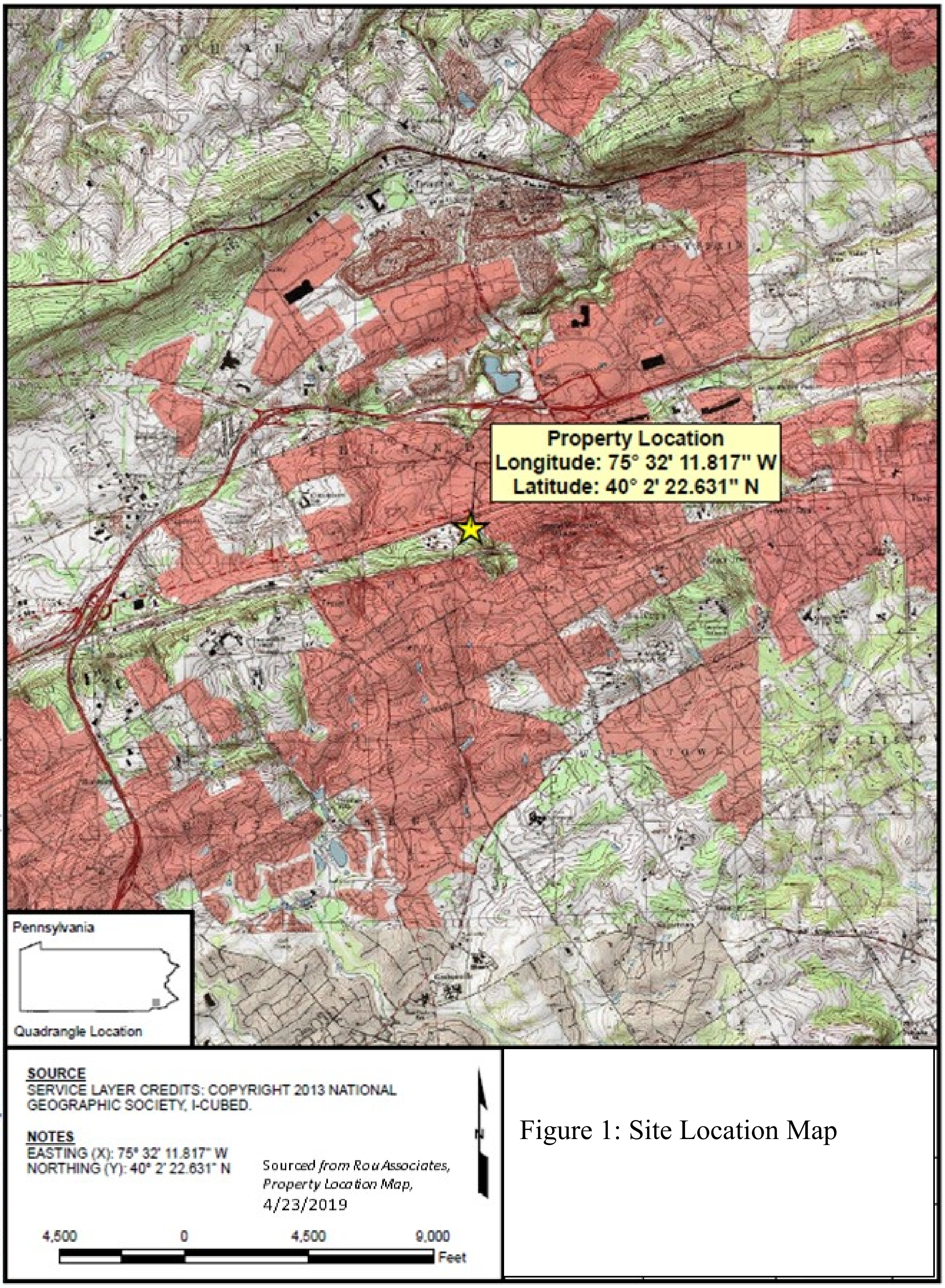
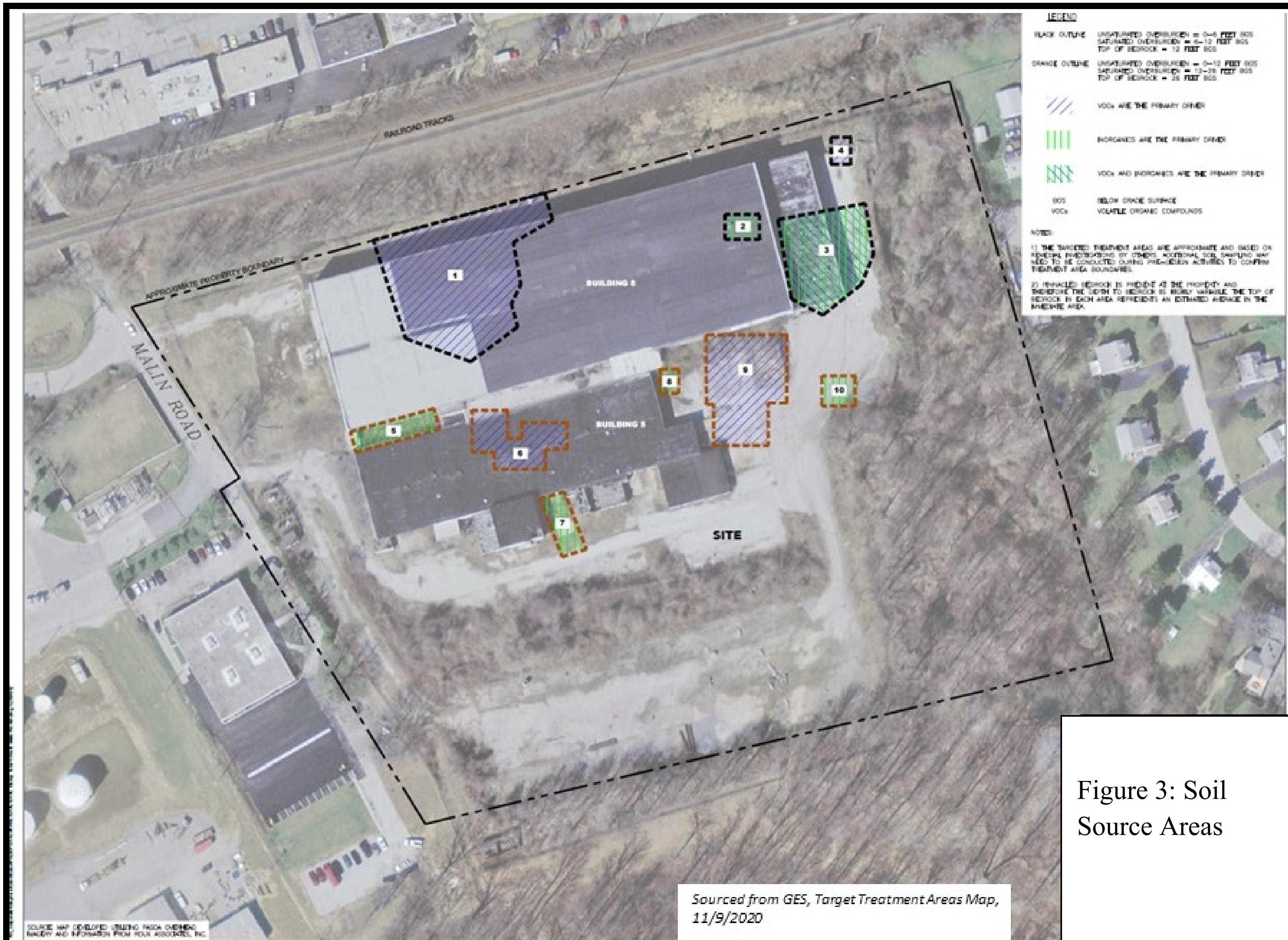


