FOURTH FIVE-YEAR REVIEW REPORT FOR CROYDON TCE SUPERFUND SITE BUCKS COUNTY, PENNSYLVANIA

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Prepared by

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Date

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LIST OF ABBREVIATIONS & ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
BBWSD	Borough of Bristol Water and Sewage Department
BCMCC	Bucks County Mosquito Control Commission
bgs	Below Ground Surface
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CIC	Community Involvement Coordinator
COC	Chemical of Concern
COE	U.S. Army Corps of Engineers
COPC	Chemical of Potential Concern
DCA	Dichloroethane
DCE	Dichloroethylene
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
EW	Extraction Well
FS	Feasibility Study
ft	Feet
FYR	Five-Year Review
HHRA	Human Health Risk Assessment
HI	Hazard Index
IC	Institutional Control
ISB	In Situ Bioremediation
MCL	Maximum Contaminant Level
mg/L	Milligrams per Liter
MNA	Monitored Natural Attenuation
µg/L	Micrograms per Liter
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
OW	Observation Well
PADEP	Pennsylvania Department of Environmental Protection
PCE	Tetrachloroethylene
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RSL	Regional Screening Level
TCA	Trichloroethane
TCE	Trichloroethylene
UU/UE	Unlimited Use/Unrestricted Exposure
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound

I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the fourth FYR for the Croydon TCE Superfund site (the Site). The triggering action for this statutory review is the completion date of the previous FYR. This FYR has been prepared due to the fact that hazardous substances, pollutants or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Site consists of two operable units (OUs). OU1 addresses the extension of a public waterline to residents affected by site groundwater contamination. OU2 addresses the containment, treatment and discharge of the contaminated groundwater plume. Both OUs will be addressed in this FYR.

The FYR was led by EPA remedial project manager (RPM) William Geiger. Participants included EPA Community Involvement Coordinator (CIC) Alexander Mandell, Matthew Taynor from EPA's Biological Technical Assistance Group (BTAG), and Colin Wade and Rebecca Flannery from the Pennsylvania Department of Environmental Protection (PADEP). Skeo provided contractor support to EPA for this FYR. EPA is the lead agency for developing and implementing the remedy for the Superfund- and state-financed cleanup at the Site. There are no viable potentially responsible parties (PRPs). The review began on 1/8/2016.

Site Background

The Site is located in a 3.5-square-mile area in Bristol Township in Bucks County, Pennsylvania (Figure B-1 of Appendix B). The area includes residential, commercial and industrial properties. It is bordered by Interstate 95 to the north, the Delaware River to the south, Route 413 to the east and Neshaminy Creek to the west. Hog Run Creek and its tributaries (i.e., East Branch and West Branch) are located within the Site.

EPA identified the Site in 1985 after an investigation at a neighboring Rohm and Haas Company industrial plant found a groundwater contaminant plume that did not appear to be related to the plant. Elevated levels of volatile organic compounds (VOCs), primarily trichloroethylene (TCE), have been detected in site groundwater and surface water. However, no source has been identified to date.

The Site consists of the groundwater contaminant plume, the groundwater treatment system building, and extraction and monitoring wells (Figure B-2 of Appendix B). The groundwater treatment system building was located on land previously owned by Rohm and Haas Company, a wholly-owned subsidiary of Dow Chemical Company. Ownership of the property, known locally as Croydon Woods, transferred from Rohm and Haas Company to the Heritage Conservancy in January 2016. The Heritage Conservancy plans to preserve the land as green space and is considering adding nature trails or other passive recreation opportunities. Croydon Woods is one of the last remaining wooded wetland forests in the region.

Groundwater at the Site occurs in an unconsolidated aquifer and an underlying bedrock aquifer. The two flow systems are not connected due to the presence of clay layers and a substantial thickness of weathered bedrock. Groundwater contamination has been identified in the shallow (about 20 feet [ft] below ground surface [bgs]) and deeper (about 55 ft bgs) portions of the unconsolidated aquifer. Deep wells at the Site are used to monitor the

bottom of the unconsolidated aquifer. Groundwater flow direction is generally to the southeast towards the Delaware River.

Appendix A includes a list of documents reviewed for this FYR. Appendix B includes site figures. Appendix C includes a site chronology. Appendix D provides additional background information for the Site, including history of contamination and physical characteristics.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Croydon TCE		
EPA ID: PAD981035009		
Region: 3	**State:** PA	**City/County:** Bristol Township/Bucks County
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: EPA		
Author name: William Geiger, with additional support provided by Skeo		
Author affiliation: EPA Region 3		
Review period: 1/8/2016 – 12/7/2016		
Date of site inspection: 4/28/2016		
Type of review: Statutory		
Review number: 4		
Triggering action date: 12/7/2011		
Due date *(five years after triggering action date)*: 12/7/2016		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

EPA conducted a human health risk assessment (HHRA) in 1988 using data collected during the remedial investigation (RI) at the Site. The HHRA concluded that exposure to contaminated groundwater posed an unacceptable risk to users of wells within the TCE plume. The highest TCE concentrations were detected in the deeper portion of the aquifer (about 55 ft bgs). The risks associated with groundwater ingestion, inhalation of contaminants volatilized from groundwater household use (i.e., showering or cooking), and dermal absorption of contaminants while bathing were found to be above the EPA benchmark of a 10^{-4} carcinogenic risk. Additionally,

TCE exceeded the federal maximum contaminant level (MCL) in water collected from residential wells in the study area.

The RI also identified TCE and 1,1,1-trichloroethane (1,1,1-TCA) contamination in surface water in nearby tributaries and streams. The presence of VOCs in the surface water appeared to be a result of discharge of contaminated groundwater. The HHRA concluded that exposures to surface water as well as sediment and surface soils by children or adults did not suggest the potential for adverse health risks. Potential impacts on aquatic species were also determined to be negligible because of the low concentrations of volatiles detected in study area surface waters.

Table 1 summarizes chemicals of potential concern (COPCs) in groundwater and surface water.

Table 1: Chemicals of Potential Concern, by Media

Chemicals of Potential Concern	Media
TCE, tetrachloroethylene (PCE), vinyl chloride, 1,1,1-TCA, 1,1-dichloroethane (1,1-DCA) and 1,1-dichloroethylene (1,1-DCE)	groundwater[a]
TCE and 1,1,1-TCA	surface water[b]

Notes:

a) Groundwater COPCs are identified as those chemicals that required monitoring according to the Site's 1990 OU2 Record of Decision (ROD). The 1990 OU2 ROD did not specify chemicals of concern (COCs) but noted that TCE and 1,1-DCE were chemicals that exceeded health-based criteria.

b) Surface water COPCs were identified in the Summary of Site Characteristics, Surface Water section of the 1990 OU2 ROD.

Response Actions

In 1987, EPA began the remedial investigation and feasibility study (RI/FS) to determine the nature and extent of contamination associated with the Site. The investigation also evaluated potential source areas. However, no definitive source could be identified. EPA completed the RI/FS in 1990.

EPA issued two Records of Decision (RODs) for the Site. EPA issued the OU1 ROD on December 28, 1988. The OU1 ROD provided for an extension of an existing public waterline to all residences and businesses affected by the groundwater contamination. On June 29, 1990, EPA issued the OU2 ROD. The OU2 ROD selected a groundwater extraction and treatment remedy to clean up the contaminated groundwater. EPA modified the OU2 remedy with three separate Explanations of Significant Differences (ESDs) issued on December 31, 1996, September 23, 2011, and September 9, 2015.

The decision documents identified the following remedial action objectives (RAOs) for the Site:

- Prevent human exposure to contaminated groundwater having concentrations of TCE and related constituents in excess of federal and state health-based applicable or relevant and appropriate requirements (ARARs).
- Prevent further migration of contaminated groundwater to uncontaminated areas of the aquifer.
- Restore the aquifer to MCLs, as modified by the 2011 ESD.
- Reduce the contaminant levels in the East Branch of Hog Run Creek. At the time of the RI, the source of VOCs in the surface water was found to be due to the discharge of contaminated groundwater.

The RODs and the ESDs identified the following major remedial components:

1988 OU1 ROD

- Connection of homes and businesses located within the groundwater contaminant plume to the existing public water supply.
- Transfer of control of the new water line and service to the Borough of Bristol Water and Sewage Department (BBWSD).
- Annual groundwater sampling outside the TCE plume area to monitor the possible migration of contaminants.

1990 OU2 ROD

- Construction and long-term operation of four extraction wells to adequately contain the migration of the groundwater contaminant plume.
- Treatment of the extracted groundwater via air stripping and carbon adsorption.
- On-site discharge of the treated groundwater to the East Branch of Hog Run Creek.
- Annual groundwater sampling of monitoring wells and residential wells to confirm the effectiveness of the extraction system and to monitor the possible migration of contaminants. Constituents to be monitored included TCE, tetrachloroethylene (PCE), vinyl chloride, 1,1,1-TCA, 1,1-dichloroethane (1,1-DCA) and 1,1-dichloroethylene (1,1-DCE).
- Institutional controls to prevent the use of groundwater during remediation.

1996 OU2 ESD

The 1996 OU2 ESD documented a significant difference in the areal extent and likely source areas of groundwater contamination. Data available at the time of the OU2 ROD suggested the Site included two co-mingled plumes. Additional investigations during remedial design determined there were two separate plumes, identified as Plume A and Plume B.[1] The 1996 OU2 ESD stated that the plumes resulted from different sources, contained different mixes of contaminants and flowed in opposite directions. The 1996 OU2 ESD documented EPA's decision that the eastern plume, Plume B, is not part of the Site and should not be addressed as part of the remedial action. Instead, Plume B is being addressed as part of an ongoing Resource Conservation and Recovery Act (RCRA) Corrective Action at the Rohm and Haas facility.

2011 OU2 ESD

The 2011 OU2 ESD modified the OU2 remedy by changing the groundwater performance standards from background concentrations to federal MCLs. The ESD also changed the monitoring program for migration of the groundwater contaminant plume using only site monitoring wells, rather than monitoring wells and residential wells, as originally called for in the OU2 ROD. During the design and implementation of the remedy for OU2, EPA determined that the two residential wells identified in the OU2 ROD were not necessary for monitoring the plume and that existing monitoring wells, mostly installed during the RI/FS phase, provided adequate coverage of the plume boundaries to ensure that further contaminant migration was not taking place.

2015 OU2 ESD

The 2015 OU2 ESD modified the OU2 remedy by officially discontinuing extraction and treatment of groundwater and allowing for the dismantling of the groundwater extraction and treatment system. Based on low influent contaminant concentrations, EPA determined that the system was no longer effectively addressing the

[1] Appendix F-7 shows the orientation of Plume A and Plume B as of March 2011. Because Plume B is no longer monitored as part of the Site, current plume maps for Plume B are not included in this FYR.

groundwater contaminant plume. Additionally, the treatment system building was subject to ongoing vandalism. PADEP contractors are collecting data to evaluate the efficacy of MNA and in-situ bioremediation (ISB) as alternative remedies for completing groundwater remediation at the Site. The MNA evaluation is ongoing and PADEP has prepared a work plan for the ISB pilot study. EPA is currently reviewing the work plan and will evaluate if an additional decision document is necessary to address the remaining groundwater contamination at the Site.

Table 2 summarizes groundwater chemical of concern (COC) cleanup goals identified in the 2011 OU2 ESD. TCE and 1,1-DCE were the only chemicals detected above health-based criteria at the time of the 1990 OU2 ROD. Therefore, they were the only COCs specified in the 2011 OU2 ESD. Decision documents did not specify surface water cleanup goals.

Table 2: Groundwater COC Cleanup Goals

Groundwater COC	Cleanup Goal (micrograms per liter, µg/L)	Basis
TCE	5	federal MCL
1,1-DCE	7	federal MCL
Notes: Source: 2011 OU2 ESD		

Status of Implementation

OU1

Construction of the water main and service connections began on November 20, 1989. Water mains were added on portions of Bellevue Avenue and Bristol Pike, the only streets in the zone of groundwater contamination without existing water mains. All eleven properties within this area were connected to the new water mains. EPA transferred control of the waterlines to the BBWSD upon construction completion in June 1990.

Aqua Pennsylvania, formerly the Philadelphia Suburban Water Company, currently owns and operates the waterline. EPA has not had further involvement with the waterline. Groundwater monitoring required by the OU1 ROD has been conducted as part of OU2 activities.

OU2

The groundwater extraction and treatment system included extraction wells EW-1 through EW-6, 11 observation wells (OW-1 through OW-11), an air stripper tower, a flow equalization tank, granular activated carbon as a polishing step for treated water and for off-gas treatment, and a building to house all equipment. The extraction wells were designed to reach the deeper portions of the unconsolidated aquifer, approximately 55 feet bgs, where the highest levels of TCE were detected. The discharge point of the treated water was changed from the East Branch to the West Branch of Hog Run Creek.

The system was placed into continuous operation on March 13, 1995. The Site achieved construction completion status when EPA issued the Site's Preliminary Close-Out Report on March 31, 1997.

From March 1995 through January 2006, EPA and its contractors conducted operation and maintenance (O&M) activities during the long-term response action (LTRA) for the groundwater extraction and treatment system. On January 27, 2006, PADEP assumed responsibility for all future O&M activities associated with the system, in accordance with the State Superfund Contract (SSC).

Between March 2007 and September 2009, all wells on site were sampled for 1,4-dioxane. The analytical method used during the September 2009 sampling event achieved a detection limit of 0.5 µg/L. All samples came back

non-detect, with the exception of OW-9, which showed 1,4-dioxane at an estimated concentration of 0.5 µg/L. EPA and PADEP determined that sampling for 1,4-dioxane in groundwater was no longer necessary at the Site.

In May 2008, EPA's contractor conducted a direct push groundwater sampling event in the residential neighborhood to address data gaps remaining from previous investigations, including the potential for vapor intrusion. TCE was detected in six of the 13 groundwater samples at concentrations below the MCL. Based on the low detections of VOCs in the 2008 groundwater samples, and the relatively low levels of VOCs in site-wide groundwater, EPA determined that vapor intrusion was not a concern at that time. This FYR re-evaluates the potential for vapor intrusion to indoor air using current groundwater data (see Section V.b).

Due to low contaminant concentrations remaining in groundwater and low contaminant concentrations in the groundwater extraction and treatment system influent (influent TCE concentrations were near steady state from 2007 to 2009, fluctuating between 6.7 µg/L and 8.3 µg/L over 19 monthly sampling events), PADEP and EPA ceased operation of the groundwater extraction and treatment system in order to conduct a contaminant rebound evaluation. On March 23, 2009, the extraction and treatment system was shut down and the system has remained off since that time. Subsequent sampling rounds did not show any contaminant rebound, indicating that the groundwater extraction and treatment system may no longer be necessary to address contaminated groundwater. Because contaminant levels have not rebounded since system shutdown, and the plume is not migrating, EPA and PADEP agreed to keep the system off while continuing to monitor the plume and evaluate alternative groundwater remedies. Since 2009, PADEP's contractor has continued to monitor groundwater on a semi-annual basis.

EPA and PADEP are currently exploring alternative groundwater remedies for the Site. In March 2014, PADEP initiated a monitored natural attenuation (MNA) evaluation to determine if MNA is an option to meet cleanup goals. MNA evaluation activities included the addition of several microbial and geochemical parameters to the monitoring well sampling program. The MNA evaluation is currently ongoing. PADEP has also agreed to conduct a pilot test to evaluate injections of bio-stimulants in certain areas where TCE levels are still above the MCL (between 5 and 20 µg/L). EPA will evaluate if a decision document is necessary for the selection of a new groundwater remedy upon completion of the pilot test and evaluation.

Institutional Control Review

The 1990 OU2 ROD required groundwater use restrictions in the groundwater contaminant plume. The document specified that institutional controls were to be implemented by state or local authorities to prevent the use of contaminated groundwater during remediation. The 1990 OU2 ROD further stated that the construction of new wells should be prevented, and existing wells should be sealed or prohibited from use as a potable water supply. The 2011 OU2 ESD clarified that EPA's intent is to prevent only potable use of contaminated groundwater during remediation, and not all uses of groundwater.

The groundwater use restrictions have been implemented at the Site through Bristol Township and the Bucks County Department of Health (DOH). All properties that overlie the Site's contaminant groundwater plume are served by the public water supply. A Bristol Township ordinance is in place that requires connection of all properties within 150 feet of a water main to public water. The ordinance also requires that water from private wells on properties connected to the public water supply may not be consumed by humans. Any uses that do not involve human consumption must be approved by the Township.

The Bucks County DOH is responsible for issuing well installation permits within the county. The DOH is aware of the extent of the Site groundwater contaminant plume and will not issue a well permit for installation of a drinking water well at any location within the plume boundaries.

