THIRD FIVE-YEAR REVIEW REPORT FOR
BOARHEAD FARMS SUPERFUND SITE
BUCKS COUNTY, PENNSYLVANIA

Prepared by

U.S. Environmental Protection Agency
Region 3
Philadelphia, Pennsylvania

Karen Melvin

Karen Melvin, Director
Hazardous Site Cleanup Division

SEP 25 2017

Date

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LIST OF ABBREVIATIONS & ACRONYMS

AOC	Administrative Order on Consent
ARAR	Applicable or relevant and appropriate requirement
BTEX	Benzene, toluene, ethylbenzene, xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of concern
DCC	Derewal Chemical Company
DCE	Dichloroethene
DMR	Discharge Monitoring Report
EE/CA	Engineering Evaluation/Cost Analysis
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FS	Feasibility Study
FYR	Five-Year Review
GAC	Granular activated carbon
GPRA	Government Performance and Results Act
HRS	Hazard Ranking System
IC	Institutional control
LTMP	Long-Term Monitoring and Quality Assurance Plan
MCL	Maximum Contaminant Level
µg/m³	Micrograms per cubic meter
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and maintenance
OU	Operable unit
PA	Preliminary Assessment
PADEP	Pennsylvania Department of Environmental Protection
PCE	Tetrachloroethene (also tetrachloroethylene or perchloroethylene)
PCOR	Preliminary Closeout Report
PRP	Potentially Responsible Party
PVC	Polyvinyl chloride
RAO	Remedial action objective
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RSL	EPA Regional Screening Level
SI	Site Inspection
SWRAU	Site-Wide Ready for Anticipated Use
TBC	To-Be-Considered
TCA	Trichloroethane
TCE	Trichloroethene (also trichloroethylene)
VOCs	Volatile organic compounds

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Boarhead Farms Superfund Site		
EPA ID: PAD047726161		
Region: 3	**State:** PA	**City/County:** Bridgeton 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 (Federal or State Project Manager): Christopher Sklaney
Author affiliation: EPA Region 3
Review period: September 2016 through September 2017
Date of site inspection: 5/16/2017
Type of review: Statutory
Review number: 3
Triggering action date: 9/27/2012
Due date: 9/27/2017

I. INTRODUCTION

The purpose of a Five-Year Review ("FYR") is to evaluate the implementation and performance of a remedial response action, or remedy, where hazardous substances or pollutants and contaminants remain at a site above levels that allow for unlimited use and unrestricted exposure in order to determine if the remedy is and will continue to be protective of human health and the environment. FYR reports identify actual or potential issues found during review of the remedy and present recommendations to address the issues. 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 third FYR for the Boarhead Farms Superfund Site ("Site"). The triggering action for this statutory review is the signature date of the previous FYR Report.

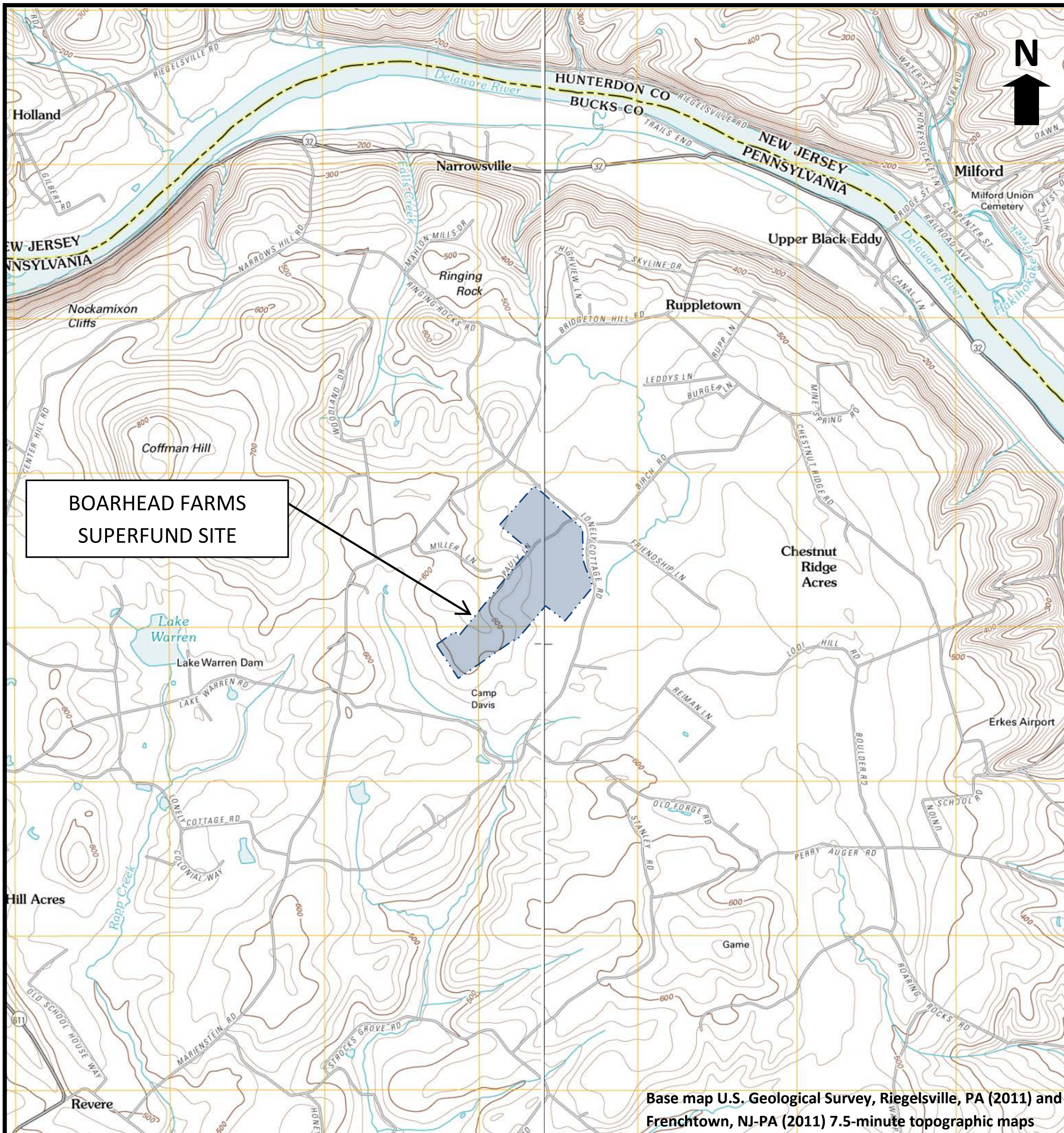
The Site consists of two operable units ("OUs"), and both OUs will be addressed in this FYR. OU-1 includes operation of a groundwater collection and treatment system, monitoring of contaminated groundwater, and maintenance of filtration units on residential wells. OU-2 includes cleanup of contaminated soils, excavation and removal of containers of hazardous waste, and implementation of institutational controls ("ICs").

EPA conducted this FYR from September 2016 to September 2017. The FYR was led by Christopher Sklaney, EPA Region 3 Remedial Project Manager ("RPM"). Participants included Nathan Doyle (EPA Region 3 Hydrogeologist), Nancy Rios-Jafolla (EPA Region 3 Toxicologist), Bruce Pluta (EPA Region 3 Biologist), Alex Mandell (EPA Region 3 Community Involvement Coordinator), and Michael Hendershot (EPA Region 3 Attorney). The Pennsylvania Department of Environmental Protection ("PADEP"), as the support agency representing the Commonwealth of Pennsylvania, provided input to EPA during the review process. The group of potentially responsible parties ("PRPs") implementing the remedy under consent decrees with the United States, including Cytec Industries, Inc., Ford Motor Company, SPS Technologies, LLC, and TI Group Automotive Systems, LLC were notified of the initiation of the FYR through their designated consultant, de maximis, inc. ("de maximis"). de maximis coordinates and oversees Site activities on behalf of the PRPs.

Site Location and Description

The Site consists of approximately 124 acres of land currently owned by Boarhead Corporation (Bucks County Parcel Nos. 03-003-026 and 03-002-007) and located in Bridgeton Township, Bucks County, Pennsylvania, southwest of the intersection of Lonely Cottage Road and Birch Road (Figure 1). Access to the Site by vehicle is obtained solely through an unpaved road located an estimated 2,000 feet south of the intersection of Lonely Cottage Road and Bridgton Hill Road. A single-family residence (often "farmhouse" in site records and referred to herein as the "Site Residence"), livestock stable, and a building containing the groundwater treatment system are located on the Site. A commercial storage building and a cellular phone tower are present west of the Site Residence. The majority of the Site is forested, and the surrounding area is comprised primarily of residential, rural properties. The eastern portion of the Site is comprised predominantly of wooded wetlands. Lonely Cottage Road forms the eastern boundary of the Site. The remaining boundaries of the Site are located in the nearby forested areas and are not well-defined by physical features. No man-made restrictions to access exist. Notable site features are shown on Figure 2.

The Site Residence is located over a cut-stone, loosely mortared foundation that is believed to have been constructed in the late 18th or 19th century, and may be the remnants of a root cellar. The above-ground portion of the structure extends beyond the footprint of the basement in all directions. A spring enters the basement in the western corner and is connected to a sump located in the southern corner through a trench drain. A second sump located in the north corner does not appear to be connected to the spring. Pumps in both sumps prevent groundwater accumulation in the basement. Staining on the basement walls indicates that water may seasonally rise as high as approximately 2 feet above the floor if not regularly pumped out. The basement is separated from the upper floors by floor doors and is not currently used as a living space. A sketch of basement features is presented on Figure 3.



SITE LOCATION MAP

BOARHEAD FARMS
BRIDGETON TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA
(MAP SCALE 1:37,000)

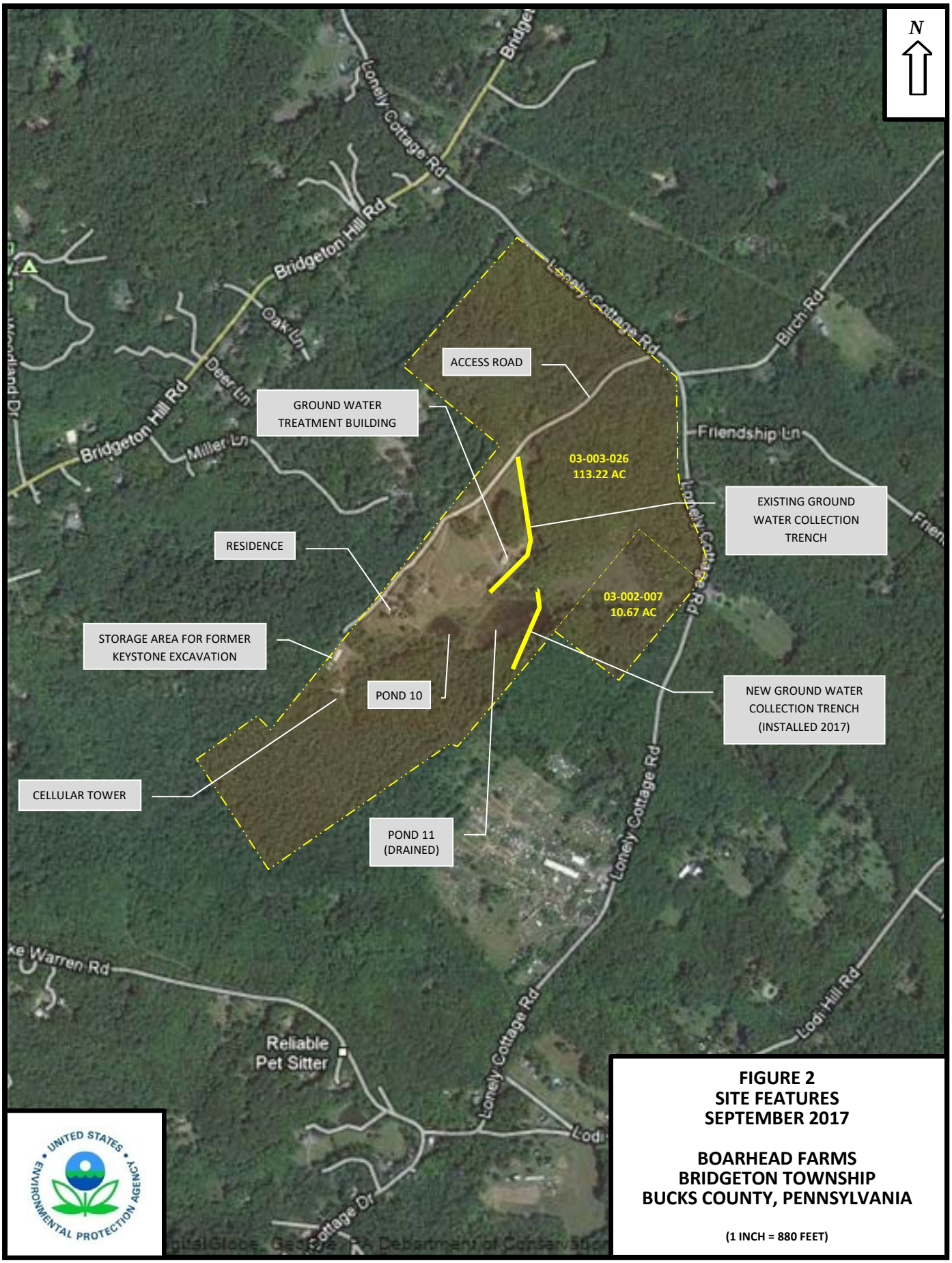


FIGURE 2
SITE FEATURES
SEPTEMBER 2017

BOARHEAD FARMS
BRIDGETON TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

(1 INCH = 880 FEET)

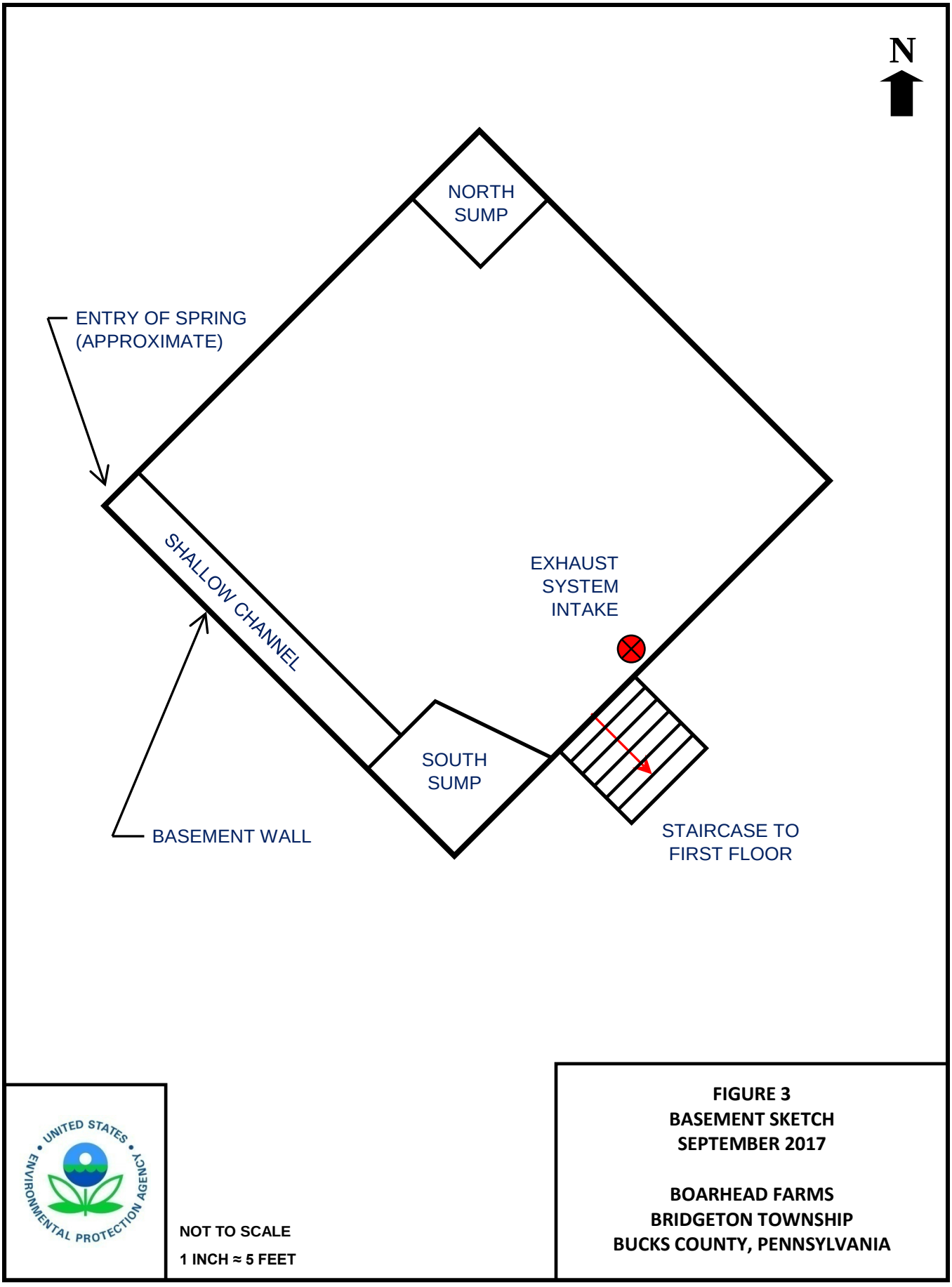


FIGURE 3
BASEMENT SKETCH
SEPTEMBER 2017

BOARHEAD FARMS
BRIDGETON TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

The Site is located near the eastern edge of a prominent regional upland area underlain by diabase, a medium- to coarse-grained, dark-gray, extremely hard crystalline igneous rock. Boreholes drilled near the Site indicate the diabase ranges from approximately 275 to 570 feet thick, generally thinning toward the east. Underlying the diabase are red and reddish-gray siltstones and shales of the Brunswick Formation. The diabase is covered by a thin sheath of clay-rich soil identified no thicker than 14 feet at the Site. Test boreholes drilled at the Site indicate that a saprolite with a texture of fine to medium sand and no more than 2 feet thick is present locally as a transition between the diabase and soil.

Two primary aquifer systems are present at the Site. The uppermost aquifer is the diabase, with most of the available groundwater located within approximately 50 feet of the ground surface. The fracture systems of this aquifer are of limited extent and locally filled with clay. Aquifer tests conducted at the Site indicate the saprolite is typically the most transmissive zone for groundwater. The clay-rich soils overlying the diabase serve as a partial confining layer. Both the quantity of fractures and degree of interconnection in the diabase decreases below 30 feet, and the absence of secondary openings in the lower portion of the diabase generally restricts downward movement between the upper diabase aquifer and underlying sedimentary rock aquifer. Wells completed in the sedimentary rock are expected, on average, to provide greater yields than those in diabase and are predominantly used near the Site as a source of potable water.

Site Background

The larger of the two land parcels comprising the Site (Parcel 03-003-26), where all known releases of hazardous substances occurred, was purchased by the Boarhead Corporation in 1969. The second parcel (Parcel 03-002-007) was purchased in 1978. Boarhead Corporation and DeRewal Chemical Company ("DCC") were incorporated by the president and sole share-holder of both companies at the time, Mr. Manfred T. DeRewal. DCC, a chemical transport company, established its office at the Boarhead Site in 1969. Available records suggest that hazardous substances were not stored, used, or released at the Site prior to purchase by Boarhead Corporation.

Mr. DeRewal was the president of Echo, Inc. prior to establishing Boarhead Corporation and operated the Revere Chemical Company in Revere, Bucks County, Pennsylvania from 1965 to 1969. The Revere Chemical Company was ordered to close in 1970 by the Pennsylvania Department of Environmental Resources (now PADEP) due to numerous pollution violations. During legal proceedings related to the Revere Chemical Company site, Mr. DeRewal claimed that he moved 260,000 gallons of liquid waste from Revere between July 1970 and August 1970. Mr. DeRewal was unable to produce any documentation regarding the disposal of this liquid waste. The Revere Chemical Site is located approximately four miles from the Site.

Between February 20, 1973, and July 30, 1976, the Bucks County Department of Health filed more than 15 Waste Discharge Inspection Reports at or near the Site. These reports cited several fish kills, incidents of improperly stored chemicals, releases of liquid chemicals in excess of 4,000 gallons on several occasions, sewage sludge dumping in excess of 6,000 pounds, and several violations of the Pennsylvania Clean Streams Law. Inspectors believed that drums were possibly being buried on the Site.

On March 29, 1976, Mr. DeRewal and the Boarhead Corporation were found guilty of nine separate violations of the Pennsylvania Clean Streams Law. On September 8, 1976, 34 residents from neighboring properties were temporarily evacuated due to the generation of a sulfuric acid mist from a leaking tanker trailer parked on the Site. In October 1976, a Bucks County court issued an order prohibiting all hazardous substances in quantities greater than those appropriate for typical household use from entering the Site and requiring all hazardous substances stored on the Site to be removed within 7 days.

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

In 1985 and 1986, EPA conducted a Preliminary Assessment ("PA") and Site Inspection ("SI"), or PA/SI, to assess releases of hazardous substances that occurred at the Site. Based on the findings of the PA/SI, EPA ranked the release pursuant to the Hazard Ranking System ("HRS"), and on March 31, 1989, added the Site to the National Priorities List ("NPL"). The inclusion of the Site on the NPL established the basis for evaluation of the releases for long-term remedial evaluation and response.

In December 1989, EPA began a Remedial Investigation ("RI") and Feasibility Study ("FS"), or RI/FS, to determine the nature and extent of contamination and evaluate cleanup alternatives. During the RI, surface geophysical investigations identified numerous burial areas throughout the central portion of the Site suspected to contain hazardous wastes. The identification of potential for buried wastes formed the basis for initiating removal response actions.

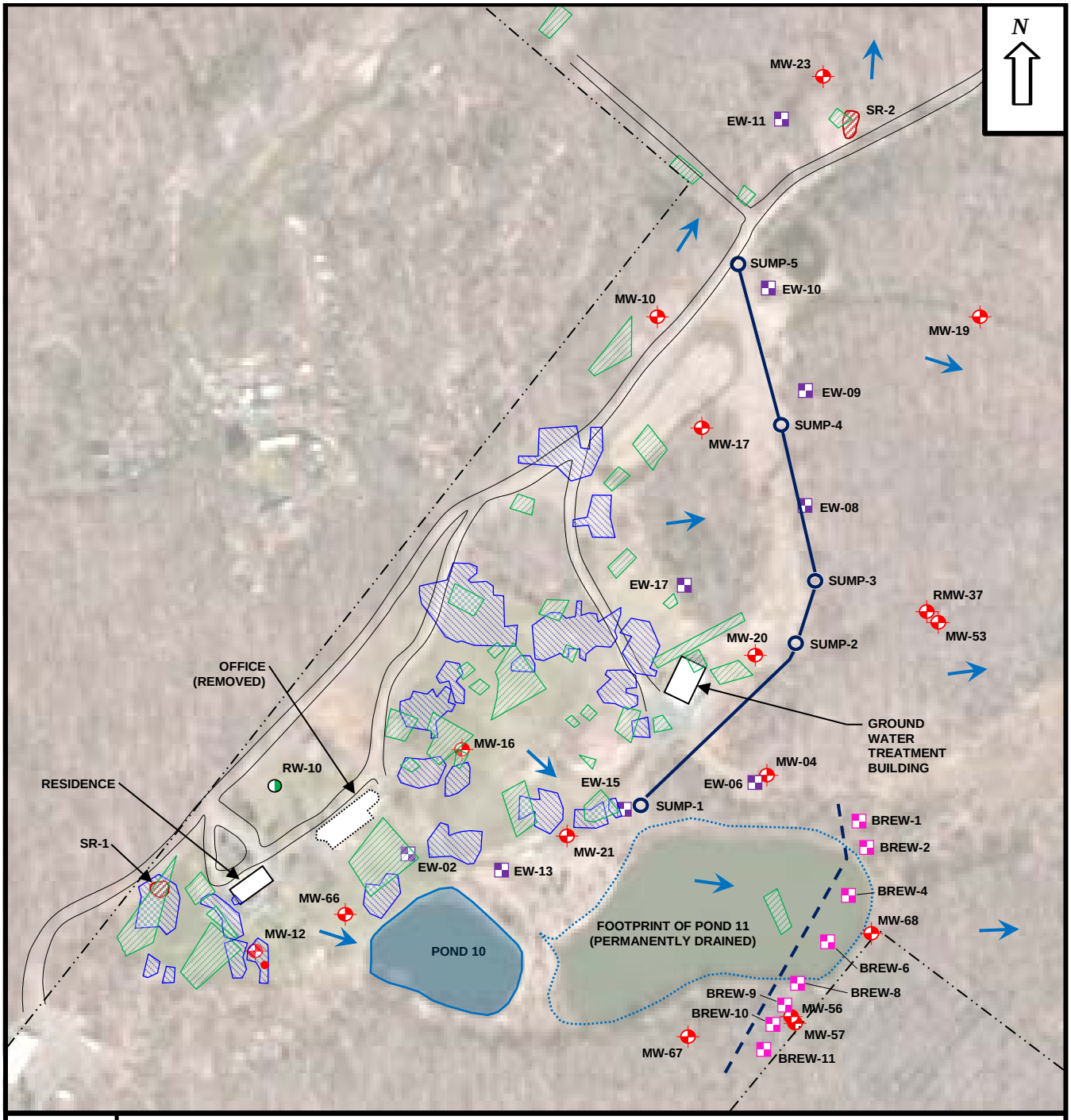
Response Actions

A combination of removal and remedial actions have been performed in response to releases at the Site. From June 1992 through September 1993, while the RI was underway, EPA conducted a time-critical removal action to address several burial areas. Approximately 2,500 drums and 9,300 cubic yards of contaminated soil were excavated and disposed of at licensed off-site disposal facilities during the removal action. In addition, approximately 60 drums with liquid or solid waste materials containing beryllium oxide and approximately 550 cubic yards of beryllium oxide-contaminated soils were excavated and staged on site. EPA subsequently issued an Administrative Order on Consent ("AOC") to General Ceramics, Inc. in December 1992 to arrange for the off-site transport of the drums and soil containing beryllium oxide to a licensed disposal facility. Approximate locations of the former sources identified during the 1993 time-critical removal actions are presented on Figure 4.

In June 1995, EPA completed an Engineering Evaluation/Cost Analysis ("EE/CA") to evaluate alternatives for conducting a non-time critical removal action to address the high concentrations of hazardous substances in groundwater. The U.S. Army Corps of Engineers designed and constructed the groundwater extraction and treatment system on behalf of EPA in 1997. The extraction system was designed to intercept and collect contaminated groundwater from overburden through a 1,500-foot-long trench and from bedrock by converting several of the exploratory wells installed as part of the EE/CA to extraction wells. The trench was installed as deep as the saprolite. EPA also installed granular activated carbon ("GAC") filtration units on 16 residential water supply wells to prevent potential exposure to groundwater contamination.

On November 18, 1998, EPA completed the RI/FS and selected a Remedy in a Record of Decision ("ROD"). The remedial action objective ("RAO") identified in the ROD was to reduce or eliminate the potential for human and ecological exposure to contaminants of concern ("COCs") in subsurface soils and groundwater at the Site. To meet this objective, the primary actions required by the ROD were maintenance of carbon filters previously installed on residential water supply wells, the removal of additional soils and drums contaminated with hazardous materials, and the ongoing recovery and treatment of contaminated groundwater. The principal components of the Remedy selected to achieve the RAO were:

- Soil aeration and treatment of surface soil at two "hot spots,"
- Excavation and off-site disposal of buried drums,
- Groundwater extraction and treatment using precipitation and air stripping,
- Installation of additional groundwater monitoring wells to monitor effectiveness of the remedial action,
- Maintenance of individual GAC filters installed on residential supply wells to prevent potential exposure to contaminated groundwater,



Base map from U.S. Geological Survey Riegelsville, PA-NJ and Frenchtown, PA-NJ 7.5-minute orthophotographs, circa 2011.

Extent of Soil Remedy Areas and sources removed during the remedial action derived from Brown & Caldwell, *Remedial Construction Report, Operable Unit No. 2, Boarhead Farms Superfund Site, May 2004.* Pre-excavation extents presented. Actual excavated areas varied slightly based on observed conditions, as outlined in the report. Extent of sources removed during removal actions derived from CH2M Hill, *Remedial Investigation Report*, January 1997.

Well, sump, and interceptor trench locations from various Brown & Caldwell reports and personal communication. Location of potential extraction wells and interceptor trench addition approximate. Inactive extraction/monitoring wells not presented.

LEGEND

- EXTRACTION WELL (ACTIVE)
- EXTRACTION WELL (FUTURE)
- EXTRACTION SUMP
- MONITORING WELL
- INTERCEPTOR TRENCH (EXISTING)
- POTABLE DRINKING WATER WELL
- INTERCEPTOR TRENCH (ADDITION)
- SITE BOUNDARY
- SOIL REMEDY AREA
- BURIED SOURCE REMOVED DURING REMEDIAL ACTION (2003)
- BURIED SOURCE REMOVED DURING REMOVAL ACTION (1992-1993)
- GROUND WATER FLOW DIRECTION (APPROXIMATE)

FIGURE 4
PRINCIPAL REMEDY COMPONENTS AND FORMER SOURCE AREAS
SEPTEMBER 2017

BOARHEAD FARMS
BRIDGETON TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

(1 INCH = 200 FEET)

- Performance of treatability studies in former disposal areas to determine whether phytoremediation is a viable treatment technique to aid in the removal of contamination from groundwater, and
- Implementation of ICs to protect the integrity of the remedial action components and the previously installed cover soil.

The ROD established numerical cleanup levels for 16 COCs in groundwater and two COCs in surface soil (i.e., soil from the ground surface to 1 foot below the surface). On April 15, 2009, EPA issued an Explanation of Significant Differences ("ESD") to modify COCs. The ESD added vinyl chloride as a COC and established a cleanup level in groundwater for vinyl chloride of 2 micrograms per liter ("µg/L"). The ESD also reduced the cleanup level for arsenic from 50 µg/L to 10 µg/L to reflect a modification of the Federal maximum contaminant level ("MCL") for arsenic that occurred on January 22, 2001. The ROD required that the cleanup levels must be achieved throughout the entire area of groundwater contamination. Remedial cleanup levels are outlined in Table 1.

Table 1. Remedial Contaminants of Concern and Cleanup Levels

Media	Contaminant of Concern	Cleanup Levels
Groundwater	Arsenic	10 µg/L
	Benzene	5 µg/L
	Beryllium	4 µg/L
	Cadmium	5 µg/L
	Chromium (total)	100 µg/L
	1,1-Dichloroethane	27 µg/L
	1,1-Dichloroethene	7 µg/L
	cis-1,2-Dichloroethene	70 µg/L
	Ethylbenzene	700 µg/L
	Lead	5 µg/L
	Nickel	100 µg/L
	Tetrachloroethene	5 µg/L
	1,1,1-Trichloroethane	200 µg/L
	Trichloroethene	5 µg/L
	Vinyl chloride	2 µg/L
	Xylenes (total)	10,000 µg/L
	Zinc	2,000 µg/L
Surface Soil	Benzene	500 µg/kg
	Trichloroethene	400 µg/kg

Note: The units "µg/L" and "µg/kg" are abbreviations for micrograms per liter and micrograms per kilogram, respectively, and are equivalent to parts per billion.

Status of Implementation

The construction of the Remedy was completed in 2003. The Preliminary Close-Out Report ("PCOR") was signed on November 10, 2003. The remedial action for OU-1 continues to be coordinated by de maximis on behalf of the OU-1 Group. On-going activities performed by the OU-1 Group includes operation and maintenance of the groundwater extraction system, semi-annual groundwater sampling of monitoring wells and certain private drinking water wells, maintenance and monitoring of residential point-of-entry groundwater treatment systems, and off-site vapor intrusion sampling at two residences. The remedial action for OU-2 is complete. No further action is planned for OU-2.

In April 1999, EPA began the remedial design for OU-1. On or about September 29, 2000, three of the PRPs agreed to perform the remaining remedial design and remedial action for OU-1 pursuant to a consent decree. Performance of the remedial action by the these PRPs ("OU-1 Group") is on-going. On March 14, 2002, the three PRPs comprising the OU-1 Group and a fourth PRP agreed to perform the remedial action for the OU-2 in accordance with a different consent decree. Implementation of the remedial action for OU-2 was conducted by these PRPs ("OU-2 Group") from March 2002 through November 2003. Over 3,000 tons of soils and 986 drums containing hazardous waste were excavated from the Site and transported off-site for disposal during the OU-2 remedial action.