Figure 1: Site Location Map

Figure 2: Site Layout Map



Sourced from GES, Target Treatment Areas Map, 11/9/2020

Figure 3: Soil Source Areas

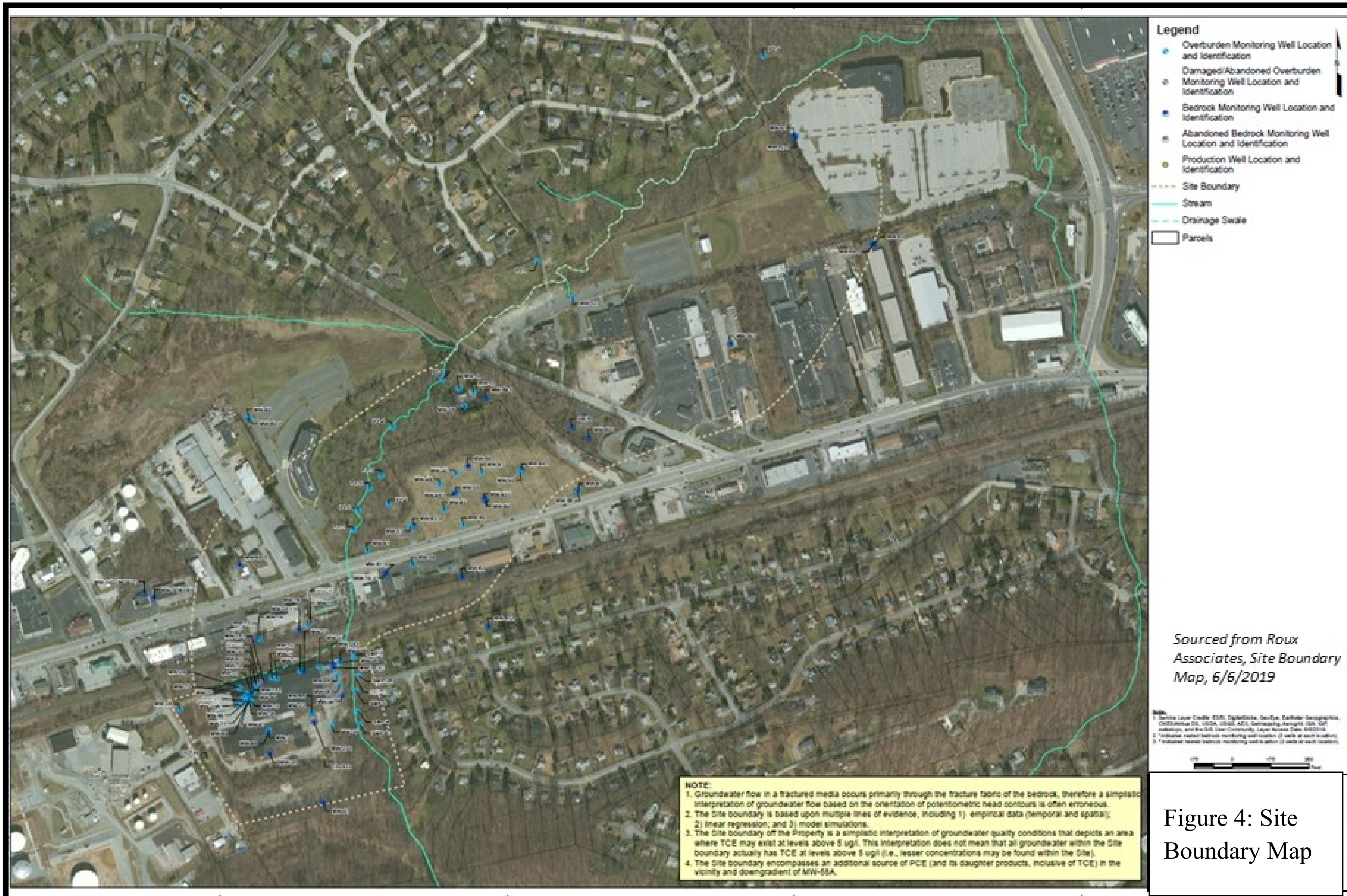


Figure 4: Site Boundary Map

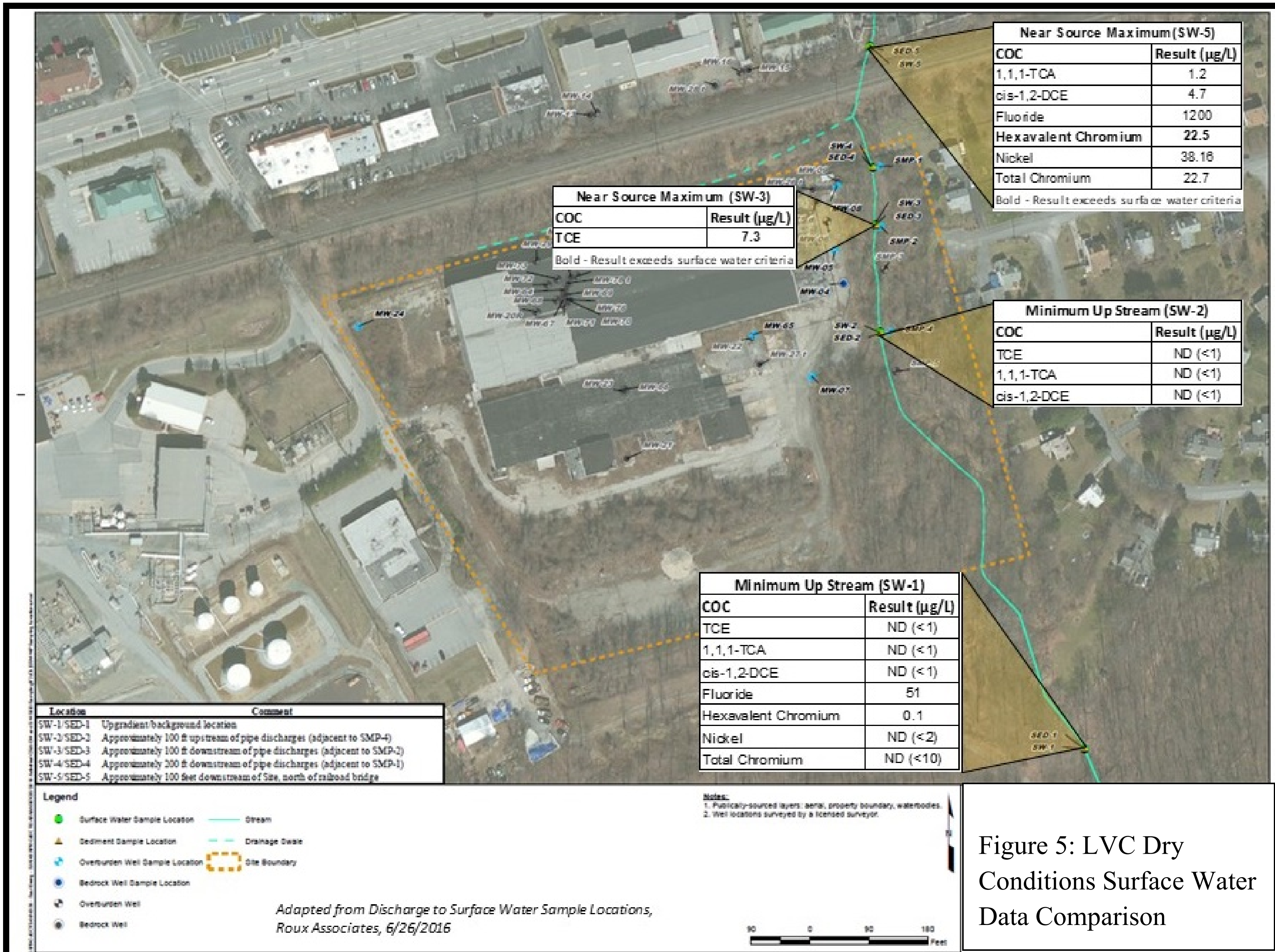


Figure 5: LVC Dry Conditions Surface Water Data Comparison

Appendix A: A Summary of ATSDR Information for COCs

COC	Health Effects	Cancer Classification
CVOCs		
TCE	Exposure to moderate amounts may cause headaches, dizziness, and sleepiness; large amounts may cause coma and even death. Eating or breathing high levels may damage some of the nerves in the face. Exposure to high levels can also result in changes in the rhythm of the heartbeat, liver damage, and evidence of kidney damage. Skin contact with concentrated solutions can cause skin rashes.	Department of Health and Human Services ("DHHS"): human carcinogen. The International Agency for Research on Cancer ("IARC"): carcinogenic to humans. EPA: carcinogenic to humans by all routes of exposure.
1,1,1-TCA	Inhaling high levels can cause dizziness and lightheadedness. Exposure to much higher levels can cause unconsciousness and other effects. There are no studies in humans that determine whether eating contaminated food or drinking contaminated water could harm health. Placing large amounts in the stomachs of animals has caused effects on the nervous system, mild liver damage, unconsciousness, and even death. Skin contact might cause some irritation. Studies in animals suggest that repeated exposure of the skin might affect the liver and that very large amounts may cause death. These effects occurred only when evaporation was prevented.	IARC: not classifiable as to its carcinogenicity in humans. EPA: not classifiable as to its carcinogenicity in humans.
1,1,2-TCA	No information is available on health effects of breathing or swallowing 1,1,2-TCA. Applying to the skin resulted in stinging and burning. When animals breathed high levels, it affected the liver, kidneys and nervous system. When animals swallowed contaminated food or water, effects on the stomach, blood, liver, kidneys, and nervous system were seen.	IARC: not classifiable as to its carcinogenicity to humans.
1,1-DCA	It affects the function of the nervous system.	EPA: possible human carcinogen.
1,1-DCE	Breathing high levels can affect the liver, kidney, and central nervous system. Animals that ingested high levels had damaged livers, kidneys, and lungs.	EPA: possible human carcinogen.