Additional institutional controls are in place for the Heritage Conservancy parcel (parcel number 05-053-052), the property on which the groundwater treatment system building is located. Rohm and Haas Company, the previous owner of the parcel, recorded an environmental covenant for the parcel with the Bucks County Recorder of Deeds on March 21, 2013. The environmental covenant restricts use of groundwater for potable, agricultural or other consumptive purposes. The environmental covenant also includes restrictions unrelated to the Site.[2] The environmental covenant was included as an attachment to the deed that transferred ownership of the parcel from Rohm and Haas Company to the Heritage Conservancy, recorded with the Bucks County Recorder of Deeds on January 15, 2016 (Instrument Number 2016003008). Appendix J includes a copy of the environmental covenant.

Table 3 below summarizes institutional controls required by site decision documents. Figure B-3 in Appendix B includes an institutional control map that shows the current plume configuration and associated property boundaries.

Table 3: Summary of Planned and/or Implemented Institutional Controls (ICs)

Media, Engineered Controls and Areas that Do not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or Planned)
Groundwater	Yes	Yes	all parcels overlying TCE plume	Restrict use of contaminated groundwater for potable use until groundwater cleanup goals are achieved.	Code of the Township of Bristol, Bucks County, Pennsylvania, Chapter 201, Water, § 201-2, last revised 1992[a] and Bucks County Department of Health well permitting program
			Heritage Conservancy parcel	Restrict use of groundwater for potable, agricultural or other consumptive purposes.[b]	2013 Environmental Covenant, recorded with the Bucks County Recorder of Deeds on March 21, 2013

Notes:

a) Code of the Township of Bristol, available at http://www.codepublishing.com/PA/BristolTownship, accessed May 19, 2016.

b) The 2013 Environmental Covenant also restricted use of the Heritage Conservancy parcel for residential purposes. Site decision documents did not require this restriction. This restriction is related to the BCMCC grounds site, which occupies part of the Heritage Conservancy parcel.

Systems Operations/Operation & Maintenance (O&M)

The public water authority is responsible for the continued O&M of the waterline portion of the remedy. From March 1995 through January 2006, EPA and its contractors conducted O&M activities during the LTRA for the groundwater extraction and treatment system. On January 27, 2006, PADEP assumed responsibility for all future O&M activities at the Site. O&M is conducted in accordance with a July 1995 Operation and Maintenance

[2] The 2013 Environmental Covenant, recorded by Rohm and Haas Company, includes restrictions on residential use as well as restrictions related to a small area referred to as the Bucks County Mosquito Control Commission (BCMCC) grounds. The BCMCC grounds was identified as a solid waste management unit in the Rohm and Haas Bristol Site's EPA RCRA Corrective Action Order.

Manual, prepared by Tetra Tech, a January 2006 Work Plan prepared by AECOM, and as modified by EPA and PADEP based on sampling results and data needs. The groundwater extraction and treatment system is currently offline and PADEP is beginning the process of dismantling the system's components.

Current activities associated with O&M include:

- Periodic inspection of site conditions and mowing of grass around the treatment system building and along the access road that leads to the building.
- Semi-annual sampling of groundwater monitoring wells for VOCs with results compared to MCLs for those chemicals for which MCLs have been established (see Appendix F4 & F6). Up to eight additional wells are also sampled for ammonia, nitrogen and sulfate.
- Semi-annual sampling of seven surface water locations along Hog Run Creek for VOCs with results compared to Pennsylvania water quality criteria.

Vandalism of the treatment system building has been an ongoing problem at the Site. Fencing has been cut on multiple occasions; door locks and alarms to the treatment system building have been damaged and various system components have been found missing or damaged. PADEP's contractor has contacted the Bristol Township Police Department on several occasions to report the damage.

The 1990 OU2 ROD estimated annual maintenance costs to be approximately $47,000. However, actual O&M costs during EPA's operation of the system were not consistent with the ROD. O&M costs during the first two years of operation were $246,000, primarily due to several major repairs during that period. After the first two years, EPA's average annual O&M costs were approximately $130,000.

PADEP has been responsible for O&M since 2006 and has incurred all costs since that time.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the last FYR as well as the recommendations from the last FYR and the current status of those recommendations.

Table 4: Protectiveness Determination from the 2011 FYR

OU #	Protectiveness Determination	Protectiveness Statement
Sitewide	Short-term Protective	The assessment of the Site by this, the third Five-Year Review, finds the Remedy has been constructed in accordance with the requirements of the RODs, as modified. The immediate threats have been addressed though the extension of a municipal water supply system. EPA evaluated the potential for vapor intrusion, and it is not considered to be a threat at the Site. 1,4-dioxane was not found above detection limits in Site groundwater in three separate sampling events. EPA coordinated with state and local authorities to ensure, that all businesses and residents in the area are connected to public water, and that Bristol Township requires any new construction in the area be connected to public water. Although the groundwater system is currently shut down for a rebound evaluation, extraction, treatment and monitoring of the groundwater have been conducted as required. As a result, the Remedy is considered protective of human health and the environment in the short-term. The Remedy is expected to be fully protective when the groundwater performance goals are achieved.

Table 5: Status of Recommendations from the 2011 FYR

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
OU2	While cleanup goals have not yet been achieved, the pump-and-treat system has been off since March 2009 to evaluate contaminant rebound and the potential for modifying the remedy.	EPA/PADEP should evaluate whether to turn the pump-and-treat system back on or to modify the remedy.	Completed	EPA/PADEP evaluated existing data and determined that the pump-and-treat system was no longer efficient at remediating the low concentrations of VOCs remaining in groundwater. EPA issued an ESD in 2015 to officially discontinue extraction and treatment of groundwater and allowing for the dismantling of the pump-and-treat system. PADEP has agreed to conduct a pilot test to evaluate injections of bio-stimulants in certain areas where TCE levels are still slightly above the MCL.	9/9/2015

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

A Public Notice announcing that EPA was conducting a FYR for the Site was published in the Bucks County Courier Times, a widely-distributed local newspaper, on November 4, 2016. The Public Notice also provided EPA point of contact information, as well as the location of the information repositories for the Site. A copy of the public notice is included in Appendix E. The results of the FYR and the complete report will be made available at the Site's information repository, the Margaret R. Grundy Memorial Library, located at 680 Radcliffe Street in Bristol, Pennsylvania. It will also be available at the following website: https://www.epa.gov/superfund/croydon.

On October 5, 2016 EPA participated in a local Environmental Advisory Council (EAC) meeting at the Bristol Township Municipal Building. During the meeting, EPA updated those in attendance on past, current, and future efforts at the Site. At the conclusion of EPA's presentation, EPA both collectively and individually met with community members and interviewed them on best practices for strong and meaningful outreach in their community.

In addition, EPA reached out to Bristol Township representatives several times over the past year in an effort to inform them of our progress at the Site.

Data Review

This data review incorporates groundwater and surface water monitoring data, as presented in the 2011 through 2015 annual and semi-annual reports. Key points from this review are provided below:

- TCE remains the primary COC detected in site groundwater and is the only monitored VOC detected above its MCL.
- Highest concentrations of TCE continue to be reported to the south and east of the groundwater treatment system building in deep zone groundwater. The maximum detected TCE concentration in November 2015 was 18.7 µg/L at deep zone well OW-3.
- Samples collected from eight of the 26 wells sampled in 2015 exhibited a decrease in TCE concentration since the groundwater treatment system was shut down in March 2009. Samples collected from 16 of the 26 wells sampled in 2015 exhibited an increase in TCE concentration since the treatment system was shut down. No trend was observed in 2 of the wells. The maximum increase was minimal at 11.1 µg/L at deep zone well OW-11 (from 3.4 µg/L in September 2009 to 14.5 µg/L in November 2015).
- The deep zone TCE plume has not changed appreciably in concentration, location or extent since the 2011 FYR.
- Low levels of TCE continue to be detected in surface water samples collected from Hog Run Creek. TCE exceeded the Pennsylvania water quality standard for protection of human health in September 2013 at sampling location SW-7. TCE was detected below the standard during all other sampling events at all locations between September 2011 and December 2015.

Groundwater

PADEP's O&M contractor collected groundwater samples from up to 40 site monitoring wells on a semi-annual basis for VOC analysis during the FYR period. Additional samples were collected for analysis of ammonia-nitrate and sulfate at up to eight locations at the direction of PADEP to monitor for migration of Plume B. In 2015, PADEP and EPA approved a reduction in the number of monitoring wells sampled because several wells consistently reported TCE below the MCL of 5 µg/L. In addition, wells MW-15S and CR-MW-15D, located within Plume B, were eliminated from the sampling program. The number of wells sampled was reduced from 40 to 26 for the November 2015 sampling event. Appendix F includes a summary of groundwater analytical results from the November 2015 sampling event, as originally presented in the Sampling and Operation & Maintenance, July 2015 to December 2015, Semi-Annual Report (Fall 2015 Semi-Annual Report). The Fall 2015 Semi-Annual Report provides a summary of all historical groundwater data.

TCE is the only monitored VOC to exceed its MCL during this FYR period. During the November 2015 sampling event, 18 of the 26 wells reported TCE at concentrations above the MCL. Samples collected from two of the five shallow zone wells exceeded the MCL, and samples collected from 16 of the 21 deep zone wells exceeded the MCL. The maximum detected concentration of TCE during the November 2015 event was 18.7 µg/L in deep zone well OW-3. The maximum detected concentration of TCE during this FYR period was 19.8 µg/L in OW-3 in September 2014.

Concentrations of 1,1-DCA, 1,1-DCE and PCE were also reported in several wells during the November 2015 sampling event. The detections of 1,1-DCE and PCE were below MCLs (7 µg/L and 5 µg/L, respectively). An MCL has not been established for 1,1-DCA. Well CR-24-15 reported 1,1-DCA (3.3 µg/L) at a concentration above EPA's tapwater regional screening level (RSL) of 2.8 µg/L but below Pennsylvania's Act 2 medium-specific concentration (MSC) of 31 µg/L for a residential used aquifer (total dissolved solids $\leq$ 2,500). Based on review of historical data provided in the Fall 2015 Semi-Annual Report, the concentrations of 1,1-DCA in this well (CR-24-15) have been generally consistent since 2004.

During the November 2015 sampling event, sulfate was detected at a concentration of 2,284 mg/L in the sample collected from CR-25-13, which is significantly higher than concentrations reported since 2006 (approximately 15 mg/L to 30 mg/L). The detected concentration exceeds EPA's secondary MCL of 250 mg/L as well as the

Pennsylvania secondary MCL of 250 mg/L.[3] Results from future scheduled semi-annual sampling will determine if the elevated detection of sulfate is an anomaly or if additional actions are needed to address the increased concentrations.

According to the Fall 2015 Semi-Annual Report, samples from nine of the 26 wells sampled exhibited a decrease in TCE concentrations since the groundwater treatment system was shut down in March 2009. The decreases in concentration ranged from 0.1 µg/L (CR-MW-5D) to 4.7 µg/L (OW-2). Samples collected from 17 of the 26 wells sampled exhibited an increase in TCE concentration since that time. The increases in concentration ranged from 0.1 µg/L (CR-18-55) to 11.1 µg/L (OW-11). The highest TCE concentrations, as well as the highest observed increases in TCE concentrations, continue to be reported in the immediate areas of the former extraction wells and generally to the south and east of the groundwater treatment system building.

Appendix F includes TCE concentration plume maps for the shallow and deep zones from the November 2015 and March 2015 sampling events (Appendix F-3 through Appendix F-6). The November 2015 and March 2015 maps were prepared by different contractors, so the plumes are presented in slightly different ways. Appendix F-7 also includes a plume map for the deep zone, as presented in the 2011 FYR, and Appendix F-8 includes a plume map for the deep zone, as presented in the 1990 FS. The TCE plume for the deep zone has not changed appreciably in location, concentration or extent since the 2011 FYR. Based on review of the 2015 maps and the 1990 map, TCE concentrations in the deep zone have decreased by an order of magnitude (from above 100 µg/L in 1990 to above 10 µg/L in 2015).

PADEP contractors are continuing to collect additional data to evaluate the efficacy of MNA and in-situ bioremediation (ISB) as alternative remedies for completing groundwater remediation at the Site. The MNA evaluations are ongoing and PADEP has prepared a work plan for the ISB pilot study. EPA is currently reviewing the work plan.

Surface Water

PADEP's O&M contractor collected surface water samples from seven locations along Hog Run Creek on a semi-annual basis for VOC analysis (locations shown in Appendix F-4). During this FYR period, low levels of TCE, between 0.52 µg/L and 2.6 µg/L, were reported at all seven surface water sample locations.[4] TCE at SW-7 (2.6 µg/L) exceeded the Pennsylvania water quality criterion protective of human health (2.5 µg/L) in September 2013. All other TCE concentrations were below the human health criterion and the criteria protective of fish and aquatic life (450 µg/L continuous concentration and 2,300 µg/L maximum concentration). The TCE surface water concentrations are consistent with concentrations reported over the last decade but are lower than those detected during the RI (TCE at 6 µg/L). Appendix F-2 includes a summary table of the surface water analytical data.

Sporadic detections of PCE, toluene, carbon disulfide and chloroform also occurred at one or more surface water sample locations during this FYR period. For those constituents for which criteria were available (PCE, toluene and chloroform), none of the detected concentrations exceeded the Pennsylvania surface water quality criteria protective of human health or fish and aquatic life. In the absence of surface water quality criteria for carbon disulfide, detected concentrations were compared to EPA's tapwater RSL (810 µg/L). Detected concentrations of carbon disulfide were well below the RSL.

Site Inspection

The site inspection took place on 4/28/2016. In attendance were EPA RPM William Geiger, EPA CIC Alexander Mandell, Matthew Taynor from EPA's BTAG, Colin Wade and Rebecca Flannery from PADEP, a representative

[3] Secondary MCLs are non-mandatory water quality standards. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color and odor.
[4] This FYR evaluated surface water data collected between September 2011 and December 2015.

from O'Brien & Gere (PADEP's O&M contractor), Rich Flack from the Bucks County Board of Health, Jim Drennan and Taylor Thompson from the Heritage Conservancy (property owner representatives), and Ryan Burdge and Jill Billus from EPA contractor Skeo. The purpose of the inspection was to assess the protectiveness of the remedy. For a full list of site inspection activities, see the Site Inspection Checklist in Appendix G. Site photographs are available in Appendix H.

Site inspection participants met at the access road to the treatment plant building, along Stella Avenue. The access gate leading onto the Heritage Conservancy property was unsecured. The Heritage Conservancy representative indicated that the local fire department had recently cut the gate's lock to gain access to the Site for a reported fire caused by trespassers. Trespassing and vandalism are an ongoing nuisance. Evidence of trespassing (trash, evidence of campfires, vehicle tracks) were observed across the property during the site inspection.

The groundwater extraction and treatment system is no longer in operation, but the treatment system building remains. The treatment system building, although covered in graffiti, is in relatively good condition and is enclosed with chain-link fencing. The building is currently bolted shut to deter unauthorized access. The interior of the building was not observed during the site inspection. PADEP representatives indicated that electricity and water have been shut off to the treatment system building. It is anticipated that remaining system components, including the chain-link fence, will be dismantled and removed within the next year.

Site inspection participants observed the West Branch of Hog Run Creek, which is included in the semi-annual sampling program for the Site. Low-flow conditions were observed at the time of the inspection.

Site inspection participants inspected several of the monitoring wells included in the current monitoring program, which included wells in the residential area of the Site. Most wells were found locked and in generally good condition; one of the wells was found to be unsecured due to a rusted lock.

Following the site inspection, Skeo staff visited the designated site repository, Margaret R. Grundy Memorial Library, located at 680 Radcliffe Street in Bristol, Pennsylvania. The repository file included 2012 and 2015 administrative records for OU2. Documents for OU1 were unavailable. The Site repository will be updated with both OU-1 and OU-2 documents.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the review of site-related documents and the results of the site inspection indicate that the remaining components of the remedy are functioning as intended by decision documents. Connection of impacted homes and businesses to the public water supply eliminated direct exposure between contaminated groundwater and human receptors. Institutional controls in the form of a Bristol Township ordinance and Bucks County DOH well permitting process are also in place to restrict use of groundwater for potable purposes. An environmental covenant, which restricts residential use and restricts use of groundwater for potable, agricultural or other consumptive purposes, is also in place for the Heritage Conservancy parcel.

The groundwater treatment system, while in operation, effectively contained the TCE plume and reduced contamination concentrations at the Site. System influent TCE concentrations were near steady state from 2007 to 2009 (fluctuating between 6.7 µg/L and 8.3 µg/L over 19 monthly sampling events) and EPA approved PADEP's shutdown of the system in March 2009 to conduct a rebound evaluation.

Significant rebound in contaminant concentrations has not occurred since the groundwater treatment system was shut down. Between 2009 and 2015, TCE concentrations have remained relatively stable. The TCE plume has not changed in location, concentration or extent since the groundwater treatment system was shut down. In addition,

there were no site-related changes to surface water quality. TCE and all other VOCs in surface water samples were below surface water quality criteria, with the exception of the September 2013 sampling event.