In the First FYR, completed in 2007, EPA identified the need to evaluate the Site Residence and two nearby off-site residences to determine if vapor intrusion was occurring. Vapor intrusion is the volatilization of volatile organic compounds ("VOCs") from contaminated groundwater and upward migration into overlying buildings. In December 2008, the OU-1 Group collected air samples collected from the Site Residence on the Site and one off-site residence at the request of EPA. Analytical results indicated vapor intrusion was not occurring at the off-site residences. Analytical results indicated that trichloroethene ("TCE") was present in air on the first floor of the Site Residence at a concentration of 200 micrograms per cubic meter ("µg/m³") and in basement air at a concentration of 1,200 µg/m³. A water sample collected from standing water in the basement contained TCE at a concentration of 2,000 µg/L. Based on these results, EPA issued a Special Bulletin on May 28, 2009 and initiated an emergency removal action to reduce the high concentrations of TCE in indoor air at the Site Residence to less than 10 µg/m³. Portable air filtration units were temporarily installed, and sampling of indoor air and sump water was conducted periodically.

In 2011, the OU-1 Group voluntarily took additional measures while the EPA-lead removal action was on-going, including cleaning sediment out of the sumps and trench, placing non-air tight rubber matting over the sumps and trench, installing a new pump in one sump, replacing the pump in another sump, and connecting the combined sump discharge to the groundwater treatment facility. The combined measures reduced TCE concentrations in air of the living space to 65 µg/m³ or less, although basement air concentrations remained elevated (as high as 510 µg/m³) and groundwater concentrations in sumps were higher (3,300 µg/L).

In or about July 2013, Boarhead Corporation unilaterally and without notice to EPA installed a basement exhaust system comprised of an in-line fan and 4-inch polyvinyl chloride ("PVC") piping. After installation of the system, EPA performed two rounds of sampling, in December 2013 and April 2014. Concentrations of TCE in the air of the living space were reduced to a maximum of 6.4 µg/m³. TCE was present in the northern sump at a concentration of 1,900 µg/L. No basement air samples were collected.

In March 2016, EPA collected samples from indoor air, basement air, and sump water to assess the status and effectiveness of the mitigation measures implemented at the Site Residence. The exhaust system and sump pumps were observed to be operating. The maximum TCE concentration in indoor air was 3.6 µg/m³ on the first or second floors, and was 79 µg/m³ in the basement. TCE was present in the northern sump at a concentration of 2,200 µg/L. The indoor air concentrations remained above the EPA's current chronic inhalation reference concentration of 2 µg/m³, therefore, additional response actions to address vapor intrusion in the Site Residence may be necessary.

Institutional Controls

ICs are non-engineered administrative and legal controls that help minimize the potential for human exposure to contamination and protect the integrity of remedial response actions. ICs were selected in the ROD to protect the integrity of remedial action components, including but not limited to the interceptor trench, groundwater treatment system, soil aeration treatment area, and phytoremediation area. An IC was also selected to prevent exposure to contaminated subsurface soils (namely, soils at depths greater than 2 feet) through excavation, construction, and regrading in and about the locations where former sources were buried and where releases of hazardous substances occurred. The ICs were to be implemented on the Site and remain in effect until, at a minimum, achievement of remedial performance standards. To date, the ICs have not been implemented.

Table 2. Summary of Institutional Controls

Media, engineered controls, and areas that do not support Unlimited Use/Unrestricted Exposure based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Affected Parcels	IC Objective	IC Implementation
Remedial action components and on-site subsurface soil (>2 feet)	Yes	Yes	03-003-026 03-002-007	Prohibit construction, excavation, or regrading to protect remedial action components and prevent exposure to contaminated soils remaining in and around former sources at depths greater than 2 feet	Not implemented
On-site groundwater and soil vapor	Yes	No	03-003-026 03-002-007	Prevent exposure to hazardous substances through potable use of contaminated groundwater and through intrusion of organic vapors into habitable structures	Not implemented

Systems Operations/Operation & Maintenance

Operations and maintenance ("O&M") for the groundwater portion of the Remedy continues to be conducted by the OU-1 Group. The remedial action for OU-2 is complete and O&M is not required. The primary activities associated with ongoing O&M at OU-1 include the following:

Operation of the groundwater extraction and treatment system,

- Inspections of the groundwater extraction wells and trench sumps,
- Collection of water level readings at extraction wells and trench sumps,
- Influent testing of groundwater extraction wells and trench sumps,
- Sampling of groundwater monitoring wells and residential wells,
- Reporting of Site conditions including groundwater sample analysis results and the operating efficiencies of the treatment system,
- Regular inspection of the treatment system,
- Review of computer-based controls and trend history,
- Effluent sampling and Discharge Monitoring Report ("DMR") preparation,
- Maintenance of extraction/treatment system equipment in accordance with manufacturer requirements in O&M manual, and
- Maintenance of residential point-of-entry treatment groundwater treatment units.

Although the system initially failed to attain the established discharge limits during the system start-up period in 1997, discharge limits for treated groundwater, as established by PADEP, have been consistently achieved since the system was upgraded in 2002. Treated groundwater is discharged to the wooded wetland east-southeast of the groundwater treatment building. O&M of the groundwater extraction and treatment systems is being performed in accordance with the O&M Plan Manuals (Volumes I and II), October 2002. Ongoing O&M activities, including site inspections are summarized in progress reports submitted to PADEP and EPA. The most recent DMR in the review period is included in Appendix B.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the Second (2012) FYR as well as the current status of steps taken to address the issues outlined in the Second FYR.

Table 3. Protectiveness Determination/Statement from the 2012 Five-Year Review

OU	Protectiveness Determination	Protectiveness Statement
Site-wide	Not Protective	The remedial action implemented for OU-2 (soil/source) is protective. However, due to the presence of site-related contaminants in indoor air at the Residence on the Boarhead Farms property at concentrations above Regional screening levels, the remedial action for OU-1 is not protective. Therefore, the Site will not be considered protective in the short-term until the risk to people living in the residence on the Boarhead Farms property has been reduced to acceptable levels. To achieve long-term protectiveness, steps should be taken to improve the capture of the groundwater extraction and treatment system, to address contamination that has migrated beyond the system, to enhance the monitoring for 1,4-dioxane in groundwater, and to revise and implement institutional controls.

Table 4. Status of Recommendations from the Second (2012) Five-Year Review

OU	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date
01	Site-related contaminants are present in groundwater beyond the extraction system and beneath adjacent properties at concentrations exceeding cleanup levels.	Evaluate alternatives in FFS to address groundwater contamination down gradient of and beyond the extraction system.	Completed	Groundwater extraction and treatment through trench and wells determined to be best remedial action alternative; construction upgrades began in 2013 and are expected to be complete by the end of 2017. Construction details are discussed in detail following the table.	8/7/2013
01	Concentration trends in sentinel monitoring wells suggest that capture of contaminated groundwater by the extraction system wells is not complete.	Evaluate additional measures to improve capture of contaminated groundwater by the system.	Addressed in Next FYR	Actions already taken are discussed following the table. Capture of optimized system to be evaluated after current construction upgrades are complete.	Not yet completed
01	TCE is present in indoor air at the residence on the Boarhead Farms property at concentrations exceeding the Regional screening level.	Evaluate additional response actions.	Ongoing	Removal actions taken during this review period have greatly reduced TCE concentrations, but TCE remains above the EPA Regional screening level.	Not yet completed

Table 4: Status of Recommendations from the Second (2012) Five-Year Review (Continued)

OU	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date
01	1,4-Dioxane is present in groundwater at concentrations exceeding the Regional screening level.	Expand monitoring program to more comprehensively define the extent of 1,4-dioxane in groundwater.	Completed	In conjunction with PADEP, the monitoring program was evaluated and modified to include 1,4-dioxane sampling at an expanded set of wells beginning in April 2014.	4/7/2014
01	Due to the large number of contaminants in groundwater, performance standards for individual constituents may eventually be achieved while total contaminant concentrations may be above acceptable risk levels.	A risk assessment of residual groundwater concentrations should be conducted after all performance standards are achieved.	Under Discussion	Through a future ESD, a performance standard requiring an assessment of cumulative risk due to the presence of multiple COCs in groundwater is proposed to be added as a component of the Remedy.	Not yet completed
01	Institutional controls, which protect the integrity of the remedy components, have yet to be implemented; no institutional controls restricting use of contaminated groundwater or limiting exposure to vapor intrusion are outlined in the ROD.	Modify decision document to include restrictions on use of contaminated groundwater and provisions for evaluating or limiting exposure to vapor intrusion; continue to work with PRPs and PADEP to revise and implement institutional controls.	Under Discussion	Through a future ESD, ICs to restrict aquifer use and require assessments for the presence of vapor intrusion in new or modified structures on the portion of the Boarhead Property in and around former buried sources are proposed to be added as a component of the Remedy.	Not yet completed

In the Second FYR, completed in 2012, EPA identified that concentration trends in wells located down gradient of the interceptor trench and extraction wells often fluctuated, suggesting that groundwater capture was incomplete. Subsequently, EPA requested that the OU-1 Group perform the following activities as part of on-going long-term remedial action activities:

- Permanently draw down the 4-acre pond located south of the treatment building ("Pond 11" in Site records),
- Assess the berm embankments on the east side of Pond 11 for the presence of new source areas,
- Evaluate soils underlying Pond 11 after re-grading to determine if soil cleanup levels were exceeded,
- Restore the Pond 11 area to a higher functioning wetland such as a native wooded wetland, and
- Perform operation and maintenance including annual invasive plant species eradication.

The OU-1 Group began and completed draw down and source investigation efforts in the footprint and berm of Pond 11 in 2014. This work included targeted surface geophysical surveying to identify any possible buried containers or drums, a direct-push soil sampling assessment, a Phase I assessment for bog turtle habitat, the review and approval of a sediment and erosion control plan by the Bucks County Conservation District, and review and approval from the Pennsylvania Fish and Boat Commission to draw water from the impoundment. No new source areas or highly contaminated soils consistent with the presence of new sources were identified during the investigations.

In 2016, the OU-1 Group began implementing measures to install a second interceptor trench and a series of bedrock extraction wells in and near the footprint of Pond 11. Work conducted to date has included the following activities:

- Performed a property boundary and topographic survey,
- Re-graded the soils within the Pond 11 footprint to mimic the presumed pre-disturbance topography of the land,
- Performed additional direct-push subsurface soil sampling for organic COCs and soil classification to determine the most appropriate location for the trench,
- Constructed an at-grade stone access road to permit access to wells and interceptor trench sumps for equipment and personnel during and after installation,
- Installed 12 shallow bedrock wells,
- Performed aquifer testing to determine the water-bearing characteristics of the newly drilled wells,
- Installed the interceptor trench extension, and
- Began construction and testing of buried lateral connection lines between extraction points and the groundwater treatment building.

No COCs were detected in subsurface soil at concentrations exceeding soil cleanup levels or Regional screening levels. Based on the results of aquifer performance testing and groundwater analytical results, 8 of the 12 shallow bedrock wells (BREW-1, BREW-2, BREW-4, BREW-6, BREW-8, BREW-9, BREW-10, and BREW-12) were selected for use as future extraction wells. The installation of the extraction wells in January 2017 and excavation and installation of the trench was completed in July 2017. It is expected that the remainder of the construction upgrades will be complete and the system will be fully operational by the end of 2017.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

On August 4, 2017, the public was notified in an advertisement posted in the Doylestown, Pennsylvania regional daily newspaper *The Intelligencer* that EPA was conducting the FYR. The public was advised of the purpose of the FYR, invited to contact EPA with questions or information, and notified of the anticipated release date. The results of the FYR and the report will available at the Site information repository located at the Main Branch of the Bucks County Free Library, 150 South Pine Street, Doylestown, Pennsylvania 18901, or will be available electronically on the internet (https://semspub.epa.gov/src/collection/03/SC30669).

During the FYR process, interviews were conducted to document any perceived problems or successes with the Remedy that has been implemented to date**.** By way of electronic mail or personal correspondence, EPA informed the Site owner, de maximis on behalf of the OU-1 Group and OU-2 Group, Bridgeton Township, and PADEP of the preparation of the third FYR. EPA Community Involvement Coordinator Alex Mandell met with representatives of Bridgeton Township to discuss the current status of the Remedy and on-going activities. Township representatives expressed continued interest in work being performed at the Site. EPA will continue to keep the Township and community members informed about the progress of the cleanup.

Site Inspection

EPA performed FYR site inspections on May 16, 2017 and June 13, 2017. The purpose of the inspections was to assess the protectiveness of the remedy. Christopher Sklaney (EPA RPM), Nathan Doyle (EPA Geologist), and Craig Coslett (de maximis) were present during the May inspection. In attendance during the June inspection were Christopher Sklaney, Nathan Doyle, Craig Coslett, Alex Mandell (EPA Community Involvement Coordinator), Bruce Pluta, (EPA Biological Technical Assessment Group Coordinator), Dustin Armstrong (PADEP), and Bonnie McClennen (PADEP).

The participants toured the groundwater treatment building, the regraded restoration area in the footprint of the drained pond, and installation of the interceptor trench, which was occurring during the June inspection. The groundwater extraction and treatment system was operational and the treatment building appeared to be in good condition. The necessary remedial action completion reports, O&M manuals and health and safety plans are available on-site in the office of the treatment building. de maximis reported that minor issues, such as repairs to some monitoring well protective casings, were observed during recent inspections and in the process of being addressed. In addition to visiting the Site, the EPA RPM toured the adjacent residential neighborhood. No major changes in land use were observed.

Data Review

The FYR included a review of relevant Site documents and monitoring data, with a focus on data collected in the five-year period from early 2012 through the end of 2016. A review of findings and data trends for groundwater and indoor air are included in this section. Time-series graphs showing data trends for select wells and COCs over the review period are presented in Appendix C. The groundwater data were collected and summarized in semi-annual monitoring reports generated as part of on-going long-term remedial action activities by de maximis on behalf of the OU-1 Group. The indoor air data collected from residences near but not on the Site were collected and reported annually by de maximis. The indoor air data collected from the on-site Site Residence were collected as part of an on-going removal action being performed by EPA.

Groundwater

The remedy was designed to pump and capture contaminated groundwater in the saprolite using the interceptor trench and in bedrock using the extraction wells (referred to collectively herein as the "extraction network"). At the time the ROD was issued in November 1998, analytical data suggested that the extent of groundwater contamination down gradient of the extraction network was limited and concentrations were near established cleanup levels. The installation of additional monitoring wells, required as a component of the remedy, subsequently identified contamination at higher concentrations in new areas, namely the "northern" and "southern" plumes.

The primary contaminants continuing to impact groundwater quality are VOCs, with TCE being the COC found at the highest concentration in almost all wells. Other COCs primarily impacting groundwater quality are 1,1,1-trichloroethane ("TCA"), *cis*-1,2-dichloroethene ("DCE"), 1,1-DCE, and tetrachloroethene ("PCE"). Benzene, toluene, xylenes, and 1,4-dioxane are also present but at fewer locations and at lower concentrations. Four areas of groundwater contamination are identified at the Site as follows:

- Former Source Area
- Northern Plume
- Southern Plume
- Access Road Plume

The Former Source Area is located in a region of groundwater recharge from which groundwater flow occurs radially to the north, east, and southeast. Groundwater that leaves the Former Source Area migrates to either the Northern Plume, Southern Plume, or the suspected plume located north of the Site access road near MW-23/SR-2

(hereafter described as the "Access Road Plume"). The Northern and Southern Plumes extend from the Former Source Area east to a location near or just east of Lonely Cottage Road. The Northern Plume flows east-northeast and the Southern Plume appears to trend southeast before turning in a more easterly direction. The Access Road Plume originates north of the northern end of the trench near monitoring well MW-23 and Soil Remedy Area SR-2, and may receive contribution from source areas near well MW-10. The Access Road Plume is poorly defined due to a lack of sentinel wells and suspected to extend an unknown distance to the north or north-northeast. The extent of groundwater at the Site contaminated with TCE as of October 2016 is presented on Figure 5; other VOCs are generally present within the same area.

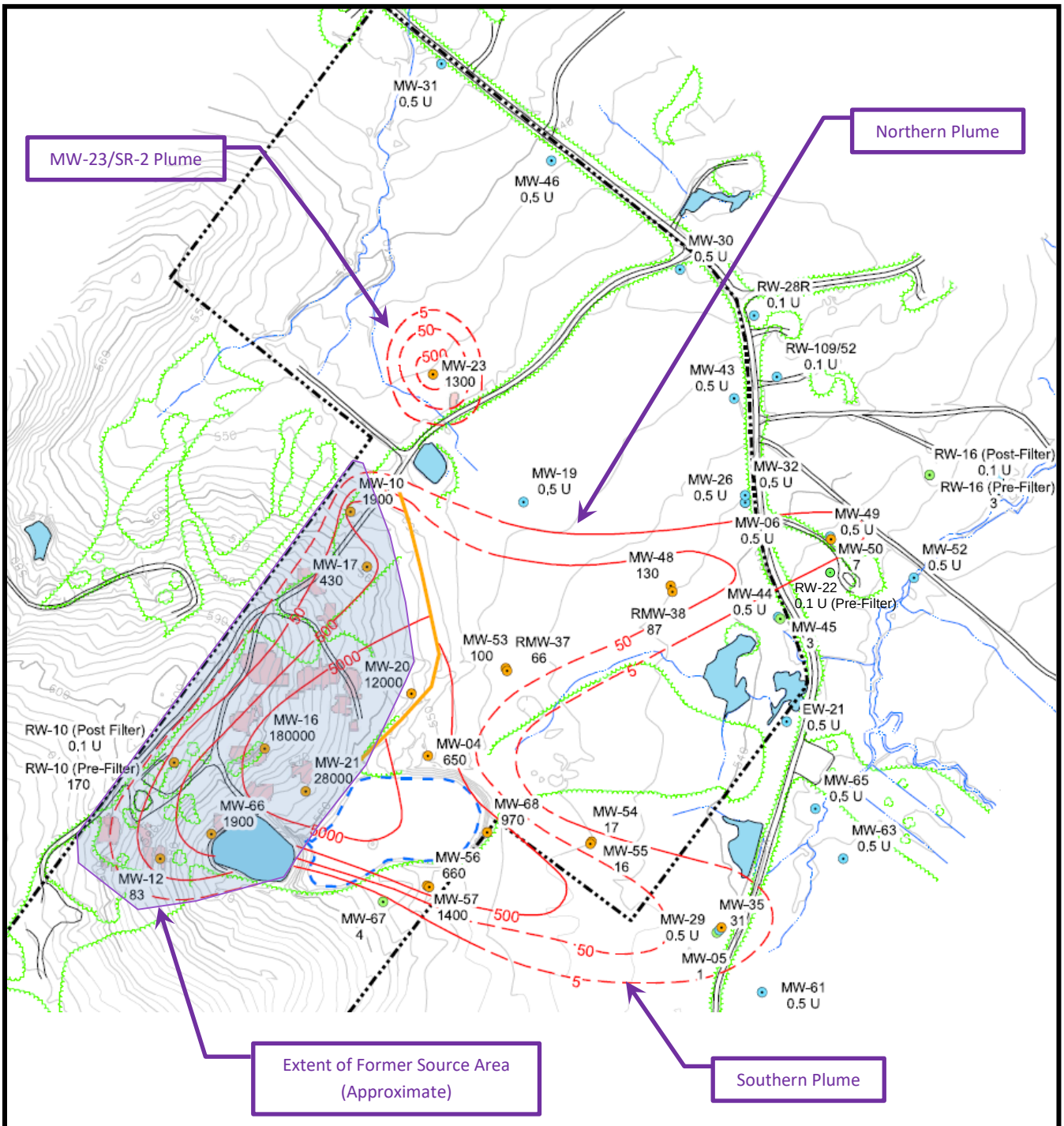
Groundwater monitoring has been conducted by EPA since the early 1990s and exclusively by the OU-1 Group since October 2001. In the last five years, monitoring has been performed semi-annually in the spring and autumn. Monitoring currently includes a network of approximately 40 wells installed to assess COCs in groundwater that are generally classified based on their location relative to the Former Source Area and treatment system. Monitoring also includes as many as six residential wells located on or near the Site. The sampling locations, laboratory analyses, and sampling frequency as of October 2016 are presented on Figure 6.

The monitoring wells are subjectively classified into three categories based on location relative to former sources and the extraction network; source area wells, sentinel wells, and perimeter wells. Source area wells are located up gradient of the trench and extraction well network where buried containers were identified and removed. Sentinel wells are located down gradient of the trench and extraction well network. Perimeter wells are located down gradient of the sentinel wells along the Site boundary near Lonely Cottage Road.

The majority of monitoring wells are completed in shallow bedrock or saprolite, which is a thin zone of weathered bedrock that sits atop competent bedrock. Several wells are completed entirely in overburden materials. Collectively, the wells completed in saprolite and overburden are described in long-term monitoring and quality assurance plan ("LTMP") reports and herein as "overburden" wells. A few monitoring wells are installed in the lower portion of the diabase sill at depths of 150 feet or greater. No monitoring wells are installed in the sedimentary rock underlying the diabase, although many local potable wells intercept both formations. Some wells are constructed of PVC, while others remain as open boreholes. Most sentinel and perimeter wells were installed as couplets or triplets, conceptually intercepting multiple horizontal flow paths at a single location. Groundwater is monitored in all wells on a semi-annual basis for VOCs, and in some wells on an annual basis for cyanide, total dissolved solids, chloride, sulfate, and chemical oxygen demand. A subset of wells is monitored semi-annually or annually for 1,4-dioxane. An evaluation of groundwater data trends in specific areas of the Site follows.

Former Source Area

In general, Former Source Area wells are characterized by high concentrations of some organic COCs that fluctuate drastically over time. Former Source Area wells include MW-10, MW-12, MW-16, MW-17, MW-20, MW-21, and MW-66. Monitoring well MW-16 contains the highest concentrations of total VOCs found in groundwater, with the highest single contaminant and total VOC concentration observed during the review period in MW-16. Wells MW-20 and MW-21 also contain significant concentrations of VOCs, but typically about an order of magnitude lower than MW-16. A summary of concentrations recorded in the Former Source Area wells is presented in Table 5.



Map excerpt from Figure 2 in Brown and Caldwell January 2017 LTMP. TCE extent shown based on data collected in October 2016.

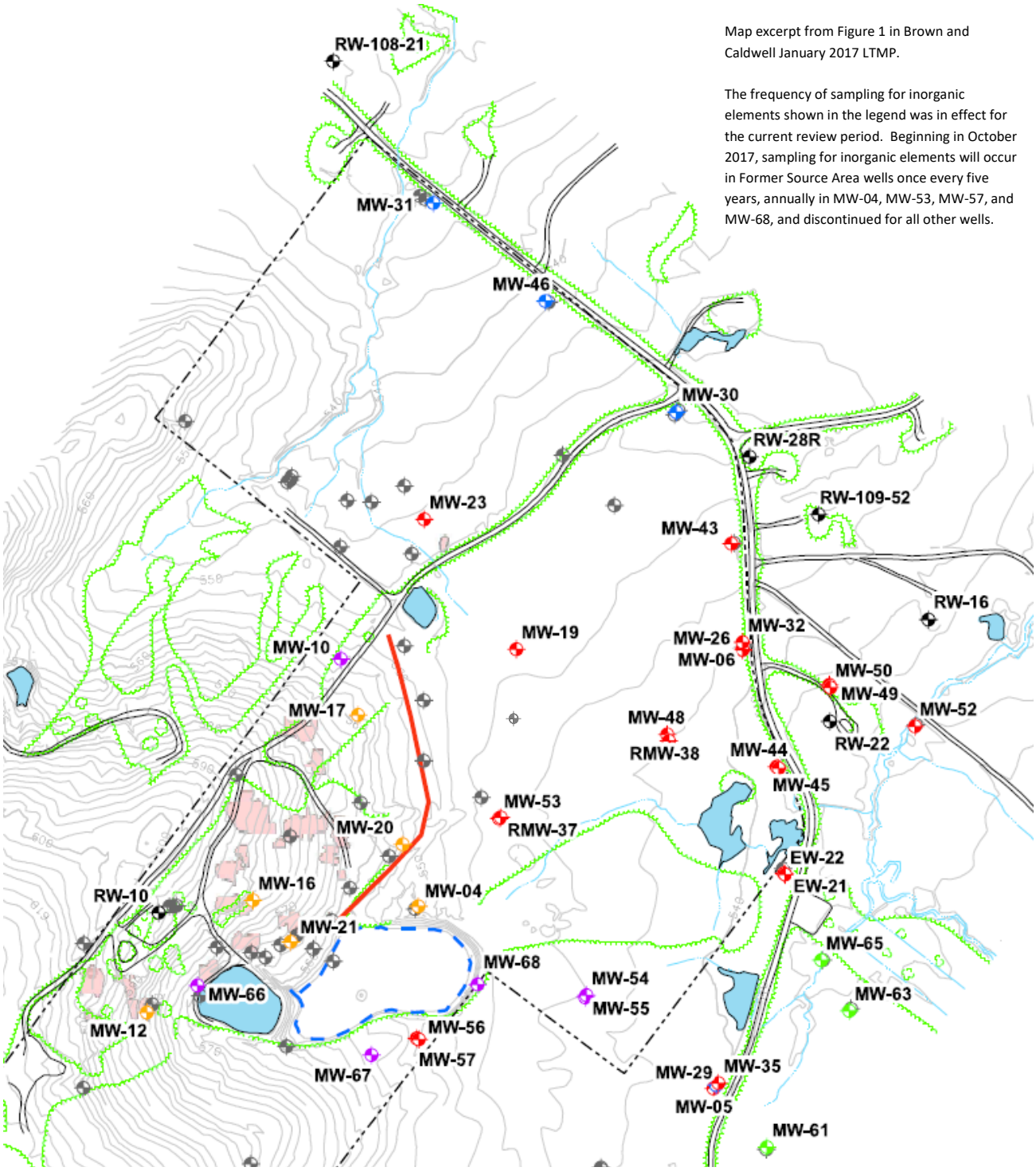
LEGEND

- MW-04 / 650 — WELL ID / TCE CONCENTRATION (µg/L)
- TCE NOT DETECTED
- TCE DETECTED BUT BELOW CLEANUP STANDARD (<5 µg/L)
- TCE DETECTED ABOVE CLEANUP STANDARD (≥5 µg/L)
- 5 — ISOCONCENTRATION CONTOUR, IN µg/L (DASHED WHERE UNCERTAIN)

FIGURE 5
LOCATION OF PLUMES AND EXTENT OF TRICHLOROETHENE (TCE) IN GROUNDWATER
(AS OF OCTOBER 2016)

BOARHEAD FARMS
BRIDGETON TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

(1 INCH = 440 FEET)



Map excerpt from Figure 1 in Brown and Caldwell January 2017 LTMP.

The frequency of sampling for inorganic elements shown in the legend was in effect for the current review period. Beginning in October 2017, sampling for inorganic elements will occur in Former Source Area wells once every five years, annually in MW-04, MW-53, MW-57, and MW-68, and discontinued for all other wells.

LEGEND

- VOCs (SEMI-ANNUAL), INORGANICS (ANNUAL), WATER QUALITY (ANNUAL)
- VOCs (SEMI-ANNUAL)
- VOCs (SEMI-ANNUAL), INORGANICS (ANNUAL), FREE CYANIDE (ANNUAL)
- VOCs (SEMI-ANNUAL), RESIDENTIAL WELLS
- VOCs (ANNUAL)
- VOCs (ANNUAL), INORGANICS (ANNUAL), WATER QUALITY (ANNUAL)
- EXTRACTION OR MONITORING WELL NOT INCLUDED IN LTMP

FIGURE 6
OU-1 MONITORING NETWORK AND SAMPLING PROGRAM
SEPTEMBER 2017

BOARHEAD FARMS
BRIDGETON TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA
(1 INCH = 470 FEET)

Table 5. Total VOC Concentrations in Former Source Area Wells, 2012-2016

Well ID	Maximum Concentration (total VOCs, µg/L)	Average Concentration (total VOCs, µg/L)	Median Concentration (total VOCs, µg/L)
MW-10	6,300	4,300	4,200
MW-12	370	190	170
MW-16	350,000	120,000	63,000
MW-17	3,300	1,300	1,100
MW-20	32,000	13,000	11,000
MW-21	72,000	42,000	46,000
MW-66	5,100	3,400	3,300

The variability in concentrations during the review period in Former Source Area wells has been as great as two to three orders of magnitude. In general, the variability appears to occur on a site-wide basis in any given monitoring period and is particularly apparent in Former Source Area wells. Monitoring conducted in April 2012, October 2012, October 2014, and October 2016 revealed individual and total VOC concentrations that were significantly higher than in other periods. Despite the variability, contaminant trends have remained generally steady overall in the past five years, with slight increases in trends in wells MW-16, MW-20, and MW-21, and slight decreases in trends in the other Former Source Area wells. The concentrations remain from one to several orders of magnitude above cleanup levels for most VOCs.

The mixture of contaminants in the Former Source Area wells differs from well to well. The most prevalent COCs in terms of concentration are TCE, 1,1,1-TCA, and *cis*-1,2-DCE. While other VOCs are present at significant concentrations, wells MW-16 and MW-20 are dominated by the presence of TCE at nearly twice the concentration of any other single contaminant. In contrast, TCE and *cis*-1,2-DCE have alternately been the most prevalent contaminant in well MW-21; concentrations of 1,1,1-TCA have been elevated but generally present at lower concentrations than the other two compounds. Well MW-21 is located approximately half way between extraction wells EW-13 and EW-15, which are 240 feet apart.

Benzene, toluene, ethylbenzene, and xylene compounds, often referenced collectively as "BTEX" compounds, are commonly although not exclusively associated with petroleum products such as gasoline or diesel fuel. BTEX compounds are generally restricted to Former Source Area wells MW-16 and MW-21. Benzene was detected in MW-21 at a concentration of 240 µg/L at the beginning of the review period, but was present at concentrations less than 25 µg/L by October 2016. Benzene has been detected at a concentration of up to 1,500 µg/L in monitoring well MW-21, but has not been detected in wells MW-16 or MW-20. Benzene has been detected at concentrations exceeding the cleanup level in the Southern Plume, but not in the Northern Plume.

Analysis for 1,4-dioxane in the Former Source Area was conducted in wells MW-10, MW-12, MW-16, MW-20, and MW-21 during the review period. Concentrations in wells MW-10 and MW-12 were below 1 µg/L during all monitoring events. Concentrations in MW-16 were all less than 10 µg/L except for the October 2014 event, when a concentration of 290 µg/L was observed. The concentration of 1,4-dioxane in MW-20 ranged from 8.2 µg/L in April 2016 to 60 µg/L in October 2014. Concentrations in MW-21 were present during every monitoring round during the review period, ranging from 38 µg/L (April 2015) to 98 µg/L (October 2014).

Northern Plume

Three well groups are primarily used to monitor concentration trends in the Northern Plume: RMW-37/MW-53, RMW-38/MW-48, and MW-49/MW-50. Overburden well RMW-37 and shallow bedrock well MW-53 are sentinel wells located 250 feet east and down gradient of the interceptor trench. Overburden well RMW-38 and shallow bedrock well MW-48 are sentinel wells located 530 feet east and down gradient of the RMW-37/MW-53

pair. Overburden well MW-49 and shallow bedrock well MW-50 are perimeter wells located 500 feet east and down gradient of the RMW 38/MW-48 pair. The MW-49/50 pair is located about 200 feet east of the eastern Site boundary and Lonely Cottage Road.

VOC concentrations in well pair RMW-37/MW-53 exhibited a downward trend during the review period, with slight increases in concentrations for several organic COCs of interest (TCE, 1,1,1-TCA, 1,1-DCE, 1,1-DCA, *cis*-1,2-DCE, PCE, and vinyl chloride) in October 2013 and April 2014. With the exception of TCE in RMW-37 and MW-53, all organic COCs were below their respective cleanup levels at the end of the review period.

VOC concentrations in down gradient well pairs RMW-38/MW-48 and MW-49/MW-50 have exhibited decreasing trends since inclusion in the sampling program in 2001 and 2004, respectively. During this review period, the organic COCs continued to show a downward trend but showed a consistent slight fluctuation during consecutive monitoring events. TCE was the primary constituent, present at concentrations of 87 µg/L in RMW-38 and 130 µg/L in MW-48. All other organic COCs were below their respective cleanup levels at the end of the review period.