1,2-DCA	Ingesting or inhaling large amounts of 1,2-DCA has reportedly caused nervous system disorders, liver and kidney diseases, and lung effects.	DHHS: reasonably be expected to cause cancer. IARC: possible human carcinogen. EPA: probable human carcinogen.

COC	Health Effects	Cancer Classification
Carbon Tetrachloride	High exposure to carbon tetrachloride can cause liver, kidney, and central nervous system damage.	DHHS: may reasonably be anticipated to be a carcinogen. IARC: possibly carcinogenic to humans. EPA: a probable human carcinogen.
Chloromethane	Exposure to high levels of chloromethane can cause serious problems to the nervous system, including convulsions and coma. It can also affect the liver, kidneys, and heart.	EPA: a possible human carcinogen.
cis-1,2-DCE	Animals that ingested extremely high doses died. Lower doses caused effects on the blood, such as decreased numbers of red blood cells, and also effects on the liver.	EPA: not classifiable as to its human carcinogenicity.
Methylene Chloride	Breathing large amounts may cause unsteadiness, dizziness, nausea and tingling or numbness of fingers and toes. Smaller amounts cause a person to become less attentive and less accurate in tasks requiring hand-eye coordination. Skin contact causes burning and redness of the skin.	DHHS: reasonably anticipated to be a cancer-causing chemical. EPA: a probable cancer-causing agent in humans. World Health Organization (“WHO”): may cause cancer in humans.
PCE	Breathing high levels for a brief period may cause dizziness or drowsiness, headache, and incoordination; higher levels may cause unconsciousness and even death. Exposure for longer periods to low levels may cause changes in mood, memory, attention, reaction time, and vision. Studies in animals have shown liver and kidney effects, and changes in brain chemistry.	DHHS: reasonably anticipated to be a human carcinogen. IARC: probably carcinogenic to humans. EPA: likely to be carcinogenic to humans by all routes of exposure.
trans-1,2-DCE	When animals breathed high levels of trans-1,2-DCE, their livers and lungs were damaged, and the effects were more severe with longer exposure times. Animals that breathed very high levels of trans-1,2-DCE had damaged hearts. Animals that ingested extremely high doses of trans-1,2-DCE died.	No EPA cancer classification is available.