Trespassing and vandalism of the treatment system building are ongoing issues at the Site. During this FYR period, fencing has been cut on multiple occasions, door locks and alarms to the treatment system building have been damaged, and various system components have been found missing or damaged. PADEP's contractor has contacted the Bristol Township Police Department on several occasions to report the damage.

Based on the performance of the groundwater extraction and treatment system, lack of significant rebound after system shutdown and the recurring vandalism of the groundwater treatment system building, the 2015 ESD formally discontinued the groundwater extraction and treatment component of the remedy and called for dismantling of the system. Groundwater and surface water quality continue to be monitored on a semi-annual basis. EPA and PADEP are currently exploring alternative groundwater remedies for the Site; PADEP is in the process of conducting a pilot study to determine if ISB is an effective technology to reduce remaining low-level concentrations of TCE to below MCLs. EPA will evaluate if a decision document is necessary to select a final groundwater remedy at the Site based on the results of the pilot test.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection still valid?

While toxicity data, cleanup levels and RAOs from the time of remedy selection are still valid, the vapor intrusion exposure pathway was not evaluated during the 1988 HHRA. As a result, it is evaluated below.

This FYR included a review of relevant site-related documents, including the OU1 and OU2 RODs, three OU2 ESDs and recent monitoring data. Appendix A provides a complete list of the documents reviewed.

To determine if a change in ARARs could call into question the protectiveness of the remedy, this FYR evaluated the chemical-specific ARARs identified in the 1990 OU2 ROD and the 2011 OU2 ESD.

The 2011 OU2 ESD changed the Site's groundwater performance standards from background concentrations to federal MCLs. In the absence of an MCL, a risk-based standard is to be used as the groundwater performance standard. MCLs are groundwater ARARs for the Site.

The MCLs for TCE and 1,1-DCE were 5 µg/L and 7 µg/L, respectively, at the time of the 2011 OU2 ESD. MCLs for these constituents have not changed since 2011. Additionally, no new MCLs have been established for any of the other VOCs included in the groundwater monitoring program (PCE, vinyl chloride, 1,1,1-TCA, 1,1-DCE and 1,1-DCA). Specifically, an MCL has not been established for 1,1-DCA. According to the 2011 OU2 ESD, a risk-based standard is to be used as the groundwater performance standard in the absence of an MCL. Decision documents did not select a risk-based standard for 1,1-DCA. This compound will be evaluated in the cumulative final risk assessment described below.

While individual COCs may be at or below their respective MCLs, multiple chemicals may result in unacceptable risks due to cumulative cancer risks, or through the effect on hazard quotients by multiple contaminants acting on the same target organ or system. To assess whether the MCLs are protective when multiple COCs are present, it is recommended that a risk assessment be performed once the groundwater cleanup goals are achieved.

The 1990 OU2 ROD identified the Pennsylvania Water Quality Standards, 25 PA Code Section 93, as ARARs for discharge of treatment system effluent to Hog Run Creek. Specific values were not included in the decision document. Surface water data are currently compared to the water quality criteria specified in 25 Pennsylvania Code Section 93.

Vapor intrusion to indoor air was not considered as a potential exposure pathway as part of the 1988 HHRA. However, EPA evaluated this potential exposure pathway prior to the 2011 FYR using data collected in 2008. Based on the low detections of VOCs in the 2008 groundwater samples, and the relatively low levels of VOCs in site-wide groundwater, EPA determined that no further assessment of the vapor intrusion pathway was necessary at that time. Based on recent updates to TCE toxicity information as well as the issuance of EPA's Office of Solid Waste and Emergency Response (OSWER) Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (June 2015) (VI Guide), this FYR reevaluates the potential for vapor intrusion to indoor air using EPA's 2016 Vapor Intrusion Screening Level (VISL) calculator to identify if any of the volatile groundwater COCs at the Site require further vapor intrusion evaluation.

Maximum detected concentrations of TCE (7.6 µg/L) and PCE (0.52 µg/L) from shallow well CR-19-15, screened from 10 to 15 ft bgs from the November 2015 sampling event were used in the VISL calculations. Data from the shallow zone wells were selected for the assessment based on the VI Guide's recommendation to use groundwater samples obtained from the uppermost portion of the aquifer that underlies the study area of interest (i.e., where buildings are located) in characterizing representative vapor source concentrations for vapor intrusion assessment. Results of the vapor intrusion assessment found that individual cancer risk levels were within EPA's risk management range of 1×10^{-6} to 1×10^{-4}. None of the chemicals resulted in a noncancer hazard index (HI) exceeding 1 (Appendix I) for a residential use scenario. Results of this evaluation suggest vapor intrusion is not a concern at this time. However, it should be noted that the vapor intrusion groundwater-based modeling is less certain than actual sampling. The pathway should be reevaluated using site-specific data if VOC concentrations increase.

No other changes in the risk assessment methodology and toxicity factors call into question the protectiveness of the remedy. The RAOs used at the time of remedy selection are still valid.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectives of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the FYR:
OU1

Issues and Recommendations Identified in the FYR:				
OU(s): OU2	**Issue Category: Remedy Performance**			
	Issue: The groundwater extraction and treatment system has been offline since 2009, and groundwater continues to exceed the MCL for TCE.			
	Recommendation: Evaluate the results of the MNA evaluation and ISB pilot study conducted by PADEP to determine if an additional decision document is necessary.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	12/7/2019

OTHER FINDINGS

In addition, the following are recommendations that were identified during the FYR but do not affect protectiveness:

- Trespassing and vandalism are an ongoing nuisance for the property where the groundwater treatment system building is located. PADEP plans to dismantle the treatment system building in the near future. Wells found unlocked during the site visit should be secured. The lock on the access gate cut by the fire department should be replaced. PADEP and the property owner should explore additional security measures to ensure the integrity of any remaining remedy components, such as monitoring wells and extraction wells.
- The site repository did not include the complete administrative record for the Site. The site repository will be updated with OU1 and OU2 site documents.
- A risk assessment will be performed once groundwater cleanup goals are achieved to evaluate cumulative risk from multiple contaminants.

VII. PROTECTIVENESS STATEMENTS

Protectiveness Statements	
Operable Unit: OU1	*Protectiveness Determination:* Protective
Protectiveness Statement: The OU1 remedy is protective of human health and the environment. Connection of impacted homes and businesses to the public water supply eliminated direct exposure between contaminated groundwater and human receptors.	

Operable Unit: OU2	*Protectiveness Determination:* Short-term Protective
Protectiveness Statement: The OU2 remedy is protective of human health and the environment in the short term because there are no complete exposure pathways between groundwater and receptors that could result in unacceptable risk. Institutional controls are in place to restrict current and future use of groundwater for potable purposes. Contaminants in surface water are below surface water standards protective of human health and aquatic life. Groundwater monitoring continues on a regular basis. For the remedy to be protective over the long term, EPA will need to determine if an additional decision document is necessary following completion of pilot studies for MNA and ISB.	

Sitewide Protectiveness Statement
Protectiveness Determination: Short-term Protective
Protectiveness Statement: Because there are no complete exposure pathways between groundwater and receptors that could result in unacceptable risk, the Site is considered protective in the short term. For the remedy to be protective over the long term, EPA will need to determine if an additional decision document is necessary following completion of pilot studies for MNA and ISB.

VIII. NEXT REVIEW

The next FYR Report for the Site is required five years from the signature of this review.

APPENDIX A – REFERENCE LIST

Annual Operations and Maintenance Report, July 2013 – June 2014, Croydon TCE Site, Croydon, PA. Prepared by AECOM. September 12, 2014.

Explanation of Significant Differences, Croydon TCE Superfund Site, Operable Unit 2. Prepared by EPA Region 3. December 31, 1996.

Final Sampling and Operation & Maintenance, July 2015 – December 2015, Semi-Annual Report, Croydon TCE National Priorities List (NPL) Site, Bristol Township, Bucks County, Pennsylvania. Prepared by Baker/O'Brien & Gere Remediation Solutions Joint Venture. April 2016.

Five-Year Review Report, Croydon TCE Site, Bristol Township, Pennsylvania. Prepared by EPA Region 3. December 12, 2001.

Operational Summary – January 1, 2015 through May 31, 2015, Croydon TCE Site, Croydon, Pennsylvania. Prepared by AECOM. June 22, 2015.

Preliminary Close Out Report (Long Term Remedial Action), Croydon TCE Superfund Site, Bristol Township, Bucks County, Pennsylvania. Prepared by EPA Region 3. March 31, 1997.

Record of Decision, Croydon TCE Site, Bristol Township, Bucks County, Pennsylvania. Alternate Water Supply Operable Unit. Prepared by EPA Region 3. December 28, 1988.

Record of Decision, Croydon TCE Site, Bristol Township, Bucks County, Pennsylvania. Groundwater Operable Unit. Prepared by EPA Region 3. June 29, 1990.

Second Explanation of Significant Differences, Croydon TCE Superfund Site, Operable Unit 2. Prepared by EPA Region 3. September 23, 2011.

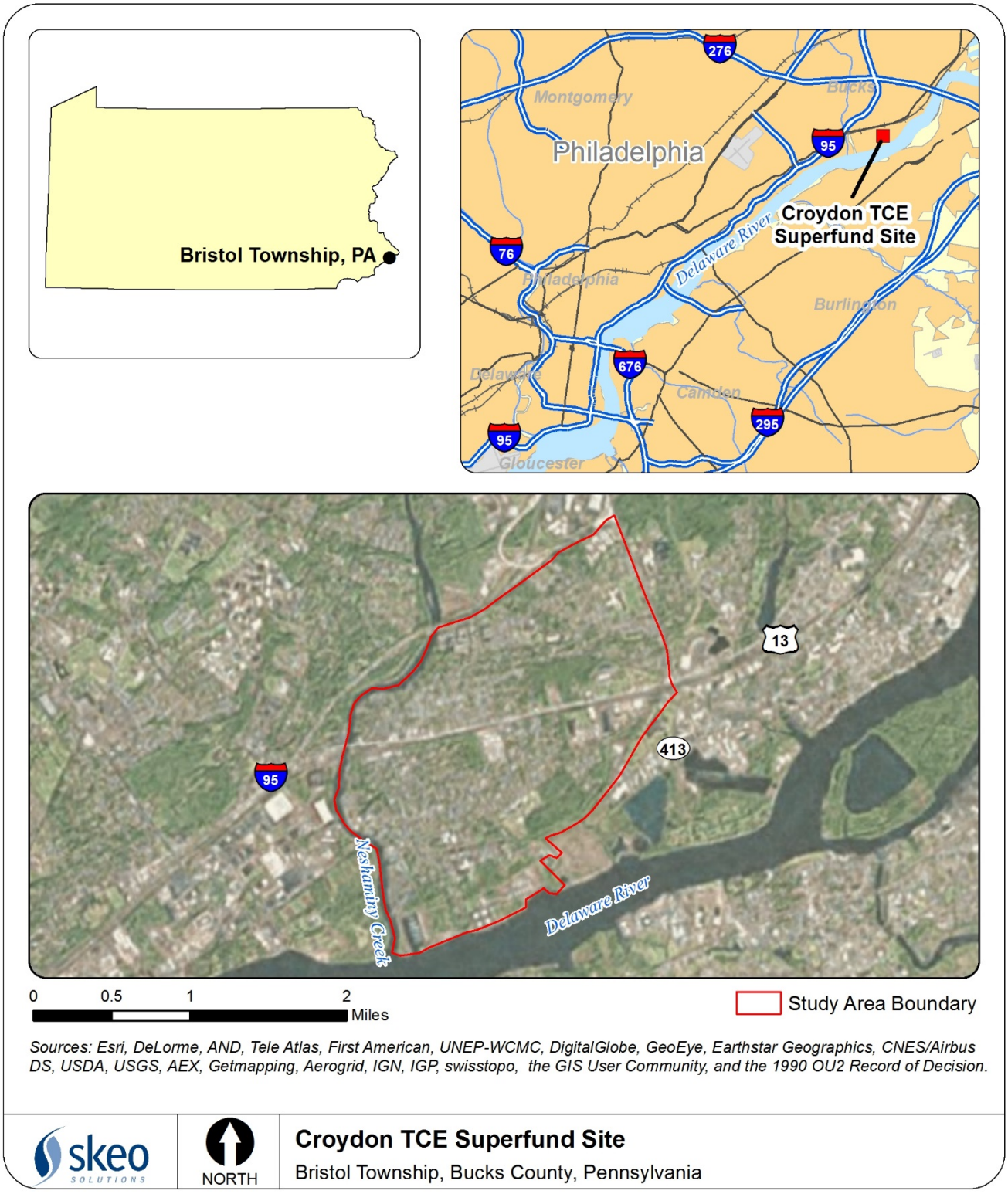
Second Five-Year Review Report, Croydon TCE Superfund Site, Bristol Township, Bucks County, Pennsylvania. Prepared by EPA Region 3. December 12, 2006.

Third Explanation of Significant Differences, Croydon TCE Superfund Site, Operable Unit 2. Prepared by EPA Region 3. September 9, 2015.

Third Five-Year Review Report, Croydon TCE Superfund Site. Prepared by EPA Region 3. December 7, 2011.

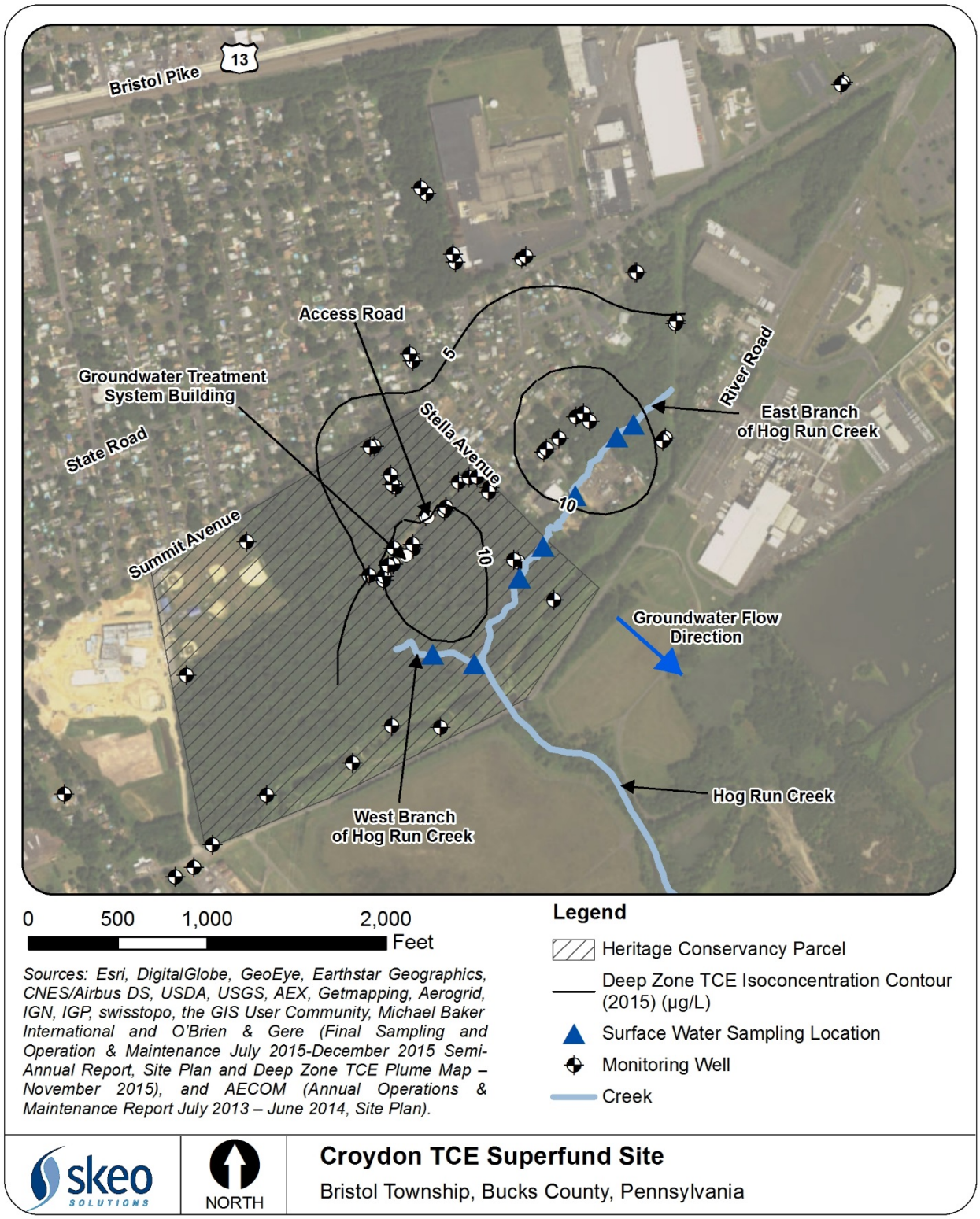
APPENDIX B – SITE FIGURES

Figure B-1: Site Vicinity Map



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site.