As with the other wells in the Northern Plume, wells MW-49 and MW-50 showed a consistent downward trend during the review period. Unlike well pair RMW-38/MW-48, this well pair did not exhibit fluctuating results in consecutive monitoring rounds. The only COC present above cleanup levels by the end of the review period was TCE in MW-50 at a concentration of 7 µg/L, down from a concentration of 47 µg/L in the April 2012 monitoring round.

Analysis for 1,4-dioxane was conducted in the Northern Plume in overburden well RMW-38, bedrock well MW-48, and bedrock well MW-50. Concentrations in well RMW-38 were generally downward, ranging from a high of 24 µg/L in October 2007 to a low of 5.9 µg/L in November 2015. The fluctuations in 1,4-dioxane concentrations are similar to those observed for the other compounds in well RMW-38. The concentration of 1,4-dioxane in MW-48 decreased from 17 µg/L to 11 µg/L, and was less than 1 µg/L in MW-50.

Southern Plume

In the Southern Plume, concentration trends have been monitored through sampling of several well groups: MW-56/MW-57, MW-05/MW-35/MW-29, MW-54/55, MW-60/61, MW-62/63, and MW-64/65. Overburden well MW-56 and shallow bedrock well MW-57 are located about 100 feet south of the Pond 11 footprint. Overburden well MW-54 and shallow bedrock well MW-55 are located about 500 feet east of the Pond 11 footprint. Overburden well MW-05, shallow bedrock well MW-35, and deep bedrock (diabase) well MW-29 are located 950 feet south-southeast of the MW-56/MW-57 pair on the west side of Lonely Cottage Road. Well pairs MW-60/MW-61, MW-62/MW-63, and MW-64/MW-65 are located down gradient of the MW-05/MW-35/MW-29 triplet on the east side of Lonely Cottage Road. Due to the absence of any COCs above reporting limits over years of monitoring, overburden wells MW-60, MW-62, and MW-64, located at the most down gradient locations, were removed during this review period. To more closely monitor the expected northward shift of the Southern Plume, the frequency of sampling in the MW-54/55 well pair was increased from annual to semi-annually beginning in October 2015.

VOC concentrations in well pair MW-56/MW-57 exhibited increasing trends over the last five years, with notable increases observed beginning in the October 2014 monitoring event. EPA suspects these increases were due to the permanent drawdown of Pond 11 that was performed in late July and early August 2014. TCE is the primary constituent, although the same group of chlorinated VOCs identified in the Northern Plume along with benzene is present.

In general, concentrations at the well group by MW-05/MW-35/MW-29 are significantly lower than at up gradient well pair MW-56/MW-57. Contaminants at or exceeding cleanup levels are limited to TCE, cis-1,2-DCE, and PCE in shallow bedrock well MW-35. As typical with other areas of the Site, TCE is the compound

found at the highest concentrations. TCE was present at 97 µg/L in April 2015. All compounds in MW-05 are currently below cleanup levels, and no detectable concentrations have been observed in deep bedrock well MW-29. Concentrations in the well pairs down or cross gradient from MW-05/MW-35/MW-29 have been below cleanup levels for all constituents.

Analysis for 1,4-dioxane was conducted in the Southern Plume in shallow bedrock wells MW-35 and MW-57 and overburden well MW-05. Concentrations in well MW-57 increased between October 2013 (5 µg/L) and April 2015 (47 µg/L) before declining to 33 µg/L in October 2016. Concentrations in well MW-35 were consistent but not greater than 9 µg/L, the result observed in April 2015. 1,4-Dioxane was not detected in well MW-05 in the last five years.

Access Road Plume

The area of groundwater contamination described as the "MW-23 Plume" in LTMP reports and as the "Access Road Plume" is located north of the Site's sole access road near well MW-23 and Soil Remedy Area SR-2. In well MW-23, concentrations for the three most prevalent organic COCs, *cis*-1,2-DCE, TCE, and 1,1,1-TCA, were steady between April 2011 and April 2015. In October 2015, concentrations of these compounds increased significantly. TCE increased by one order of magnitude to 2,600 µg/L, 1,1,1-TCA increased by a factor of about three to 540 µg/L, and *cis*-1,2-DCE almost doubled to 520 µg/L. In the following monitoring period, April 2016, concentrations returned to those observed previously, but in October 2016 concentrations increased again, most notably TCE at 1,300 µg/L. 1,4-Dioxane was present in samples collected from well MW-23 in the last five years, but at concentrations no higher than 2 µg/L.

No COCs or 1,4-dioxane have been detected to date in perimeter well groups MW-08/MW-31/MW-25 or MW-46/MW-47. The groups are are located along Lonely Cottage Road, about 1,000 feet north and 750 feet north-northeast, respectively, of MW-23. However, the concentrations of COCs and extent of contamination in the 1,000-foot distance between MW-23 and the perimeter wells are unknown due to the lack of any sentinel wells. Due to the absence of any COCs above reporting limits over years of monitoring, several perimeter wells (overburden well MW-08, overburden well MW-47, and deep bedrock well MW-25) were removed from the LTMP in this review period.

Residential Monitoring Program

Six residential potable wells have been included in the groundwater monitoring program in the last five years, including the potable well on the Site (RW-10). In October 2016, one residential well (RW-22) was temporarily removed from the monitoring program when the residence was vacated for unknown reasons, while a new residential well (RW-28R) was added where access had been denied since 1993. Analytical results of samples collected from off-site residential wells indicate that the off-site residential wells are not being impacted by site-related contaminants at concentrations above cleanup levels. The filtration units on these wells serve as a contingency. TCE was present in the pre-filtration samples collected from RW-10 at concentrations ranging from 87 µg/L to 200 µg/L. No samples collected after filtration units on any residential well contained TCE above laboratory reporting limits. No other VOCs, inorganic elements, or 1,4-dioxane were detected above cleanup levels in any off-site residential well.

Indoor Air

Monitoring of vapor intrusion during this review period was conducted periodically in the Site Residence by EPA as part of an on-going removal action and in two nearby residences by the OU-1 Group as part of annual vapor intrusion monitoring.

Site Residence

Monitoring of the Site Residence included sampling for VOCs in indoor air (i.e., the first, second, and third floors), basement air, ambient air, and groundwater in the open basement sumps. Data collected during this period exhibited generally consistent results, with notable declines in concentrations of indoor air and basement air occurring after the installation of the basement exhaust fan in or about July 2013. TCE concentrations in indoor air decreased by more than an order of magnitude from 65 µg/m^3 in the monitoring event prior to installation of the fan to 4.1 µg/m^3 after installation. Two subsequent rounds of sampling of indoor air indicated TCE concentrations of 2.4 µg/m^3 and 3.5 µg/m^3 on the first floor. Likewise, basement air concentrations decreased by about an order of magnitude from 510 µg/m^3 in the monitoring event prior to installation of the fan to 79 µg/m^3 after installation. However, samples collected from the basement sumps was not affected by installation of the exhaust fan. The most recently collected sump water sample (March 2016) contained TCE at a concentration of 2,200 µg/L.

Off-Site Residences

The off-site vapor intrusion monitoring program assesses residential structures that overlie or are in close proximity to areas of known groundwater contamination to determine if vapors from the VOC plumes are impacting indoor air. Sampling of the indoor air, sub-slab soil vapor, and ambient air occured annually in December or January during the review period. Analytical data indicates that TCE or other site-related VOCs are not present in soil vapor beneath the off-site residences and have not impacted indoor air of the residences.

Summary

Groundwater cleanup levels were established for 17 compounds, including ten VOCs and seven inorganic elements. Analysis conducted as part of scheduled monitoring includes numerous other VOCs, 1,4-dioxane, and inorganic elements. Chlorinated VOCs are the most prevalent COCs, and are present near the Former Source Area and down gradient of the collection trench and extraction system. COC concentrations in Former Source Area wells are up to several orders of magnitude greater than in other areas, and are subject to extreme variability. TCE is found at the highest concentrations and in more wells than another COC. With the exception of benzene in the Southern Plume, BTEX compounds are restricted to the Former Source Area, particularly near MW-16 and MW-21. Monitoring for 1,4-dioxane was increased during this review period.

Although the 1,4-dioxane continued to be found in several wells at concentrations above the EPA Regional Screening Level ("RSL") for potable water of 0.46 µg/L (no MCL has been promulgated and no site-specific cleanup standard has been established), the extent of 1,4-dioxane remains generally similar as found in the last FYR. Inorganic elements are rarely present in groundwater at concentrations above cleanup levels, and when present, appear random in occurrence and exhibit no discernable trend.

Analytical results up and down gradient of the capture network indicate the system continues to capture most of the contaminated groundwater emanating from the vicinity of the Former Source Area. However, some observations suggest capture is incomplete. Concentrations in the Southern Plume have increased in the review period, due in part to the removal of Pond 11 in order to install an interceptor trench and extraction wells. Upon completion and connection of the system extension, it is anticipated that COC concentrations in the Southern Plume will decrease significantly. Down gradient results in the Northern Plume consistently decreased during the review period, although fluctuating results observed in sentinel wells suggest that capture in the northern part of the system is incomplete. Contaminated groundwater in the MW-23/SR-2 Area is not fully characterized because no additional sentinel wells are in reasonable proximity to MW-23. Perimeter wells located along the Site boundary indicate that contaminated groundwater from the MW-23/SR-2 Area is not migrating off-site.

The Site Residence is being impacted by organic vapors migrating from groundwater into the living space. The installation of a basement exhaust system has reduced the TCE concentrations in indoor air. However,

concentrations of TCE above EPA's current chronic inhalation reference concentration of 2 µg/m³ still exist, and the high concentrations of TCE in basement air and sump water indicates a significant potential for exposure exists. No other residential properties have been impacted or are anticipated to be impacted by organic vapors originating from site-related contamination.

V. TECHNICAL ASSESSMENT

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

Question A Summary:

No, the Remedy is not currently functioning as intended by the 1998 ROD. The RAO, which is to reduce or eliminate the potential for human and ecological exposure to COCs in subsurface soils and groundwater, has been met. However, observations made during the preparation of this FYR that have identified the potential for unacceptable exposures to occur unless certain steps are taken. The fundamental performance issue with the Remedy identified in the 2012 FYR was the absence of groundwater capture and containment near Pond 11, which allowed the potential for the Southern Plume to expand and COCs to migrate beyond the capture network. To address this issue, enhancement of the Remedy began in 2013 that involved the permanent draw down and regrading of the land in Pond 11, construction of a second interceptor trench, and installation of additional extraction wells. This work is anticipated to be completed by the end of 2017. Upon connection of the new components, it is anticipated that the enhancements will achieve capture and containment of contaminated groundwater on the southern portion of the Site and result in the reduction in the concentration of COCs and extent of the Southern Plume as intended by the Remedy.

However, it is evident from the data collected over the previous five years that the concentration of COCs in the Former Source Area has not been reduced and in some areas has increased. Additionally, increasing concentrations in some monitoring wells down gradient of the system in the Northern Plume and the Access Road Plume indicate capture and containment of contaminated groundwater by the interceptor trench and network of extraction wells may not be complete. Also, concentrations of some organic COCs in MW-23, which is located near the upper end of the suspected Access Road Plume, increased unexpectedly by as much as an order of magnitude within the last five years. The extent of contamination in the Access Road Plume is not fully defined. The installation of the groundwater interceptor trenches, when installed in the appropriate locations, is expected to be effective for controlling migration but will not have a significant effect on reducing COC concentrations in groundwater to achieve cleanup levels throughout the entire area of groundwater contamination.

Therefore, it is recommended that a remedial alternatives be evaluated and implemented to achieve cleanup levels throughout the entire area of groundwater contamination. Furthermore, an evaluation is necessary to determine if modification or optimization of the system is necessary to prevent the migration of contaminated groundwater. Finally, additional characterization of the Access Road Plume is necessary to determine if migration of contaminated groundwater is occurring in this portion of the Site.

ICs are required by the ROD to prevent disturbance of existing components of the Remedy, but have not yet been implemented. Additionally, ICs restricting the use of contaminated groundwater and preventing future exposure to vapor intrusion are necessary, but are not included in the ROD. A future decision document is necessary to include these additional ICs in the Remedy for the Site.

No man-made restrictions preventing access to the property are present. Natural features and the rural setting of the property restrict vehicular access and most pedestrian access. No vandalism or other impacts to the physical features of the remedy have been observed.

The soil cleanup and drum removal work (OU-2) is complete and was effective in removing contaminated soils and the drums that originally contained the sources of contamination. No current exposures to human health and

the environment exist because the residual hazardous substances are in the subsurface and access to the Site is restricted. However, ICs restricting potential exposure to subsurface soils that may contain elevated concentrations of COCs are not in place.

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

Question B Summary:

Some changes have been made to the exposure assumptions, toxicity data, and cleanup levels since the selection of the remedy in 1998. RAOs have not changed and are still valid. The changes do not impact the protectiveness or performance of the remedy. The cleanup level for arsenic in groundwater was lowered from 50 µg/L to 10 µg/L to meet the revised MCL through the ESD issued on April 15, 2009.

As part of this FYR, EPA reviewed the applicable or relevant and appropriate requirements ("ARARs") for the Site to determine if any significant changes in regulations, promulgated standards, or those "to be considered" ("TBC") such as criteria and guidance had occurred, and if so, whether the changes impact the selected cleanup levels or protectiveness of the remedy. A comprehensive list of those ARARs identified for the Site is included in the decision documents. During the review, EPA did not identify any changes in regulations, standards, or TBCs that would call into question the protectiveness of the remedy.

The groundwater and soil cleanup levels were derived in accordance with the requirement that remedial actions "at least" attain ARARs, including MCLs, and be protective of human health and the environment. The groundwater cleanup levels meet the current federal and Pennsylvania state cleanup levels or MCL. Toxicity criteria have changed for TCE and PCE, and the methodology of calculating risk for TCE has changed. These changes do not significantly impact the remedy at this time, and will be evaluated after all cleanup levels have been reached. Soil cleanup levels for both Soil Remedy Areas were reached upon completion of the remedial action.

Due to the large number of contaminants in groundwater, cleanup levels may be achieved for individual COCs but the cumulative risk presented all COCs may not be protective of human health. Therefore, to ensure that the cumulative risk is within the acceptable risk range after individual cleanup levels are achieved, a future decision document will include the requirement for a cumulative risk assessment after groundwater cleanup levels are achieved for all COCs.

Land use has not changed since the previous FYR. The Site is still used solely for residential purposes.

The potential for VOCs in groundwater to volatilize and impact human health by migrating into living spaces of overlying residential structures has continued to be evaluated as an exposure pathway by EPA for the Site Residence and by the OU-1 Group for off-Site residences closest to the groundwater plumes. At the Site Residence, the initial evaluation of this pathway was conducted during the winter of 2008-2009, and has been conducted each subsequent winter. Results of sampling from winter 2008-2009 through winter 2010-2011 indicate that the Site Residence on the Boarhead Farms property contained concentrations of TCE in indoor air approximately two to three orders of magnitude above the Regional screening level. The action that significantly reduced the intrusion of organic vapors at the Site Residence was installation of a basement exhaust fan. After installation of the fan in 2013, concentrations of TCE in indoor air and basement air decreased by approximately one order of magnitude. However, TCE concentrations in indoor air are still above EPA's current chronic inhalation reference concentration of 2 µg/m³. EPA continues to monitor the conditions in the Site Residence and evaluate alternatives to address the elevated concentrations of VOCs in indoor air. Results from sampling performed annually in two off-Site residences by the OU-1 Group indicates that the intrusion of organic vapors is not occurring.

No newly identified contaminants, contaminant sources or unanticipated toxic byproducts of the remedy are known, and physical site conditions have not changed in a way that could affect the protectiveness of the remedy.

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

Question C Summary:
No other information has come to light that could call into question the protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None

Issues and Recommendations Identified in the Five-Year Review:				
OU: 01	**Issue Category:** Remedy Performance			
	Issue: Fluctuating concentration trends in down gradient monitoring wells suggests that capture and containment of contaminated groundwater by the extraction system is not complete.			
	Recommendation: Determine if optimization of the extraction system network is necessary to fully capture and contain contaminated groundwater and reduce the potential for further migration of contaminated groundwater at the Site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	9/30/2018

OU: 01	**Issue Category:** Remedy Performance			
	Issue: The extent of groundwater contaminated with COCs above cleanup levels in the Access Road Plume is not fully defined.			
	Recommendation: Install sentinel monitoring wells to define the extent of contaminated groundwater in the Access Road Plume.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	9/30/2018

Issues and Recommendations Identified in the Five-Year Review (Continued):					
OU: 01	**Issue Category:** Remedy Performance				
	Issue: The Remedy requires that cleanup levels for all COCs be met throughout the entire area of contaminated groundwater. Concentrations of some COCs in the Former Source Area are periodically as great as five orders of magnitude above cleanup levels and COC concentrations in the Northern, Southern, and Access Road Plumes have shown periodic increases. The selected Remedy, as currently implemented, may not be able to achieve groundwater cleanup levels throughout the entire area of contaminated groundwater.				
	Recommendation: Evaluate and implement remedial alternatives to achieve groundwater cleanup levels throughout the entire area of contaminated groundwater.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**	
No	Yes	PRP	EPA	9/30/2018	

OU: 01	**Issue Category:** Remedy Performance				
	Issue: TCE is present in indoor air at the Site Residence on the Site at concentrations exceeding EPA's current chronic inhalation reference concentration of 2 µg/m³.				
	Recommendation: Evaluate and implement additional measures until indoor air concentrations present no unacceptable risks to human health.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**	
Yes	Yes	PRP	EPA	3/31/2018	

OU: 01	**Issue Category:** Remedy Performance				
	Issue: Due to the large number of contaminants in groundwater, performance standards for individual COCs may be achieved while total COC concentrations may be above acceptable risk levels.				
	Recommendation: Modify the Remedy in a future decision document to require the performance of a cumulative risk assessment after cleanup levels for all contaminants are achieved.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**	
No	Yes	PRP	EPA	3/31/2018	

Issues and Recommendations Identified in the Five-Year Review (Continued):				
OU: 01	**Issue Category:** Remedy Performance			
	Issue: 1,4-Dioxane has been observed in groundwater at concentrations above the Regional screening level.			
	Recommendation: Perform a risk assessment, and if warranted, add 1,4-dioxane as a COC in groundwater in a future decision document.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	12/31/2017

OU: 01, 02	**Issue Category:** Institutional Controls			
	Issue: Institutional controls selected in the Remedy do not restrict the use of contaminated groundwater or limit the potential for exposure due to vapor intrusion.			
	Recommendation: Modify the Remedy in a future decision document to include restrictions on use of contaminated groundwater and provisions for evaluating or limiting exposure to vapor intrusion.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	12/31/2017

OU: 01, 02	**Issue Category:** Institutional Controls			
	Issue: Institutional controls selected in the remedy have not been implemented.			
	Recommendation: Implement institutional controls.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	6/30/2019

Other Findings

No other findings that actually or potentially impact protectiveness of the Remedy were identified.

VII. PROTECTIVENESS STATEMENT

OU1 Protectiveness Statement	
Protectiveness Determination: Not Protective	*Planned Addendum Completion Date:* 06/30/2018
Protectiveness Statement: The remedy for OU-1 has been constructed as designed and is effective at treating groundwater captured in the trench extraction wells. The capture of contaminated groundwater by the extraction system from the Former Source Area is not complete but overall is effective at preventing unacceptable exposures to human health. The new interceptor trench and extraction wells installed in the footprint of former Pond 11 are scheduled to be activated in 2017. Residential point-of-entry treatment systems are installed at the Site Residence and at off-site residences. The Remedy for OU-1 is not considered protective due to the presence of TCE in indoor air at the Site Residence at concentrations EPA's current chronic inhalation reference concentration of 2 µg/m³. Organic vapors in indoor air of the Site Residence must be addressed to achieve protectiveness in the short term. In order for the OU-1 Remedy to be protective in the long term, the newly installed interceptor trench and extraction wells must be activated, capture of contaminated groundwater by the extraction system must be evaluated and verified, the Access Road Plume must be adequately characterized, alternatives for achieving groundwater cleanup levels throughout the area of groundwater contamination must be evaluated and verified, the risk due to 1,4-dioxane in groundwater must be assessed, ICs restricting aquifer use and requiring O&M of the vapor mitigation components in the Site Residence must be added to the Remedy, and ICs must be implemented.	

OU2 Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Planned Addendum Completion Date:* N/A
Protectiveness Statement: The Remedy for OU-2 is currently protective of human health and the environment. The immediate threats were addressed through excavation and off-site disposal of buried containers and heavily contaminated soil in immediate contact with buried containers. In order for the remedy to be protective in the long term, ICs restricting potential exposures to residual hazardous substances in subsurface soils must be implemented.	

Sitewide Protectiveness Statement	
Protectiveness Determination: Not Protective	*Planned Addendum Completion Date:* 06/30/2018
Protectiveness Statement: The Remedy for OU-2 and the majority of OU-1 is currently protective. However, due to the presence of site-related contaminants in indoor air at the Site Residence on the Site at concentrations EPA's current chronic inhalation reference concentration of 2 µg/m³, the Remedy for OU-1 is not considered protective. Therefore, the Site will not be considered protective in the short term until vapor intrusion has been addressed in the Site Residence. To achieve long-term protectiveness, the newly installed interceptor trench and extraction wells must be activated, capture of contaminated groundwater by the extraction system must be evaluated and verified, the Access Road Plume must be adequately characterized, alternatives for achieving groundwater cleanup levels throughout the area of groundwater contamination must be evaluated and implemented, the risk due to 1,4-dioxane in groundwater must be assessed, ICs restricting aquifer use and requiring O&M of the vapor mitigation components in the Site Residence must be added to the Remedy, and ICs must be implemented.	

VIII. GOVERNMENT PERFORMANCE AND RESULTS ACT MEASURES

As part of this five-year review, the Government Performance and Results Act ("GPRA") Measures have also been reviewed. The GPRA Measures and their status are provided as follows:

Environmental Indicators
Human Health: Human Exposure Not Under Control
Groundwater Migration: Groundwater Migration Not Under Control

Sitewide Ready for Anticipated Use ("SWRAU")
Conditions for SWRAU status have not been achieved.

IX. NEXT REVIEW

The next FYR report for the Site is required five years from the completion date of this review.

APPENDIX A – REFERENCE LIST

Brown and Caldwell. 2002. Boarhead Farms Superfund Site, Upper Black Eddy, Bucks County, PA. Operable Unit No. 2 Remedial Design, Engineering Report. Volumes I, II, and III. Prepared for Boarhead Farms Superfund Site OU-2 Group. October 1.

Brown and Caldwell. 2004. Boarhead Farms Superfund Site, Upper Black Eddy, Bucks County, PA. Remedial Construction Report, Operable Unit No. 2. Prepared for Boarhead Farms Superfund Site OU-2 Group. May 28.

Brown and Caldwell. 2011. Boarhead Farms Superfund Site, Upper Black Eddy, Bucks County, PA. Draft Focused Feasibility Report, Operable Unit No. 1. Prepared for Boarhead Farms Superfund Site OU-1 Group. September.

Brown and Caldwell. 2017. Boarhead Farms Superfund Site, Upper Black Eddy, Bucks County, PA, LTMP Monitoring Report, October 2016 (Monitoring). Prepared for Boarhead Farms Superfund Site OU-1 Group. January.

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CH2M Hill. 1997. Boarhead Farms Remedial Investigation Report. January 31.

J.M. Sorge, Inc. 1993. Response Action Plan, Boarhead Farms EPA Superfund Site, Lonely Cottage Road, Upper Black Eddy, Bucks County, Pennsylvania. Prepared for General Ceramics, Inc. January.

Tetra Tech EM Inc. 2016. Trip Report for Boarhead Farms. Boarhead Farms Superfund Site, Bridgeton Township, Bucks County, Pennsylvania. June 16.

U.S. Environmental Protection Agency. 1992. Memorandum, RE: Approval of a Funding Request for a Removal Action, Boarhead Farms NPL Site, Upper Black Eddy, Bucks County, Pennsylvania. From Edwin B. Erickson, Regional Administrator to Donald R. Clay, Assistant Administrator, Office of Solid Waste and Emergency Response. February 26.

U.S. Environmental Protection Agency. 1994. Memorandum, RE: Engineering Evaluation and Cost Analysis (EE/CA) Approval Memorandum, Boarhead Farms NPL Site, Upper Black Eddy, Bucks County, Pennsylvania. From Peter H. Kostmayer, Regional Administrator to Elliott Laws, Assistant Administrator, Office of Solid Waste and Emergency Response. April 18.

U.S. Environmental Protection Agency. 1995. Federal On-Scene Coordinator's Report, Boarhead Farms Superfund Site, Bridgeton Township, Bucks County, Pennsylvania. May 12.

U.S. Environmental Protection Agency. 1995. Engineering Evaluation/Cost Analysis, Boarhead Farms Superfund Site, Bridgeton Township, Bucks County, Pennsylvania. June.

U.S. Environmental Protection Agency. 1998. Record of Decision, Boarhead Farms Superfund Site, Bridgeton Township, Bucks County, Pennsylvania. November 18.

U.S. Environmental Protection Agency. 2003. Preliminary Close-Out Report, Boarhead Farms Superfund Site, Bridgeton Township, Bucks County, Pennsylvania. November 10.

U.S. Environmental Protection Agency. 2007. Five-Year Review Report, Boarhead Farms Superfund Site, Bridgeton Township, Bucks County, Pennsylvania. August 22.

U.S. Environmental Protection Agency. 2009. Explanation of Significant Differences, Boarhead Farms Superfund Site, Bridgeton Township, Bucks County, Pennsylvania. April 15.

U.S. Environmental Protection Agency. 2009. Memorandum, RE: Notification of CERCLA Emergency Removal Action at the Boarhead Farms NPL Site. From Eugene Dennis, On-Scene Coordinator to Regional Response Center. May 28.

U.S. Environmental Protection Agency. 2012. Five-Year Review Report, Boarhead Farms Superfund Site, Bridgeton Township, Bucks County, Pennsylvania. September 22.

APPENDIX B - DISCHARGE MONITORING REPORT

PERMITTEE NAME/ADDRESS (Include Facility Name/Location if Different)
NAME Boarhead Farms c/o de maximis, inc.
ADDRESS 1550 Pond Rd, Suite 120
Allentown, PA 18104

FACILITY LOCATION Groundwater Treatment System
1310 Lonely Cottage Rd 18972

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

(2-16) PERMIT NUMBER	(17-19) DISCHARGE NUMBER
PAXXXX	001

MONITORING PERIOD

	YEAR	MO	DAY		YEAR	MO	DAY
FROM	16	10	01	TO	16	12	31
	(20-21)	(22-23)	(24-25)		(26-27)	(28-29)	(30-31)

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PARAMETER (32-37)		(3 Card Only) QUANTITY OR LOADING (46-53) AVERAGE	(54-61) MAXIMUM	UNITS	(4 Card Only) QUALITY OR CONCENTRATION (38-45) MINIMUM	(46-53) AVERAGE	(54-61) MAXIMUM	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAMPLE TYPE (69-70)
FLOW (MGD)	SAMPLE MEASUREMENT	0.004021	0.008334	MGD	XXXX	XXXX	XXXX	XXXX		CONT	REC
	PERMIT REQUIREMENT	MONITOR	MONITOR		XXXX	XXXX	XXXX			CONT	REC
ANTIMONY	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0077	<0.0077	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.015	0.031			1/QTR	8 HC
ARSENIC	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	0.0445	0.0445	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	MONITOR/ REPORT	MONITOR/ REPORT			1/QTR	8 HC
CADMIUM	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.00049	<0.00049	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.0042	0.0084			1/QTR	8 HC
CHROMIUM HEXAVALENT	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0010	<0.0010	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.011	0.023			1/QTR	8 HC
COPPER	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0041	<0.0041	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.016	0.033			1/QTR	8 HC
LEAD	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0062	<0.0062	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.007	0.014			1/QTR	8 HC

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE		
	I CERTIFY UNDER PENALTY OF LAW THAT THIS DOCUMENT AND ALL ATTACHMENTS WERE PREPARED UNDER MY DIRECTION OR SUPERVISION IN ACCORDANCE WITH A SYSTEM DESIGNED TO ASSURE THAT QUALIFIED PERSONNEL PROPERLY GATHER AND EVALUATE THE INFORMATION SUBMITTED. BASED ON MY INQUIRY OF THE PERSON OR PERSONS WHO MANAGE THE SYSTEM, OR THOSE PERSONS DIRECTLY RESPONSIBLE FOR GATHERING THE INFORMATION, THE INFORMATION SUBMITTED IS, TO THE BEST OF MY KNOWLEDGE AND BELIEF, TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT FOR KNOWING VIOLATIONS.		AREA CODE	NUMBER	YEAR	MO	DAY
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT					

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

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NICKEL	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	0.0039	0.0039	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.09	0.18			1/QTR	8 HC
ZINC	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	0.0066	0.0066	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.157	0.315			1/QTR	8 HC
MANGENESE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	0.595	0.595	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	1.12	2.24			1/QTR	8 HC
ALUMINUM	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0868	<0.0868	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.623	1.25			1/QTR	8 HC
COBALT	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0019	<0.0019	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.021	0.043			1/QTR	8 HC
IRON/TOTAL	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0747	<0.0747	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	1.68	3.36			1/QTR	8 HC
MERCURY	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.000050	<0.000050	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	ND	ND			1/QTR	8 HC

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SILVER	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0019	<0.0019	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.008	0.017			1/QTR	8 HC
CYANIDE, FREE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0040	<0.0040	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.005	0.011			1/QTR	8 HC
2,4,6-TRICHLOROPHENOL	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0007	<0.0007	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.0038	0.0076			1/QTR	GRAB
BENZENE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.0022	0.004			1/QTR	GRAB
1,2-DICHLOROETHANE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.0007	0.0014			1/QTR	GRAB
1,1-DICHLOROETHYLENE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	ND	0.0002			1/QTR	GRAB
METHYLENE CHLORIDE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0002	<0.0002	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.0086	0.017			1/QTR	GRAB

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TETRACHLOROETHYLENE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.0015	0.003			1/QTR	GRAB
TOLUENE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.0023	0.0046			1/QTR	GRAB
1,1,1-TRICHLOROETHANE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.017	0.034			1/QTR	GRAB
TRICHLOROETHYLENE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	0.0001	0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.005	0.01			1/QTR	GRAB
VINYL CHLORIDE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	0.0036	0.0072			1/QTR	GRAB
ACETONE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0030	<0.0030	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	MONITOR/ REPORT	MONITOR/ REPORT			1/QTR	GRAB
XYLENES, TOTAL	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	MONITOR/ REPORT	MONITOR/ REPORT			1/QTR	GRAB

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE		
	I CERTIFY UNDER PENALTY OF LAW THAT THIS DOCUMENT AND ALL ATTACHMENTS WERE PREPARED UNDER MY DIRECTION OR SUPERVISION IN ACCORDANCE WITH A SYSTEM DESIGNED TO ASSURE THAT QUALIFIED PERSONNEL PROPERLY GATHER AND EVALUATE THE INFORMATION SUBMITTED. BASED ON MY INQUIRY OF THE PERSON OR PERSONS WHO MANAGE THE SYSTEM, OR THOSE PERSONS DIRECTLY RESPONSIBLE FOR GATHERING THE INFORMATION, THE INFORMATION SUBMITTED IS, TO THE BEST OF MY KNOWLEDGE AND BELIEF, TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT FOR KNOWING VIOLATIONS.		AREA CODE	NUMBER	YEAR	MO	DAY
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT					

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

PERMITTEE NAME/ADDRESS (Include Facility Name/Location if Different)
NAME Boarhead Farms c/o de maximis, inc.
ADDRESS 1550 Pond Rd, Suite 120
Allentown, PA 18104

FACILITY LOCATION Groundwater Treatment System
1310 Lonely Cottage Rd 18972

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

(2-16) PERMIT NUMBER	(17-19) DISCHARGE NUMBER
PAXXXX	001

MONITORING PERIOD	YEAR	MO	DAY		YEAR	MO	DAY
FROM / TO	16	10	01		16	12	31
	(20-21)	(22-23)	(24-25)		(26-27)	(28-29)	(30-31)