COC	Health Effects	Cancer Classification
Vinyl Chloride	Breathing high levels of for short periods of time can cause dizziness, sleepiness, unconsciousness, and at extremely high levels can cause death. Breathing for long periods of time can result in permanent liver damage, immune reactions, nerve damage, and liver cancer. The effects of drinking high levels are unknown. Skin contact can cause numbness, redness, and blisters.	DHHS: known carcinogen.
Other Organic Compounds		
1,2,4-TMB [5]	Effects on the nervous, respiratory, and hematological (i.e., blood) systems have been reported in occupationally- and residentially-exposed humans, but these effects were observed following exposure to complex mixtures containing TMB isomers, thus making it difficult to determine the contribution of each TMB isomer to the observed health effects.	There is inadequate information to evaluate the carcinogenicity of TMBs.
1,4-Dioxane	Exposure to high levels in the air can result in nasal cavity, liver, and kidney damage. Ingestion or dermal contact with high levels can result in liver and kidney damage.	DHHS: reasonably anticipated to be a human carcinogen.
Benzene	Breathing benzene can cause drowsiness, dizziness, and unconsciousness; long-term benzene exposure causes effects on the bone marrow and can cause anemia and leukemia.	DHHS: known carcinogen. IARC: carcinogenic to humans. EPA: carcinogenic to humans.
Bromomethane	Breathing can harm your respiratory tract (nose and lungs) and nervous system. In workers, bromomethane in air has caused damage to the lungs and signs of nervous system damage, such as dizziness, muscle weakness, and seizures.	DHHS: has not classified for carcinogenicity in humans. IARC: not classifiable as to human carcinogenicity. EPA: not classifiable as to human carcinogenicity.

[5] Information was unavailable on ATSDR's website. Information was obtained from EPA's Integrated Risk Information System website.

COC	Health Effects	Cancer Classification
MTBE	Breathing small amounts for short periods may cause nose and throat irritation. There are no data on the effects in people of drinking MTBE. Studies with rats and mice suggest that drinking MTBE may cause gastrointestinal irritation, liver and kidney damage, and nervous system effects.	DHHS: not classifiable as to its carcinogenicity to humans. IARC: not classifiable as to its carcinogenicity to humans. EPA: not classifiable as to its carcinogenicity to humans.
Inorganics		
Antimony	Studies in workers, who are typically exposed to higher levels of antimony, show that breathing antimony dust can cause heart and lung problems, stomach pain, diarrhea, vomiting, and stomach ulcers. Swallowing large doses of antimony can cause vomiting in people.	DHHS: antimony trioxide[6] to be reasonably anticipated to be a human carcinogen. IARC: antimony trioxide is possibly carcinogenic to humans and that antimony trisulfide is not classifiable.
Arsenic	Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer.	DHHS: known human carcinogen. IARC: carcinogenic to humans. EPA: known human carcinogen.
Cobalt	Cobalt can benefit or harm human health. Cobalt is beneficial for humans because it is part of vitamin B12. Exposure to high levels of cobalt can result in lung and heart effects and dermatitis.	IARC: possibly carcinogenic to humans.
Fluoride	Human studies of people exposed to high concentrations of fluoride through long-term ingestion suggest that fluoride may cause harmful effects to bone density and the skeletal system.	IARC: carcinogenicity to humans cannot be classified.
Hexavalent Chromium	Animal studies suggest that effects associated with ingestion of hexavalent chromium may include stomach and intestinal tumors, irritation, and ulcers of the digestive tract, anemia, and fetal development effects.	DHHS: known human carcinogen. IARC: known human carcinogen. EPA: known human carcinogen.

[6] The nature of Antimony or its compounds present at the Site is not fully characterized

COC	Health Effects	Cancer Classification
Lead	The effects are the same whether it enters the body by breathing it in or eating it. Lead can affect almost every organ and system in the body. The nervous system is the main target for lead poisoning. Long-term exposure can result in decreased learning, memory, and attention, and weakness in fingers, wrists, or ankles. Lead exposure can cause anemia and damage to the kidneys. It can also cause increases in blood pressure. Exposure to high lead levels can severely damage the brain and kidneys and can cause death. In pregnant women, exposure to high levels of lead may cause a miscarriage. In men, it can cause damage to reproductive organs.	DHHS: reasonably anticipated to be human carcinogens. IARC: probably carcinogenic to humans. EPA: a probable human carcinogen.
Manganese	Manganese is an essential nutrient. Eating a small amount of it each day is important to stay healthy. The most common health problems in workers exposed to high levels involve the nervous system. Exposure to high levels of manganese in air can cause lung irritation and reproductive effects. Nervous system and reproductive effects have been observed in animals after high oral doses of manganese.	EPA: existing scientific information cannot determine whether or not excess manganese can cause cancer.
Nickel	Animal studies suggest that exposure to high levels of nickel could cause harmful effects to reproduction, liver, kidneys, blood, and stomach.	DHHS: nickel metal -may reasonably be anticipated to be a carcinogen. Nickel compounds - known human carcinogens.
Thallium	Breathing high levels of thallium may result in effects on the nervous system, while ingesting high levels of it results in vomiting, diarrhea, temporary hair loss, and other effects.	DHHS: IARC: not classifiable as to its carcinogenicity to humans. IARC: not classifiable as to its carcinogenicity to humans. EPA: not classifiable as to its carcinogenicity to humans.
Vanadium	Nausea, mild diarrhea, and stomach cramps have been reported in people who have been exposed. A number of effects have been found in animals ingesting vanadium compounds including decreases in the number of red blood cells, increased blood pressure, and mild neurological effects. The amounts of vanadium given in these animal studies that resulted in harmful effects are much higher than those likely to occur in the environment.	DHHS: not classified as to its human carcinogenicity. EPA: not classified as to its human carcinogenicity.

Appendix B: Applicable, or Relevant and Appropriate Requirements ("ARARs")

ARARs	Citation/Reference	Description	Chemical[7]	Location[8]	Action[9]	Status	Applicability to Proposed Remedial Actions
ENVIRONMENTAL CLEANUP AND BROWNFIELDS							
Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("CERCLA")	42 U.S. Code § 9601 *et seq.*	The Federal Superfund program, administered by the U.S. EPA is designed to investigate and clean-up sites contaminated with hazardous substances.			X	Relevant & Appropriate	RI and FS were completed in accordance with CERCLA requirements.
Hazardous Sites Cleanup Act (Act 108)	35 P.S. § 6020.101 *et seq.*	Provides means for funding and enforcement at response and remediation cleanups.			X	Applicable	The Site is on Pennsylvania's ("PA's") priority list, and the remedial action is being proposed in accordance with HSCA.
Land Recycling and Environmental Remediation Standards Act ("Act 2")	35 P.S. § 6026.101 *et seq.*	Provides a statute and regulations for establishing environmental remediation standards: background standard, Statewide health standards, site-specific standards ("SSS").	X			Applicable	The remedial response will achieve a combination of Act 2 standards.
Administration of the Land Recycling Program, Chapter 250	25 Pa. Code § 250.250.1 *et seq.*						
Land Recycling Program Technical Guidance Manual, January 19, 2019	Document Number: 261-0300-101	Provides suggestions and examples of how to best approach site characterization, remediation and demonstration of attainment.	X		X	TBC	Chemical-specific: discusses pathway elimination to achieve SSS. Action-specific: discusses vapor intrusion and groundwater monitoring.
The PA Uniform Environmental Covenants Act, Act No. 68 of 2007 ("UECA")	27 Pa. C.S. §§ 6501 – 6517	Provides a standardized process for creating, documenting and assuring the enforceability of activity and use limitations on contaminated sites.			X	Applicable	Most remedial alternatives considered may require Activity and Use Limitations.
Administration of UECA, Chapter 253	25 Pa. Code § 253 *et seq.*						

[7] Chemical-specific requirements establish legal health or risk-based concentration limits or ranges, in various environmental media for specific hazardous substances, pollutants, or contaminants.
[8] Location-specific requirements set restrictions on activities depending on the characteristics of a site.
[9] Action-specific requirements or design specifications set controls or restrictions on particular kinds of activities related to management of hazardous substances, pollutants, or contaminants. These requirements are triggered not by the specific chemicals present at a site but rather by the particular remedial activities that are selected to accomplish a remedy. Since there are usually several alternative actions for any remedial site, very different requirements can come into play.

ARARs	**Citation/Reference**	**Description**	**Chemical**[7]	**Location**[8]	**Action**[9]	**Status**	**Applicability to Proposed Remedial Actions**
CLEAN WATER/WATERWAYS & WETLANDS							
The Clean Water Act	33 U.S.C. §1251 *et seq.*	Establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. and regulating quality standards for surface waters.	X			Applicable	Stormwater discharges will not occur that would contain toxic or hazardous pollutants as defined in sections 307 and 311 of the Clean Water Act.
The Clean Streams Law, Act of June 22, 1937, P.L. 1987, as amended	35 P.S. §§ 691.1 – 691.1001	An act to preserve and improve the purity of the waters of the Commonwealth for the protection of public health, animal and aquatic life, and for industrial consumption, and recreation.	X	X	X	Applicable	Applicable to remedial actions that may impact the waters of the Commonwealth i.e. earth disturbance, direct discharge, etc.
		Act 162 of 2014 amendment to the Clean Streams Law addresses buffer requirements in PA regulations, found in 25 Pa Code Chapter 102.		X	X	Applicable	Applicable to construction activities within 150 ft. of a water of the Commonwealth.
General Provisions, Chapter 91	25 Pa. Code § 91.1 *et seq.*	Establishes specific application requirements and conditions for the approval and permitting of the construction and operation of waste water treatment and disposal projects.	X		X	Applicable	§ 91.33: any incident causing or threatening pollution needs to be immediately reported. § 91.34: Persons engaged in an activity which includes the impoundment, transportation, storage, application or disposal etc. of pollutants shall take necessary measures to prevent the substances from directly or indirectly reaching waters of this Commonwealth. §§ 91.51-52 relates to underground disposal of wastes.
National Pollutant Discharge Elimination System (“NPDES”) Permitting, Monitoring and Compliance, Chapter 92a	25 Pa. Code § 92a.1 *et seq.*	Establishes criteria for the content of NPDES permit applications, effluent standards, monitoring requirements, standard permit conditions, public notification procedures, etc.	X		X	Applicable	§ 92a.54: Discharges not authorized include discharges to surface waters classified as Exceptional Value (EV) waters under 25 Pa. Code Chapter 93 or discharges containing toxic or hazardous pollutants.

ARARs	Citation/Reference	Description	Chemical[7]	Location[8]	Action[9]	Status	Applicability to Proposed Remedial Actions
Water Quality Standards, Chapter 93	25 Pa. Code § 93.1 *et seq.*	Establishes specific standards for the quality of PA's waters and includes specific water quality criteria and designated water use protection for each stream in PA.	X		X	Applicable	Any discharge of treated groundwater to surface water during the remedial action will abide by the Water Quality Criteria including Table 5 and will not impair the designated uses of surface waters at the Site. All of the water uses listed in §93.3 are protected to existing uses.
Wastewater Treatment Requirements, Chapter 95	25 Pa. Code § 95 *et seq.*	Sets forth waste treatment requirements for dischargers, including developing quality standards for discharges to acid impregnated streams and acid-bearing waters.	X		X	Applicable	§ 95.2: Discharges of treated groundwater to the surface water during the remedial action will meet pH requirements.
Water Quality Standards Implementation, Chapter 96	25 Pa. Code § 96 *et seq.*	Describes water quality standards implementation.	X		X	Relevant & Appropriate	Existing and designated surface water uses shall be protected. § 96.6: Discharges of treated groundwater to the surface water during the remedial action will meet requirements related to thermal discharges.
Water Quality Toxics Management Strategy Statement of Policy, Chapter 16	25 Pa. Code § 16 *et seq.*	Establishes discharge criteria, and analytical methods for toxic substances.	X		X	Applicable	May apply to contaminants that are not currently listed in Chapter 93 Table 5
The Dam Safety and Encroachments Act, Act of 1978, P.L. 1375, as amended	32 P.S. § 693.1 *et seq.*	Sets forth provisions for the regulation and supervision of dams, reservoirs, water obstructions and encroachments in waters of the Commonwealth, including wetlands.		X	X	Applicable	§ 105.17 defines exceptional value wetlands that deserve special protections. § 105.18a. Permitting of structures and activities in wetlands. Additional steps may be needed to ensure remedial activities do not impact nearby wetlands.
Dam Safety and Waterway Management, Chapter 105	25 Pa. Code § 105.1 *et seq.*						
The Flood Plain Management Act, Act of October 4, 1978, P.L. 851, No. 166	32 P.S. § 679.101 *et seq.*	Sets forth provisions for the regulation of obstructions located in the 100-year floodplain as delineated by FEMA Flood Hazard Boundary Maps.		X		Relevant & Appropriate	May apply to any earth disturbance activity in a floodplain.
Flood Plain Management, Chapter 106	25 Pa. Code § 106.1 *et seq.*						

ARARs	Citation/Reference	Description	Chemical[7]	Location[8]	Action[9]	Status	Applicability to Proposed Remedial Actions
The Stormwater Management Act, October 4, 1978, P.L. 864 (Act 167), as amended	32 P.S. § 680.1 *et seq.*	Sets forth provisions that impose requirements on all earth disturbance activities.		X	X	Applicable	Sediment & erosion control features will need to be implemented before start of intrusive earth disturbance activities.
Erosion and Sediment Control, Chapter 102	25 Pa. Code § 102.1 *et seq.*				X		
Erosion and Sediment Pollution Control Program Manual, March 2012	Document Number: 363-2134-008	Provides guidance and procedures on ways to minimize accelerated erosion and resulting sediment pollution to surface waters.			X	TBC	
PA Stormwater Best Management Practices Manual, December 30, 2006	Document Number: 363-0300-002	Ensures effective stormwater management to minimize the adverse impacts of stormwater on groundwater and surface water resources.			X	TBC	Relevant to engineering controls designed to protect waters of the Commonwealth.
Water Quality Antidegradation Implementation Guidance, November 29, 2003	Document Number: 391-0300-002	Aides with the implementation of the Antidegradation Program in PA.		X	X	TBC	Existing uses are protected when DEP makes a final decision on any permit or approval for an activity that may affect a protected use.
Implementation Plan for Act 162 of 2014, December 20, 2014	Document Number: 310-2135-001	Provides guidance for interpretation, implementation and compliance with Act 162.		X	X	TBC	Applies to individual NPDES permits for stormwater discharges associated with construction activities who proceed under 35 P.S. § 691.402(c)(1)(ii) in utilizing alternatives to riparian buffer best management practices ("BMPs") to address runoff.
Frequently Asked Questions for Act 162 of 2014 Implementation, December 18, 2014				X	X	TBC	
Riparian Buffer or Riparian Forest Buffer Equivalency Demonstration, March 21, 2015	Document Number: 310-2135-002	Outlines the equivalency demonstration criteria and process related to the riparian buffer or riparian forest buffer equivalency demonstration required by Act 162.		X	X	TBC	
Riparian Buffer or Riparian Forest Buffer Offsetting Guidance, March 21, 2015	Document Number: 310-2135-003	Provides guidance and procedures for meeting the requirements of Act 162 as it relates to the riparian buffer or riparian forest buffer offsetting requirements.		X	X	TBC	

ARARs	Citation/Reference	Description	Chemical[7]	Location[8]	Action[9]	Status	Applicability to Proposed Remedial Actions
Waste Management							
Resource Conservation and Recovery Act (RCRA), Part 261 -Identification and Listing of Hazardous Waste	40 CFR Part 261, Subparts C & D	Part 261 defines those solid wastes which are subject to regulations as characteristic or listed hazardous wastes.	X			Applicable	Applicable to determining whether wastes are considered hazardous under RCRA.
RCRA Manifesting, Transport and Recordkeeping Requirements	40 CFR 262, Subparts B & C	Applies to management of hazardous wastes prior to transport.			X	Applicable	Applicable if remedial activities include the off-site transport of hazardous waste.
RCRA Subtitle C, Hazardous Waste Treatment Facility Design and Operating Standards for Treatment and Disposal Systems.	40 CFR § 264.310	Develops standards for hazardous waste treatment, storage and landfill cover.			X	Applicable	Applicable if remedial activities include the management of hazardous wastes at treatment and disposal facilities.
RCRA Subtitle D, Nonhazardous Waste Management Standards	40 CFR § 258.60	Develops standards for the closure of nonhazardous waste landfills.			X	Applicable	Applicable if remedial activities include the management of non-hazardous wastes.
Solid Waste Management Act, Act 97 of 1980	35 P.S. §§ 6018.101-6018.1003	Provides for the planning and regulation of solid waste storage, collection, transportation, processing treatment, and disposal.	X	X	X	Applicable	Applicable for all remedial actions that involve solid waste treatment, storage, transportation, and/or disposal activities.
Hazardous Waste Management Regulations	Article VII, Chapters 260a-270a, including incorporated parts of 40 CFR 260-270.	Applies to the identification and listing, generation, transportation, storage, treatment, and disposal of hazardous waste in PA authorized by RCRA.	X			Applicable	Applicable for all remedial actions that involve hazardous waste treatment, storage, transportation, and/or disposal activities.
Residual Waste Management-General Provisions, Chapter 287	25 Pa. Code §§ 287.1- 287.666	Specifies general procedures, definitions and rules for the generation, management, and handling of residual waste.	X		X	Applicable	Many of the remedial alternatives considered involve generation of residual waste. - In-situ/ex-situ treatment processes need to meet permit-by-rule requirements; - Capping standards may apply if closing in place; - Soil/waste remedial actions may involve transportation and/or disposal of residual waste on-/off-site.

ARARs	Citation/Reference	Description	Chemical[7]	Location[8]	Action[9]	Status	Applicability to Proposed Remedial Actions
Residual Waste Landfills, Chapter 288	25 Pa. Code §§ 288.1 - 288.625	Sets forth application and operating requirements for residual waste landfills and disposal impoundments.	X		X	Applicable	Closure/capping standards may apply if closing in place.
Residual Waste Disposal Impoundments, Chapter 289	25 Pa. Code §§ 289.1-289.557				X	Applicable	
Management of Fill Policy, January 16, 2021	Document Number: 258-2182-773	Provides DEP's procedures for determining whether material is clean fill or regulated fill and their acceptance and operation criteria.			X	TBC	Fill that is used for backfilling excavated areas will need to meet the acceptance and operation standards for clean fill or regulated fill as defined in this document.
SAFE DRINKING WATER							
National Primary Drinking Water Regulations, Maximum Contaminant Levels ("MCLs")	40 CFR § 141.61	Establishes primary drinking water regulations pursuant to section 1412 of the Public Health Service Act, as amended by the Safe Drinking Water Act, 42 U.S.C. § 300f *et seq*.	X			Relevant & Appropriate	Applies to drinking water supplies within the site boundary protected by OU2 ICs and addressed by OU3.
Safe Drinking Water Act ("SDWA") of 1974	42 U.S.C. § 300f *et seq*.	Establishes requirements for the Underground Injection Control ("UIC") program. Describes the minimum federal requirements for injection operations and the sections of the SDWA that address injection.			X	Applicable	Remedial Alternatives involving injections would need to comply with these regulations.
PA Safe Drinking Water Act, Act of May 1, 1984, P.L. 206	35 P.S. § 721.1 *et seq.*	Sets forth drinking water quality standards at least as stringent as federal standards: MCLs and additional state requirements.	X		X	Applicable	- Chemical-Specific: One residential well is impacted above MCLs. - Action-Specific: Standards would have to be considered during construction of waterline main &/or lateral.
Safe Drinking Water, Chapter 109	25 Pa. Code § 109 *et seq.*	Establishes requirements for public water systems permit design and construction, source quality, and siting requirements.	X		X	Applicable	
Public Water Supply Manual - Part II Community System Design Standards, May 6, 2006	Document Number: 383-2125-108	Part II provides detailed design and construction standards for all Community Water Supplies except bottled water systems, bulk water haulers, vended water systems, and retail water facilities.			X	TBC	

ARARs	Citation/Reference	Description	Chemical[7]	Location[8]	Action[9]	Status	Applicability to Proposed Remedial Actions
Underground Injection Control Program, Part 144	40 CFR Part 144	Provides minimum requirements for the UIC program promulgated under the SDWA.			X	Applicable	Remedial Alternatives involving injections would need to comply with these regulations.
Criteria and Standards, Part 146	40 CFR Part 146	Includes technical standards for various classes of injection wells.					
State Underground Injection Control Programs, Part 147	40 CFR Part 147	Outlines the applicable UIC programs for each state.					
Air Quality							
National Emissions Standards for Hazardous Air Pollutants: Site Remediation, promulgated under Section 112 of the Clean Air Act of 1970, as amended ("CAA"), 42 US. C. § 74122	40 CFR Part 63 Subpart GGGGG	Establishes national emissions limitations and Maximum Achievable Control Technology ("MACT") standards for hazardous air pollutants ("HAPs") emitted from site remediation activities. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emissions limitations and work practice standards.	X			Applicable	Any vapor emissions during the remedial actions will be controlled and monitored.
National Ambient Air Quality Standards ("NAAQS"), promulgated under Sections 108 and I09 of the CAA, 42 US.C. §§ 7408-09	40 CFR Part 50	These NAAQs regulate six criteria air pollutants.	X			Applicable	Three of the criteria pollutants - carbon monoxide, nitrogen dioxide, and sulfur dioxide - may be generated in small amounts during the implementation of in situ thermal treatment
The Air Pollution Control Act, Act of January 8, 1960, P.L. 2119	35 P.S. § 4001, *et seq.*	Provides for the better protection of the health, general welfare and property of the people of the Commonwealth by the control, abatement, reduction and prevention of the pollution of the air by smokes, dusts, fumes, gases, odors, mists, vapors, pollens and similar matter, or any combination, thereof.	X		X	Applicable	Any vapor emissions during the remedial action will be controlled and monitored.

ARARs	Citation/Reference	Description	Chemical[7]	Location[8]	Action[9]	Status	Applicability to Proposed Remedial Actions
Standards for Contaminants, Chapter 123	25 Pa. Code § 123.1 *et seq.*	Sets forth requirements for fugitive emissions, including open burning and demolition activities; establishes specific limitations for particulate matter, sulfur dioxide, odor, and visible emissions.	X			Applicable	Fugitive dust emissions generated during remedial activities that involve excavation will need to be controlled (123.1 & 123.2). Odor emissions (123.31), as well as visible emissions (123.41) may also apply, depending on the controls and activity on Site.
National Emission Standards for Hazardous Air Pollutants ("NESHAP"), Chapter 124	25 Pa. Code § 124.1 *et seq.*	Adopts federal NESHAP standards (40 CFR Part 61, Subpart M) by reference.			X	Applicable	Any building demolition is subject to the Asbestos NESHAP, and will require an inspection for asbestos, notification to DEP and EPA, and possible abatement, if asbestos is found, prior to the demolition.
Construction, Modification, Reactivation and Operation of Sources, Chapter 127	25 Pa. Code § 127.1 *et seq.*	Requires the use of Best Available Technology ("BAT") for control of new sources, plan approval and operating permit requirements, and special requirements for sources in nonattainment areas.			X	Applicable	Any controls (carbon adsorber, thermal treatment, air strippers) may require permitting under 127.11. Remediation activities may be exempt under the Air Quality Permit Exemption list (Doc #275-2101-003) but generally requires the DEP's approval to proceed without a plan approval or permit.
Air Quality Permit Exemptions, July 26, 2003, August 10, 2013 for Category No. 33 and Category No. 38 Exemptions	Document Number: 275-2101-003	Provides criteria for sources and physical changes to sources determined to be eligible for permitting exemptions as sources of minor significance.			X	TBC	
Sampling and Testing, Chapter 139	25 Pa. Code § 139.1 *et seq.*	Sets forth requirements for sampling of facilities, sampling methods and analytical procedures.			X	Applicable	Sampling and test methods may apply if a treatment system is employed. At that time, any sampling or testing would be dictated by the approval provided by DEP, whether it is in a permit or an exemption approval. § 139.14. Emissions of VOCs.
Asbestos Occupations Accreditation and Certification Act of 1990, P.L. 805, No. 194	63 P.S. §§ 2101—2112	Requires a minimum five-day notification of any asbestos project (Section 8) and certification for asbestos contractors and certain occupations (Sections 3 -5)			X	Applicable	Applies to demolition work associated with OU1 alternatives if asbestos is identified.

ARARs	Citation/Reference	Description	Chemical[7]	Location[8]	Action[9]	Status	Applicability to Proposed Remedial Actions
Other							
Policy for Pennsylvania Natural Diversity Inventory ("PNDI") Coordination During Permit Review and Evaluation, May 25, 2013	Document Number: 021-0200-001	The PNDI coordination effort facilitates the avoidance and minimization of impacts to threatened and endangered species and special concern species where applicable in PA.		X		TBC	The PNDI search would need to be performed to identify any habitats or species of concern that may have been impacted by the release or remedial action.
Historic Preservation Act of Nov. 22, 1978, P.L. 1160, as amended	71 P.S. § 1047.1 *et seq.*	Provides authority over historic preservation to the PA Historic and Museum Commission.		X		Applicable	If a historically significant site is identified, these provisions would apply.
PA History Code, P.L. 414, No. 72	37 Pa.C.S. § 101 *et seq.*						
The Water Well Drillers License Act (610), Act of May 29, 1956, P.L. 1840	32 P.S. § 645.1 *et seq.*	Sets forth requirements for the licensing of water well drillers, prevention of pollution of underground waters, submittal of well construction records and well abandonment notification.			X	Relevant & Appropriate	Wells drilled or decommissioned during remedial action will need to meet these requirements. Well Drillers will need to be licensed.
Drilling Water Wells, Chapter 47	17 Pa. Code §§ 47.1-47.8						
Chester County Health Department: Water, Wells, Nuisances, Sewage and Liquid Waste	Chapter 500	Sets forth requirements for the installation and/or decommissioning of wells.			X	Applicable	Wells drilled or decommissioned during remedial action will need to meet these requirements. Well Drillers will need to be licensed.
Environmental Accreditation Act 90 of 2002	27 Pa. C.S. §§ 4101-4113	Establishes PA's Laboratory accreditation program.	X			Applicable	Facilities that test or analyze environmental samples will need to be accredited.
Environmental Laboratory Accreditation	25 Pa. Code Chapter 252						

Appendix C: Summary of Alternative Costs

Alternative Name	Description	Costs
OU1		
Alternative 1 - No Action	No cost	$ -
Alternative 2 - Engineering Controls, Coupled with ICs	Design/Preconstruction	$ 16,900
	Construction	$ 114,910
	OM&M	$ 664,440
	Total	**$ 796,250**
Alternative 3 - Excavation with Offsite Treatment and/or Disposal	Design/Preconstruction	$ 83,200
	Construction	$ 7,218,040
	OM&M	$ -
	Total	**$ 7,301,240**
Alternative 4 - Excavation with Onsite Treatment	Design/Preconstruction	$ 143,000
	Construction	$ 5,900,010
	OM&M	$ -
	Total	**$ 6,043,010**
Alternative 5 - ISCO/ISCR Coupled with Soil Mixing	Design/Preconstruction	$ 124,800
	Construction	$ 2,692,900
	OM&M	$ -
	Total	**$ 2,817,700**
OU2		
Alternative 1 – No Action	No cost	$ -
Alternative 2 – MNA	Design/Preconstruction	$ 215,000
	Construction	$ 358,530
	OM&M	$ 2,427,790
	Total	**$ 3,001,320**
Alternative 3 – In Situ Injection (ISCO/ISCR/Bioremediation)	Design/Preconstruction	$ 415,000
	Construction	$ 2,343,310
	OM&M	$ 2,452,420
	Total	**$ 5,210,730**
Alternative 4 – ISTT	Design/Preconstruction	$ 324,200
	Construction	$ 14,278,510
	OM&M	$ 2,279,480
	Total	**$ 16,882,190**
Alternative 5 – HC	Design/Preconstruction	$ 615,000
	Construction	$ 8,735,540
	OM&M	$ 29,116,910
	Total	**$ 38,467,450**

Alternative Name	**Description**	**Costs**
OU3		
Alternative 1 - No Action	No cost	$ -
Alternative 2 - Continued Operation, Maintenance, and Monitoring of Whole House Carbon Filtration Systems, Combined with Restrictions on the Use of Groundwater	Design/Preconstruction	$ 3,000
	Construction	$ -
	OM&M	$ 34,420
	Total	**$ 37,420**
Alternative 3 - Connection to the Existing Public Water Supply Waterline, Combined with Restrictions on the Use of Groundwater	Design/Preconstruction	$ 5,000
	Construction	$ 19,000
	OM&M	$ -
	Total	**$ 24,000**

Appendix D: Proposed Remedy Cost Summary

Alternative	Total
OU 1: ALTERNATIVE 5 ISCO/ISCR, Coupled with Soil Mixing	$ 2,817,700
OU 2: ALTERNATIVE 3 In Situ Injection (ISCO/ISCR/Bioremediation)	$ 5,210,730
OU 3: ALTERNATIVE 3 Connection to the Existing Public Water Supply Waterline, Combined with Restrictions on the Use of Groundwater	$ 24,000
Grand Total Combined Remedy	**$ 8,052,430**

Appendix E: List of Abbreviations

µg/l	micrograms per liter
1,1,1-TCA	1,1,1-Trichloroethane
1,1,2-TCA	1,1,2-Trichloroethane
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2,4-TMB	1,2,4-Trimethylbenzene
1,2-DCA	1,2-Dichloroethane
Act 2	Land Recycling and Environmental Remediation Standards Act
AOCs	areas of concern
ARARs	Applicable, or Relevant and Appropriate Requirements
AS/SVE System	air sparging and soil vapor extraction remedial system
AST	aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
AULs	activity and use limitations
Baker	Baker Environmental Inc,
BAT	best available technology
BMPs	best management practices
CAA	Clean Air Act
CCHD	Chester County Health Department
CDP	Constitution Drive Partners, L.P.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
Christiana Metals	Christiana Metals Corporation
cis-1,2-DCE	cis-1,2-Dichloroethene
COA	Consent Order and Agreement
COCs	contaminants of concern
CVOCs	Chlorinated Volatile Organic Compounds
DCNR	Pennsylvania Department of Conservation and Natural Resources
DEP	Department of Environmental Protection
DHHS	Department of Health and Human Services
DNAPL	dense non-aqueous phase liquid
DSA	drum storage area
EC	environmental covenant
EPA	United States Environmental Protection Agency
EV	exceptional value
FS	feasibility study
ft msl	ft. mean sea level
GAC	granulated activated carbon
GES	Groundwater and Environmental Services, Inc.
HAPs	hazardous air pollutants

HC	hydraulic control
HHRA	human health risk assessment
HRS	hazard ranking system
HSCA	Hazardous Sites Cleanup Act
IARC	International Agency for Research on Cancer
ICs	institutional controls
ISCO	in situ chemical oxidation
ISCR	in situ chemical reduction
ISTT	in situ thermal treatment
Johnson Matthey	Johnson Matthey, Inc.
LVC	Little Valley Creek
MACT	Maximum Achievable Control Technology
Marcegaglia	Marcegaglia USA, Inc.
MCL	maximum contaminant level
MNA	monitored natural attenuation
MSC	medium-specific concentration
MTBE	Methyl tert-butyl ether
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
OM&M	operations, maintenance, and monitoring
OU	operable unit
PA	Pennsylvania
PADER	Pennsylvania Department of Environmental Resources
PAPL	Pennsylvania’s Priority List of Hazardous Sites for Remedial Response
PCE	tetrachloroethene
PNDI	Pennsylvania Natural Diversity Inventory
POET	point of entry treatment system
PPA	Prospective Purchaser Agreement
ppb	parts per billion
PV	present value
RAA	remedial alternatives analysis
RAOs	remedial action objectives
RAs	remedial alternative technologies
RCRA	Resource Conservation and Recovery Act
RDC	residential direct contact
RI	remedial investigation
Roux	Roux Associates, Inc.
RUA	residential used aquifer
SDWA	Safe Drinking Water Act
Site	The Bishop Tube Site

Source Property	former Bishop Tube property
SSS	site-specific standard
TBC	to be considered
TCE	trichloroethene
Tech Memo	Technical Memorandum
TEG	Technical Evaluation Grant
trans-1,2-DCE	trans-dichloroethylene
TS	treatability study
UECA	Uniform Environmental Covenants Act
UIC	Underground Injection Control
USGS	United States Geological Survey
VI	vapor intrusion
VOC	volatile organic compound
Whittaker	Whittaker Corporation
WHO	World Health Organization