Figure B-2: Site Map



Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site.

Figure B-3: Institutional Control Base Map

0 500 1,000 2,000 Feet

Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, the GIS User Community, Michael Baker International and O'Brien & Gere (Final Sampling and Operation & Maintenance July 2015-December 2015 Semi-Annual Report, Site Plan and Deep Zone TCE Plume Map – November 2015), and Bucks County ArcGIS Viewer.

Legend

Parcel Boundary

Heritage Conservancy Parcel - 2013 Environmental Covenant in Place

Deep Zone TCE Isoconcentration Contour (2015) (µg/L)

A Bristol Township ordnance is in place that requires all properties within 150 feet of a water main be connected to public water. The ordnance also requires that private wells on properties connected to the public water supply may not be used for human consumption.

skeo SOLUTIONS

NORTH

Croydon TCE Superfund Site

Bristol Township, Bucks County, Pennsylvania

APPENDIX C – SITE CHRONOLOGY

Table C-1: Site Chronology

Event	Date
Site discovery	February 1, 1985
EPA site inspection	March 29, 1985
EPA proposed the Site for listing on the National Priorities List (NPL)	September 18, 1985
EPA listed the Site on the NPL	June 10, 1986
EPA began the operable unit (OU) 1 remedial investigation/feasibility study (RI/FS)	June 19, 1987
EPA began the OU2 RI/FS	September 29, 1988
EPA issued the OU1 Record of Decision (ROD), which called for provision of a waterline extension and service connections to the existing public water supply	December 28, 1988
EPA completed the RI/FS	December 29, 1988
EPA began the OU1 remedial design	April 20, 1989
EPA completed the OU1 remedial design	September 9, 1989
EPA began the OU1 remedial action	September 11, 1989
EPA began construction of the OU1 waterline	November 20, 1989
EPA completed a human health risk assessment (HHRA)	January 1, 1990
EPA completed the OU2 RI/FS and issued the OU2 ROD, which called for groundwater extraction and treatment	June 29, 1990
The Bristol Water and Sewage Department verified the OU1 waterline	July 12, 1990
EPA began the OU2 remedial design	September 20, 1990
EPA completed the OU1 remedial action	October 11, 1990
EPA completed the OU2 remedial design	September 25, 1991
EPA began the OU2 remedial action	September 30, 1991
EPA issued an Administrative Order on Consent	September 22, 1993
EPA completed a potentially responsible party (PRP) search; no viable PRPs were identified	October 15, 1993
EPA began construction of the OU2 groundwater extraction and treatment system	June 13, 1994
EPA completed construction of the OU2 groundwater extraction and treatment system	March 30, 1995
EPA considered the OU2 remedy operational and functional	November 21, 1995
EPA issued an Administrative Order on Consent	September 20, 1996
EPA issued an Explanation of Significant Differences (ESD) for the OU2 remedy to define the areal extent of the groundwater contaminant plume associated with the OU2 remedy	December 31, 1996
EPA issued the Site's Preliminary Close-Out Report, indicating that the construction phase of the remedy was complete	March 31, 1997
EPA issued the Site's first Five-Year Review (FYR) Report	December 12, 2001
EPA issued the Site's second FYR Report	December 12, 2006
EPA transferred operation and maintenance (O&M) responsibilities to the Pennsylvania Department of Environmental Protection (PADEP)	January 27, 2006
PADEP shut down the groundwater extraction and treatment system	March 23, 2009
EPA issued a second ESD for the OU2 remedy; the ESD changed groundwater cleanup goals to maximum contaminant levels (MCLs) and documented that groundwater is monitored by monitoring wells and not residential wells	September 23, 2011
EPA issued the Site's third FYR Report	December 7, 2011
PADEP contractor began a monitored natural attenuation (MNA) study	March 2014

Event	Date
EPA issued a third ESD for the OU2 remedy; the ESD formally discontinued extraction and treatment of groundwater and allowed for the dismantling of the groundwater extraction and treatment system	September 9, 2015

APPENDIX D – SITE BACKGROUND

D-1: History of Contamination

The U.S. Environmental Protection Agency (EPA) discovered the Site during an investigation of the adjacent Rohm and Haas facility in the early 1980s. The Rohm and Haas facility is located on the southern boundary of the Site's original 3.5-square-mile study area. Early investigations identified trichloroethylene (TCE) and other volatile organic compounds (VOCs) in monitoring wells and residential wells north of a Rohm and Haas landfill. The contamination was not considered part of the Rohm and Haas facility. Therefore, EPA proposed the Site for listing on the National Priorities List (NPL) on September 18, 1985, as a groundwater plume without an identified source. EPA listed the Site on the NPL on June 10, 1986.

In 1987, EPA and its contractor began a remedial investigation and feasibility study (RI/FS) to determine the nature and extent of contamination associated with the Site. Because the source of the contamination was unknown, EPA conducted the RI in two phases. Phase I focused on a 1.5-square-mile area of the town of Croydon. Results from Phase I identified a VOC groundwater plume in the southeastern portion of the study area. TCE was the primary chemical of concern (COC) and was detected at levels as high as 420 micrograms per liter (μg/L) in site groundwater monitoring wells, exceeding the federal maximum contaminant level (MCL) of 5 μg/L. TCE and other VOCs were also detected in residential wells above federal MCLs.

VOC contamination was detected in surface water in nearby tributaries and streams. The East and West Branches of Hog Run Creek originate in the area between River Road and State Road and join Hog Run Creek just north of River Road. Hog Run Creek then flows southward under River Road, between two Rohm and Haas landfills, and into the Delaware River. The Delaware River is the regional discharge point for groundwater and surface water. TCE concentrations of 6 μg/L and 1,1,1-trichloroethane (1,1,1-TCA) concentrations of 2.3 μg/L were detected in surface water samples from the East Branch of Hog Run Creek, and TCE concentrations of 0.4 μg/L were detected in samples from Hog Run Creek. The East Branch is located in the area where the highest concentrations of TCE and other related VOCs were detected in groundwater. The source of VOCs in the surface water was thought to be discharge of contaminated groundwater from the Site.

D-2: Physical Characteristics

The Site is located in a residential, commercial and industrial area in the southernmost portion of Bristol Township in Bucks County, Pennsylvania. The Site's study area is bordered by Interstate 95 to the north, the Delaware River to the south, Route 413 to the east and Neshaminy Creek to the west.

The Site consists of groundwater impacted by site-related contaminants, a water treatment facility, and extraction and monitoring wells that facilitate the remedy. The water treatment facility is housed in a brick building on land owned by the Heritage Conservancy. Access to the water treatment facility is via a gated access road off Stella Avenue.

The Site's geology consists of unconsolidated sand, gravel, silt and clay deposits overlying metamorphic bedrock. Total thickness of the unconsolidated deposits ranged from 29 to 69 feet in the study area. Groundwater occurs in both the unconsolidated deposits and in the underlying bedrock. Within the study area, groundwater was encountered at a depth of approximately 9 feet in the unconsolidated deposits. The two flow systems are not interconnected in the study area due to the presence of local clay layers and a substantial thickness of weathered bedrock (saprolite). Groundwater flow direction is generally to the southeast towards the Delaware River.

Hog Run Creek and its tributaries (i.e., East Branch and West Branch) are located within the focused area of investigation. The Site is located in the Delaware River Basin. On a regional and local basis, the Delaware River is the local discharge point for both groundwater and surface water.

A large variety of plant and animal species are found throughout the study area. Areas providing habitat include open fields, open water, woods and freshwater tidal marshes. The largest wooded area, owned by the Heritage Conservancy, is situated between State Road and River Road near Hog Run Creek and its tributaries. Tidal marshes are also present along the Delaware River.

APPENDIX E – PUBLIC NOTICE

EPA REVIEWS CLEANUP

Croydon TCE Superfund Site

The U.S. Environmental Protection Agency (EPA) is conducting a Five-Year Review of the Croydon TCE Superfund Site located in Bristol Township, Bucks County. EPA inspects sites regularly to ensure that cleanups conducted remain fully protective of public health and the environment. A prior review of the site in 2011 determined that the remedy was protective in the short-term, and that more testing was needed to make a long-term protectiveness determination. Since then, additional tests have been conducted indicating successful cleanup of groundwater. Detailed test results and a protectiveness determination will be available January 2017.

To access results of the review (starting January 2017):
http://epa.gov/5yr

To read detailed site and contact information:
http://go.usa.gov/xkQ7g

To ask questions or provide site information:
Contact: Alex Mandell **Phone**: 215-814-5517
Email: Mandell.alexander@epa.gov

Protecting public health and the environment

APPENDIX F – DATA REVIEW SUPPORTING INFORMATION

Appendix F-1: Groundwater Analytical Data – November 2015[5]

Table 2 - Groundwater and Blank Analytical Summary
Croydon TCE Site
November 2015 Sampling Event

Well ID	Sampling Date	Depth to Water	1,1,1-TCA	1,1-DCA	1,1-DCE	PCE	TCE	VC
CR-MW-5D	November 2015	21.61	ND	ND	ND	ND	**3.9**	ND
CR-MW-7D	November 2015	22.32	ND	ND	ND	ND	**3.3**	ND
CR-MW-8D	November 2015	13.75	ND	ND	ND	ND	**7.7**	ND
CR-18-30	November 2015	20.84	ND	ND	ND	ND	**1.8**	ND
CR-18-55	November 2015	20.84	ND	ND	ND	ND	**2.9**	ND
CR-19-15	November 2015	2.15	ND	ND	ND	**0.52**	**7.6**	ND
CR-19-37	November 2015	2.56	ND	ND	**0.72**	**0.66**	**12.2**	ND
CR-24-7	November 2015	2.47	ND	ND	ND	ND	**4.8**	ND
CR-24-15	November 2015	3.41	ND	**3.3**	**2.3**	ND	**7.4**	ND
CR-25-13	November 2015	4.62	ND	ND	**0.55**	ND	**5.9**	ND
CR-25-34	November 2015	4.11	ND	ND	ND	ND	**5.4**	ND
LF-13-18	November 2015	10.51	ND	ND	ND	ND	**2.4**	ND
LF-13-43	November 2015	9.33	ND	ND	ND	**0.89**	**7.7**	ND
LF-15-37	November 2015	9.95	ND	ND	ND	ND	**0.79**	ND
PZ-5-55	November 2015	21.11	ND	ND	ND	**0.73**	**7.6**	ND
OW-1	November 2015	4.37	ND	ND	ND	**0.63**	**4.6**	ND
OW-2	November 2015	9.11	ND	ND	ND	**0.61**	**8.3**	ND
OW-3	November 2015	7.55	ND	ND	**1.1**	**0.74**	**18.7**	ND
OW-4	November 2015	10.02	ND	ND	ND	**0.62**	**8.3**	ND
OW-5	November 2015	8.92	ND	ND	**0.59**	**0.81**	**10.7**	ND
OW-6	November 2015	9.25	ND	ND	ND	**0.69**	**6.3**	ND
OW-7	November 2015	9.49	ND	ND	ND	**0.78**	**6.5**	ND
OW-8	November 2015	5.15	ND	ND	ND	**0.94**	**12.1**	ND
OW-9	November 2015	4.41	ND	ND	**0.66**	**0.98**	**12.8**	ND
OW-10	November 2015	3.21	ND	ND	**0.82**	**0.82**	**14.0**	ND
OW-11	November 2015	5.71	ND	ND	**0.66**	**0.76**	**14.5**	ND

Croydon - FB1	November 2015	Field Blank	ND	ND	ND	ND	ND	ND
Croydon - FB2	November 2015	Field Blank	ND	ND	ND	ND	ND	ND
Croydon - FB3	November 2015	Field Blank	ND	ND	ND	ND	ND	ND
Croydon - FB4	November 2015	Field Blank	ND	ND	ND	ND	ND	ND

Notes:
S = Shallow well D = Deep well (DUP) = Duplicate sample
Only site constituents of concern are presented.
All concentrations are reported in micrograms per liter (µg/L).
Detections in **bold**
ND = Not detected
FB = Field Blank

[5] Source: Final Sampling and Operation & Maintenance July 2015 – December 2015 Semi-Annual Report, Croydon TCE NPL Site, prepared by Baker | O'Brien & Gere Remediation Solutions Joint Venture, dated April 2016.

Appendix F-2: Surface Water Analytical Data[6]

Table 5 - Surface Water and Blank Analytical Results
April 2006 through November 2015
Croydon TCE Site

Sample ID	Location*	Sample Date	1,1,1-TCA	1,1-DCA	1,1-DCE	PCE	TCE	Toluene	VC	cis-1,2-DCE	Methylene Chloride	Carbon-Disulfide	Chloro-benzene	Chloro-methane	Chloroform
SW-1	500 feet downstream of plant discharge	4/5/2006	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.6**	<0.1	<0.1	<0.1	<0.1
SW-1	500 feet downstream of plant discharge	3/7/2007	<0.1	<0.1	<0.1	<0.1	**0.1 J**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-1	500 feet downstream of plant discharge	9/12/2007	<0.1	<0.1	<0.1	<0.1	**0.1 J**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-1	500 feet downstream of plant discharge	3/4/2008	<0.1	<0.1	<0.1	**0.2 J**	**0.7**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.1 J**
SW-1	500 feet downstream of plant discharge	9/18/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-1	500 feet downstream of plant discharge	3/5/2009	<0.1	<0.1	<0.1	<0.1	**0.1 J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-1	500 feet downstream of plant discharge	9/2/2009	<0.1	<0.1	<0.1	**0.2 J**	**0.6**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.3 J**
SW-1	500 feet downstream of plant discharge	3/10/2010	<0.1	<0.1	<0.1	**0.1 J**	**0.6**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.2 J**
SW-1	500 feet downstream of plant discharge	9/14/2010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-1	500 feet downstream of plant discharge	3/30/2011	<0.1	<0.1	<0.1	**0.1 J**	**0.7**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.2 J**
SW-1	500 feet downstream of plant discharge	9/15/2011	<0.5	<0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-1	500 feet downstream of plant discharge	3/29/2012	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-1	500 feet downstream of plant discharge	9/26/2012	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-1	500 feet downstream of plant discharge	3/26/2013	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-1	500 feet downstream of plant discharge	9/24/2013	<0.5	<0.5	<0.5	<0.5	**1.5**	**0.55**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-1	500 feet downstream of plant discharge	3/27/2014	<0.5	<0.5	<0.5	<0.5	**1.4**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-1	500 feet downstream of plant discharge	9/17/2014	<0.5	<0.5	<0.5	**0.51**	**2.2**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-1	500 feet downstream of plant discharge	3/30/2015	<0.5	<0.5	<0.5	**<0.5**	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-1	500 feet downstream of plant discharge	12/4/2015	<0.5	<0.5	<0.5	<0.5	**0.61**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	4/5/2006	<0.1	<0.1	<0.1	**0.3 J**	**0.9**	<0.1	<0.1	**0.1 J**	**0.7**	<0.1	<0.1	<0.1	<0.1
SW-2	600 feet downstream of plant discharge	3/7/2007	<0.1	<0.1	<0.1	<0.1	**0.3 J**	**0.2 J**	<0.1	<0.1	<0.2	**0.2 J**	<0.1	**0.1 J**	**0.1 J**
SW-2	600 feet downstream of plant discharge	9/12/2007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-2	600 feet downstream of plant discharge	3/4/2008	<0.1	<0.1	<0.1	<0.1	**0.2 J**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.2 J**
SW-2	600 feet downstream of plant discharge	9/18/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-2	600 feet downstream of plant discharge	3/5/2009	<0.1	<0.1	<0.1	<0.1	**0.2 J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-2	600 feet downstream of plant discharge	9/2/2009	<0.1	<0.1	<0.1	**0.2 J**	**0.6**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.3 J**
SW-2	600 feet downstream of plant discharge	3/10/2010	<0.1	<0.1	<0.1	<0.1	**0.5 J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.2 J**
SW-2	600 feet downstream of plant discharge	9/14/2010	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2 J**	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-2	600 feet downstream of plant discharge	3/30/2011	<0.1	<0.1	<0.1	**0.1 J**	**0.5**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.2 J**
SW-2	600 feet downstream of plant discharge	9/15/2011	<0.5	<0.5	<0.5	<0.5	**0.98**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	3/29/2012	<0.5	<0.5	<0.5	<0.5	**0.85**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	9/26/2012	<0.5	<0.5	<0.5	<0.5	**0.72**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	3/26/2013	<0.5	<0.5	<0.5	<0.5	**0.74**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	9/24/2013	<0.5	<0.5	<0.5	<0.5	**1.3**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	3/27/2014	<0.5	<0.5	<0.5	<0.5	**1.7**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	9/17/2014	<0.5	<0.5	<0.5	<0.5	**1.0**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	3/30/2015	<0.5	<0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-2	600 feet downstream of plant discharge	12/4/2015	<0.5	<0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	4/5/2006	<0.1	<0.1	<0.1	<0.1	**0.9**	<0.1	<0.1	<0.1	**0.6**	<0.1	<0.1	<0.1	<0.1
SW-3	Hog Run Creek and Oak Avenue	3/7/2007	<0.1	<0.1	<0.1	<0.1	**1.1**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-3	Hog Run Creek and Oak Avenue	9/12/2007	<0.1	<0.1	<0.1	<0.1	**0.3 J**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.2 J**
SW-3	Hog Run Creek and Oak Avenue	3/4/2008	<0.1	<0.1	<0.1	<0.1	**0.8**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.2 J**
SW-3	Hog Run Creek and Oak Avenue	9/18/2008	<0.1	<0.1	<0.1	<0.1	**0.3J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-3	Hog Run Creek and Oak Avenue	3/5/2009	<0.1	<0.1	<0.1	<0.1	**1.0**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.3 J**
SW-3	Hog Run Creek and Oak Avenue	9/2/2009	<0.1	<0.1	<0.1	<0.1	**0.9**	<0.1	<0.1	**0.1 J**	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-3	Hog Run Creek and Oak Avenue	3/10/2010	<0.1	<0.1	<0.1	<0.1	**0.9**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-3	Hog Run Creek and Oak Avenue	9/14/2010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-3	Hog Run Creek and Oak Avenue	3/30/2011	<0.1	<0.1	<0.1	<0.1	**0.8**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.2 J**
SW-3	Hog Run Creek and Oak Avenue	9/15/2011	<0.5	<0.5	<0.5	<0.5	**0.98**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	3/29/2012	<0.5	<0.5	<0.5	<0.5	**2.3**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	9/26/2012	<0.5	<0.5	<0.5	<0.5	**0.57**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	3/26/2013	<0.5	<0.5	<0.5	<0.5	**0.66**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	9/24/2013	<0.5	<0.5	<0.5	<0.5	**0.92**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	3/27/2014	<0.5	<0.5	<0.5	<0.5	**1.0**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	9/17/2014	<0.5	<0.5	<0.5	<0.5	**0.59**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	3/30/2015	<0.5	<0.5	<0.5	<0.5	**0.98**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-3	Hog Run Creek and Oak Avenue	12/4/2015	<0.5	<0.5	<0.5	<0.5	**0.71**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

[6] Source: Final Sampling and Operation & Maintenance July 2015 – December 2015 Semi-Annual Report, Croydon TCE NPL Site, prepared by Baker | O'Brien & Gere Remediation Solutions Joint Venture, dated April 2016.