Form Approved.
OMB No. 2040-0004
Approval expires 05-31-98

☐ Check here if No Discharge

NOTE: Read Instructions before completing this form

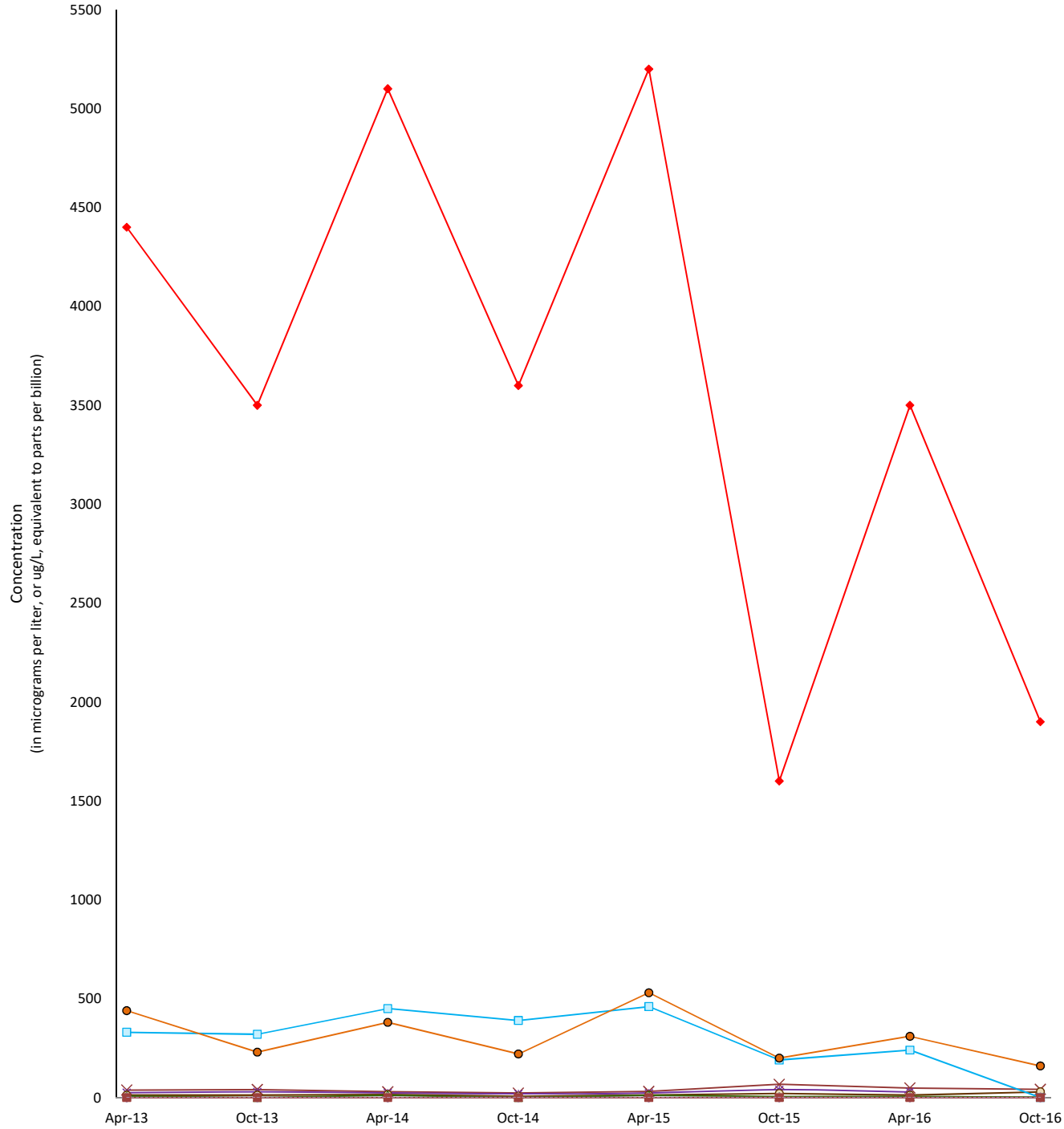
PARAMETER (32-37)		(3 Card Only) QUANTITY OR LOADING (46-53) AVERAGE	(54-61) MAXIMUM	UNITS	(4 Card Only) QUALITY OR CONCENTRATION (38-45) MINIMUM	(46-53) AVERAGE	(54-61) MAXIMUM	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAMPLE TYPE (69-70)
1,2-DICHLOROBENZENE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0001	<0.0001	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	MONITOR/ REPORT	MONITOR/ REPORT			1/QTR	GRAB
NAPHTHALENE	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0002	<0.0002	MG/L		1/QTR	GRAB
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	MONITOR/ REPORT	MONITOR/ REPORT			1/QTR	GRAB
CHROMIUM, TRIVALENT	SAMPLE MEASUREMENT	XXXX	XXXX	XXXX	XXXX	<0.0018	<0.0018	MG/L		1/QTR	8 HC
	PERMIT REQUIREMENT	XXXX	XXXX		XXXX	MONITOR/ REPORT	MONITOR/ REPORT			1/QTR	8 HC
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										
	SAMPLE MEASUREMENT										
	PERMIT REQUIREMENT										

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE		
	I CERTIFY UNDER PENALTY OF LAW THAT THIS DOCUMENT AND ALL ATTACHMENTS WERE PREPARED UNDER MY DIRECTION OR SUPERVISION IN ACCORDANCE WITH A SYSTEM DESIGNED TO ASSURE THAT QUALIFIED PERSONNEL PROPERLY GATHER AND EVALUATE THE INFORMATION SUBMITTED. BASED ON MY INQUIRY OF THE PERSON OR PERSONS WHO MANAGE THE SYSTEM, OR THOSE PERSONS DIRECTLY RESPONSIBLE FOR GATHERING THE INFORMATION, THE INFORMATION SUBMITTED IS, TO THE BEST OF MY KNOWLEDGE AND BELIEF, TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT FOR KNOWING VIOLATIONS.		AREA CODE / NUMBER	YEAR	MO	DAY
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT					

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

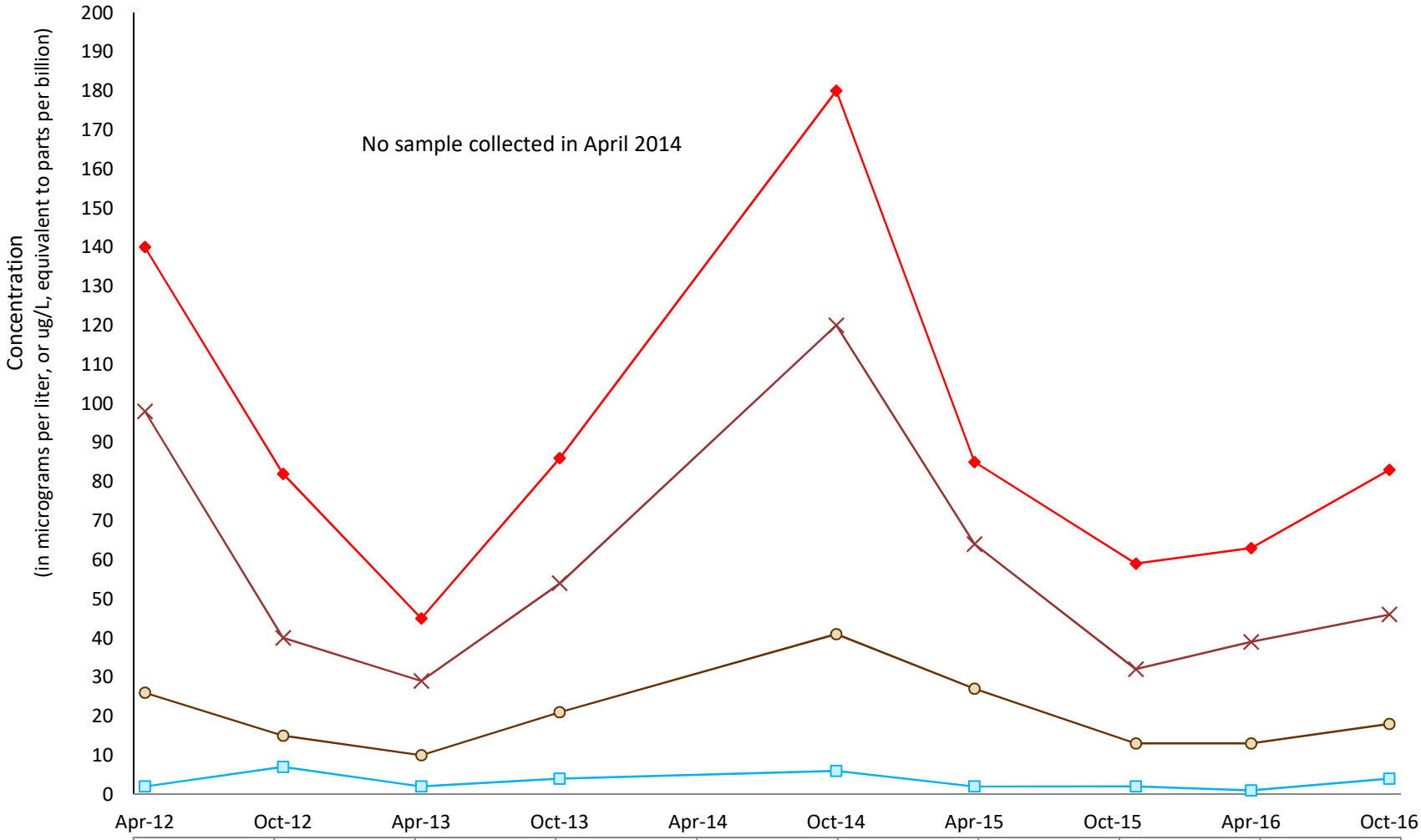
APPENDIX C - CONTAMINANT TIME-SERIES GRAPHS

Concentrations of VOCs in Source Area Well MW-10 (2012-2016)



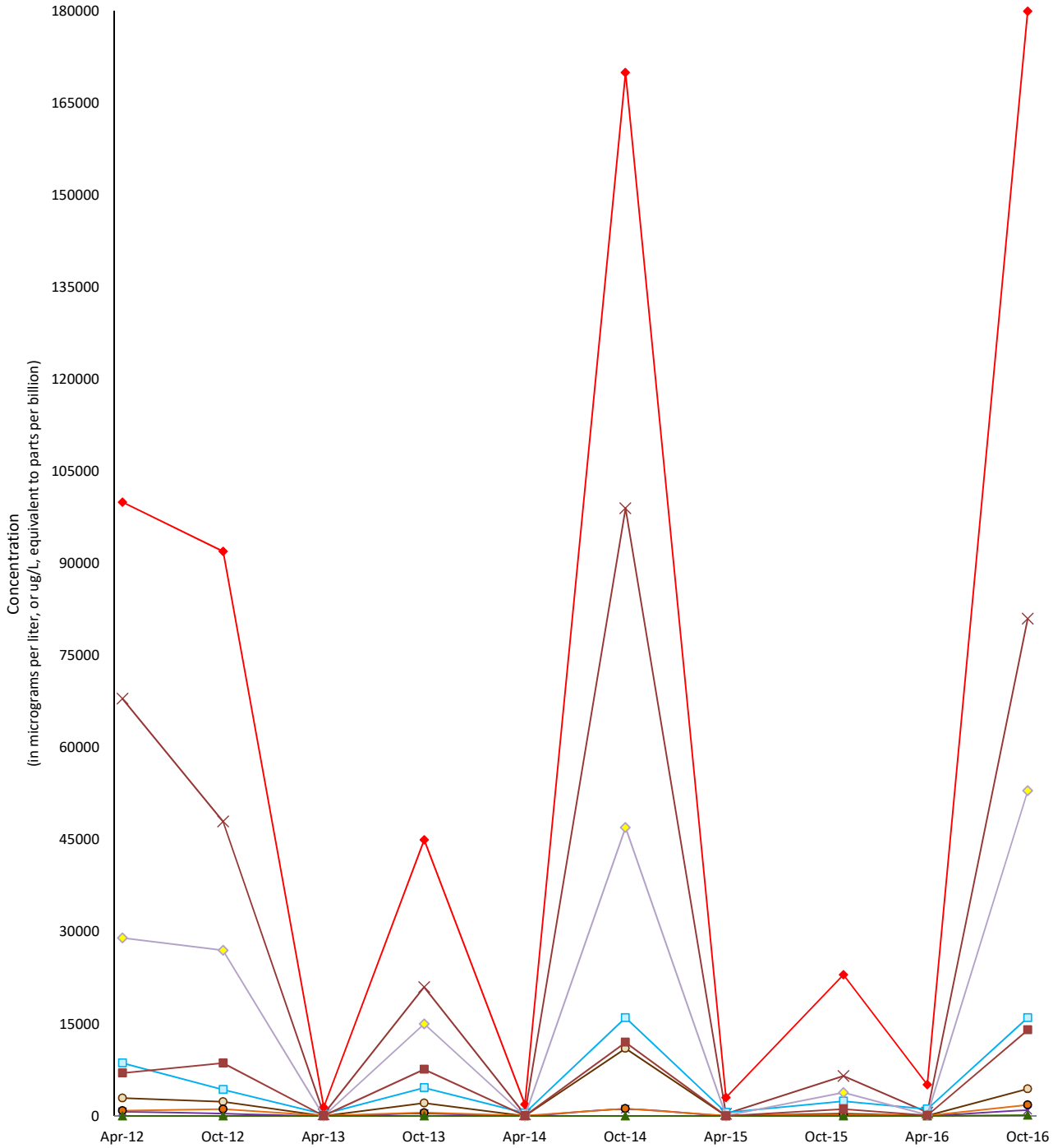
	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Oct-15	Apr-16	Oct-16
1,1,1-TCA	38	41	29	23	31	67	48	42
1,1-DCA	25	29	24	19	23	40	28	
1,1-DCE	12	12	15	7	12	21	12	29
Benzene	0	0	0	0	0	0	0	0
cis-1,2-DCE	330	320	450	390	460	190	240	0
PCE	440	230	380	220	530	200	310	160
TCE	4400	3500	5100	3600	5200	1600	3500	1900
VC	8	0	12	0	12	5	5	3
Toluene	0	0	0	0	0	0	0	0
Xylene	0	0	0	0	0	0	0	0

Concentrations of Select VOCs in Source Area Well MW-12 (2012-2016)



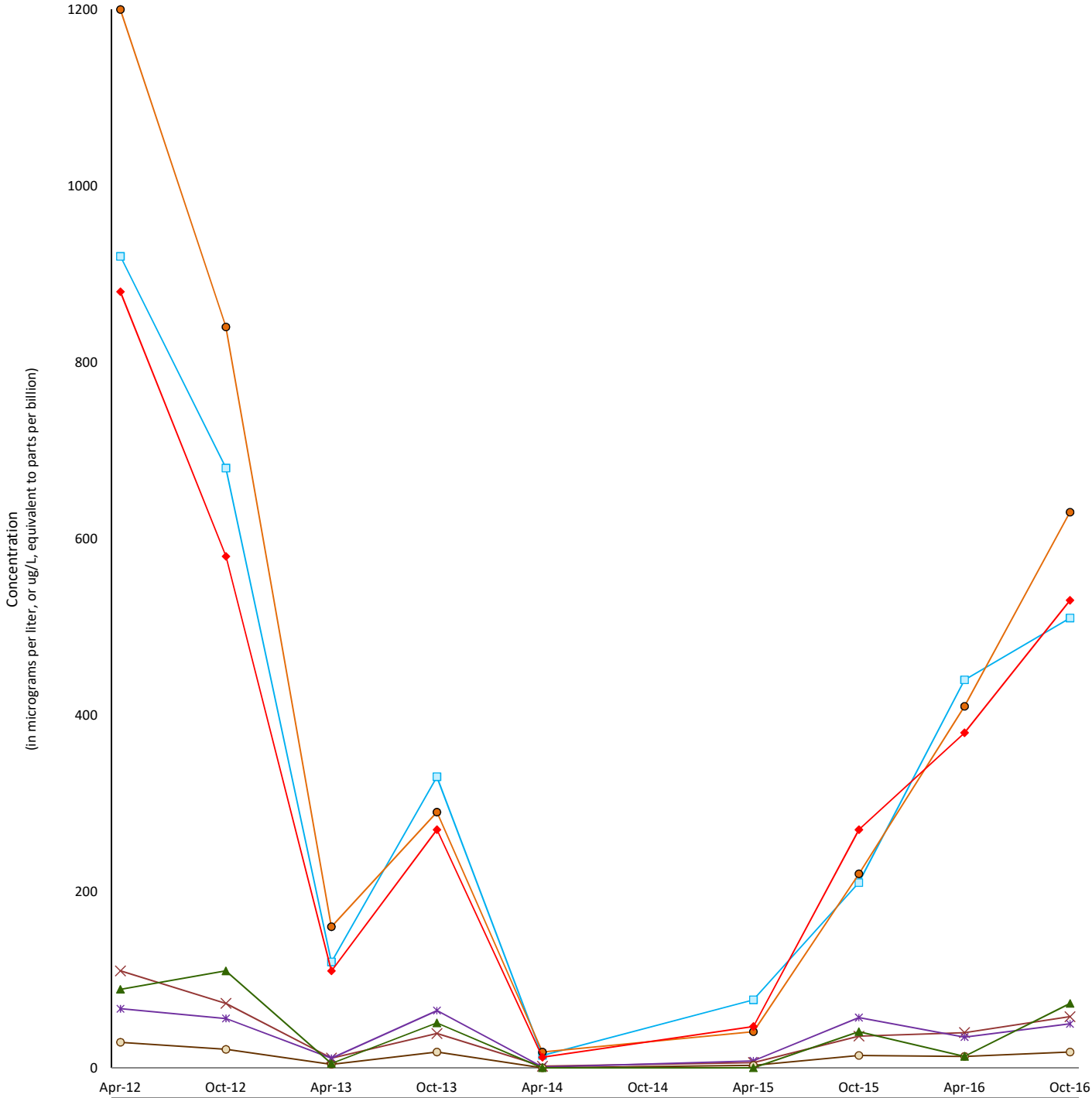
	Apr-12	Oct-12	Apr-13	Oct-13	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
1,1,1-TCA	98	40	29	54	120	64	32	39	46
1,1-DCE	26	15	10	21	41	27	13	13	18
cis-1,2-DCE	2	7	2	4	6	2	2	1	4
TCE	140	82	45	86	180	85	59	63	83

Concentrations of VOCs in Source Area Well MW-16 (2012-2016)



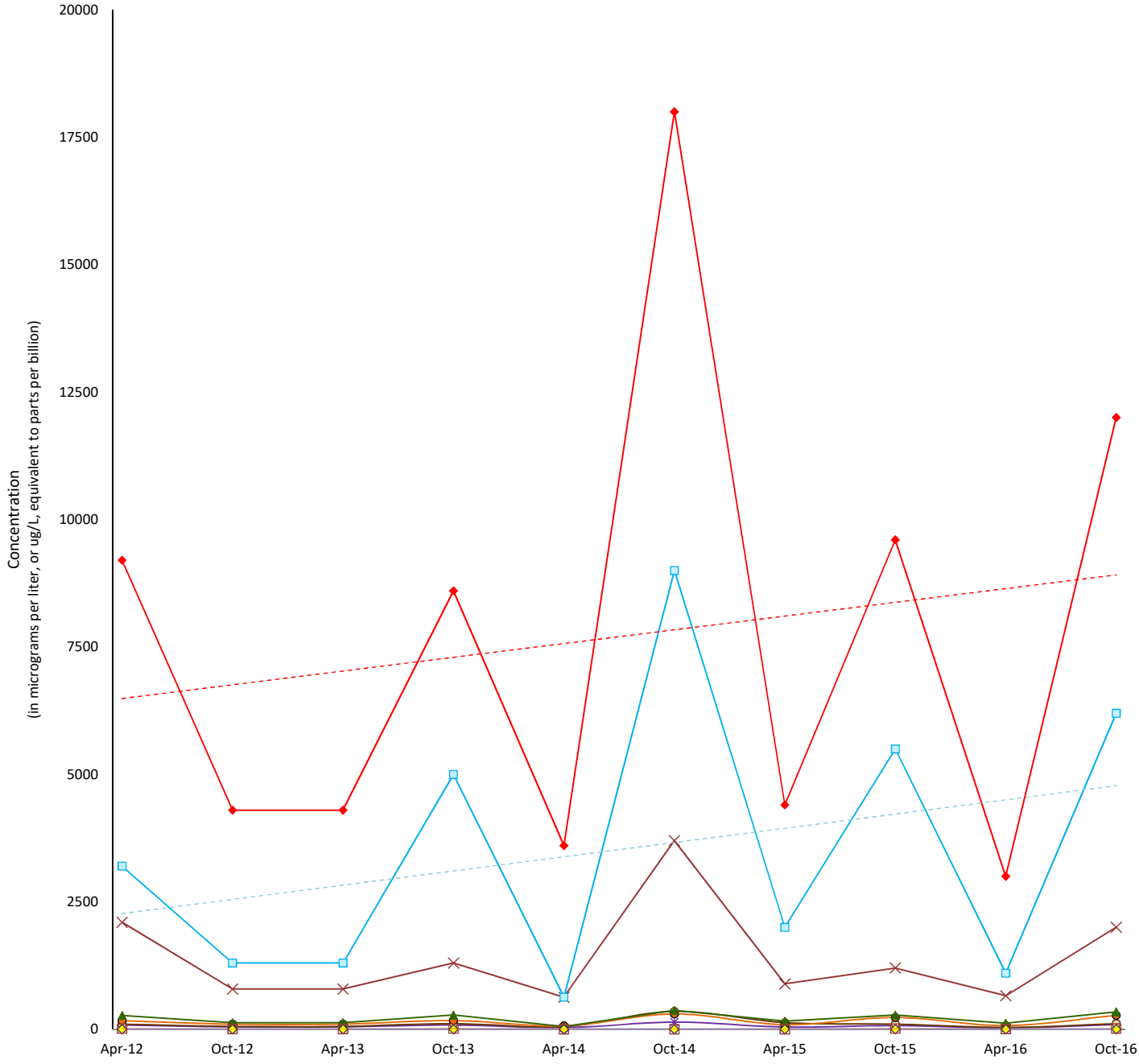
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
1,1,1-TCA	68000	48000	280	21000	270	99000	360	6500	580	81000
1,1-DCA	690	390	27	400	31	1100	62	180	87	960
1,1-DCE	2900	2300	10	2100	17	11000	48	370	35	4400
Benzene	0	0	0	0	0	0	0	0		
cis-1,2-DCE	8600	4300	300	4600	480	16000	560	2400	1100	16000
PCE	860	1100	37	540	30	1200	31	230	46	1800
TCE	100000	92000	1400	45000	1900	170000	3000	23000	5100	180000
VC	0	0	9	0	0	0	7	0	12	140
Toluene	29000	27000	6	15000	6	47000	21	3800	150	53000
Xylene	7000	8600	51	7600	41	12000	22	1100	73	14000

Concentrations of VOCs in Source Area Well MW-17 (2012-2016)



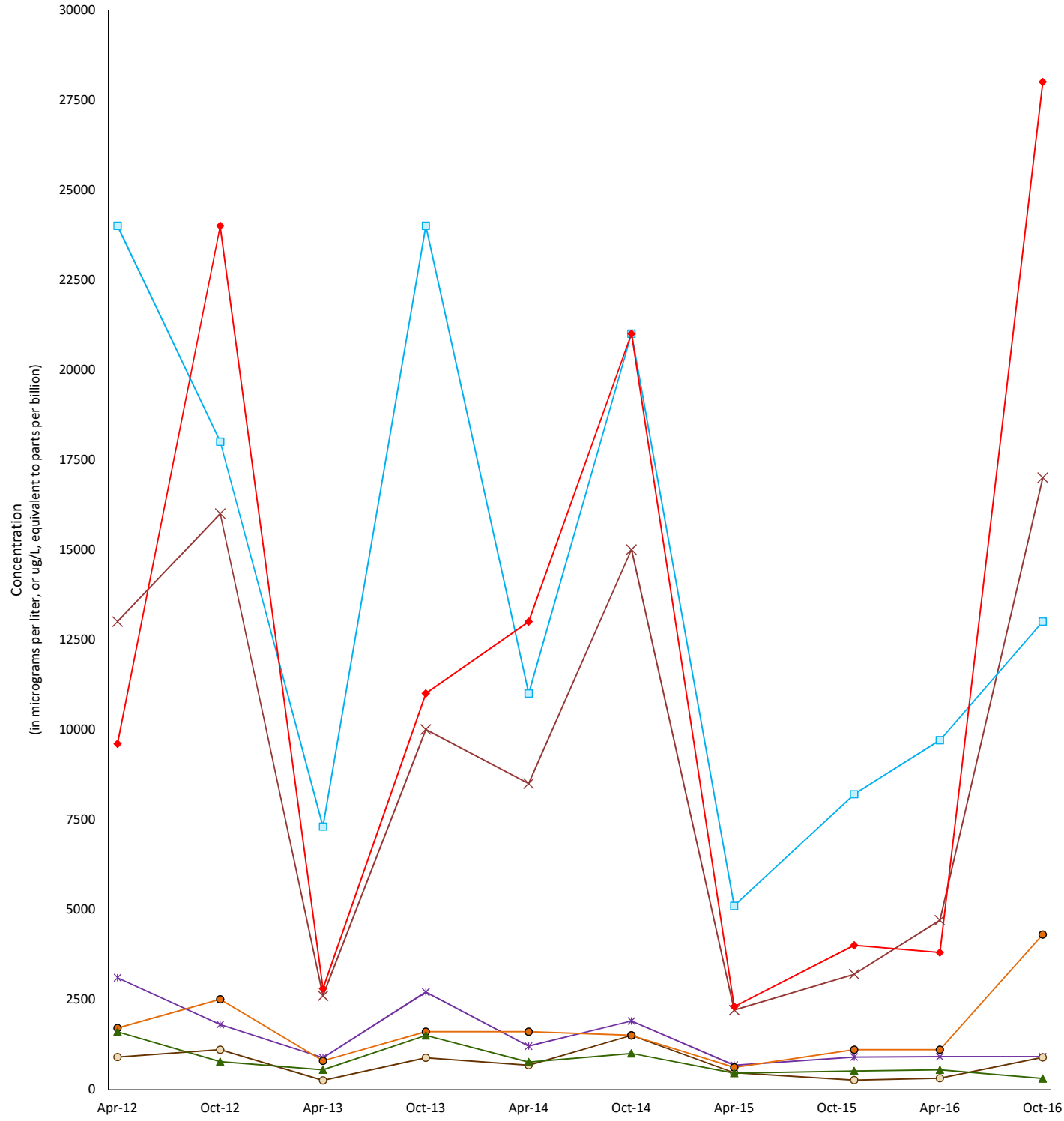
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Apr-15	Oct-15	Apr-16	Oct-16
1,1,1-TCA	110	73	11	39	2	6	36	40	58
1,1-DCA	67	56	11	65	1	8	57	35	50
1,1-DCE	29	21	4	18	0	3	14	13	18
cis-1,2-DCE	920	680	120	330	14	77	210	440	510
PCE	1200	840	160	290	18	41	220	410	630
TCE	880	580	110	270	12	47	270	380	530
VC	89	110	5	51	0	0	41	13	73

Concentrations of VOCs in Source Area Well MW-20 (2012-2016)



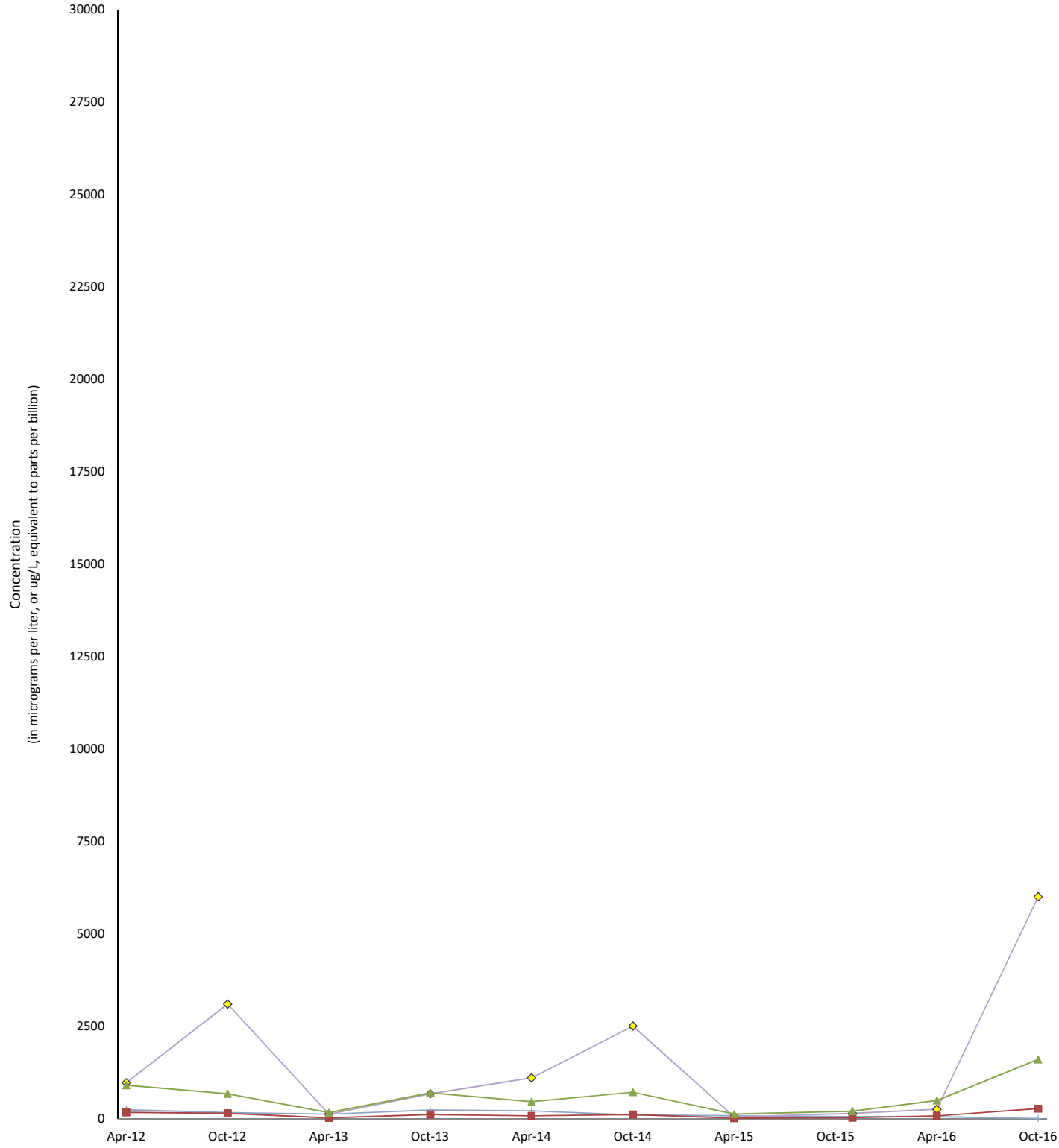
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Oct-15	Apr-16	Oct-16
1,1,1-TCA	2100	790	790	1300	630	3700	890	1200	660	2000
1,1-DCA	83	48	48	83	33	140	45	71	29	93
1,1-DCE	100	55	55	110	54	350	130	100	36	110
Benzene	0	0	0	0	0	0	0	0	0	0
cis-1,2-DCE	3200	1300	1300	5000	630	9000	2000	5500	1100	6200
PCE	170	100	100	170	66	300	90	230	72	270
TCE	9200	4300	4300	8600	3600	18000	4400	9600	3000	12000
VC	270	130	130	280	55	370	160	280	120	340
Toluene	0	0	0	0	0	0	0	0	0	0
Xylene	12	5	5	11	0	0	0	12	4	15

Concentrations of Chlorinated VOCs in Source Area Well MW-21 (2012-2016)



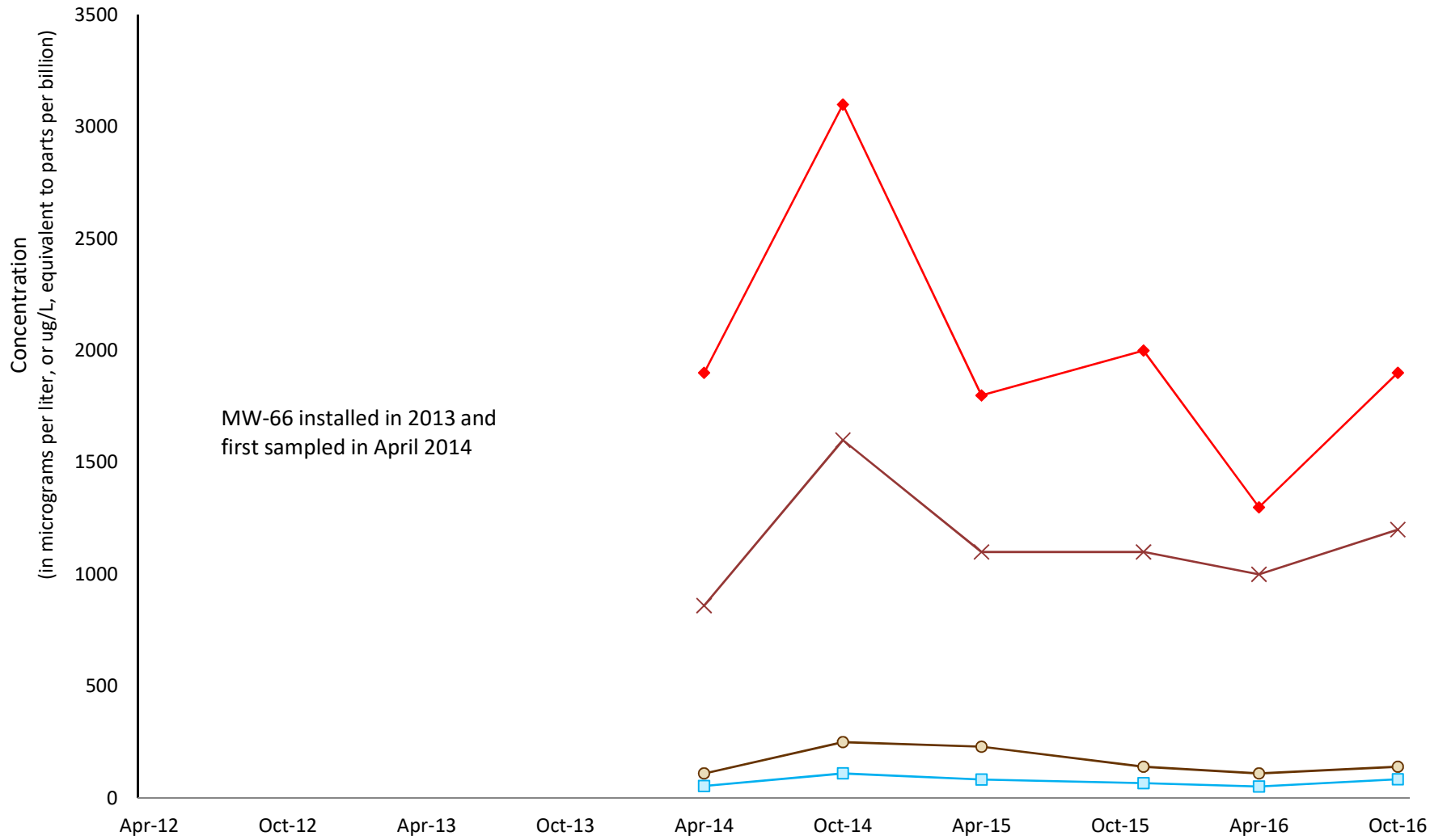
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
1,1,1-TCA	13000	16000	2600	10000	8500	15000	2200	3200	4700	17000
1,1-DCA	3100	1800	880	2700	1200	1900	670	900	910	910
1,1-DCE	900	1100	250	880	670	1500	460	260	310	890
cis-1,2-DCE	24000	18000	7300	24000	11000	21000	5100	8200	9700	13000
PCE	1700	2500	790	1600	1600	1500	610	1100	1100	4300
TCE	9600	24000	2800	11000	13000	21000	2300	4000	3800	28000
VC	1600	770	540	1500	760	1000	450	510	540	300

Concentrations of BTEX Compounds in Source Area Well MW-21 (2012-2016)



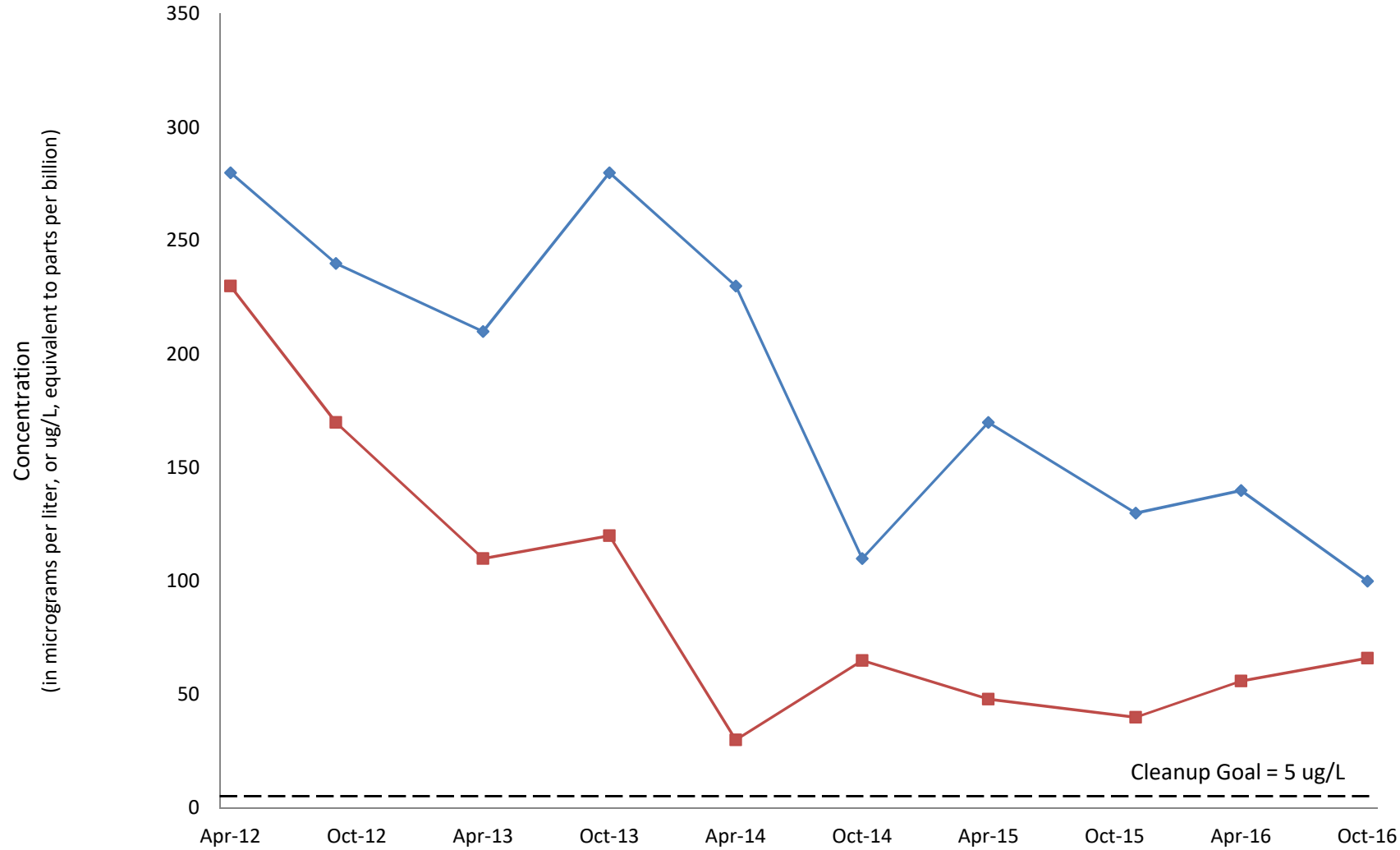
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
Benzene	240	160	120	230	210	95	79	51	49	0
Toluene	970	3100	120	670	1100	2500	43	140	250	6000
Ethylbenzene	170	140	19	110	73	110	12	22	74	270
Xylene	900	670	160	700	460	710	120	200	490	1600

Concentrations of VOCs in Source Area Well MW-66 (2012-2016)



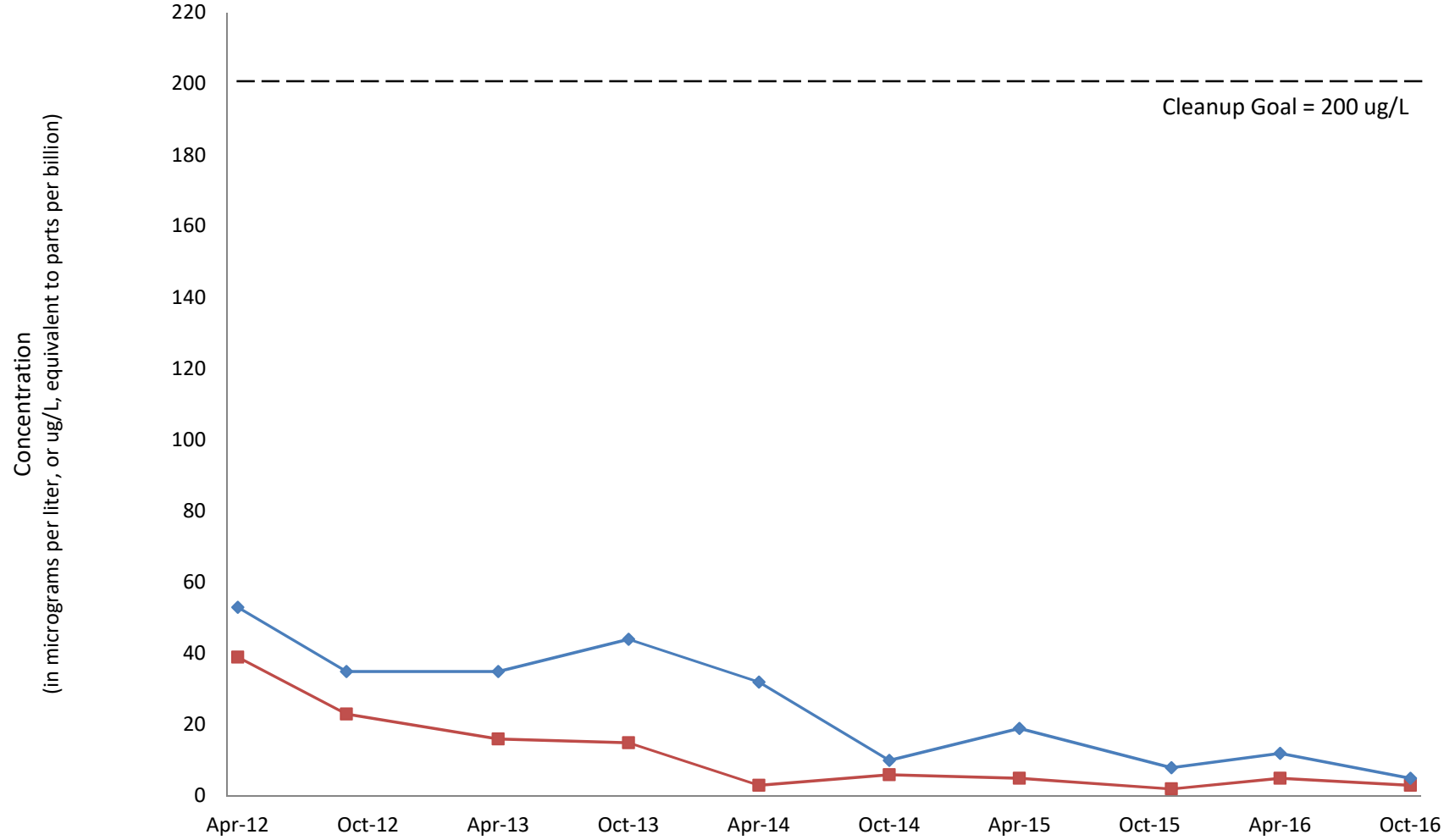
	Apr-12	Oct-12	Apr-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
1,1,1-TCA				860	1600	1100	1100	1000	1200
1,1-DCE				110	250	230	140	110	140
cis-1,2-DCE				54	110	83	67	52	84
TCE				1900	3100	1800	2000	1300	1900

Concentrations of TCE in Sentinel Well Pair RMW-37 and MW-53 (2012-2016)



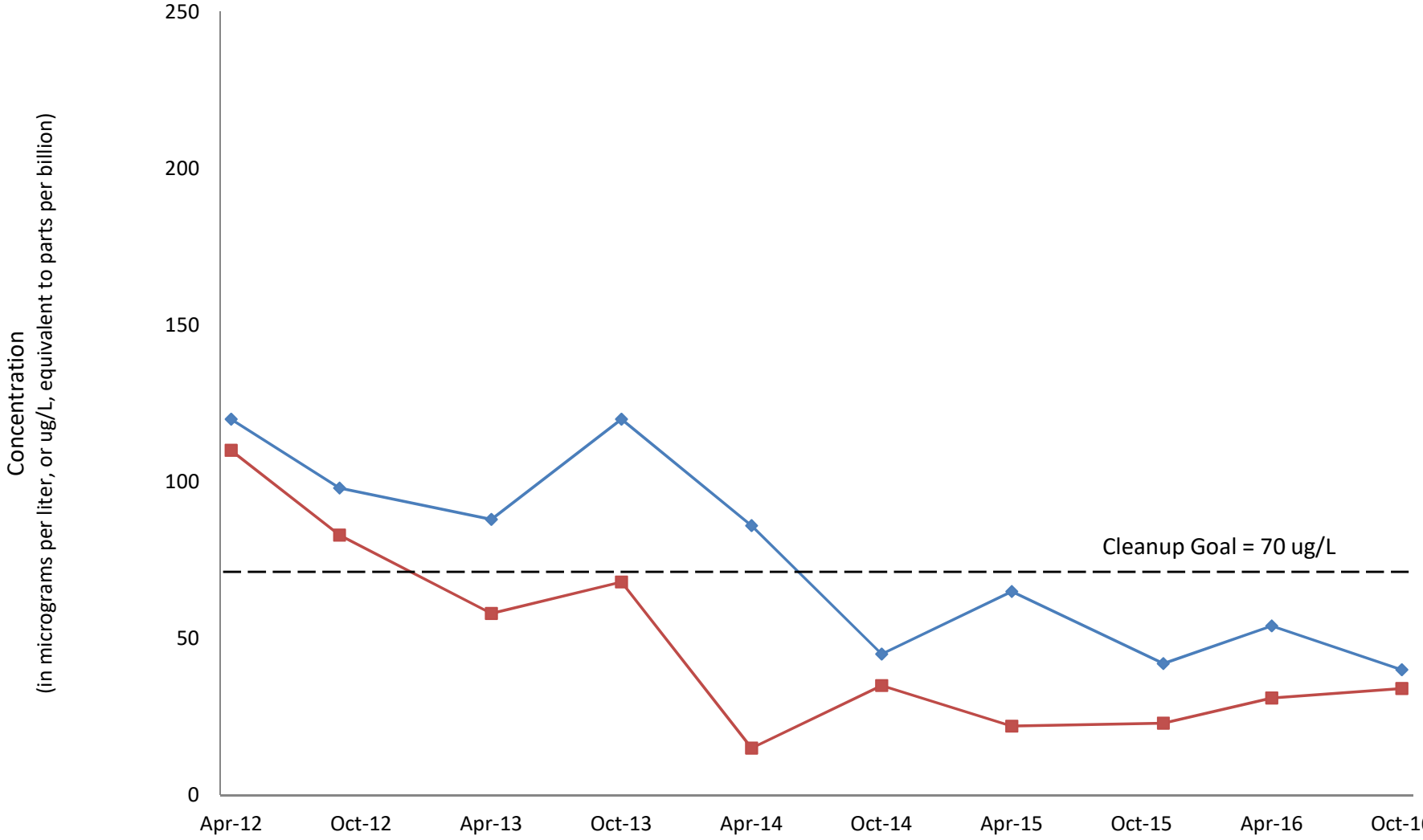
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-37 (saprolite)	230	170	110	120	30	65	48	40	56	66
MW-53 (bedrock)	280	240	210	280	230	110	170	130	140	100

Concentrations of 1,1,1-TCA in Sentinel Well Pair RMW-37 and MW-53 (2012-2016)



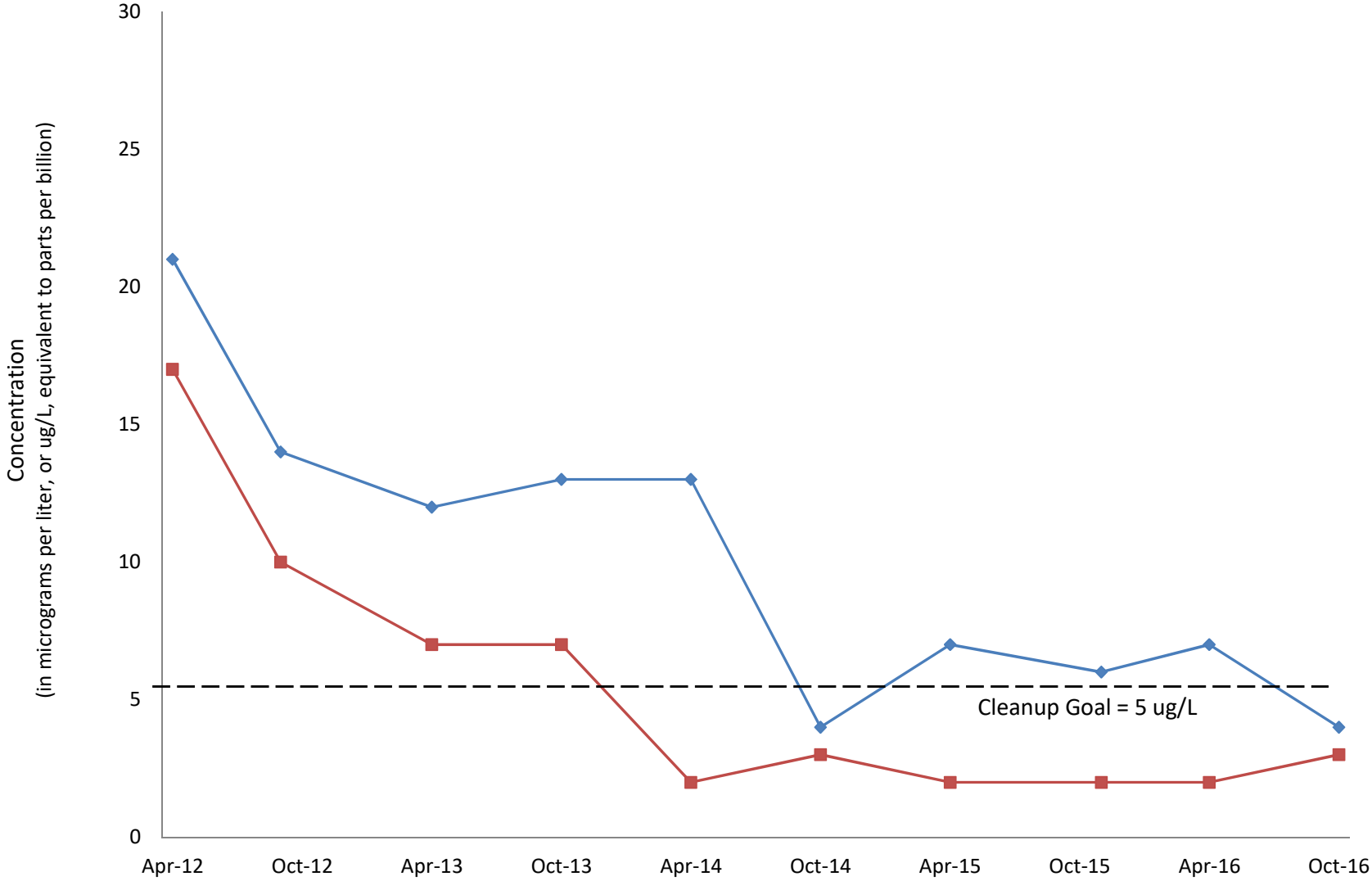
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-37 (saprolite)	39	23	16	15	3	6	5	2	5	3
MW-53 (bedrock)	53	35	35	44	32	10	19	8	12	5

Concentrations of cis-1,2-DCE in Sentinel Well Pair RMW-37 and MW-53 (2012-2016)



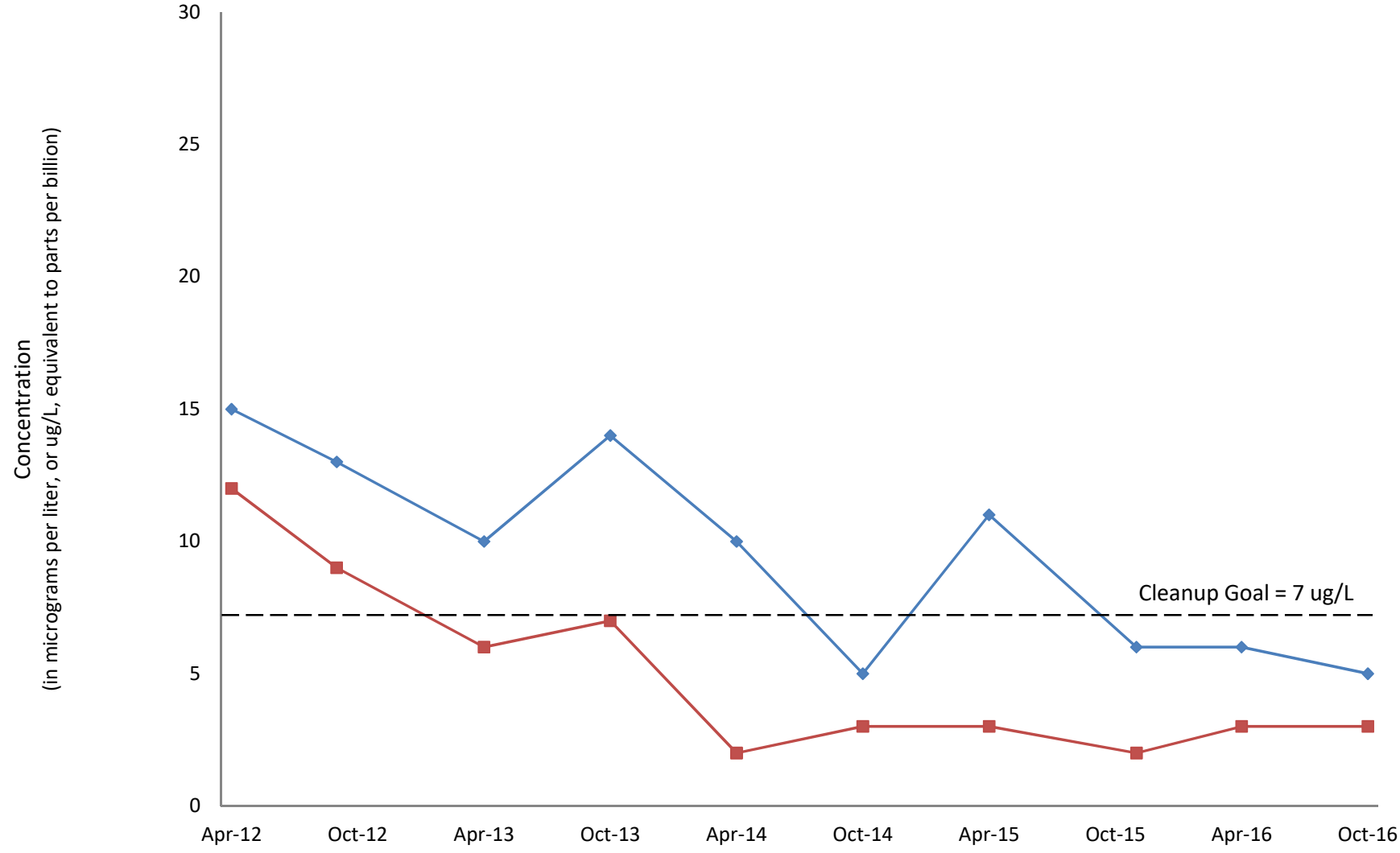
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-37 (saprolite)	110	83	58	68	15	35	22	23	31	34
MW-53 (bedrock)	120	98	88	120	86	45	65	42	54	40

Concentrations of PCE in Sentinel Well Pair RMW-37 and MW-53 (2012-2016)



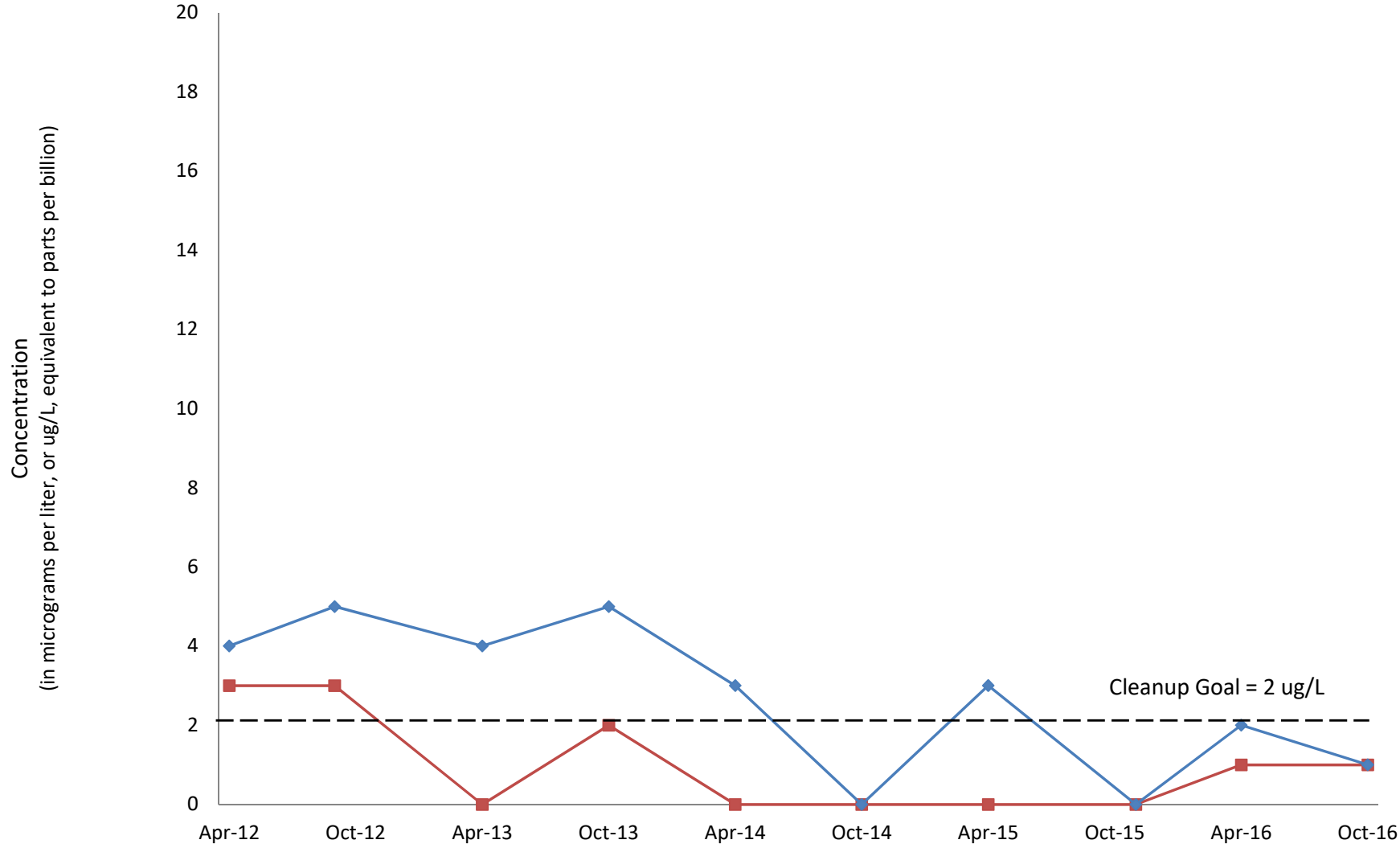
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-37 (saprolite)	17	10	7	7	2	3	2	2	2	3
MW-53 (bedrock)	21	14	12	13	13	4	7	6	7	4

Concentrations of 1,1-DCE in Sentinel Well Pair RMW-37 and MW-53 (2012-2016)



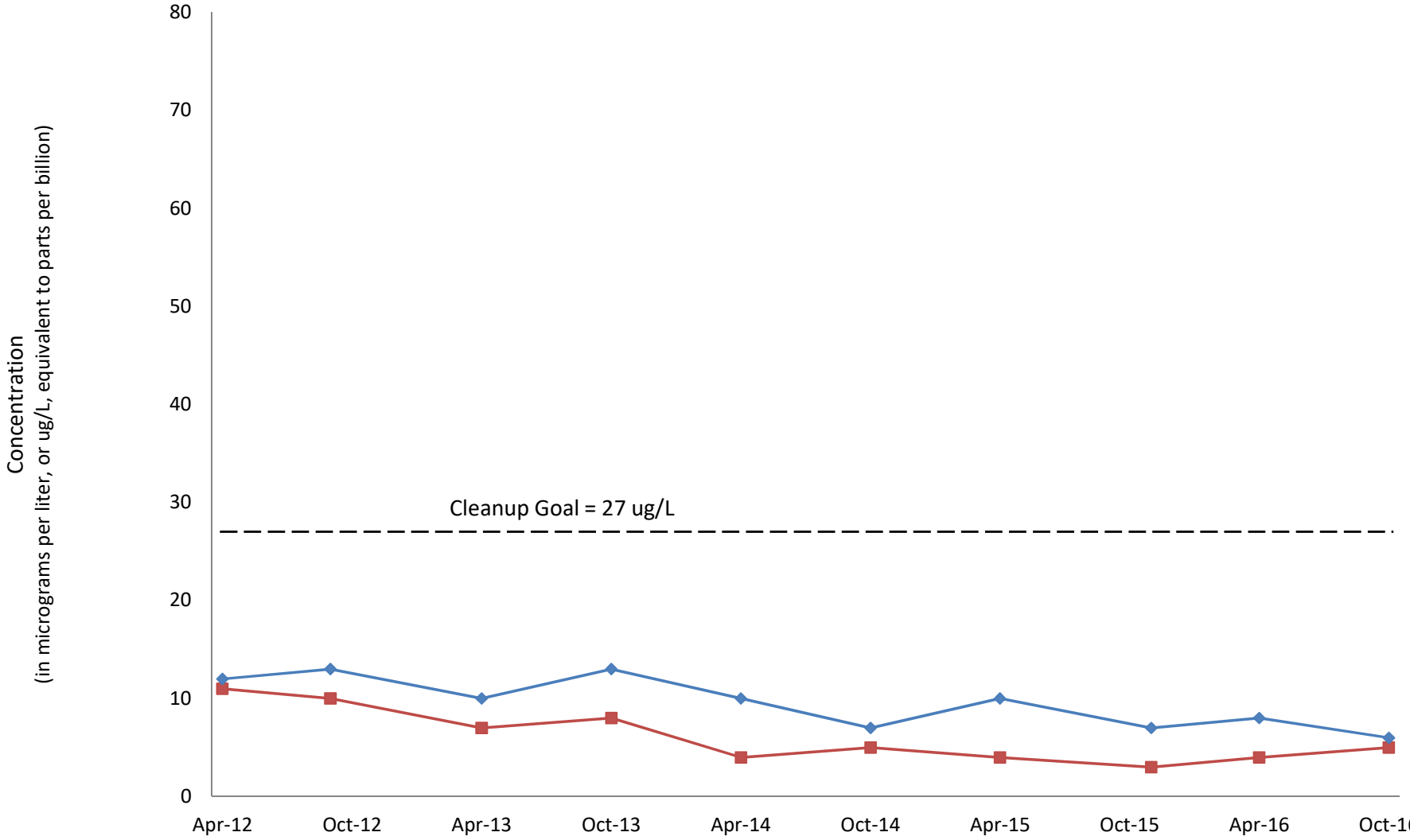
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-37 (saprolite)	12	9	6	7	2	3	3	2	3	3
MW-53 (bedrock)	15	13	10	14	10	5	11	6	6	5

Concentrations of Vinyl Chloride in Sentinel Well Pair RMW-37 and MW-53 (2012-2016)