Table 5 - Surface Water and Blank Analytical Results
April 2006 through November 2015
Croydon TCE Site

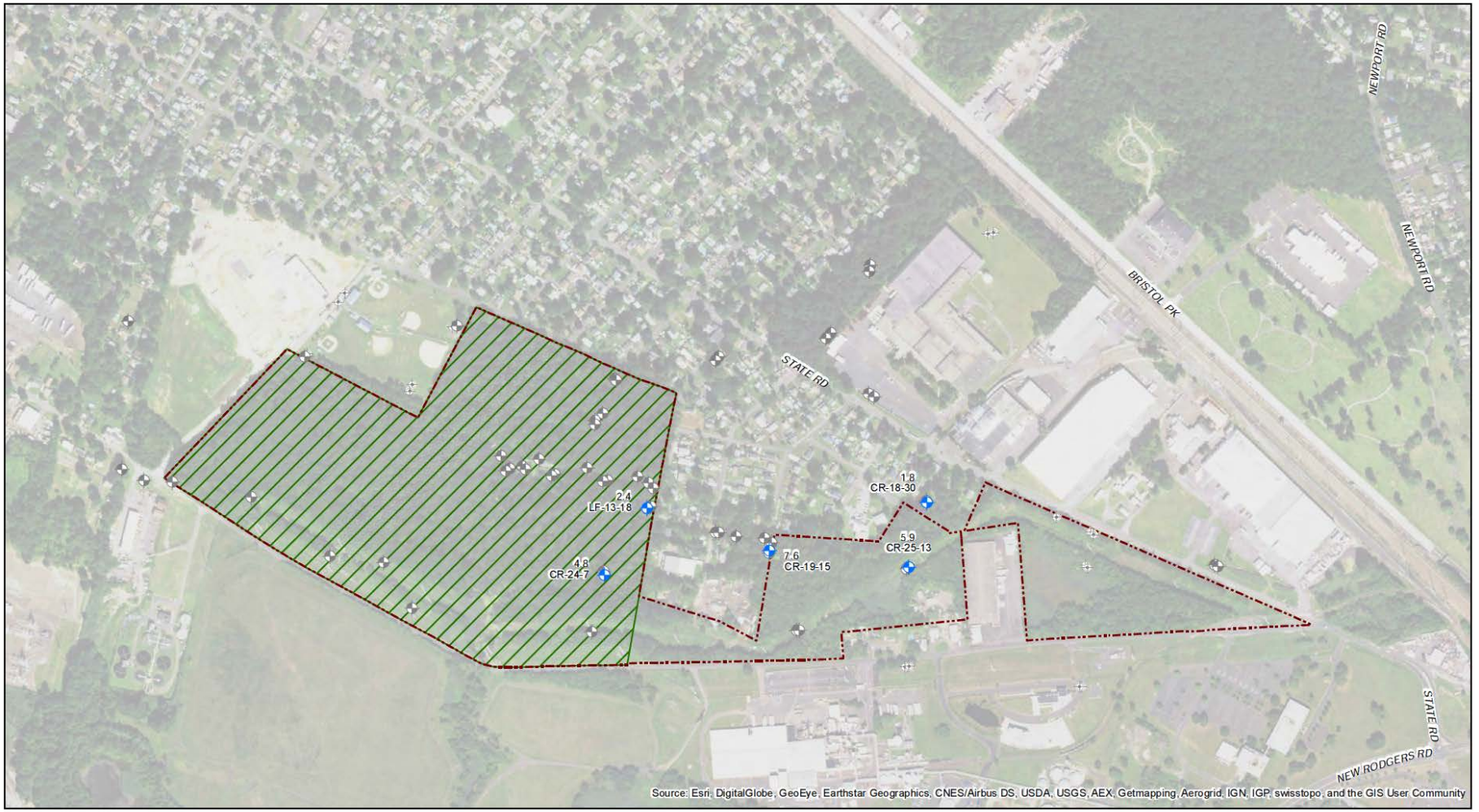
Sample ID	Location*	Sample Date	1,1,1-TCA	1,1-DCA	1,1-DCE	PCE	TCE	Toluene	VC	cis-1,2-DCE	Methylene Chloride	Carbon-Disulfide	Chloro-benzene	Chloro-methane	Chloroform
SW-4	500 feet ENE of EW-6	4/5/2006	<0.1	<0.1	<0.1	<0.1	**1.0**	<0.1	<0.1	<0.1	**0.6**	<0.1	<0.1	<0.1	<0.1
SW-4	500 feet ENE of EW-6	3/7/2007	<0.1	<0.1	<0.1	**0.1 J**	**1.4**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-4 (dup)	500 feet ENE of EW-6	3/7/2007	<0.1	<0.1	<0.1	<0.1	**1.1**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-4	500 feet ENE of EW-6	9/12/2007	<0.1	<0.1	<0.1	<0.1	**0.6**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.3 J**
SW-4 (dup)	500 feet ENE of EW-6	9/12/2007	<0.1	<0.1	<0.1	<0.1	**0.6**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.3 J**
SW-4	500 feet ENE of EW-6	3/4/2008	<0.1	<0.1	<0.1	**0.1 J**	**1.2**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.2 J**
SW-4	500 feet ENE of EW-6	9/18/2008	<0.1	<0.1	<0.1	<0.1	**0.4J**	<0.1	<0.1	**0.1J**	<0.2	<0.4	<0.1	<0.2	**0.1J**
SW-4 (dup)	500 feet ENE of EW-6	9/18/2008	<0.1	<0.1	<0.1	<0.1	**0.5J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1J**
SW-4	500 feet ENE of EW-6	3/5/2009	<0.1	<0.1	**0.1J**	**0.1J**	**1.6**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.4J**
SW-4 (dup)	500 feet ENE of EW-6	3/5/2009	<0.1	<0.1	<0.1	**0.1 J**	**1.4**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.3J**
SW-4	500 feet ENE of EW-6	9/2/2009	<0.1	<0.1	<0.1	<0.1	**0.9**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1J**
SW-4 (dup)	500 feet ENE of EW-6	9/2/2009	<0.1	<0.1	<0.1	<0.1	**0.9**	<0.1	<0.1	**0.1J**	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-4	500 feet ENE of EW-6	3/10/2010	<0.1	<0.1	<0.1	<0.1	**1.1**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1J**
SW-4 (dup)	500 feet ENE of EW-6	3/10/2010	<0.1	<0.1	<0.1	<0.1	**1.1**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-4	500 feet ENE of EW-6	9/14/2010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-4 (dup)	500 feet ENE of EW-6	9/14/2010	<0.1	<0.1	<0.1	<0.1	**0.1 J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-4	500 feet ENE of EW-6	3/30/2011	<0.1	<0.1	<0.1	<0.1	**0.5**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-4 (dup)	500 feet ENE of EW-6	3/30/2011	<0.1	<0.1	<0.1	<0.1	**0.6**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-4	500 feet ENE of EW-6	9/15/2011	<0.5	<0.5	<0.5	<0.5	**0.94**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4 (dup)	500 feet ENE of EW-6	9/15/2011	<0.5	<0.5	<0.5	<0.5	**0.92**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4	500 feet ENE of EW-6	3/29/2012	<0.5	<0.5	<0.5	<0.5	**1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4	500 feet ENE of EW-6	9/26/2012	<0.5	<0.5	<0.5	<0.5	**0.66**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4	500 feet ENE of EW-6	3/26/2013	<0.5	<0.5	<0.5	<0.5	**0.74**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4	500 feet ENE of EW-6	9/24/2013	<0.5	<0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4	500 feet ENE of EW-6	3/27/2014	<0.5	<0.5	<0.5	<0.5	**1.0**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4	500 feet ENE of EW-6	9/17/2014	<0.5	<0.5	<0.5	<0.5	**0.57**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4	500 feet ENE of EW-6	3/30/2015	<0.5	<0.5	<0.5	<0.5	**0.99**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-4	500 feet ENE of EW-6	12/4/2015	<0.5	<0.5	<0.5	<0.5	**0.83**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	3/7/2007	<0.1	<0.1	<0.1	**0.2 J**	**1.0**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-5	1000 feet downstream of plant discharge	9/12/2007	<0.1	<0.1	<0.1	<0.1	**0.3 J**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-5	1000 feet downstream of plant discharge	3/4/2008	**0.1 J**	<0.1	**0.2 J**	**0.3 J**	**2.5**	<0.1	<0.1	**0.1 J**	<0.2	<0.1	<0.1	<0.1	**0.4 J**
SW-5	1000 feet downstream of plant discharge	9/18/2008	<0.1	<0.1	<0.1	<0.1	**0.4J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-5	1000 feet downstream of plant discharge	3/5/2009	<0.1	<0.1	<0.1	**0.4 J**	**1.1**	<0.1	<0.1	**0.1 J**	<0.2	<0.4	<0.1	<0.2	**0.3 J**
SW-5	1000 feet downstream of plant discharge	9/2/2009	**0.1 J**	<0.1	**0.2 J**	**0.3 J**	**2.3**	<0.1	<0.1	**0.1 J**	<0.2	<0.4	<0.1	<0.2	**0.4 J**
SW-5	1000 feet downstream of plant discharge	3/10/2010	**<0.1**	<0.1	**<0.1**	**0.1 J**	**0.6**	<0.1	<0.1	**<0.1**	<0.2	<0.4	<0.1	<0.2	**0.2 J**
SW-5	1000 feet downstream of plant discharge	9/14/2010	<0.1	<0.1	<0.1	<0.1	**0.2 J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-5	1000 feet downstream of plant discharge	3/30/2011	<0.1	<0.1	<0.1	**0.2 J**	**1.1**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.2 J**
SW-5	1000 feet downstream of plant discharge	9/15/2011	<0.5	<0.5	<0.5	<0.5	**0.73**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	3/29/2012	<0.5	<0.5	<0.5	<0.5	**0.93**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	9/26/2012	<0.5	<0.5	<0.5	<0.5	**0.74**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	3/26/2013	<0.5	<0.5	<0.5	<0.5	**1.9**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	9/24/2013	<0.5	<0.5	<0.5	<0.5	**0.77**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	3/27/2014	<0.5	<0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	<0.5	<0.5	**2.0**	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	9/17/2014	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	3/30/2015	<0.5	<0.5	<0.5	<0.5	**0.67**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-5	1000 feet downstream of plant discharge	12/4/2015	<0.5	<0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	3/7/2007	<0.1	<0.1	<0.1	**0.2 J**	**1.1**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-6	1250 feet downstream of plant discharge	9/12/2007	<0.1	<0.1	<0.1	<0.1	**0.5 J**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-6	1250 feet downstream of plant discharge	3/4/2008	<0.1	<0.1	<0.1	**0.2 J**	**1.0**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.1 J**
SW-6	1250 feet downstream of plant discharge	9/18/2008	<0.1	<0.1	<0.1	<0.1	**0.4J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-6	1250 feet downstream of plant discharge	3/5/2009	<0.1	<0.1	<0.1	**0.5 J**	**1.2**	<0.1	<0.1	**0.2 J**	<0.2	<0.4	<0.1	<0.2	**0.3 J**
SW-6	1250 feet downstream of plant discharge	9/2/2009	<0.1	<0.1	<0.1	<0.1	**1.0**	<0.1	<0.1	**0.1 J**	<0.2	<0.4	<0.1	<0.2	**0.2 J**
SW-6	1250 feet downstream of plant discharge	3/10/2010	<0.1	<0.1	<0.1	**0.2 J**	**1.0**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-6	1250 feet downstream of plant discharge	9/14/2010	<0.1	<0.1	<0.1	<0.1	**0.3 J**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
SW-6	1250 feet downstream of plant discharge	3/30/2011	<0.1	<0.1	<0.1	**0.3 J**	**0.9**	<0.1	<0.1	**0.1 J**	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-6	1250 feet downstream of plant discharge	9/15/2011	<0.5	<0.5	<0.5	<0.5	**0.61**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	3/29/2012	<0.5	<0.5	<0.5	<0.5	**1.6**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	9/26/2012	<0.5	<0.5	<0.5	<0.5	**0.85**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	3/26/2013	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	9/24/2013	<0.5	<0.5	<0.5	<0.5	<0.5	**1.3**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	3/27/2014	<0.5	<0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	9/17/2014	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	3/30/2015	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-6	1250 feet downstream of plant discharge	12/4/2015	<0.5	<0.5	<0.5	**0.51**	**1.0**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Table 5 - Surface Water and Blank Analytical Results
April 2006 through November 2015
Croydon TCE Site

Sample ID	Location*	Sample Date	1,1,1-TCA	1,1-DCA	1,1-DCE	PCE	TCE	Toluene	VC	cis-1,2-DCE	Methylene Chloride	Carbon-Disulfide	Chloro-benzene	Chloro-methane	Chloroform
SW-7	200 feet northeast of SW-4	3/7/2007	<0.1	<0.1	**0.2 J**	**0.1 J**	**2.0**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
SW-7	200 feet northeast of SW-4	9/12/2007	<0.1	<0.1	**<0.1**	**<0.1**	**0.7**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.3 J**
SW-7	200 feet northeast of SW-4	3/21/2008	**0.1 J**	<0.1	**0.2 J**	**0.3 J**	**2.5**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.2 J**
SW-7 (dup)	200 feet northeast of SW-4	3/21/2008	<0.1	<0.1	**0.2 J**	**0.3 J**	**2.1**	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	**0.1 J**
SW-7	200 feet northeast of SW-4	9/18/2008	<0.1	<0.1	<0.1	<0.1	**0.6**	<0.1	<0.1	**0.1J**	<0.2	<0.4	<0.1	<0.2	**0.2J**
SW-7	200 feet northeast of SW-4	3/5/2009	<0.1	<0.1	<0.1	<0.1	**1.3**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.4J**
SW-7	200 feet northeast of SW-4	9/2/2009	<0.1	<0.1	<0.1	<0.1	**0.9**	<0.1	<0.1	**0.1 J**	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-7	200 feet northeast of SW-4	3/10/2010	<0.1	<0.1	<0.1	<0.1	**1.0**	<0.1	<0.1	**<0.1**	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-7	200 feet northeast of SW-4	9/14/2010	<0.1	<0.1	<0.1	<0.1	**0.1 J**	<0.1	<0.1	**<0.1**	<0.2	<0.4	<0.1	<0.2	**<0.1**
SW-7	200 feet northeast of SW-4	3/30/2011	<0.1	<0.1	<0.1	<0.1	**0.7**	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	**0.1 J**
SW-7	200 feet northeast of SW-4	9/15/2011	<0.5	<0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-7	200 feet northeast of SW-4	3/29/2012	<0.5	<0.5	<0.5	<0.5	**1.0**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-7	200 feet northeast of SW-4	9/26/2012	<0.5	<0.5	<0.5	<0.5	**1.2**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-7	200 feet northeast of SW-4	3/26/2013	<0.5	<0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-7	200 feet northeast of SW-4	9/24/2013	<0.5	<0.5	<0.5	<0.5	**2.6**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-7	200 feet northeast of SW-4	3/27/2014	<0.5	<0.5	<0.5	<0.5	**1.2**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.51**
SW-7	200 feet northeast of SW-4	3/27/2014	<0.5	<0.5	<0.5	<0.5	**1.2**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.51**
SW-7	200 feet northeast of SW-4	9/17/2014	<0.5	<0.5	<0.5	<0.5	**0.52**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-7	200 feet northeast of SW-4	3/30/2015	<0.5	<0.5	<0.5	<0.5	**1.30**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SW-7	200 feet northeast of SW-4	12/4/2015	<0.5	<0.5	<0.5	<0.5	**0.81**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-4	Field Blank	4/5/2006	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.9**	<0.1	**18**	<0.1	<0.1
FB-SW	Field Blank	3/7/2007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.3 J**	<0.1	<0.1	<0.1	<0.1
FB-1 (SW)	Field Blank	9/12/2007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**1.5**	<0.1	<0.1	<0.1	<0.1
FB-1 (SW)	Field Blank	3/4/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2 J**	<0.1	**0.3 J**	<0.1	<0.1	<0.1	<0.1
FB-3	Field Blank	3/5/2009	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
FB-SW	Field Blank	9/2/2009	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1 J**	<0.1	<0.1	**0.6**	<0.4	<0.1	<0.1	<0.1
FB-SW	Field Blank	3/10/2010	<0.1	<0.1	<0.1	<0.1	<0.1	**2.5**	<0.1	<0.1	**0.6**	<0.4	<0.1	<0.1	<0.1
FB-SW	Field Blank	9/14/2010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.3 J**	<0.4	<0.1	<0.2	<0.1
FB-SW	Field Blank	3/30/2011	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.3 J**	<0.4	<0.1	<0.2	<0.1
FB-SW	Field Blank	9/15/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-03	Field Blank	3/29/2012	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-02	Field Blank	3/29/2012	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-02	Field Blank	9/26/2012	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-02	Field Blank	3/27/2013	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-02	Field Blank	3/27/2013	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-04	Field Blank	3/27/2014	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-03	Field Blank	9/17/2014	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB-03	Field Blank	3/30/2015	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FB5	Field Blank	12/4/2015	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TB06088	Trip Blank	4/5/2006	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.6**	<0.1	<0.1	<0.1	<0.1
TB002	Trip Blank	3/7/2007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
TB-2	Trip Blank	9/12/2007	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
TB-1 (SW)	Trip Blank	3/4/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
TB (SW)	Trip Blank	9/18/2008	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.1	<0.1
TB -2	Trip Blank	3/4/2009	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.1	<0.1
TB -2	Trip Blank	9/2/2009	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.3 J**	<0.4	<0.1	<0.1	<0.1
TB -2	Trip Blank	3/10/2010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.1	<0.1
TB -1	Trip Blank	9/14/2010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.1	<0.2	<0.1
TB -01	Trip Blank	3/29/2011	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2 J**	<0.4	<0.1	<0.2	<0.1
Croydon TB	Trip Blank	9/13/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TB -2	Trip Blank	3/27/2013	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TB -01	Trip Blank	3/30/2015	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

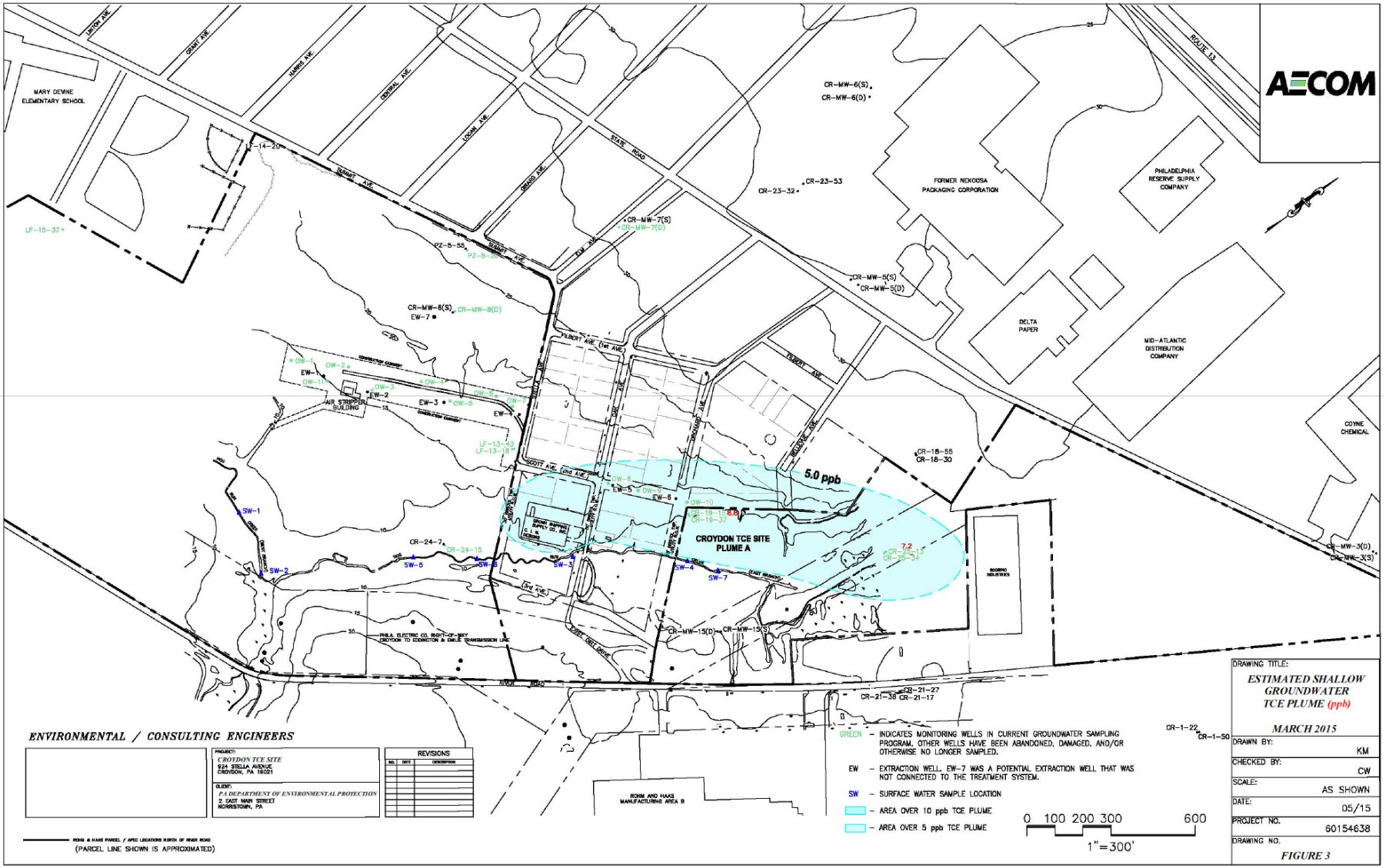
All concentrations reported in micrograms per liter (µg/L).
Detections ir **bold**
J = Estimated concentration
VOCs not listed here were not detected in any samples with the exception of acetone which was detected in the September 2009 SW-1 sample at 3.3 ug/l. Only detected site constituents of concern are listed for the field and trip blanks.
Acetone was also detected in SW-1 (3.5 ug/l), SW-2 (3.9 ug/l) and SW-3 (3.5 ug/l) during the September 2010 sampling event.
Acetone, benzene, 2-butanone, ethylbenzene, napthalene, 1,2,4/1,3,5-trimethylbenzene and xylene were detected in the March 2010 surface water field blank.
Xylene was detected in the March 2011 Field Blank.
Acetone (3.5 ug/l) was detected in SW-2 during the September 2011 sampling event.
Acetone was detected in SW-3 (4.3 ug/l) and SW-4 (2.9 ug/l)during the March 2012 sampling event.
Acetone was detected in SW-5 (3.4 ug/l) and SW-6 (2.9 ug/l) during the September 2013 sampling event.
Acetone was detected in SW-5 (4.3 ug/l) during the March 2014 sampling event.
Acetone was detected in SW-3 (2.7 ug/l) and SW-5 (6.7 ug/l) during the September 2014 sampling event.
Acetone was detected in SW-6 (3.5 ug/l) during the March 2015 sampling event.
TB = Trip Blank, FB = Field Blank, Dup =Duplicate Sample.
Only locations SW-1, SW-2, SW-3 and SW-4 were sampled on 4/5/06.
NS = The SW-1 location was dry during the March and September 2012 sampling events and therefore could not be sampled.
* Locations were measured along creek bank and wooded areas with measuring wheel and are approximate.

Appendix F-3: Shallow Zone TCE Detections – November 2015[7]



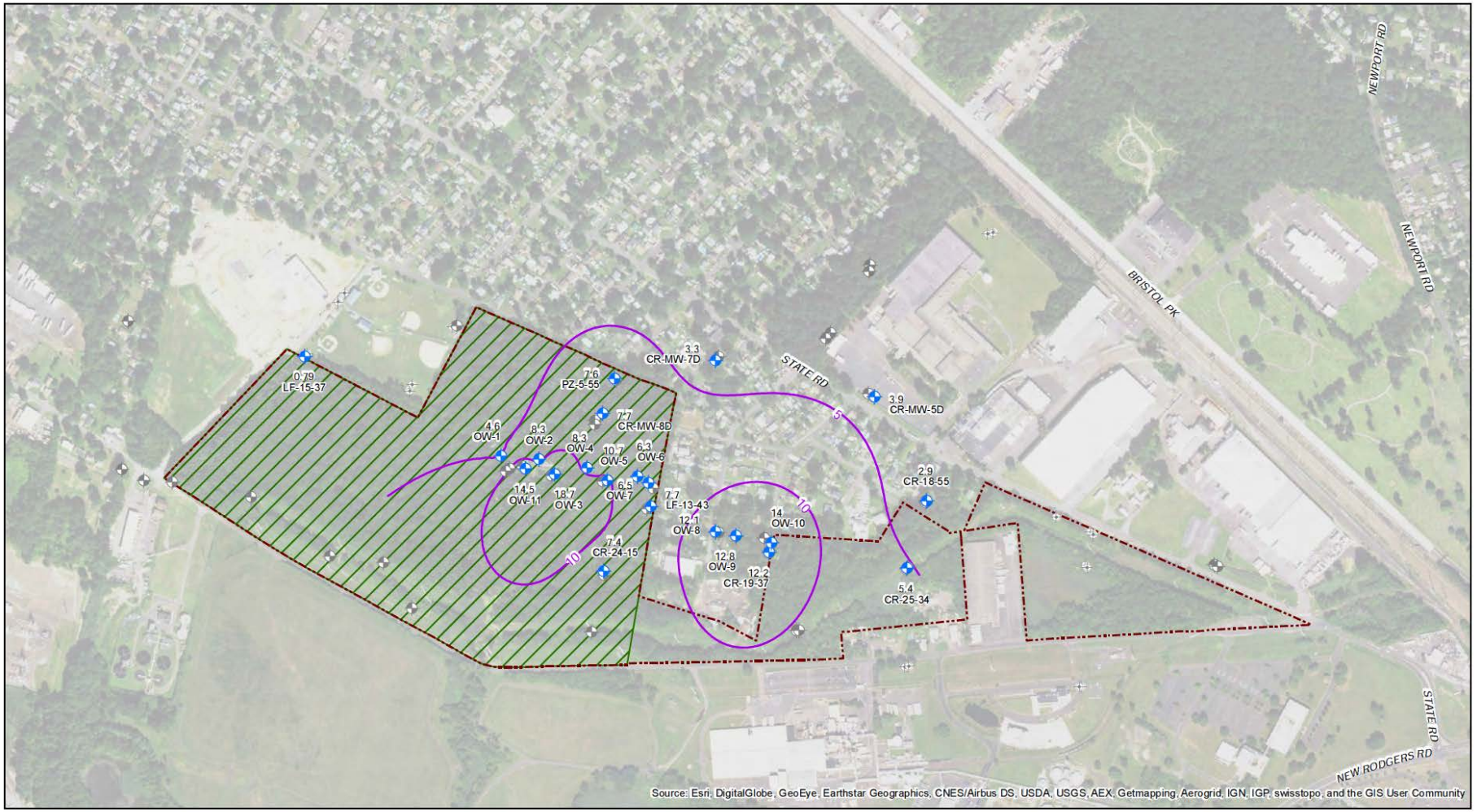
[7] Source: Final Sampling and Operation & Maintenance July 2015 – December 2015 Semi-Annual Report, Croydon TCE NPL Site, prepared by Baker | O'Brien & Gere Remediation Solutions Joint Venture, dated April 2016.

Appendix F-4: Shallow Zone TCE Plume – March 2015[8]



[8] Source: Croydon TCE Site, Croydon, PA, Operational Summary – January 1, 2015 through May 31, 2015, prepared by AECOM.

Appendix F-5: Deep Zone TCE Plume – November 2015[9]



LEGEND

- MONITORING WELL WITH TCE RESULT (µg/L; DEEP ZONE WELLS ONLY)
- MONITORING WELL (ROHM AND HAAS)
- TCE ISOCONCENTRATION CONTOUR (µg/L)
- SITE BOUNDARY
- HERITAGE CONSERVANCY PARCEL

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (PADEP)
CROYDON TCE SUPERFUND SITE
BRISTOL TOWNSHIP, PENNSYLVANIA

0 250 500 1,000 1,500 2,000
Feet

N

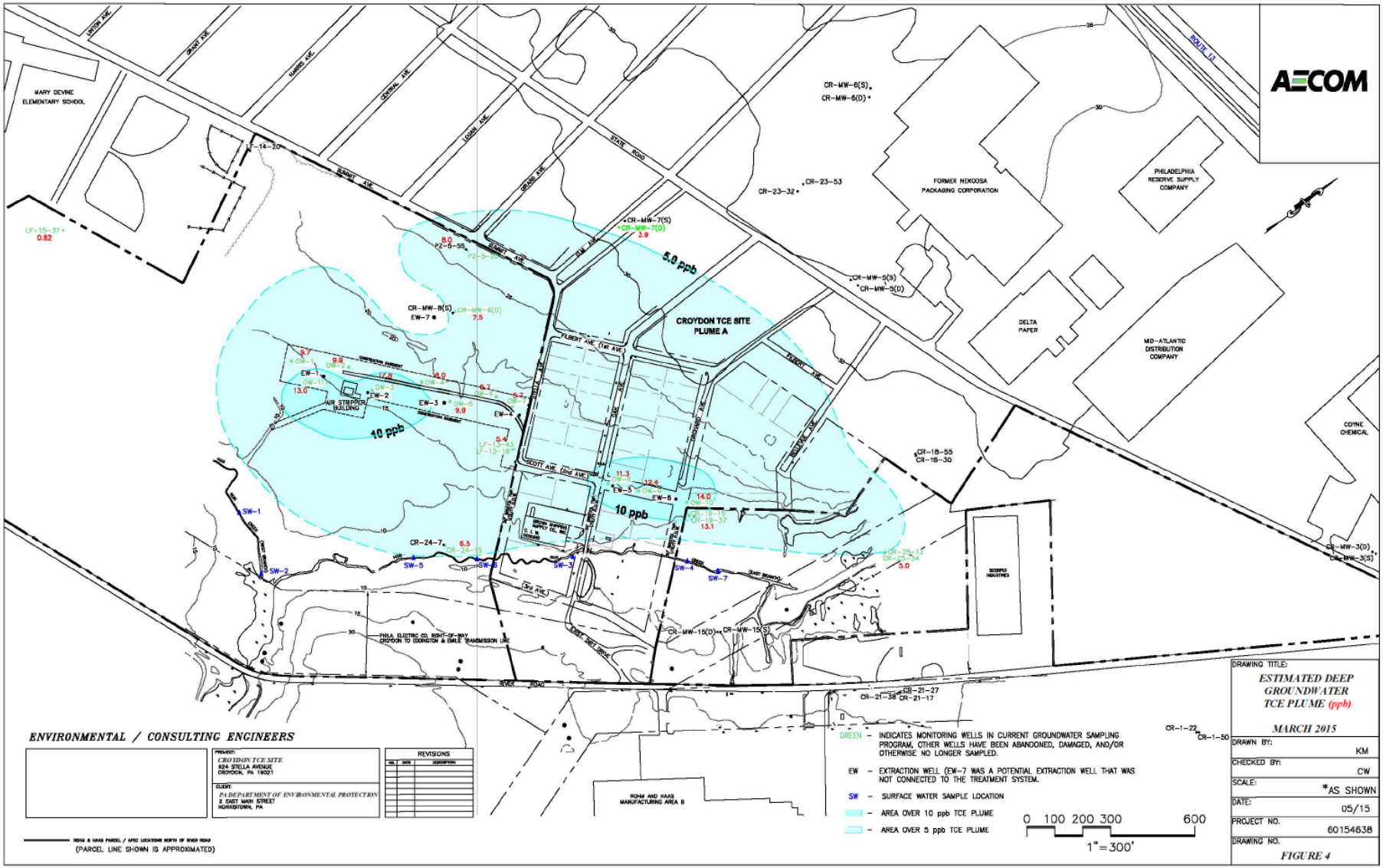
DEEP ZONE TCE PLUME
MAP - NOVEMBER 2015

2379/62167
MARCH 2016

Michael Baker INTERNATIONAL O'BRIEN & GERE
Baker | O'Brien & Gere Remediation Solutions Joint Venture

[9] Source: Final Sampling and Operation & Maintenance July 2015 – December 2015 Semi-Annual Report, Croydon TCE NPL Site, prepared by Baker | O'Brien & Gere Remediation Solutions Joint Venture, dated April 2016.