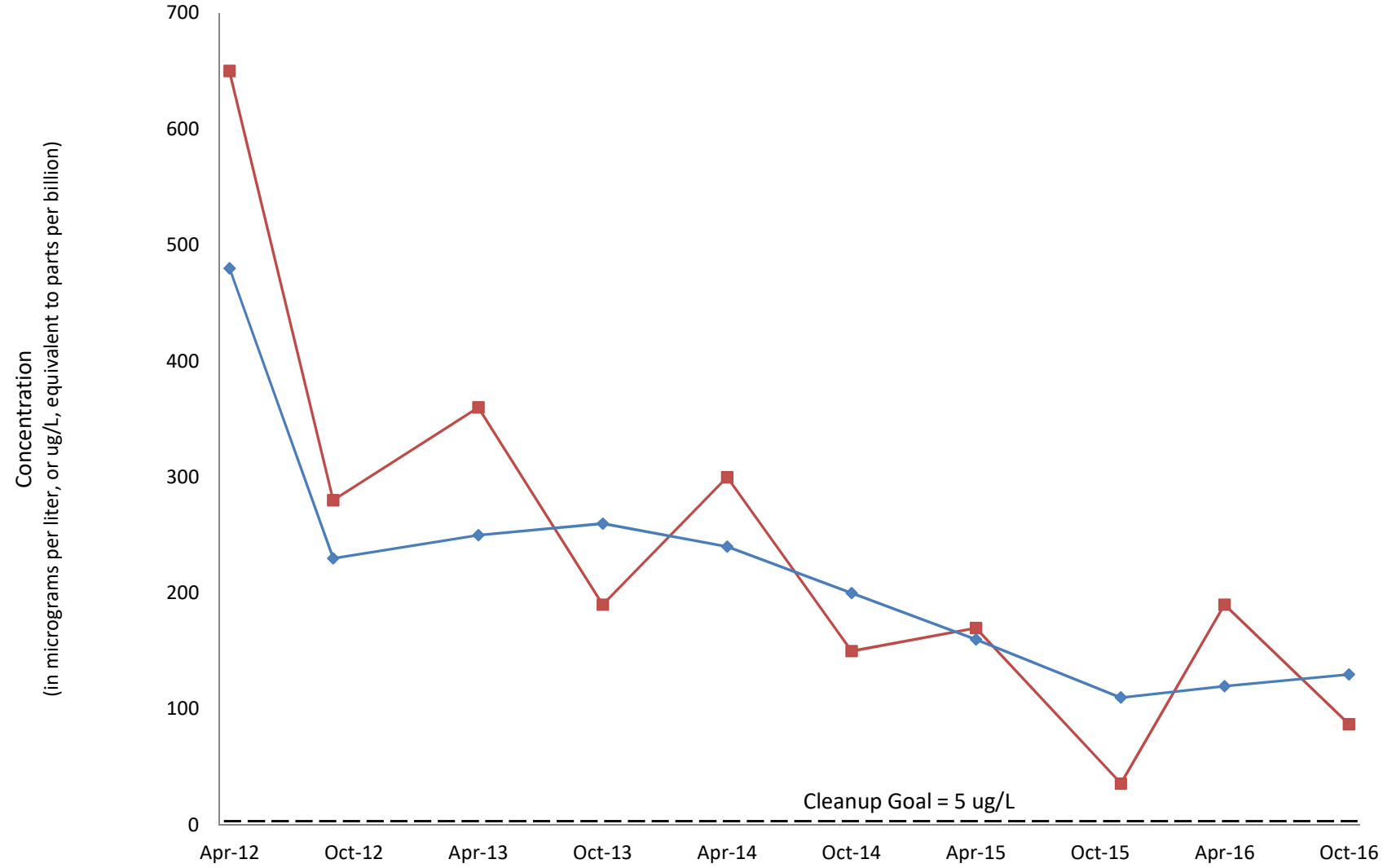
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-37 (saprolite)	3	3	0	2	0	0	0	0	1	1
MW-53 (bedrock)	4	5	4	5	3	0	3	0	2	1

Concentrations of 1,1-DCA in Sentinel Well Pair RMW-37 and MW-53 (2012-2016)



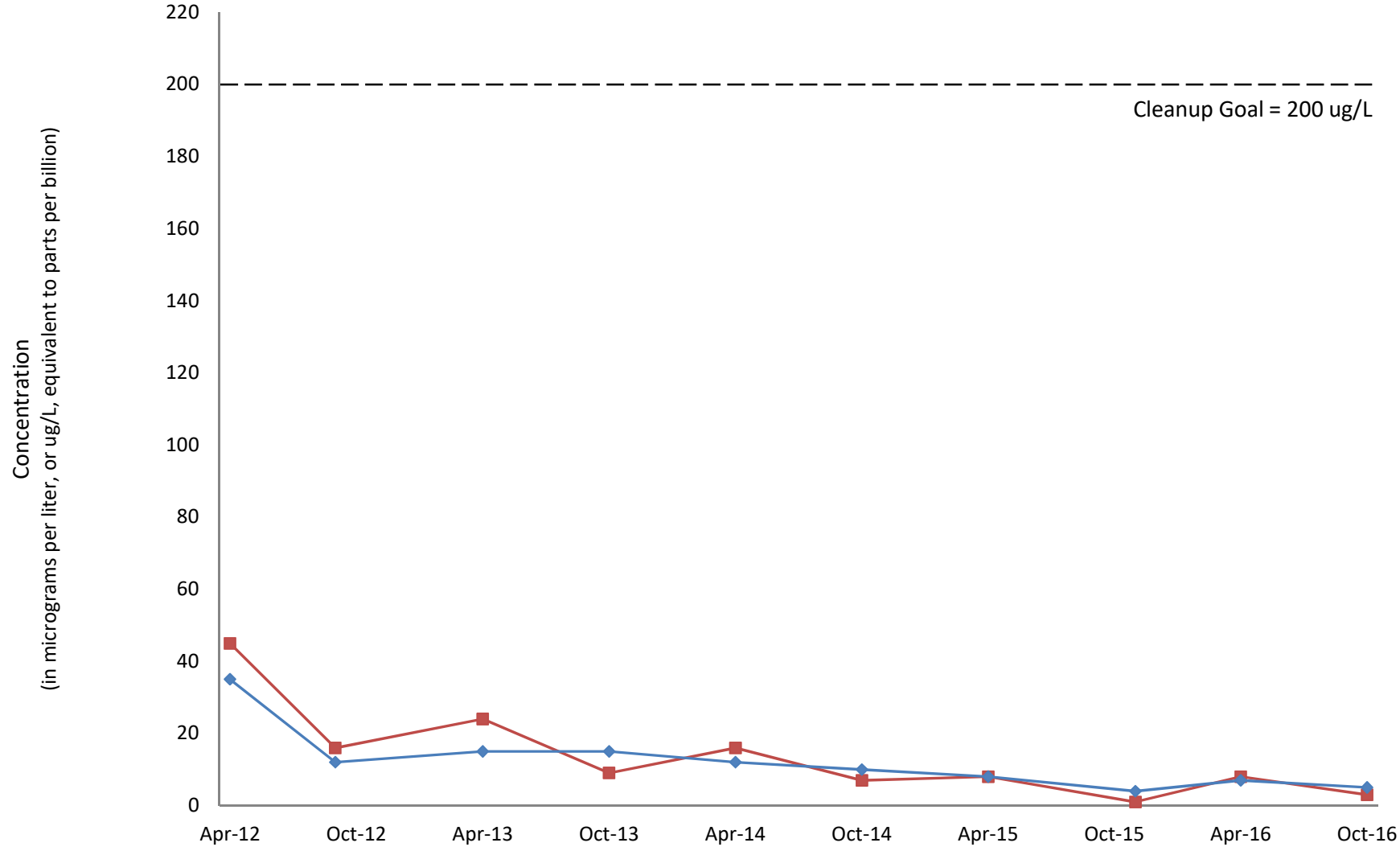
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-37 (saprolite)	11	10	7	8	4	5	4	3	4	5
MW-53 (bedrock)	12	13	10	13	10	7	10	7	8	6

Concentrations of TCE in Sentinel Well Pair RMW-38 and MW-48 (2012-2016)



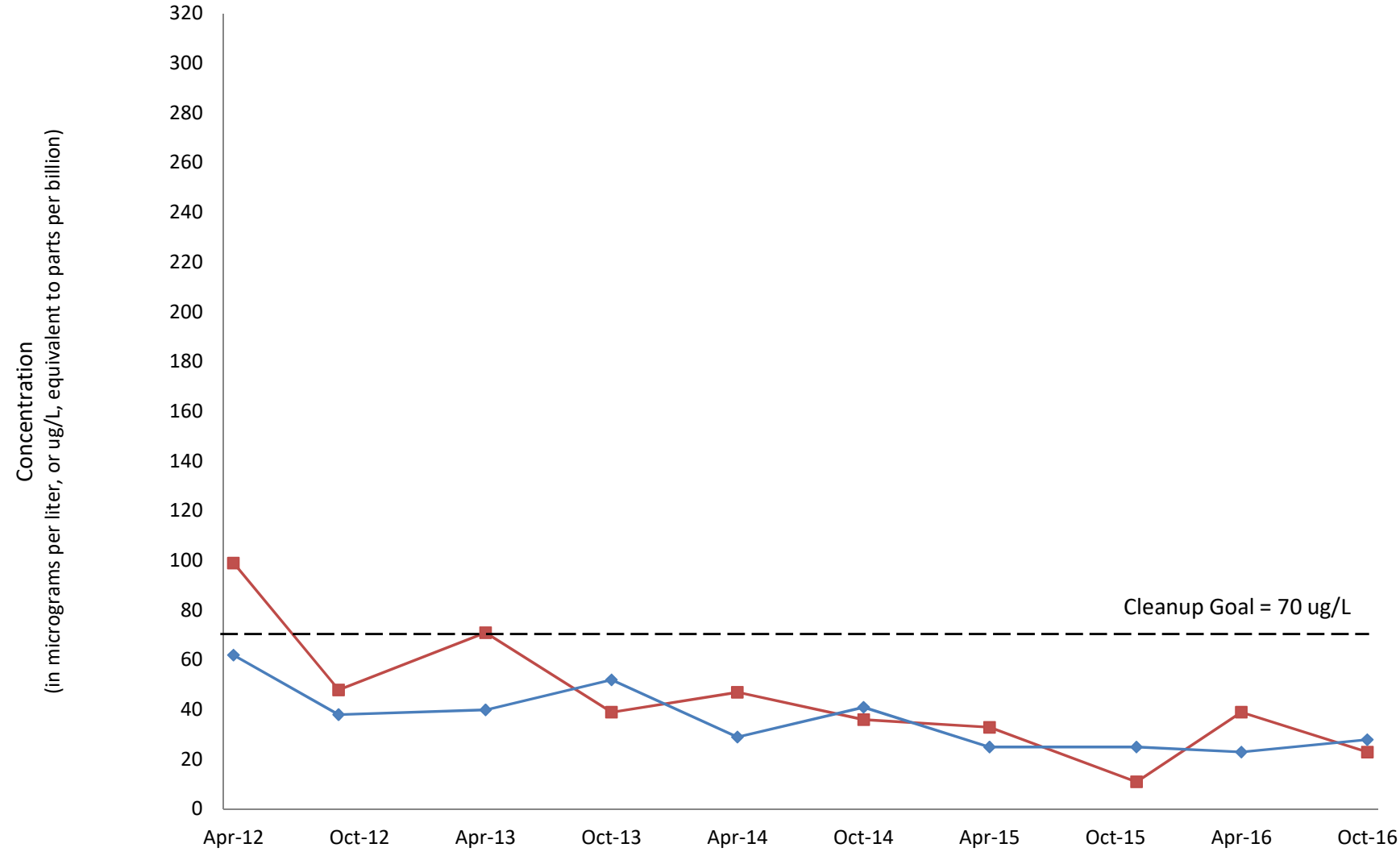
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-38 (saprolite)	650	280	360	190	300	150	170	36	190	87
MW-48 (bedrock)	480	230	250	260	240	200	160	110	120	130

Concentrations of 1,1,1-TCA in Sentinel Well Pair RMW-38 and MW-48 (2012-2016)



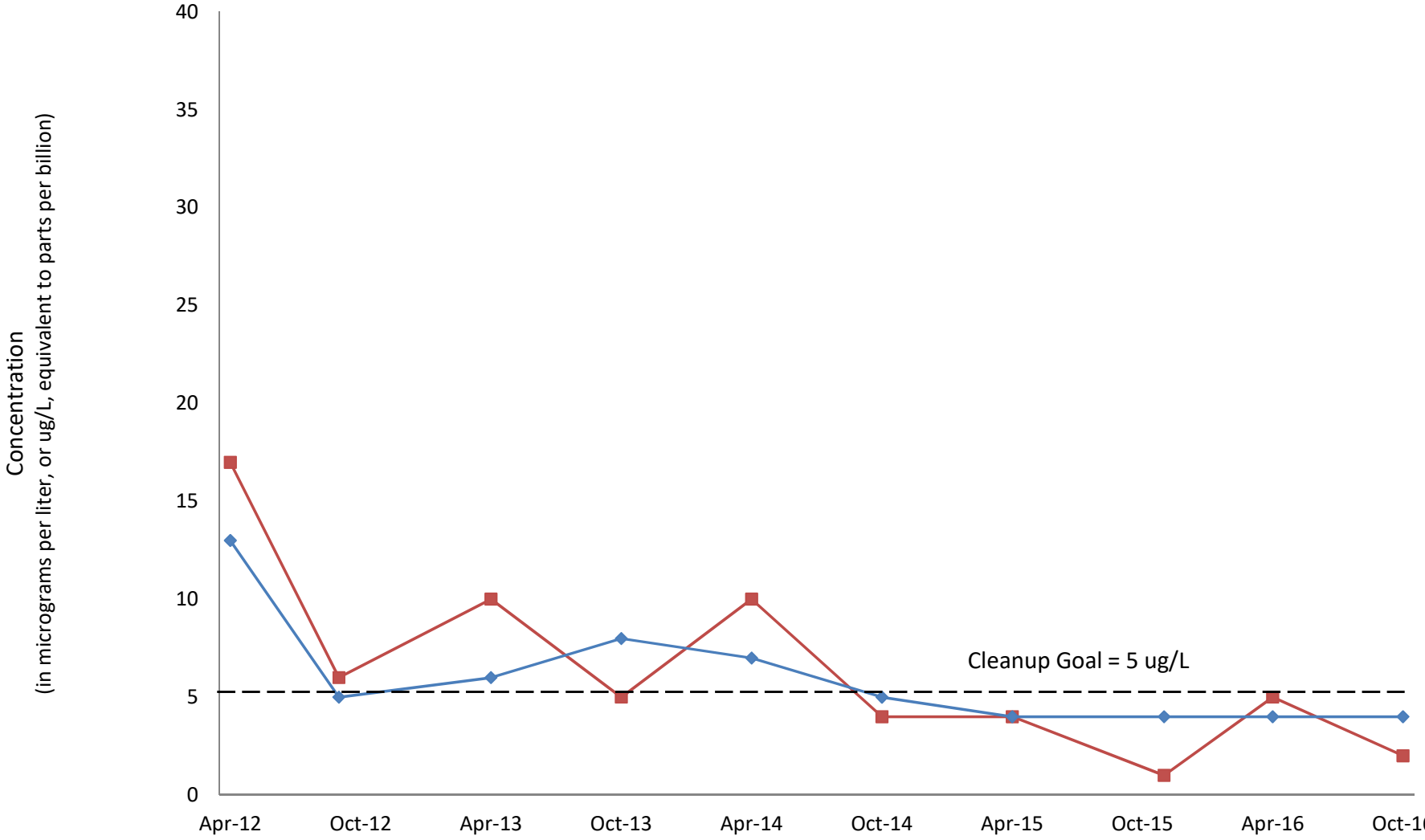
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-38 (saprolite)	45	16	24	9	16	7	8	1	8	3
MW-48 (bedrock)	35	12	15	15	12	10	8	4	7	5

Concentrations of cis-1,2-DCE in Sentinel Well Pair RMW-38 and MW-48 (2012-2016)



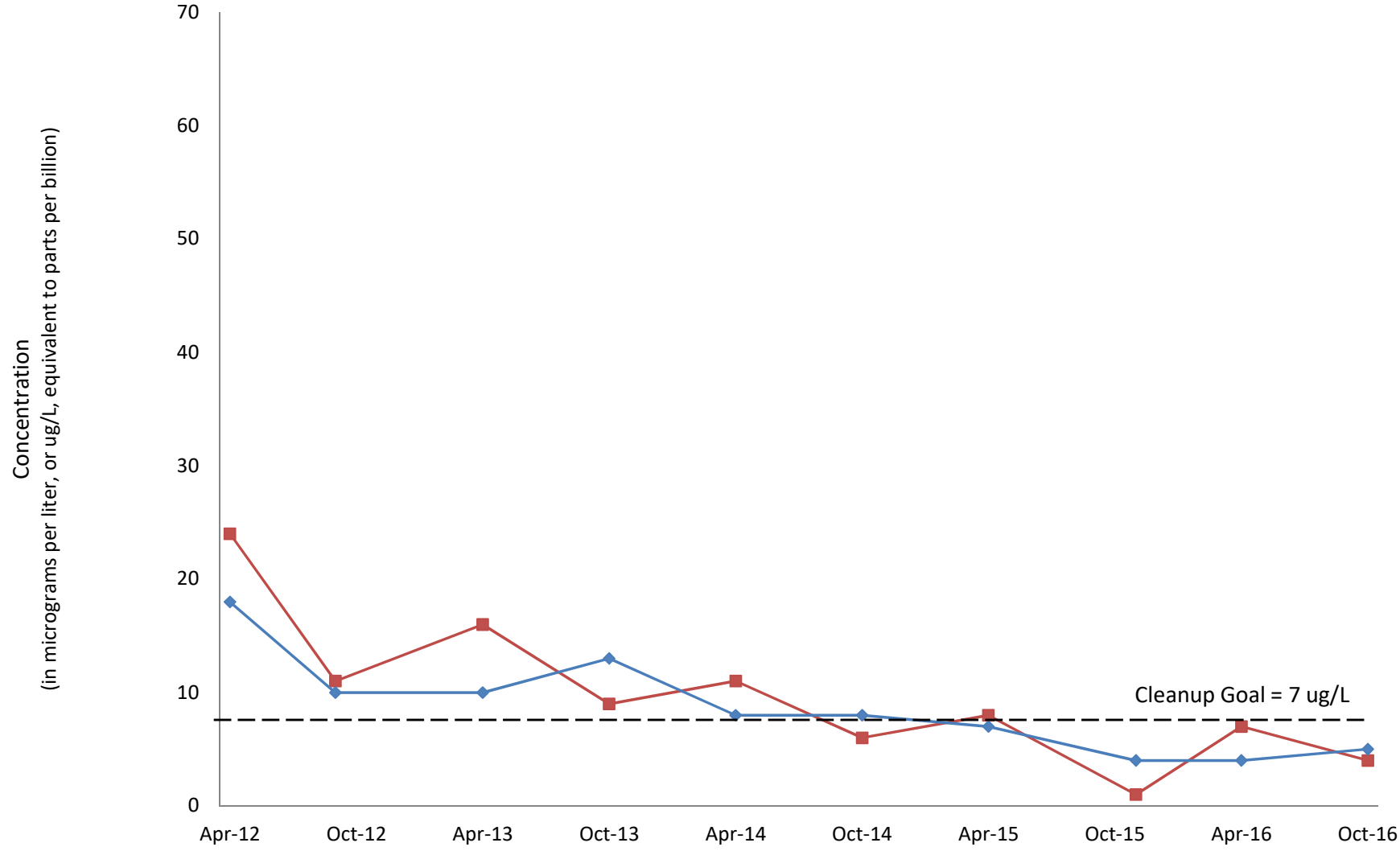
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-38 (saprolite)	99	48	71	39	47	36	33	11	39	23
MW-48 (bedrock)	62	38	40	52	29	41	25	25	23	28

Concentrations of PCE in Sentinel Well Pair RMW-38 and MW-48 (2012-2016)



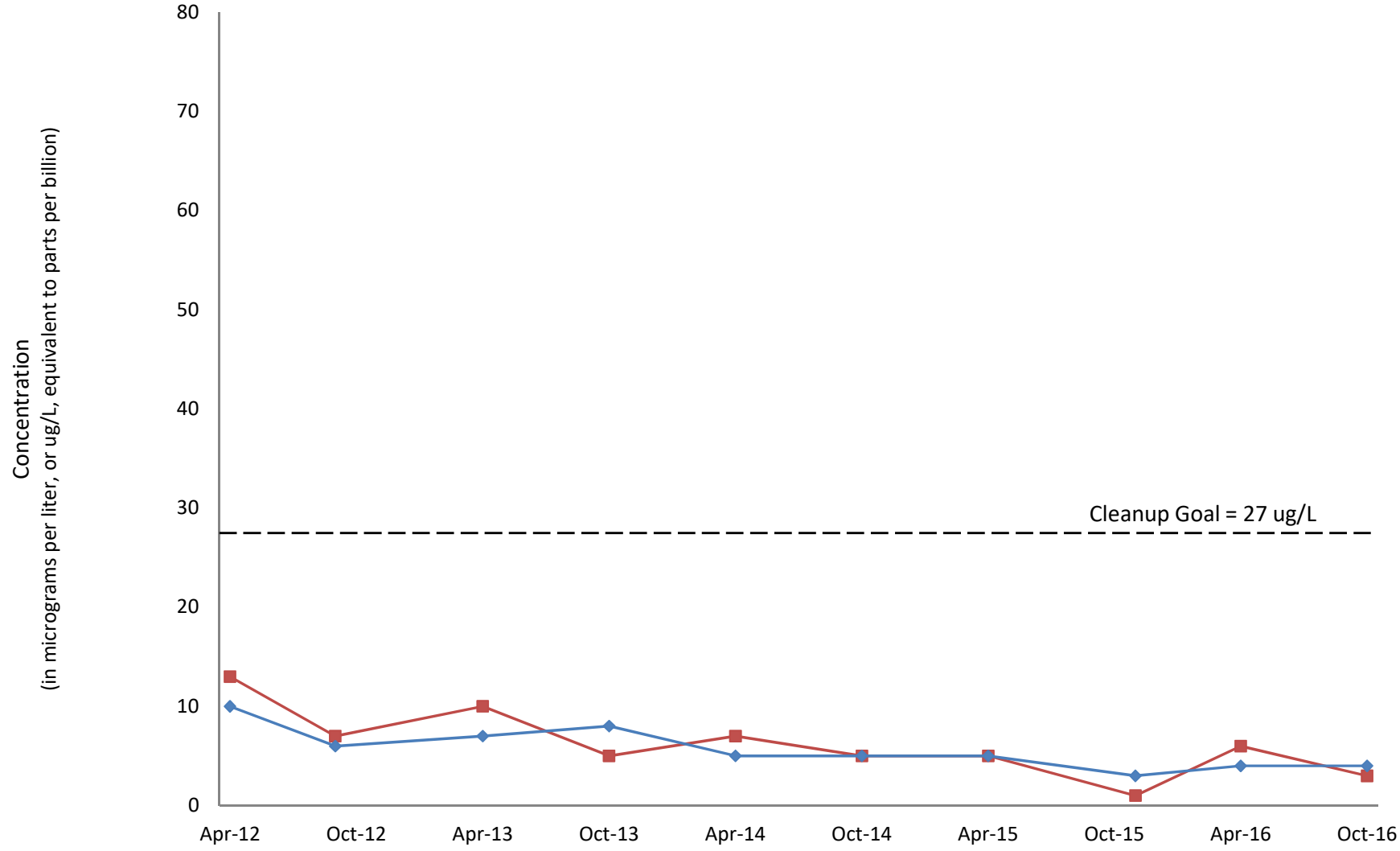
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-38 (saprolite)	17	6	10	5	10	4	4	1	5	2
MW-48 (bedrock)	13	5	6	8	7	5	4	4	4	4

Concentrations of 1,1-DCE in Sentinel Well Pair RMW-38 and MW-48 (2012-2016)



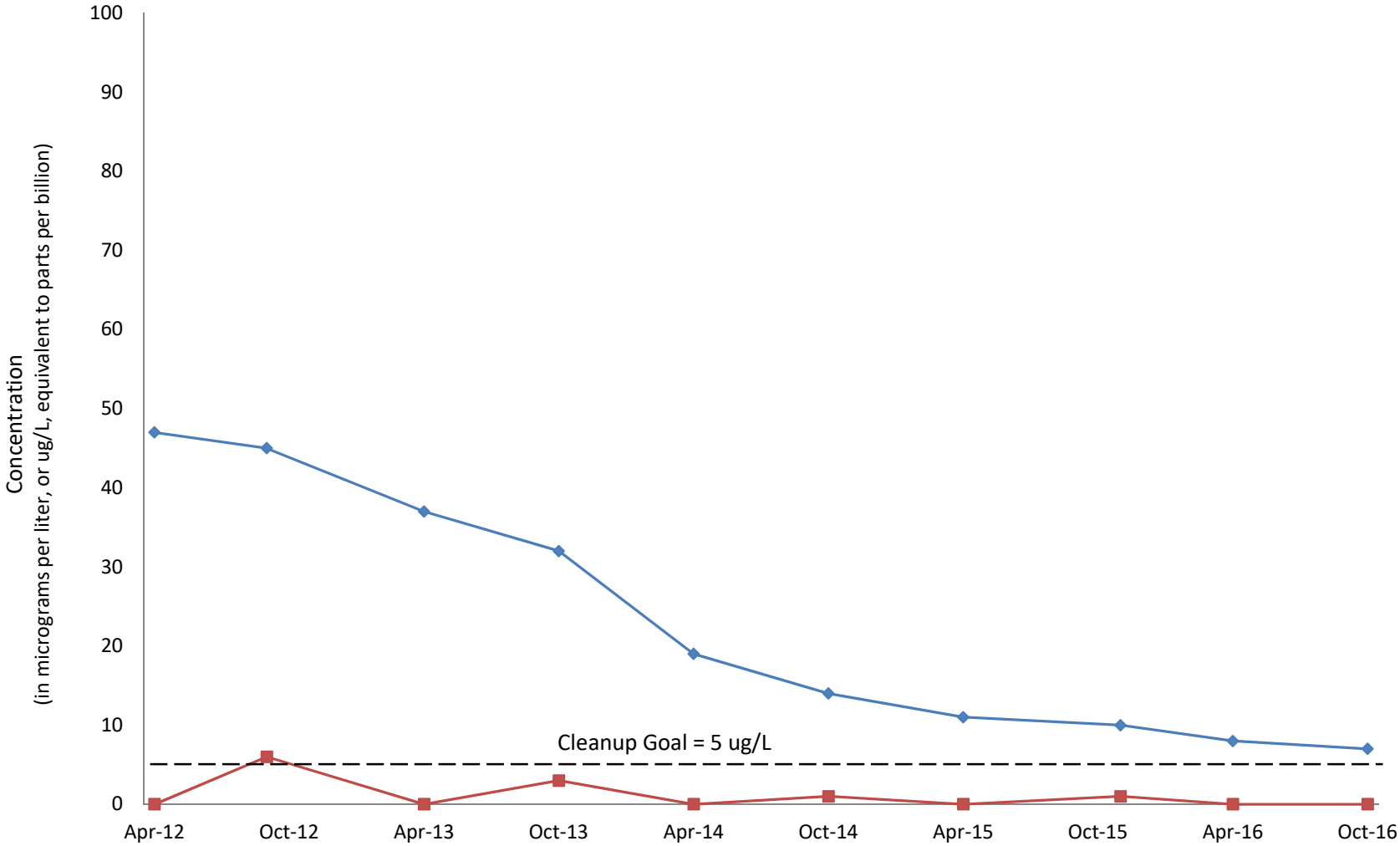
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-38 (saprolite)	24	11	16	9	11	6	8	1	7	4
MW-48 (bedrock)	18	10	10	13	8	8	7	4	4	5

Concentrations of 1,1-DCA in Sentinel Well Pair RMW-38 and MW-48 (2012-2016)



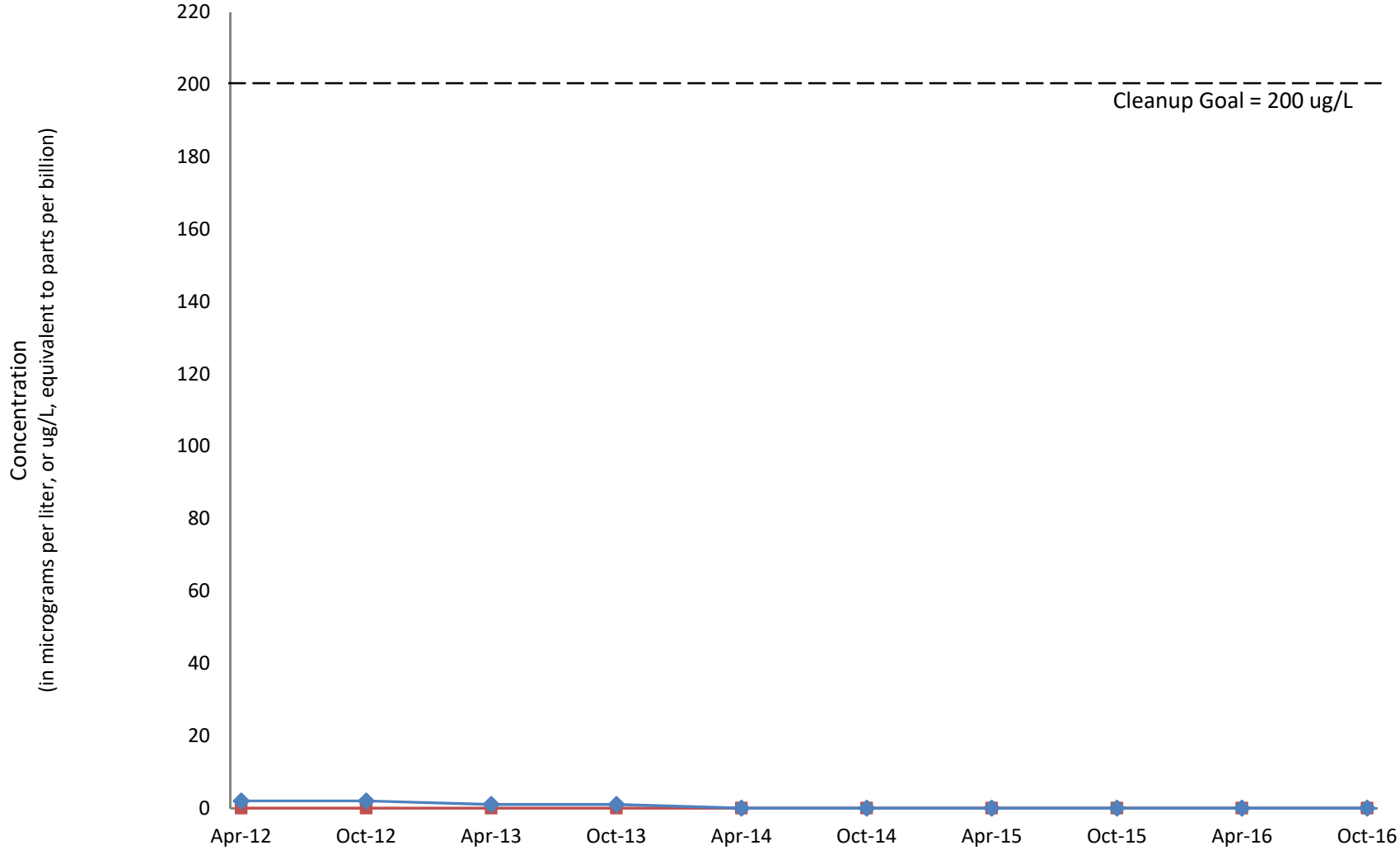
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
RMW-38 (saprolite)	13	7	10	5	7	5	5	1	6	3
MW-48 (bedrock)	10	6	7	8	5	5	5	3	4	4

Concentrations of TCE in Sentinel Well Pair MW-49 and MW-50 (2012-2016)



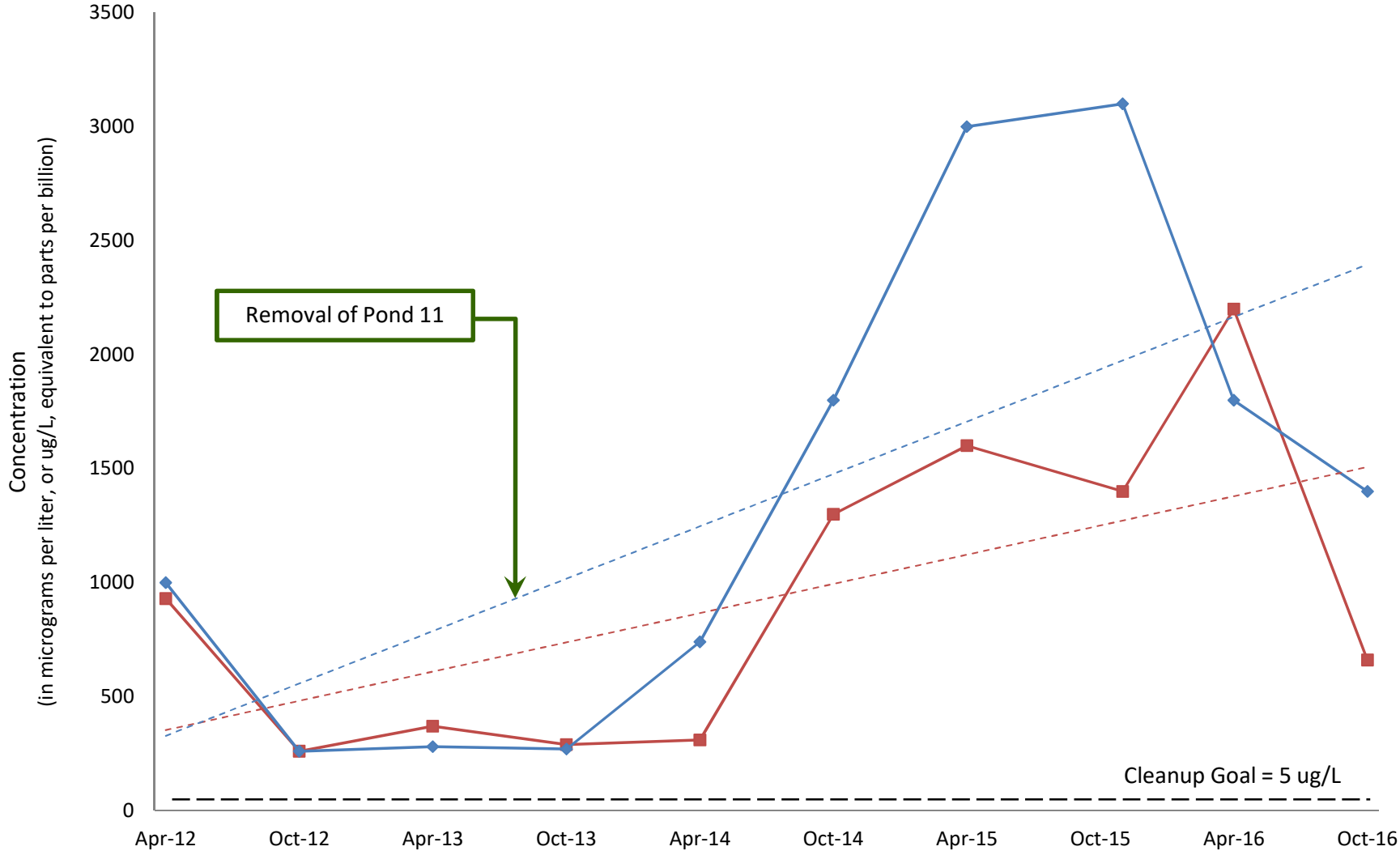
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-49 (saprolite)	0	6	0	3	0	1	0	1	0	0
MW-50 (bedrock)	47	45	37	32	19	14	11	10	8	7

Concentrations of 1,1,1-TCA in Sentinel Well Pair MW-49 and MW-50 (2012-2016)



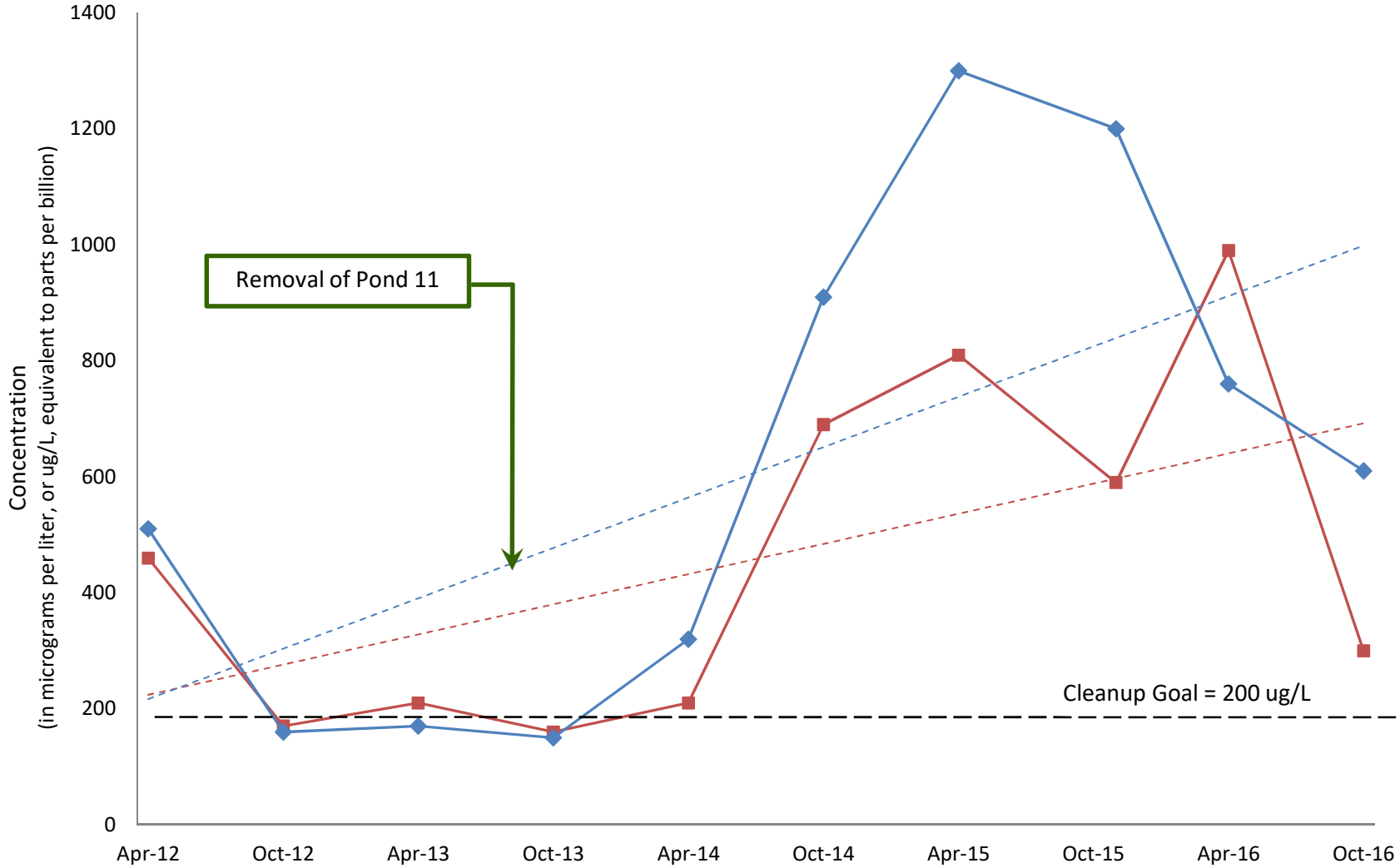
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Oct-15	Apr-16	Oct-16
MW-49 (overburden)	0	0	0	0	0	0	0	0	0	0
MW-50 (bedrock)	2	2	1	1	0	0	0	0	0	0

Concentrations of TCE in Sentinel Well Pair MW-56 and MW-57 (2012-2016)



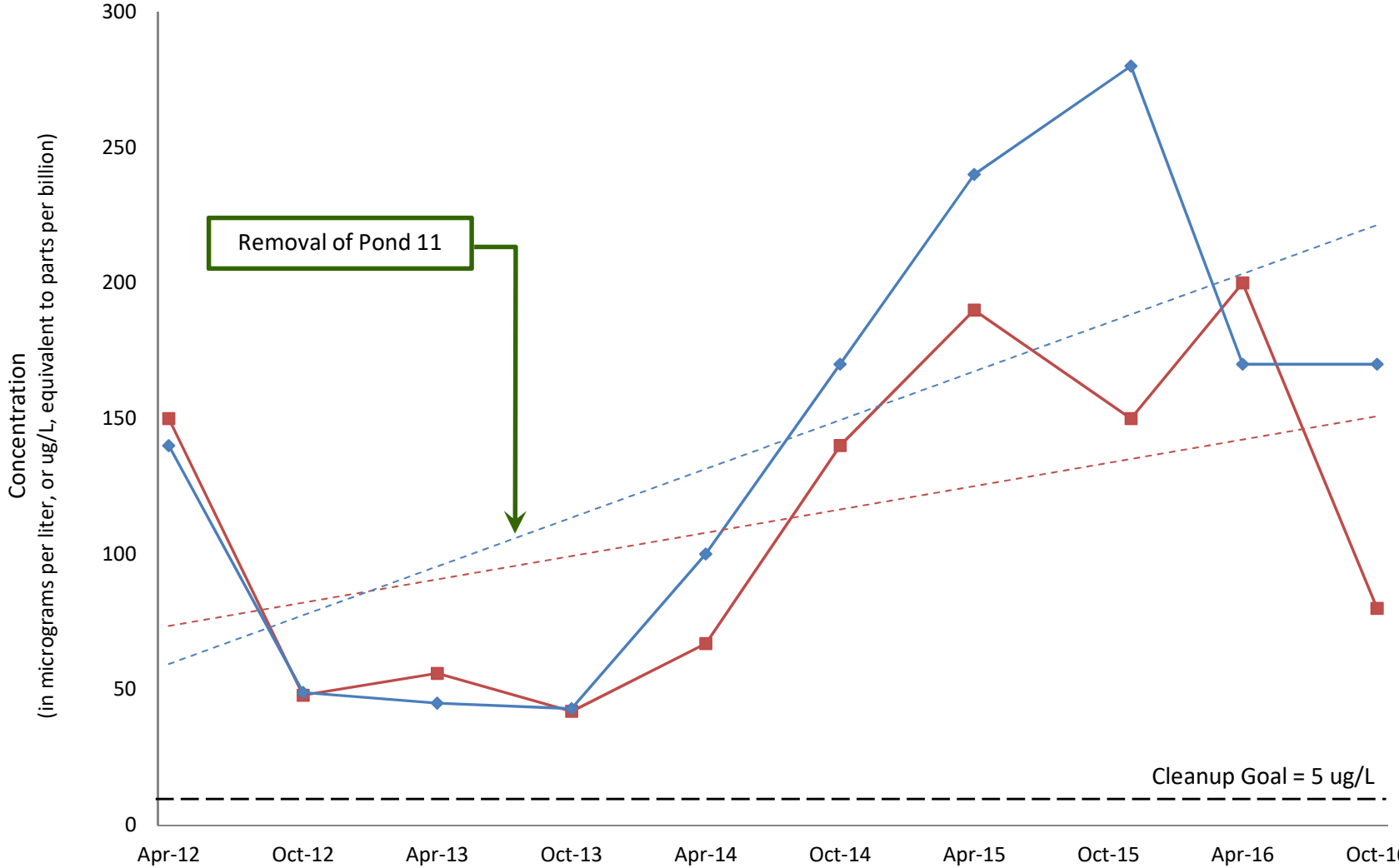
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-56 (saprolite)	930	260	370	290	310	1300	1600	1400	2200	660
MW-57 (bedrock)	1000	260	280	270	740	1800	3000	3100	1800	1400

Concentrations of 1,1,1-TCA in Sentinel Well Pair MW-56 and MW-57 (2012-2016)



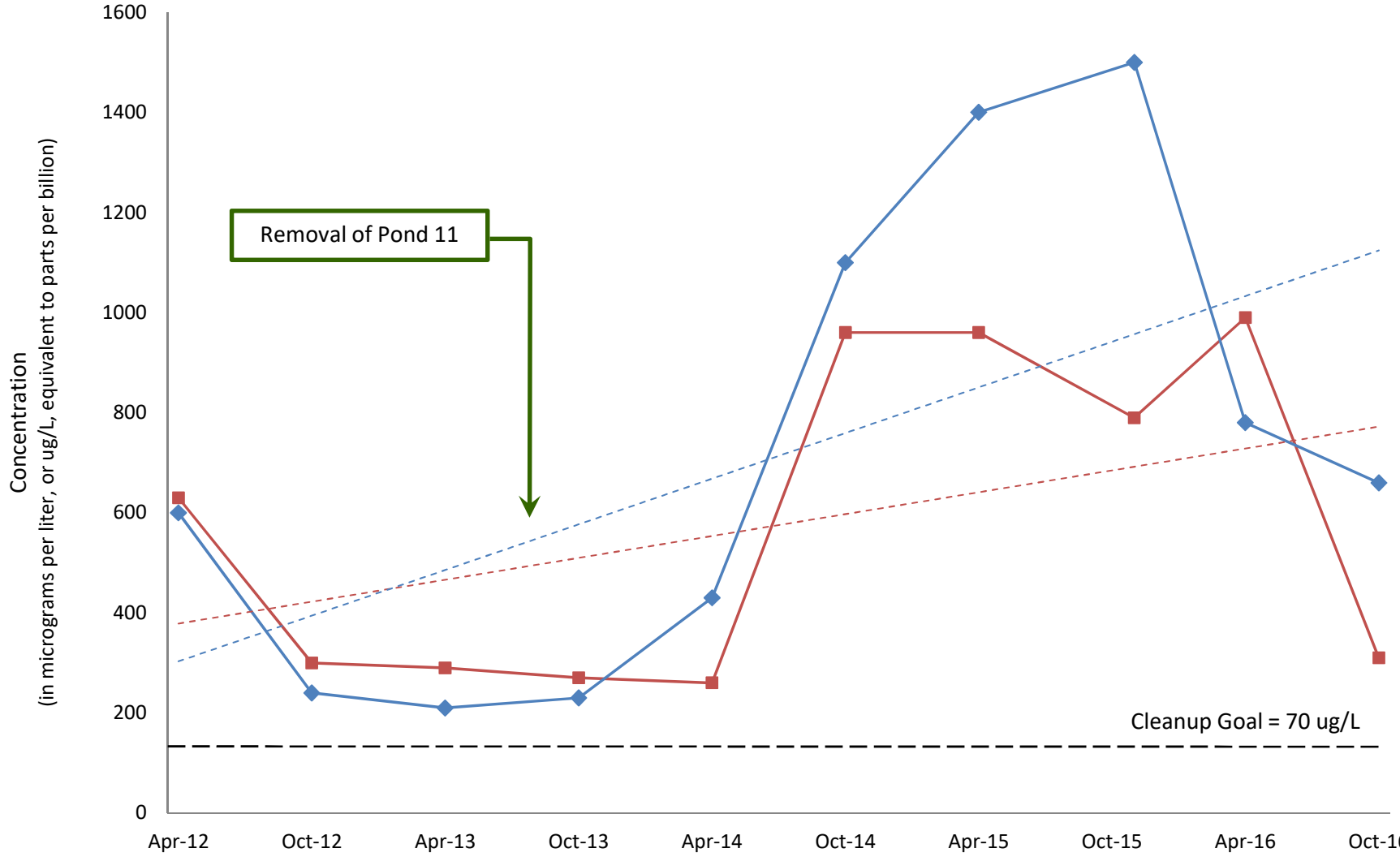
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-56 (saprolite)	460	170	210	160	210	690	810	590	990	300
MW-57 (bedrock)	510	160	170	150	320	910	1300	1200	760	610

Concentrations of PCE in Sentinel Well Pair MW-56 and MW-57 (2012-2016)



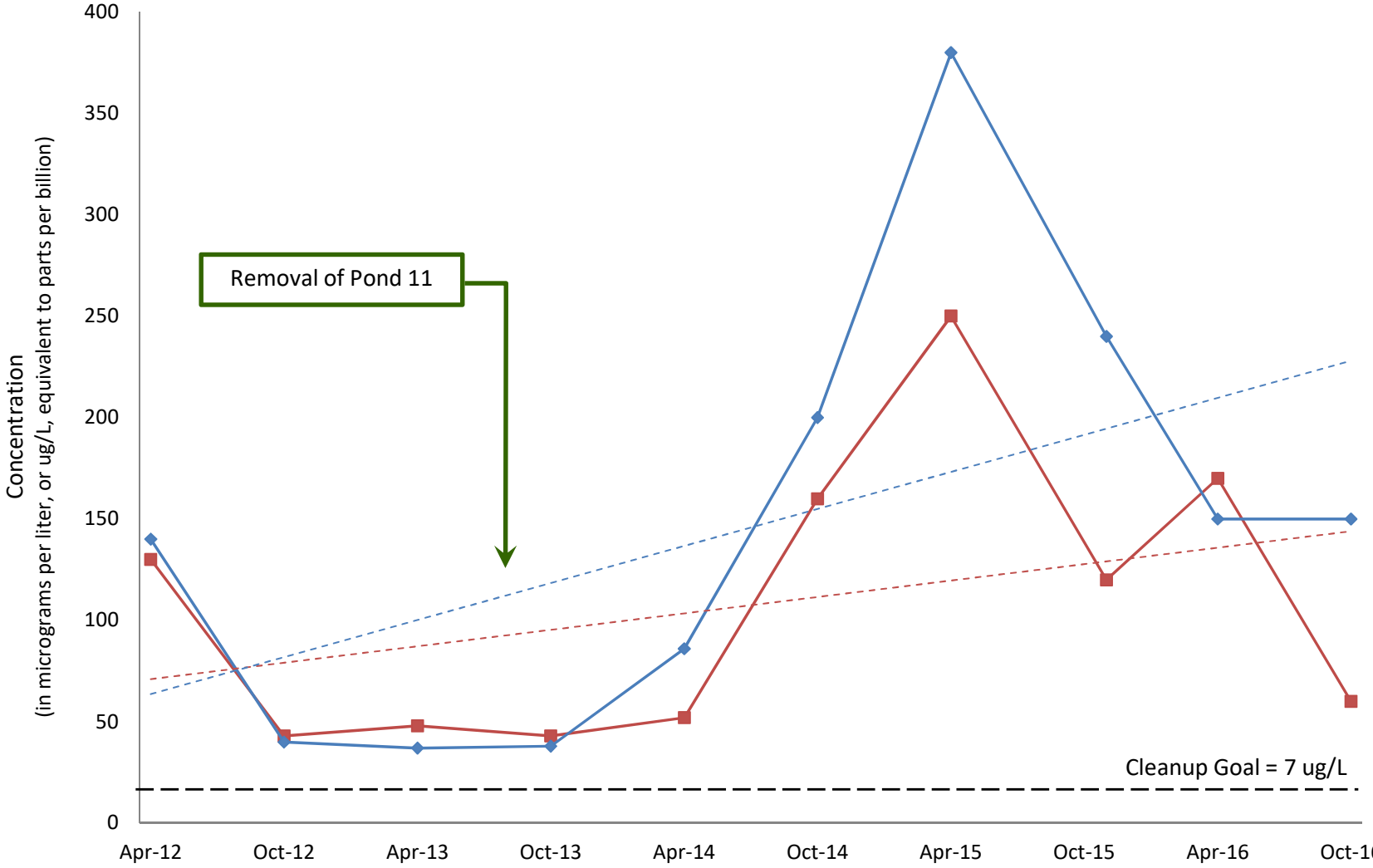
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-56 (saprolite)	150	48	56	42	67	140	190	150	200	80
MW-57 (bedrock)	140	49	45	43	100	170	240	280	170	170

Concentrations of cis-1,2-DCE in Sentinel Well Pair MW-56 and MW-57 (2012-2016)



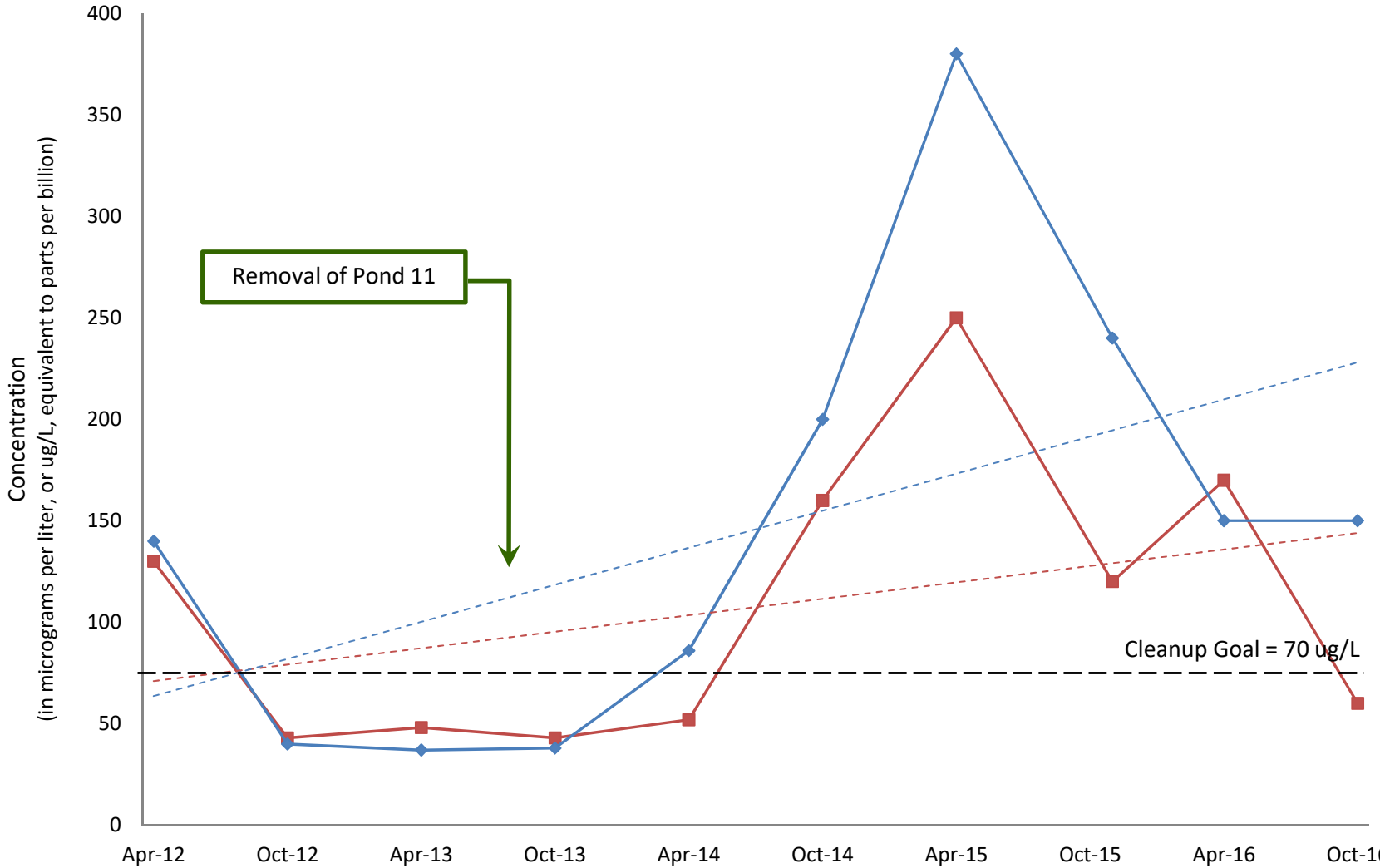
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-56 (saprolite)	630	300	290	270	260	960	960	790	990	310
MW-57 (bedrock)	600	240	210	230	430	1100	1400	1500	780	660

Concentrations of 1,1-DCE in Sentinel Well Pair MW-56 and MW-57 (2012-2016)



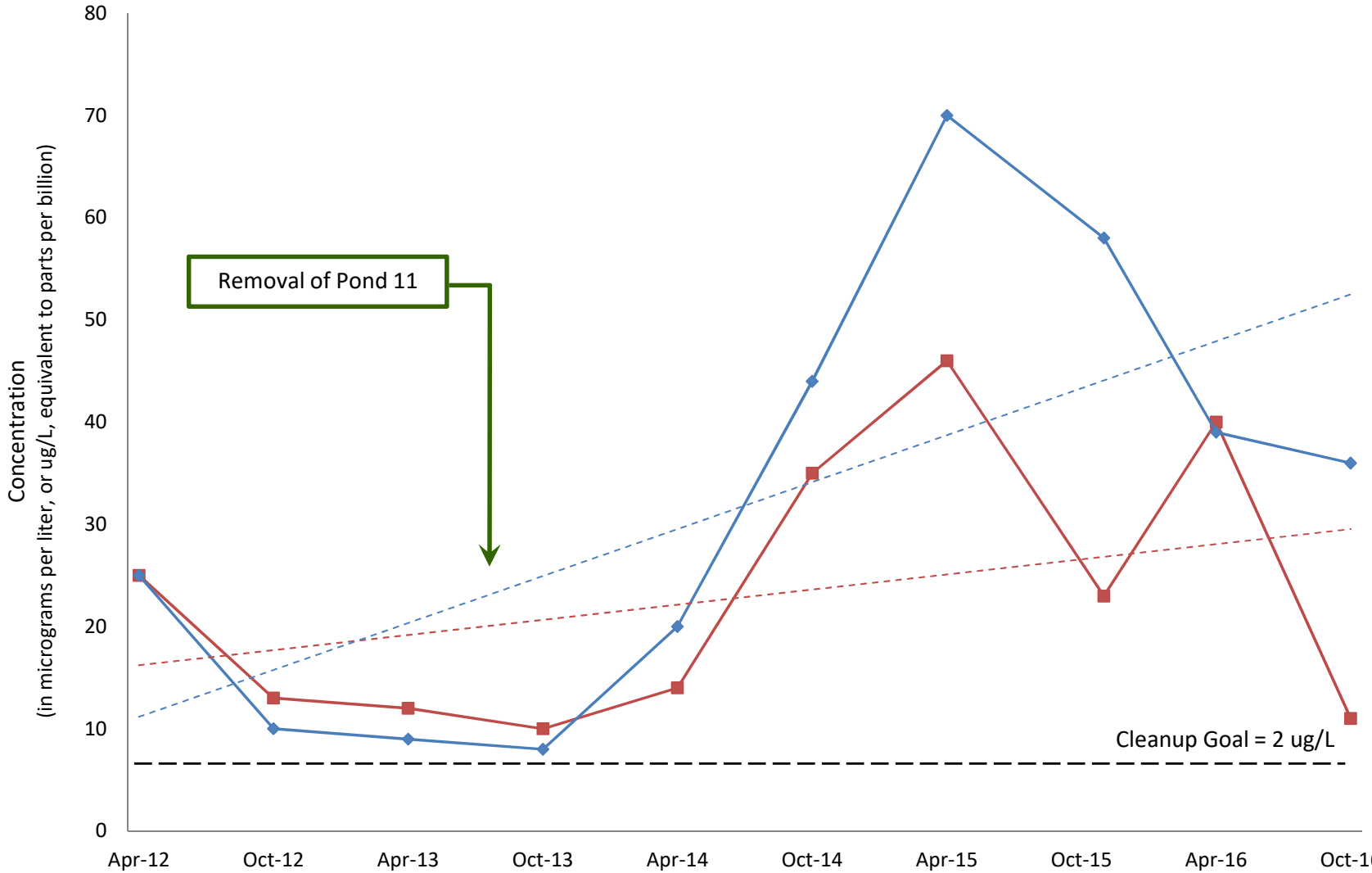
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-56 (saprolite)	130	43	48	43	52	160	250	120	170	60
MW-57 (bedrock)	140	40	37	38	86	200	380	240	150	150

Concentrations of 1,1-DCA in Sentinel Well Pair MW-56 and MW-57 (2012-2016)



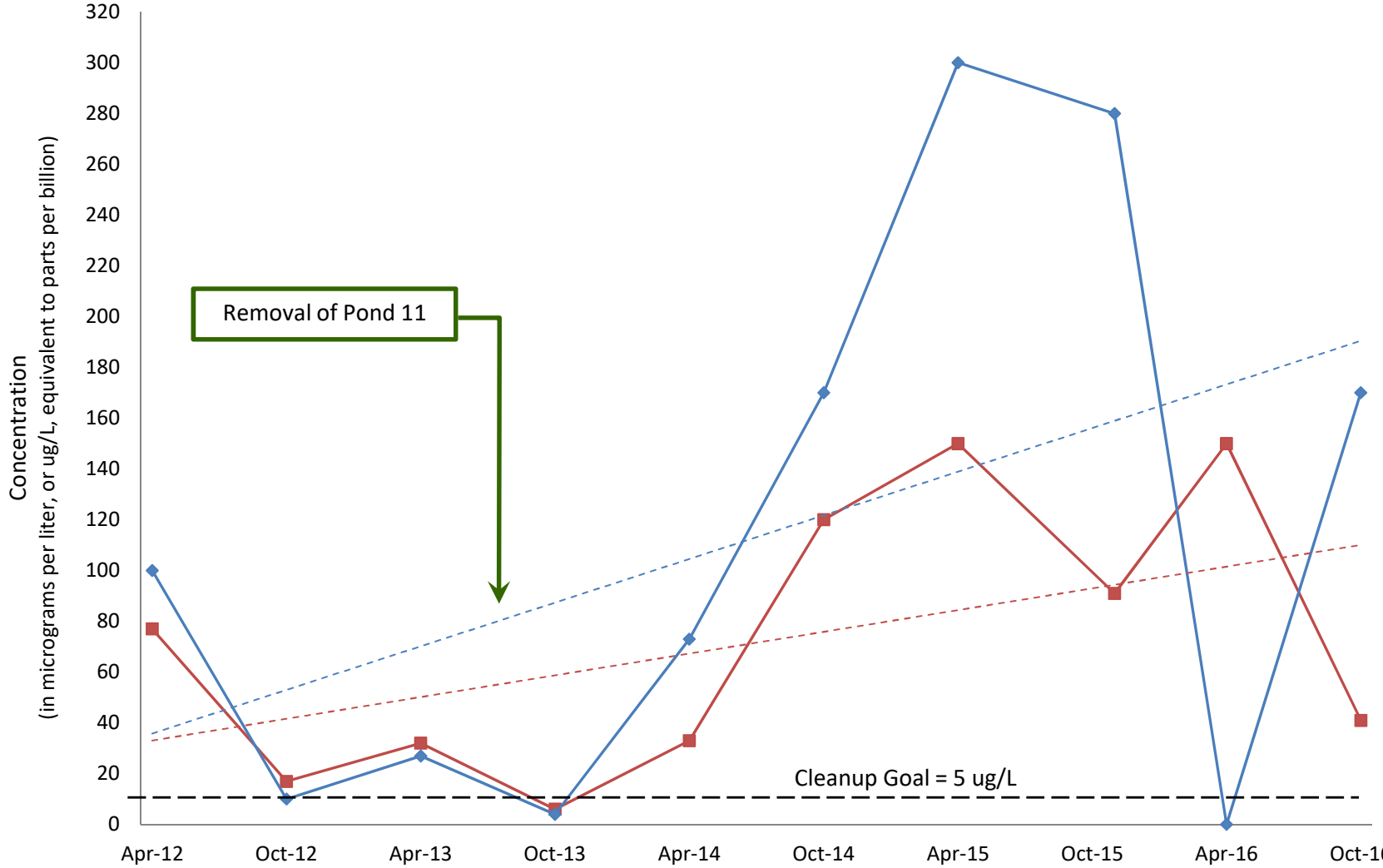
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-56 (saprolite)	130	43	48	43	52	160	250	120	170	60
MW-57 (bedrock)	140	40	37	38	86	200	380	240	150	150

Concentrations of Vinyl Chloride in Sentinel Well Pair MW-56 and MW-57 (2012-2016)



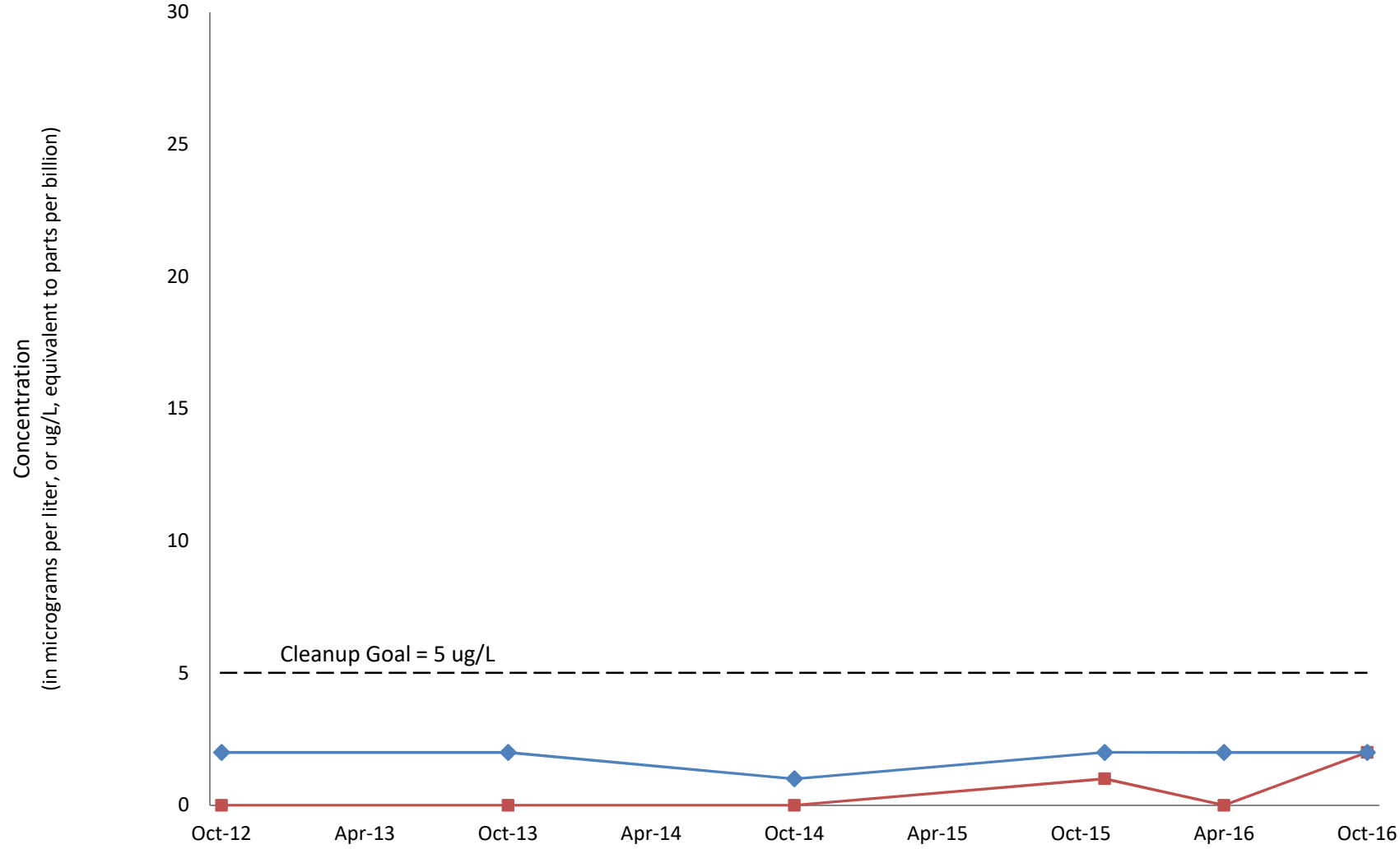
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-56 (saprolite)	25	13	12	10	14	35	46	23	40	11
MW-57 (bedrock)	25	10	9	8	20	44	70	58	39	36

Concentrations of Benzene in Sentinel Well Pair MW-56 and MW-57 (2012-2016)



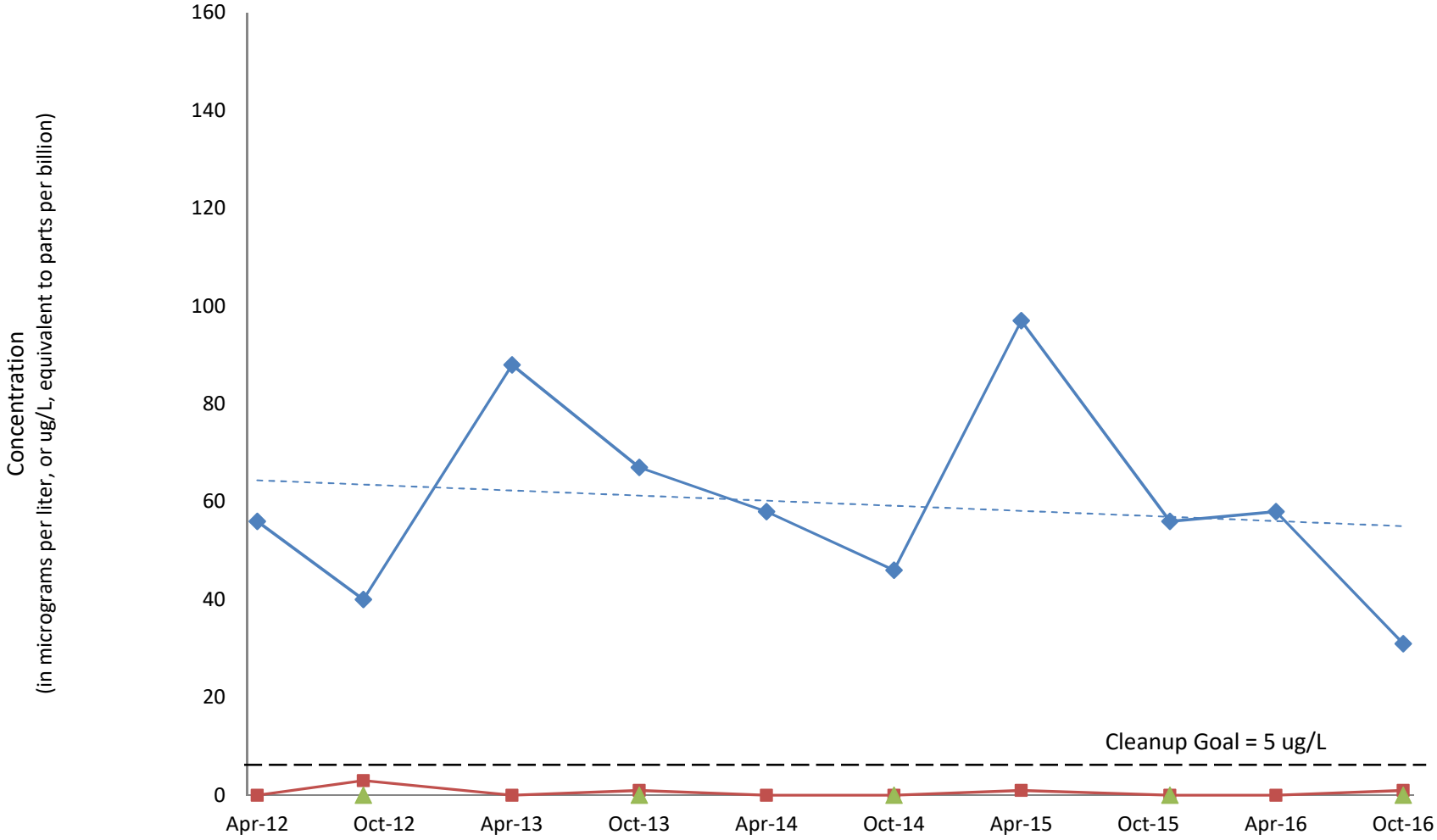
	Apr-12	Oct-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-56 (saprolite)	77	17	32	6	33	120	150	91	150	41
MW-57 (bedrock)	100	10	27	4	73	170	300	280	0	170

Concentrations of TCE in Sentinel Well Pair MW-54 and MW-55 (2012-2016)



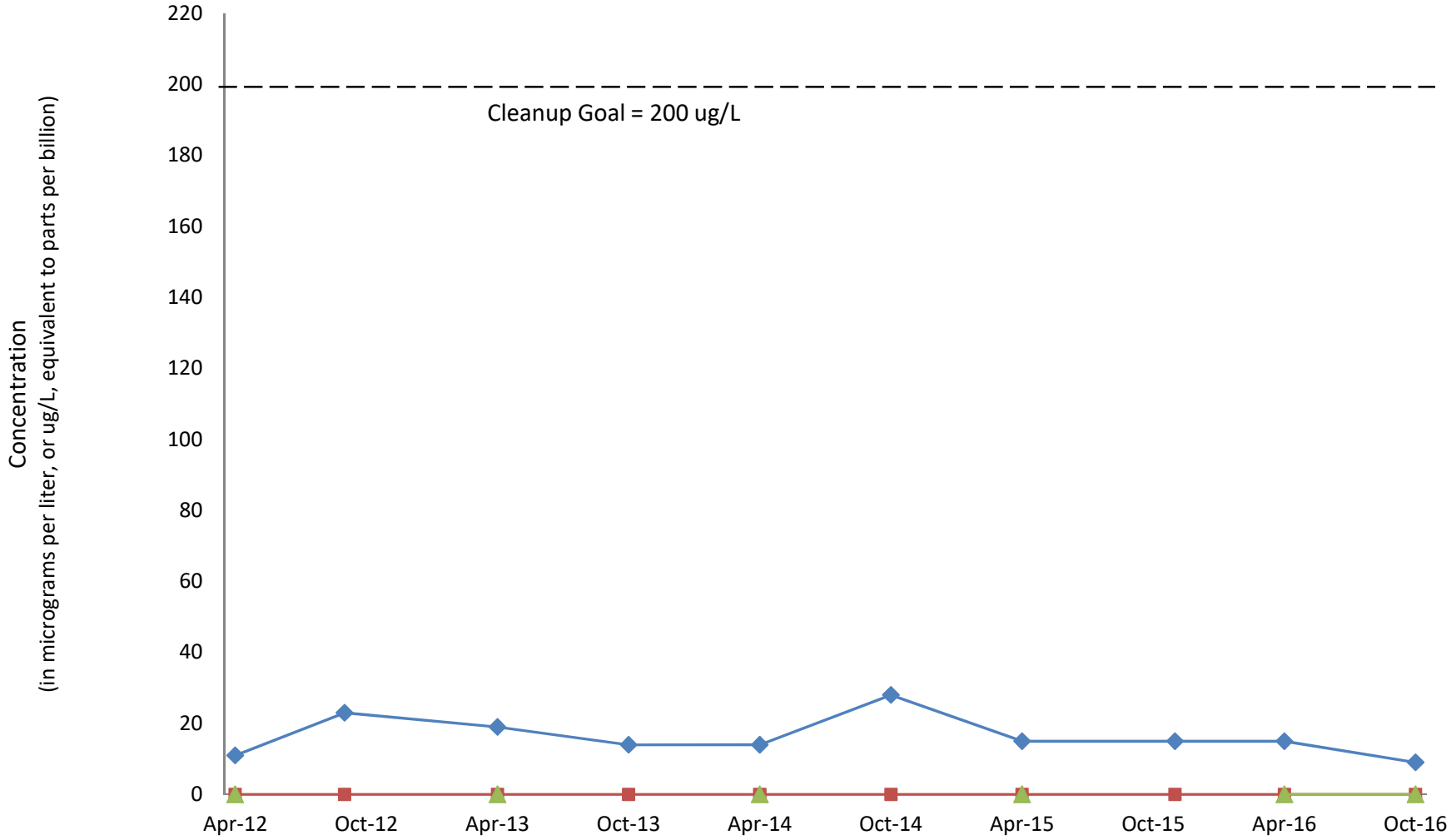
	Oct-12	Oct-13	Oct-14	Nov-15	Apr-16	Oct-16
MW-54 (saprolite)	0	0	0	1	0	2
MW-55 (bedrock)	2	2	1	2	2	2

Concentrations of TCE in Perimeter Well Triplet MW-05, MW-35, and MW-29 (2012-2016)



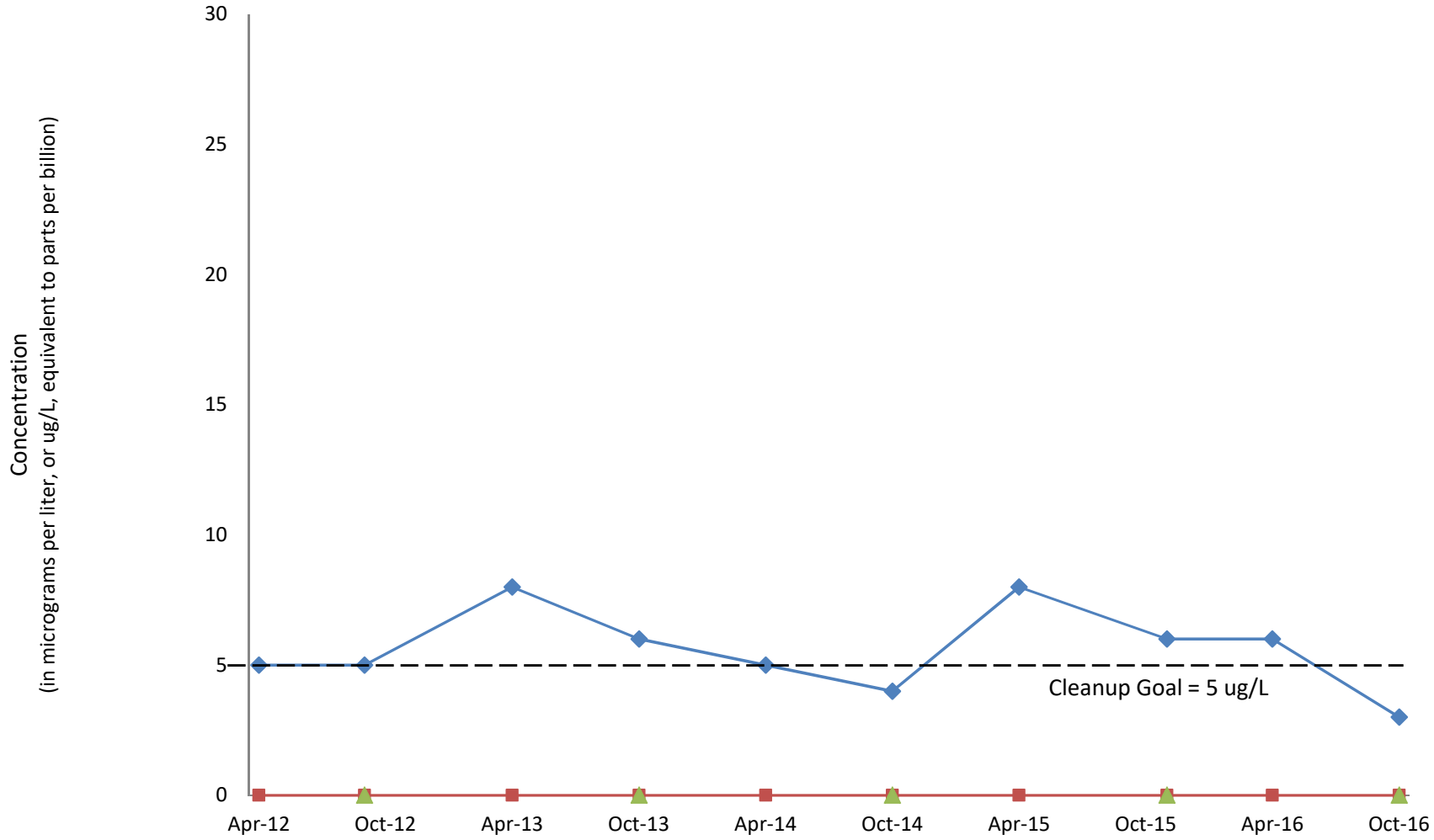
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-05 (overburden)	0	3	0	1	0	0	1	0	0	1
MW-35 (bedrock)	56	40	88	67	58	46	97	56	58	31
MW-29 (deep diabase)		0		0		0		0		0

Concentrations of 1,1,1-TCA in Perimeter Well Triplet MW-05, MW-35, and MW-29 (2012-2016)



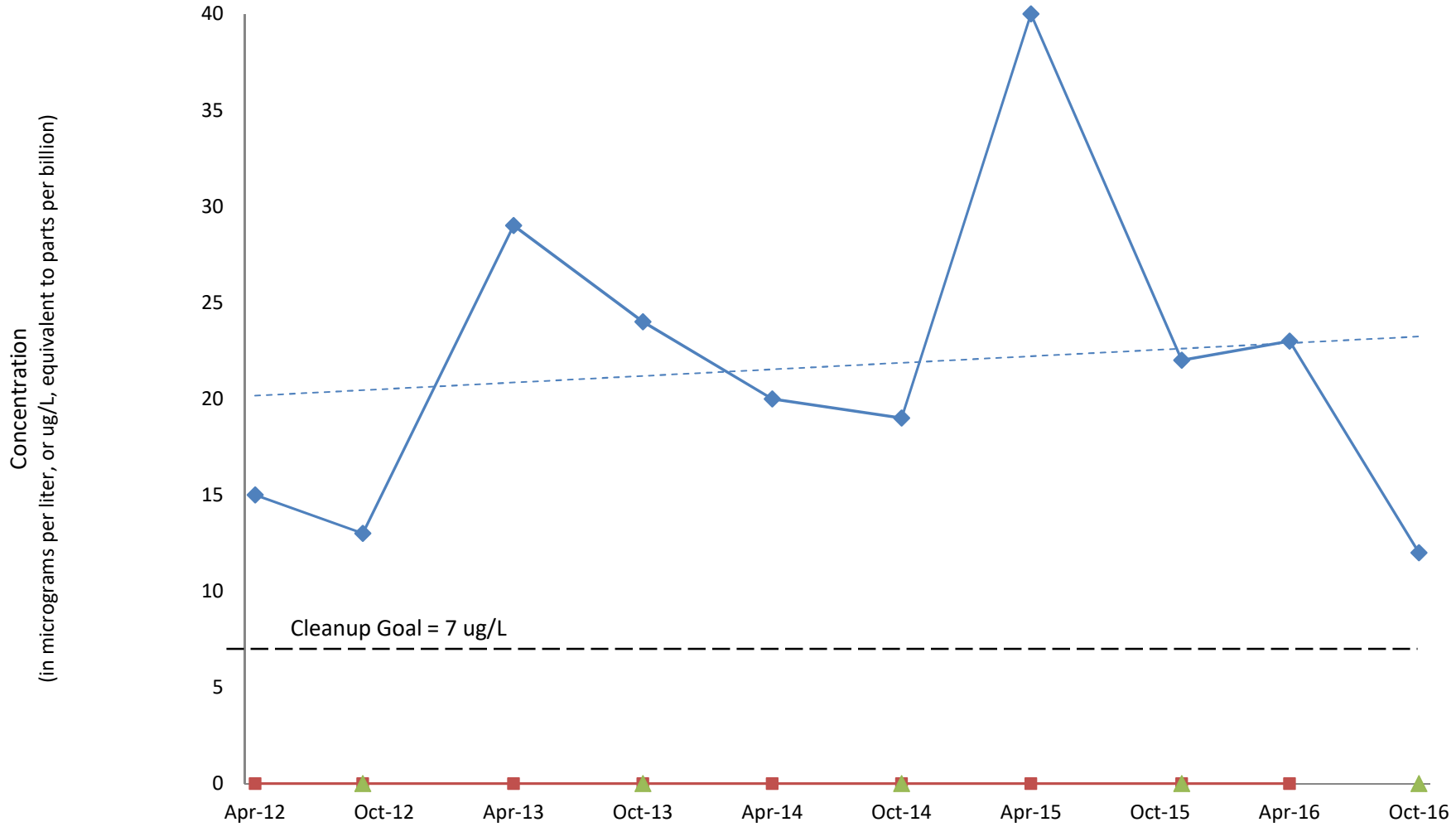
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-05 (overburden)	0	0	0	0	0	0	0	0	0	0
MW-35 (bedrock)	11	23	19	14	14	28	15	15	15	9
MW-29 (deep diabase)	0		0		0		0		0	0

Concentrations of PCE in Perimeter Well Triplet MW-05, MW-35, and MW-29 (2012-2016)



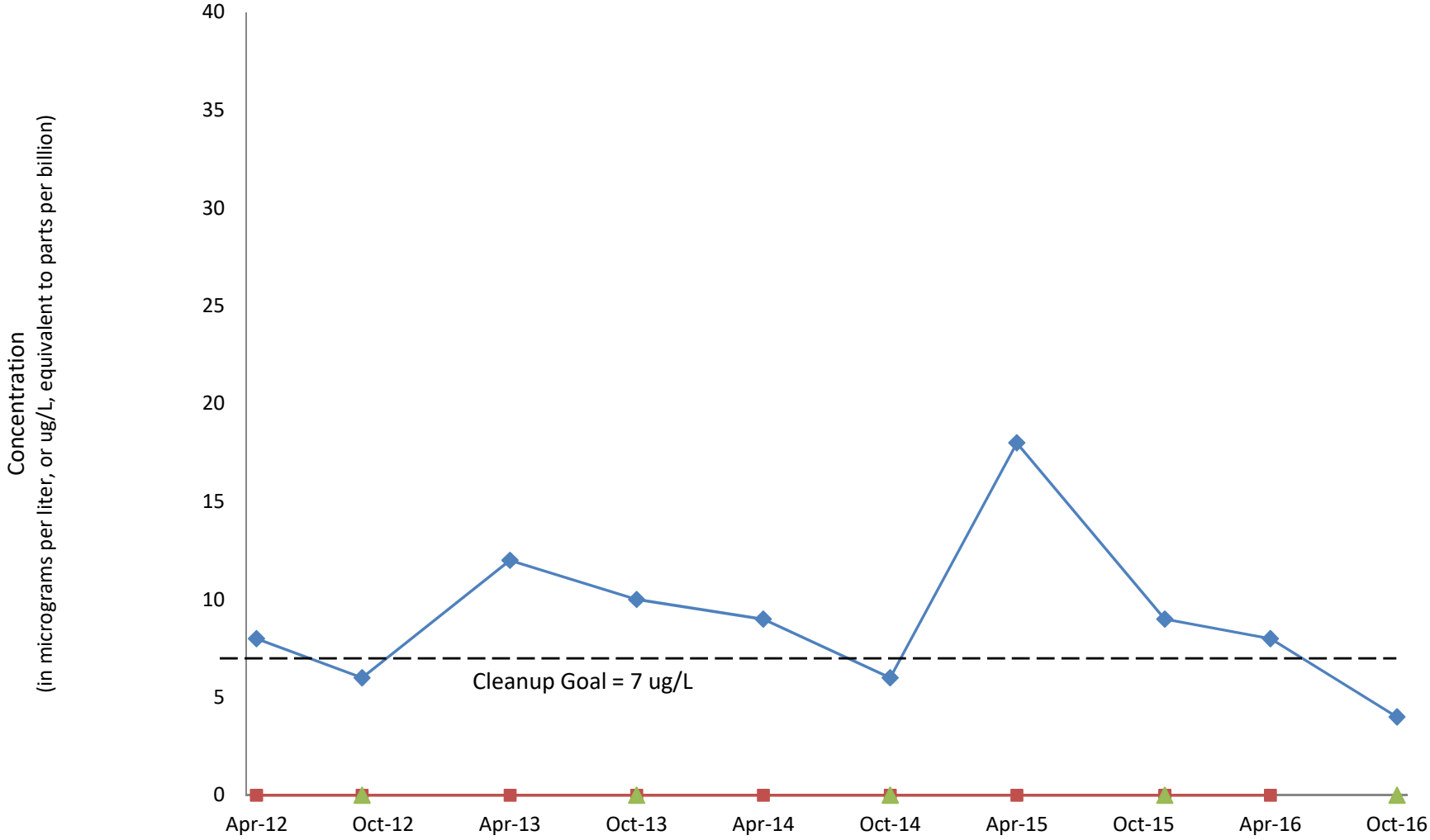
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-05 (saprolite)	0	0	0	0	0	0	0	0	0	0
MW-35 (bedrock)	5	5	8	6	5	4	8	6	6	3
MW-29 (deep diabase)		0		0		0		0		0

Concentrations of cis-1,2-DCE in Perimeter Well Triplet MW-05, MW-35, and MW-29 (2012-2016)



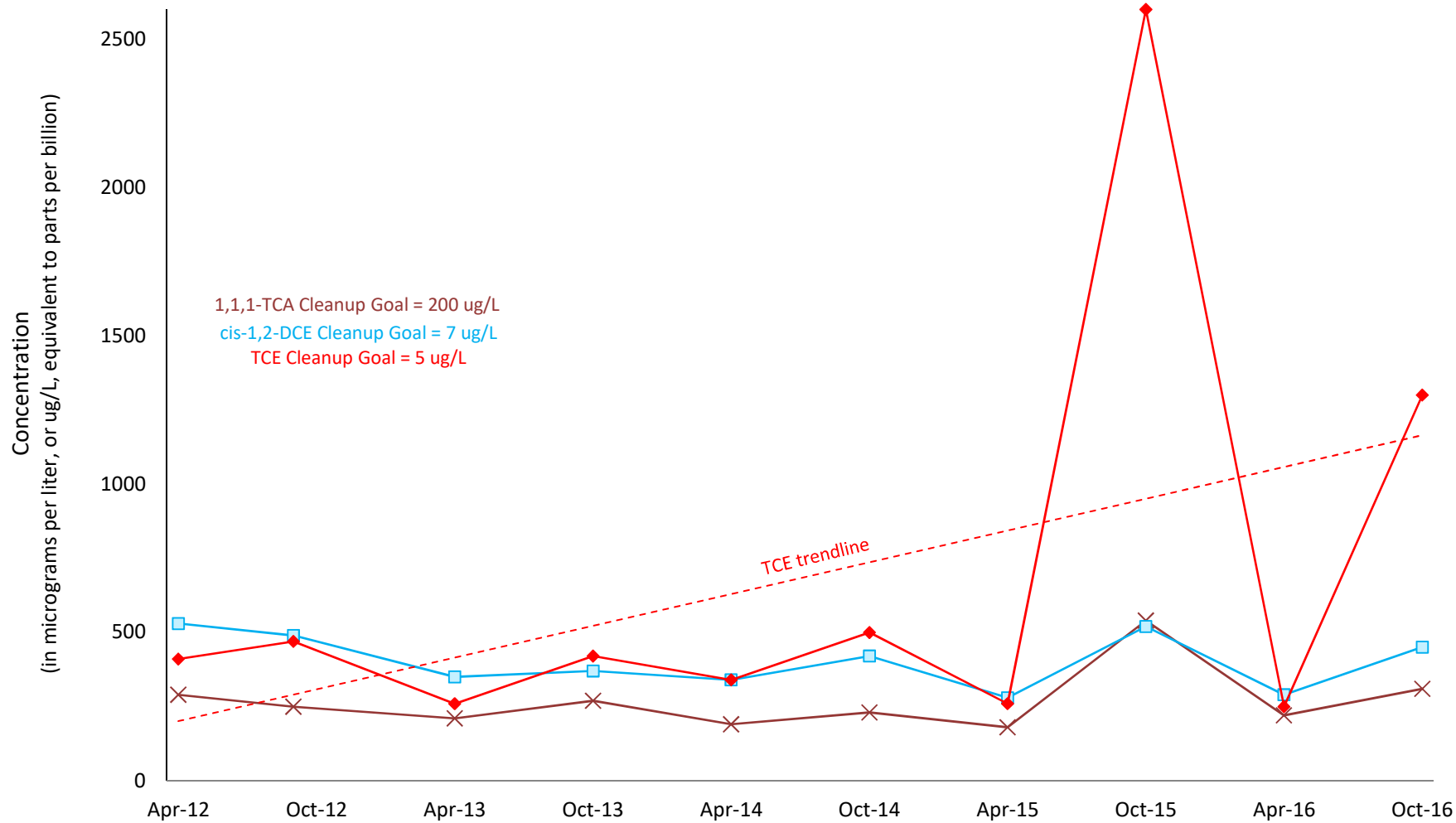
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-05 (overburden)	0	0	0	0	0	0	0	0	0	
MW-35 (bedrock)	15	13	29	24	20	19	40	22	23	12
MW-29 (deep diabase)		0		0		0		0		0

Concentrations of 1,1-DCE in Perimeter Well Triplet MW-05, MW-35, and MW-29 (2012-2016)



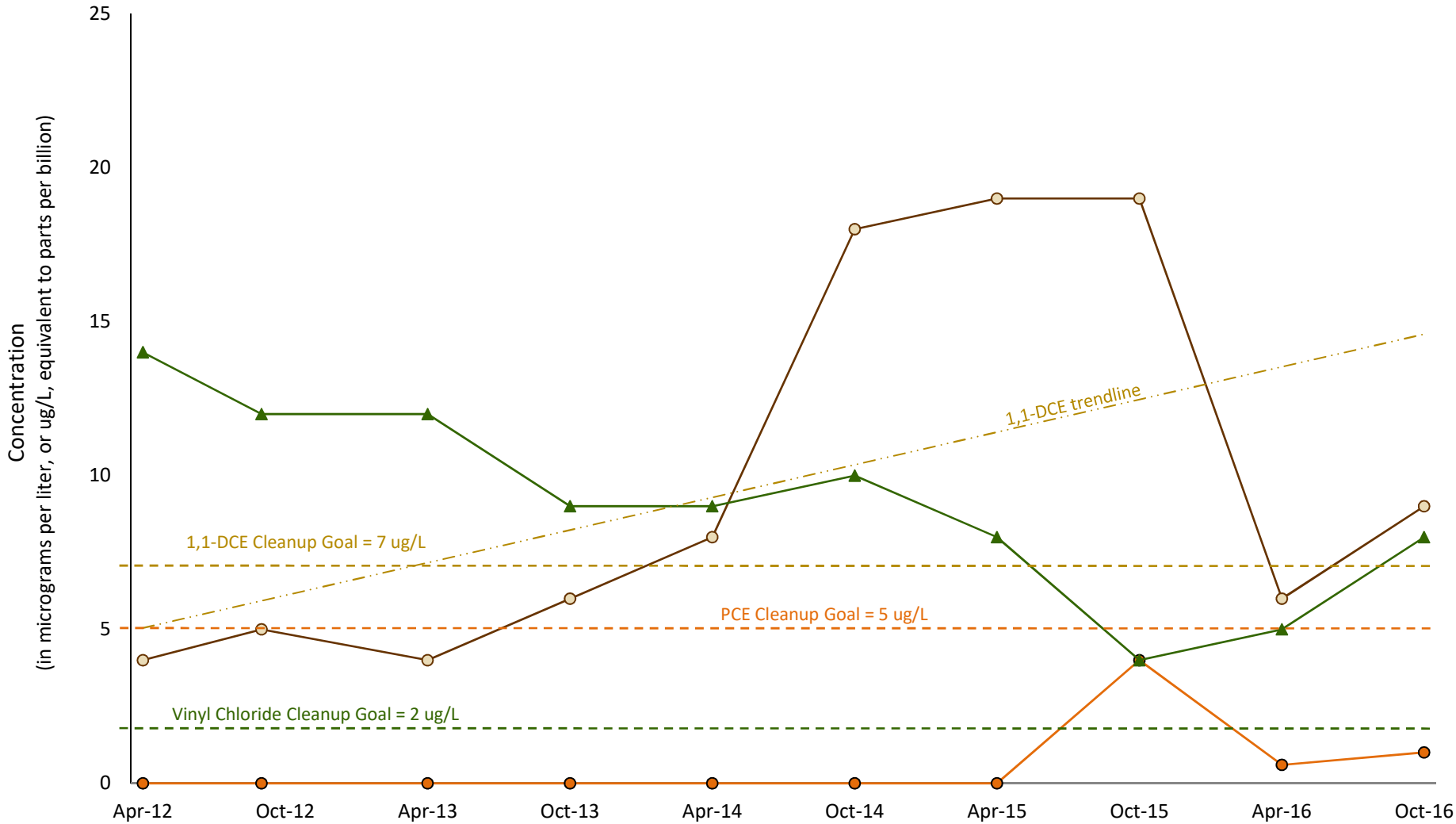
	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Nov-15	Apr-16	Oct-16
MW-05 (overburden)	0	0	0	0	0	0	0	0	0	
MW-35 (bedrock)	8	6	12	10	9	6	18	9	8	4
MW-29 (deep diabase)		0		0		0		0		0

Concentrations of 1,1,1-TCA, cis-1,2-DCE, and TCE in Sentinel Well MW-23 (2012-2016)



	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Oct-15	Apr-16	Oct-16
1,1,1-TCA	290	250	210	270	190	230	180	540	220	310
cis-1,2-DCE	530	490	350	370	340	420	280	520	290	450
TCE	410	470	260	420	340	500	260	2600	250	1300

Concentrations of 1,1-DCE, PCE, and Vinyl Chloride in Sentinel Well MW-23 (2012-2016)



	Apr-12	Sep-12	Apr-13	Oct-13	Apr-14	Oct-14	Apr-15	Oct-15	Apr-16	Oct-16
1,1-DCE	4	5	4	6	8	18	19	19	6	9
PCE	0	0	0	0	0	0	0	4	0.6	1
VC	14	12	12	9	9	10	8	4	5	8