Appendix F-6: Deep Zone TCE Plume – March 2015[10]

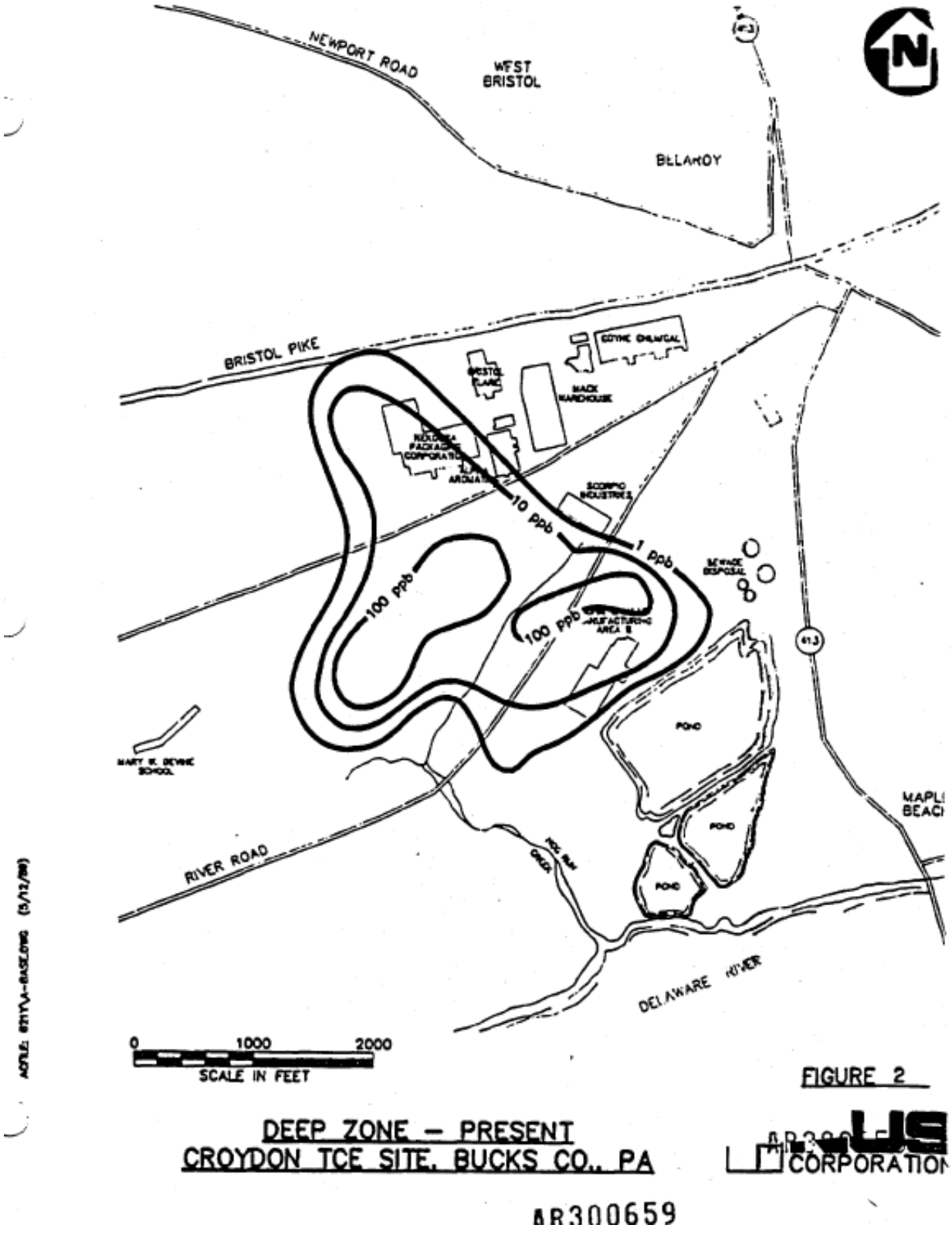


[10] Source: Croydon TCE Site, Croydon, PA, Operational Summary – January 1, 2015 through May 31, 2015, prepared by AECOM.

Appendix F-7: Deep Zone TCE Plume – March 2011[11]

[11] Source: Third FYR Report, prepared by EPA, December 2011.

Appendix F-8: Deep Zone TCE Plume – 1990[12]



[12] Source: Final Feasibility Study Report, Croydon TCE Site, Bucks County, Pennsylvania, dated January 1990, prepared by NUS Corporation.

APPENDIX G – SITE INSPECTION CHECKLIST

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

I. SITE INFORMATION

Site Name: Croydon TCE	**Date of Inspection:** 04/28/2016
Location and Region: Bristol Township, PA/Region 3	**EPA ID:** PAD981035009
Agency, Office or Company Leading the Five-Year Review: EPA Region 3	**Weather/Temperature:** Cloudy/50s

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pumping and treatment (no longer in operation)
- ☐ Surface water collection and treatment
- ☐ Other: _____
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (check all that apply)

1. **O&M Site Manager** _____ (Name) _____ (Title) _____ (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone: _____
   Problems, suggestions ☐ Report attached: _____

2. **O&M Staff** _____ (Name) _____ (Title) _____ (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone: _____
   Problems/suggestions ☐ Report attached: _____

3. **Local Regulatory Authorities and Response Agencies** (i.e., state and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices). Fill in all that apply.

   Agency _____
   Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone No.)
   Problems/suggestions ☐ Report attached: _____

   Agency _____
   Contact _____Name _____ (Title) _____ (Date) _____ (Phone No.)
   Problems/suggestions ☐ Report attached:_____

   Agency _____
   Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone No.)
   Problems/suggestions ☐ Report attached:_____

   Agency _____
   Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone No.)
   Problems/suggestions ☐ Report attached: _____

   Agency _____

	Contact Name _____	Title _____	Date _____	Phone No. _____	
	Problems/suggestions ☐ Report attached: _____				
4.	**Other Interviews** (optional) ☐ Report attached: _____				
	III. ON-SITE DOCUMENTS AND RECORDS VERIFIED (check all that apply)				
1.	**O&M Documents***				
	☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A	
	☒ As-built drawings	☒ Readily available	☒ Up to date	☐ N/A	
	☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: *O&M documents are no longer kept on site due to frequent break-ins and vandalism. They are readily available from the O&M contractor and PADEP.				
2.	**Site-Specific Health and Safety Plan***	☒ Readily available	☒ Up to date	☐ N/A	
	☐ Contingency plan/emergency response plan	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: *A Health and Safety Plan is available from the O&M contractor and PADEP.				
3.	**O&M and OSHA Training Records**	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				
4.	**Permits and Service Agreements**				
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Other permits: _____	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: The pump-and-treat system is no longer in operation; no effluent discharge occurs.				
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
7.	**Groundwater Monitoring Records**	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
9.	**Discharge Compliance Records**				
	☐ Air	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	☒ N/A	

Remarks: _____

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☒ Contractor for state

☐ PRP in-house ☐ Contractor for PRP

☐ Federal facility in-house ☐ Contractor for Federal facility

☐ _____

2. **O&M Cost Records**

☐ Readily available ☐ Up to date

☒ Funding mechanism/agreement in place ☒ Unavailable

Original O&M cost estimate: _____ ☐ Breakdown attached

Total annual cost by year for review period if available

From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached
From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached
From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached
From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached
From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached

Wi3. **Unanticipated or Unusually High O&M Costs during Review Period**

Describe costs and reasons: Additional costs were incurred to address frequent break-ins at the treatment system building; increased costs were also incurred for the ISB study.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing Damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks: The gate to the access road to the treatment system was unsecured. The local fire department had recently cut the lock to respond to a fire caused by trespassers. Fencing surrounding the treatment building is also damaged.

B. Other Access Restrictions

1. **Signs and Other Security Measures** ☐ Location shown on site map ☐ N/A

Remarks: No trespassing signs are posted throughout the wooded area where the groundwater treatment system is located. However, trespassing has occurred.

C. Institutional Controls (ICs)

1. **Implementation and Enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive by): drive by

Frequency: _____

Responsible party/agency: _____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Reporting is up to date ☐ Yes ☐ No ☒ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A

Violations have been reported ☐ Yes ☒ No ☐ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy*** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks: Institutional controls include a Bristol Township ordnance that requires connection of all properties within 150 feet of a water main to the public water supply. The ordnance also requires that any private well on properties connected to the public water supply may not be used for human consumption. An environmental covenant restricting residential use and use of groundwater has also been recorded for the Heritage Conservancy parcel with the Bucks County Recorder of Deeds office.

D. General

1. **Vandalism/Trespassing** ☐ Location shown on site map ☐ No vandalism evident

Remarks: PADEP reports that the treatment system has been vandalized on many occasions. The exterior of the treatment system building is covered in graffiti. The property owner reports that the property is used significantly by trespassers for off-road vehicle activities, campfires and other unauthorized activities.

2. **Land Use Changes On Site** ☐ N/A

Remarks: None. The groundwater treatment system is no longer in operation and the treatment system building has been secured shut to deter trespassing.

3. **Land Use Changes Off Site** ☐ N/A

Remarks: None

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads** ☒ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks: _____

B. Other Site Conditions

Remarks: Trash, evidence of campfires and other signs of trespassing are evident across the Site.

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

A. Landfill Surface

1. **Settlement** (low spots) ☐ Location shown on site map ☐ Settlement not evident

Arial extent: _____ Depth: _____

	Remarks: _____		
2.	**Cracks**	☐ Location shown on site map	☐ Cracking not evident
	Lengths: _____	Widths: _____	Depths: _____
	Remarks: _____		
3.	**Erosion**	☐ Location shown on site map	☐ Erosion not evident
	Arial extent: _____		Depth: _____
	Remarks: _____		
4.	**Holes**	☐ Location shown on site map	☐ Holes not evident
	Arial extent: _____		Depth: _____
	Remarks: _____		
5.	**Vegetative Cover**	☐ Grass	☐ Cover properly established
	☐ No signs of stress	☐ Trees/shrubs (indicate size and locations on a diagram)	
	Remarks: _____		
6.	**Alternative Cover** (e.g., armored rock, concrete)		☐ N/A
	Remarks: _____		
7.	**Bulges**	☐ Location shown on site map	☐ Bulges not evident
	Arial extent: _____		Height: _____
	Remarks: _____		
8.	**Wet Areas/Water Damage**	☐ Wet areas/water damage not evident	
	☐ Wet areas	☐ Location shown on site map	Arial extent: _____
	☐ Ponding	☐ Location shown on site map	Arial extent: _____
	☐ Seeps	☐ Location shown on site map	Arial extent: _____
	☐ Soft subgrade	☐ Location shown on site map	Arial extent: _____
	Remarks: _____		
9.	**Slope Instability**	☐ Slides	☐ Location shown on site map
	☐ No evidence of slope instability		
	Arial extent: _____		
	Remarks: _____		
B. Benches		☐ Applicable ☐ N/A	
	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		
1.	**Flows Bypass Bench**	☐ Location shown on site map	☐ N/A or okay
	Remarks: _____		
2.	**Bench Breached**	☐ Location shown on site map	☐ N/A or okay
	Remarks: _____		
3.	**Bench Overtopped**	☐ Location shown on site map	☐ N/A or okay

Remarks: _____

C. Letdown Channels ☐ Applicable ☐ N/A

(Channel lined with erosion control mats, riprap, grout bags or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ No evidence of settlement
   Arial extent: _____ Depth: _____
   Remarks: _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
   Material type:_____ Arial extent: _____
   Remarks: _____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
   Arial extent: _____ Depth: _____
   Remarks: _____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
   Arial extent: _____ Depth: _____
   Remarks: _____

5. **Obstructions** Type: _____ ☐ No obstructions
   ☐ Location shown on site map Arial extent: _____
   Size: _____
   Remarks: _____

6. **Excessive Vegetative Growth** Type: _____
   ☐ No evidence of excessive growth
   ☐ Vegetation in channels does not obstruct flow
   ☐ Location shown on site map Arial extent: _____
   Remarks: _____

D. Cover Penetrations ☐ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ☐ Passive
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
   Remarks: _____

2. **Gas Monitoring Probes**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
   Remarks: _____

3. **Monitoring Wells** (within surface area of landfill)
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

4. **Extraction Wells Leachate**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A

Remarks: _____

E. Gas Collection and Treatment ☐ Applicable ☐ N/A

1. **Gas Treatment Facilities**

☐ Flaring ☐ Thermal destruction ☐ Collection for reuse

☐ Good condition ☐ Needs maintenance

Remarks: _____

2. **Gas Collection Wells, Manifolds and Piping**

☐ Good condition ☐ Needs maintenance

Remarks: _____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)

☐ Good condition ☐ Needs maintenance ☐ N/A

Remarks: _____

F. Cover Drainage Layer ☐ Applicable ☐ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A

Remarks: _____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A

Remarks: _____

G. Detention/Sedimentation Ponds ☐ Applicable ☐ N/A

1. **Siltation** Area extent: _____ Depth: _____ ☐ N/A

☐ Siltation not evident

Remarks: _____

2. **Erosion** Area extent: _____ Depth: _____

☐ Erosion not evident

Remarks: _____

3. **Outlet Works** ☐ Functioning ☐ N/A

Remarks: _____

4. **Dam** ☐ Functioning ☐ N/A

Remarks: _____

H. Retaining Walls ☐ Applicable ☐ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident

Horizontal displacement: _____ Vertical displacement: _____

Rotational displacement: _____

Remarks: _____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident

Remarks: _____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☐ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident

Area extent: _____ Depth: _____

Remarks: _____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A

☐ Vegetation does not impede flow

Area extent: _____ Type: _____

Remarks: _____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident

Area extent: _____ Depth: _____

Remarks: _____

4. **Discharge Structure** ☐ Functioning ☐ N/A

Remarks: _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident

Area extent: _____ Depth: _____

Remarks: _____

2. **Performance Monitoring** Type of monitoring: _____

☐ Performance not monitored

Frequency: _____ ☐ Evidence of breaching

Head differential: _____

Remarks: _____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps and Pipelines ☐ Applicable ☒ N/A*

*The groundwater extraction wells are no longer in operation; electricity and water for the treatment system have been shut off.

1. **Pumps, Wellhead Plumbing and Electrical**

☐ Good condition ☐ All required wells properly operating ☐ Needs maintenance ☐ N/A

Remarks:_____

2. **Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances**

☐ Good condition ☐ Needs maintenance

Remarks: _____

3. **Spare Parts and Equipment**

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: _____

B. Surface Water Collection Structures, Pumps and Pipelines ☐ Applicable ☒ N/A

1. **Collection Structures, Pumps and Electrical**

☐ Good condition ☐ Needs maintenance

Remarks: _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes and Other Appurtenances**

☐ Good condition ☐ Needs maintenance

Remarks: _____

3. **Spare Parts and Equipment**

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: _____

C. Treatment System ☐ Applicable ☒ N/A*

*Active groundwater treatment is no longer occurring. The treatment system building has been secured to deter trespassing. The interior of the building was not inspected for this FYR.

1. **Treatment Train** (check components that apply)

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation

☐ Air stripping ☐ Carbon adsorbers

☐ Filters: _____

☐ Additive (e.g., chelation agent, flocculent): _____

☐ Others: _____

☐ Good condition ☐ Needs maintenance

☐ Sampling ports properly marked and functional

☐ Sampling/maintenance log displayed and up to date

☐ Equipment properly identified

☐ Quantity of groundwater treated annually: _____

☐ Quantity of surface water treated annually: _____

Remarks: _____

2. **Electrical Enclosures and Panels** (properly rated and functional)

☐ N/A ☐ Good condition ☐ Needs maintenance

Remarks: _____

3. **Tanks, Vaults, Storage Vessels**

☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs maintenance

Remarks: _____

4. **Discharge Structure and Appurtenances**

☐ N/A ☐ Good condition ☐ Needs maintenance

Remarks: _____

5. **Treatment Building(s)**

☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair

☐ Chemicals and equipment properly stored

Remarks: _____

6. **Monitoring Wells** (pump and treatment remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: _____

D. Monitoring Data

1. **Monitoring Data**

☒ Is routinely submitted on time ☒ Is of acceptable quality

2. **Monitoring Data Suggests:**

☐ Groundwater plume is effectively contained*

☐ Contaminant concentrations are declining*

*A determination will be made as part of this FYR.

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: _____

X. OTHER REMEDIES

If there are remedies applied at the site and not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is designed to accomplish (e.g., to contain contaminant plume, minimize infiltration and gas emissions).

The goals of the remedy are to prevent exposure to contaminated groundwater, prevent further migration of contaminated groundwater to uncontaminated areas, to restore the aquifer to MCLs and to reduce contaminant levels in the East Branch of Hog Run Creek. The initial stage of the remedy (OU1) included connection of affected properties to the public water supply. The second phase included groundwater extraction and treatment (OU2). The groundwater extraction and treatment system reduced TCE levels to below or just above MCLs across the Site. All other site-related contaminants were below MCLs. Because the system was showing diminishing returns, PADEP turned off the system in March 2009 to conduct a rebound test. The system has remained off since that time. Significant rebound has not occurred. EPA officially removed groundwater extraction and treatment as a remedy component in a 2015 ESD. PADEP is currently evaluating alternative groundwater remedies to reduce remaining contamination to acceptable levels. A pilot test for ISB is currently underway.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M procedures are adequate. PADEP's O&M contractor routinely monitors the Site to identify and address any problems associated with ongoing trespassing.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. PADEP is currently evaluating alternative groundwater remedies to reduce remaining contamination to acceptable levels. A pilot study for ISB is currently underway.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. PADEP is currently evaluating alternative groundwater remedies to reduce remaining contamination to acceptable levels. A pilot study for in-situ bioremediation is currently underway. Additional opportunities for optimization, including a potential reduction in sampling/frequency, will be evaluated pending the results of the pilot study.

Site Inspection Participants:

William Geiger, RPM, EPA Region 3
Alexander Mandell, CIC, EPA Region 3
Matthew Taynor, BTAG, EPA Region 3
Colin Wade, PADEP
Rebecca Flannery, PADEP
Tom Cornuet, O'Brien & Gere (PADEP contractor)
Rich Flack, Bucks County Board of Health
Jim Drennan, Heritage Conservancy (property owner representative)
Taylor Thompson, Heritage Conservancy (property owner representative)
Ryan Burdge, Skeo (EPA contractor)
Jill Billus, Skeo (EPA contractor)

APPENDIX H –SITE INSPECTION PHOTOS

Access road to the groundwater treatment system building

Private property sign on the Heritage Conservancy parcel

Fenced groundwater treatment system building

Former extraction well EW-1

West Branch of Hog Run Creek

Monitoring wells

Heritage Conservancy sign


View of access road looking toward gate at Stella Avenue

APPENDIX I – VAPOR INTRUSION SCREENING

OSWER VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Residential	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (°C)	Tgw	13.8	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ
127-18-4	Tetrachloroethylene	5.2E-01	2.01E-01	1.9E-08	4.8E-03
79-01-6	Trichloroethylene	7.6E+00	1.75E+00	**3.7E-06**	8.4E-01

Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator i
2.60E-07	I	4.00E-02	I	
see note	I	2.00E-03	I	TCE

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	26	ATnc_C_GW	25	Atnc_GW	26
Exposure duration	(yrs)	ED_R_GW	26	ED_C_GW	25	ED_GW	26
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	350
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	24

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Groundwater (-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas (-)	AFss_R_GW	0.03	AFss_C_GW	0.03	AFss_GW	0.03

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)
Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)
Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**

Trichloroethylene	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
	mIURTCE_R_GW	1.00E-06	mIURTCE_C_GW	0.00E+00	mIURTCE_GW	1.00E-06
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	3.10E-06

Mutagenic Chemicals — The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

Age Cohort	Exposure Duration	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 72 — This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride — See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:

I = IRIS: EPA Integrated Risk Information System (IRIS). Available online at: http://www.epa.gov/iris/subst/index.html
P = PPRTV. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at: http://hhpprtv.ornl.gov/pprtv.shtml
A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html
CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp
H = HEAST. EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml
S = See RSL User Guide, Section 5
X = PPRTV Appendix
Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).
VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).
TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).
Yellow highlighting indicates site-specific parameters that may be edited by the user.

APPENDIX J – ENVIRONMENTAL COVENANT

Prepared By: Rohm and Haas Company 3100 State Road Croydon, PA 19021 c/o Robert Casselberry **Return To:** Rohm and Haas Company 3100 State Road Croydon, PA 19021 c/o Robert Casselberry Phone: 215-785-7917 CPN Number: 05-053-052	For Recorder's Use Only RECEIVED 2013 MAR 21 P 12:51 BUCKS COUNTY RECORDER OF DEEDS

GRANTOR: **Rohm and Haas Company**
PROPERTY ADDRESS: **River Road, Bristol Township, Croydon, PA**

ENVIRONMENTAL COVENANT

This Environmental Covenant is executed on February 25, 2013 pursuant to the Pennsylvania Uniform Environmental Covenants Act, Act No. 68 of 2007, 27 Pa. C.S. §§ 6501 – 6517 (UECA). This Environmental Covenant subjects the Property identified in Paragraph 1 to the activity and/or use limitations in this document. As indicated later in this document, this Environmental Covenant has been approved by the Pennsylvania Department of Environmental Protection (Department).

1. Property affected. The property affected (Property) by this Environmental Covenant is located in Bristol Township, Bucks County.

The postal street address of the Property is: River Road, Croydon, Pennsylvania 19021.

The latitude and longitude of the center of the Property affected by this Environmental Covenant is: latitude 40 deg, 5 min, 14.316 sec/ longitude -74 deg, 53 min, 19.8702 sec.

The Property has been known by the following name(s): River Road North Parcel including Former Bucks County Mosquito Control Commission (BCMCC) Solid Waste Management Unit (SWMU), Pennsylvania Department of Environmental Protection primary facility ID No. 745672 (remediation ID No. 41340).

A legal description of the Property is attached to this Environmental Covenant as **Exhibit A**. Maps of the Property are attached to this Environmental Covenant as **Exhibit B**.

2. Property Owner / GRANTOR / GRANTEE. Rohm and Haas Company is the owner of the Property and the GRANTOR and GRANTEE of this Environmental Covenant.

3. The mailing address of the Owner is: Robert Casselberry, Dow Engineering Solutions, 3100 State Road, Croydon, Pennsylvania 19021.

4. Description of Contamination & Remedy

The River Road North (RRN) Parcel consists of approximately 80 acres of undeveloped land ("Croydon Woods") located north of the Rohm and Haas Bristol, PA Plant. The RRN Parcel has never been used by Rohm and Haas for any manufacturing purpose. The RRN Parcel does contain the a small parcel of ground which was formerly leased ground to the Bucks County Mosquito Control Commission (BCMCC) which was a division of the Bucks County Health Department. The BCMCC was active during the 1950s to early 1970s. The BCMCC leased ground was identified as a Solid Waste Management Unit (SWMU), in the Rohm and Haas Bristol Site's US EPA RCRA Corrective Action Order.

Rohm and Haas submitted to the Department an Act 2 Final Report for soil and groundwater at the RRN Parcel dated August 2012, and an Addendum to the Final Report dated January 7, 2013. The Final Report and Addendum characterized soil and groundwater quality at the RRN Parcel and demonstrated attainment of Act 2 standards as discussed below. The Department approved the Final Report and Addendum by letter dated January 16, 2013.

Soil Quality

Soil characterization of the RRN Parcel identified one area of concern: shallow soil in the former BCMCC SWMU exhibited 4,4-DDX[1] (4,4'-DDD, 4,4'-DDE, and 4,4'-DDT) concentrations exceeding Act 2 residential Statewide health standards (SHS). These impacted soils were excavated in 2011 and replaced with soil meeting PADEP Clean Fill requirements. During remediation of the BCMCC soils, a historical seepage pit was discovered, resulting in supplemental characterization of 4,4-DDX impacted subsurface saturated soils. Attainment of Act 2 standards for soil is summarized below.

Groundwater Quality

Volatile organic compounds [primarily trichloroethene (TCE)] historically present in groundwater in the eastern portion of the RRN Parcel have been remediated through the operation, by the U.S. Environmental Protection Agency (EPA)/PADEP, of a pump-and-treat system between 1996 and 2009 as part of the Croydon TCE Superfund Site. System operations were shutdown in March 2009 in favor of long-term monitoring. Groundwater quality was evaluated in the Act 2 Final Report by reviewing historical groundwater data collected over the past 10+ years by EPA/PADEP's contractor AECOM Technical Services (AECOM), as well by reviewing March 2002 data for some wells that were not regularly sampled by AECOM. Attainment of the site-specific standard (SSS) for groundwater is summarized below.

Attainment of Act 2 Standards

Attainment of the Act 2 residential SHS/SSS for soil, SSS for groundwater, and the SSS for the vapor intrusion pathway at the RRN Parcel have been demonstrated in the Act 2 Final Report and Addendum, as follows:

[1] DDD: dichlorodiphenyldichloroethane, DDE: dichlorodiphenyldichloroethylene, DDT: dichlorodiphenyltrichloroethane

- BCMCC Soils:
  - The excavated area of approximately 0.2 acres attained the SHS for DDX in soil based on post-excavation sampling results meeting the 75%/10x rule.
  - Saturated soils below the historical seepage pit meet the SSS for 4,4'-DDD and 4,4'-dichlorodiphenyltrichloroethane (4, 4'-DDT) by pathway elimination: (1) the environmental covenant will eliminate potential direct contact, and (2) hydropunch groundwater sampling in 2012 indicated the soil in question did not adversely impact groundwater.
- Groundwater: Attainment of the SSS equivalent to the highest groundwater concentration of the past 10+ years for two VOCs [39 µg/l of TCE and 6.6 µg/l of tetrachloroethene (PCE)] is demonstrated based on pathway elimination [fate and transport (F&T) analysis and ecological evaluation]. The remaining VOCs that are monitored in groundwater on a regular basis include 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, and vinyl chloride; these VOCs meet the SHS.
- Vapor Intrusion: The vapor intrusion pathway via soils and/or groundwater to indoor air is currently incomplete since there are no habitable buildings on the RRN Parcel.

5. **Activity & Use Limitations.**

The Property is subject to the following activity and use limitations, which the then current owner of the Property, and its tenants, agents, employees and other persons under its control, shall abide by:

- The Property conveyed hereby shall never be used for any form or type of residential structure whatsoever including by way of example, and not by way of limitation, single and multiple family dwellings, apartments, condominiums, modular homes, houses, trailers, schools, and day care centers.

- At the former seepage pit in the BCMCC area, clean soil extends to 9 feet below ground surface and provides a soil cap over the impacted soils that are below the former seepage pit. This soil cap shall be maintained and inspected annually. Notwithstanding anything to the contrary contained in this Paragraph 5, the soil cap over the former seepage pit in the BCMCC area may be temporarily disturbed to perform construction or utility installation or repair activities provided that the cap is repaired or replaced immediately following the completion of such construction activities. The details of any disturbance shall be summarized in the annual compliance report described in Paragraph 7 below.

- Groundwater Use: On-site groundwater shall not be used for potable, agricultural, or any other consumptive purposes unless groundwater quality conditions are re-evaluated under the provisions of Act 2 or the appropriate statute, and are shown to meet the applicable SHS as evidenced by written approval from PADEP.

- Vapor intrusion pathway is currently incomplete. Any future construction of occupied buildings in the area of the RRN Parcel formerly underlain by VOC-impacted groundwater must be preceded by an evaluation of the vapor intrusion pathway and installation of vapor barriers as necessary.

6. **Notice of Limitations in Future Conveyances**. Each instrument hereafter conveying any interest in the Property subject to this Environmental Covenant shall contain a notice of the activity and use limitations set forth in this Environmental Covenant and shall provide the recorded location of this Environmental Covenant.

7. **Compliance Reporting**. By the end of every January following the Department's approval of this Environmental Covenant, the current owner of the Property shall submit to the Department written documentation stating whether or not the activity and use limitations in this Environmental Covenant are being abided by. In addition, within 1 month after any of the following events, the current owner of the Property shall submit to the Department written documentation: noncompliance with the activity and use limitations in this Environmental Covenant; transfer of the Property; changes in use of the Property; or filing of applications for building permits for the Property and any proposals for any site work, if the building or proposed site work will affect the contamination on the Property subject to this Environmental Covenant.

8. **Access by the Department**. In addition to any rights already possessed by the Department, this Environmental Covenant grants to the Department a right of reasonable access of the Property in connection with implementation or enforcement of this Environmental Covenant.

9. **Recording & Proof & Notification**. Within 30 days after the date of the Department's approval of this Environmental Covenant, Rohm and Haas Company shall file this Environmental Covenant with the Recorder of Deeds for each County in which the Property is located, and send a file-stamped copy of this Environmental Covenant to the Department within 60 days of recording. Within that time period, Rohm and Haas Company also shall send a file-stamped copy to each of the following:

- Bristol Township;
- Bucks County;
- Each person holding a recorded interest in the Property;
- East person in possession of the Property; and
- Other persons as required by the Department.

10. **Termination or Modification**.

(a) This Environmental Covenant may only be terminated or modified in accordance with 27 Pa. C.S. §§ 6509 or 6510, or in accordance with this paragraph.

(b) This Environmental Covenant may be amended or terminated as to any portion of the Property that is acquired for use as state highway right-of-way by the Commonwealth provided that: (1) the Department waives the requirements for an environmental covenant and for conversion pursuant to 27 Pa. C.S. §6517 to the same extent that this Environmental Covenant is amended or terminated; (2) the Department determines that termination or modification of this Environmental Covenant will not adversely affect human health or the environment; and (3) the Department provides 30-days advance written notice to the current property owner, each holder, and, as practicable, each person that originally signed the Environmental Covenant or successors in interest to such persons.

(c) This Environmental Covenant shall terminate upon attainment, in accordance with 35 P.S. §§ 6026. 101 – 6026.908, with an unrestricted use remediation standard for the above-described contamination at the Property. The Department must approve, in writing, of such termination.

(d) In accordance with 27 Pa. C.S. § 6510(a)(3)(i), Grantor hereby waives the right to consent to any amendment or termination of the Environmental Covenant by consent; it being intended that any amendment to or termination of this Environmental Covenant by consent in accordance with this Paragraph requires only the following signatures on the instrument amending or terminating this Environmental Covenant: (i) the Holder at the time of such amendment or termination; (ii) the then current owner of the Property and (iii) the Department.

11. **Department's address**. Communications with the Department regarding this Environmental Covenant shall be sent to:

ECP Manager, Land Recycling Program
PADEP, Southeast Regional Office
2 East Main Street, Norristown, Pennsylvania 19401

ACKNOWLEDGMENTS by Owner and any Holder, in the following form:

Rohm and Haas Company, Grantor

Date: 2/25/13

By: _____

Name: Robert L. Casselberry Jr.

Title: Remediation Leader

APPROVED, by Commonwealth of Pennsylvania, Department of Environmental Protection

Date: 3/7/13

By: _____

Name: Stephan Sinding

Title: ECB Manager

COMMONWEALTH OF PENNSYLVANIA

COUNTY OF BUCKS

On this 25 day of February, ~~2012,~~ 2013 before me, the undersigned officer, personally appeared Robert Casselberry (Owner, Grantor, Grantee) who acknowledged himself to be the person whose name is subscribed to this Environmental Covenant, and acknowledged that he executed same for the purposes therein contained.

In witness whereof, I hereunto set my hand and official seal.

_____
Notary Public

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
COLLEEN M. HUGHES, Notary Public
Bristol Twp., Bucks County
My Commission Expires April 1, 2016

Property Owner: Rohm and Haas Company

Property Address: River Road

Bristol Township

Bucks County

APPROVED, by Commonwealth of Pennsylvania,

Department of Environmental Protection

Date: 3/7/13

By: _____

Name: Stephan Sinding

Title: Environmental Cleanup & Brownfields Program Manager

PA DEP - Southeast Regional Office

COMMONWEALTH OF PENNSYLVANIA

COUNTY OF MONTGOMERY

On this 7th day of March, 2013, before me, the undersigned officer, personally appeared Stephan Sinding, who acknowledged himself to be the Environmental Cleanup & Brownfields Manager of the Commonwealth of Pennsylvania, Department of Environmental Protection, Southeast Regional Office, whose name is subscribed to this Environmental Covenant, and acknowledged that he executed same for the purposes therein contained.

In witness whereof, I hereunto set my hand and official seal.

_____

Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Judy Lashley, Notary Public
Norristown Boro, Montgomery County
My Commission Expires July 28, 2016
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES