FISCAL YEAR 2017 ANNUAL PERFORMANCE REPORT NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE

Prepared for:

**Commander
Twin Cities Army Ammunition Plant
4761 Hamline Avenue
ATTN: DAIM-BD-TW
Arden Hills, Minnesota 55112**

**PIKA ARCADIS U.S., INC. (JV)
ORBITAL ATK
GHD**

**July 2018
Final Report**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

June 22, 2018

REPLY TO THE ATTENTION OF: SR-6J

Nicholas B. Smith
U.S. Army Environmental Command
2450 Connell Road
Building 2264
JBSA Fort Sam Houston, TX 783245-7664

RE: Consistency Test for the Fiscal Year 2017 Annual Performance Report, New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota

Dear Mr. Smith:

Staff at the U.S. Environmental Protection Agency (U.S. EPA) and the Minnesota Pollution Control Agency (MPCA) have completed review of the Fiscal Year 2017 Annual Performance Report for the New Brighton/Arden Hills Superfund Site (FY17 APR). Our review of the FY17 APR included the following documents and communications:

- Fiscal Year 2017 Annual Performance Report, New Brighton/Arden Hills Superfund Site, Draft Report, Prepared for the Commander, Twin Cities Army Ammunition Plant by PIKA Arcadis U.S., Inc. (JV), 15 February 2018;
- U.S. EPA comments on the Draft FY17 APR (March 23, 2018);
- MPCA comments on the Draft FY17 APR (April 20, 2018);
- U.S. Army (Army) responses to U.S. EPA and MPCA comments and redline changes (May 31, 2018).

Based upon our review, you are hereby advised that, in accordance with Chapter XIV of the Federal Facility Agreement, the Fiscal Year 2017 Annual Performance Report passes the Consistency Test.

If you have any questions, please contact Amy Hadiaris at (651) 757-2402 or Tom Barounis at (312) 353-5577.

Sincerely

Tom Barounis

Tom Barounis
Remedial Project Manager
U.S. Environmental Protection Agency
Region 5

Tom Barounis for

Amy Hadiaris
Project Manager
Remediation Division
Minnesota Pollution Control Agency

Twin Cities Army Ammunition Plant

FISCAL YEAR 2017 ANNUAL PERFORMANCE REPORT

New Brighton/Arden Hills Superfund Site

16 July 2018

FISCAL YEAR 2017 ANNUAL PERFORMANCE REPORT

New Brighton/Arden Hills Superfund Site

Prepared for:

Commander

Twin Cities Army Ammunition Plant

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ATTN: DAIM-BD-TW

Arden Hills, Minnesota 55112

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16 July 2018

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ACRONYMS AND ABBREVIATIONS

APR	Annual Performance Report
AOP	Advanced Oxidation Potential
Army	United States Army
AS	air sparging
Barr	Barr Engineering
BGRS	Boundary Groundwater Recovery System
BRAC	Base Realignment and Closure Division
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
COC	contaminant of concern
CRA	Conestoga-Rovers & Associates, Inc. (now GHD)
DNAPL	dense non-aqueous phase liquid
EBS	Environmental Baseline Survey
EE/CA	Engineering Evaluation/Cost Analysis
ESA	Environmental Site Assessment
ESD	Explanation of Significant Difference
EW	extraction well
FFA	Federal Facility Agreement
FS	feasibility study
FY	fiscal year
GAC	granular activated carbon
GOS	TGRS Global Operation Strategy
gpm	gallons per minute
HRL	Health Risk Limits
JV	PIKA Arcadis U.S., Inc. a Joint Venture
LUC	land use control
LUCRD	land use control remedial design
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal

MDH	Minnesota Department of Health
mg/L	milligrams per liter
MNA	monitored natural attenuation
MOS	TGRS Micro Operation Strategy
MNARNG	Minnesota Army National Guard
MPCA	Minnesota Pollution Control Agency
MW	monitoring well
NB/AH	New Brighton/Arden Hills
NBCGRS	New Brighton Contaminated Groundwater Recovery System
NBM	New Brighton Municipal
NPL	National Priorities List
OM	Operational Minimum
OS	TGRS Operating Strategy
OU	Operable Unit
OU1	Operable Unit 1
OU2	Operable Unit 2
OU3	Operable Unit 3
OU1TG	OU1 Technical Group
PCE	tetrachloroethene
PGAC	permanent granular activated carbon
PGRS	Plume Groundwater Recovery System
PLC	programmable logic controller
PM	preventative maintenance
POTW	Publicly-Owned Treatment Works
PTA	Primer/Tracer area
QAPP	Quality Assurance Project Plan
QC	quality control
ROD	Record of Decision
scfm	standard cubic feet per minute
SDWA	Safe Drinking Water Act
Shaw	Shaw Environmental & Infrastructure, Inc. (formerly Stone & Webster)

SI Report	Summary Report for 135 Primer/Tracer Area Site Inspection Investigation
SVE	soil vapor extraction
SWBCA	special well boring and construction area
SWCA	special well construction area
TCAAP	Twin Cities Army Ammunition Plant
TCE	trichloroethene
TGRS	TCAAP Groundwater Recovery System
TWISS	Tecumseh/Wenck Installation Support Services
USACHPPM	US Army Center for Health Promotion & Preventive Medicine
USEPA	United States Environmental Protection Agency
UV	Ultra Violet
VIC	Voluntary Investigation and Cleanup
VOC	volatile organic compound
Wenck	Wenck Associates, Inc.
WWP	Wet Well Pump
µg/L	micrograms per liter

1 EXECUTIVE SUMMARY

This Fiscal Year (FY) 2017 Annual Performance Report (APR):

- Summarizes the status of remedy implementation, and
- Addresses how the remedies are performing,

for each of the three operable units related to the New Brighton/Arden Hills (NB/AH) Superfund Site. Figure 2-1 shows the approximate locations of the three operable units (OUs). FY 2017 is defined as the period from October 1, 2016 through September 30, 2017.

Records of Decision (RODs) have been signed for each of the three OUs:

- OU1 ROD signed 1993, Amended 2006;
- OU2 ROD signed 1997, Amended 2007, 2009, 2012, and 2014; and
- OU3 ROD signed 1992, Amended 2006.

The RODs, and subsequent Amendments and Explanations of Significant Differences (ESDs), present the major components of the final remedies for the media of concern. This report looks at each of the major components and addresses:

1. Are the remedies being implemented? (Compliance check with the RODs and ROD Amendments)
2. Are the remedies doing what they are supposed to?

Table 1-1 summarizes the status of remedial actions at the end of FY 2017. Following are highlights of the accomplishments for each OU, as well as other activities during FY 2017.

Operable Unit 1 (OU1)

OU1 consists of the “north” plume of volatile organic compound (VOC) groundwater contamination. The final remedy for OU1 consists of pumping from six municipal wells (New Brighton Municipal [NBM] wells NBM #3, #4, #5, #6, #14, and #15), treating the extracted groundwater through the Permanent Granular Activated Carbon (PGAC) system, and discharging the treated water to the New Brighton water supply system for distribution as potable water. Routine OU1 remedy pumping was ceased on April 15, 2015, with notice to the United States Environmental Protection Agency (USEPA)/Minnesota Pollution Control Agency (MPCA), due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells. Since the PGAC does not remove 1,4-dioxane, a “remedy time-out” was placed along with New Brighton switching to preferential extraction from deep aquifer wells while evaluating removal technologies. Since early summer 2016 New Brighton has switched to the City of Minneapolis water system (Mississippi River). Other remedy components include providing alternate water supply and/or well abandonment to affected private wells, and drilling advisories for new well construction. Highlights for FY 2017 are:

- A new treatment technology using Ultraviolet (UV)/Peroxide Advanced Oxidation Potential (AOP) was selected as a pilot study in 2017, with upgrades to the New Brighton water treatment plant scheduled for completion by October 2018. In the interim, water supply will continue via City of Minneapolis supplied water until the upgraded AOP treatment system is fully designed and constructed, such that both VOCs and 1,4-dioxane are removed. A formal change to the Comprehensive Environmental Response, Compensation, and Liability Act remedy regarding AOP treatment is still required.

- The Minnesota Department of Health (MDH) Special Well Construction Area (SWCA) remains in effect. The MDH has the regulatory responsibility to assure that wells constructed in the advisory area meet appropriate well construction and human health requirements. In FY 2017, there were no new recommendations for abandonment or alternate water supply.

Operable Unit 2 (OU2)

OU2 is defined as the area occupied by Twin Cities Army Ammunition Plant (TCAAP) in 1983, when the NB/AH Superfund Site was placed on the National Priorities List. The remedial action requirements were set forth in the OU2 ROD (1997), ROD Amendment #1 related to Site C-2 (2007), ROD Amendment #2 related to Site I groundwater (2009), ROD Amendment #3 related to various soil sites (2009), ESD #1 related to groundwater (2009), ESD #2 related to various soil sites (2009), ROD Amendment #4 related to Building 102 shallow groundwater, aquatic sites, and various soil sites (2012), and ROD Amendment #5 related to various soil sites (2014). Highlights for activities within OU2 during FY 2017 are:

- Shallow Soil Sites: No activities other than ongoing United States Army (Army) implementation of land use controls (LUCs).
- Deep Soil Sites: No activities other than ongoing Army implementation of LUCs.
- Site A Shallow Groundwater
  - In accordance with the Site A Shallow Groundwater: 10-Year Evaluation Report (Wenck Associates [Wenck] 2008a), and with regulatory approval, the groundwater extraction system was shut down on September 24, 2008 to evaluate monitored natural attenuation (MNA) through abiotic degradation as a potential remedy component in lieu of groundwater extraction and discharge. The groundwater system has remained in stand-by mode in case MNA does not adequately control plume migration and one or more extraction wells need to be restarted. In late 2015, following review of FY 2015 groundwater monitoring results, MNA was deemed an acceptable remedy by the USEPA and MPCA. The Army, USEPA, and MPCA drafted a ROD amendment in FY 2017 to document the change in this remedy component. Formal approval of the ROD amendment was pending at the end of FY2017.
  - Monitoring results from four contingency wells located along the north side of County Road I did not exceed the approved trigger levels, which are equal to the cleanup levels for all Site A contaminants of concern.
  - The MDH SWCA remains in effect. In FY 2017, there were no locations identified in need of well abandonment or alternate water supply.
  - Monitoring wells were sampled to confirm the FY 2016 results which suggested 1,4-dioxane is not a contaminant of concern in Site A shallow groundwater. The FY 2017 sampling results were consistent with FY 2015 and FY 2016 results for 1,4-dioxane, in that there were only two detections, both well below the MDH Health Risk Limit (HRL).
- Site C Shallow Groundwater

   - In accordance with the Site C Groundwater Extraction System Evaluation Report (Wenck 2008c), and with regulatory approval, the groundwater extraction system was shut down on November 13, 2008. System operation ceased due to the lead concentration footprint exceeding groundwater cleanup levels no longer reaching extraction wells.
   - Only monitoring wells located near the source area still exceeded the groundwater cleanup level for lead in FY 2017.
   - None of the groundwater contingency locations exceeded the approved lead trigger levels in FY 2017.
   - Continued monitoring is recommended prior to any decision on whether to formally change the remedy to eliminate the groundwater extraction component.
- Site I Shallow Groundwater
   - All Site I Unit 1 monitoring wells abandoned in FY 2014 to allow demolition of building 502 and related soil cleanup activities by Ramsey County; therefore, no new groundwater quality data are available to evaluate.
   - Previous investigations show Unit 1 groundwater is discontinuous and does not extend beyond Site I; rather, Unit 1 impacts migrate downward into Unit 3, which is hydraulically influenced by TCAAP Groundwater Recovery System (TGRS) operation.
   - Monitoring well 01U667 will be reinstalled following redevelopment related grading to occur in the area. The well was scheduled to be reinstalled in 2017 but was delayed due to the extent of grading to be completed. Reinstallation is now scheduled for 2018.
- Site K Shallow Groundwater
   - The Site K groundwater extraction trench and treatment system continued to operate as designed. For FY 2017, the system captured and treated 5,370,496 gallons of water and maintained a continuous zone of capture downgradient of the former Building 103. A total of 8.5 pounds of VOCs were removed in FY 2017.
   - Groundwater samples were collected from all eight wells scheduled for sampling in FY 2017. With the exception of relatively stable trichloroethene (TCE) concentrations in 01U615, the overall trend throughout Site K Unit 1 monitoring wells continues to show a gradual decrease in TCE concentrations over the last twenty years of sampling.
   - The extracted water was treated and discharged to Rice Creek in compliance with discharge criteria except for phosphorus concentrations in March and June 2017 and zinc in June 2017. The effluent was resampled in June, July, and August 2017 using the same sampling protocols as specified in the TCAAP Quality Assurance Project Plan (QAPP). Based on sampling results, no correlation was found between the earlier and infrequent exceedances of phosphorus and zinc discharge limits for the Site K treatment system effluent and particulate accumulation in the treatment system. Future sampling will ensure sample port piping is thoroughly purged prior to collecting effluent samples.
   - Fifteen Unit 1 wells at Site K were abandoned as part of redevelopment activities in FY 2014; three of these wells are scheduled to be reinstalled upon the completion of the regrading and

related construction. One Unit 1 Site K well was abandoned in FY 2017 as part of redevelopment activities and will not be reinstalled.

- Building 102 Shallow Groundwater
  - VOC concentrations were generally similar to those observed in the prior year.
  - The well adjacent to Rice Creek continued to show shallow groundwater discharging to Rice Creek below the Site cleanup levels.
  - Monitoring wells were sampled to confirm the FY 2016 results which suggested 1,4-dioxane is not present in Building 102 shallow groundwater. The FY 2017 sampling results were consistent with the FY 2015 and FY 2016 results for 1,4-dioxane, except at well 01U048, where 1,4-dioxane was detected at 1.1 micrograms per liter (µg/L), which is above the MDH HRL. Due to the lack of 1,4-dioxane detections throughout the rest of the Building 102 monitoring well network, this exceedance was deemed an anomaly.
- Aquatic Sites: No activities other than ongoing discussion of Round Lake.
- Deep Groundwater
  - The TGRS operated in accordance with the OU2 ROD.
  - The TGRS operated at a rate sufficient to support the conclusion that the OU2 5 µg/L TCE source area footprint is hydraulically influenced respective of the OU2 ROD. In FY 2017, the total extraction well water pumped averaged 1,769 gallons per minute (gpm), which exceeds the Global Operation Strategy (GOS) Operating Minimum (OM) (1,745 gpm). In August 2017, the TGRS extraction rate (1,649 gpm) was less than the GOS minimum due to forcemain cleaning between wells B1 to B8.
  - In FY 2017, the TGRS extracted and treated approximately 929,926,100 gallons of water. The mass of VOCs removed was 1,988 pounds, 257 pounds more than FY 2016. The total VOC mass removed by the TGRS through FY 2017 is 216,749 pounds.
  - Groundwater analytical data shows a continued general decrease in TCE concentration. This decrease demonstrates that the TGRS is removing VOC mass from the aquifer.
  - Effluent VOC concentrations were below contaminant specific requirements for all sampling events.
  - Sampling for 1,4-dioxane continued in FY 2017. Sample results were similar to that reported in FY 2015 and FY 2016.

Operable Unit 3 (OU3)

OU3 contains the South Plume of VOC groundwater contamination. Overall, the statistical evaluation of groundwater data collected in FY2017 indicates stable to declining concentration trends at the center and edge of the South Plume. 1,4-dioxane sampling continued in FY 2017 with results similar to FY 2015 and FY 2016.

Other Investigation and/or Remediation Activities Not Prescribed by a Current ROD

- Round Lake Supplemental Remedial Investigation and Feasibility Study

- o After a series of conference calls held in attempt to resolve the informal dispute between the Army, USEPA, and MPCA regarding Round Lake ecological risks and commensurate remedy, the USEPA Region 5 Federal Facilities Chief and Headquarters Department of Army personnel reached an agreement on September 20, 2016. Per the agreement, a revised draft-final Supplemental Remedial Investigation and Feasibility Study for Round Lake was scheduled to be prepared and submitted to the USEPA and MPCA in the third quarter of FY 2017. The document was submitted for regulator review on May 10, 2017 with subsequent redlined revisions proposed in an October 6, 2017 submittal.

2 INTRODUCTION

2.1 Purpose

The Annual Performance Report (APR) is intended to both summarize the status of remedy implementation and address remedy performance. For FY 2017, remedial actions at the New Brighton/Arden Hills (NB/AH) Superfund (Site) extend from October 1, 2016 through September 30, 2017. Additionally, the NB/AH Site is divided into three designated Operable Units: (OU)1, OU2, and OU3 (Figure 2-1). OU1 encompasses off-site deep groundwater sometimes referred to as the North Plume. OU2 includes soil, sediment, surface water, and groundwater contamination in the area that comprised the Twin Cities Army Ammunition Plant (TCAAP) in 1983, when the NB/AH Site was placed on the National Priorities List (NPL). OU2 also includes the Site A groundwater plume that extends off the north end of the federally-owned property. OU3 consists of off-site deep groundwater sometimes referred to as the South Plume. A Record of Decision (ROD) was developed and signed for each OU:

- OU1 ROD signed 1993, Amended 2006;
- OU2 ROD signed 1997, Amended 2007, 2009, 2012, and 2014; and
- OU3 ROD signed 1992, Amended 2006.

The RODs, subsequent Amendments, and Explanations of Significant Differences (ESDs) present the major components of the final remedies for the media of concern. Monitoring activities and submittal of this APR are in fulfillment of the Federal Facility Agreement (FFA) signed in 1987 by the United States Army (Army), United States Environmental Protection Agency (USEPA), and Minnesota Pollution Control Agency (MPCA) with performance assessment answered via two questions:

1. Are all of the remedies being implemented? (Compliance check with the RODs)

2. Are the remedies performing as required?

For each OU, this APR answers the questions posed above by evaluating the major components of the selected remedies of each ROD (and subsequent modifications). Performance standards are then presented for each major remedy component and subsequently used to evaluate successful implementation or completeness. For some remedy components, performance standards are clearly defined in the RODs (soil or groundwater cleanup levels). For others (alternate water supply) performance standards are less clear but may have been agreed within Work Plans or design documents. With performance standards identified, the APR then addresses both questions discussed above through a series of sub-questions, written to facilitate a focused and user-friendly document promoted, as possible, in the form of figures and/or graphs.

In addition to reporting on FY 2017, proposed future monitoring is also presented (Appendix A), with proposed changes in monitoring locations and/or sampling frequencies highlighted in yellow. Monitoring covers a rolling 5-year time span (i.e., currently FY 2017 through FY 2021 where next year FY 2017 will drop off and FY 2022 will be added).

This document represents collaboration by the Army and Orbital ATK (formerly Alliant Techsystems). On behalf of the Army, PIKA Arcadis U.S., Inc., a Joint Venture (JV) prepared Sections 2 through 7, 10, 11 and 14. On behalf of Orbital ATK, GHD (formerly Conestoga-Rovers & Associates, Inc. [CRA]) prepared Sections 8, 9, 12 and 13. JV and GHD both contributed to the Executive Summary.

2.2 Brief Overview of TCAAP

TCAAP was constructed between August 1941 and January 1943 in the northern portion of the Minneapolis – St. Paul metropolitan area, in Ramsey County, surrounded by the cities of New Brighton, Arden Hills, Mounds View, and Shoreview, Minnesota (Figure 2-1). TCAAP primarily produced and proof-tested small-caliber ammunition and related materials for the Army. Other uses included manufacture of munitions-related components, handling/storage of strategic and critical materials for other government agencies, and various non-military activities. Production began in 1942, and operations alternated between periods of activity and standby related to wars until manufacturing ceased in 2005. During active periods, solvents were used as part of some manufacturing operations. Disposal of solvents and other wastes resulted in soil and groundwater contamination that migrated beyond the original TCAAP boundary.

Groundwater impacts were first discovered in July 1981, leading to soil and groundwater investigations on and off-Site. In 1983, it was determined the source of impacts and other areas of affected groundwater contamination were from TCAAP, which was placed on the NPL denoted as the NB/AH Superfund Site.

Several known and potential contaminant source areas on the TCAAP property were initially identified within OU2: Sites A, B, C, D, E, F, G, H, I, J, K, 129-3, 129-5, and 129-15 (Figure 2-2). The 1997 OU2 ROD specified requirements for each site except Site F (which was addressed under the Resource Conservation and Recovery Act prior to 1997) and Site J (a sewer line determined not to have a contamination release). Additionally, other areas have also undergone investigation and/or remediation, namely the Grenade Range, Outdoor Firing Range, Trap Range, 135 Primer/Tracer Area (PTA) (and adjacent stormwater ditch), 535 PTA, Water Tower Area, Environmental Baseline Survey (EBS) Areas, and Building 102. These areas are also shown on Figure 2-2.

Since 1983 the size of TCAAP has periodically shrunk due to property transfers. Some property has been transferred out of federal-ownership to Ramsey County and the City of Arden Hills. Other property is still owned by the federal government, but control has been reassigned to the Army Reserve or the National Guard Bureau, which has licensed property to the Minnesota Army National Guard (MNARNG). Figure 2-3 presents property under federal ownership at the end of FY2017, along with the organizations responsible for control. The minimal remaining TCAAP (BRAC-controlled) property is currently in the process of being transferred out of federal ownership. It is likely that within the next few years, there will no longer be an organization or property called TCAAP. These property transfers do not alter the responsibilities of the Army under the FFA.

2.3 Hydrogeologic Units and Well Nomenclature

For purposes of studies and work related to the NB/AH Superfund Site, four hydrogeologic units have been designated: Unit 1 through Unit 4, described in Appendix B, along with well designation nomenclature overview. A well-designation cross-reference guide is included in Table B-1 within Appendix B. The well index includes all Army owned or used wells to gather groundwater elevation or water quality data, sorted by Minnesota unique number. Well information includes the Army designation

(Installation Restoration Data Management Information System number), Minnesota unique number, and any other name(s). Well locations included in the monitoring plan are shown on Figure B-2 (OU1/OU3 wells) and Figure B-3 (OU2 wells) in Appendix B. With a known well name, the location can be identified using the “Edit, Find” or “Edit, Search” function and typing in the well name, which will highlight the desired well name on the figure. Available information concerning a well, including well logs and other information, can be viewed in the Appendix B Attachment, which is sorted by the Minnesota unique number. See instructions in Appendix B for more information.

2.4 Data Collection, Management, and Presentation

Performance monitoring data were collected in accordance with the FY 2017: Monitoring Plan for Groundwater Monitoring Wells, Monitoring Plan for Remedial Treatment Systems, Monitoring Plan for Surface Water and New Brighton Water System Sampling and Analysis Plan.
Data were collected by the JV on behalf of the Army, GHD on behalf of Orbital ATK, and Barr Engineering (Barr) on behalf of the City of New Brighton. Data collection, management, and presentation are discussed in Appendix C. Lastly, comprehensive groundwater levels and quality databases from 1987 through FY 2017 are contained in Appendix D.1.

Are the data complete and representative (are we making decisions based on complete and technically-sound information)?

Yes. The data were collected in accordance with the FY 2017 Monitoring Plan and verified and validated in accordance with the QAPP for Performance Monitoring (Pika-Arcadis JV 2016).

Data tables in the various report sections and the comprehensive water quality databases (Appendix D.1) show the assigned data qualifiers as a result of data verification and/or data validation. The data qualifiers assigned to FY 2017 data are explained in the data table footnotes. Data verification (performed on 100% of the data) and data validation (performed on 100% of 1,4-dioxane data and a minimum of 10% of the data, except at Site K) were provided to the USEPA and MPCA via submittal of quarterly Data Usability Reports covering FY 2017 information. The final MPCA/USEPA approval letter for the FY 2017 Data Usability Reports is included in Appendix C.3.

Regarding completeness, Appendix C.2 summarizes any deviations from the FY 2017 Monitoring Plan. The emergence of 1,4-dioxane in 2015 prompted substantial changes in FY 2016, which were carried over into FY 2017. The field and laboratory completeness goals for performance monitoring are both 95%, except for TCAAP Groundwater Recovery System (TGRS) effluent, Site K effluent, and well inventory samples, for which field and laboratory completeness goals are 100%. Apart from seven missed 1,4-dioxane samples (monitoring wells) due to a laboratory preservation error, and three surface water sampling locations that were inadvertently missed, actual field and laboratory completeness were both 100%, meeting overall completeness goals (dry, frozen, or inoperative wells were not considered as missed samples, nor owner nonresponsive or refused sample collection). Also, the actual field and laboratory completeness for the subset of samples with 100% completeness goals was successful at 100%.

Regarding Quality Control (QC) samples, the QAPP specifies field duplicates, equipment rinse blanks, and matrix spike/matrix spike duplicates are to be collected at overall frequencies of 10%, 10%, and 5%.

Actual QC sample frequencies met these goals, with respective frequencies of 10%, 10% and 10% for VOCs and 12%, 12%, and 12% for 1,4-dioxane in the performance monitoring.

With regard to data validation, the performance monitoring QAPP specifies that data validation be completed at an overall rate of 10%, with 100% validation of 1,4-dioxane data and well inventory samples. The actual validation rate for VOCs far exceeded 10%, and all data requiring 100% data validation were fully validated, meeting the specified validation rates for performance monitoring.

FY 2017 data are deemed to be representative and meet data quality objectives based on: 1) adherence to QAPP-specified sampling and laboratory analytical procedures; 2) completion of data verification and data validation; and 3) comparability to historical results (any substantial deviations from historical and/or anticipated results are discussed within the site-specific sections of this APR).

3 OPERABLE UNIT 1: DEEP GROUNDWATER

The 1993 OU1 ROD was amended in 2006 to formalize adoption of groundwater quality statistical analysis. Primary elements of the OU1 ROD are as follows (amendment changes in italics):

1. Providing alternate water supplies to residents with private wells within the North Plume.
2. Implementing drilling advisories that would regulate the installation of new private wells within the North Plume as a Special Well Construction Area (SWCA.
3. *Extracting groundwater from the North Plume using the New Brighton Contaminated Groundwater Recovery System* (NBCGRS), subject to the following:
    a. the initial aggregate groundwater extraction rate shall be consistent with long-term NBCGRS operating history;
    b. future decreases in the aggregate extraction rate shall be determined by the Army, USEPA, and MPCA using a transparent public process and rational engineering, scientific, and economic analyses at least as rigorous as those employed in the Feasibility Study (FS) that was the basis for the original remedy selection;
    c. future changes to the aggregate or individual well extraction rates shall be made to assure that the rate of restoration of the aquifer will not be slowed or result in a duration of remedy longer than was contemplated by the original ROD;
    d. future changes to the aggregate or individual well extraction rates shall be made to assure that the rate of restoration of the aquifer will not be slowed or result in a duration of remedy longer than was contemplated by the original ROD;
4. Future changes to the aggregate or individual well extraction rates shall be made to assure that the rate of restoration of the aquifer will not be slowed or result in a duration of remedy longer than was contemplated by the original ROD Pumping the extracted groundwater to the permanent granular activated carbon (PGAC) Water Treatment Facility in New Brighton for removal of volatile organic compounds (VOCs) by a pressurized granular activated carbon (GAC) system.
5. Discharging all treated water to the New Brighton municipal distribution system.
6. *Monitoring the groundwater to verify effectiveness of the remedy through measurement of overall plume shrinkage (geographically) and decreasing contaminant concentrations*.

Requirement No. 6 is met by evaluating analytical groundwater data according to statistical methods contained in the OU1 Technical Group Technical Memorandum Statistical Evaluation Method For Water Quality Data, Operable Unit 1, dated December 2004 (and any subsequent addendums or revisions approved by the USEPA and MPCA). The statistical analysis is conducted annually and is reported in the APR.

The OU1 remedy encountered a new and substantial issue in FY 2015 that has continued to affect remedy performance. In early 2015, the City of New Brighton was notified by the Minnesota Department of Health (MDH) that an emerging contaminant, 1,4-dioxane, had been detected in New Brighton's water supply (with detections up to 6.8 micrograms per liter [µg/L]). The NBCGRS wells extract groundwater from the Prairie du Chien and/or Jordan Aquifers (Upper and Lower Unit 4). Concentrations of 1,4-

dioxane in samples collected from New Brighton's deeper municipal wells (Mount Simon Aquifer) were non-detect. Currently, no 1,4-dioxane federal drinking water standard exists; however, a state MDH Health Risk Limit (HRL) of 1 µg/L is in place, with most of the 1,4-dioxane concentrations in samples collected from the NBCGRS exceeding the MDH HRL. A 'remedy time-out' was placed, ceasing NBCGRS operation on April 15, 2015. The City switched to preferential extraction from deep aquifer wells while evaluating removal technologies. A pilot study report for Advanced Oxidation Technology for treatment of 1,4-dioxane was completed in August 2016.

A preliminary design review was held with the Army and Regulators in December 2016. Barr Engineering was awarded a contract in May 2017 and began the design process for installation of Ultraviolet Reactor(s) to treat 1,4-dioxane at the NBCGRS. A new treatment technology using UV/Peroxide Advanced Oxidation Potential was selected for pilot study in 2017, with upgrades to the New Brighton water treatment plant scheduled for completion by October 2018. In the interim, New Brighton is obtaining its water from the City of Minneapolis until the Advanced Oxidation Potential (AOP) treatment system is fully operational.

The six major components of the remedy prescribed by the amended ROD are evaluated below, including discussion of the effects of the remedy time-out noted above.

3.1 Remedy Component #1: Alternate Water Supply/Well Abandonment

Description: "Providing an alternative water supply to residents with private wells within the North Plume." (OU1 ROD, page 2)".

- Clarified by the *OU1 Alternate Water Supply Plan* (Montgomery Watson 1995) to delete "residents with" because the remedy applies to other wells in addition to residential wells. The plan also lists the criteria for identifying the wells that are eligible for an alternate water supply.
- Clarified by the *OU1 Alternate Water Supply Plan* to also include well abandonment.
- Clarified by the *OU1 Alternate Water Supply Plan* (page i-2) to also encompass OU3 and the OU2 Site A shallow groundwater plume.

Performance Standard (how do you know when you're done):

For alternate water supply, when the owners of all wells that meet all the following criteria have been offered and provided with an alternate water supply (or when the well owners have rejected the offers):

i. The well is located within the area affected by groundwater plumes that originate at OU2, as shown on Figures E-1, E-2 and E-3 in Appendix E; and

ii. The well is completed in an affected aquifer; and

iii. The well contains detectable concentrations of the NB/AH Superfund Site-related COCs identified on page 18 of the OU1 ROD (or page 26 of the OU3 ROD, or Table 1 of the OU2 ROD, as appropriate for the well location); and

iv. The well is used in a manner to cause exposure (uses are defined in the *OU1 Alternate Water Supply Plan*); and

v. The well owner does not already have an alternate water supply.

If eligible well owners refuse the offer to have an alternate water supply provided, this also satisfies the performance standard.

For well abandonment, when the owners of all wells that meet all the following criteria have been offered and provided abandonment (or when the well owners have rejected the offers):

i. The well is located within the area affected by groundwater plumes that originate at OU2; and

ii. The well is completed in an affected aquifer; and

iii. The well contains detectable concentrations of the NB/AH Superfund Site-related COCs identified on page 18 of the OU1 ROD (or page 26 of the OU3 ROD, or Table 1 of the OU2 ROD, as appropriate for the well location); and

iv. The well was constructed prior to the MDH SWCA advisory; and

v. The well is being used by the well owner or use was discontinued due to contamination; and

vi. The well is used in a manner to cause exposure (uses are defined in the Alternate Water Supply Plan).

If eligible well owners refuse the offer for abandonment, this also satisfies the performance standard. An exception to abandonment would be if the well is needed for groundwater monitoring.

Also, note that per Appendix E, program requirements for both alternate water supply and well abandonment have been clarified such that a well should contain a cleanup level exceedance (or an additivity of 1.0, similar to the MDH Hazard Index calculation), rather than merely “detectable concentrations” as noted above. On a case-by-case basis, review by the Army, USEPA, and MPCA could lead to an Army offer for alternate water supply and/or well abandonment for a given well with detectable concentrations that do not exceed a cleanup level (or additivity criteria), particularly if that well is used to supply drinking water.

Is this remedy component being implemented?

Yes. The Alternate Water Supply and Well Abandonment Program has been implemented and is an ongoing, Army maintained program. The process of identifying wells eligible for alternate water supply and/or abandonment is accomplished by maintaining a “well inventory” (Appendix E). The well inventory is a database that was initially developed in 1992 and has been periodically updated since (now annually as part of the APR). For the purposes of the well inventory, a study area was established to encompass the groundwater plume (same area as the MDH SWCA). The well inventory is intended to include all wells within the study area, whereas areas of concern are defined by the edge of the groundwater plume, plus an additional ¼-mile buffer. The wells are grouped into categories based on factors such as location relative to the area of concern, type of use, active/non-active status, sealed, etc. Wells in categories with the potential to be impacted are periodically sampled to see if they qualify for alternate water supply and/or abandonment. Thus, maintenance of the well inventory consists of the following tasks:

1. Check if the area of concern needs to be adjusted based on the extent of contamination,
2. Check if there are any previously unknown wells to be added to the database (coordination with the MDH as described in Appendix E),

3. Sample wells on a prescribed schedule,
4. Take the appropriate course of action per results,
5. Update the well inventory database with any new information (e.g., water quality results, owner information, construction information, well re-categorizing),
6. Report findings in the APR.

The following questions and answers summarize developments since the last APR with respect to OU1.

Did the area of concern within OU1 change during FY 2017, as defined by the 5 µg/L contour line?

As shown on Figure 3-1, the area of concern did not change during FY 2017 on the western side of the buffer but increased in the southern portion of the plume. However, the south eastern portion did decrease in area to some extent. The well inventory study area encompasses the FY 2017 area of concern.

Were any additional water supply wells discovered within the area of concern for OU1 that are completed within an aquifer of concern?

No. See Appendix E for additional information.

Were any water supply wells within the area of concern for OU1 sampled during FY 2017 (outside of those included in the OU1 performance monitoring plan)? If yes, what were the findings?

No. The next comprehensive sampling event for water supply wells within the OU1 area of concern is scheduled for FY2020.

Were any well owners offered an alternate water supply and/or well abandonment during FY 2017?
No.

For OU1, are there any well owners that meet the criteria, but have not yet been provided an alternate water supply?

No.

For OU1, are there any wells that meet the criteria, but have not yet been abandoned?

No.

Is any sampling of water supply wells (excluding those included in the OU1 performance monitoring plan) proposed prior to the next report?

No. FY 2018 is not a scheduled sampling event for inventory wells, as shown in Appendix A.1. The next major sampling event is scheduled for FY 2020.

Are there any changes or additional actions required for this remedy component?

No.

3.2 Remedy Component #2: Drilling Advisories

Description: “Implementing drilling advisories that would regulate the installation of new private wells within the North Plume as a SWCA.” (OU1 ROD, page 2)

Performance Standard (how do you know when you're done):

For initial implementation, when the MDH has issued a SWCA Advisory. Implementation will continue until such time that the groundwater concentrations are below the cleanup levels.

Has the MDH issued a SWCA Advisory?

Yes, in June 1996. In June 1999, the MPCA requested the MDH extend the SWCA boundary further southwest to the Mississippi River and Marshall Avenue ensuring the southern boundary fully encompassed the plume. The SWCA also covers OU3 and, as of April 2016, all of OU2. The current boundary of the SWCA is shown on Figure E-1 (Appendix E).

Are any changes or additional actions required for this remedy component?

No.

3.3 Remedy Component #3: Extract Groundwater

Description: Extracting groundwater from the North Plume using the NBCGRS, subject to the following:

1. The initial aggregate groundwater extraction rate shall be consistent with the long-term operating history of the NBCGRS;
2. Future decreases in the aggregate extraction rate shall be determined by the Army, USEPA, and MPCA using a transparent public process and rational engineering, scientific, and economic analyses at least as rigorous as those employed in the FS that was the basis for the original remedy selection;
3. Future changes to the aggregate or individual well extraction rates shall be made so as to assure that the rate of restoration of the aquifer will not be slowed or result in a duration of remedy longer than was contemplated by the original ROD;
4. The facilities comprising the NBCGRS may be modified as necessary to assure the restoration of the full areal and vertical extent of the aquifer in a timeframe as contemplated in 3.c, above (2006 OU1 ROD Amendment, page 5-2 & 5-3).

Through January 2008, the remedy component consisted of recovering deep (Unit 4) groundwater using three primary City of New Brighton wells (NBM #4, #14, and #15) with three alternate wells (NBM #3, #5, and #6). NBM #3 and #4 were existing wells completed in both the Prairie du Chien and Jordan. NBM #5 and #6 were existing wells completed in the Jordan. NBM #14 and NBM #15 were constructed in the Prairie du Chien as part of the remedy and began pumping in December 1996 and March 1998, respectively. The locations of the recovery wells are shown on Figure 3-1.

The extracted groundwater is used as part of the New Brighton water supply system (except during the current remedy time-out), and as such, New Brighton took the lead on design and construction of the system and is responsible for system operation. New Brighton contracted Barr to provide design and construction oversight services. The federal government is paying for the OU1 remedy.

In 2006, New Brighton proposed to the Army modifying the agreement between the two parties to allow more flexibility in how they operate the NBCGRS, and to increase removal of contaminant mass from the aquifer. In November 2007, the USEPA and MPCA provided consistency approval of the revised pumping rates. Appendix A.5 (Table D-1 and Table D-2 from the settlement agreement between the Army and New Brighton) presents the new pumping rates in effect as of January 2008.

The revised pumping approach does not affect the approved statistical analysis used to evaluate the effectiveness of the remedy as set forth by the OU1 ROD Amendment. The Army has made it clear to New Brighton that if the changes cause statistical evaluation results that are not in compliance with the OU1 ROD Amendment, the pumping allocations will revert to the previous scheme.

Performance Standard (how do you know when you're done):

When the NBCGRS is operating consistent with long-term NBCGRS operating rates.

During FY 2017, did the OU1 extraction system operate per the New Brighton operational plan and consistent with past operations?

No. As discussed above, 1,4-dioxane detections in the NBCGRS wells caused pumping cessation on April 15, 2015, including the Fridley Interconnection. Based on past operations, the target average daily pumping rate is 3.168 million gallons per day (Appendix A.5). In FY 2017, the NBCGRS continues in a remedy time-out. Hence, FY 2017 pumping did not meet targeted extraction.

Are any changes or additional actions required for this remedy component?

Yes. The City of New Brighton will continue the process of designing and installing Ultraviolet Reactors for Advanced Oxidation to treat 1,4-dioxane, enabling restart of the groundwater extraction remedy.

3.4 Remedy Component #4: Removal of VOCs by GAC

Description: "Pumping the extracted groundwater to the PGAC Water Treatment Facility in New Brighton for removal of VOCs by a pressurized GAC system." (OU1 ROD, page 2)

Treatment by the PGAC (along with iron and manganese removal and chlorination) makes the recovered groundwater suitable for municipal drinking water purposes, with respect to VOCs. The PGAC is located approximately one-third mile south of Interstate 694 near Silver Lake Road. The City of New Brighton is responsible for operation and maintenance of the PGAC, with cost reimbursement from the Army for the operations related to the remedy.

Performance Standard (how do you know when you're done):

When the treated water meets the MCL and non-zero Maximum Contaminant Level Goals (MCLGs) established by the Safe Drinking Water Act (SDWA) for the chemicals of concern, as identified on page 18 of the OU1 ROD.

Did the treated water meet the MCLs and non-zero MCLGs established by the SDWA for the OU1 chemicals of concern?

Not applicable. As the NBCGRS did not operate in FY 2017, treated water samples could not be collected and evaluated for compliance. Some very limited pumping occurred for non-supply plant operations (e.g., filter backwashing).

Is any sampling of the treated water proposed prior to the next report?

Sampling of the treated water will resume when the NBCGRS once again becomes operational, which is anticipated to occur in October 2018 (e.g. FY 2019).

Are any changes or additional actions required for this remedy component?

Yes. The City of New Brighton will continue with its process of designing and installing Ultraviolet Reactors for Advanced Oxidation treatment so the water treatment remedy component can resume. Note that this remedy component will need to be modified in a ROD amendment or ESD such that “removal of VOCs by GAC” will become “removal of VOCs and 1,4-dioxane by Advanced Oxidation.”

3.5 Remedy Component #5: Discharge of Treated Water

Description: “Discharging all of the treated water to the New Brighton municipal distribution system” (OU1 ROD, page 2).

Performance Standard (how do you know when you’re done):

When the connection to the New Brighton municipal supply system has been completed and water is being discharged.

Is the treated water being discharged to the New Brighton municipal distribution system?

No. As a remedy time-out is still in place, no water was treated or discharged in FY 2017.

Are any changes or additional actions required for this remedy component?

Yes. The City of New Brighton will continue with its process of designing and installing Ultraviolet Reactors for Advanced Oxidation treatment at the NBCGRS to treat 1,4-dioxane so the groundwater discharge remedy component can resume.

3.6 Remedy Component #6: Groundwater Monitoring with Verification of Continuing Aquifer Restoration

Description: “Monitoring the groundwater to verify the effectiveness of the remedy through measurement of overall plume shrinkage (geographically) and decreasing contaminant concentrations” (2006 OU1 ROD Amendment, page 5-3).

Performance Standard (how do you know when you’re done):

When performance groundwater monitoring verifies aquifer restoration.

Is this remedy component being implemented?

Yes. Performance monitoring programs have been established to collect the data required to verify the effectiveness of remedy components #1 through #6. Table 3-1 summarizes the performance monitoring requirements, implementing parties, and the specific documents that contain the monitoring plans.

Were the groundwater monitoring requirements for this remedy met?

Yes. FY 2017 was a “minor” sampling year. Also, with the detection of 1,4-dioxane in the NBCGRS wells, the USEPA and MPCA requested that the Army analyze groundwater samples for 1,4-dioxane at all scheduled OU1 sampling locations during the summer FY 2017 sampling event. All the required and requested sampling was completed. As an aside, at the end of regulator review for the FY 2016 APR, it was agreed that the sampling frequency for monitoring wells 03L811, 04U839, 04U855, and 04U879 would revert to annual. However, the FY2017 monitoring event was completed prior to finalizing the FY 2016 APR, so these wells were not sampled in FY 2017. The wells will be sampled annually going forward.

Is any groundwater monitoring proposed prior to the next report?

Yes. When operating, monthly monitoring of the extraction wells and treatment system effluent is performed by the City of New Brighton in accordance with the "New Brighton Water System Sampling and Analysis Plan," June 1997. However, the OU1 extraction system is not anticipated to be restarted within FY 2018 and therefore no such monitoring is anticipated to occur.

Other groundwater monitoring will be in accordance with the Groundwater Monitoring Plan included as Appendix A.1. A "minor" event was conducted for FY 2017. The next "major" performance monitoring event will be in FY 2018. The next "major" well inventory sampling event is scheduled for FY 2020.

Does groundwater monitoring show aquifer restoration is occurring?

Historic groundwater data trends and quality (Appendix D) indicate there has been significant improvement in groundwater conditions as a result of both TGRS and NBCGRS operation. Based on data leading up to the April 2015 remedy time-out, TCE trends in the NBCGRS wells appeared to be stable for NBM #3, #4, #14, and #15 and decreasing for NBM #5 and #6, as shown in Figure 3-2.. Aquifer restoration based on TCE trends in the NBCGRS wells will be further examined when monitoring resumes upon restarting the NBCGRS remedy.

Figure 3-3, Figure 3-4, and Figure 3-5 show both the TCE and 1,4-dioxane plumes depicted by depth and geology (5 µg/L for TCE; 1 µg/L for 1,4-dioxane) in the Upper and Lower Unit 3 Combined, Upper Unit 4, and Lower Unit 4 portions of the aquifer for FY 2017, along with cross-section lines, based on the summer 2016 and 2017 sampling events. Figure 3-3 presents the combined Upper and Lower Unit 3 TCE plume with the highest concentrations residing near the OU2 source areas. Concentrations decline as the plume moves toward the southwest due to mass removal by the TGRS and as concentrations migrate into bedrock via deeply eroded bedrock valleys as mapped by the Minnesota Geologic Survey (Mossler 2013). The regional presence of these valleys within and beyond TCAAP affects groundwater movement. TCAAP is divided roughly in half by a southeast-to-northwest trending bedrock valley, which is joined from the east by a branching valley containing south trending dead-end tributary valleys crossing portions of OU1.

The buried valleys may act as hydraulic short-cuts, allowing groundwater to move directly from Unit 3 into bedrock. Moreover, buried valleys create isolated points and bedrock knobs, cut off from adjacent bedrock by valley-fill sediments. In a bedrock aquifer system as complex as this, groundwater does not flow uniformly from up-to-down-gradient, distributed evenly along parallel paths, but is concentrated in the highest permeability, most-interconnected beds, within conduits (Prairie du Chien) and bedding-plane fractures (Jordan). Figures 3-4 and 3-5 present both TCE and 1,4-dioxane in the Upper and Lower Unit 4 bedrock plumes, respectively. Additionally, unlike historical plume maps, these figures show a conceptual representation of bedrock geology. As presented in both figures, eroded bedrock valleys are filled with overburden where concentration isocontours follow the bedrock topography. Further discussion on buried bedrock valleys and the effect on local hydrogeology is discussed in the current remedy review report, currently under regulatory review.

Figure 3-1 shows the 1 µg/L TCE contour for Upper Unit 4 in 1990, 1999, 2009, and 2017. Figures 3-6 and 3-7 depict cross-sections showing both the OU1 and OU3 plumes, which overlap to some extent and should be viewed together. Figure 3-8 depicts the 100 µg/L TCE contour for Upper Unit 4 for certain years between 1990 and 2017, similar to Figure 3-1 which shows the 1 µg/L TCE contour over that same period. In general, the plumes show “no trend” or stable concentrations (see statistical analysis below); as Figure 3-1 and Figure 3-8 show, the plume footprint remains similar to 2009. A slight northward shift of the 1 µg/L and 100 µg/L TCE contours north of the NBCGRS can be seen on the northwest edge of the plume, likely a result of the NBCGRS remedy time- out since April 2015. This shift was first observed following the FY 2015 sampling event and was observed slightly farther north again in FY 2016. Additional sampling will be needed to see if the trend continues, and to see if the west edge of the plume in areas south of the NBCGRS also begin to show a similar trend. Other differences between 2009 and 2017 plumes are due to plume reinterpretation by JV as part of the OU Remedy Review.

The OU1 Technical Group Technical Memorandum Statistical Evaluation Method for Water Quality Data, Operable Unit 1 (Army 2004) was prepared to develop statistical methods specifically selected to evaluate the long-term progress of remediation, plume evolution, and aquifer restoration in OU1. The OU1 Technical Group (OU1TG) states the objective of the statistical evaluation as follows:

“Verify progress in cleanup of the plume through measurement of overall geographic plume shrinkage and decreasing contaminant concentrations.”

The OU1TG identified five issues that need to be statistically evaluated with respect to the above objective:

1. Measure changing concentrations immediately downgradient of the TGRS, as this area is the first to be affected by any potential contaminant migration via TCAAP.
2. Measure changes in the geographical size of the plume over time.
3. Measure changes in concentrations immediately downgradient of the NBCGRS, as this is the first area to be affected by any potential contaminant migration outside of NBCGRS capture.
4. Measure any unforeseen changes in plume configuration. This addresses the possibility that changing flow patterns may cause a shift in the plume but not necessarily any change in size. A plume shift may require a redistribution of pumping.
5. Measure the long-term trends in overall VOC concentrations (as an indicator of contaminant mass). This provides an overall picture of remedial progress.

The OU1TG developed a series of five well groups designed to address each of the issues listed above. For each group, appropriate statistical tools were specified and a threshold identified that would trigger closer scrutiny by the Army and regulators (USEPA and MPCA). Appendix D.2.1.5 shows the factors to consider and potential additional actions that may be implemented if the statistical threshold is triggered. As Appendix D.2.1.5 shows, a threshold trigger initiates a closer look at the data and the context of the data in terms of remedy performance or potential risk. A threshold trigger does not automatically require any specific action. The five groups, corresponding to the five issues discussed above, are:

Group 1: Downgradient of the TGRS capture zone. This zone should show reductions over time in response to TGRS mass removal and containment. However, it is also theorized as the TGRS stagnation zone where groundwater velocities are reduced and response may be slow. Furthermore, individual wells near the stagnation zone may show increases in contaminant concentrations during some points in time, as the plume shifts in response to changes in pumping.

Group 2: Plume Edge Wells. This zone includes wells that define the edges of the plume downgradient of the TGRS. These are wells with low concentrations of VOCs (<100 µg/L) that will indicate a reduction in overall plume size if VOC concentrations continue to decline.

Group 3: Downgradient Sentinel Wells. This is a zone downgradient of the NBCGRS stagnation zone. This group includes three wells but more accurately is defined as a geographic area immediately downgradient of the NBCGRS. This group should help demonstrate improvement due to the VOC mass removal by the NBCGRS over time, analogous to Group 1 and the TGRS.

Group 4: Lateral Sentinel Wells. These are "clean" wells downgradient of the TGRS that are beyond the current plume boundaries. These wells should help identify large, unexpected, lateral changes in plume configuration, such as a shifting or expansion of the plume boundary.

Group 5: Global Plume Mass Wells. This group includes all the monitoring wells necessary to construct a contour map of the VOC plume. Production wells are not used in Group 5 since the data may not be comparable to monitoring well data. Some wells located within OU2 are included in Group 5 to support the contouring near the OU2 boundary. This group reflects the overall VOC mass in the aquifer and should show an overall reduction in VOC mass over time.

In October 2005, the Army received a consistency determination on Modification #1 to: *OU1 Technical Group Technical Memorandum Statistical Evaluation Method for Water Quality Data, Operable Unit 1,* prepared by the Army, dated December 2004. This modification created well Group 6 to address the Jordan portion of the Unit 4 aquifer.

Group 6: Jordan Wells. The group includes all Jordan monitoring wells, the Prairie du Chien wells nested with them, and NBM Wells #3, #4, #5, and #6. The inclusion of the Prairie du Chien wells is to facilitate comparing the trends between it and the Jordan at these locations. This group will help identify any changes in the plume occurring in the Jordan portion of the aquifer. Additional detail on the well groups and analysis is presented in the OU1 Technical Memorandum, Modification #1 and Appendix D.2.

FY 2017 was a minor sampling year; therefore, new comprehensive plume mapping is based on the FY 2016 summer sampling event (Figures 3-3 through 3-8). Table 3-2 presents the FY 2017 groundwater quality data for OU1 collected to support the statistical analysis developed by the OU1TG. Historical TCE concentrations at any well can be viewed in the Appendix D Groundwater Quality: Organic Data spreadsheet included on the FY 2017 APR CD-ROM. The statistical analysis in Appendix D.2 follows the format described in the OU1 Technical Memorandum and Modification #1.

Table 3-3 summarizes the statistical results for all groups, from Appendix D.2, reflecting the data collected through FY 2017. Table 3-3 includes an assessment of the statistical thresholds that were triggered in the analysis and brief comments addressing these threshold triggers. Only wells that were sampled in 2017 and have "increasing" or "no significant trend" trends are discussed below. For discussion of other wells or well groups, refer to FY 2016 APR.

Group 2 (Plume Edge Wells):

04U877 (No Significant Trend): The trend at this well has previously been identified as stable. While results have varied less than 1.0 µg/L (between 0.34 µg/L and 1.2 µg/L) since 2005, the erratic increases and decreases in TCE concentrations over the years has resulted in a high “p-value” and thus a no significant trend outcome for this well.

Group 6 (Jordon Wells):

04J847 (Increasing): This well is located just downgradient of the TGRS. TCE concentration increased from 790 µg/L in FY 2014 to 910 µg/L in FY 2016 and decreased to 780 µg/L in FY 2017. The overall trend is still increasing and continued annual monitoring is appropriate given its central plume location.

04J849 (Increasing): This well had historically been a non-detect well. TCE was 0.7 µg/L in FY 2016 and jumped to 59 µg/L in FY 2017. Continued annual monitoring is appropriate to further evaluate how the OU1 plume is shifting.

Overall Statistical Assessment:

No additional threshold triggers were identified in FY 2017. Discussion of established threshold triggers can be found in the FY 2016 APR. Overall, the data meet the statistical criteria developed in this document for assessing the remedial progress in the OU1 aquifers. The data show continuing improvement in the OU1 plume through FY 2017. The statistical behavior of the OU3 plume is addressed in Section 13.

How much VOC mass has been removed (at each well and total)?

The NBCGRS did not operate in FY 2017; therefore, no VOCs were removed by the NBCGRS in FY 2017. The total cumulative VOCs removed by the NBCGRS through April 2015 is 23,644 pounds.

Figure 3-9 shows the annual VOC mass removed (graph top), annual pumping volumes, and annual mass removal per unit volume pumped since FY 1997 (when NBM #14 was brought online). As stated above, the mass removal in FY 2017 was null, due to the remedy time-out. Generally, mass removal has been decreasing since FY 1998, when the last extraction well was activated (NBM #15). This overall decline in mass removal is consistent with observed decreasing trends for TCE in OU1 deep groundwater, suggesting that aquifer restoration is progressing.

Are any changes or additional actions required for this remedy component?

Yes. As stated previously, the City of New Brighton will continue designing and constructing an Advanced Oxidation treatment system so aquifer restoration can resume with better protection for the consumer.

4 OPERABLE UNIT 2: SHALLOW SOIL AND DUMP SITES

The 1997 OU2 ROD and subsequent Amendments and ESDs are discussed in Sections 4 through 12 of this APR. This section specifically addresses the shallow soil and dump sites. Relevant modifications to the OU2 ROD include Amendments #1, #3, #4, #5, and ESD #2.

Through the OU2 Remedial Investigation/Feasibility Study process, Sites A, C, E, H, 129-3, and 129-5 were found to have inorganic and/or organic contaminants above the cleanup goals specified in Table 1 of the OU2 ROD. Unpermitted landfills, or dumps, were identified within Sites A, B, E, H, and 129-15. The OU2 ROD (page 2) describes nine remedy components to address the shallow soil and dump sites.

OU2 ROD Amendment #1 modified the requirements for Site C-2 soil and sediment (note that Site C groundwater and surface water is addressed separately in Section 7). Because the depth to groundwater is shallow at Site C-2, it was not feasible to remove all contaminated soil and sediment. The Amendment modified remedy component #2 related to excavation of soil, to allow the placement of a 4- foot thick soil cover over areas where contamination remains in-place above the cleanup levels. ROD Amendment #1 also specified land used controls (LUCs) as an additional remedy component for Site C-2.

OU2 ROD Amendment #2 addressed shallow groundwater at Site I, which is discussed in Section 8.

OU2 ROD Amendment #3 affected the shallow soil and dump sites in four principal ways:

1. The Amendment documented, as final remedies, the additional actions performed for shallow soil at Site D and the dump at Site G, after completion of the deep soil requirements set forth for both in the OU2 ROD (see Section 5 of this report for discussion of the deep soil).
2. The Amendment documented the use of soil covers as part of the final remedy at Sites E, G, H, and 129-15.
3. The Amendment documented final remedies for five sites with soil contamination that were not originally included in the OU2 ROD: Grenade Range, Outdoor Firing Range, 135 PTA Stormwater Ditch, Trap Range, and Water Tower Area. At these sites, either previous removal actions had been completed that reduced soil contamination to below cleanup levels, or investigations had determined that no action or no further action was needed. The Amendment incorporated the remedies for these sites into the overall remedy for OU2.
4. The Amendment specified LUCs as an additional remedy component for shallow soil and dump Sites D, E, G, H, 129-15, Grenade Range, and Outdoor Firing Range. LUCs are not needed for the 135 PTA Stormwater Ditch or Trap Range because contamination levels are suitable for unlimited use/ unrestricted exposure. The water tower area is also suitable for unlimited use/ unrestricted exposure; however, it is located within the area having blanket land use restrictions as specified in the Land Use Control Remedial Design (LUCRD).

ESD #1 is discussed in Section 6 (Site A shallow groundwater), Section 9 (Site K shallow groundwater), and Section 12 (OU2 deep groundwater).

ESD #2 specified LUCs as an additional remedy component for Sites A, C-1, 129-3, and 129-5. ESD #2 also documented that no further action is required at Site B. Site B is located within the area having blanket land use restrictions.

ROD Amendment #4 was signed in January 2012 and documents previously-completed soil removal actions conducted at two sites: the 535 PTA and Site K. No further action is required for the soils located near the excavation areas at these two sites; though the excavation area for the 535 PTA is located within the area of the Arden Hills Army Training Site that has restricted commercial use. The ROD amendment also addressed Building 102 shallow groundwater, discussed in Section 10, and OU2 aquatic sites, discussed in Section 11.

ROD Amendment #5 was signed in March 2014 and documents previously-completed soil removal actions conducted at soil areas of concern at three sites: Site A, the eastern portion of the 135 PTA, and the MNARNG EBS Areas. It also documents that LUCs are required at these sites.

4.1 Remedy Components #1 through #9: Soil Remediation

The nine remedy components specified in the OU2 ROD (page 2) have been completed for the shallow soils and dumps at Sites A, C, D, E, G, H, K, 129-3, 129-5, 129-15, Grenade Range, Outdoor Firing Range, 135 PTA Stormwater Ditch, the eastern portion of the 135 PTA, 535 PTA, MNARNG EBS Areas, and Water Tower Area. Remedy Components #1 through #8 addressed the characterization, excavation, sorting, treatment, disposal, site restoration, site access restrictions (during remedial actions), and limited period of post-remediation groundwater monitoring. Remedy Component #9 addressed the characterization of dumps at Sites B and 129-15. The characterization work at both sites led to a determination that no further action was required at Site B and construction of a cover at Site 129-15, which were documented through ESD #2 and OU2 ROD Amendment #3, respectively.

4.2 Remedy Component #10: Land Use Controls

Description: ”OU2 ROD Amendments and ESDs made LUCs a part of the remedy for shallow soil and dump sites where contamination remains in-place above levels that allow for unlimited use and unrestricted exposure. LUCs are also necessary to protect the integrity of the soil covers constructed at various sites.”

Performance Standard (how do you know when you’re done):

Initial implementation was done when the USEPA and MPCA provided consistency approval for an OU2 LUCRD document. Implementation will continue indefinitely unless further action is taken that would allow for unlimited use and unrestricted exposure.

Has a LUCRD document been approved to address LUC issues for OU2, and is it being implemented?

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and it has been implemented by the Army. Revision 4 of the OU2 LUCRD was approved by the USEPA and MPCA in August 2016. This revision eliminated soil LUCs from the “California-Shaped Area” (which is 380 acres of the 427 acres transferred/leased to Ramsey County in 2013), following soil cleanup to levels consistent with unlimited use / unrestricted exposure. LUCs for other shallow soil sites were not affected by this revision. Revision 5 of the OU2 LUCRD has been drafted and at the close of FY2017 was being reviewed by the Agencies. Revision 5 will change the land use controls for approximately 108 acres in the western portion of OU2 to allow for recreational use, on land to be transferred to Ramsey County.

Was an annual site inspection for LUCs conducted in FY 2017?

Yes. On August 24, 2017, the Army, National Guard, and JV conducted the annual inspection of OU2 sites. The checklist that was completed during the inspection is included as Appendix F.

Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs?

No.

5 OPERABLE UNIT 2: DEEP SOIL SITES

For purposes of the OU2 ROD, Sites D and G were considered deep soil sites because VOC contamination extended to depths between 50 and 170 feet. Some additional shallow soil contaminants were also present at Site D, and Site G also contains a dump. The OU2 ROD (pages 2-3) describes seven remedy components to be implemented for these two sites:

Remedy Component #1: Groundwater Monitoring,

Remedy Component #2: Restrict Site Access (During Remedial Actions),

Remedy Component #3: Soil Vapor Extraction (SVE) Systems,

Remedy Component #4: Enhancements to the SVE Systems,

Remedy Component #5: Maintain Existing Site Caps,

Remedy Component #6: Maintain Surface Drainage Controls, and

Remedy Component #7: Characterize Shallow Soils and Dump.

For Remedy Component #1, ongoing groundwater monitoring near these two sites is completed as part of OU2 deep groundwater monitoring (Section 12) and is not discussed separately in this section. Remedy Components #2 to #6 were related to continued operation of the SVE systems that had been installed in 1986, shut down in 1998 and subsequently removed completing Remedy Components #2 to #6.

Regarding Remedy Component #7, additional shallow soil investigation work (for non-VOC contaminants) was completed at Site D, and characterization work of the dump was completed at Site G, which completed this remedy component. The investigation/characterization work led to removal of shallow soils at Site D and construction of a cover at Site G, which were documented through OU2 ROD Amendment #3.

In summary, the deep soil requirements of the OU2 ROD have been completed. There are ongoing LUC requirements for the shallow soil at Site D and the dump at Site G, as discussed in Section 4.

6 OPERABLE UNIT 2: SITE A SHALLOW GROUNDWATER

Shallow groundwater at Site A has been impacted by VOCs and antimony. The selected remedy in the OU2 ROD incorporates the use of a groundwater extraction system, which began operation May 31, 1994. When operating, the system conveyed extracted groundwater to the sanitary sewer for treatment at a Publicly-Owned Treatment Works (POTW). However, as further discussed below, the groundwater system ceased operation (with regulatory approval) on September 24, 2008, while implementation of monitored natural attenuation (MNA) was being evaluated. The ROD prescribes five major components of the remedy, and until a ROD amendment can be approved, the original components will be retained in this section (with discussion that is appropriate to the MNA remedy).

The original 8-well groundwater extraction system that was selected in the OU2 ROD began operation May 31, 1994. On July 11, 2000, with regulatory approval, EW-5 through 8 (the “second line” of extraction wells) were shut down due to VOC concentrations in these wells having declined below cleanup levels. In July 2008, the USEPA and MPCA approved the Site A Shallow Groundwater: 10-Year Evaluation Report (Wenck 2008a). The 10-Year Report was prepared to fulfill a requirement of the ROD, which states that for shallow groundwater contamination at Site A, “should aquifer restoration not be attained within the ten-year lifespan of the remedy, additional remedial measures will be addressed”. Because the 10-year mark had been reached and contamination was still present above the cleanup levels, the 10-Year Report was prepared to discuss the status of the site and to evaluate any potential changes to the remedy that would be beneficial. MNA (through abiotic degradation) was the recommended alternative for Site A that was approved by the USEPA and MPCA.

In September 2008, the USEPA and MPCA approved the Site A Shallow Groundwater: Monitoring and Contingency Plan (Wenck 2008b), and EW-1 through 4 (the “first line” of extraction wells) were then shut off on September 24, 2008. The Monitoring and Contingency Plan presented the monitoring plan to be implemented when the extraction wells were shut off, and presented the contingency actions that will be taken by the Army if groundwater monitoring indicates that any of the identified trigger points are exceeded. These monitoring and contingency actions were incorporated into the APR, and thus any changes to monitoring and contingency actions must be approved by the USEPA and MPCA through revisions to the APR.

The decision to proceed with MNA was based in part on the MPCA and USEPA natural attenuation study at the site (2000) and follow-up MPCA/USEPA microcosm studies that have verified that abiotic degradation of VOCs in Site A groundwater is occurring at substantial rates. Such degradation acts to reduce contaminant mass and mobility by breaking down the contaminants as they move downgradient. The decision to proceed with MNA was also based on the absence of any likely receptors. The closest potential groundwater receptor is located approximately 1,000 feet downgradient from 01U352 (EW-2) and 01U353 (EW-3). This domestic well has not been operable for many years (and even when it was, the water was only used for irrigation purposes). Beyond this unlikely receptor, there are no other existing downgradient receptors between the plume and Rice Creek, which is approximately 1,800 feet away.

Based on a November 11, 2015 Technical Memorandum submitted by the Army that documented the FY 2015 monitoring results and recommended changing the remedy to MNA, the USEPA and MPCA approved changing the remedy to MNA in lieu of groundwater extraction and discharge. In FY 2017, a proposed plan and ROD amendment was prepared by the Army to formally document this change. At the close of FY 2017, ROD Amendment #6 was undergoing Agency review. Since the extraction wells are still included in the monitoring plan for Site A, they will not be sealed.

6.1 Remedy Component #1: Groundwater Monitoring

Description: "Groundwater monitoring to track plume migration and remedy performance." (OU2 ROD, page 3)

Performance Standard (how do you know when you're done):

When a performance groundwater monitoring program has been established and ongoing monitoring is compliant with the program.

Is this remedy component being implemented?

Yes. Table 6-1 summarizes performance monitoring requirements, implementing parties, and monitoring plan documents. The FY 2017 Monitoring Plan is included in Appendix A, and the FY 2017 water quality monitoring locations and frequencies are also summarized on Figure 6-1. Any deviations are explained in Appendix C.2. Figure 6-2 presents June 2017 measured groundwater elevation contours.

Were the groundwater monitoring requirements for this remedy met? Yes.

Is any groundwater sampling proposed prior to the next report?

Yes, sampling of Site A groundwater monitoring wells will be according to the monitoring plan in Appendix A.1.

Groundwater sampling of water supply wells related to alternate water supply and well abandonment will be in accordance with recommendations in Appendix E. The next "major" event was previously scheduled for FY 2017; however, due to the discovery of 1,4-dioxane in deep groundwater, an unscheduled "major" event was conducted in FY 2015 and repeated by the Army in FY 2016. The next "major" event is now scheduled for FY 2020 to maintain the normal frequency of once every four years.

Are any changes or additional actions required for this remedy component?

Yes. As first proposed in the FY 2015 APR, monitoring of wells 01U350, 01U351 (EW-1), and 01U354 (EW-4) ceased in FY 2017. These wells are essentially redundant monitoring points to nearby wells 01U108, 01U116, and 01U138, respectively. However, 01U350 will be used as a temporary monitoring point in place of 01U108 until the obstruction that prevented monitoring in FY 2017 can be removed.

6.2 Remedy Component #3A: Land Use Controls

Description: The OU2 ROD (page 3) stated: "Institutional controls to restrict new well installations and provide alternate water supplies and well abandonment as necessary." For ease of discussion, the requirement has been broken into two pieces, with this section focusing on the LUCs. OU2 ESD #1 clarified the LUC component to include protection of the groundwater monitoring and extraction system infrastructure.

Performance Standard (how do you know when you're done):

For initial implementation, when the MDH has issued a SWCA Advisory, and when the USEPA and MPCA have provided consistency approval for an OU2 LUCRD document. Implementation will continue until such time that the groundwater concentrations are below the cleanup levels.

Has the MDH issued a SWCA Advisory for the area impacted by Site A?

Yes, issued June 1996, revised in December 1999 and April 2016; however, these revisions did not affect the boundary for the Site A vicinity.

Has a LUCRD document been approved to address LUC issues for OU2, including Site A groundwater, and is it being implemented?

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010, which is being implemented by the Army. Subsequent revisions to the OU2 LUCRD have not changed the LUCs for Site A.

Was an annual site inspection for LUCs conducted in FY 2017?

Yes. On August 24, 2017, the Army, National Guard, and JV conducted OU2 site annual inspection, with a completed checklist included as Appendix F.

Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs?

No.

6.3 Remedy Component #3B: Alternate Water Supply/Well Abandonment

Description: The OU2 ROD (page 3) states: "Institutional controls to restrict new well installations and provide alternate water supplies and well abandonment as necessary." For ease of discussion, the requirement has been broken into two pieces, with this section focusing on the alternate water supplies and well abandonment.

Performance Standard (how do you know when you're done):

When well owners who qualify have been offered and provided with alternate water supply and/or have had their wells abandoned (or the offers have been rejected).

Is the remedy component being implemented?

Yes. The OU1 Alternate Water Supply and Well Abandonment Program is underway and was expanded to cover the area affected by the OU2 Site A shallow groundwater plume. See Section 3.1 for further information.

Did the boundary of the Site A plume get any bigger during FY 2017, as defined by the 1 µg/L contour?

No. Table 6-2 presents the FY 2017 groundwater quality data for Site A. Using these data, Figure 6-3 shows the tetrachloroethene (PCE) concentrations and Figure 6-4 shows the cis-1,2-dichloroethene (cis-1,2-DCE) concentrations. The latter is a degradation product of the former and represents the larger areal footprint. The plume did not increase in size, but it appears to have migrated slightly downgradient from the previous year, as shown on Figure 6-5.

Were any additional water supply wells discovered within the area of concern for the Site A plume that are completed within the aquifer of concern?

No. wells were sampled.

Were any water supply wells within the Site A plume sampled during FY 2017? If yes, what were the findings?

No wells were sampled

Were any well owners offered an alternate supply and/or well abandonment in FY 2017?

No.

Within the Site A plume, are there any well owners that meet the criteria, but have not yet been provided an alternate water supply?

No.

Within the Site A plume, are there any wells that meet the criteria, but have not yet been abandoned?

No.

Is any sampling of water supply wells proposed prior to the next report?

No. There are no water supply wells in the vicinity of Site A vicinity that require sampling.

Are any changes or additional actions required for this remedy component?

No.

6.4 Remedy Component #5: Source Characterization/ Remediation

Description: "Source characterization/remediation" (OU2 ROD, page 3).

Performance Standard (how do you know when you're done):

For characterization, when the investigation answered needed questions to prepare remedial design documents. For remediation, when soil contaminant concentrations are below cleanup levels specified in Table 1 of the OU2 ROD.

Is this remedy component being implemented?

Yes. Characterization work has been completed. Stone & Webster performed investigation work in 1997 and the Final Site A Investigation Report (Stone & Webster Environmental Technology & Services 1997) was issued December 12, 1997. The report delineated the extent of both VOC-contaminated and metal-contaminated soils requiring remediation. The source of VOC-contaminated soils was found to be the “1945 Trench”.

Remediation has been completed. Shaw Environmental and Infrastructure, Inc. (Shaw, formerly Stone & Webster) completed removal of metal-contaminated soils in FY 1999. Construction of an air sparging/soil vapor extraction (AS/SVE) system to remediate VOC-contaminated soils was completed by Stone & Webster in FY 2000, which began operation in early FY 2001. The AS system was shut off permanently in June 2001 due to a lack of increase in SVE VOC levels and due to concern regarding potential plume spreading. The AS system was being implemented voluntarily by the Army and was not a OU2 ROD requirement. Soil samples were collected within the source area in July 2002 (and previously in August 2001). In both events, the results showed minimal reduction in soil VOC concentrations. Since it appeared that many years of SVE system operation would be required before soil cleanup levels would be reached (if ever), the Army ceased SVE system operation on August 21, 2002, and submitted a work plan clarification to the USEPA and MPCA for excavation of source area VOC-contaminated soils, which received regulatory approval in early FY 2003. Post approval, 688 cubic yards of contaminated soil were excavated by Shaw and transported off-site to a permitted disposal facility (see Figures 6-3 and 6-4 for the location of the soil excavation area at the former 1945 Trench). The Site A Former 1945 Trench Closeout Report (prepared by Shaw) received regulatory consistency in FY 2004.

Are any changes or additional actions required for this remedy component?

No.

6.5 Overall Remedy for Site A Shallow Groundwater

Performance Standard (how do you know when you’re done):

When the cleanup levels in Table 1 of the OU2 ROD have been attained throughout the areal and vertical extent of the Site A plume (OU2 ROD, page 54).

Has the Site A shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the OU2 ROD been attained throughout the areal and vertical extent of the Site A plume)?

No. Table 6-2 presents the FY 2017 groundwater quality data and highlights the values that exceed a cleanup level. The respective cleanup levels were exceeded by concentrations of cis-1,2-DCE at 01U139 (540 µg/L), 01U157 (380 µg/L), 01U355/EW-5 (200 µg/L), and 01U356/EW-6 (290 µg/L), and of antimony at 01U103 (7.6 µg/L). None of the other COCs exceeded their respective cleanup levels in FY 2017.

What impact is MNA having on contaminant concentrations?

As evident in Table 6-2, and on Figures 6-3 and 6-4, PCE and TCE continue to be degraded to cis-1,2-DCE via natural attenuation. This degradation generally occurs within the distance between the source area and the first line of extraction wells (EW-1 through EW-4), with primarily only cis-1,2-DCE being detected downgradient of the first line of extraction wells. Figure 6-6 shows the cis-1,2-DCE concentrations plotted on geologic cross sections to illustrate the vertical extent of contamination (the cross-section locations are illustrated on Figure 6-4). Cis-1,2-DCE continues to be degraded via an abiotic process as the plume migrates. The MPCA and USEPA initially evaluated attenuation at the site using computer modeling of contaminant degradation, as documented in Evaluation of Natural Attenuation of Chlorinated Solvents in Ground Water at the Twin Cities Army Ammunition Plant (MPCA and USEPA 2000). The MPCA conducted a follow-up microcosm study (unpublished), the results of which were presented to the Army and USEPA on April 10, 2007. The work conducted in this study showed that the degradation being observed at Site A was an abiotic process (not biological), which likely involves the presence of the mineral magnetite in soils. Note that the predominant degradation process does not “degrade through” vinyl chloride, which is no longer monitored at this site given the historical lack of detections that led to the OU2 ROD not selecting this compound as a COC.

Since September 2008 when the “first line” of extraction wells was shut off, some wells have shown decreased concentrations while others have, in some periods, shown increased concentrations (see Figures 6-7, 6-8, 6-9, and 6-10). Collectively, the cis-1,2-DCE water quality trends evident on Figures 6-7 through 6-10 indicate the plume has essentially stabilized. Most importantly, the contingency locations (the four 900-series wells located along the north side of County Road I) have peaked and now show stable or decreasing trends at concentrations below the cis-1,2-DCE cleanup level of 70 µg/L (Figure 6-10).

Specifically, concentrations of cis-1,2-DCE in 01U901 and 01U903 have been at or near non-detect since 2008 and basically throughout their history. The concentrations of cis-1,2-DCE in 01U902 had stabilized between 15 and 20 µg/L by June 2013. The cis-1,2-DCE concentration jumped to 29 µg/L in FY 2016 and 35 µg/L in FY 2017, but remains well below the cleanup level. Additional monitoring will be necessary to evaluate if the cis-1,2-DCE concentration at 01U902 is trending upwards, or if it remains stable. The concentration of cis-1,2,-DCE in 01U904, which increased to a peak of 57 µg/L in June 2013, decreased steadily through FY 2014 and now appears to have stabilized between approximately 20 and 30 µg/L. The cis-1,2-DCE concentration at 01U904 was 27 µg/L in June 2017. 01U904 is located directly downgradient of the two highest-concentration wells in June 2017: 01U157 and 01U139.

Concentrations of cis-1,2-DCE at EW-8 have been stable near non-detect since December 2012. Concentrations of cis-1,2-DCE at EW-7 peaked just above the cleanup level in December 2012 and have steadily declined to the June 2017 concentration of 11 µg/L. At EW-5, cis-1,2-DCE concentrations appeared to have stabilized below the cleanup level; however, in June 2017 the cis-1,2-DCE concentration increased to 200 µg/L. A generally increasing trend has been observed at EW-6 since 2012. The reason for this is not clear, but continued monitoring of EW-6 will be performed and alternate strategies may be implemented if the trend continues.

In the monitoring wells located between the two rows of extraction wells (Figure 6-8), concentrations of cis-1,2-DCE appeared to have stabilized or to have been on a declining trend. 01U139, currently the well with the highest concentration of cis-1,2-DCE at Site A, had a peak concentration of 510 µg/L in June 2013, and appeared to have stabilized between 240 and 350 µg/L. However, in June 2017, the cis-1,2-DCE concentration increased to 540 g/L. Future monitoring will be evaluated to confirm the overall trend. 01U140, after showing three slight exceedances of the cleanup level in 2011 and 2012, has shown a steadily declining cis-1,2-DCE concentration to 5.3 µg/L in June 2017. 01U157 had two slight exceedances of the cis-1,2-DCE cleanup level in 2011 and 2012 and appeared to have stabilized between 18 and 25 µg/L; however, the cis-1,2-DCE concentration in June 2017 increased to 380 µg/L. Future monitoring will be evaluated to confirm the overall trend.

01U158 had a peak cis-1,2-DCE concentration of 410 µg/L in April 2011, but had since stabilized between 28 and 67 µg/L. The observed cis-1,2-DCE concentration of 80 µg/L in June 2016 was the first exceedance of the cleanup level at 01U158 since December 2011. The June 2017 decreased to 13 µg/L and the overall trend at this location still appears to be stable.

In EW-1 through EW-4 (Figure 6-7), concentrations of cis-1,2-DCE have been at or near non-detect since 2010 or earlier. In June 2017, samples were collected from EW-2 and EW-3 (sampling has been discontinued at EW-1 and EW-4, as discussed in Section 6.1). The concentration of cis-1,2-DCE was non-detect in EW-3 and 6.0 µg/L in EW-2.

In summary, the cis-1,2-DCE plume has largely stabilized following shutdown of EW-1 through EW-4 in 2008. Most importantly, contingency locations 01U901, 01U903, and 01U904 along the north side of County Road I show stable or decreasing trends at concentrations below the cis-1,2- DCE cleanup level of 70 µg/L (despite 01U904 being located directly downgradient of EW-6). The cis-1,2-DCE concentration in 01U902 increased slightly in 2016 and again in 2017 and will require continued monitoring to assess this potential upward trend. Hence the collective trend suggests that the slight uptrend at EW-6 merely reflects a slight shifting of the axis of the plume in the “cross-plume” direction, which also likely explains the greater variability that is evident in two other wells near the axis of the plume (01U157 and 01U139).

Were any trigger levels exceeded at any of the contingency locations?

No. The four contingency locations are 01U901, 902, 903 and 904, which are the four monitoring wells located along the north side of County Road I. The trigger level is equal to groundwater cleanup levels and no COCs at Site A exceeded their respective cleanup levels in these four wells in FY 2017 (Table 6- 2). As noted previously, 01U901 and 01U903 have been at or near non-detect for cis-1,2-DCE since 2008 and basically throughout their history. Concentrations of cis-1,2-DCE in 01U902 and 01U904 show stable or slightly increasing trends with cis-1,2-DCE concentrations below the cleanup level of 70 µg/L.

The *Site A Shallow Groundwater: Monitoring and Contingency Plan* (Wenck 2008b) noted that if the groundwater trigger is exceeded, three key contingency actions are required:

1. Army will contact the well owner at 1783 Pinewood Drive to verify the well remains out of service (and will do this annually for as long as the trigger is being exceeded);
2. Army will prepare and submit a plan to address the exceedance to the USEPA and MPCA for approval; and
3. Army will prepare and submit a plan to evaluate the indoor air pathway.

The third action was perhaps the most critical item, as no soil vapor sampling had ever been conducted at Site A and increasing VOC groundwater concentrations in any of the wells north of County Road I would raise the question of whether these increases could cause an increase in soil gas VOC concentrations leading to a vapor intrusion risk. A vapor intrusion report had been prepared previously: Off-TCAAP Vapor Intrusion Pathway Analysis, Operable Unit 1, Operable Unit 3, and Operable Unit 2 (Site A) prepared by Tecumseh/Wenck Installation Support Services (TWISS), May 2005. This report concluded that the vapor intrusion pathway for the offsite Site A plume was incomplete, since the concentrations in groundwater were below the USEPA generic screening criteria. However, no actual soil vapor sampling was conducted for that report. In December 2012, the MPCA requested that soil vapor sampling be conducted, since their 2008/2010 vapor intrusion guidance is newer than the 2005 report, and since that guidance states that groundwater screening levels should not be used as a single line of evidence for decisions regarding vapor intrusion risk. Based on this MPCA request, the Army prepared an investigation QAPP, which was approved by the USEPA and MPCA in June 2013, and then conducted the vapor intrusion investigation work in July 2013. This work was documented in Site A Vapor Intrusion Investigation Report (Wenck 2014), which received regulatory consistency approval in FY 2014. The report concluded that no significant VOC concentrations are present in soil gas near the 14 samples collected (10 of which were located along the north side of County Road I), and that there is no significant soil vapor risk. Hence, the third contingency action has already been completed and was ultimately found not to be of concern.

With regard to the first contingency action, the Army attempted to contact the well owner at

1783 Pinewood Drive in FY 2014, even though the trigger had not been exceeded. While there is no reason to believe the owner will ever put this well back into service (and it would be physically difficult based on prior conversation), if this intention could be reconfirmed with the well owner, the well should be properly sealed. The Army was willing to voluntary conduct the sealing work. While it remains a very unlikely receptor, sealing of this well would eliminate the only known groundwater receptor between Site A and Rice Creek. Unfortunately, the resident did not respond to the two letters mailed to this address in 2014 and it appears the Army will be unable to obtain approval to conduct this work.

If a trigger level should be exceeded, the only remaining contingency action would be the second one. However, the need to “address the exceedance” would have been driven primarily by either a groundwater receptor or a vapor receptor, and since these pathways have been eliminated as discussed above (or deemed not to be of concern, in the case of a nonresponsive and unlikely groundwater receptor), a slight exceedance of the trigger may not require any specific remedial action, especially given the strong degradation evident at the site (i.e., the distance any slight exceedance would carry downgradient from the “900” wells would be expected to be minimal).

Can it be determined whether MNA is an adequate long-term remedy for Site A in lieu of groundwater extraction and discharge? (If MNA is determined to be adequate, a recommendation to formally change the remedy should be made.)

Yes. In the November 11, 2015 Technical Memorandum, the Army recommended that MNA be implemented as the long-term remedy for Site A in lieu of groundwater extraction and discharge. This recommendation was made in consideration of three key facts: 1) the vapor intrusion investigation concluded that there is no significant soil vapor risk north of County Road I; 2) the only known groundwater receptor between Site A and Rice Creek (1783 Pinewood Drive) is not believed to be operable, was only used for irrigation purposes when it was operable, and now has an unresponsive resident to a voluntary Army offer to seal this well; and 3) 1,4-dioxane was not found to be present in Site A shallow groundwater. Because the USEPA and MPCA have approved this recommendation, a ROD amendment was prepared by the Army in FY 2017 to formally change the remedy to MNA. At the close of FY2017, the Agencies were in the process of reviewing ROD Amendment #6.

Regarding the third key fact noted above, due to the discovery of 1,4-dioxane within the OU1 plume, the USEPA and MPCA requested sampling for the presence of 1,4-dioxane at all sites where VOCs are present (including Site A shallow groundwater) during the FY 2017 sampling event. However, eight wells were not sampled for 1,4-dioxane due to an obstruction in a well and a sample preservation error. Samples were not recollected based on samples collected in 2016 being non-detect for 1,4-dioxane. As shown in Table 6-2, there were only two detections of 1,4-dioxane, both below the MDH HRL, in Site A shallow groundwater in the summer 2017 sampling event. These results are consistent with those observed during the June 2015 and June/July 2016 sampling events. Results from the three sampling events support the conclusion that 1,4-dioxane is not a contaminant of concern in shallow groundwater at Site A. Therefore, no further 1,4-dioxane monitoring is necessary at Site A. Annual monitoring of Site A wells for VOCs will continue in FY 2018 according to the monitoring plan in Appendix A.

Do additional remedial measures need to be addressed? No.

7 OPERABLE UNIT 2: SITE C SHALLOW GROUNDWATER

Impacts to Site C shallow groundwater had not occurred at the time of the 1997 OU2 ROD. In FY 1997, the U.S. Army Environmental Command sponsored a technology demonstration to phyto-remediate Site C lead-contaminated soil. During the growing seasons, ethylenediaminetetraacetic acid and acetic acid were applied to the soils to improve metals uptake by the crops and had the unintended consequence of causing migration of lead from the soils into the shallow groundwater present within a few feet from the ground surface. In FY 2000, the MPCA took enforcement action, requiring the Army implement corrective actions. Initially, the Army installed a groundwater recovery trench to contain the lead plume (operated between November 2000 and July 2001). On July 6, 2001, the Army began operating three extraction wells to contain the plume (replacing recovery trench operation), with discharge of extracted groundwater (treated as necessary) to a POTW. In FY 2004, a Stipulation Agreement was signed that resolved the enforcement action and directed that response actions be conducted under the authority of the FFA. The 2007 OU2 ROD Amendment #1 incorporated the existing groundwater extraction system as the final remedy.

On November 13, 2008, the groundwater system was shut off (with regulatory approval), since the lead concentrations in the three extraction wells had been below the groundwater cleanup level since March 2008 (i.e., the area of lead concentrations exceeding the groundwater cleanup level was not reaching the extraction wells and so operation of the extraction system was no longer required for plume containment). The recommendation to de-energize the extraction system was presented in the Site C Groundwater Extraction System Evaluation Report (Evaluation Report; Wenck 2008c) and was approved by the USEPA and MPCA in November 2008. The 2007 ROD Amendment #1 prescribes four major components of the remedy, and until a decision is made to formally change the remedy, the original components of ROD Amendment #1 will be retained in this section (with discussion that is appropriate to the current remedy implementation status).

The Evaluation Report also presented the monitoring plan to be implemented at the point that the extraction wells were shut off and presented the contingency actions that will be taken by the Army if groundwater and/or surface water monitoring indicates that any of the stated trigger points are exceeded. These monitoring and contingency actions have been incorporated into the APR, and thus any changes to monitoring and contingency actions must be approved by the USEPA and MPCA through revisions to the APR.

At some point, the remedy could be formally changed. This change would presumably require an ESD, at a minimum, or possibly a ROD amendment. However, given that groundwater cleanup levels may be reached throughout Site C within a few years, it may not be necessary to go through the process of formally changing the remedy. Evaluation in future APRs will ultimately determine whether the USEPA, MPCA, and Army should formally change the remedy or, possibly, whether the site should just be closed.

7.1 Remedy Component #1: Groundwater and Surface Water Monitoring

Description: "The existing Site C groundwater monitoring program will be revised as needed." "A new surface water monitoring plan will be prepared" (OU2 ROD Amendment #1, page 39-40).

Performance Standard (how do you know when you're done):

When a performance groundwater and surface water monitoring program has been established and ongoing monitoring is in compliance with the program.

Is this remedy component being implemented?

Yes. Table 7-1 summarizes the performance monitoring requirements, the implementing parties, and the documents that contain the monitoring plans. FY 2017 monitoring was conducted in accordance with the Monitoring Plans included in Appendix A. The water quality monitoring locations and frequencies are also summarized on Figure 7-1, and any deviations explained in Appendix C.2.

Were the monitoring requirements for this remedy met?

Groundwater samples were collected as per the FY 2017 monitoring plan in Appendix A; however, surface water locations were inadvertently missed during the FY 2017 monitoring event. Concentrations at these locations have historically been non-detect. Sampling will be completed in FY 2018.

Is any sampling proposed prior to the next report?

Yes. Groundwater and surface water monitoring at Site C will be in accordance with the monitoring plans shown in Appendix A.1 and A.3, respectively.

Are any changes or additional actions required for this remedy component? No.

7.2 Remedy Component #2: Groundwater Containment

Description: "Three extraction wells, EW-1 through EW-3, will continue collecting contaminated groundwater" (OU2 ROD Amendment #1, page 38).

Is this remedy component being implemented?

No. As discussed previously, because the area of lead concentrations that exceed the groundwater cleanup level no longer extends to the extraction wells, the extraction system is no longer operating and this remedy component is not currently being implemented.

7.3 Remedy Component #3: Discharge of Extracted Water

Description: "Extracted groundwater will be pretreated onsite (as necessary) to meet the sanitary sewer discharge limit" (OU2 ROD Amendment #1, page 38).

Is this remedy component being implemented?

No. As discussed previously, because the area of lead concentrations that exceed the groundwater cleanup level no longer extends to the extraction wells, the extraction system is no longer operating and this remedy component is not currently being implemented.

7.4 Remedy Component #4: Land Use Controls

Description: “LUCs will be established to protect the groundwater extraction, treatment, and monitoring system and to prohibit the drilling of water supply wells within the contaminated portion of the Unit 1 aquifer” (OU2 ROD Amendment #1, page 39).

Performance Standard (how do you know when you’re done):

For initial implementation, when the USEPA and MPCA have provided consistency approval for an OU2 LUCRD document. Implementation will continue until such time that the groundwater concentrations are below the cleanup levels.

Has a LUCRD document been approved to address LUC issues for OU2, including Site C groundwater, and is it being implemented?

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and it is being implemented by the Army. As of the end of FY 2017, Revision 5 of the OU2 LUCRD was being reviewed by the Agencies. Site C is part of the 108 acres planned for transfer to Ramsey County as described in Revision 5. The LUCs for groundwater and a soil cover for Site C remain in place.

Was an annual site inspection for LUCs conducted in FY 2017?

Yes. On August 24, 2017, the Army, National Guard, and JV conducted the annual inspection of OU2 sites. The checklist that was completed during the inspection is included as Appendix F.

Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs? No.

7.5 Overall Remedy for Site C Shallow Groundwater

Performance Standard (how do you know when you’re done):

When the cleanup levels in Table 1 of OU2 ROD Amendment #1 have been attained throughout the areal and vertical extent of the Site C plume.

Has the Site C shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the OU2 ROD Amendment #1 been attained throughout the areal and vertical extent of the Site C plume)?

No. Table 7-2 presents FY 2017 groundwater quality data and highlights the values that exceed the lead cleanup level. Surface water locations were inadvertently missed during the FY 2017 event and samples were not collected. Figure 7-2 presents groundwater elevation contours based on measurements in June 2017. Figure 7-3 shows the lead results for groundwater (surface water locations were not sampled in FY 2017). Figures 7-4 and 7-5 show the lead concentrations plotted on geologic cross sections for Site C to illustrate the vertical extent of contamination (the cross-section locations are illustrated on Figure 7-3).

In FY 2017, lead exceeded the groundwater cleanup level of 15 µg/L in two monitoring wells located near the source area. The lead concentrations at MW-13 and MW-14 were detected at 140 µg/L and 170 µg/L in June 2017. The water quality trends (dissolved lead) for wells nearest the source (MW-3, MW-13, MW-14, and MW-15) are shown on Figure 7-6. As Figure 7-6 shows, the variable concentrations observed at individual wells in FY 2017 has occurred throughout recent years for the four source area wells. Overall, lead concentrations at source area wells have decreased significantly in the last 10 years indicating substantial progress towards reaching groundwater cleanup levels. Surface water monitoring locations were not sampled in FY 2017 but will completed in FY 2018.

Were any trigger levels exceeded at any of the contingency locations?

No. The Site C contingency locations and trigger levels are shown in Table 7-3. Depending on the location, the trigger level is either equal to the groundwater cleanup level or a surface water cleanup level. Groundwater results (Table 7-2) show that trigger levels were not exceeded in FY 2017. If a trigger level were exceeded, the Army would implement contingency action(s) specified in the footnotes to Table 7-3.

Can it be determined whether a formal change to the remedy should be made (to eliminate the groundwater extraction and discharge components) or, possibly, whether the Site should just be closed?

No. Two wells still exceeded the cleanup level. Additional monitoring should be conducted before this determination is made.

Do additional remedial measures need to be addressed?

No. Continued monitoring will provide the additional data needed to determine whether a formal change to the remedy should be made or, possibly, whether the site should be closed.

8 OPERABLE UNIT 2: SITE I SHALLOW GROUNDWATER

VOCs have been identified in Unit 1 (perched aquifer) at Site I. The selected remedy in the OU2 ROD (1997) consisted of four components: Groundwater monitoring, Groundwater extraction, POTW discharge, and Additional characterization.

The additional investigation and Predesign Investigation Work Plan (Work Plan) were completed in FY 2000. Based on these documents, the proposed remedy was to consist of a dual phase vacuum extraction system, which combined groundwater extraction with soil vapor extraction, to be installed beneath Building 502. A dual phase extraction pilot test subsequently determined that the technology was not feasible due to the low Unit 1 permeability. OU2 ROD Amendment #2 (2009) revised the requirements for shallow groundwater to groundwater monitoring, additional characterization and LUCs. These three major remedy components are evaluated in the following sections

8.1 Remedy Component #1: Groundwater Monitoring

Description: " Groundwater monitoring to track remedy performance." (OU2 ROD, page 3).

Performance Standard (how do you know when you're done):

When a monitoring plan has been established and ongoing monitoring is in compliance with the plan.

Is the remedy component being implemented?

Yes. Table 8-1 summarizes the performance monitoring requirements, the implementing parties, and documents containing monitoring plans. Appendix A summarizes the FY 2017 monitoring plan and any deviations are explained in Appendix C.2.

As previously approved by the USEPA/MPCA, all Site I (Building 502) Unit 1 monitoring wells were abandoned in FY 2014 prior to the demolition of Building 502. Only well 01U667 is scheduled to be replaced, which could be delayed beyond FY 2018 due to the extent of pending regrading associated with planned site redevelopment. Because well 01U667 was not replaced in FY 2017, no groundwater sampling was conducted during FY 2017. Once reinstalled, monitoring well 01U667 will be sampled annually in accordance with the FY 2017 - FY 2021 Monitoring Plan (Appendix A.1). Figure 8-1 presents a site plan for Site I, including the former locations of the now abandoned monitoring wells and a cross section location presented on Figure 8-2.

Is any groundwater sampling proposed prior to the next report?

Yes, although it is contingent on completion of grading activities in this area and subsequent reinstallation of monitoring well 01U667. Groundwater monitoring at Site I will be in accordance with the monitoring plan shown in Appendix A.1.

Are any changes or additional actions required for this remedy component?

Yes. Monitoring well 01U667 must be reinstalled after grading activities have been completed.

8.2 Remedy Component #2: Additional Investigation

Description: "Additional characterization of the Unit 1 and Unit 2 soil and groundwater." (OU2 ROD, page 3).

Performance Standard (how do you know when you're done):

When the work has been completed according to an agency approved work plan.

Has the remedy component been implemented?

Yes. Additional investigation results were included in Appendix A of the Predesign Investigation Work Plan (January 1999) which resulted in a pilot study to evaluate dual phase vacuum extraction technology applicability. The resultant Predesign Investigation Report (March 2001) concluded that neither dual phase extraction nor groundwater extraction is feasible at Site I. The May 2009 OU2 ROD Amendment removed the groundwater extraction and POTW discharge component of the remedy.

Are any changes or additional actions required for this remedy component? No.

8.3 Remedy Component #3: Land Use Controls

Description: "LUCs will be established to protect the groundwater extraction, treatment, and monitoring system and to prohibit the drilling of water supply wells within the contaminated portion of the Unit 1 aquifer." (OU2 ROD Amendment #1, page 39).

Performance Standard (how do you know when you're done):

Implementation of the land use controls will continue until such time that the groundwater concentrations are below the cleanup levels.

Has a LUCRD document been approved to address land use control (LUC) issues for OU2, including Site I groundwater, and is it being implemented?

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010, and the LUCRD is being implemented by the Army. Subsequent revisions to the LUCRD have not changed the groundwater LUCs for Site I. Following additional soil investigation and remediation completed by Ramsey County in 2014/2015, the site is now suitable for unrestricted use/unlimited exposure and soil LUCs at Site I are no longer necessary. The USEPA and MPCA provided consistency approval for the OU2 LUCRD Revision 5 in March 2018, which formally removes Site I soil LUCs.

Was an annual site inspection for land use controls conducted in FY 2017?

On August 24, 2017, the Army, National Guard, and JV conducted the annual OU2 site inspection. The completed checklist is included as Appendix F.

Did the inspection identify any follow up actions needed to maintain the protectiveness of the LUCs? No.

8.4 Overall Remedy for Site I Shallow Groundwater

Performance Standard (how do you know when you're done):

When the cleanup levels in Table 1 of the OU2 ROD have been attained throughout the areal and vertical extent of the Site I plume (OU2 ROD, page 55).

Has the Site I shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the OU2 ROD been attained throughout the areal and vertical extent of the Site I plume)?

No. Groundwater monitoring was not conducted in FY 2017 due to the approved abandonment of all Unit 1 wells related to Site I demolition activities; however, the most recent groundwater quality data (from FY 2013) suggests that cleanup levels have not been attained. Table 8-2 presents FY 2013 data and highlights values which exceeded the cleanup level. The concentration of TCE in former well 01U632 had decreased over time but was still above the cleanup level in FY 2013. Results from the sampling of well 01U667 indicated concentrations of 1,2 dichloroethene and vinyl chloride remained above the cleanup levels. Figure 8-3 presents the FY 2013 Site I shallow groundwater TCE and vinyl chloride sample results.

Do additional remedial measures need to be addressed?

Yes. As requested by Orbital ATK in their letter dated August 12, 2013 and approved by the USEPA and MPCA on August 14, 2013, all Unit 1 monitoring wells were abandoned in 2014. In accordance with the Orbital ATK request and agency approval, monitoring well 01U667 will be reinstalled at the same location and depth following completion of redevelopment-related grading to occur at former Building 502, with expected installation to be in 2018. However, due to the significant extent of grading to occur, reinstallation of 01U667 could be delayed.

9 OPERABLE UNIT 2: SITE K SHALLOW GROUNDWATER

VOC contamination has been identified in Unit 1 (perched aquifer) at former Building 103. The limits of the VOC plume in the perched groundwater have been defined to be beneath and immediately northwest of former Building 103.

The remedy selected in the OU2 ROD consisted of seven components that incorporated the existing groundwater extraction trench and air stripper, which began operation in August 1986. The remedy also included additional investigation of the unsaturated soils beneath the building slab. OU2 ESD #1 added LUCs as a remedy component in 2009.

9.1 Remedy Component #1: Groundwater Monitoring

Description: "Groundwater monitoring to track remedy performance." (OU2 ROD, page 3)

Performance Standard (how do you know when you're done):

When a monitoring plan is established, and monitoring is in compliance with the plan.

Is the remedy component being implemented?

Yes. Table 9-1 summarizes the performance monitoring requirements, the implementing parties, and the monitoring plan documents. Appendix A summarizes the FY 2017 monitoring plan and any deviations are explained in Appendix C.2.

Water levels are collected annually from monitoring wells and bundle piezometers in the vicinity of the groundwater collection and treatment system. In FY 2014, 15 Unit 1 monitoring wells were permanently abandoned, as approved by the USEPA/MPCA on August 14, 2013 and May 7, 2014. In FY 2017, one Unit 1 monitoring well (01U047) was permanently abandoned as approved by the USEPA/MPCA in September 2017. The monitoring wells currently included in the Site K Monitoring Plan were sampled in June 2017. Figure 9-1 presents the sampling and water level monitoring locations, as well as the location of the monitoring wells that have been abandoned. Figure 9-1 also shows the cross-section alignment. Three of the wells abandoned in 2014 (01U608, 01U609, and 01U611) were scheduled to be reinstalled in spring 2017; however, the scheduling was pushed to 2018 due to a delay in construction activities associated with site redevelopment. Once reinstalled, the wells will have the same monitoring requirements as prior to abandonment. Wells 01U608 and 01U609, once reinstalled, will be added to the water level monitoring list and well 01U611 will be added to the annual water quality sampling list. Monitoring well 01U047 was permanently abandoned in FY 2017 for site redevelopment activities and will not be reinstalled once the redevelopment activities are completed.

Is any groundwater sampling proposed prior to the next report?

Yes. Groundwater monitoring at Site K will be in accordance with the monitoring plan shown in Appendix A.1.

Are any changes or additional actions required for this remedy component?

Yes. Wells 01U608, 01U609, and 01U611, which were abandoned in 2014, are scheduled to be reinstalled in 2018. However, due to construction of pending storm water infrastructure related to redevelopment, replacement of these wells may be delayed. Once installed, the replacement wells will be added to the monitoring plan and monitored for water level (01U608, 01U609, and 01U611) and water quality (01U611).

9.2 Remedy Component #2: Sentinel Wells

Description: “Installation of sentinel wells at the bottom of Unit 1 and top of Unit 3.” (OU2 ROD, page 3)

Performance Standard (how do you know when you’re done):

When the wells have been installed according to a regulator approved work plan.

Is the remedy component being implemented?

Yes. The Upper Unit 3 sentinel well was installed in February 2000 to monitor potential VOCs migration through the Unit 2 till aquitard into the Unit 3 aquifer.

Existing piezometers were used to accomplish the deep Unit 1 sentry monitoring. Piezometers 01U625D, 01U626D, 01U627D, and 01U628D were used since they monitor the Unit 1 aquifer base near the trench. The issue is the potential for Dense Non-Aqueous Phase Liquids (DNAPLs) to migrate beneath the trench along the Unit 1/Unit 2 interface. These four piezometers are screened at that interface. Figure 9-1 shows the location of the Upper Unit 3 sentinel well (03U621) and the piezometers.

What are the results of the Unit 1 piezometer and Unit 3 sentinel well sampling?

The piezometers (Unit 1 sentinel wells) were sampled in March 2000 with results showing no DNAPL presence at the Unit 1/Unit 2 interface, as discussed in the FY 2000 APR. This was a one-time sampling event, as required by the MPCA/USEPA approved Predesign Investigation Work Plan, Site K, TCAAP, CRA, February 1999, and as documented in the Predesign Investigation Report, Site K, TCAAP, CRA, December 2001, for which concurrence was received.

The Unit 3 sentinel well (03U621) was sampled in March, July, and September 2000 and in January 2001 for the quarterly sampling required by the Work Plan. Subsequently, the well was incorporated into the regular TCAAP monitoring plan. The well was sampled in June 2017 for FY 2017 with results presented in Table 9-7. No Site K COCs were detected in the Unit 3 sentinel well at concentrations above the method detection limit. However, the 03U621 sample reported a 1,4-dioxane concentration of 8.4 µg/L. This is likely related to the presence of 1,4-dioxane in Unit 3 groundwater throughout the western portion of TCAAP, as opposed to a release from Site K.

Are any changes or additional actions required for this remedy component? No.

9.3 Remedy Component #3: Hydraulic Containment

Description: “Use of existing interceptor/recovery trench to contain the plume and remove impacted groundwater.” (OU2 ROD, page 3)

Performance Standard (how do you know when you’re done):

When the trench is operating as designed and capturing all groundwater exceeding the cleanup levels presented in Table 1 of the OU2 ROD, as described below.

Is the remedy component being implemented?

Yes. The groundwater collection system continues to provide capture (as described later) of the Unit 1 groundwater, upgradient of the trench and beneath the former Building 103 footprint, as designed. In FY 2014, the Building 103 slab was removed as part of the site redevelopment activities.

Is the system providing hydraulic capture of the plume?

Yes. Water level data are presented in Table 9-3. Figure 9-2 presents a plan view of the groundwater contours from the June 2017 round of groundwater level measurements. At nested wells, the numerically lowest water elevation was used to create the plan view contours. Monitoring wells downgradient (i.e. 01U627) of the extraction trench show consistently higher water levels than those near of the trench (i.e. 01U626). This demonstrates that the horizontal hydraulic gradient has been reversed toward the extraction trench due to system operation.

Vertical capture was also effective as illustrated on Figure 9-3. As seen in the figure, groundwater both upgradient and downgradient of the trench is captured and collected. The upward gradient exhibited on the downward gradient side of the trench (01U626) indicates that groundwater does not migrate below the trench. The monitoring coverage provided by the bundle piezometers, demonstrates complete vertical and horizontal hydraulic capture.

Upgradient well (01U625C) is obstructed. The cause of the obstruction is unknown. An unsuccessful attempt was made to remove the obstruction the spring 2017. Well 01U625C is not critical in the collection trench flow evaluation. Historically, this well has maintained a similar groundwater elevation as 01U625B and 01U625D (see Appendix D). Based on 2016 and 2017 groundwater elevation data showing the return to typical levels, replacement of 01U625C is not recommended.

Figure 9-4 presents the TCE concentrations from the June 2017 annual sampling event. The plume was originally defined based on data from all of the monitoring wells. The plume was then refined based on the results of the 2014 geoprobe investigation. The current monitoring well network is used to confirm the plume contours and measure the progress of remediation. Thus, the contours on Figure 9-4 were drawn with consideration of the extensive historical data, specifically the 2014 data from the geoprobe investigation.

Are any changes or additional actions required for this remedy component?

Not at this time. Two monitoring wells (01U604 and 01U628) historically used to monitor hydraulic capture were abandoned in 2014 because of site redevelopment activities. However, existing wells (01U603, 01U612, 01U615, 01U617, 01U621, 01U625, 01U626 and 01U67) located up and down gradient of the collection trench provide adequate coverage for shallow groundwater hydraulic and water quality monitoring and verify hydraulic containment at Site K. Additional monitoring (including the need for additional monitoring wells) will be evaluated upon completion of redevelopment plans for the area.

9.4 Remedy Component #4: Groundwater Treatment

Description: “Treatment of contaminated groundwater using air stripping.” (OU2 ROD, page 3)

Performance Standard (how do you know when you’re done):

When the air stripping facility is treating water to the cleanup standards.

Is the remedy component being implemented?

Yes. During FY 2017, the treatment system functioned and was operational 96% of the time. During FY 2017, a regular maintenance schedule was maintained. Appendix G.1 summarizes operational data and events at the groundwater extraction and treatment system.

Are any changes or additional actions required for this remedy component? No.

9.5 Remedy Component #5: Treated Water Discharge

Description: “Discharge of treated groundwater to Rice Creek.” (OU2 ROD, page 3)

Performance Standard (how do you know when you’re done):

When the system is operating as designed and the treated water discharges to the storm sewer that outlets to Rice Creek. Treated water is required to meet the substantive requirements of Document No. MNU0009579 (MPCA), which contains the state-accepted discharge limits for surface water. Sampling and analysis are performed to monitor performance (see below).

Is the remedy component being implemented?

Yes. See discussion in Section 9.6.

Are any changes or additional actions required for this remedy component? No.

9.6 Remedy Component #6: Discharge Monitoring

Description: “Monitoring to track compliance with discharge requirements.” (OU2 ROD, page 3)

Performance Standard (how do you know when you’re done):

When a monitoring plan is established and is being implemented in accordance with the plan.

Is the remedy component being implemented?

Yes. Treatment system monitoring consisted of quarterly influent and effluent sampling. Influent and effluent analytical results are presented in Table 9-4 (organics) and Table 9-5 (inorganics). The discharge met the treatment requirements during FY 2017, with the exception of total phosphorus (March and June 2017) and zinc (June 2017). On June 8, 2017 the effluent sample contained zinc (230 µg/L) and phosphorus (7.5 milligrams per liter [mg/L]) greater than the respective discharge limits of 134 µg/L and 1.0 mg/L. The effluent was resampled on June 29, 2017 and contained much lower zinc and phosphorus concentrations of 13 µg/L and 1.4 mg/L. Additional influent and effluent sampling in July, August and September 2017 was undertaken to see if zinc and phosphorus are dissolved phase, or if they are mainly associated with solids that may periodically and infrequently be released by the air stripping tower. Based on sampling results, no clear evidence was found to correlate the earlier and infrequent exceedances of phosphorus and zinc discharge limits for the Site K treatment system effluent with particulate accumulation in the treatment system. Review of operation data was also unsuccessful in determining the cause of the exceedances, this includes:

1. No phosphorus-containing chemicals used in treatment system cleaning or sample containers;

2. No apparent correlation between average daily pumping rate and high zinc or phosphorus effluent concentrations; and
3. No apparent correlation between time of year sampling and high zinc or phosphorus effluent concentrations.

Sampling procedures have been modified to ensure a thorough flushing of all the sampling piping before effluent samples are collected. This procedure will minimize the potential that particles accumulating on the piping are not being carried over into the samples.

Are any changes or additional actions required for this remedy component? No.

9.7 Remedy Component #7: Additional Investigation

Description: "Additional characterization of the unsaturated Unit 1 soil." (OU2 ROD, page 3)

Performance Standard (how do you know when you're done):

When the additional investigation has been completed according to a regulator approved work plan.

Is the remedy component being implemented?

Yes. The Work Plan was approved in FY 1999. A report of the investigation results received a consistency determination from the Agencies on December 6, 2001. The report defined the extent of VOC contaminated soils beneath Building 103 and refined the location of the source area. The report and subsequent follow up sampling resolved anomalous dissolved zinc, lead, and nickel data at two monitoring wells. Zinc, lead, and nickel are no longer groundwater concerns.

Are any changes or additional actions required for this remedy component? No.

9.8 Remedy Component #8: Land Use Controls

Description: "LUCs will be established to protect the groundwater extraction, treatment, and monitoring system and to prohibit the drilling of water supply wells within the contaminated portion of the Unit 1 aquifer." (OU2 ROD Amendment #1, page 39)

Performance Standard (how do you know when you're done):

Implementation of the land use controls will continue until such time that the groundwater concentrations are below the cleanup levels.

Has a LUCRD document been approved to address land use control (LUC) issues for OU2, including Site K groundwater, and is it being implemented?

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and it is being implemented by the Army. Subsequent revisions to the LUCRD have not affected the groundwater LUCs for Site K.

Was an annual site inspection for land use controls conducted in FY 2017?

On August 24, 2017, the Army, National Guard, and JV conducted the annual inspection of OU2 sites. The checklist that was completed during the inspection is included as Appendix F.

Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs? No.

9.9 Overall Remedy for Site K

Performance Standard (how do you know when you're done):

Once the cleanup levels in Table 1 of the OU2 ROD have been attained throughout the areal and vertical extent of the Site K plume (OU2 ROD, page 55).

Has the Site K shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the OU2 ROD been attained throughout the areal and vertical extent of the Site K plume)?

No. Overall, the remedy for Site K continued to operate consistent with past years and in compliance with the required performance criteria.

Table 9-6 presents the VOC mass removal and monthly flow rates. The treatment system captured and treated 5,370,496 gallons of water resulting in the removal of 8.5 pounds of VOCs from the aquifer in FY 2017. The cumulative VOC mass removal is 381.2 pounds of VOCs.

As shown on Figure 9-4, TCE concentrations ranged from non-detect to 1,200 µg/L. In general, Site wide TCE concentrations were lower than those reported in 2016. Monitoring wells 01U611 and 01U615 monitored the core of the plume. However, well 01U611 was abandoned in 2014 for site redevelopment activities and will be reinstalled once the redevelopment activities are completed; no 01U611 data is available for FY 2017. Prior to abandonment, TCE concentrations at monitoring well 01U611 had been relatively stable over the previous seven years, ranging from 4,900 µg/L to 11,000 µg/L.

The TCE concentration at well 01U615 decreased from 1,700 µg/L in FY 2016 to 1,200 µg/L in FY 2017. The FY 2017 concentration of TCE at 01U615 is a ten-year low, but is comparable with historical concentrations from the last ten years of sampling, which have ranged from 1,200 µg/L to 6,500 µg/L. Figure 9-5 shows TCE and total 1,2-dichloroethene versus time for 01U615. Water levels measured during the FY 2017 monitoring were 2.5 feet higher at 01U615 compared to FY 2016 elevations. This well has historically exhibited fluctuating groundwater elevations

Concentrations of TCE in monitoring well 01U603 had always been non-detect (less than 1.0 µg/L). However, in May 2014, TCE was detected at a 2,000 µg/L in 01U603. Well 01U603 was resampled in July 2014 (5,600 µg/L) and September 2014 (4,600 µg/L). The July and September results confirmed that elevated concentrations of TCE and other VOCs are present in the well. However, groundwater samples collected downgradient of 01U603 as part of a Site K geoprobe investigation in September 2014 were non-detect for TCE and confirmed capture by the collection trench. The geoprobe investigation in 2014 determined that historically high groundwater levels in April and May 2014 likely mobilized TCE in the former storm sewer bedding that was present underneath the former building footprint. The geoprobe results were submitted to the USEPA and MPCA in a letter dated February 3, 2015. Since that time, TCE concentrations in 01U603 have steadily declined, to 1200 µg/L (FY 2015), 30 µg/L (FY 2016) and now 3.3 µg/L (FY 2017).

Well 01U617 continues to exhibit low and relatively consistent concentrations of 1,2-dichloroethene downgradient of the groundwater collection system's capture zone. The concentration at this well was consistent with those measured in FY 2014 and previous years. The detected 1,2-dichloroethene concentration is below the cleanup level for Site K.

Do additional remedial measures need to be addressed? No.

9.10 Other Related Activity in FY 2017

In March 2015, the USEPA and MPCA requested sampling and analysis for 1,4-dioxane to be included in the annual sampling event for Site K. The analysis was added to all regularly-scheduled monitoring wells in 2015 and 2016. Due to low 1,4-dioxane concentrations in Unit 1 wells (less than 1 µg/L), no Unit 1 wells were required to be sampled for 1,4-dioxane in FY 2017. Unit 3 monitoring well, 03U621 had a 1,4-dioxane concentration exceeding the HRL in 2015 and 2016, therefore, monitoring well 03U621 was sampled for 1,4 dioxane in FY 2017. The 1,4-dioxane concentration at 03U621 decreased from 9.3 µg/L in FY 2016 to 8.4 µg/L in FY 2017. As mentioned above, the presence of 1,4-dioxane in 03U621 is likely related to its presence in Unit 3 groundwater throughout the western portion of TCAAP, as opposed to a release from Site K.

Table 9-7 presents the FY 2017 1,4-dioxane sampling results. No Federal MCL has been established for 1,4-dioxane; however, the MDH established a HRL value of 1.0 µg/L as shown on Table 9-7.

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10 OPERABLE UNIT 2: BUILDING 102 SHALLOW GROUNDWATER

The former Building 102, located as shown on Figure 10-1, was constructed in 1942 and used periodically until the 1980s for production of small caliber ammunition and various other munitions components. Between March 2002 and February 2004, shallow (Unit 1) groundwater contamination was discovered emanating from beneath Building 102 (discovered during Phase I and Phase II Environmental Site Assessment [ESA] in support of future TCAAP property transfer).

Additional groundwater investigation was conducted and is documented in the Groundwater Investigation Report for Building 102 (Wenck and Keres Consulting Inc 2006), approved by the USEPA and MPCA in FY 2006. The Army then proceeded to address the remedy for Building 102 shallow groundwater as a non-time critical removal action under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). To support the Engineering Evaluation/Cost Analysis (EE/CA), additional groundwater investigation was conducted in FY 2007 and FY 2008 to further define the extent and magnitude of groundwater contamination. Delineation was completed and COCs were identified, including TCE and related chlorinated VOCs (TCE was found to be degrading to cis-1,2-DCE and vinyl chloride through abiotic degradation). The EE/CA documenting the additional investigation work and recommending a remedy for Building 102 shallow groundwater was approved by the USEPA and MPCA in FY 2008.

The Army Action Memorandum documenting the final remedy selection for Building 102 groundwater MNA was signed in FY 2009. The remedy also includes LUCs to prohibit installation of water supply wells in the contaminated portion of the Unit 1 aquifer and protect the groundwater monitoring system infrastructure (i.e., monitoring wells). OU2 ROD Amendment #4 formally documented selection of MNA and LUCs for the Building 102 groundwater remedy and thereby added this site to the OU2 remedy.

The decision to proceed with MNA was based on strong evidence from water quality monitoring (i.e., degradation products) and on MPCA microcosm studies which verified abiotic degradation of VOCs in Building 102 groundwater is occurring at substantial rates. Such degradation acts to reduce contaminant mass and mobility by breaking down the contaminants as they migrate. The decision to proceed with MNA was also based on the absence of any groundwater receptors.

10.1 Remedy Component #1: Monitored Natural Attenuation

Description: ""Use of naturally-occurring abiotic degradation to limit plume mobility and to ultimately restore the aquifer" (OU2 ROD Amendment #4, page 4-1).

Performance Standard (how do you know when you're done):

When a monitoring program is established, and monitoring is in compliance with the regulator approved Annual Monitoring Plan.

Is the remedy component being implemented?

Yes. Appendix A summarizes the FY 2017 monitoring plan and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in the next section.

10.2 Remedy Component #2: Groundwater Monitoring

Description: "Groundwater monitoring to track remedy performance and to verify that groundwater reaching Rice Creek does not exceed state surface water standards" (OU2 ROD Amendment #4, page 4-1).

Performance Standard (how do you know when you're done):

When a performance groundwater monitoring program has been established and ongoing monitoring is in compliance with the program.

Is this remedy component being implemented?

Yes. Table 10-1 summarizes performance monitoring requirements, implementing parties, and the documents that contain the monitoring plans. The FY 2017 Monitoring Plan is included in Appendix A, documenting the water quality monitoring locations and frequencies. Building 102 groundwater level data collected in June 2017 are shown as groundwater elevation contours on Figure 10-2. Site K water levels are also contoured to provide a more complete water level map in the Site vicinity. Groundwater quality data collected in FY 2017 are shown in Table 10-2. Groundwater quality data for FY 2017 are also shown for three of the COCs: TCE (Figure 10-3), cis-1,2-DCE (Figure 10-4), and vinyl chloride (Figure 10-5).

Monitoring for 1,4-dioxane was repeated during FY 2017 summer sampling to verify that 1,4-dioxane is not a COC in Building 102 shallow groundwater. As shown in Table 10-2, there were five low detections of 1,4-dioxane in Building 102 shallow groundwater in the June 2017 sampling event, one of which exceeded the MDH HRL (1.1 µg/L). Due to the lack of 1,4-dioxane exceedances in other Building 102 monitoring wells, this exceedance was deemed an anomaly. Future monitoring will be conducted to further evaluate whether 1,4-dioxane is a COC in Building 102 shallow groundwater.

Were the groundwater monitoring requirements for this remedy met? Yes.

Is any groundwater sampling proposed prior to the next report?

Yes. Groundwater monitoring at Building 102 will be in accordance with the monitoring plan shown in Appendix A.1.

Are any changes or additional actions required for this remedy component? No.

10.3 Remedy Component #3: Land Use Controls

Description: : "LUCs to restrict installation of water supply wells into the contaminated portion of the Unit 1 aquifer and to protect the infrastructure related to this alternative (monitoring wells)" (OU2 ROD Amendment #4, page 4-2).

Performance Standard (how do you know when you're done):

Implementation of the LUCs will continue until such time that the groundwater concentrations are below the cleanup levels.

Has a LUCRD document been approved to address LUC issues for OU2, including Building 102 groundwater, and is it being implemented?

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and is being implemented by the Army. Subsequent revisions of the LUCRD have not changed the groundwater LUCs for Building 102.

Was an annual site inspection for LUCs conducted in FY 2017?

Yes. On August 24, 2017, the Army, National Guard, and JV conducted the annual inspection of OU2 sites. The completed checklist during inspection is included as Appendix F.

Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs? No.

10.4 Overall Remedy for Building 102 Shallow Groundwater

Performance Standard (how do you know when you're done):

When the cleanup levels in OU2 ROD Amendment #4 have been attained throughout the areal and vertical extent of the Building 102 plume (OU2 ROD Amendment #4, page 2-13).

Has the Building 102 shallow groundwater remedy been completed (i.e., have the cleanup levels in the table on Page 2-13 of OU2 ROD Amendment #4 been attained throughout the areal and vertical extent of the Building 102 plume)?

No. As shown in Table 10-2, cleanup levels have not been reached throughout the areal extent of the plume and the site cannot be closed. TCE concentrations exceed the cleanup level in four monitoring wells and vinyl chloride exceeds the cleanup level in one monitoring well.

What impact is MNA having on contaminant concentrations?

Natural attenuation continues to occur, with TCE being the primary VOC present in the source area vicinity, and primary degradation products being present in downgradient wells (e.g., primarily cis-1,2-DCE and vinyl chloride in 01L584 and 01U584). Significant changes that were noted in the FY 2017 groundwater quality results include:

- 01U579 and 01U580 (source area): TCE concentration decreased slightly in 01U579 and 01U580 from 1.7 µg/L and 4.3 µg/L to 0.71 µg/L and 1.1 µg/L, respectively. Historically, the concentrations in these two wells have shown relatively large increases and decreases.
- 01L582 (further downgradient of the source area): Concentration of cis-1,2-DCE decreased (14 to 8 µg/L). The vinyl chloride Method 8260C-SIM analysis was inadvertently collected from the 584 well nest in FY 2017, but vinyl chloride was not detected in the 01L582 sample run with a higher detection limit. The vinyl chloride concentration has historically shown a decreasing trend.
- 01L584 (downgradient): This well was inadvertently sampled for the Method 8260C-SIM analysis and had a vinyl chloride detection of 0.50 µg/L, which is above the cleanup level of 0.18 µg/L.
- 01U048 (adjacent to Rice Creek): 1,4 dioxane was the only contaminant detected in this well. 1,4-Dioxane was detected at 1.1 µg/L, above the MDH HRL of 1.0 µg/L. The 1,4-dioxane concentration

has risen in the short time it has been monitored; this well was non-detect for 1,4-dioxane in 2015 and had a concentration of 0.15 µg/L in 2016.

Were any trigger levels exceeded at the contingency location?

Yes. The contingency location is 01U048, located next to Rice Creek. The trigger level is equal to groundwater cleanup levels or, in the case of 1,4-dioxane, the MDH HRL. 1,4-dioxane was detected at a concentration of 1.1 µg/L, which is above the MDH HRL of 1 µg/L. Due to the lack of 1,4-dioxane exceedances in other wells in the Building 102 monitoring network, this exceedance was deemed an anomaly; 1,4-dioxane monitoring will continue to assess whether it is a COC in Building 102 shallow groundwater. No additional COCs for Building 102 groundwater exceeded their respective cleanup levels in FY 2016 (Table 10-2).

Do additional remedial measures need to be addressed?

No. However, it should be noted that as part of Ramsey County's site redevelopment work, Ramsey County has relocated a section of Rice Creek to create more space for construction of a new I-35W / County Road H interchange. The relocation work placed Rice Creek much closer to the west side of the Building 102 plume. While the long-term impacts to groundwater flow are not yet known, given that Unit 1 groundwater discharges to Rice Creek, it is a possible that the new location could cause contaminated groundwater to begin flowing in a more westerly direction, and could potentially discharge into the creek in its revised location rather than continuing to discharge into the creek near 01U048. With this potential adverse outcome in mind, in FY 2016, Ramsey County installed two sets of nested monitoring wells adjacent to the revised creek location, on the east side of the creek near the point of potential groundwater discharge. Ramsey County intends to perform ongoing sampling at the new wells. The MPCA has indicated to Ramsey County that if Ramsey County's actions cause a shift in the Building 102 plume and resultant exceedance of an action level in a Ramsey County Rice Creek monitoring well, it will be Ramsey County's responsibility to address that situation.

Bay West, working on behalf of Ramsey County, provided the "Groundwater Monitoring Report – March 2017 Sampling Event for the Rice Creek Remeander, TCAAP Redevelopment" to Arcadis in April 2017. According to groundwater monitoring performed at Building 102 in March 2017 after the Rice Creek Remeander was completed, there appears to be no impacts to groundwater quality. Vinyl chloride was detected in 01URC1D during the March 2017 event at a concentration of 0.058 µg/L, which is well below the MDH HRL of 0.2 µg/L. As of the March 2017 groundwater monitoring event, there was no apparent change in the Building 102 plume configuration or groundwater flow. Bay West will continue to monitor the groundwater quality during four semi-annual events and will provide a monitoring report with cumulative monitoring data following each event. For a more detailed summary of the Rice Creek Remeander groundwater monitoring, refer to Bay West, 2017.

It should also be noted that Ramsey County plans further development in this area that may result in loss of monitoring wells (subject to Army and regulator approval) due to installation of a storm water control basin. Ongoing efforts will be made to address any issues resulting from Ramsey County's development plans.

11 OPERABLE UNIT 2: AQUATIC SITES

The Tier II Ecological Risk Assessment Report (U.S. Army Center for Health Promotion and Preventative Medicine [USACHPPM] 2004) for aquatic sites, was approved by the MPCA and USEPA in December 2004. In June 2005, the Army submitted a draft feasibility study (FS) for aquatic sites to support the risk management decisions with respect to “No Further Action” or “Implement a Remedy” for each aquatic site. Following comments to the draft FS, it was agreed that additional sampling of Marsden Lake and Pond G would be conducted. This sampling was completed in 2008. Revised draft FS versions were submitted in January 2009 and April 2010. After review of the 2010 draft FS, the USEPA and MPCA requested that the Army prepare a work plan for collection of additional Round Lake sediment data (Round Lake is located off the southwest corner of OU2). Given the time required to collect the additional data, the Army, USEPA, and MPCA agreed to separate the FS into two documents: one for Round Lake and one for the OU2 aquatic sites, i.e., Rice Creek, Sunfish Lake, Marsden Lake North, Marsden Lake South, and Pond G. These sites are located as shown on Figure 11-1.

The USEPA and MPCA provided consistency for the Rice Creek, Sunfish Lake, Marsden Lake, and Pond G FS in January 2011. No Action was recommended for Rice Creek, Sunfish Lake, Marsden Lake North, and Marsden Lake South. A remedy was recommended for Pond G (surface water hardness adjustment) to attain compliance with the Minnesota surface water standard for lead (Class 2Bd chronic standard). OU2 ROD Amendment #4, which documents selection of the recommended alternative, was signed in January 2012.

The USEPA and MPCA provided consistency for the Pond G RD/RA Work Plan in March 2012, and the pond was treated in June 2012. The pond surface water was then monitored in 2012 and 2013, and results verified compliance with the surface water standard for lead. The completed Pond G remedial action work and surface water monitoring results were documented in the Remedial Action Completion and Close Out Report, Pond G (Wenck 2013b), which received regulatory consistency approval in FY 2014. The report recommended that the Pond G site be closed with no long-term maintenance, monitoring, or LUC requirements. The 2014 CERCLA five-year review also indicated final concurrence regarding the adequacy of the Pond G remedy, and the Pond G site has been closed. Since the completed remedy does not result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, future CERCLA 5-year reviews are not required for Pond G and, as noted above, there are no monitoring or LUC requirements.

12 OPERABLE UNIT 2: DEEP GROUNDWATER

The selected remedy for the Deep Groundwater in the OU2 ROD consists of five remedial components that include continued use of the TGRS, with modifications to improve VOC contaminant removal from the source area. It also includes an annual review of new and emerging technologies potentially applicable to the Deep Groundwater. This report documents all performance and monitoring data collected from October 2016 through September 2017.

Historical Design and Evaluation of TGRS Remedial Action

Historical design has been previously discussed in various APRs to date. As a brief summary, an Interim Response Action Plan for TCAAP (USEPA 1987) was prepared providing specific criteria for the Boundary Groundwater Recovery System (BGRS) which started on October 19, 1987. Initially operated as six extraction wells on the southwest OU2 boundary, the BGRS was later expanded between 1987 and 1989 to include six additional extraction and five source control wells as part of the TGRS. The TGRS was designed to prevent TCE mass migrating from OU2 towards OU1 based on a 5 µg/L TCE plume contour width at the southwestern OU2 boundary. As the TCE plume has narrowed since the start of operation, select wells positioned outside the plume footprint, or not contributing substantive capture benefit, have been turned off. As of 2017, the TGRS operates with 11 wells including eight boundary extraction wells and three source control wells with treated effluent discharged to the Arsenal Sand and Gravel Pit where it recharges overburden sands (Upper and Lower Unit 3). The TGRS was designed to operate at a maximum theoretical capacity of 2,900 gallons per minute (gpm), which includes a significant safety margin above its current operational flow rate to accommodate potential fluctuations in system operation.

The 1989 Annual Monitoring Report was the first report covering the fully configured TGRS, which concluded that a continuous zone of capture, approximately 4,500 feet wide, was developed at the TCAAP property boundary. The zone of capture widened to approximately 8,300 feet upgradient of the boundary. This zone of capture was developed at average system pumping rates of 2,400 to 2,700 gpm.

Operation of the TGRS remedy has been effective in reducing COC concentrations at nearly all OU2 monitoring wells by over approximately one order of magnitude. Significant reductions in TCE concentrations were evident during the early 1990s; however, slower relative declines in TCE concentration have occurred over the last 10 to 20 years. Currently, a remedy review has been conducted and submitted to the regulatory agencies presenting improvements for consideration toward overall mass removal and TGRS operational efficiency.

In FY 2003, the Army received agency approval on the TGRS Operating Strategy (OS) document. The OS was based, in part, on findings from the 1989 Annual Monitoring Report. The OS presented a Global Operation Strategy (GOS) for the entire TGRS extraction system and a Micro Operation Strategy (MOS) for selected well groups. Evaluations now consider and compare actual pumping rates to the GOS and MOS rates presented in the Final TGRS OS.

TGRS Modifications

There were no TGRS modifications in FY 2017. As of 2017, the TGRS operates with 11 wells including eight boundary extraction wells and three source control wells with treated effluent discharged to the

Arsenal Sand and Gravel Pit where it recharges overburden sands. For more detailed discussion on historical modifications refer to previous APRs.

12.1 Remedy Component #1: Hydraulic Containment and Contaminant Removal From the Source Area

Description: "Groundwater extraction to hydraulically contain the contaminated source area to the 5 µg/L TCE concentration contour and optimize the removal of contaminants from the source area through pumping of select wells." (OU2 ROD, page 3)

Performance Standard (how do you know when you're done):

When the TGRS is containing the contaminated source area to the 5 µg/L TCE contour and the system is operated to maximize the contaminant removal from the source area.

Is the remedy component being implemented?

Yes. The TGRS operated in FY 2017 consistent with the requirements of the OU2 ROD. Table 12-1 presents the TGRS cleanup requirements per the OU2 ROD. During FY 2017, the TGRS average extraction rate was approximately 1,769 gpm, as shown in Table 12-2. This rate is approximately 1.4 percent more than the GOS Total System Operational Minimum (1,745 gpm) where the Army and the agencies agree that OU2 ROD requirements are met with an adequate safety factor.

Two of the three individual well groupings were above their respective MOS minimums for FY 2017. The B1, B11, B13 well grouping was below the MOS minimum of 415 gpm due to an approved February 2013 B11 shut down and TGRS maintenance events. B11 will continue to be monitored to verify containment.

How is the system operated and what preventative maintenance measures were conducted during the year?

Summary of Operations

Previous APRs denote the Summary of Operations. As of 2017, the TGRS operates with 11 wells including eight southwestern boundary extraction wells (B1, B3, B4, B5, B6, B8, B9, and B13) and three source control wells downgradient of interior OU2 source areas (SC1, SC2, and SC5). The TGRS layout is presented on Figure 12-1.

The TGRS was designed and constructed with three options for treated water discharge: recharge at the Arsenal Sand and Gravel Pit, discharge to Rice Creek, and discharge to the elevated water tank. Water stored in the elevated tank was "softened" and then "polished" with GAC prior to distribution at the Facility. Since the Army discontinued all non-environmental services at the Facility in September 2007, the elevated water tank and the water softening and polishing equipment are no longer used. As such, the Arsenal Sand and Gravel Pit receives all of the extracted and treated water from the TGRS.

System Operation Specifications

In general, the influent and effluent water flow rates at the treatment plant are designed to be equal, thereby providing continuous operation of all processes and equipment. The following is a summary of the original system design parameters:

- The groundwater extraction system, including the treatment center and 17 TGRS extraction wells, was originally designed to provide a theoretical hydraulic capacity of 2,900 gpm and a sustained daily average capacity of 2,730 gpm.
- The influent to the treatment plant is divided between Towers 1 and 2, each receiving up to a maximum of 1,450 gpm.
- Wet Well Pumps 1 and 2 (WWP#1 and WWP#2 located in Wet Wells 1 and 2) transfer water to Towers 4 and 3, respectively. Each pump and tower handles up to a maximum of 1,450 gpm.
- Wet Well Pumps 3 and 4 (WWP#3 and WWP#4 located in Wet Well 3) discharge treated water to an end use at a combined rate of up to a maximum of 2,900 gpm
- Air blowers provide air to the towers. Each blower for Towers 1 and 2 are designed to provide 6,000 – 7,000 standard cubic feet per minute (scfm). The blowers for Towers 3 and 4 are designed to provide 9,000 – 14,000 scfm.

The TGRS was modified to allow for 2 air stripping tower treatment instead of the original design of 4 air stripping tower treatment, which resulted in a reduction of energy use while still meeting the 5 µg/L TCE effluent discharge limit. Wet Well Pumps 1 and 2 (40 horsepower each) and blowers 1 and 2 (5 horsepower each) were shut down and the valves to Towers 1 and 2 were closed. Since March 2010, groundwater has been effectively treated by air stripping Towers 3 and 4 while Towers 1 and 2 remain in standby.

Water level sensors within the wet wells communicate with the programmed logic controller (PLC) according to changing water levels. A complete and balanced operation should provide continuing water levels above the low-level sensors and below the high-level sensors. However, given the probability of unbalanced flows for any number of reasons (e.g., changing hydraulic heads, maintenance, repairs, temporary malfunctions), the PLC has provisions within its program to cycle-off the extraction well(s) or wet well pumps according to high water levels occurring in the wet wells; and in turn, cycle-off the wet well pumps according to low levels occurring within these wet wells.

The system operates such that the wet well pumps cycle rather than the extraction well pumps. The rationale behind this is that there are a relatively small number of motors, starters and electrically controlled valves associated with the wet wells when compared with the extraction well field. This also provides for more continuous and complete hydraulic capture within the aquifer units. However, the extraction well field will cycle if necessary, starting with the least contaminated extraction well, B7 (if operating), and followed by the other extraction wells in a predetermined sequence. In summary, the priority of operation is as follows:

- Maintain constant operation of all extraction wells and air stripping towers above the operating minimum;
- Maintain the desired flow rates at individual wells;
- If operating in four tower mode, maintain WWP#1 and WWP#2 pumping rates equal to or slightly above the combined pumping rate of the extraction well field; and

- Maintain treatment center WWP#3 and WWP#4 pumping rate equal to or slightly above the WWP#1 and #2 pumping rate (if operating in four tower mode) or slightly above the combined pumping rate of the extraction well field (if operating in two tower mode).

FY 2017 Maintenance and Inspection Activity

During FY 2017, the following inspection and maintenance activities occurred:

Preventive Maintenance (PM): The extensive PM program allowed the operations staff to identify and repair or replace equipment to avoid a downtime failure. The program consists of monthly, quarterly and annual maintenance tasks. When required, further repair work was scheduled rather than waiting for the failure to occur. A broad range of system-specific information was collected during this year's PM. This information is used to direct future repair work.

Electrical Inspection and Temperature Survey: A system-wide electrical inspection and infrared temperature survey was performed to identify loose connections and overheating components. Component overheating often precedes equipment failure. Electrical components that were identified as failing were replaced.

Verification of Flow Meters: As part of the routine PM, flow meters in the pumphouses were compared to a factory-calibrated flow meter. Flow volume measurements before and after conducting maintenance on the meters were compared to verify the consistency of measurements. Meters found to be out of calibration were replaced or recalibrated.

Daily Tracking of Flow Rates: Pumphouse and treatment center meter readings were recorded in the course of the daily inspections. Daily meter readings were tabulated and the flow rates were calculated and reviewed by the operations staff. Early detection of changes in flow rate was critical in early identification of failing equipment. By early detection of flow rate changes, equipment repair was typically scheduled before a failure occurred.

Did the system operate at a rate sufficient for complete capture?

Respective of current OU2 ROD requirements, yes. At 1,769 gpm, the total extraction well pumping rate was above the GOS Total System Operational Minimum (1,745 gpm) where the Army and the agencies agree that OU2 ROD requirements are met with an adequate safety factor. The TGRS OS pumping scheme was developed, in part, on the findings in the 1989 Annual Monitoring Report and updated to hydraulically capture the 5 µg/L TCE contour for the TCE source areas based on 2001 chemical data. A factor of safety was added to the base theoretical capture rate (1,200 gpm) to provide a buffer and/or flexibility for system maintenance. Based on this approach, a minimum combined TGRS extraction rate of 1,745 gpm was agreed to by the Army and the agencies that OU2 ROD requirements are met with an adequate safety factor.

Figure 12-2 plots the TGRS daily average flow rate from October 1, 2016 through September 30, 2017 and shows operation above the Operational Minimum (OM) for the majority of the time (301 days or 82 percent of the time) in FY 2017. Total TGRS monthly extraction rates were greater than 1,745 gpm except for August 2017 (1,649 gpm) due to cleaning/jetting of the below ground forcemain from wells B1 to B8. Appendix G.2 provides additional information on the various downtimes throughout FY 2017.

The monthly and annual volume of water pumped is presented in Table 12-2 and 12-3. Table 12-2 presents the pumphouse metered monthly flow volumes of each extraction well. The individual pumphouse flow meters are used to determine the amount of groundwater extracted from the various well groups, individual extraction wells, and the total amount of groundwater extracted during the fiscal year. Table 12-3 presents the combined pumphouse-metered flow volume (extraction wells) and the flow volumes metered at various stages in the treatment center along with historical data. These flow meters are used to evaluate the flow of water through the treatment process to ensure proper system operation. As shown on Table 12-3, the TGRS successfully captured and treated approximately 929,926,100 gallons of contaminated water from October 2016 through September 2017 based on the sum of the individual pumphouse flow meters. This volume converts to an average flow rate of 1,769 gpm, which exceeds GOS minimum of 1,745 gpm.

Monthly Flow Reports

Each month a Monthly Flow Report is prepared. The report includes the month's meter totalizer readings, calculated flow volumes and operational notes. Flow volumes are presented on a daily basis and are totaled to provide a monthly flow volume. A compilation of FY 2017 operational notes is presented in Appendix G.2. During FY 2017, the sum of the individual pumphouse flow meters was used to measure total flow volumes in monthly reports for comparison with Operating Strategy limits. Daily variation in readings at individual wells is primarily due to differences in the time of day when meter readings were taken.

How much down time occurred during the year?

The down time for each extraction well, over the last five years, is presented in Table 12-4. A summary of average down time for the pumphouses and the treatment center by the category of failure is presented in Table 12-5. A description of each down time event, organized chronologically, is presented in Appendix G.2. The same descriptions organized by affected pumphouse, treatment center, and forcemain is presented in Appendix G.3.

Treatment center and extraction well down times resulted primarily from failure and subsequent repair of components in the pumphouses, treatment center, and electrical service. The downtime in FY 2017 decreased from FY 2016 (from 15.9 days in FY 2016 to 6.7 days in FY 2017). The decrease in downtime is primarily due to less downtime in the pumphouse and electrical services categories.

Description of Down Time Categories

Pumphouse component failures accounted for an average of 1.9 days down time per pumphouse. The major pumphouse repairs causing down time were:

- Electrical issues, and
- Repair of motor at Pumphouse B9.

Treatment center component failures and repairs that caused pumphouse down time consisted of electric check valve maintenance, malfunctions and repairs, and electrical control equipment failures and subsequent repairs.

Treatment center component failures, repairs, and adjustments accounted for an average of 0.4 days down time per pumphouse. The major treatment center repair causing substantial down time was a failed solenoid valve that had to be removed and rebuilt.

Electrical service system failures accounted for an average of 0.6 days down time per pumphouse. Electrical storm damage and power grid failures were the primary causes of down time.

Preventative maintenance procedures accounted for less than 0.9 days of down time in FY 2017. For the most part, preventative maintenance was able to be performed without interruptions to the treatment system. Preventative maintenance procedures are described in the project Operation and Maintenance Manual. System modifications did not account for any days of down time in FY 2017.

Forcemain issues accounted for 2.3 days down time per pumphouse. Jetting of the forcemain between B1 and B8 was completed in FY 2017 and accounted for the majority of the downtime.

Were there any major operational changes during the year? No.

Did the system achieve hydraulic capture?

Respective of current OU2 ROD requirements hydraulic influence is noted via extraction above the GOS Operational Minimum under Army and agency agreement. In addition, a remedy review has been conducted and submitted to the regulatory agencies presenting improvements for consideration toward overall mass removal and TGRS operational efficiency. Another sign, with respect to system operation, is the generally stable or decreasing TCE concentrations evident at many wells across the TGRS boundary since FY 2001. Moreover, comparison of the OU1 TCE plume footprint over the past 20 years as summarized in the last four USEPA five-year reviews and further discussed below indicates a stable bedrock TCE plume footprint. Groundwater elevation measurements collected in June 2017 are presented in Appendix D.

How much VOC mass was removed by the system and how is it changing with time?

As discussed above, the TGRS extracted and treated approximately 929,926,100 gallons of water from October 2016 through September 2017. Based on the monthly influent and effluent VOC concentrations and the monthly flow totals as measured by the extraction well flow meters, the TGRS removed a total of 1,988 pounds of VOCs from October 2016 through September 2017. The VOC mass removal in FY 2016 was 1,731 pounds. The increase in the VOC mass removal occurred because the TGRS operated the majority of FY 2017 with limited downtime. When comparing the FY 2017 to FY 2016 and past years and taking into account operational downtime, the trend still depicts an overall reduction in mass removal.

Average VOC influent concentrations increased slightly from 230 μg/L in FY 2016 to 256 μg/L in FY 2017 (11.3 percent higher). Table 12-6 summarizes the individual VOC mass contribution of each extraction well and the entire system. Overall, the TGRS has removed over 108 tons (216,740 pounds) of VOCs from the aquifers since 1987 and 20 tons of VOCs since the end of FY 2001 (the TGRS OS was based on data through 2001). If the annual VOC mass removal from the TGRS is less than 1,709 pounds (50 percent of the FY 2001 mass removal) then the Army and agencies have agreed that review of the OS operating minimum rates should be conducted and potentially reduced. At 1,988 pounds in FY 2017, the VOC mass removal from the TGRS is at 58 percent of the FY 2001 mass removal.

The total mass removed is based on the monthly TGRS influent and effluent sampling and flow through the treatment system. The monthly sampling of the treatment system provides the best estimate of overall mass removal, compared to the individual extraction well sampling, due to the larger number of samples and consistency in the month-to-month analytical results. The percent contributions for each well are based on the average flows from each well and the semi-annual VOC results from each well.

VOC samples were collected semi-annually from the TGRS operating extraction wells. Wells B2, B7, B10, B11, B12, SC3, and SC4 are shut down, but were temporarily operated for June 2017 sampling.

Table 12-7 presents a summary of the sampling results for the extraction wells. Variations in detection limits from round to round are the result of varying sample dilution performed by the laboratory where dilutions are required due to the high concentrations of some analytes. The locations of the extraction wells are presented on Figure 12-1.

Appendix H.1 presents TCE versus time graphs for each extraction well. As shown, TCE concentrations have declined in each well, and now at many wells TCE concentrations appear to be stable or still declining. Since FY 2001, the following extraction wells have shown the most improvement (greater than 50 percent reduction) in TCE concentrations:

- B11 (4.8 µg/L in FY 2001 to non-detect in FY 2017 – 100% reduction),
- SC3 (5.5 µg/L in FY 2001 to 0.33 µg/L in FY 2016 – 94% reduction),
- B10 (5.1 µg/L in FY 2001 to non-detect µg/L in FY 2016 – 100% reduction),
- B6 (230 µg/L in FY 2001 to 22 µg/L in FY 2017 – 90% reduction),
- B4 (500 µg/L in FY 2001 to 81 µg/L in FY 2017 – 83% reduction),
- B5 (410 µg/L in FY 2001 to 75 µg/L in FY 2017 – 82% reduction),
- B1 (180 µg/L in FY 2001 to 56 µg/L in FY 2017 – 69% reduction),
- SC2 (100 µg/L in FY 2001 to 38 µg/L in FY 2017 – 62% reduction),
- B3 (8.7 µg/L in FY 2001 to 3.2 µg/L in FY 2017 – 59% reduction),
- B9 (110 µg/L in FY 2001 to 33 µg/L in FY 2017 – 70% reduction),
- SC4 (6.9 µg/L in FY 2001 to 2.7 µg/L in FY 2016 – 61% reduction), and
- B8 (21 µg/L in FY 2001 to 8.9 µg/L in FY 2017 – 58% reduction).

In fact, only 3 wells (B2, SC5, and SC1) have shown less than a 50 percent reduction in TCE concentrations since FY 2001. These trends reflect the overall decline in OU2 deep groundwater contaminant concentrations. In addition, as discussed below, there has been a reduction in overall TGRS influent concentrations over the previous several years

As Table 12-6 illustrates, eight wells, B1, B4, B5, B6, B9, B13, SC1 and SC5, that are located in the centers of the plume, achieve the largest rates of VOC removal. These eight wells together accounted for over 99 percent of the VOC mass removed.

The source control wells, SC1 through SC5, together accounted for over 87.7 percent of the VOC mass removed while accounting for only 8.4 percent of the water pumped by the system. SC5, in particular, removed over 72.6 percent of the total VOC mass at a rate of only approximately 86 gpm (4.9 percent of the total water pumped by the system). This illustrates the efficiency of extracting groundwater from near the source areas, which is further discussed in the current remedy review.

What do the long-term trends in the monitoring wells show?

A majority of wells on and off TCAAP exhibit decreasing trends in TCE concentration, indicating an overall improvement in water quality both upgradient and downgradient of the TGRS. Due to the complexity of the flow system, changes in flow direction over time, and the variation in chemical transport properties across the study area, the trends may not reflect a uniform or easily predictable pattern.

Several wells were identified in previous APRs, or when reviewing the FY 2017 database that have inconsistent or upward trends in TCE concentrations that warrant further observation and discussion:

Well	Trend Observation
03L806	Trend identified in FY 2001 APR. Dropped from 1,000s of μg/L in early 1990s. TCE decreased steadily from 410 μg/L in 2001 to 140 μg/L in 2005.From 2006 to 2011, TCE concentrations varied between 120 μg/L and 240 μg/L with no apparent trend. TCE increased to 490 μg/L in 2012 and 620 μg/L in 2013. Decreased to 440 μg/L in 2014, 330 μg/L in 2015, 120 μg/L in 2016, and 42 μg/L in 2017. The overall increase in 2012 through 2014 coincided with a decrease in TCE concentration at well 03M806. However, in 2016 and 2017 the TCE levels dropped to pre-2012 concentrations. Maintain annual sampling frequency to determine if this downward trend continues.
04U806	Trend identified in FY 2001 APR. Dropped from 1,000’s of μg/L in early to mid-1990s. TCE steadily decreased from 470 μg/L in 2001 to 96 μg/L in 2007. In 2008, TCE spiked at 380 μg/L, but concentrations decreased the next year and have varied between 52 μg/L and 220 μg/L since 2009 with a notable steadily decreasing trend (52 μg/L in 2017). Maintain annual sampling frequency.
03U094	Trend identified during FY 2004 data review. TCE increased from 170 μg/L in 2003 to 470 μg/L in 2005. From 2005 to 2013, TCE concentrations decreased to 80 μg/L in 2013, a historical low concentration. Increased to 610 μg/L in 2015, the highest concentration since 1996, then decreased to 360 μg/L in 2016. Maintain biennial sampling frequency (next event 2018).
03M806	Trend identified during FY 2003 data review. TCE concentrations dropped from approximately 900 μg/L in 1987, to less than 100 μg/L from 1993 through 1996. In 2003, TCE increased to 1,300 μg/L, a historical high concentration. TCE concentrations decreased from 680 μg/L in 2008 to 250 μg/L in 2015 but increased to 410 μg/L in 2017. Maintain annual sampling frequency.
03U711	Trend identified in FY 2001 APR. TCE concentrations decreased from approximately 1,000 μg/L in 1994 to 75 μg/L in 1999 but rebounded to 250 μg/L by 2004. Since 2004, concentrations have steadily decreased to 27 μg/L in 2016. Maintain biennial sampling frequency (next event 2018).
03L809	Trend identified in FY 2001 APR. TCE concentrations decreased from over 3,000 μg/L to 67 μg/L through 1998 but rebounded to 520 μg/L by 2001. Since 2001, concentrations have decreased to 140 μg/L in 2016. Maintain biennial sampling frequency (next event 2018).
04U843	Trend identified in FY 2001 APR. TCE concentrations were below 15 μg/L from late 1980s through 1997, and then increased to between 22 μg/L and 38 μg/L from 1998 through 2001. In 2003, TCE dropped below 1 μg/L, but steadily increasing since it was 180 μg/L in 2016. This well is nearly 1 mile from

Well	Trend Observation
	from TGRS and is part of the OU1 sampling program; also see Section 3. Maintain biennial sampling frequency (next event 2018).
04U841	Trend identified in FY 2001 APR. TCE concentrations were below 10 µg/L through 1995, and then increased to 25 µg/L in 2001. In 2003, TCE decreased to 5 µg/L, but rebounded to 19 µg/L in 2005. TCE appears stabilized around 20 µg/L, with concentrations ranging between 14 and 24 µg/L since 2005 (14 µg/L in 2016). Well is nearly 0.5 mile from TGRS and is part of the OU1 sampling program; also see Section 3. Maintain biennial sampling frequency (next event 2018).
03U822	Trend identified during FY 2003 data review. TCE concentrations were below 25 µg/L through 1998, and then peaked at 375 µg/L in 1999. Concentrations have ranged between 120 and 160 µg/L from 2005 to 2015 (150 µg/L in 2016). Well is approximately 1 mile from TGRS and is part of the OU1 sampling program; also see Section 3. Maintain biennial sampling frequency (next event 2018).
03L822	Trend identified in FY 2001 APR. TCE concentration increased from less than 5 µg/L during early 1990s to over 600 µg/L from 1999 through 2003. Concentrations steadily decreased from 620 µg/L in 2003 to 180 µg/L in 2011 but rebounded slightly in 2013 to 220 µg/L. Concentration decreased slightly in 2016 to 190 µg/L. Well is approximately 1 mile from TGRS and is part of the OU1 sampling program; also see Section 3. Well historically showed 1,1,1-trichloroethane as major contaminant. Maintain biennial sampling frequency (next event 2018).

12.2 Remedy Component #2: Groundwater Treatment

Description: “Groundwater treatment using air stripping.” (OU2 ROD, page 3)

Performance Standard (how do you know when you’re done):

When the air stripping treatment facility is treating water and meeting the cleanup requirements in Table 1 of the OU2 ROD.

Is the remedy component being implemented?

Yes. The air stripping treatment facility has been operating since 1986.

Did the treatment system meet the treatment requirements in the OU2 ROD?

Yes. Influent and effluent water were sampled on a monthly basis during FY 2017. The influent/effluent database for FY 2017 is contained in Appendix G.2. Figure 12-3 presents a graph of influent TCE versus time. This graph is cumulative and includes data from before 1989, when the system consisted of only six extraction wells. The average FY 2017 influent TCE concentration was 209 µg/L, which is a 11 percent increase from 187 µg/L in FY 2016. FY 2017 represents the fifth-tenth year since the TGRS was reconfigured to pump more in the centers of the VOC plumes and pump less on the edges of the plumes where VOC concentrations are much lower. The influent TCE concentrations had been steadily decreasing for several years, likely due to the overall decrease in plume concentration. The increased influent TCE concentrations observed in FY 2017 are due, in part, to the higher flow rate that resulted from the cleaning of the forcemain later in FY 2016 and FY 2017.

Figure 12-3 also presents a graph of the effluent TCE concentration versus time. As indicated, the effluent was below 5 µg/L TCE for all sampling events in FY 2017. A review of the FY 2017 database indicates that the effluent remained below the treatment requirements for all other VOC compounds specified in the OU2 ROD. Comparison of influent and effluent concentrations for all specified VOC compounds indicates an average removal efficiency of 99.4 percent. As expected, effluent concentrations of TCE increased slightly after the treatment was changed to two tower operation (two tower operation was tested in February 2011 and went into full operation in March 2011). The maximum effluent TCE concentration in FY 2017 was 2.3 µg/L and the average was 1.6 µg/L, which are both well below the discharge limit.

What was the mass of VOCs emitted into the air?

The air stripping towers remove VOCs with an efficiency of approximately 99.4 percent. The air emissions are equal to the VOC mass removal rates presented in Table 12-6. Air emissions averaged 5.4 pounds per day based on the VOC mass removal rates. The total VOC emissions from October 2016 through September 2017 were 1,988 pounds.

12.3 Remedy Component #3: Treated Water Discharge

Description: "Discharge of treated water to the on-site gravel pit." (OU2 ROD, page 3)

Performance Standard (how do you know when you're done):

When the gravel pit is accommodating the discharge from the treatment system and allowing it to recharge to the aquifer.

Is the remedy component being implemented?

Yes. Based on visual observation during FY 2017, there were no noticeable changes in Gravel Pit performance. The Gravel Pit is accommodating the TGRS discharge as designed.

12.4 Remedy Component #4: Institutional Controls

Description: **"**Institutional controls to restrict access to contaminated aquifers and prevent exposure to contaminated groundwater." (OU2 ROD, page 4)

Performance Standard (how do you know when you're done):

When a special well construction area and alternate water supply have been established and private wells in impacted areas have been sealed.

Is the remedy component being implemented?

Yes. There are no private users of groundwater on the property and no potable water supply. There are ICs in place for future groundwater use associated with upcoming property redevelopment.

Are any changes or additional actions required for this remedy component?

Yes. On April 20, 2016, the MDH issued a memorandum updating the Special Well and Boring Construction Area (SWBCA) that noted the rezoning of the TCAAP facility for future development and updated the SWBCA boundary to include the entirety of TCAAP. As such, all wells and borings constructed or modified within the SWBCA must first be approved by the MDH.

12.5 Remedy Component #5: Review of New Technologies

Description: **"**Reviews of new and emerging technologies that have the potential to cost-effectively accelerate the timeframe for aquifer restoration. Reviews shall be performed by the Army and reported annually in accordance with the consistency provisions of the TCAAP FFA." (OU2 ROD, page 4).

The intent is to consider new technologies of merit, which is not on any set schedule. To have merit, a new technology must have promise in reducing cost and time for cleanup. There may be years where no technologies are considered. It is envisioned that at any time, any interested party (Army, USEPA, and MPCA) can suggest new technologies for consideration. If a technology is agreed to have merit by the Army, USEPA, and MPCA, then the Army will evaluate the technology. The level of effort for evaluations can range from simple literature searches to extensive treatability studies. On an annual basis, the Army will report on:

- Whether or not any new technologies were identified and considered to have merit that year,
- The progress or results of any evaluations during that year, and
- Any planned evaluations for the following year.

Performance Standard (how do you know when you're done):

When the Army reports on the status of any reviews of emerging technologies in the annual monitoring report.

Is the remedy component being implemented?

Yes. Since the FY 1997 Annual Performance Report, the Army reports annually on the status of any reviews of emerging technologies.

- In September 2002, the MPCA and USEPA announced they would be conducting a natural attenuation microcosm study using carbon dating. In October 2002, Army drilled a boring at Site G to collect soil for the study. The study results were published in 2004.
- The MPCA identified a study involving the addition of vegetable oil to groundwater that is being monitored at the Navy site in Fridley, Minnesota, as a potential technology of interest.

Were any new technologies identified and considered to have merit during FY 2017?

Yes. The Army is currently evaluating optimization strategies for the TGRS via a remedy review report, which is under regulatory review.

What is the status and/or findings of any previously initiated reviews of emerging technologies?

MPCA continued its research into natural attenuation processes at TCAAP. The MPCA and USEPA published the results of the microcosm study for deep groundwater sediments in 2004 showing that abiotic degradation of cis-DCE is an important factor contributing to the natural attenuation of this compound at the site. (*Non-biological Removal of cis-dichloroethylene and 1,1-dichloroethylene in aquifer sediment containing magnetite*. Environmental Science and Technology, 38: 1746-1752.)

Are any new reviews planned at this time for the coming year?

Yes. As stated earlier, the remedy review report is under regulatory review.

12.6 Remedy Component #6: Groundwater Monitoring

Description: "Groundwater monitoring to track remedy performance." (OU2 ROD, page 4).

Performance Standard (how do you know when you're done):

When a regulator approved monitoring plan is in place and monitoring is conducted according to the plan.

Is the remedy component being implemented?

Yes. Monitoring in FY 2017 was consistent with the OU2 ROD. Water level measurements and water quality samples were collected as stated in Appendix A.1. Appendix A summarizes the FY 2017 monitoring plan and any deviations are explained in Appendix C.2. Monitoring was as follows:

Groundwater

TGRS groundwater level measurements were collected during December 2016 and June 2017 according to the monitoring plan. Appendix D contains the comprehensive groundwater quality and water level database for the TGRS monitoring wells. Water quality samples were collected from TGRS wells according to the monitoring plan. Groundwater samples were collected at wells stated in Appendix A.1. All wells were sampled for VOC (8260B) analysis and 1,4-dioxane (Method 522). FY 2017 was a "small round" year in the biennial sample program, samples were collected from a select list of wells. Table 12-8 presents the groundwater quality data for FY 2017. Figures 12-6 through 12-8 present plan views of the TCE and 1,4-dioxane plumes. Results from the FY 2017 groundwater sampling showed that most of the wells sampled continued to have declining or stable TCE concentrations. Notable steadily decreasing trends are observed at 04U806 (decrease from 725 µg/L in 2000 to 52 µg/L in 2017), 03U708 (steady decrease from 120 µg/L in 2005 to 23 µg/L in 2017), 03L806 (620 µg/L in 2013 to 42 µg/L in 2017).

Two wells showed a slight increase in TCE concentration in 2017; however, the trend at most wells since 1999 is either declining or stable. Although the general trend at most wells since 1999 appears to be declining or stable, the monitoring wells listed below had notable increases in TCE concentration in FY 2017:

- 03M802 (5.2 µg/L in 2016 to 7.1 µg/L in 2017),
- 03M806 (380 µg/L in 2016 to 410 µg/L in 2017),
- 03U301 (SC-1) (1,700 µg/L in 2016 to 2,600 µg/L in 2017), and
- 03U317 (SC-5) (2,600 µg/L in 2016 to 3,100 µg/L in 2017).

All of these wells will continue to be monitored and no further sampling beyond the scheduled events is necessary at this time.

Estimated TCE Plume Width

The 2003 TGRS OS stated that the actual measured width of the 5 µg/L TCE plume at the source area based on FY 2001 analytical data was 3,600 feet (this value was then rounded up to 4,000 feet to determine an operating minimum flow rate noted in Section 12-1). Since that time, 20 tons of VOCs have been removed from groundwater. TCE concentrations are decreasing across Site, especially at the following wells which have been below 5 µg/L since 2001: B10, SC4, 03L021, 03L833, 03U701, 04J702, 04U701, 04U702, and 04U833. Monitoring well 03U672, which was located outside the southern end of the 5 µg/L TCE plume, decreased from 3.1 µg/L in 2001 to not detectable (less than 1 µg/L) from 2003 until it was abandoned in 2014. Well 03U677 replaced 03U672 in September 2014 and has never contained detectable concentrations of VOCs (including TCE). In addition, B11, which is no longer operating, reported a June 2017 TCE concentration of not detect.

As a result, the TCE plume width is narrowing. Figure 12-4 shows FY 2017 TCE data with the 5 µg/L TCE contours for FY 2001 and FY 2017. For FY 2017, a reduced numbers of wells were sampled in accordance with the FY 2017 monitoring plan and do not provide a complete current TCE plume representation. The overall FY 2017 sample results are similar, or lower compared to the FY 2016 sample results. Therefore, the FY 2016 contours and plume widths are still applicable.

Based on these contours, the estimated width of the source area TCE plume has decreased approximately 17 percent from 3,600 feet to 3,000 feet or approximately 83 percent of the FY 2001 width. According to the TGRS OS, overall TGRS operating goals will be reviewed if the source area plume width shrinks to 75 percent of the FY 2001 width, or 2,700 feet. At the boundary, the TCE plume narrowing is more pronounced, having decreased approximately 24 percent from 4,600 feet to 3,500 feet, which represents approximately 76 percent decrease from the FY 2001 width. These plume widths will be re-examined in FY 2018 when a comprehensive sample round is collected.

Based on discussions and correspondence with MPCA and USEPA staff, the Agencies may be receptive to changes in the operating strategy earlier than stated in the TGRS OS. As stated previously, the Army is evaluating optimization alternatives to the TGRS with the remedy review report currently under regulatory review.

Treatment System

The TGRS treatment system influent and effluent was sampled monthly during FY 2017 in accordance with the FY 2017 monitoring plan. Groundwater samples from the extraction wells were collected in December 2016 and June 2017 in accordance with the FY 2017 monitoring plan.

Is there additional monitoring proposed prior to the next report?

No additional monitoring for FY 2017 is proposed beyond that presented in the Monitoring Plan (Appendix A) of the FY 2017 APR. Table 12-9 and Appendix A of this report provide the FY 2017 – FY 2021 monitoring plan.

12.7 Overall Remedy for Deep Groundwater

Did the TGRS meet the requirements of the OU2 ROD? Yes.

- Hydraulic influence in Units 3 and 4 extends upgradient within OU2 beyond the 5 µg/L contour, meeting VOC criterion in the OU2 ROD.
- The total average extraction well water pumped exceeded Total System Operational Minimum (1,745 gpm). The FY 2017 annual average extraction rate was 1,769 gpm.

- The TGRS extracted and treated 929,926,100 gallons of water and removed 1,988 pounds of VOCs from October 2016 to September 2017. Average VOC influent concentrations increased by 12.9% from FY 2016.
- Groundwater analytical data of the source area show a general decrease in TCE concentration. This concentration decrease demonstrates that the TGRS is effectively removing VOC mass from the aquifer.
- Effluent VOC concentrations were below contaminant-specific requirements for all sampling events.

Do any additional measures need to be addressed? Not at this time.

12.8 Other Related Activity in FY 2017

In 2017, monitoring wells proposed for sampling in the FY 2017 Monitoring Plan were sampled for 1,4-dioxane. Table 12-10 presents the results of the 1,4-dioxane sampling for the TGRS influent, effluent, and extraction wells. No Federal MCL has been established for 1,4-dioxane; however, the MDH has established a HRL value of 1.0 µg/L. All locations sampled except extraction wells (B5, B11, and SC5) had 1,4-dioxane concentrations exceeding the HRL. The TGRS influent and effluent were sampled in June 2016 where 1,4-dioxane concentrations were virtually identical in influent and effluent samples, indicating no concentration reduction from the treatment system. The monitoring well sampling results are presented on Table 12-11. 56 percent of the monitoring wells sampled (9 of 16) had 1,4-dioxane concentrations exceeding the HRL, with the highest concentrations found in the samples at 03M806 (15.4 µg/L) and 03L806 (14.2 µg/L). Figure 12-5 shows the 1,4-dioxane concentrations in plan view for the west portion of OU2. Generally, the 2017 results are similar to those results reported for wells sampled in FY 2016.

13 OPERABLE UNIT 3: DEEP GROUNDWATER

A 1992 OU3 ROD was developed, amended and finalized in August 2006 that significantly changed the OU3 remedy. The basis for the OU3 ROD Amendment was the “Groundwater Statistical Evaluation, OU3” technical memorandum, which received consistency on May 2, 2005. This document presented a statistical evaluation showing that the South Plume has been receding since at least 1996, including the period after the Plume Groundwater Recovery System (PGRS) was shut off in 2001. The South Plume had receded well upstream of the PGRS, which was basically pumping clean water. The ROD Amendment removed the need for a pump and treat remedy, eliminating the PGRS extraction well and treatment train. Figure 13-1 presents an OU3 site plan.

The PGRS was an off-post groundwater extraction and treatment system and municipal potable water supply. The PGRS consisted of NBM #13 and a GAC treatment plant. New Brighton used the water for municipal supply. The PGRS was designed to contain the South Plume of VOC contamination emanating from the former TCAAP property and to prevent further downgradient migration. Recovered groundwater was treated and used by the City of New Brighton to fulfill its municipal water supply demand.

The PGRS began operating on May 3, 1994. In 1997, the PGRS influent dropped below the ROD required limits for all VOCs. In December 1999, under an agreement with the Agencies, the PGRS pumping rate was reduced from a nominal rate of 1,000 gpm to 400 gpm to help determine if the VOC reductions in concentration were the result of actual plume decreases or the result of dilution from over pumping. In conjunction with the flow rate decrease, a quarterly monitoring program was undertaken to monitor for potential “rebound” in VOC concentrations. By the end of FY 2000, no rebound was observed and a review of the historical database for all of OU3 and the associated source area in OU2 revealed that the entire South Plume had dramatically decreased in size and concentration since the early 1990s. The VOC concentration decreases were such that the leading edge of the South Plume, at the PGRS, dropped below the ROD requirements.

The results of this evaluation were presented to the Agencies on September 6, 2000, and a report titled “Plume History Evaluation, Operable Unit 3”, CRA, was submitted to the Agencies on October 10, 2000. The report documents the history of plume size and concentration reductions throughout OU3. Based on the dramatic reductions in plume size and concentration, the report recommended shutting down the PGRS, which the Agencies subsequently accepted. The City of New Brighton stopped significant pumping in August 2001 and the PGRS was maintained in standby status. During the period May through September 2003, the PGRS was operated solely to satisfy peak water supply demands and then was placed back into standby status, remaining throughout FY 2004, FY 2005, and FY 2006. The City conducted an evaluation of its municipal system to, in part, determine the future use of the PGRS extraction well and treatment system. The City decided the PGRS treatment system and well NBM #13 were not part of the City’s long-term water supply plan. During FY 2007, the PGRS treatment system was dismantled and NBM #13 was abandoned.

13.1 Remedy Component #1: Monitored Natural Attenuation

Description: “Monitored natural attenuation.” (OU3 ROD Amendment, page 17).

Performance Standard (how do you know when you're done):

When a monitoring program is established and monitoring is in compliance with the regulator approved Annual Monitoring Plan.

Is the remedy component being implemented?

Yes. Appendix A summarizes the FY 2017 monitoring plan and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in Section 13.2.

13.2 Remedy Component #2: Groundwater Monitoring

Description: "Monitoring of the groundwater for VOCs to verify the effectiveness of the selected remedy and the natural attenuation of the South Plume." (OU3 ROD Amendment, page 17).

Performance Standard (how do you know when you're done):

When a monitoring program is established and monitoring is in compliance with the regulator approved Annual Monitoring Plan.

Is the remedy component being implemented?

Yes. Appendix A summarizes the FY 2017 monitoring plan and any deviations are explained in Appendix C.2.

Groundwater samples were collected from two OU3 wells in FY 2017 as part of OU1, OU2, and OU3 annual sampling. Samples were collected as specified in the monitoring plan and analyzed for VOCs and 1,4-dioxane at locations shown on Figure 13-1. The specific purpose of monitoring each well is provided in Appendix A. Groundwater elevations were also measured during the monitoring event and are presented in Appendix D.1.

Table 13-1 presents a summary of the analytical results for the two monitoring wells that were sampled in FY 2017. The wells sampled contained TCE concentrations similar to those reported for the previous sampling events. Downgradient sentry well 04U863 TCE concentration remained less than 1.0 µg/L or not detectable (less than 1.0 µg/L) for the fifth consecutive year, after rising above 1.0 µg/L for the first time since December 1999 in 2012 (1.2 µg/L). Well 03M848 had TCE concentrations above the cleanup standard of 5 µg/L at 110 µg/L.

What were the results of the Statistical Analyses?

The Mann-Kendall statistical analysis has historically been completed for ten edge-of-plume and center-of-plume wells. In FY 2017 only well 03M848 was sampled within the ten edge-of-plume and center-of-plume wells. A summary of the statistical analyses was completed for well 03M848 and the other nine well were included with FY 2016 results for an overview of the site and is presented in Table 13-2. A spreadsheet and graph presenting the Mann-Kendall test results for the wells are provided in Appendix I.

The trend for 03M848, which has historically been the center of the South Plume, changed from no trend or stable to decreasing as concentrations have decreased over the last five sampling events. The TCE concentrations at 03M848 have steadily decreased from 1,400 µg/L (FY 1996) to 700 µg/L (FY 1999) to 450 µg/L (FY 2003) to 110 µg/L (FY 2016) to the current concentration of 100 µg/L in FY 2017. However, recent low-level detections of degradation products associated with 1,1,1-trichloroethane (i.e. 1,1-

Dichloroethane) at 03M848, may indicate that the North Plume is not only beginning to mingle with the South Plume at the OU1-OU3 boundary. In summary, based on the data collected in FY 2017, the center of the South Plume, represented by 03M848, indicates decreasing concentration trends. Recent data show that the North Plume may be present even toward the center of the South Plume and may also be a factor in the trends noted there.

Are contingency actions warranted?

No. The OU3 ROD Amendment requires contingency actions to be considered when the Mann-Kendall statistical analysis shows that a well at the edge of the South Plume has an increasing trend. The wells analyzed in FY 2017 showed a decreasing trend.

What groundwater monitoring is proposed before the next report?

Since the 1,4-dioxane issue in FY 2015, sampling has been conducted including 1,4-dioxane. FY 2018 will continue monitoring for 1,4-dioxane. The proposed OU3 monitoring requirements are presented in Table 13-3 and Appendix A.

13.3 Remedy Component #3: Drilling Advisories

Description: "Continued implementation of the drilling advisories that regulates the installation of new private wells within OU3 as a Special Well Construction Area." (OU3 ROD Amendment, page 17).

Performance Standard (how do you know when you're done):

When a SWCA Advisory is issued.

Has the MDH issued a Special Well Construction Area Advisory?

Yes, in June 1996. In June 1999, via the MDH the SWCA boundary extended southwest including the Mississippi River and Marshall Avenue to ensure plume coverage. The SWCA also covers OU3 and all of OU2 as of April 2016, with the current boundary shown on Figure E-1 (Appendix E).

Are any changes or additional actions required for this remedy component? No.

13.4 Overall Remedy for OU3

Is the Remedy for OU3 Operating in Compliance with the OU3 ROD and OU3 ROD Amendment?

Yes. In FY 2017, groundwater monitoring took place as prescribed in the Annual Monitoring Plan. The annual sampling round of FY 2017 indicates that the South Plume footprint appears to be decreasing or at least stable, with a stable to decreasing trend at the center of the plume.

Are any changes or additional actions required for OU3?

No. No additional actions are necessary because no increasing trends at the edge of the plume were identified by the statistical analysis.

13.5 Other Related Activity in FY 2017

In 2017, samples from two wells were collected for 1,4-dioxane for OU3 annual sampling presented in Table 13-4 showing both locations (03M848 and 04U863) were below the HRL.

14 OTHER INSTALLATION RESTORATION ACTIVITIES DURING FY 2017

This section summarizes the status of other activities that are related to the Installation Restoration Program but are not required in the RODs for OU1 through OU3.

14.1 Round Lake

The *Tier II Ecological Risk Assessment Report* (USACHPP 2004) for aquatic sites (including Round Lake), was approved by the MPCA and USEPA in December 2004. In June 2005, the Army submitted a draft FS for aquatic sites to support the risk management decisions with respect to "No Further Action" or "Implement a Remedy" for each aquatic site. Based on comments to the draft FS, it was agreed to conduct additional sampling of Marsden Lake and Pond G, which was completed in 2008. A revised FS was submitted in January 2009. Based on comments received and resolution thereof, the Army then submitted a revised (redlined) FS in April 2010. After review of this report, USEPA and MPCA requested that the Army prepare a work plan for collection of additional Round Lake sediment data. Given the time required to collect the additional data, the Army, USEPA, and MPCA agreed to separate the FS for aquatic sites into two documents: one for Round Lake and one for Rice Creek, Sunfish Lake, Marsden Lake, and Pond G.

The USEPA and MPCA provided consistency for the QAPP for Round Lake Sediment Investigation in January 2011. The sediment sampling work was completed in January – February 2011. A *Draft Summary of Investigation Findings* was submitted in May 2011, and a meeting between Army, USEPA, MPCA, Minnesota Department of Natural Resources, U.S. Fish and Wildlife Service, and the TCAAP Restoration Advisory Board was held in June 2011 for preliminary discussion of the findings. Final core dating results were distributed in February 2012. In March 2012, the Army provided responses to the stakeholder comments on the Round Lake portion of the April 2010 FS, which had been placed on hold pending collection and evaluation of the 2011 sediment data. A comment resolution meeting was then held in April 2012, and a TCAAP Restoration Advisory Board meeting was held in May 2012, primarily to discuss the status of the Round Lake FS.

With USEPA and MPCA agreement, the Army initiated a strategy to revise the FS in segments, with the intent to gain agreement/approval at key steps along the way. In accordance with this strategy, the Army submitted revised Sections 1 through 5 of the Round Lake FS in August 2012, and the USEPA and MPCA provided comments in September 2012. The Army sought clarifications on these comments, and ultimately submitted responses to those comments and the proposed redlines to Sections 1 through 5 in January 2013. The USEPA and MPCA provided comments to that submittal in March 2013. Through this process (and the multiple earlier drafts of the FS), it became clear that the Army, USEPA, and MPCA did not agree on the ecological risks and commensurate remedy associated with Round Lake. Given the difficulty reaching a consensus, the Army Environmental Command desired a fresh look at the ecological risk by someone who has national experience with such matters and obtained the assistance of the Risk and Regulatory Analysis Team of the Environmental Sciences Division at the Oak Ridge National Laboratory. In early FY 2014, the Army submitted *a Supplemental Remedial Investigation and Feasibility Study for Round Lake* (Wenck 2013a) which incorporated the *Supplemental Ecological Risk Assessment*

(Oak Ridge National Laboratory 2013). Comments received from the USEPA and MPCA in March 2014 indicated that significant disagreement remained. In April 2014, the Army, USEPA, and MPCA entered an “informal dispute resolution” phase which continued in FY 2015 and FY 2016. In a teleconference between the USEPA Region 5 Federal Facilities Chief and Headquarters Department of Army personnel on September 20, 2016, an agreement was reached in which Army would submit a revised Supplemental Remedial Investigation and Feasibility Study in the third quarter of FY 2017. The document was submitted for regulator review on May 10, 2017. The regulators provided written comments in July 2017, with Army response issued on October 6, 2017. At the end of FY 2017, unresolved issues pertaining to Round Lake were still under discussion.

14.2 135 Primer/Tracer Area

The *Preliminary Assessment* (Alliant Techsystems Inc. 2001) report received regulatory approval in FY 2002. It was recommended that a site inspection (SI) be conducted. The *Summary Report for the 135 Primer/Tracer Area Site Inspection Investigation* (SI Report; EnecoTech Midwest, Inc. 2005) received MPCA and USEPA approval in FY 2005. The SI Report recommended that an EE/CA be conducted to determine what, if any, remediation is required to address contamination observed in the soil. The 135 PTA is on property that is proposed to be transferred out of federal ownership. The Army is anticipating transfer of the 135 PTA to Ramsey County. Currently, it is anticipated that the western portion of the 135 PTA would be utilized for purposes of a public trail corridor, and the eastern portion would be utilized for other development purposes.

For the western portion, in anticipation of the property transfer, Ramsey County conducted soil investigation work on this portion of the 135 PTA in early FY 2012. A Draft Phase II ESA report documenting this work was submitted to the MPCA Voluntary Investigation and Cleanup (VIC) Program in December 2011.

For the eastern portion, additional soil investigation to support preparation of an EE/CA was conducted in March-June 2012. The EE/CA received consistency approval from the USEPA and MPCA in November 2012, and the EE/CA recommended soil excavation and off-site disposal. The Army published legal notices in newspapers regarding the availability of the EE/CA for public comment and established a 30-day public comment period beginning on November 7, 2012. No comments were received. The Army selected the EE/CA-recommended remedy in an Action Memorandum signed on December 18, 2012. The Army then prepared a Removal Action Work Plan to describe the implementation procedures for the soil excavation and offsite disposal. The Removal Action Work Plan received consistency approval from the USEPA and MPCA in March 2013. The soil excavation and off-site disposal work was implemented in May-June 2013, with a total of 1,846 tons of contaminated soil removed from the various soil areas of concern, collectively (i.e., Site A, the eastern portion of the 135 PTA, and the MNARNG EBS areas). The *Removal Action Completion Report* (Wenck 2013c), documenting implementation of this work, received consistency approval from the USEPA and MPCA in November 2013. OU2 ROD Amendment #5, signed in March 2014, documented that the soil removal actions were the final remedies for these sites and incorporated these remedies into OU2. Discussion of the eastern portion of the 135 PTA is now being included in Section 4.

14.3 Property Transfer-Related Environmental Activities

In 2002, the remaining 774 acres still under the TCAAP control were declared excess to the needs of the Department of Defense. The Army BRAC Office funded ESA work to collect information regarding the environmental condition of the property to facilitate property transfer. The work included document reviews and field sampling of various media. The findings were published in Environmental Site Assessment for 774-Acre Excess Parcel, Phase I and Phase II Report, Twin Cities Army Ammunition Plant (Plexus Scientific Corporation 2004). Based on comments from the MPCA and USEPA, additional samples were collected and analyzed in FY 2005. The Army prepared an ESA Addendum Report (TWISS 2006) that was approved in FY 2006. Originally, it was proposed to transfer approximately 585 acres through a negotiated sale with the City of Arden Hills, who in turn had an agreement with a developer. In FY 2007, the developer collected additional samples of various media on the property proposed for transfer to Arden Hills. In FY 2009, the developer withdrew from its agreement with Arden Hills, who in turn withdrew its offer to purchase with the federal government. The federal government was then working towards a public auction of the remaining TCAAP property; however, in FY 2011, Ramsey County initiated discussions with the federal government regarding purchase of the property for the potential purpose of locating a new Minnesota Vikings stadium (and other development). Although the final decision placed the Vikings stadium in Minneapolis, Ramsey County then sought to purchase 427 acres of the 427 acres of the TCAAP property for other mixed-use redevelopment. Ultimately, this deal was closed in April 2013, which initially transferred ownership of approximately 397 acres to Ramsey County and provided a lease to Ramsey County for the balance of the property (approximately 30 acres). The leased property had known exceedances of the MPCA industrial cleanup standards, and Ramsey County was to cleanup such exceedances before taking ownership of the remaining 30 acres.

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TABLES

Table 1-1
Status of Remedial Actions
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

	Remedy Component	Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
Operable Unit 1: Deep Groundwater					
#1	Alternate Water Supply/Well Abandonment	Yes	Yes	No	
#2	Drilling Advisories	Yes	Yes	No	
#3	Extract Groundwater	No	No	No	NBCGRS pumping has temporarily been suspended (referred to as a "Remedy Time-out") to allow the City of New Brighton to design and construct a 1,4-dioxane treatment system, which will allow a return to normal pumping.
#4	Removal of VOCs by GAC (Discharge Quality)	No	No	No	See comment for Remedy Component #3.
#5	Discharge of Treated Water	No	No	No	See comment for Remedy Component #3.
#6	Groundwater Monitoring with Verification of Continuing Aquifer Restoration	Yes	Yes	No	
	Overall Remedy	Partially	Not Applicable	No	Yes for components being implemented
Operable Unit 2: Shallow Soil Sites					
#1-7	Soil Remediation				
	Site A	Yes	Yes	Yes	
	Site C	Yes	Yes	Yes	
	Site E	Yes	Yes	Yes	
	Site H	Yes	Yes	Yes	
	Site 129-3	Yes	Yes	Yes	
	Site 129-5	Yes	Yes	Yes	
	Grenade Range	Yes	Yes	Yes	
	Outdoor Firing Range	Yes	Yes	Yes	
	135 PTA Stormwater Ditch	Yes	Yes	Yes	
	535 Primer/Tracer Area	Yes	Yes	Yes	
	Site K Soils	Yes	Yes	Yes	
	Water Tower Area	Yes	Yes	Yes	
	Soil AOCs (Site A, 135 PTA, EBS Areas)	Yes	Yes	Yes	
#8	Groundwater Monitoring	Yes	Yes	Yes	
#9	Characterization of Dumps	Yes	Yes	Yes	
	Site B	Yes	Yes	Yes	
	Site 129-15	Yes	Yes	Yes	
#10	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	Partially	

Table 1-1
Status of Remedial Actions
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS
a joint venture

	Remedy Component	Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
Operable Unit 2: Deep Soil Sites					
#1	Groundwater Monitoring	Yes	Yes	Yes	
#2	Restrict Site Access During Remediation	Yes	Yes	Yes	Long-term land use controls are addressed by Remedy Component #8
#3	SVE Systems	Yes	Yes	Yes	Systems were turned off in 1998.
#4	Enhancements to SVE Systems	Yes	Yes	Yes	Neither system required operation with enhancements. Both SVE systems have been dismantled.
#5	Maintain Existing Site Caps	Yes	Yes	Yes	This remedy component was intended to minimize short-circuiting of airflow when the SVE systems were operating. The long-term land use controls for the cap/cover that must be maintained at Sites D and G (due to shallow soil contamination at Site D and the Site G dump) are addressed by Remedy Component #8.
#6	Maintain Surface Drainage Controls	Yes	Yes	Yes	
#7	Characterize Shallow Soils and Dump	Yes	Yes	Yes	
#8	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	Partially	
Operable Unit 2: Site A Shallow Groundwater					
#1	Groundwater Monitoring	Yes	Yes	No	
#2	Groundwater Containment/Mass Removal	No	Not Applicable	No	The groundwater extraction system was shut off on 9/24/08 and was in standby while implementation of MNA was evaluated. In late 2015, MNA was deemed an acceptable remedy, and therefore a ROD amendment was prepared in FY2017 to document the change in this remedy component.
#3A	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
#3B	Drilling Advisory/Alternate Water Supply/Well Abandonment	Yes	Yes	No	
#4	Discharge of Extracted Water	No	Not Applicable	No	See comment for Remedy Component #2.
#5	Source Characterization Remediation	Yes	Yes	Yes	
	Overall Remedy	Yes	Yes	No	USEPA and MPCA have approved a formal change of the remedy to MNA. A ROD amendment was prepared and approved in FY 2017

Table 1-1
Status of Remedial Actions
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	Remedy Component	Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
Operable Unit 2: Site C Shallow Groundwater					
#1	Groundwater and Surface Water Monitoring	Yes	Yes	No	
#2	Groundwater Containment	No	Not Applicable	No	Since the lead plume no longer extends to the extraction wells, the groundwater extraction system was shut off on 11/13/08. Future monitoring will determine whether a ROD modification will be prepared to document the change in this remedy component, or whether the Site can be closed.
#3	Discharge of Extracted Water	No	Not Applicable	No	See comment for Remedy Component #2.
#4	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Site I Shallow Groundwater					
#1	Groundwater Monitoring	Yes	Yes	No	
#2	Additional Investigation	Yes	Yes	Yes	
#3	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Site K Shallow Groundwater					
#1	Groundwater Monitoring	Yes	Yes	No	
#2	Sentinel Wells	Yes	Yes	Yes	
#3	Hydraulic Containment	Yes	Yes	No	
#4	Groundwater Treatment	Yes	Yes	No	
#5	Treated Water Discharge	Yes	Yes	No	
#6	Discharge Monitoring	Yes	Yes	No	
#7	Additional Investigation	Yes	Yes	Yes	
#8	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Building 102 Shallow Groundwater					
#1	Monitored Natural Attenuation	Yes	Yes	No	
#2	Groundwater Monitoring	Yes	Yes	No	
#3	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	No	

Table 1-1
Status of Remedial Actions
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Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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	Remedy Component	Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
Operable Unit 2: Aquatic Sites					
#1	Pond G Surface Water Treatment	Yes	Yes	Yes	
#2	Pond G Surface Water Monitoring	Yes	Yes	Yes	
	Overall Remedy	Yes	Yes	Partially	
Operable Unit 2: Deep Groundwater					
#1	Hydraulic Containment and Contaminant Mass Removal	Yes	Yes	No	
#2	Groundwater Treatment	Yes	Yes	No	
#3	Treated Water Discharge	Yes	Yes	No	
#4	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
#5	Review of New Technologies	Yes	Yes	No	Currently evaluating optimization strategies for the TGRS
#6	Groundwater Monitoring	Yes	Yes	No	
	Overall Remedy	Yes	Yes	No	
Operable Unit 3: Deep Groundwater					
#1	Monitored Natural Attenuation	Yes	Yes	No	
#2	Groundwater Monitoring	Yes	Yes	No	Long-term land use controls are addressed by Remedy Component #8
#3	Drilling Advisories	Yes	Yes	No	
	Overall Remedy	Yes	Yes	No	

Acronyms and Abbreviations:
GAC - granular activated carbon
MNA - monitored natural attenuation
NBCGRS - New Brighton Contaminated Groundwater Recovery System
OU2 LUCRD - Operable Unit 2 Land Use Control Remedial Design
ROD - Record of Decision
SVE - soil vapor extraction
TGRS - TCAAP Groundwater Recovery System
VOC - volatile organic compound

Table 3-1
Summary of OU1 Monitoring Requirements
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

Remedy Component	Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1: Alternate Water Supply / Well Abandonment	a. Water quality data for the perimeter of the plume to define the area of concern	Army	OU1 Groundwater Monitoring Plan in the Annual Performance Report
	b. Water quality data for water supply wells to determine eligibility for alternate supply/abandonment	Army	Well Inventory Report
#2: Drilling Advisories	a. Verification that drilling advisories are in place and functioning as intended	Army/MDH	N/A
#3: Extract Groundwater	a. Pumping volume and rates for each extraction well for comparison to target flowrates	New Brighton	New Brighton Water System Sampling and Analysis Plan
	b. Water levels from monitoring wells to draw contour maps, if desired	Army	OU1 Groundwater Monitoring Plan in the Annual Performance Report
#4: Removal of VOCs	a. Effluent water quality to demonstrate compliance with the Safe Drinking Water Act	New Brighton	New Brighton Water System Sampling and Analysis Plan
#5: Discharge of Treated Water	a. Verification of discharge	New Brighton	N/A
#6: Groundwater Monitoring with Verification of Continuing Aquifer Restoration	a. Water quality, to assist in evaluation of statistical improvements in groundwater quality.	Army	OU1 Groundwater Monitoring Plan in the Annual Performance Report
	b. Water quality data throughout the North Plume to evaluate remedial progress	Army	OU1 Groundwater Monitoring Plan in the Annual Performance Report

Acronyms and Abbreviations:
MDH - Minnesota Department of Health
N/A - not applicable
OU1 - Operable Unit 1

Table 3-2
OU1 Groundwater Quality Data
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

Sample Location	Date	Trichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	1,4-Dioxane (µg/L)	1,1-Dichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	1,1,2-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)
OU1 Cleanup Level [a]		5	200	--	6	70	3	70
MDH HRL [b]		--	--	1	--	--	--	--
04U871	6/22/2017	13	0.52 J	1.6	0.80 J	< 1.0 U	< 1.0 U	0.95 J
04U872	6/21/2017	3.5	< 1.0 U	1.1	< 1.0 U	< 1.0 U	< 1.0 U	0.68 J
04U877	6/22/2017	0.75 J	< 1.0 U	0.2	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
04U877 (Dup)	6/22/2017	0.71 J	< 1.0 U	0.29	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
04J822	6/23/2017	29	3.7	2.1	4.6	0.82 J	< 1.0 U	2.9
04J847	6/23/2017	780	23	48.3	51	8.8	< 2.0 U	42
04J849	6/22/2017	59	2.1	9.9	4.7	0.83 J	< 1.0 U	3.8

Footnotes:

a. The cleanup level for OU1 Groundwater is from Table 1 of OU2 Record of Decision Amendment #1. Gray shading indicates exceedance of the cleanup level.

b. No OU1 cleanup level has been established for 1,4-dioxane. For reference, the Minnesota Department of Health (MDH) Health Risk Limit (HRL) for 1,4-dioxane is 1 µg/L. Gray shading indicates exceedance of the HRL or cleanup level.

Acronyms and Abbreviations:

-- = no relevant cleanup level or HRL for this compound.

< X.X U = analyte was not detected above the Method Detection Limit (MDL)

Dup = duplicate

J = reported value is between the MDL and the Reporting Limit

OU = Operable Unit

µg/L = micrograms per liter

Table 3-3
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Group	S Value	P Value	R^2 Value	Fraction of Detections	Results Trend	Threshold Triggered?	Comments
Group 2 Wells:							
409549	18	0.0034	0.854	7 / 7	Increasing	Yes	Near plume center, plume shifted slightly
409557	19	0.0014	0.958	7 / 7	Increasing	Yes	Between north & south plume, lateral dispersion
03L673	-18	0.0034	0.814	7 / 7	Decreasing	No	
03L833	-13	0.0350	0.465	7 / 7	Decreasing	No	
03L848	-17	0.0054	0.776	7 / 7	Decreasing	No	
03L859	-17	0.0054	0.854	7 / 7	Decreasing	No	
03U677	NA	NA	NA	0 / 9	NA	No	All ND
03U805	15	0.0150	0.580	7 / 7	Increasing	Yes	Southern edge of north plume, plume shifted slightly
04U673	-9	0.1190	0.00155	7 / 7	No Significant Trend	Yes	Near south plume center, plume shifted slightly
04U821	-11	0.0680	0.423	7 / 7	Probably Decreasing	No	
04U832	-2	0.4430	0.00364	7 / 7	No Significant Trend	Yes	Relatively stable, between 46 and 56 µg/L since 2007
04U833	-22	0.0028	0.6075	8 / 8	Decreasing	No	
04U841	-14	0.0250	0.585	7 / 7	Decreasing	No	
04U843	20	<0.001	0.965	7 / 7	Increasing	Yes	Near plume center
04U845	-12	0.0515	0.317	7 / 7	Probably Decreasing	No	
04U846	20	<0.001	0.942	7 / 7	Increasing	Yes	Near plume center, historically erratic
04U849							See Group 6 summary.
04U854	-16	0.0102	0.738	7 / 7	Decreasing	No	
04U859	-20	<0.001	0.891	7 / 7	Decreasing	No	
04U861 (abandoned)	11	0.0280	0.752	6 / 6	NA	NA	Abandoned after 2006 sample, in New Brighton Development
04U875	-16	0.0310	0.299	4 / 8	Decreasing	No	
04U877	-1	0.5000	0.0004	8 / 8	No Significant Trend	Yes	
206688	-4	0.2980	0.007	6 / 6	No Significant Trend	Yes	
Group 1 NP	-5	0.281	0.0971	7 / 7	No Significant Trend	Yes	
Group 1 SP	0	0.563	2010	7 / 7	Stable	Yes	
Group 3	-10	0.0935	0.335	7 / 7	Probably Decreasing	No	
Group 5	11	0.068	0.463	7 / 7	Probably Increasing	Yes	
Group 5 Unit 3 Wells:							
409550	-6	0.2360	0.442	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
409597 (abandoned)	-11	0.0280	0.809	6 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
409596 (abandoned)	-8	0.1020	0.633	6 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
03U831 (abandoned)	9	0.0680	0.405	2 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
03U821	-19	0.0014	0.951	7 / 7	Decreasing	No	
03U822	2	0.4430	0.0259	7 / 7	No Significant Trend	Yes	Between 120 and 160 µg/L since 2003
03L822	-14	0.0250	0.69	7 / 7	Decreasing	No	
03L809	-8	0.1550	0.499	7 / 7	No Significant Trend	Yes	Raw trend is decreasing

Notes and Abbreviations on Page 2.

Table 3-3
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
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Group	S Value	P Value	R^2 Value	Fraction of Detections	Results Trend	Threshold Triggered?	Comments
Group 6 OU1 Jordan Wells:							
04J822	-12	0.0890	0.364	8 / 8	Decreasing	No	
04J834	-16	0.0102	0.702	4 / 7	Decreasing	No	
04J836	18	0.0160	0.683	8 / 8	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J838	13	0.0350	0.700	7 / 7	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J837	-9	0.1690	0.294	8 / 8	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J839	0	0.5480	0.034	8 / 8	Stable	Yes	Below 5 µg/L
04J847	24	0.0565	0.218	12 / 12	Increasing	Yes	Near plume center
04J849	18	0.0160	0.337	3 / 8	Increasing	Yes	Below 1 µg/L
04J882	NA	NA	NA	0 / 7	NA	No	All ND
04J077	-18	0.0160	0.653	8 / 8	Decreasing	No	
04J702	-18	0.0034	0.595	7 / 7	Decreasing	No	
04J708	13	0.0350	0.565	7 / 7	Increasing	Yes	Southern edge of north plume, plume shifted slightly
04J713	NA	NA	NA	0 / 7	NA	No	All ND
Group 6 Nested Unit 4 Wells:							
04U077	-21	<0.001	0.889	7 / 7	Decreasing	No	
04U702	-2	0.4430	0.0000324	7 / 7	No Significant Trend	Yes	Below 3 µg/L
04U708	-16	0.0102	0.721	4 / 7	Decreasing	No	
04U713	-11	0.0680	0.350	5 / 7	Probably Decreasing	No	
04U834	-20	<0.001	0.869	5 / 7	Decreasing	No	
04U836	1	0.5000	0.0117	8 / 8	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U837	-5	0.3170	0.357	8 / 8	No Significant Trend	Yes	Raw trend is decreasing
04U838	0	0.5630	0.374	7 / 7	Stable	Yes	Below 3 µg/L since 2009
04U839	22	0.0028	0.566	8 / 8	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U847	-5	0.2810	0.0923	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
04U849	12	0.0515	0.781	7 / 7	Probably Increasing	Yes	Near plume center, appears relatively stable since 2011
04U882	-10	0.0935	0.234	6 / 7	Probably Decreasing	No	

General Notes:
Response Threshold triggers are defined in Table D.2.1.3.
Acronyms and Abbreviations:
NA = not applicable; trend analysis not performed at this location
ND = non-detect
NBCGRS = New Brighton Contaminated Groundwater Recovery System
P Value = represents uncertainty in the trend
R^2 Value = represents the fit of the data to the regression
S Value = indicates increasing (positive S) or decreasing (negative S) trend
µg/L = micrograms per liter

Table 6-1
Summary of Site A Shallow Groundwater Monitoring Requirements
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Remedy Component		Monitoring Requirements		Implementing Party	Documents Containing the Monitoring Plan
#1:	Groundwater Monitoring	a.	Outlined below		
#2:	Containment and Mass Removal	a.	None. The groundwater extraction system was shut down in September 2008 allowing implementation of Monitored Natural Attenuation (MNA) to be evaluated. In late 2015, MNA was deemed an acceptable remedy, and therefore a Record of Decision amendment will be prepared in FY2016 to document the change in this remedy component.		
#3A:	Land Use Controls	a.	None		
#3B:	Alternate Water Supply / Well Abandonment		See Operable Unit 1, Remedy Component #1 which also includes the area north of Site A		
#4:	Discharge of Extracted Water	a.	None (see #2 above)		
#5:	Source Characterization / Remediation	a.	None. volatile organic compound-contaminated soils in the source area (1945 Trench) were excavated and transported to a permitted offsite disposal facility in FY 2003.		
OR:	Overall Remedy (Attainment of Cleanup Goals)	a.	Water quality data throughout the Site A plume to evaluate attainment and to verify that Natural Attenuation is adequately controlling plume migration.	Army	Site A Monitoring Plan in the Annual Performance Report

Table 6-2
Site A Groundwater Quality Data
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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Sample Location	Date	Tetrachloroethene ug/L	Trichloroethene ug/L	1,4-Dioxane ug/L	cis-1,2-Dichloroethene ug/L	1,1-Dichloroethene ug/L	1,2-Dichloroethane ug/L	Chloroform ug/L	Benzene ug/L	Antimony ug/L
Site A Cleanup Level [a]		7	30	--	70	6	4	60	10	6
MDH HRL [b]		--	--	1	--	--	--	--	--	--
01U039	6/16/2017	< 1.0 U	< 1.0 U	NA	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U102	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U103	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	7.6
01U108 [c]	--	NS	NS	NS	NS	NS	NS	NS	NS	NS
01U115	6/14/2017	< 1.0 U	1.6	NA	23	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U116	6/15/2017	< 1.0 U	1	< 0.07 U	1.4	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U117	6/15/2017	1.8	0.63 J	0.11	5.4	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U126	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U138	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U139	6/14 & 6/16/2017	< 1.0 U	0.66 J	< 0.07 U	540	0.46 J	< 1.0 U	< 1.0 U	3	NA
01U140	6/14 & 6/20/2017	< 1.0 U	< 1.0 U	< 0.07 U	5.3	< 1.0 U	< 1.0 U	< 1.0 U	0.31 J	NA
01U157	6/15/2017	0.32 J	1.2	< 0.07 U	380	0.36 J	< 1.0 U	< 1.0 U	4.1	NA
01U158	6/16/2017	< 1.0 U	0.79 J	< 0.07 U	13	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U352	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U353	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U355	6/14/2017	< 1.0 U	0.54 J	NA	200	< 1.0 U	< 1.0 U	< 1.0 U	1.4	NA
01U356	6/14 & 6/20/2017	< 1.0 U	0.68 J	< 0.07 U	290	< 1.0 U	< 1.0 U	< 1.0 U	1.5	NA
01U356 (Dup)	6/14/2017	< 1.0 U	0.65 J	NA	280	< 1.0 U	< 1.0 U	< 1.0 U	1.5	NA
01U357	6/14 & 6/20/2017	< 1.0 U	< 1.0 U	< 0.07 U	11	< 1.0 U	< 1.0 U	< 1.0 U	0.54 J	NA
01U358	6/16/2017	< 1.0 U	< 1.0 U	< 0.07 U	0.40 J	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U901	6/14 & 6/20/2017	< 1.0 U	< 1.0 U	0.017 J	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U902	6/13/2017	< 1.0 U	0.30 J	NA	35	< 1.0 U	< 1.0 U	< 1.0 U	0.49 J	< 2.0 U
01U903	6/13/2017	< 1.0 U	< 1.0 U	NA	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U904	6/14/2017	< 1.0 U	< 1.0 U	NA	27	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 2.0 U

Footnotes:

a. The extraction wells are currently in standby (not operating) while Monitored Natural Attenuation (MNA) is being evaluated.

b. No Site A cleanup level has been established for 1,4-dioxane. For reference, the Minnesota Department of Health (MDH) Health Risk Limit (HRL) for 1,4-dioxane is 1 µg/L. Gray shading indicates exceedance of the HRL or cleanup level.

3. The extraction wells are currently in standby (not operating) while MNA is being evaluated.

c. 01U108 was not sampled due to an obstruction in the well.

Acronyms and Abbreviations:

-- = no relevant cleanup level or HRL for this compound

< X.XX U = analyte was not detected above the Method Detection Limit (MDL)

D = duplicate

J = reported value is between the MDL and the Reporting Limit

NA = sample was not analyzed for compound

µg/L = micrograms per liter

Table 7-1
Summary of Site C Shallow Groundwater Monitoring Requirements
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

Remedy Component		Monitoring Requirements		Implementing Party	Documents Containing the Monitoring Plan
#1:	Groundwater and Surface Water Monitoring	a.	Outlined below		
#2:	Groundwater Containment	a.	None. The groundwater extraction system was shut down in November 2008, since the area of groundwater that exceeded the groundwater cleanup level no longer extended to the extraction wells.		
#3:	Discharge of Extracted Water	a.	None (see #2 above)		
#4:	Land use controls to Restrict Well Installation and to Protect the Remedy Infrastructure	a.	None.		
OR:	Overall Remedy (Attainment of Cleanup Goals)	a.	Groundwater quality data throughout the Site C plume to evaluate attainment and to verify that operation of a groundwater extraction system is not required. Also surface water data in the plume vicinity to verify that groundwater does not impact surface water above surface water standards.	Army	Site C Monitoring Plan in the Annual Performance Report

Table 7-2
Water Quality Data for Site C Groundwater
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Sample Location	Date Collected	Lead (Dissolved) (µg/L)
Groundwater Cleanup Level(1):		15
01U561 (MW1)	6/19/2017	< 1.0
01U562 (MW2)	6/19/2017	< 1.0
01U561 (MW2 - Dup)	6/19/2017	< 1.0
01U563 (MW3)	6/19/2017	3.1
01U564 (MW4)	6/19/2017	< 1.0
01U567 (MW7)	6/19/2017	< 1.0
01U571 (MW11)	6/19/2017	< 1.0
01U573 (MW13)	6/19/2017	140
01U574 (MW14)	6/19/2017	170
01U575 (MW15)	6/19/2017	5.8
01U576 (MW16)	6/19/2017	< 1.0
01U046	6/19/2017	< 1.0

Footnotes:
1. The cleanup level for Site C Groundwater is from Table 1 of OU2 Record of Decision Amendment #1. Gray shading indicates exceedance of the cleanup level.

Acronyms and Abbreviations:

< X.X = analyte was not detected above the Method Detection Limit (MDL)

Dup = duplicate

J = reported value is between the MDL and the Reporting Limit

µg/L = micrograms per liter

Table 7-3
Contingency Locations for Site C Monitoring
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Sampling Location	CONTINGENCY ROLE	
	Trigger for Contingency Action(1)	Contingency Action
MW-4	If 3-event moving average > 15 µg/L	Note 3
MW-7	If 3-event moving average > 15 µg/L	Note 3
MW-11	If 3-event moving average > 15 µg/L	Note 3
MW-16	If 3-event moving average > 15 µg/L	Note 3
01U046	If 3-event moving average > 6.9 µg/L	Note 4
SW5(2)	If one sampling event > 6.9 µg/L	Note 4
SW6(2)	If one sampling event > 6.9 µg/L	Note 5
NE Wetland (2)	If one sampling event > 6.9 µg/L	Note 4

Footnotes:

1. Water quality monitoring is for dissolved lead in monitoring wells and surface water.
2. Surface water sampling is performed on three consecutive days and results are averaged for comparison to the trigger.
3. Army notify USEPA/MPCA within 1 week from receipt of data and submit an evaluation report within 30 days from notification.
4. Army notify USEPA/MPCA within 1 week from receipt of data; initiate monthly sampling of SW-5, SW-6, the NE Wetland, and the replacement wetland; and submit an evaluation report within 30 days from notification.
5. Army notify USEPA/MPCA within 1 week from receipt of data; initiate monthly sampling of SW-5, SW-6, the NE Wetland, and the replacement wetland; and submit an evaluation report within 30 days from notification. If SW-6 exceedance continues for 3 consecutive months, contain the surface water at SW-6, treat (if necessary) and discharge to sanitary sewer.

Acronyms and Abbreviations:

MPCA - Minnesota Pollution Control Agency
USEPA - United States Environmental Protection Agency

Table 8-1

Summary Of Groundwater Monitoring Requirements
Fiscal Year 2017
Site I, OU2
Arden Hills, Minnesota

Remedy Component	Monitoring Requirements	Responsible Party	Documents Containing the Monitoring Plan
#1 Groundwater Monitoring	a. Groundwater quality and water levels to track remedy progress	Orbital ATK	Site I Monitoring Plan in Annual Performance Report
#2 Additional Investigation	a. None (completed)		
#3 Land Use Controls	a. None		
OR Overall Remedy	a. Water quality data to evaluate attainment	Orbital ATK	Site I Monitoring Plan in Annual Performance Report

Table 8-2

Most Recent Groundwater Quality Data (FY 2013)
Site I, OU2
Arden Hills, Minnesota

			cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl Chloride
Site I Cleanup Level[1]			**70 (total)**		**30**	**0.20**
Location	**Date**	**Dup**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
01U064	4/26/2013		4.2	< 1.0	0.94 JP	< 1.0
01U632	4/26/2013		27	0.35 JP	120	< 1.0
01U636	4/26/2013		< 1.0	< 1.0	< 1.0	< 1.0
01U639	4/26/2013		< 1.0	< 1.0	9.5	< 1.0
01U640	4/26/2013		< 1.0	< 1.0	< 1.0	< 1.0
I01MW	4/26/2013		< 1.0	< 1.0	0.33 JP	< 1.0
I02MW	4/26/2013		< 1.0	< 1.0	0.62 JP	< 1.0
I02MW	4/26/2013	D	< 1.0	< 1.0	0.76 JP	< 1.0
I05MW	4/26/2013		< 1.0	< 1.0	1.6	< 1.0
01U667	8/13/2013		500	1.4	4.7	300

Notes:

(1) Cleanup levels for Site I are from the OU2 ROD. Shading indicates exceedence of the cleanup level.

D - Field Duplicate

JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit.

Table 9-1

Summary Of Groundwater Monitoring Requirements
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

Remedy Component	Monitoring Requirements	Responsible Party	Documents Containing the Monitoring Plan
#1 Groundwater Monitoring	• Outlined below		
#2 Sentinel Wells	a. Water quality to monitor potential migration	Orbital ATK	Site K Monitoring Plan in Annual Performance Report
#3 Hydraulic Containment	a. Water levels for use in drawing contour maps showing capture	Orbital ATK	Site K Monitoring Plan in Annual Performance Report
	b. Pumping volumes and rates for reporting	Orbital ATK	Site K Monitoring Plan in Annual Performance Report
#4 Groundwater Treatment	• None		
#5 Treated Water Discharge	• None		
#6 Discharge Monitoring	a. Treated effluent water quality for comparison to substantive requirements criteria for discharge maximum daily concentration	Orbital ATK	Site K Monitoring Plan in Annual Performance Report
#7 Additional Investigation	a. None (completed)		

Table 9-2

Groundwater Quality Data
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

			cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene
Site K Cleanup Level[(1)]			**70 (Total DCE)**		**30**
Location	**Date**	**Dup**	**µg/L**	**µg/L**	**µg/L**
K04-MW (482083)	6/8/2017		< 1.0	< 1.0	< 1.0
01U128	6/9/2017		< 1.0	< 1.0	< 1.0
01U603	6/9/2017		19	0.69 JP	3.3
01U615	6/9/2017		1100	74	1200
01U617	6/9/2017		5.9	0.41 JP	< 1.0
01U618	6/9/2017		1.5	< 1.0	1.8
01U621	6/8/2017		< 1.0	< 1.0	< 1.0
03U621	6/8/2017		< 1.0	< 1.0	< 1.0

Notes:

(1) Cleanup levels for Site K are from the OU2 ROD. Shading indicates exceedence of the cleanup level.

JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit.

Table 9-3

Groundwater Elevation Monitoring
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

Well ID	Groundwater Elevation (June 2016)	Groundwater Elevation (Historical Maximum)	Groundwater Elevation (June 2017)
01U047	873.56	875.75	Abandoned
01U048	873.46	876.61	875.50
01U052	875.51	876.64	876.26
01U065	Abandoned	874.91	Abandoned
01U128	874.53	877.07	876.23
01U601	Abandoned	886.65	Abandoned
01U602	Abandoned	886.37	Abandoned
01U603	878.54	882.86	879.81
01U604	Abandoned	879.79	Abandoned
01U605	Abandoned	879.61	Abandoned
01U607	886.46	887.56	885.81
01U608	Abandoned	888.06	Abandoned
01U609	Abandoned	886.83	Abandoned
01U611	Abandoned	887.16	Abandoned
01U612	879.66	884.70	880.04
01U613	Abandoned	886.15	Abandoned
01U615	878.50	883.71	880.96
01U616	Abandoned	882.75	Abandoned
01U617	877.67	883.22	879.11
01U618	881.98	885.58	882.70
01U619	Abandoned	886.60	Abandoned
01U620	Abandoned	881.93	Abandoned
01U621	878.96	883.87	880.15
01U624A	Abandoned	881.66	Abandoned
01U624B	Abandoned	881.63	Abandoned
01U624C	Abandoned	881.64	Abandoned
01U624D	Abandoned	881.64	Abandoned
01U625A	878.72	883.95	879.92
01U625B	878.70	883.90	879.51
01U625C	Obstructed	887.91	Obstructed
01U625D	878.69	883.91	879.87
01U626A	878.28	882.77	879.53
01U626B	877.99	883.50	879.30
01U626C	878.07	883.58	879.33
01U626D	878.14	883.61	879.39
01U627A	879.32	882.67	880.24
01U627B	878.23	883.57	879.45
01U627C	878.16	883.56	879.38
01U627D	878.16	883.57	879.39
01U628A	Abandoned	880.39	Abandoned

Table 9-3

Groundwater Elevation Monitoring
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

Well ID	Groundwater Elevation (June 2016)	Groundwater Elevation (Historical Maximum)	Groundwater Elevation (June 2017)
01U628B	Abandoned	880.34	Abandoned
01U628C	Abandoned	880.25	Abandoned
01U628D	Abandoned	880.25	Abandoned
482085 (K01MW)	Abandoned	887.09	Abandoned
482084 (K02MW)	Abandoned	887.41	Abandoned
482083 (K04MW)	881.93	885.38	881.96
03U621	858.96	856.63	859.12

Table 9-4

Treatment System Concentrations (Organics)
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

			1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
	Effluent Limit[(1)]		**--**	**7.0**	**3.8**	**70**	**100**	**10**	**0.18**
Location	**Date**		**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Effluent	12/8/2016		< 1.0	< 1.0	< 1.0	2.7	< 1.0	0.89 JP	< 1.0
Effluent	12/8/2016	D	< 1.0	< 1.0	< 1.0	2.8	< 1.0	0.91 JP	< 1.0
Effluent	3/2/2017		< 1.0	< 1.0	< 1.0	3.0	< 1.0	1.0	< 1.0
Effluent	3/2/2017	D	< 1.0	< 1.0	< 1.0	3.0	< 1.0	1.1	< 1.0
Effluent	6/8/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Effluent	6/8/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Effluent	9/12/2017		< 1.0	< 1.0	< 1.0	2.9	< 1.0	0.72 JP	< 1.0
Effluent	9/12/2017	D	< 1.0	< 1.0	< 1.0	2.7	< 1.0	0.73 JP	< 1.0
Influent	12/8/2016		< 1.0	< 1.0	< 1.0	130	13	79	0.88 JP
Influent	3/2/2017		< 1.0	< 1.0	< 1.0	100	15	65	0.91 JP
Influent	6/8/2017		< 1.0	< 1.0	< 1.0	89	10	54	0.59 JP
Influent	9/12/2017		< 1.0	< 1.0	< 1.0	120	13	66	1.0

Notes:

(1) Substantive Requirement Document Concentration Limit, Maximum Daily Effluent Concentration

D - Field Duplicate

JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit

Table 9-5

Treatment System Concentrations (Inorganics)
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

			Copper	Cyanide	Lead	Mercury	Silver	Zinc	Total Phosphorus
	Effluent Limit[(1)]		21	17	106	0.20	3.4	134	1.0
Location	Date		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L
Effluent	12/8/2016		2.2	< 10	0.44 JP	< 0.10	< 1.0	9.1	0.37 JP
Effluent	3/2/2017		7.0	< 10	0.86 JP	< 0.10	< 1.0	53	1.9
Effluent	6/8/2017		4.0	6.9 JP	< 1.0	< 0.10	< 1.0	230	7.5
Effluent	6/29/2017		--	--	--	--	--	13	1.4
Effluent	9/12/2017		3.5	4.9 JP	< 1.0	< 0.10	< 1.0	5.1	1.0

Notes:

(1) Substantive Requirement Document Concentration Limit, Maximum Daily Effluent Concentration.

JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit.

Table 9-6

Summary Of Monthly VOC Removal
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

Month	Total Monthly Flow (gallons)	Total VOC Influent (µg/L)	Total VOC Effluent (µg/L)	Total VOCs Treated (lbs)	Total VOCs Remaining (lbs)	Total VOC Mass Removed (lbs)
Cumulative as of September 30, 2016						372.7
October[(1)]	509,493	223	0	0.95	0.00	0.95
November[(1)]	454,595	223	0	0.85	0.00	0.85
December	494,440	223	0	0.92	0.00	0.92
January[(1)]	467,660	181	0	0.71	0.00	0.71
February[(1)]	357,760	181	0	0.54	0.00	0.54
March	442,100	181	0	0.67	0.00	0.67
April[(1)]	439,890	154	0	0.56	0.00	0.56
May[(1)]	507,245	154	0	0.65	0.00	0.65
June	447,136	154	0	0.57	0.00	0.57
July[(1)]	453,869	200	0	0.76	0.00	0.76
August[(1)]	394,936	200	0	0.66	0.00	0.66
September	401,372	200	0	0.67	0.00	0.67
Total - FY 2017						8.50
Cumulative To Date						381.2

Notes:

[(1)] Influent and Effluent VOC concentrations from the quarterly VOC samples collected on 12/8/2016, 3/2/2017 and 6/8/2017 and 9/12/2017.

Table 9-7

1,4-Dioxane Groundwater Sampling Results
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

		1,4-Dioxane
	Screening Criteria (HRL)	1.0
Location	Date	µg/L
03U621	6/8/2017	8.4

Notes:

HRL Health Risk Limit (Minnesota Department of Health). Shad indicates exceedence of the HRL.

Table 10-1
Summary of Building 102 Shallow Groundwater Monitoring Requirements
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture

Remedy Component		Monitoring Requirements		Implementing Party	Documents Containing the Monitoring Plan
#1:	Monitored Natural Attenuation (abiotic degradation)	a.	Outlined below		
#2:	Groundwater Monitoring	a.	Outlined below		
#3:	Land Use Controls to Restrict Well Installation and to Protect the Remedy Infrastructure	a.	None.		
OR:	Overall Remedy (Attainment of Cleanup Goals)	a.	Groundwater quality data throughout the Building 102 plume to evaluate attainment and to verify that groundwater reaching Rice Creek does not exceed state surface water standards.	Army	Building 102 Monitoring Plan in the Annual Performance Report

Table 10-2
Building 102 Groundwater Quality Data
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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Sample Location	Date Sampled	Trichloroethene (µg/L)	1,4 Dioxane (µg/L)	cis-1,2-Dichloroethene (µg/L)	1,1-Dichloroethene (µg/L)	Vinyl Chloride (µg/L)	Vinyl Chloride(3) (µg/L)
Building 102 Cleanup Level(1)		5	---	70	6	0.18	0.18
MDH HRL(2)		---	1	---	---	---	---
01U048	6/20/17	< 1.0	1.1	< 1.0	< 1.0	< 1.0	0.039 J
01U579	6/19/17	0.71 J	0.05 J	< 1.0	< 1.0	< 1.0	NA
01U580	6/19/17	1.1	< 0.070	0.35 J	< 1.0	< 1.0	NA
01U581	6/16/17	29	< 0.070	7.7	< 1.0	< 1.0	NA
01L581	6/16/17	6.9	0.12	3.2	< 1.0	< 1.0	NA
01L581 - Dup	6/16/17	7.2	NA	3.5	< 1.0	< 1.0	NA
01U582	6/20/17	0.34 J	< 0.070	0.72 J	< 1.0	< 1.0	NA
01L582	6/20/17	< 1.0	0.11	8.8	< 1.0	< 1.0	NA
01U583	6/16/17	< 1.0	< 0.070	0.72 J	< 1.0	< 1.0	NA
01L583	6/16/17	< 1.0	< 0.070	< 1.0	< 1.0	< 1.0	NA
01U584	6/20/17	< 1.0	0.061 J	0.67 J	< 1.0	< 1.0	0.050
01L584	6/20/17	13	< 0.070	6.7	< 1.0	< 1.0	0.520

Footnotes:

1. The cleanup level for Building 102 Groundwater are from pages 2-13 of OU2 ROD Amendment #4. Gray shading indicates exceedance of the cleanup level.

2. No Building 102 cleanup level has been established for 1,4-dioxane. For reference, the Minnesota Department of Health (MDH) Health Risk Limit (HRL) for 1,4-dioxane is 1 µg/L.

3. This analysis of vinyl chloride is by Method 8260C-SIM to obtain a lower reporting limit for vinyl chloride.

Acronyms and Abbreviations:

--- = no relevant cleanup level or HRL for this compound
< X.XX = analyte was not detected above the indicated Method Detection Limit (MDL)
Dup = duplicate
J = reported value is between the MDL and the Reporting Limit
NA = sample not analyzed for this compound
µg/L = micrograms per liter

Table 12-1

Groundwater Cleanup Levels
TGRS, OU2
Arden Hills, Minnesota

Substance	Expected Level in Discharge (ppb)	Operable Unit 2 Rod Requirements (ppb)
Volatile Organic Compounds (VOCs)		
cis-1,2-Dichloroethene plus trans-1,2-Dichloroethene	<1.0	70
1,1-Dichloroethene	<1.0	6.0
1,1,1-Trichloroethane	<1.0	200
1,2-Dichloroethane	<1.0	4.0
Trichloroethene	<5.0	5.0
1,1-Dichloroethane	<1.0	70
Tetrachloroethene	<1.0	5.0

Table 12-2

Extraction Well Water Pumped
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

	Volume of Water Pumped (gallons)												
	B1	**B3**	**B4**	**B5**	**B6**	**B8**	**B9**	**B11**	**B13**	**SC1**	**SC2**	**SC5**	**Total**
October 2016	9,113,100	9,888,500	9,985,600	9,742,300	8,391,400	8,411,200	11,509,300	0	4,191,900	1,048,700	3,326,500	3,160,400	78,768,900
(gpm)	204	222	224	218	188	188	258	0	94	23	75	71	1,765
November 2016	8,937,600	9,108,000	9,763,500	11,617,800	8,332,900	9,832,900	11,593,000	0	4,213,200	996,200	2,044,800	2,950,400	79,390,300
(gpm)	207	211	226	269	193	228	268	0	98	23	47	68	1,838
December 2016	9,080,300	9,407,300	9,913,600	12,056,300	8,410,800	9,771,700	11,807,700	0	4,310,800	1,074,500	2,618,900	2,943,400	81,395,300
(gpm)	203	211	222	270	188	219	265	0	97	24	59	66	1,823
January 2017	9,017,800	9,396,500	9,860,600	11,791,200	7,457,000	9,059,600	11,713,500	0	4,241,800	1,062,500	2,877,800	3,643,700	80,122,000
(gpm)	202	210	221	264	167	203	262	0	95	24	64	82	1,795
February 2017	7,654,700	9,274,900	9,039,200	10,443,200	6,638,300	7,350,400	10,123,900	0	2,958,800	970,000	2,690,900	3,720,000	70,864,300
(gpm)	190	230	224	259	165	182	251	0	73	24	67	92	1,758
March 2017	7,953,500	10,097,900	9,763,800	11,813,700	7,240,600	8,851,200	13,181,900	0	3,113,900	1,046,000	1,666,800	2,879,600	77,608,900
(gpm)	178	226	219	265	162	198	295	0	70	23	37	65	1,739
April 2017	7,390,100	11,070,200	9,541,600	11,536,600	6,213,100	9,482,000	12,947,700	0	2,974,200	992,800	1,580,600	2,180,900	75,909,800
(gpm)	171	256	221	267	144	219	300	0	69	23	37	50	1,757
May 2017	7,843,100	9,918,800	9,630,100	11,488,800	9,057,500	7,151,400	13,149,900	0	3,092,000	1,022,400	1,537,700	5,655,900	79,547,600
(gpm)	176	222	216	257	203	160	295	0	69	23	34	127	1,782
June 2017	7,480,400	9,101,800	9,182,500	10,714,100	10,689,700	7,805,100	12,113,100	0	2,869,400	976,900	1,107,700	3,885,800	75,926,500
(gpm)	173	211	213	248	247	181	280	0	66	23	26	90	1,758
July 2017	7,720,400	11,039,600	9,446,200	11,199,300	11,499,300	7,849,400	11,680,300	0	2,699,400	950,300	682,500	4,698,700	79,465,400
(gpm)	173	247	212	251	258	176	262	0	60	21	15	105	1,780
August 2017	8,074,700	9,027,600	8,327,600	9,648,700	10,648,500	7,694,100	11,275,500	0	2,600,000	936,500	539,600	4,825,300	73,598,100
(gpm)	181	202	187	216	239	172	253	0	58	21	12	108	1,649
September 2017	9,067,700	9,171,500	9,025,500	10,908,600	10,195,500	8,102,400	11,849,600	0	2,784,300	914,700	401,800	4,907,400	77,329,000
(gpm)	210	212	209	253	236	188	274	0	64	21	9	114	1,790
Total FY 2017	**99,333,400**	**116,502,600**	**113,479,800**	**132,960,600**	**104,774,600**	**101,361,400**	**142,945,400**	**0**	**40,049,700**	**11,991,500**	**21,075,600**	**45,451,500**	**929,926,100**
Operational Minimum (gpm)	225	170	195	195	210	135	275	80	110	20	30	100	1,745

	B1, B11, B13	B4, B5, B6	B4, B5, B6, B8, B9	Total System
FY17 Average Flow Rate (gpm)	265	668	1,133	1,769
MOS Operational Minimum (gpm)	415	600	1,010	1,745

Table 12-3

Treatment Center Water Meter Totals
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Volume of Water Pumped (gallons)										
	Extraction Wells	**Meter 1**	**Meter 2**	**Total Meters 1 & 2**	**Meter 3**	**Meter 4**	**Total Meters 3 & 4**	**Meter 5**	**Meter 6**	**Total Meters 5 & 6**
October 2016	78,768,900	0	0	0	949,000	61,392,000	62,341,000	0	0	0
November 2016	79,390,300	0	0	0	46,000	63,123,000	63,169,000	0	0	0
December 2016	81,395,300	0	0	0	29,000	63,812,000	63,841,000	0	0	0
January 2017	80,122,000	0	0	0	32,000	61,935,000	61,967,000	0	0	0
February 2017	70,864,300	0	0	0	144,000	54,912,000	55,056,000	0	0	0
March 2017	77,608,900	0	0	0	0	62,085,000	62,085,000	0	0	0
April 2017	75,909,800	0	0	0	8,000	60,814,000	60,822,000	0	0	0
May 2017	79,547,600	0	0	0	33,000	47,003,000	47,036,000	0	0	0
June 2017	75,926,500	0	0	0	28,000	21,703,000	21,731,000	0	0	0
July 2017	79,465,400	0	0	0	8,000	13,888,000	13,896,000	0	0	0
August 2017	73,598,100	0	0	0	8,000	8,434,000	8,442,000	0	0	0
September 2017	77,329,000	0	0	0	1,064,000	6,733,000	7,797,000	0	0	0
Total FY 2017	**929,926,100**	**0**	**0**	**0**	**2,349,000**	**525,834,000**	**528,183,000**	**0**	**0**	**0**

Table 12-3

Treatment Center Water Meter Totals
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Volume of Water Pumped (gallons)										
	Extraction Wells	Meter 1	Meter 2	Total Meters 1 & 2	Meter 3	Meter 4	Total Meters 3 & 4	Meter 5	Meter 6	Total Meters 5 & 6
FY 1989	1,033,353,676	501,826,000	560,836,000	1,062,662,000	383,736,000	587,596,000	971,332,000	493,681,000	582,955,000	1,076,636,000
FY 1990	1,008,415,750	493,915,000	526,417,000	1,020,332,000	371,391,000	588,642,000	960,033,000	487,946,000	543,726,000	1,031,672,000
FY 1991	1,382,327,590	666,166,000	708,313,000	1,374,479,000	523,702,000	789,947,000	1,313,649,000	601,307,000	649,621,000	1,250,928,000
FY 1992	1,401,346,600	68,289,000	724,328,000	1,407,227,000	557,169,000	772,509,000	1,329,678,000	767,707,000	677,735,000	1,445,442,000
FY 1993	1,388,206,172	666,814,000	725,341,000	1,392,155,000	504,027,000	651,149,000	1,155,176,000	729,078,000	762,791,000	1,491,869,000
FY 1994	1,245,663,275	660,700,000	659,953,000	1,320,653,000	457,210,000	715,668,000	1,172,878,000	653,913,000	550,131,000	1,204,044,000
FY 1995	1,369,361,500	706,114,000	683,982,000	1,390,096,000	500,275,000	739,744,000	1,240,019,000	495,616,000	274,507,000	770,123,000
FY 1996	1,341,763,220	734,443,000	629,327,000	1,363,770,000	503,518,000	754,399,000	1,257,917,000	4,000	600,035,000	600,039,000
FY 1997	1,213,035,110	688,312,000	568,804,600	1,257,116,600	538,625,000	586,515,000	1,125,140,000	13,000	578,900,000	578,913,000
FY 1998	1,196,007,900	624,784,000	540,353,000	1,220,604,000	511,065,000	603,871,000	1,114,936,000	58,000	178,076,000	178,134,000
FY 1999	1,158,224,870	623,500,000	496,773,200	1,177,206,200	398,620,000	718,384,000	1,117,004,000	26,000	17,000	43,000
FY 2000	1,148,448,350	635,724,000	489,669,000	1,183,258,000	389,709,000	663,807,000	1,053,516,000	0	0	0
FY 2001	1,113,163,360	614,341,000	443,167,000	1,113,164,000	318,517,000	718,661,000	1,037,178,000	0	0	0
FY 2002	917,318,879	491,082,800	434,959,700	926,042,500	225,460,000	650,839,000	876,299,000	0	0	0
FY 2003	904,295,450	545,281,000	345,993,000	891,274,000	125,965,000	750,518,000	876,483,000	0	0	0
FY 2004	908,718,760	518,391,900	376,889,660	895,281,560	216,177,000	680,633,000	896,810,000	0	0	0
FY 2005	895,339,710	520,073,000	363,275,000	883,348,000	224,823,000	658,405,000	883,228,000	0	0	0
FY 2006	929,715,590	534,305,000	377,499,000	911,804,000	266,299,000	669,900,000	936,199,000	0	0	0
FY 2007	945,317,300	447,901,000	487,701,000	935,602,000	281,061,000	833,161,000	1,114,222,000	0	0	0
FY 2008	943,318,161	424,289,615	512,634,095	936,923,709	217,134,430	778,717,620	995,852,050	0	0	0
FY 2009	925,232,745	357,698,000	552,505,000	910,203,000	173,004,000	795,057,000	968,061,000	0	0	0
FY 2010	933,789,205	368,260,000	556,160,000	924,420,000	61,957,000	894,152,000	956,109,000	0	0	0
FY 2011	952,379,000	183,460,000	268,747,000	452,207,000	15,479,000	890,850,000	906,329,000	0	0	0
FY 2012	964,996,900	0	0	0	695,000	848,465,000	849,160,000	0	0	0
FY 2013	924,550,600	0	0	0	5,503,000	883,772,000	891,338,000	0	0	0
FY 2014	937,934,854	0	0	0	3,956,000	895,176,000	899,132,000	0	0	0
FY 2015	920,197,600	0	0	0	8,122,000	724,325,000	732,447,000	0	0	0
FY 2016	907,577,164	0	0	0	7,145,000	690,956,000	698,101,000	0	0	0
FY 2017	929,926,100	0	0	0	2,349,000	525,834,000	528,183,000	0	0	0

Table 12-4

Pumphouse Down Time
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Well Name	FY17 Down Time (Days)	FY16 Down Time (Days)	FY15 Down Time (Days)	FY14 Down Time (Days)	FY13 Down Time (Days)
B1	3.3	4.2	2.7	3.4	10.7
B2	(1)	(1)	(1)	(1)	(1)
B3	3.7	9.7	5.4	3.0	4.3
B4	3.3	6.5	10.2	9.2	4.0
B5	4.0	9.1	8.7	2.0	13.0
B6	8.7	7.8	2.4	9.6	2.8
B7	(1)	(1)	(1)	(1)	(1)
B8	7.1	8.9	8.5	2.4	2.9
B9	11.2	21.7	9.5	6.8	9.4
B10	(1)	(1)	(1)	(1)	(1)
B11	(1)	(1)	(1)	(1)	16.4 (2)
B12	(1)	(1)	(1)	(1)	(1)
B13	4.3	3.9	4.5	2.9	9.3
SC1	3.9	10.7	2.6	17.0	14.0
SC2	3.7	81.3	4.4	4.4	20.3
SC3	(1)	(1)	(1)	(1)	(1)
SC4	(1)	(1)	(1)	(1)	(1)
SC5	20.2	11.7	6.6	9.4	32.5

Note:

(1) The extraction well was not in operation during the fiscal year.

(2) The extraction well was in operation for only part of the fiscal year.

Table 12-5

Down Time By Category
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Category	**Down Time (Days)**
Pumphouse Component	1.9
Treatment Center Component	0.4
Electrical Service	0.6
Miscellaneous	0.6
Preventive Maintenance	0.9
System Modification	0.0
Forcemain	2.3
Total System Equivalent	6.7
Anticipated Down Time for Fiscal Year 2017	
Pumphouse Component	4.0
Treatment Center Component	1.5
Electrical Service	2.0
Miscellaneous	1.0
Preventive Maintenance	1.0
System Modification	0.5
Forcemain	1.0

Table 12-6

VOC Mass Loading Summary
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Well	Percent Contribution to VOC Mass Removal	FY 2017 Total Pounds VOCs Mass Removed
B1	2.3%	45.1
B2[1]	0.0%	0.00
B3	0.1%	2.73
B4	2.3%	45.2
B5	3.2%	64.3
B6	0.9%	17.8
B7[1]	0.0%	0.00
B8	0.4%	7.00
B9	2.0%	40.6
B10[1]	0.0%	0.00
B11[1]	0.0%	0.00
B12[1]	0.0%	0.00
B13	1.1%	21.1
SC1	14.7%	292
SC2	0.5%	10.04
SC3[1]	0.0%	0.00
SC4[1]	0.0%	0.00
SC5	72.6%	1,443
Fiscal Year 2017 Total (lbs)		**1,988**
Daily Average (lbs/day)		**5.4**

Notes:

[1] Extraction well was not in operation during the fiscal year.

Table 12-6

VOC Mass Loading Summary
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Historical Total

Fiscal Year		Pounds VOC Mass Removed
2017		1,988
2016		1,731
2015		1,748
2014		2,020
2013		2,082
2012		1,801
2011		1,834
2010		2,096
2009		2,167
2008		2,292
2007		2,507
2006		2,552
2005		2,663
2004		3,291
2003	(First year of reconfigured system)	3,041
2002		2,852
2001		3,418
2000		4,499
1999		4,878
1998		6,132
1997		6,210
1996		10,655
1995		13,355
1994		15,070
1993		20,165
1992		24,527
1991		26,760
1990		18,005
1989	(First year of full scale system)	19,510
1988		4,800
1987		2,100
Total		**216,749**

Table 12-7

VOC Concentrations in TGRS Extraction Wells
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Location	Alias	Date	Dup	1,1,1-Trichloroethane µg/L	1,1-Dichloroethane µg/L	1,1-Dichloroethene µg/L	1,2-Dichloroethane µg/L	cis-1,2-Dichloroethene µg/L	Tetrachloroethene µg/L	Trichloroethene µg/L
03F302	B1	12/7/2016		2.8	0.58 JP	0.91 JP	< 1.0	3.2	1.1	53
03F302	B1	6/7/2017		3.0	0.56 JP	0.74 JP	< 1.0	3.4	0.90 JP	56
03F303	B2	6/8/2017		< 1.0	< 1.0	0.83 JP	0.44 JP	1.2	0.94 JP	27
03F304	B3	12/7/2016		< 1.0	0.32 JP	0.41 JP	< 1.0	< 1.0	< 1.0	3.1
03F304	B3	6/7/2017		< 1.0	0.30 JP	0.38 JP	< 1.0	< 1.0	< 1.0	3.2
03F305	B4	12/7/2016		6.5	3.5	3.2	< 1.0	2.0	< 1.0	87 JMS140
03F305	B4	6/6/2017		6.2	3.1	2.6	< 1.0	1.8	< 1.0	81
03F305	B4	6/6/2017	D	6.3	3.1	2.7	< 1.0	1.8	< 1.0	80
03F306	B5	12/7/2016		2.2	2.8	1.4	< 1.0	0.98 JP	4.5	75
03F306	B5	6/6/2017		2.3	2.6	2.4	< 1.0	0.89 JP	4.4	75
03F307	B6	12/7/2016		0.54 JP	< 1.0	0.43 JP	< 1.0	< 1.0	< 1.0	26
03F307	B6	6/6/2017		0.46 JP	< 1.0	0.36 JP	< 1.0	< 1.0	< 1.0	22
03F307	B6	6/6/2017	D	0.45 JP	< 1.0	0.38 JP	< 1.0	< 1.0	< 1.0	22
03F312	B11	6/8/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03F319	B13	12/7/2016		1.5	0.62 JP	0.58 JP	< 1.0	3.4	< 1.0	76
03F319	B13	6/7/2017		0.87 JP	0.34 JP	< 1.0	< 1.0	2.2	< 1.0	55
03U301	SC1	12/7/2016		17	2.9	4.3	< 1.0	120	0.59 JP	3600
03U301	SC1	6/7/2017		21	3.7 JP	3.9 JP	< 5.0	150	< 5.0	2600

Table 12-7

VOC Concentrations in TGRS Extraction Wells
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Location	Alias	Date	Dup	1,1,1-Trichloroethane µg/L	1,1-Dichloroethane µg/L	1,1-Dichloroethene µg/L	1,2-Dichloroethane µg/L	cis-1,2-Dichloroethene µg/L	Tetrachloroethene µg/L	Trichloroethene µg/L
03U314	SC2	12/7/2016		19	1.3	2.1	< 1.0	1.2	< 1.0	45
03U314	SC2	6/8/2017		13	1.1	0.83 JP	< 1.0	1.1	< 1.0	38
03U314	SC2	6/8/2017	D	13	1.0	0.92 JP	< 1.0	1.1	< 1.0	37
03U317	SC5	12/7/2016		980	26	78	2.0	6.2	5.6	3300
03U317	SC5	6/12/2017		800	20	37	1.5 JP	5.8	5.9	3100
PJ#309	B8	12/7/2016		< 1.0	0.40 JP	0.46 JP	< 1.0	< 1.0	< 1.0	9.9
PJ#309	B8	12/7/2016	D	0.43 JP	0.41 JP	0.50 JP	< 1.0	< 1.0	< 1.0	9.4
PJ#309	B8	6/6/2017		0.39 JP	0.36 JP	0.40 JP	< 1.0	< 1.0	< 1.0	8.9
PJ#310	B9	12/7/2016		1.6	1.8	1.9	< 1.0	0.71 JP	< 1.0	33
PJ#310	B9	6/6/2017		1.6	1.8	1.8	< 1.0	0.62 JP	< 1.0	33

Notes:

D - Field Duplicate
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
JMS - Result is qualified as estimated based on outlying matrix spike sample recovery (# following JMS is actual % reco

Table 12-8

Groundwater Quality Data
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

			1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
TGRS Cleanup Level[1]			200	70	6.0	4.0	70	5.0	5.0
Location	Date	Dup	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
03L802	6/7/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0 JL74.0	1.7
03L806	6/6/2017		1.1	< 1.0	0.35 JP	< 1.0	< 1.0	< 1.0	42
03M802	6/7/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0 JL74.0	7.1
03M806	6/6/2017		0.94 JP	28	16	0.53 JP	6.5	< 1.0	410
03U093	6/8/2017		55	0.30 JP	4.2	< 1.0	1.9	< 1.0	130
03U099	6/7/2017		0.49 JP	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0 JL74.0	1.5
03U677	6/6/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0 JL74.0	< 1.0
03U708	6/5/2017		1.5	< 1.0	0.36 JP	< 1.0	< 1.0	2.4	23
03U801	6/7/2017		< 1.0	< 1.0	< 1.0	< 1.0	0.47 JP	< 1.0 JL74.0	16
03U806	6/6/2017		< 1.0	0.61 JP	0.37 JP	< 1.0	< 1.0	0.72 JL74.0	36
04J077	6/5/2017		0.91 JP	2.1	1.9	< 1.0	0.61 JP	< 1.0	51
04U711	6/6/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0 JL74.0	< 1.0
04U802	6/7/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0 JL74.0	< 1.0
04U806	6/6/2017		0.88 JP	1.9	1.7	< 1.0	0.60 JP	< 1.0 JL74.0	52
04U833	6/5/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	0.45 JP
PJ#806	6/6/2017		0.32 JP	0.46 JP	0.34 JP	< 1.0	< 1.0	< 1.0 JL74.0	16

Notes:

[1] Cleanup levels for TGRS are from the OU2 ROD. Shading indicates exceedence of the cleanup level.
D - Field Duplicate
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
JL - Result is qualified as estimated based on outlying lab control sample recovery (# following JL is actual % recovery)

Table 12-9

Summary Of OU2 Deep Groundwater Monitoring Requirements
TGRS, OU2
Arden Hills, Minnesota

Remedy Component	Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1 Hydraulic Containment and Mass Removal	a. Water levels to draw contour maps showing hydraulic zone of capture	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
	b. Pumping volumes and rates for comparison to design rates	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
	c. Influent and extraction well water quality for overall mass removal calculations	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
#2 Groundwater Treatment	• Outlined below		
#3 Treated Water Discharge	• Effluent monitoring to verify attainment of treatment requirements	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
#4 Land Use Controls	• None		
#5 Review of New Technologies	• None		
#6 Groundwater Monitoring	a. Water levels to draw contour maps showing hydraulic zone of capture	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
	b. Groundwater quality to verify attainment of clean up goals	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
Overall Remedy	a. Groundwater quality to verify attainment of clean up goals	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report

Table 12-10

1,4-Dioxane Concentrations in TGRS and Extraction Wells
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

				1,4-Dioxane
		Screening Criteria (HRL)		1.0
Location	**Alias**	**Date**	**Dup**	**µg/L**
03F302	B1	6/7/2017		1.7
03F303	B2	6/8/2017		0.67
03F304	B3	6/7/2017		6.3
03F305	B4	6/6/2017		29.1
03F305	B4	6/6/2017	D	28.4
03F306	B5	6/6/2017		13.5
03F307	B6	6/6/2017		12.5
03F307	B6	6/6/2017	D	12.3
03F312	B11	6/8/2017		0.66
03F319	B13	6/7/2017		2
03U301	SC1	6/7/2017		16.4
03U314	SC2	6/8/2017		18.6
03U314	SC2	6/8/2017	D	18.9
03U317	SC5	6/12/2017		16.7
PJ#309	B8	6/6/2017		11.4
PJ#310	B9	6/6/2017		14
TGRSE		6/12/2017		11.6
TGRSE		6/12/2017	D	11.1
TGRSI		6/12/2017		11.4

Notes:

HRL - Health Risk Limit (Minnesota Department of Health). Shading indicates exceedence of the HRL

D - Field Duplicate

Table 12-11

1,4-Dioxane Concentrations in TGRS and Extraction Wells
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

			1,4-Dioxane
	Screening Criteria (HRL)		**1.0**
Location	**Date**	**Dup**	**µg/L**
03L802	6/7/2017		0.26
03L806	6/6/2017		14.2
03M802	6/7/2017		0.13
03M806	6/6/2017		15.4
03U093	6/8/2017		1.6
03U099	6/7/2017		< 0.070
03U677	6/6/2017		0.29
03U708	6/5/2017		0.19
03U801	6/7/2017		0.13
03U806	6/6/2017		4.2
04J077	6/5/2017		13.0
04U711	6/6/2017		7.5
04U802	6/7/2017		0.36
04U806	6/6/2017		13.2
04U833	6/5/2017		13.3
PJ#806	6/6/2017		14.0

Notes:

HRL - Health Risk Limit (Minnesota Department of Health). Sh
indicates exceedence of the HRL.
D - Field Duplicate
FB - Field Blank
UB - Blank contamination, #= highest concentration of
blank affecting data

Table 13-1

Groundwater Quality Data
Fiscal Year 2017
Operable Unit 3

			1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	Trichloroethene
OU3 Cleanup Level(1)			**200**	**3.0**	**70**	**6.0**	**70**	**5.0**
Location	**Date**	**Dup**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
03M848	6/8/2017		< 1.0	< 1.0	0.51 JP	0.63 JP	6.9	100
04U863	6/8/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	0.43 JP
04U863	6/8/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	0.48 JP

Notes:

(1) Cleanup levels for OU3 are from the OU3 ROD. Shading indicates exceedence of the cleanup level.

D - Field Duplicate

JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit.

Table 13-2

Mann-Kendall Statistical Summary
Fiscal Year 2017
Operable Unit 3

	Well	Kendall S	Number of Data Points	Raw Trend	Confidence	Coefficient of Variance	Raw Trend Decision	MAROS Conclusion	TRCLE Concentration 2016
	Edge of Plume Wells								
*	03L673	-12	6	Decreasing	98.19%	0.1844	Definite	Decreasing	63
*	03L848	-12	6	Decreasing	98.19%	0.1517	Definite	Decreasing	3.3
*	04U673	-15	6	Decreasing	99.86%	0.2963	Definite	Decreasing	16
*	04U832	4	6	Increasing	70.25%	0.0753	Stable or No Trend	No Trend	46
*	04U845	-7	6	Decreasing	86.40%	0.3750	Stable or No Trend	Stable	6.1
*	04U848	-9	6	Decreasing	93.20%	0.1843	Probable	Decreasing	3.1
*	04U854	-11	6	Decreasing	97.20%	0.1928	Definite	Decreasing	6.2
	Center of Plume Wells								
*	03L859	-13	6	Decreasing	99.17%	0.2205	Definite	Decreasing	4.8
	03M848	-15	6	Decreasing	99.86%	0.2390	Definite	Decreasing	100
*	04U859	-14	6	Decreasing	99.51%	0.2443	Definite	Decreasing	27

Notes:
* - Denotes sample results collected in FY 201

Table 13-3

Summary Of Groundwater Monitoring Requirements
Operable Unit 3

	Remedy Component		Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1	Monitored Natural Attenuation		Outlined below.		
#2	Groundwater Monitoring	a.	Water levels for use in drawing contour maps.	Orbital ATK	OU3 Monitoring Plan in Annual Report
		b.	Groundwater sampling to track progress of clean-up and attenuation of plume.	Orbital ATK	OU3 Monitoring Plan in Annual Report
#3	Drilling Advisories	a.	Verification that drilling advisories are in place and functioning as intended.	Army/MDH	NA
OR:	Overall Remedy	a.	Water quality monitoring to verify attainment of clean-up goals.	Orbital ATK	OU3 Monitoring Plan in Annual Report

Table 13-4

1,4-Dioxane Groundwater Sampling Results
Fiscal Year 2017

Operable Unit 3

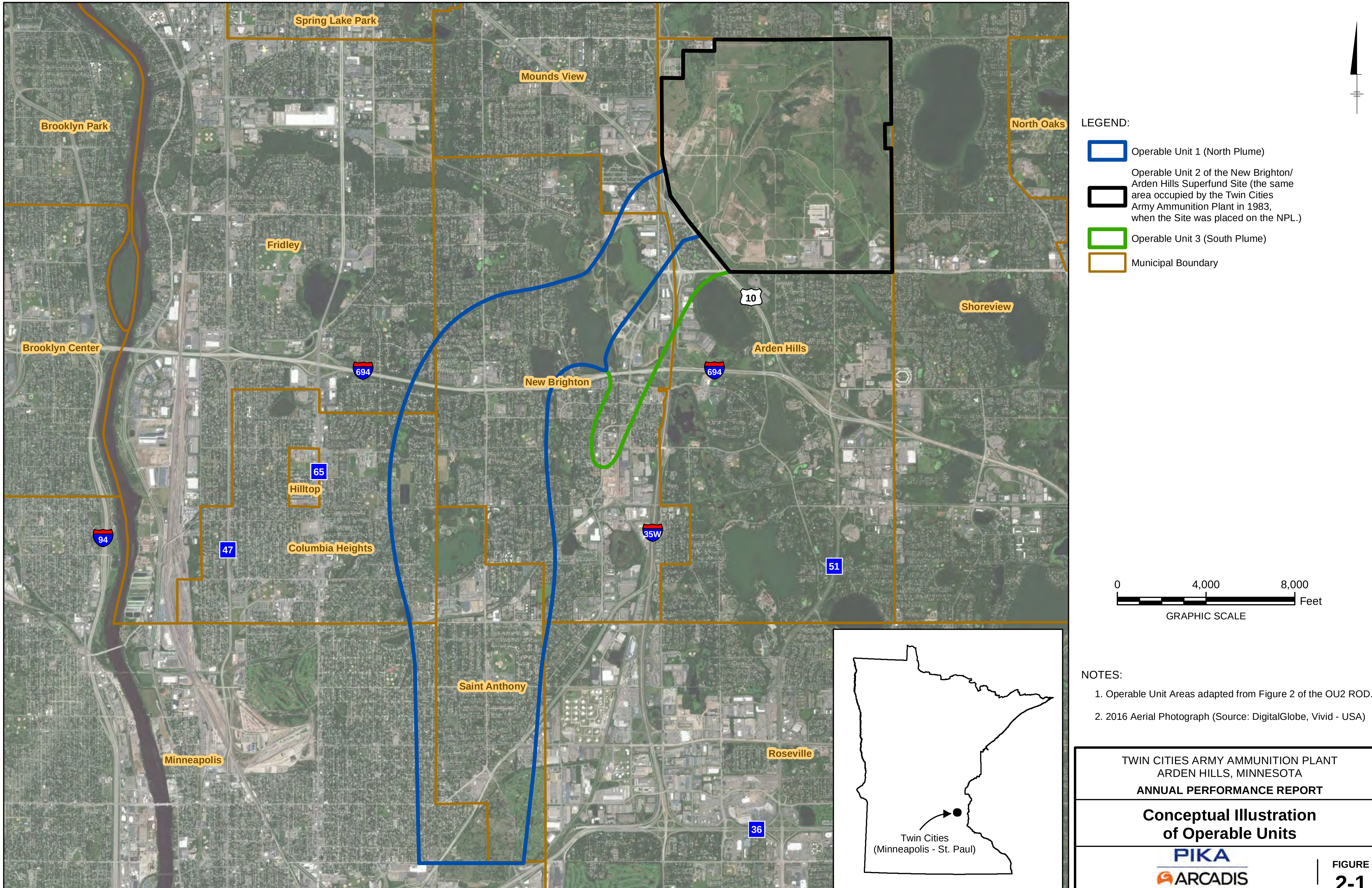
			1,4-Dioxane
	Screening Criteria (HRL)		1.0
Location	**Date**	**Dup**	**µg/L**
03M848	6/8/2017		0.52
04U863	6/8/2017		< 0.070
04U863	6/8/2017	D	0.11

Notes:

HRL Health Risk Limit (Minnesota Department of Health). Shading indicates exceedence of the HRL.

D Field Duplicate

FIGURES



NOTES:

1. Operable Unit Areas adapted from Figure 2 of the OU2 ROD.
2. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

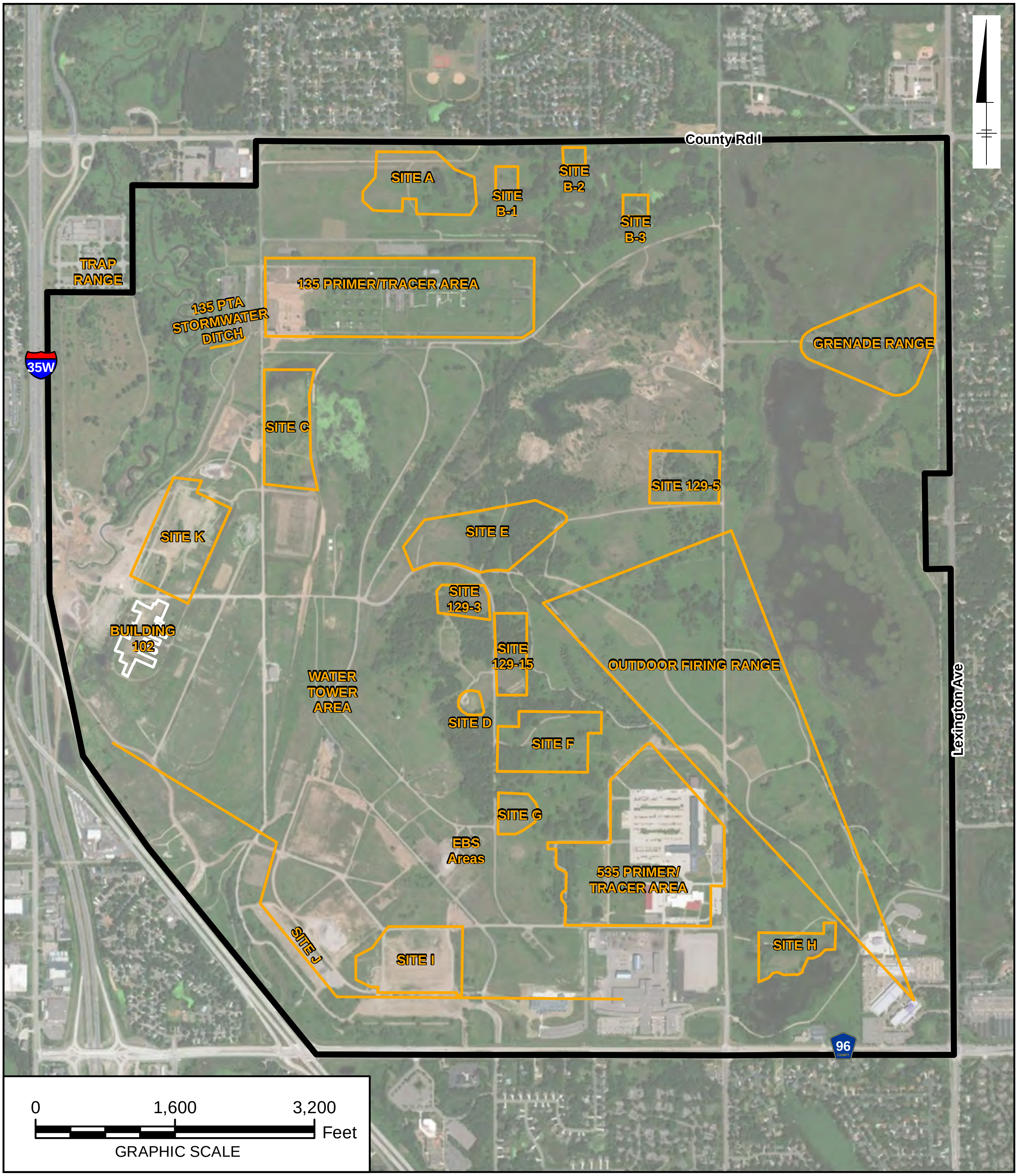
ANNUAL PERFORMANCE REPORT

Conceptual Illustration of Operable Units

PIKA ARCADIS a joint venture

FIGURE **2-1**

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\OU1_OU2_SiteMap_20180131.mxd 2/1/2018 8:24:59 AM



LEGEND:

Operable Unit 2

General NPL Site Boundary (See Note 1)

NOTES:

1. General NPL site boundaries determined during the initial site investigations. Please refer to the latest site reports for the current boundary definitions.
2. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

ANNUAL PERFORMANCE REPORT

Operable Unit 2
Site Boundaries

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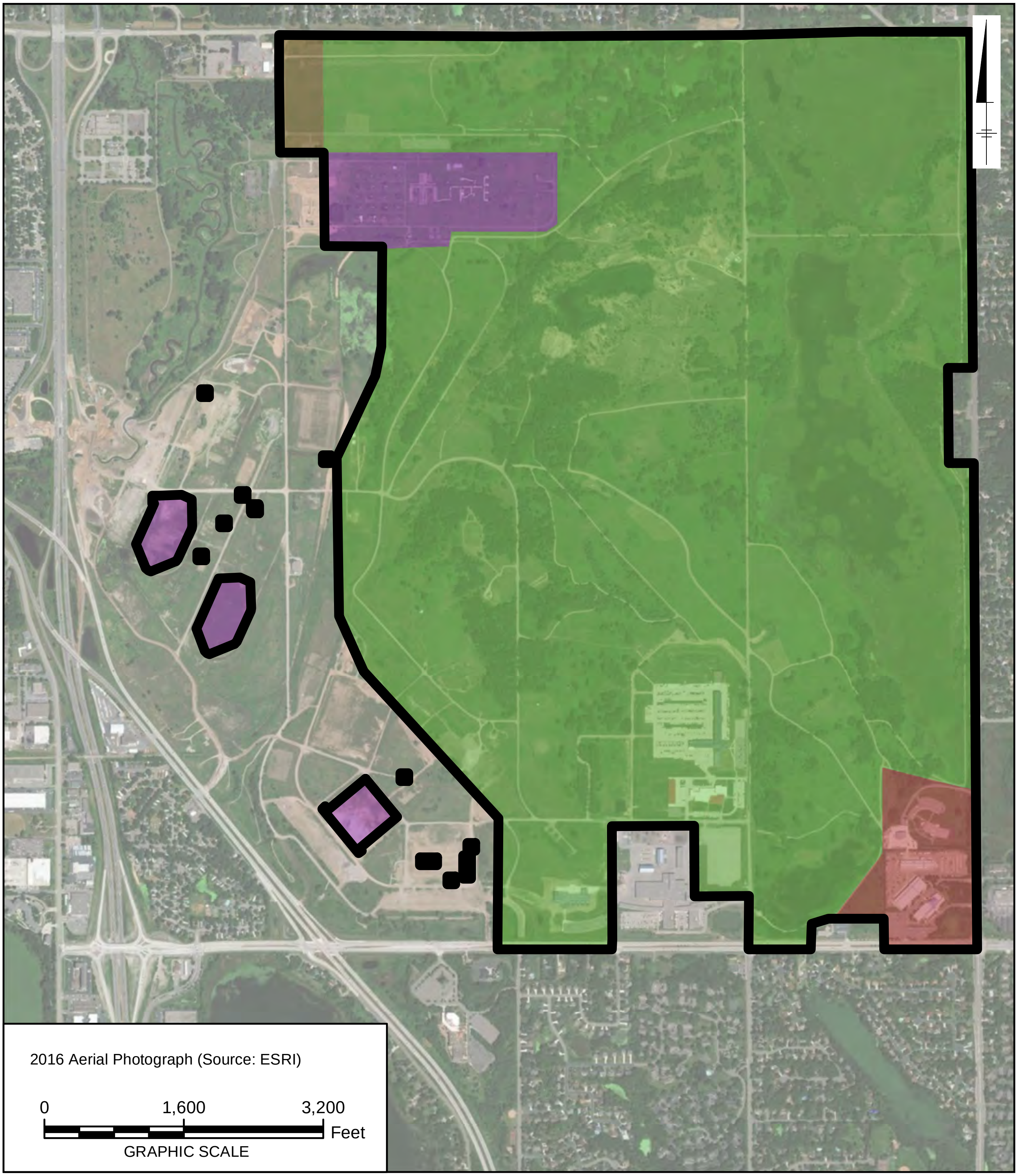
FIGURE
2-2

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01APR_2017\General_Locations_OU2_Sites_FY2017.mxd 2/1/2018 8:04:23 AM



LEGEND:

- Federally - owned property controlled by the U.S. Army
- Control Delegated to the Base Realignment and Closure Division (what remains of TCAAP)
- Control Delegated to the U.S. Army Reserve
- Control Delegated to the National Guard Bureau, who in turn has licensed use of the property to the Minnesota Army National Guard
- Easement to Ramsey County

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

ANNUAL PERFORMANCE REPORT

Federally Owned Property Within Operable Unit 2

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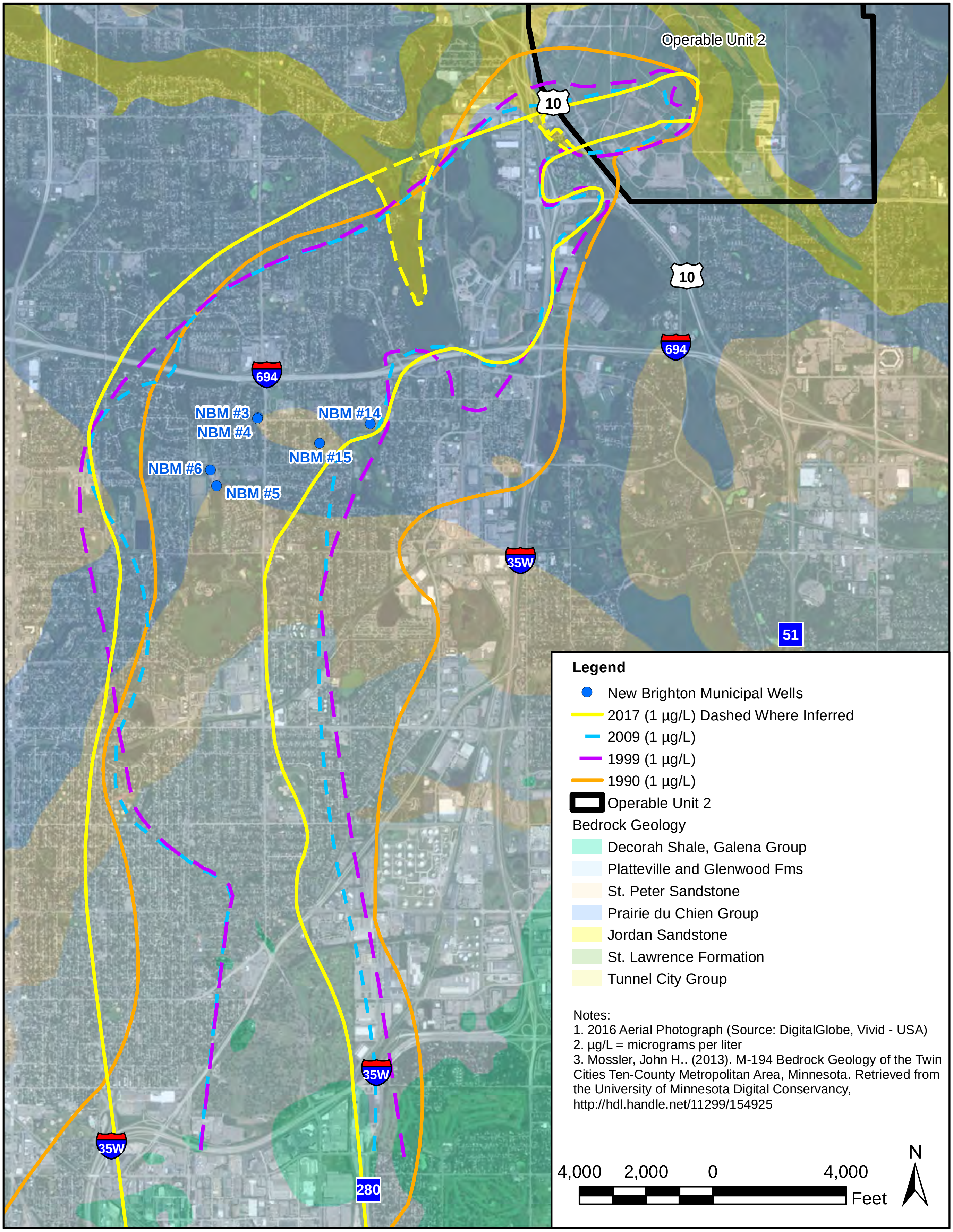
FIGURE
2-3

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01APR_2017\Federally_Owned_Property_within_OU2_20180112.mxd 1/12/2018 2:21:07 PM



ANNUAL PERFORMANCE REPORT

Upper Unit 4,

1 µg/L Trichloroethene Isoconcentration Map

PIKA ARCADIS a joint venture

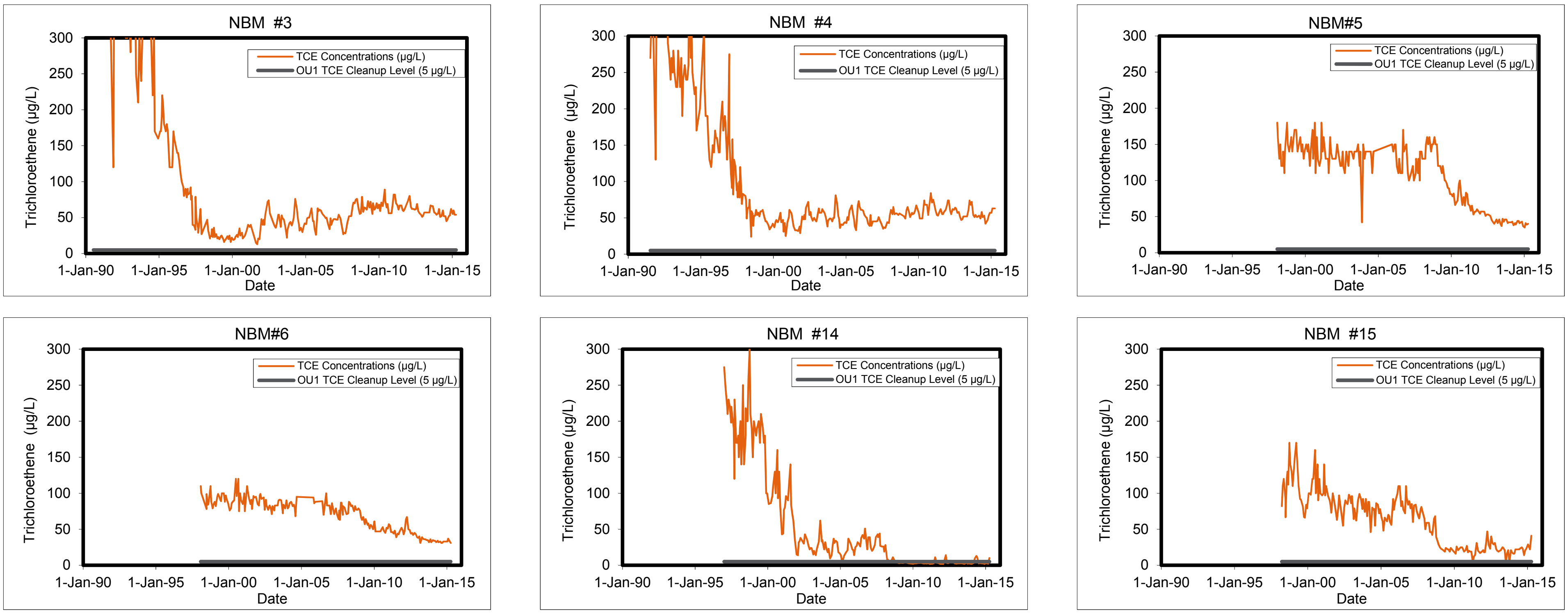
FY 2017

Figure 3-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Upper Unit 4 1ug TCE_FY2017.mxd
Date: 5/11/2018 Time: 10:48:03 AM User: mgress

Figure 3-2
New Brighton Municipal Wells: Trichloroethene Water Quality Trends

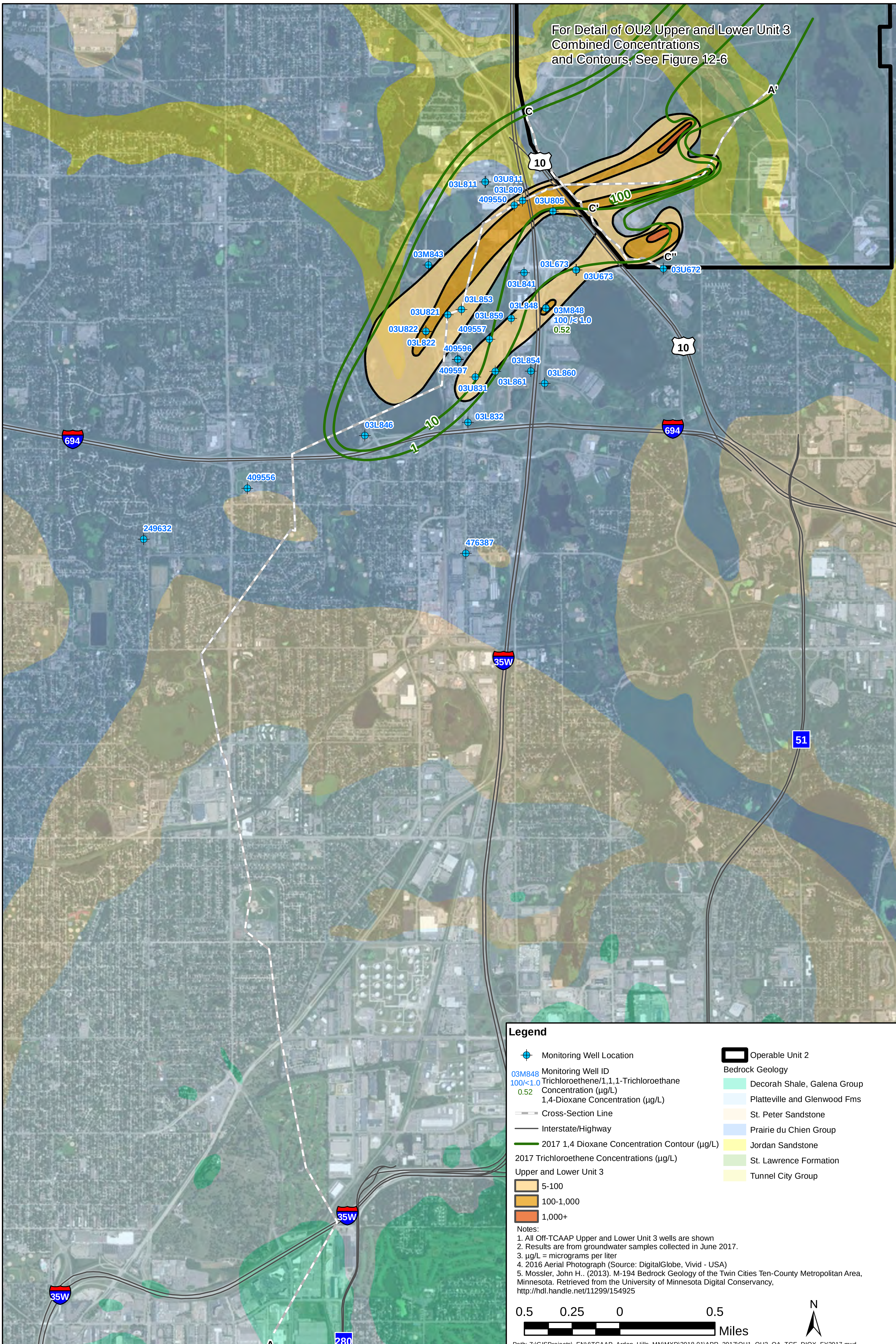
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota



Notes:

1. Routine pumping of the NBCGRS was ceased on April 15, 2015, with notice to the USEPA/MPCA, due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells. Since the granular activated carbon (GAC) does not remove 1,4-dioxane, New Brighton is preferentially pumping deep aquifer wells that have no detectable 1,4-dioxane while the City evaluates the feasibility of 1,4-dioxane removal technologies. This has been referred to as a “Remedy Time-Out,” and normal pumping of the NBCGRS will not be resumed until a technology is selected and modification of the NBCGRS is designed and constructed. The Fridley Interconnection was also closed on April 15, 2015.

Acronyms and Abbreviations:
TCE = Trichloroethene
µg/L = micrograms per liter



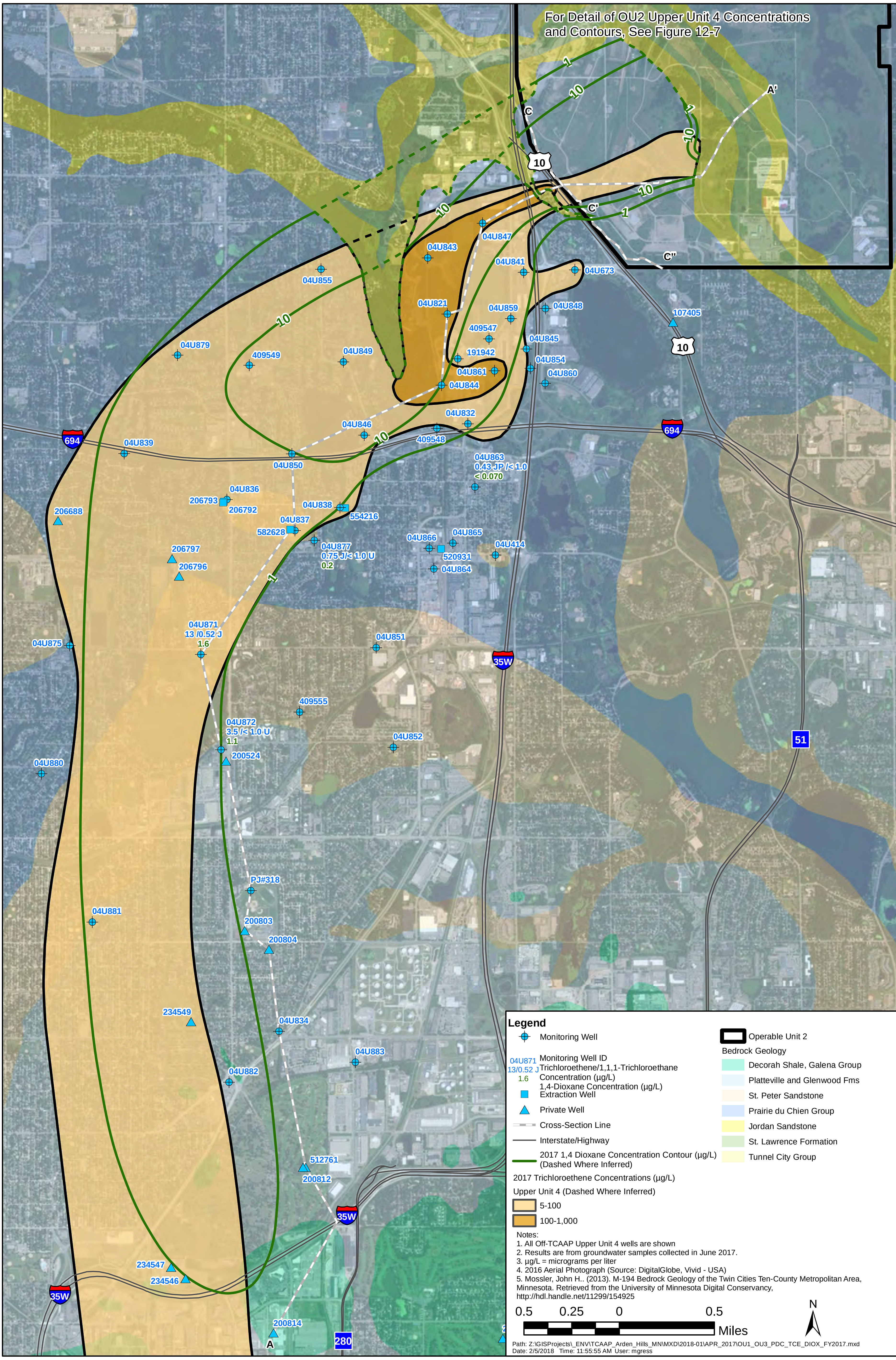
ANNUAL PERFORMANCE REPORT

OU1 & OU3, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 3-3



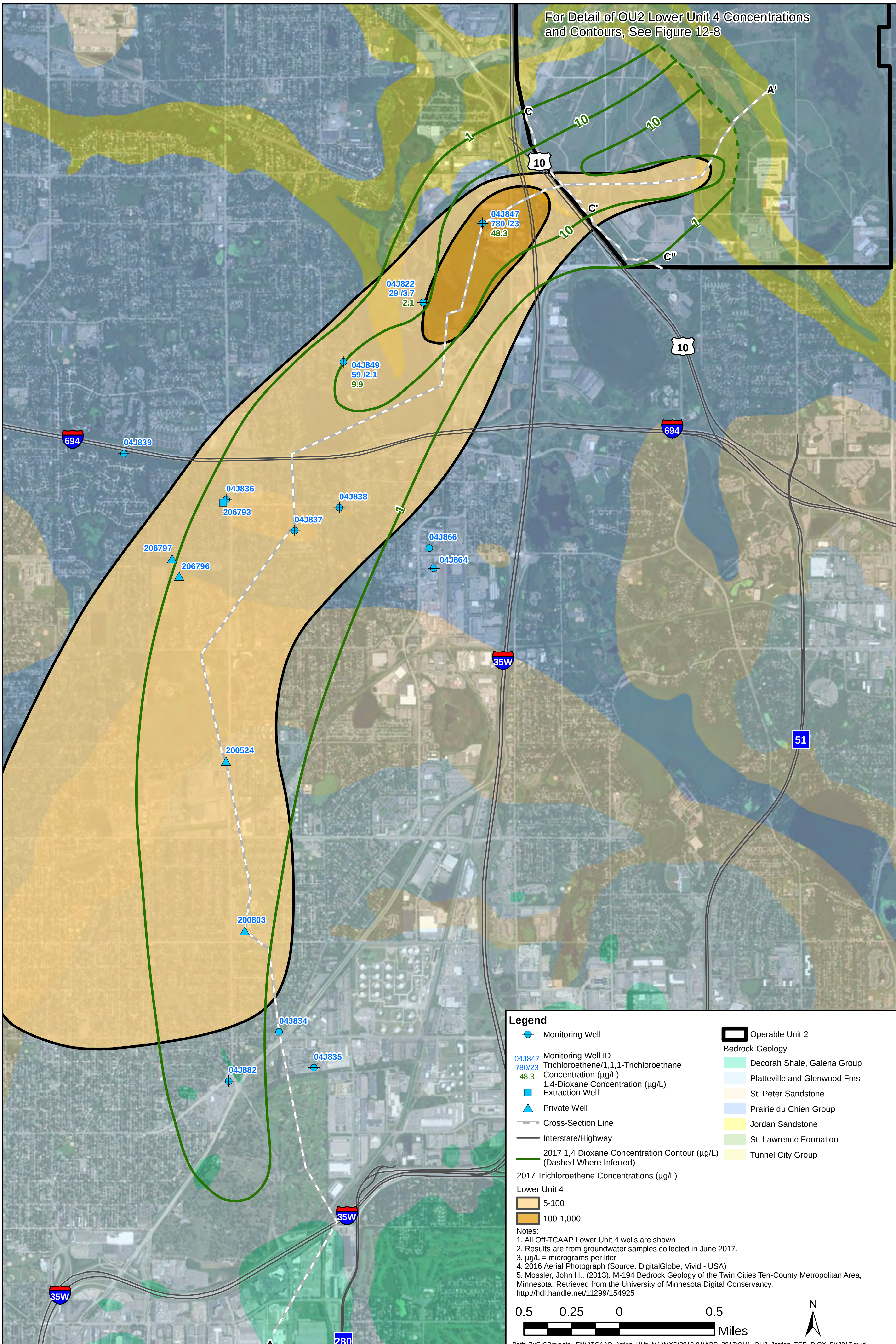
ANNUAL PERFORMANCE REPORT

OU1 & OU3, Upper Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 3-4



ANNUAL PERFORMANCE REPORT

OU1 & OU3, Lower Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 3-5

Figure 3-6
OU2-OU1 Trichloroethene
Cross Section A-A’ (North Half)

U.S Army - TCAAP
Arden Hills, Minnesota

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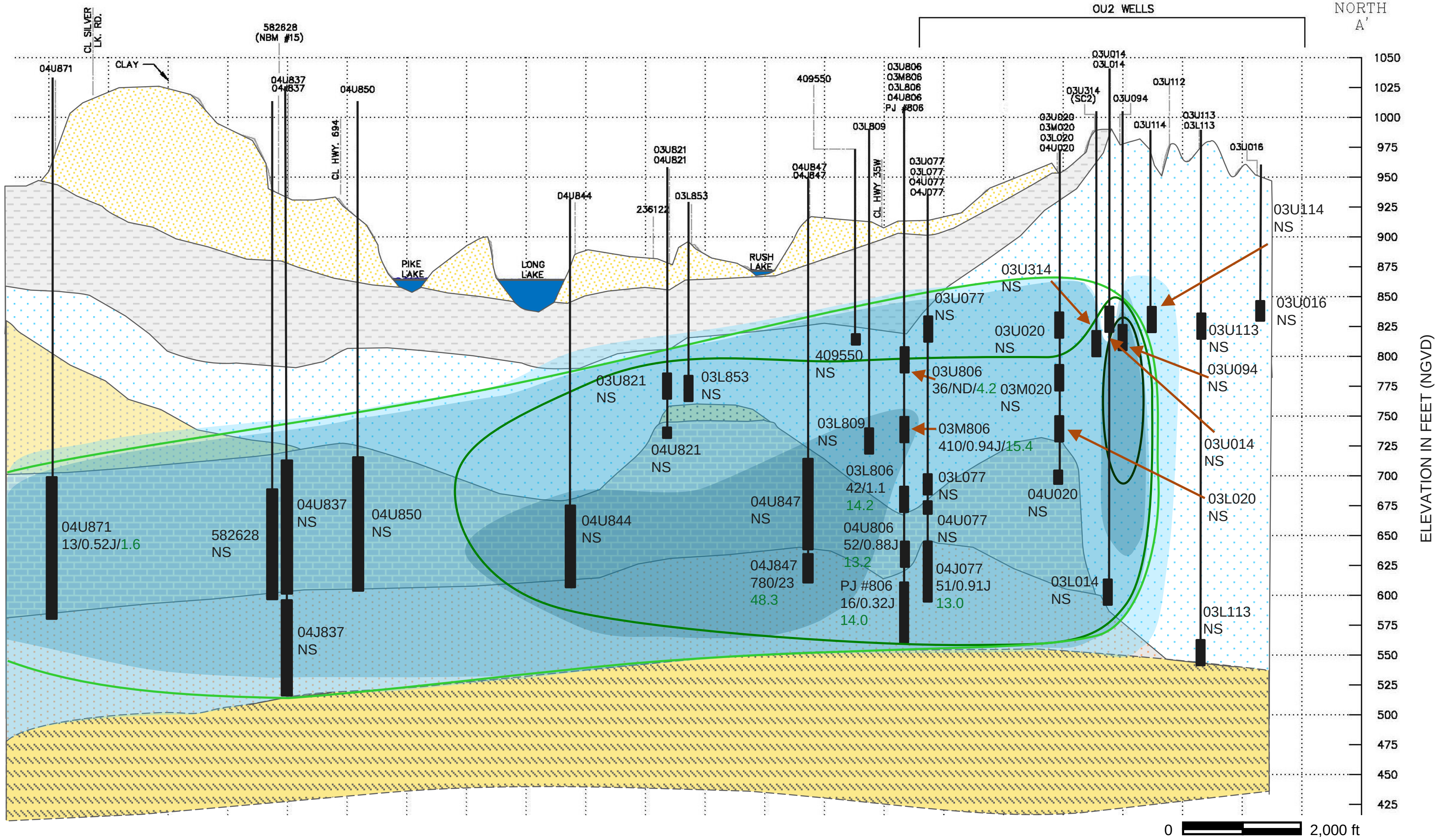


Legend

04J077 Well ID
NS Not Sampled
ND Analyte Not Detected
µg/L Micrograms per Liter
NGVD National Geodetic Vertical Datum
69/1.5 Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)

14.6 1,4-Dioxane concentration* (µg/L)
J Reported value is between the method detection limit and reporting limit

Geologic Contact (inferred where dashed)
Screened Interval

Trichloroethene Concentration* (µg/L)
- 1-10
- 10-100
- 100-1,000

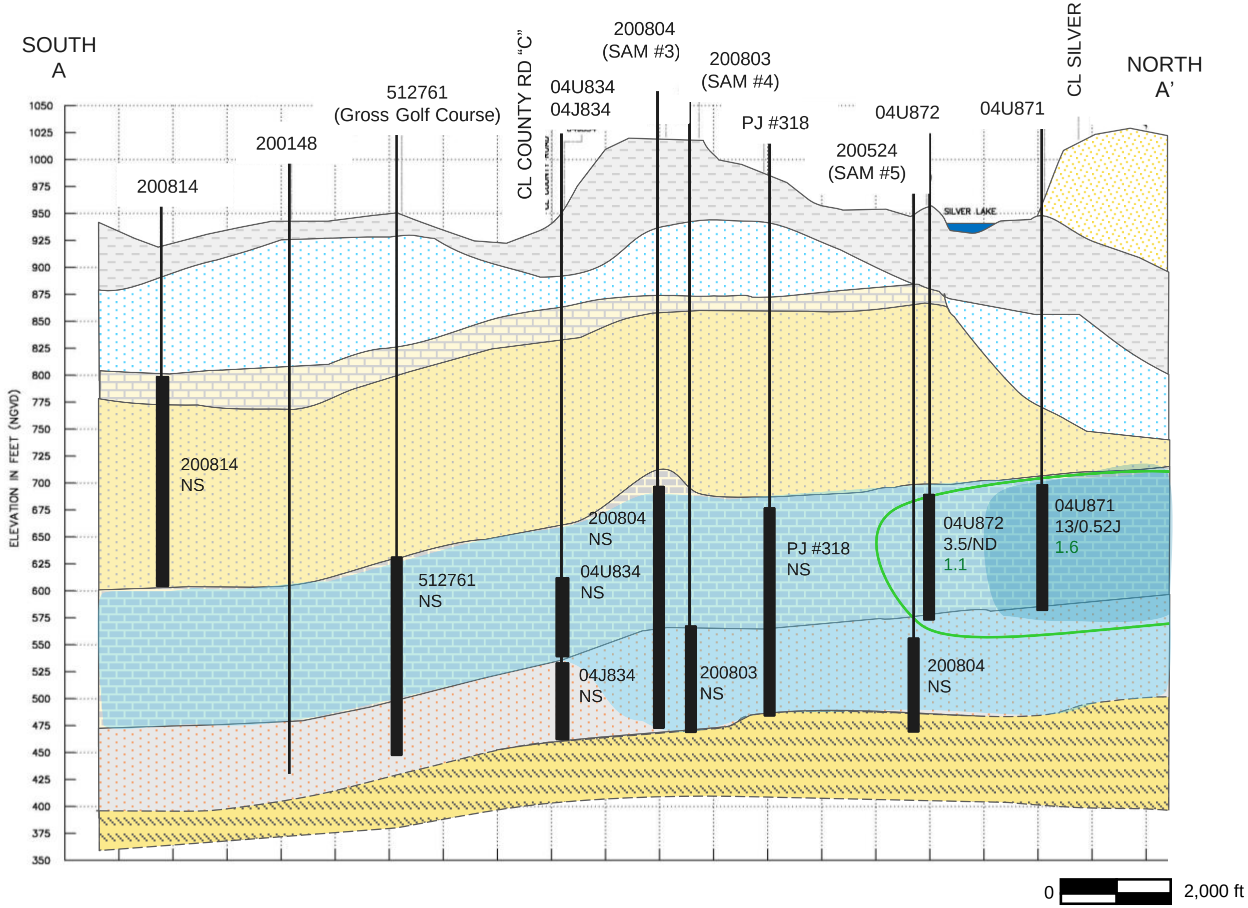
1,4-Dioxane Concentration* (µg/L)
- 1-10
- 10-100
- 100-1,000

Unit 1
Unit 2
Unit 3
St. Peter Sandstone
Upper Unit 4
Lower Unit 4
St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 and FY 2017 sampling events

Figure 3-7
OU2-OU1 Trichloroethene
Cross Section A-A' (South Half)

U.S Army - TCAAP
Arden Hills, Minnesota



Legend

512761	Well ID
NS	Not Sampled
ND	Analyte Not Detected
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
J	Reported value is between the method detection limit and reporting limit

2.6/ND	Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)
0.24	1,4-Dioxane concentration* (µg/L)
	Geologic Contact (inferred where dashed)
	Screened Interval

Trichloroethene Concentration* (µg/L)

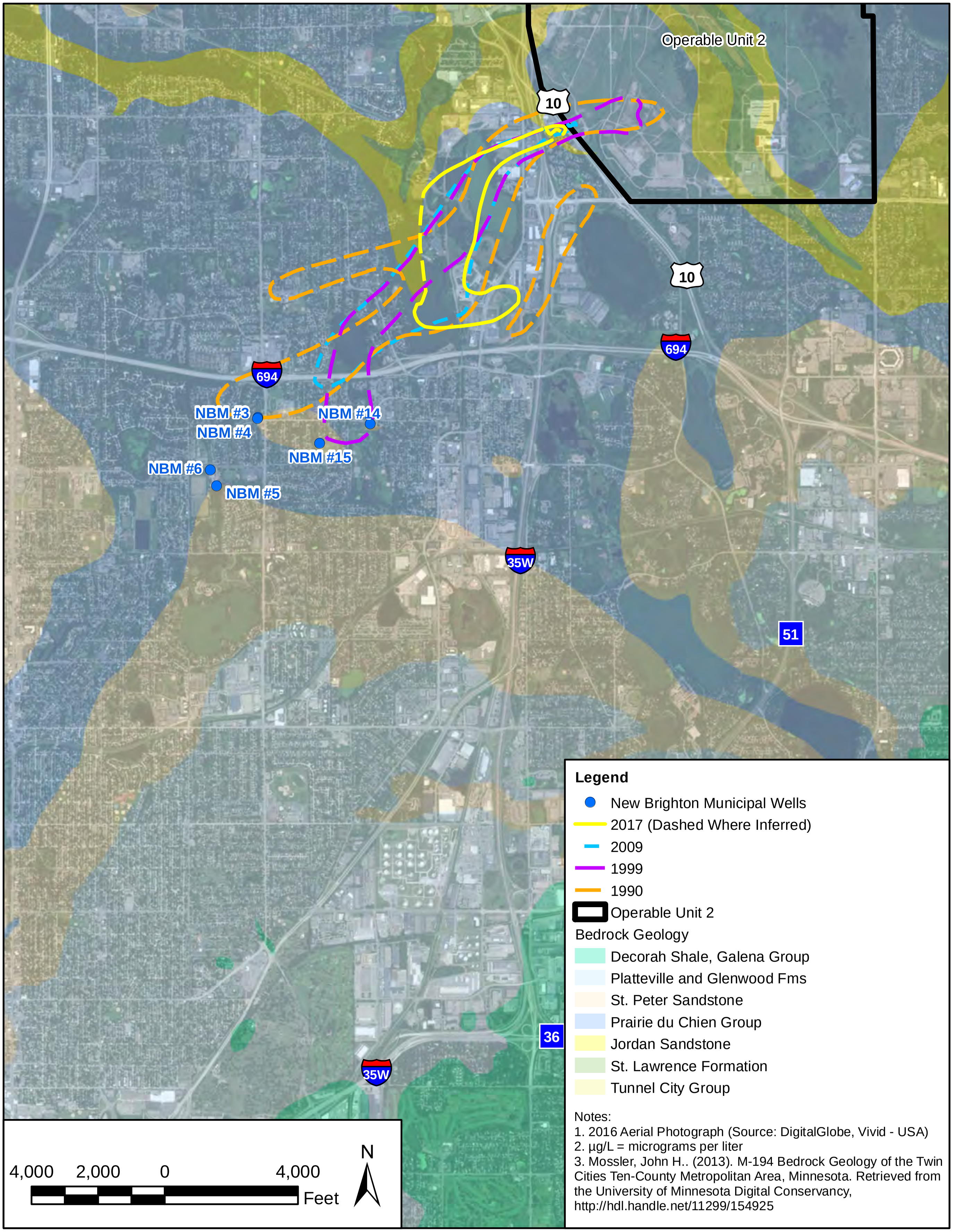
- 1-10
- 10-100

1,4-Dioxane Concentration* (µg/L)

- 1-10

- Unit 1
- Unit 2
- Unit 3
- Platteville Limestone
- St. Peter Sandstone
- Upper Unit 4
- Lower Unit 4
- St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 and FY 2017 sampling events



ANNUAL PERFORMANCE REPORT

Upper Unit 4,

100 µg/L Trichloroethene Isoconcentration Map

PIKA ARCADIS a joint venture

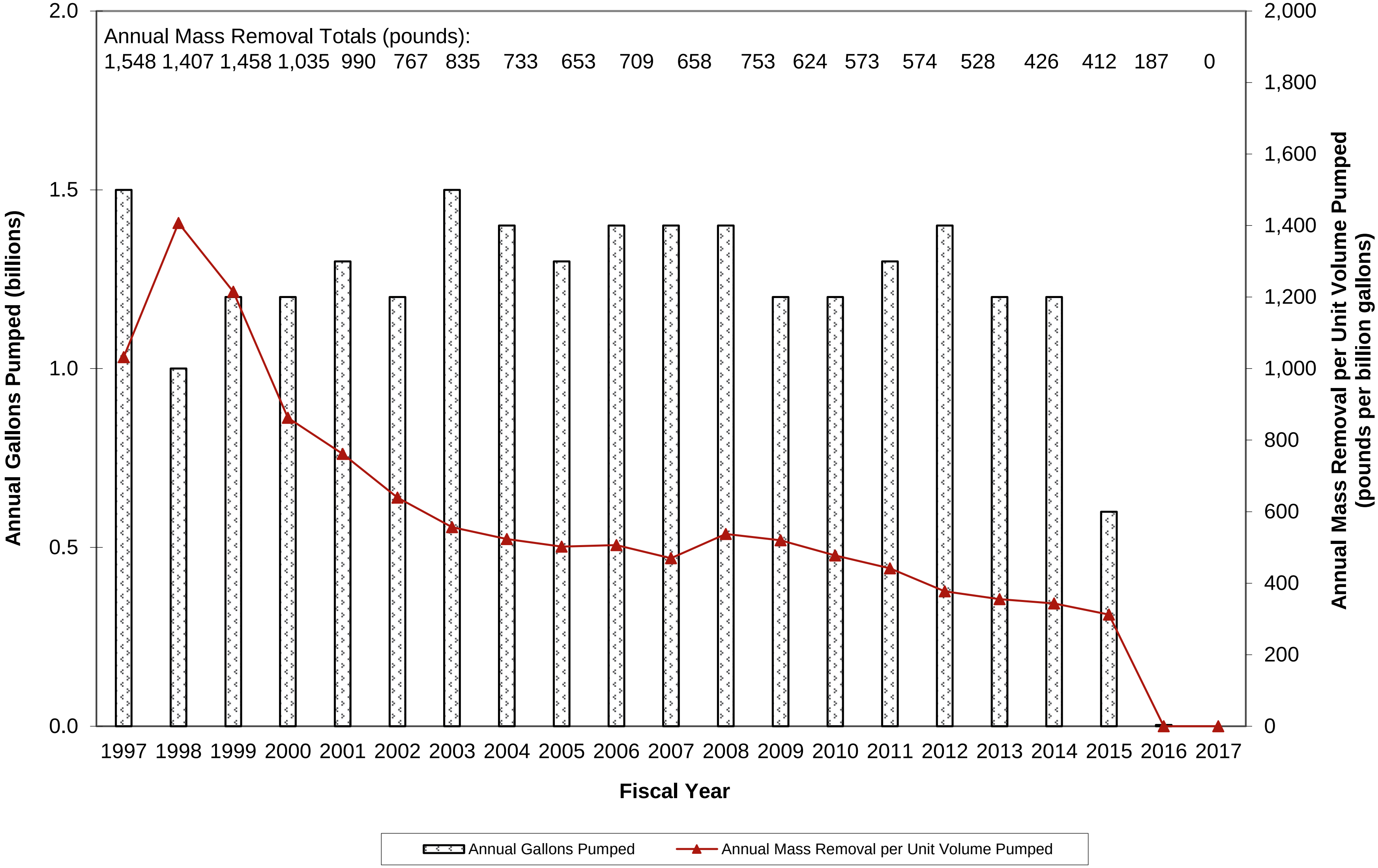
FY 2017

Figure 3-8

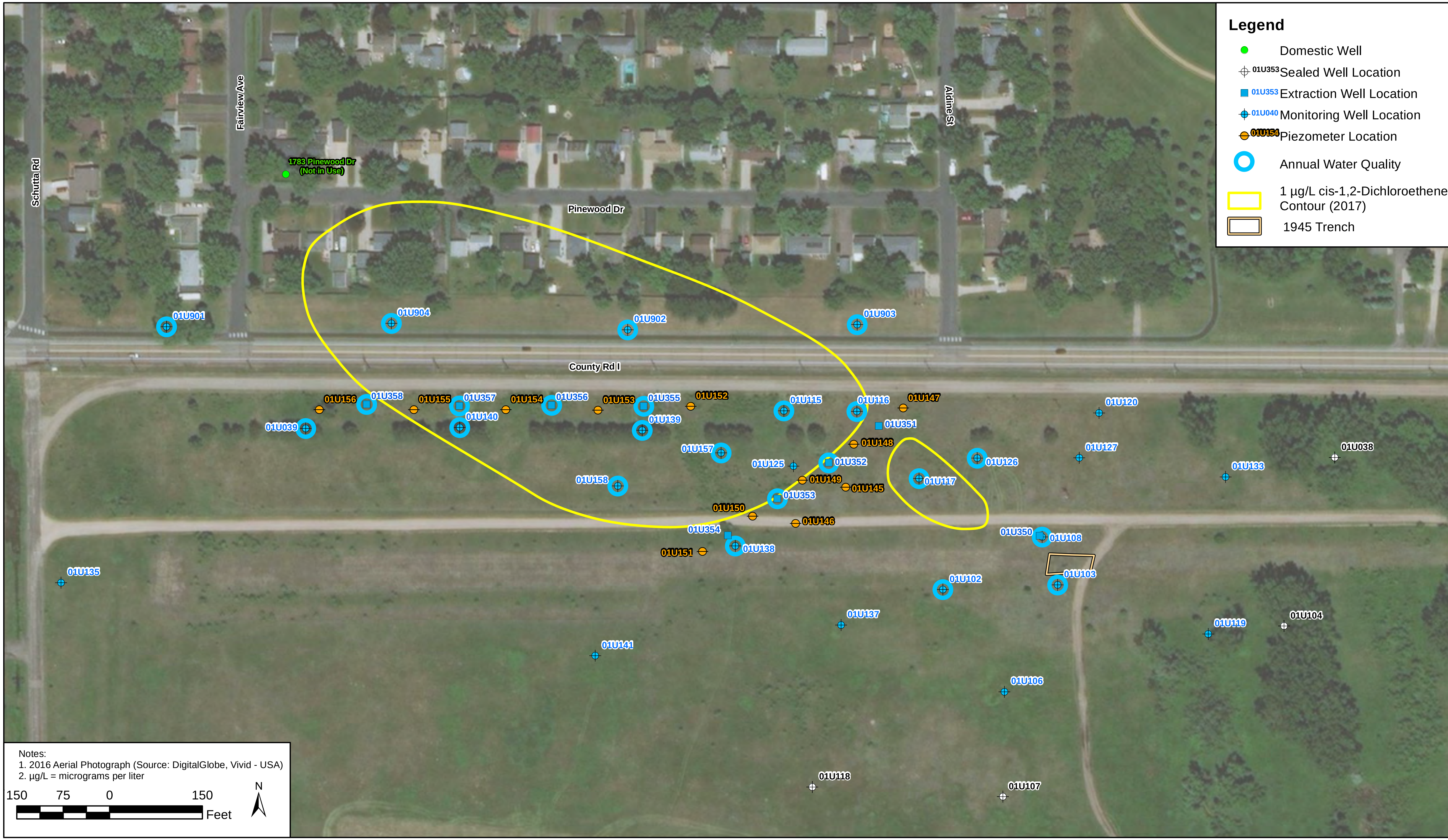
Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Upper Unit 4 100ug TCE_FY2017.mxd
Date: 1/30/2018 Time: 11:27:38 AM User: mgress

Figure 3-9
NBCGRS History

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota



1



ANNUAL PERFORMANCE REPORT

Site A, Groundwater Monitoring Plan

PIKA ARCADIS a joint venture

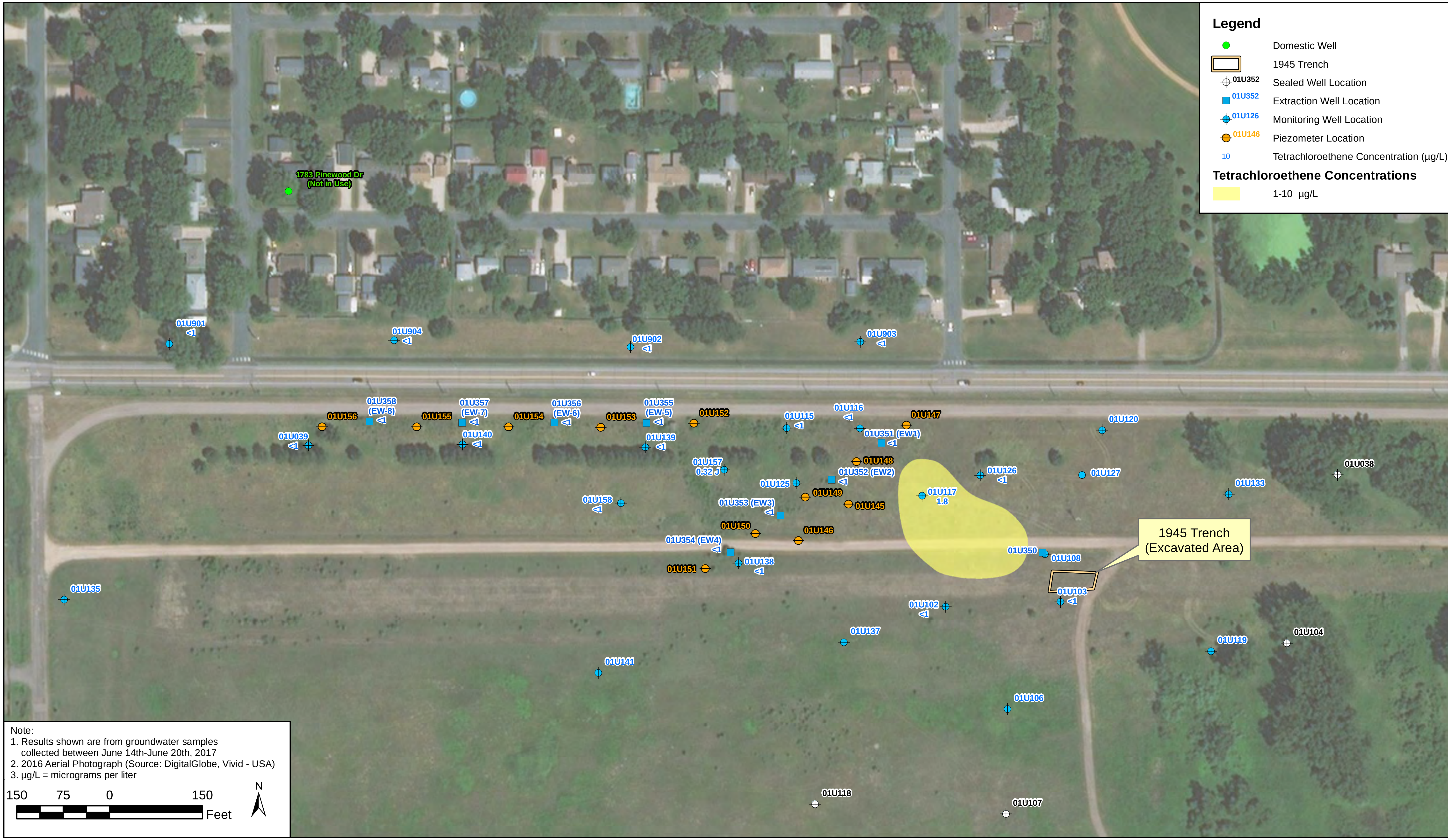
FY 2017

Figure 6-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site A Monitoring Plan_FY2017.mxd
Date: 5/11/2018 Time: 11:19:23 AM User: mgress

ANNUAL PERFORMANCE REPORT	PIKA ARCADIS a joint venture	FY 2017
Site A, Unit 1, Potentiometric Map, June 2017		Figure 6-2

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site A Potentiometric Map_FY2017.mxd
Date: 1/30/2018 Time: 2:21:13 PM User: mgress



ANNUAL PERFORMANCE REPORT

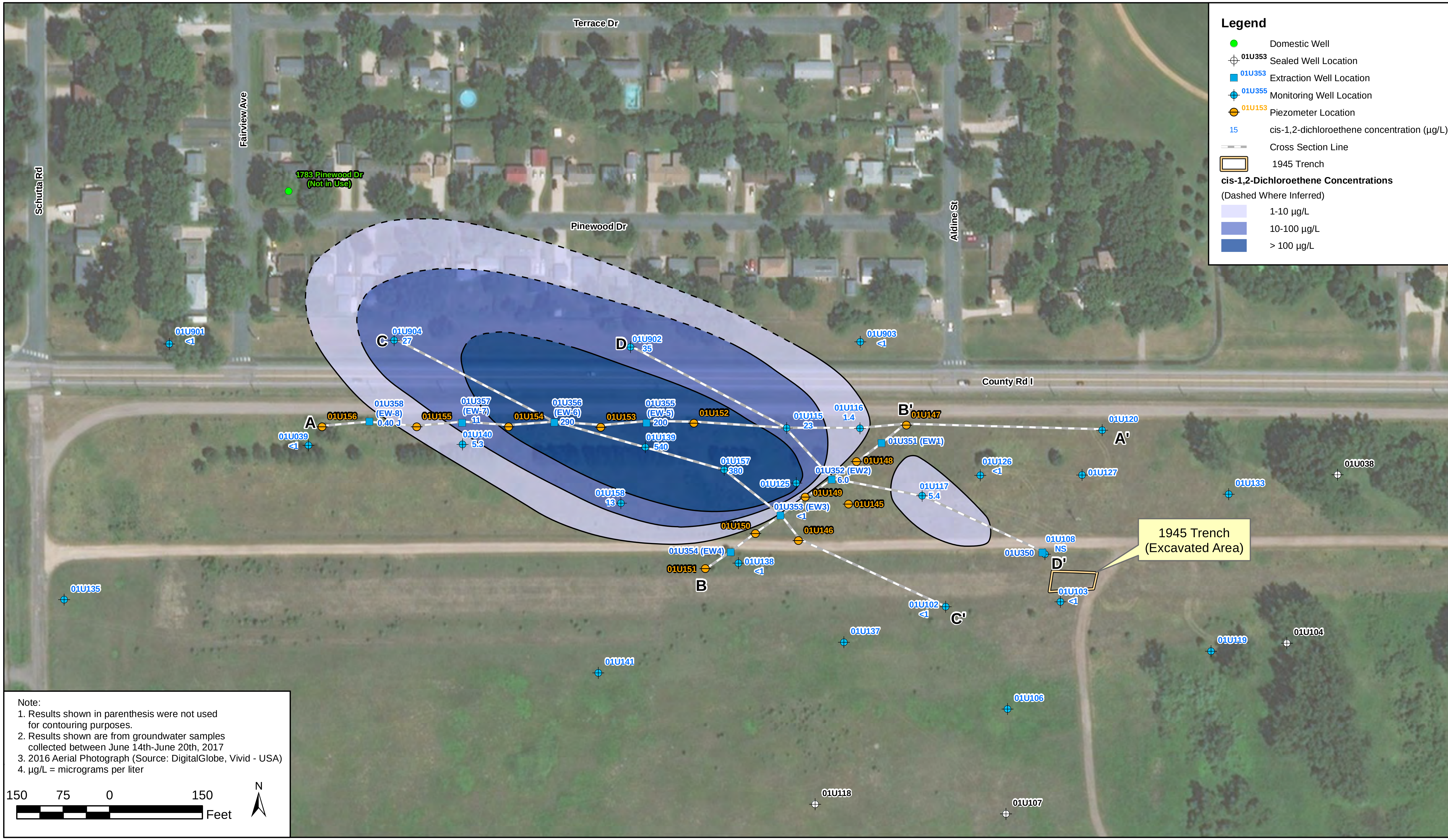
Site A, Unit 1, Tetrachloroethene Isoconcentration Map, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 6-3

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site A Tetra Plume Map_FY2017.mxd
Date: 1/30/2018 Time: 2:21:55 PM User: mgress



Legend

- Domestic Well
- 01U353 Sealed Well Location
- 01U353 Extraction Well Location
- 01U355 Monitoring Well Location
- 01U153 Piezometer Location
- 15 cis-1,2-dichloroethene concentration (µg/L)
- Cross Section Line
- 1945 Trench

cis-1,2-Dichloroethene Concentrations

(Dashed Where Inferred)

- 1-10 µg/L
- 10-100 µg/L
- > 100 µg/L

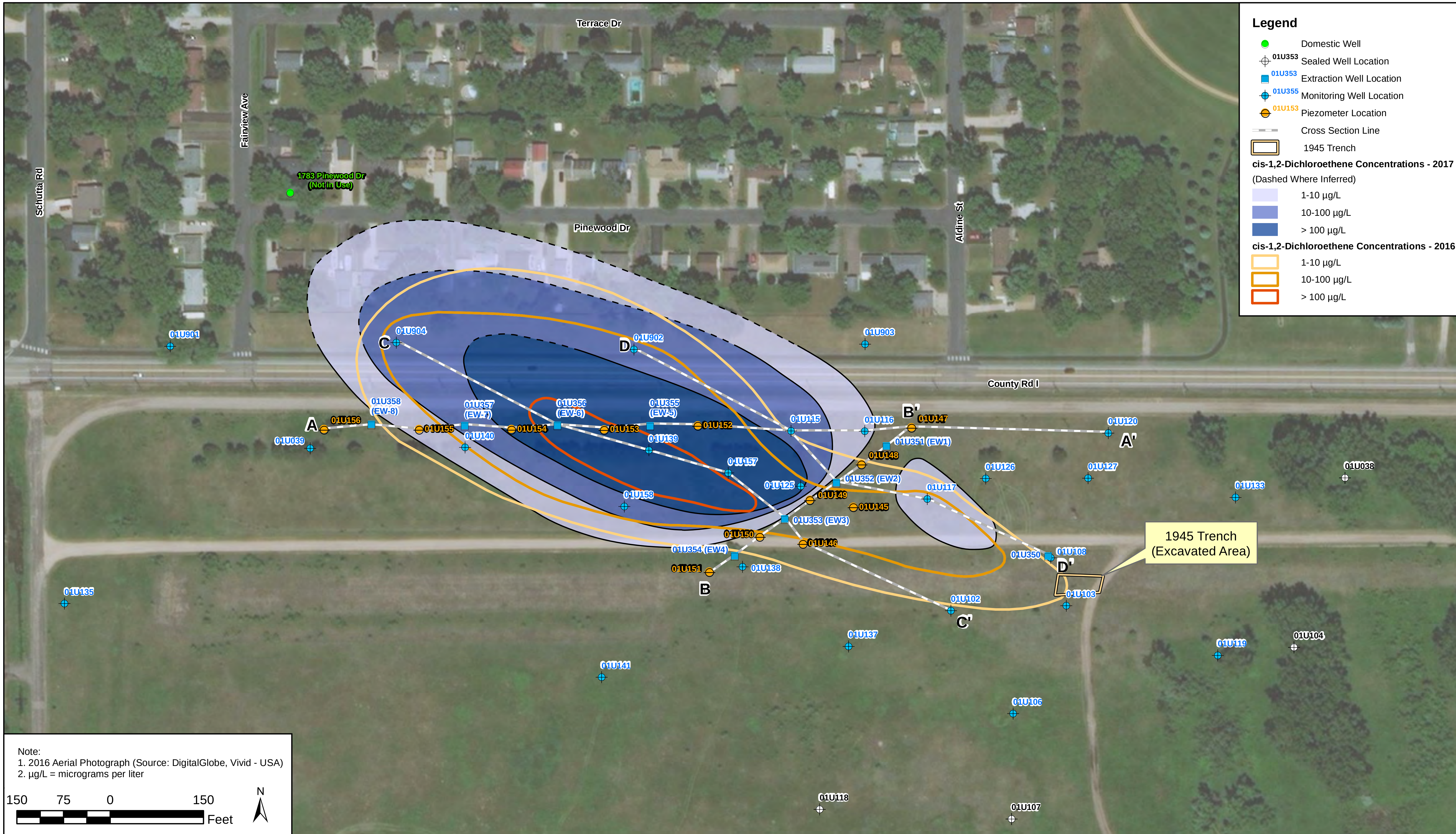
Note:
1. Results shown in parenthesis were not used for contouring purposes.
2. Results shown are from groundwater samples collected between June 14th-June 20th, 2017
3. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
4. µg/L = micrograms per liter

150 75 0 150 Feet

N

ANNUAL PERFORMANCE REPORT	PIKA ARCADIS a joint venture	FY 2017
Site A, Unit 1, cis-1,2-Dichloroethene Isoconcentration Map, Summer 2017		Figure 6-4

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site A cis-1,2 DCE Plume Map_FY2017.mxd
Date: 2/5/2018 Time: 12:01:20 PM User: mgress



ANNUAL PERFORMANCE REPORT

Site A, Unit 1, cis-1,2-Dichloroethene Plume Comparison

PIKA ARCADIS a joint venture

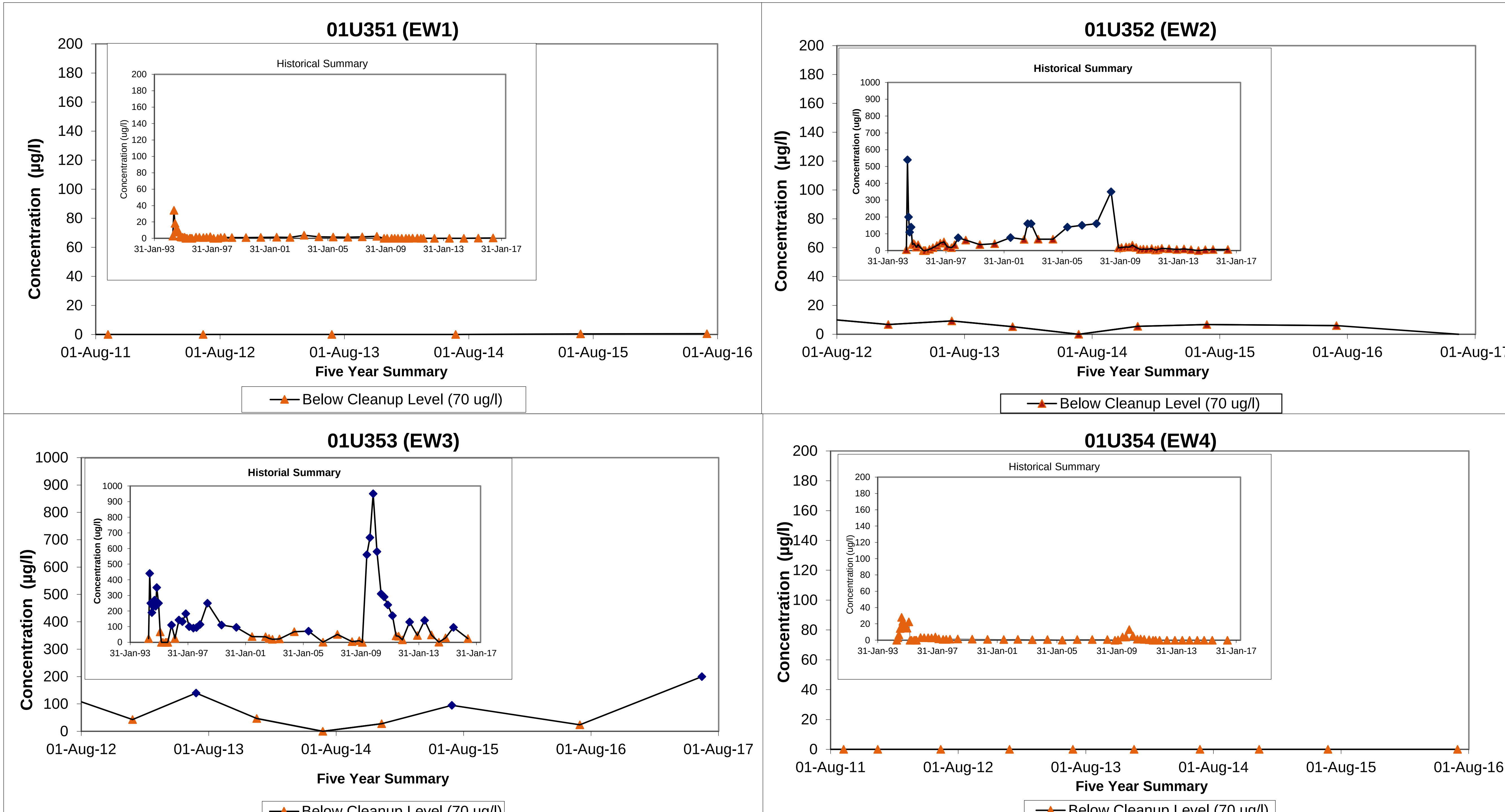
FY 2017

Figure 6-5

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site A cis-1,2 DCE Plume Comparison Map_FY2017.mxd
Date: 5/15/2018 Time: 12:44:07 PM User: mgress

Figure 6-6
Site A, cis-1,2-Dichloroethene Water Quality Trends: Extraction Wells 1-4

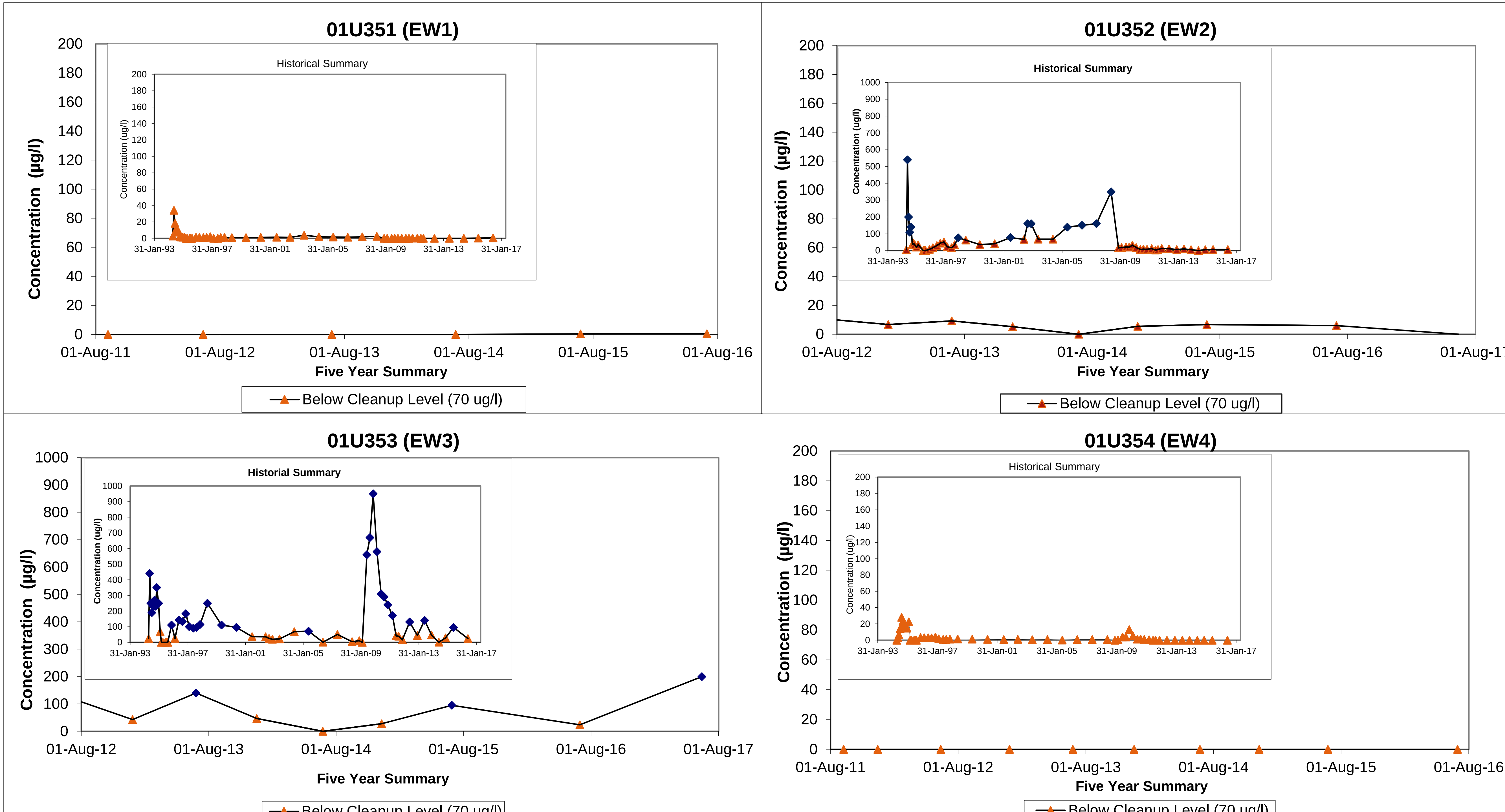
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota



Acronyms and Abbreviations:
EW = Extraction Well
µg/L = micrograms per liter

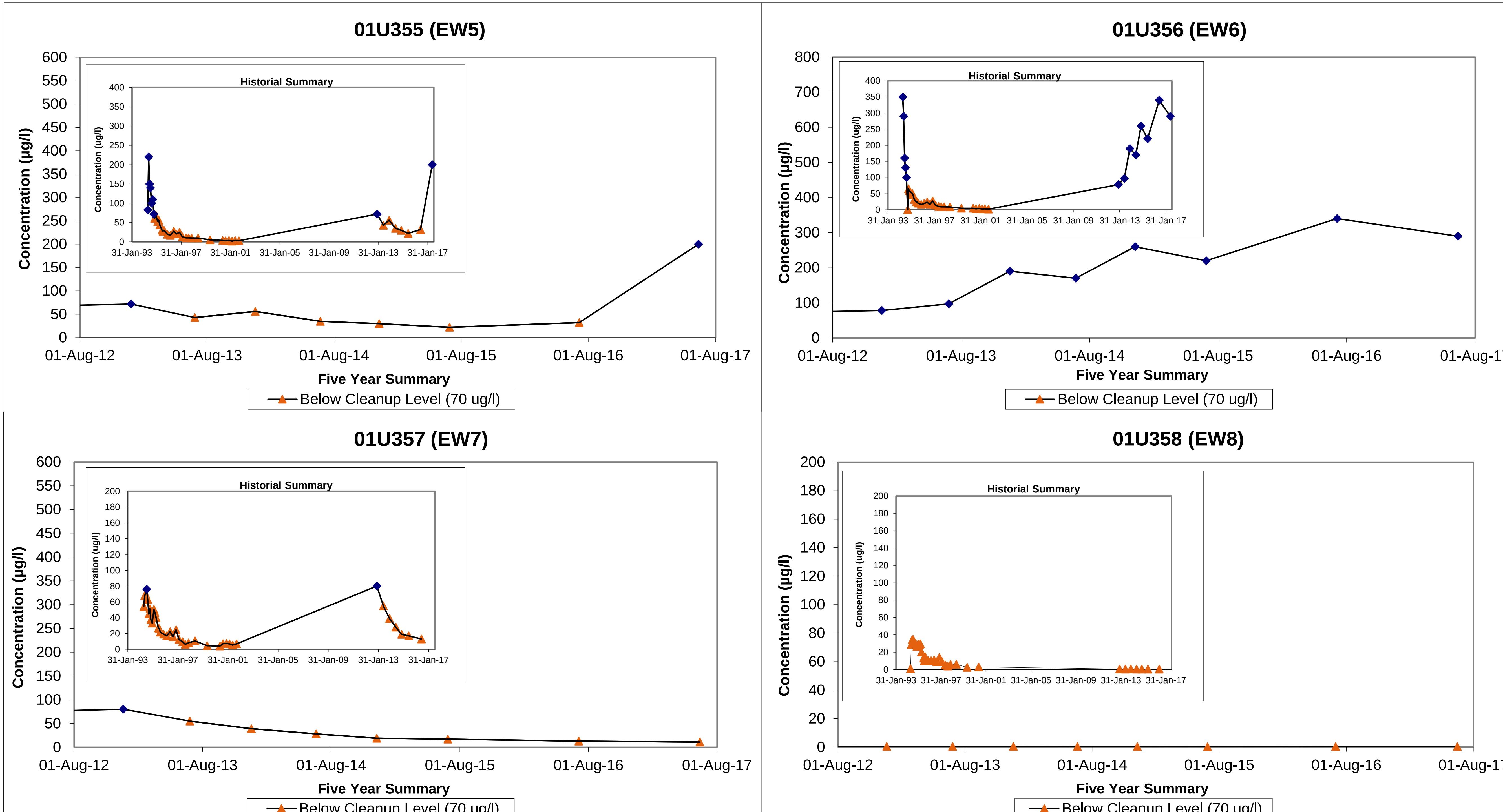
Figure 6-7
Site A, cis-1,2-Dichloroethene Water Quality Trends: Extraction Wells 1-4

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota



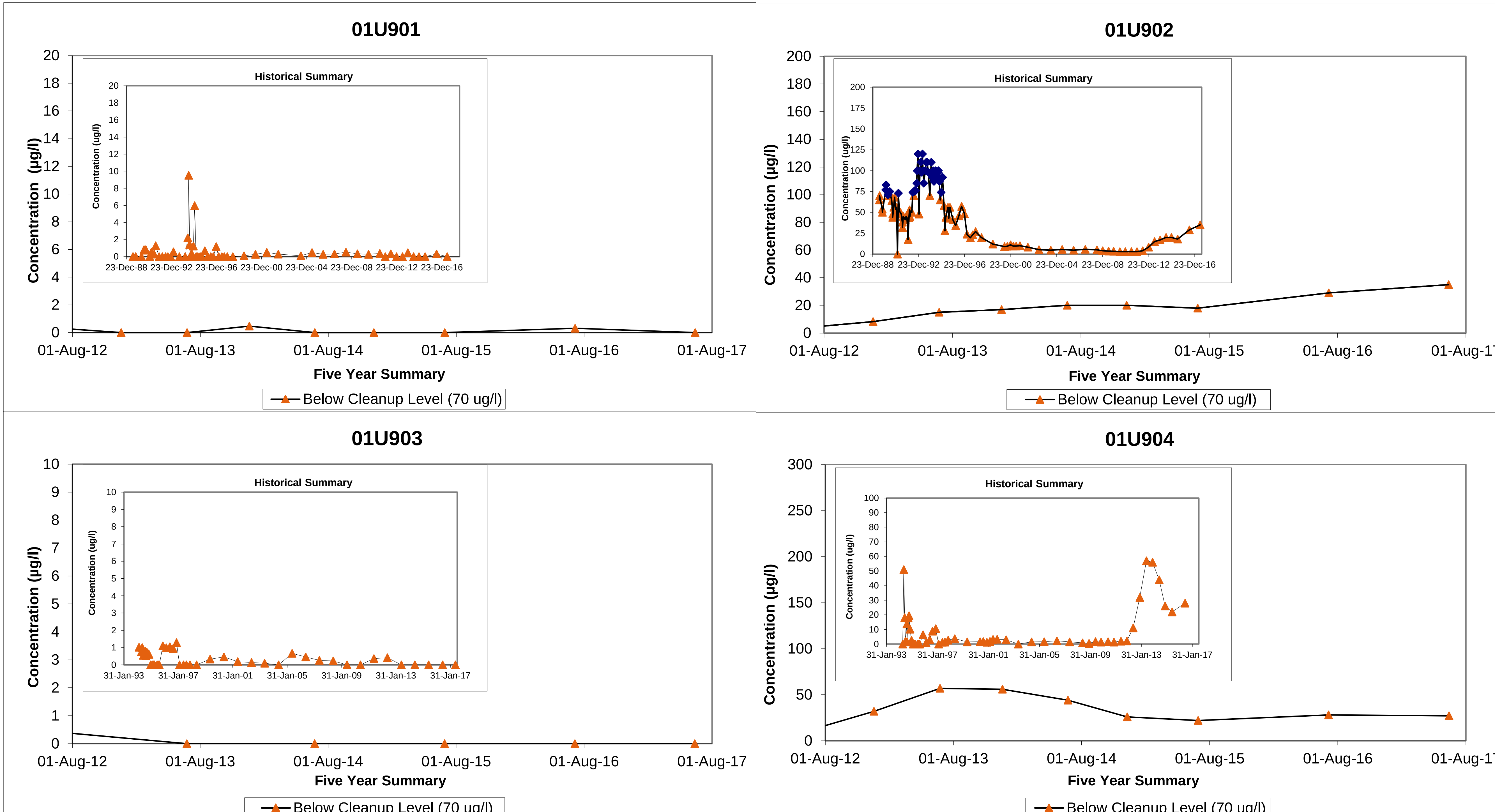
Acronyms and Abbreviations:
EW = Extraction Well
µg/L = micrograms per liter

Figure 6-8
Site A, cis-1,2-Dichloroethene Water Quality Trends: Extraction Wells 5-8
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

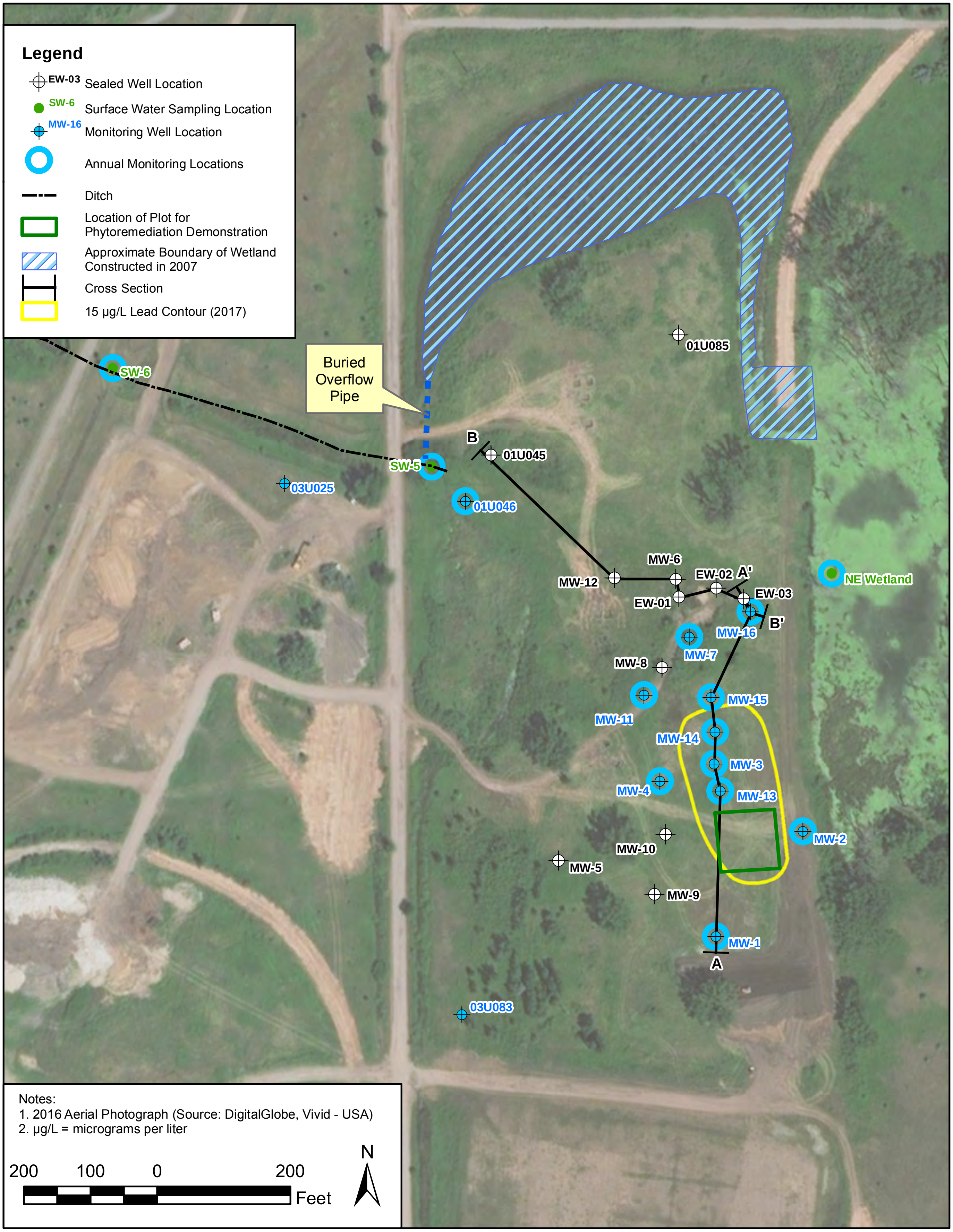


Acronyms and Abbreviations:
EW = Extraction Well
µg/L = micrograms per liter

Figure 6-9
Site A, cis-1,2-Dichloroethene Water Quality Trends: Contingency Locations
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota



Acronyms and Abbreviations:
µg/L = micrograms per liter



ANNUAL PERFORMANCE REPORT

Site C Monitoring Plan

PIKA ARCADIS a joint venture

FY 2017

Figure 7-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site C Site Plan_FY2017.mxd
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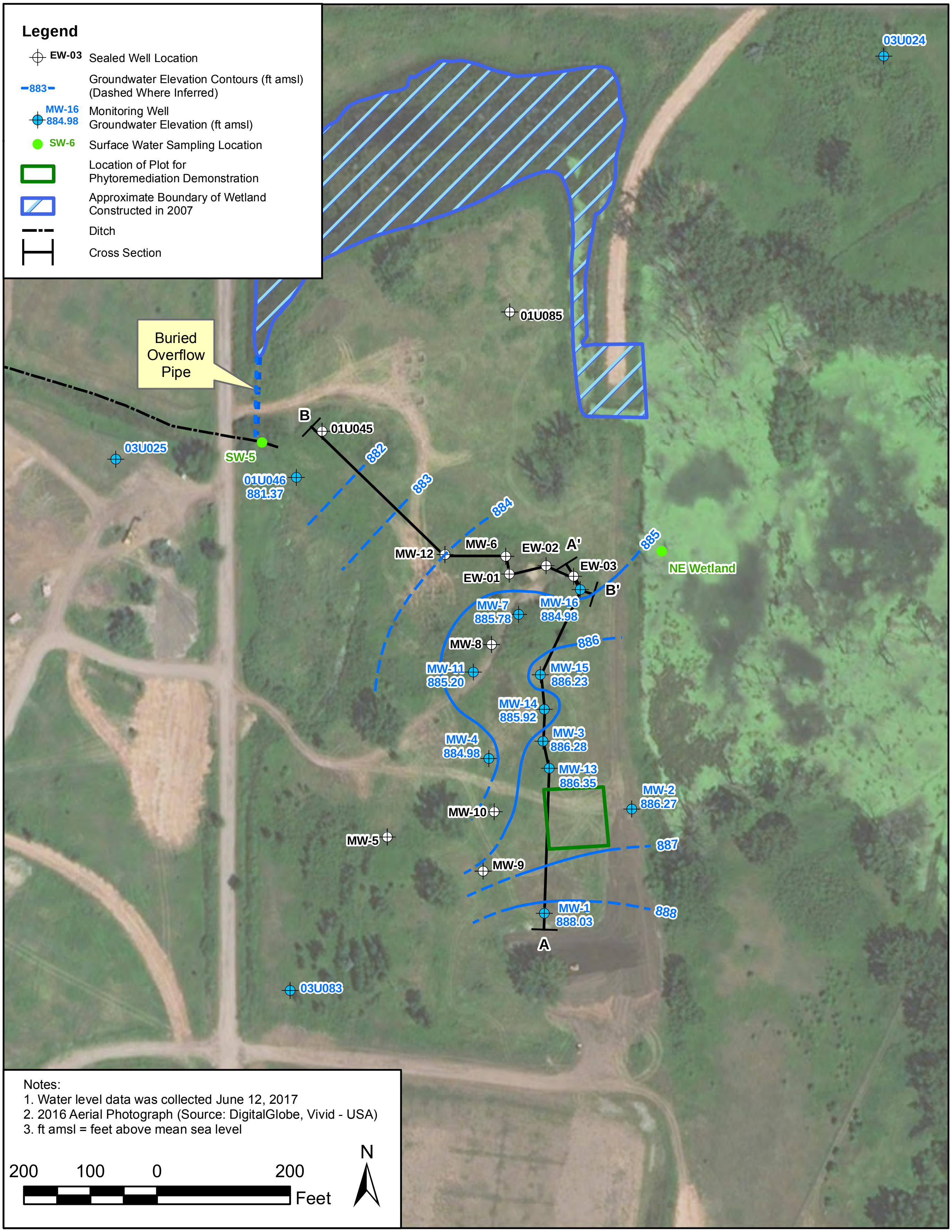


ANNUAL PERFORMANCE REPORT

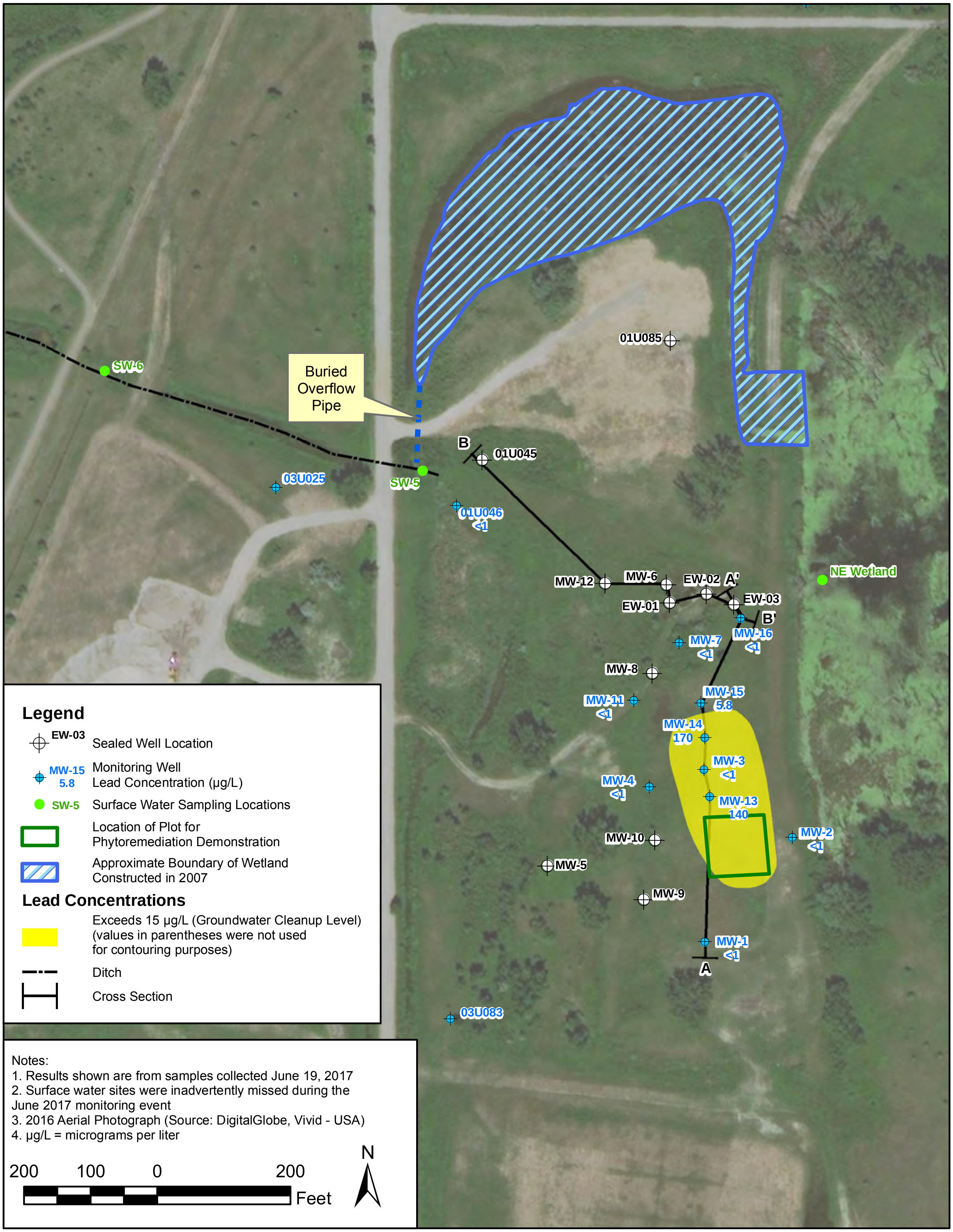
Site C, Unit 1, Potentiometric Map, June 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 7-2

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site C Potentiometric Map_FY2017.mxd
Date: 1/30/2018 Time: 2:54:55 PM User: mgress



ANNUAL PERFORMANCE REPORT

Site C, Unit 1, Lead Results,
Summer 2017

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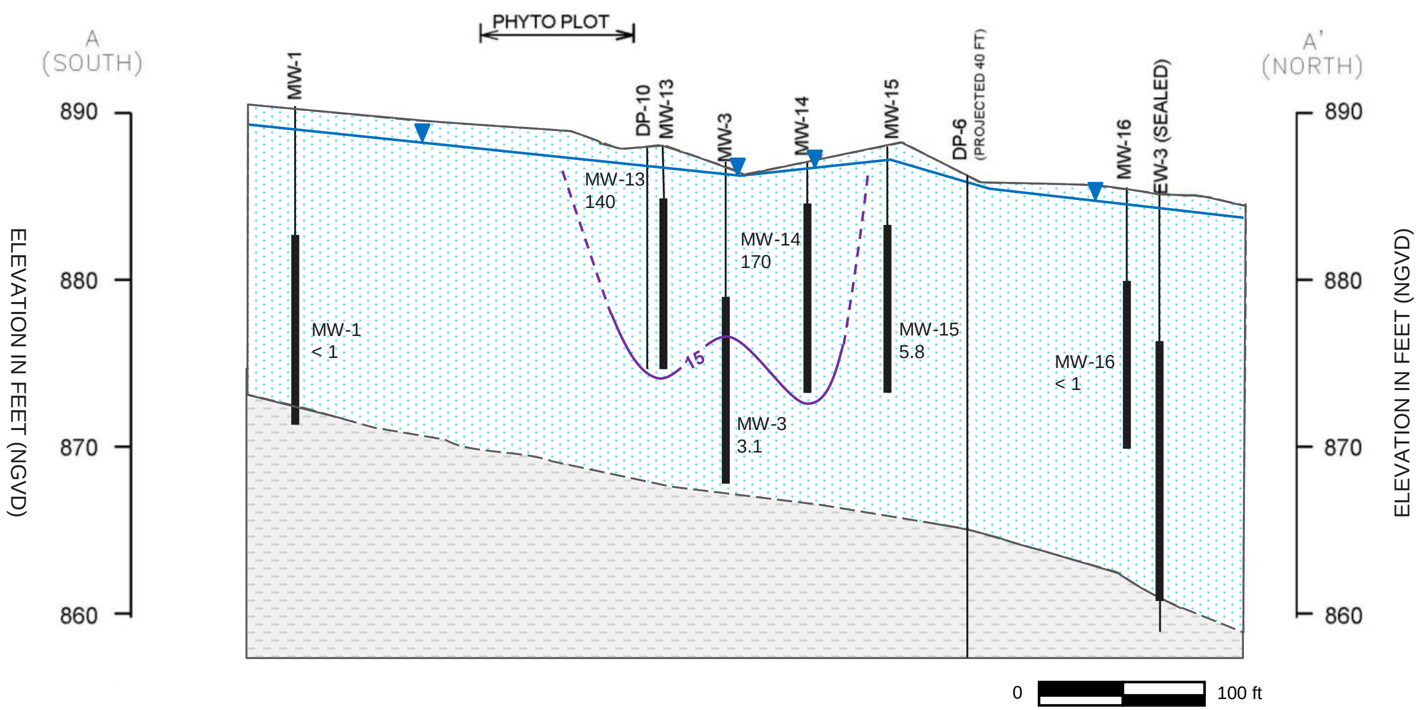
FY 2017

Figure 7-3

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site C Lead in GW_FY2017.mxd
Date: 5/15/2018 Time: 12:51:54 PM User: mgress

Figure 7-4
Site C Cross Section A-A'

U.S Army - TCAAP
Arden Hills, Minnesota

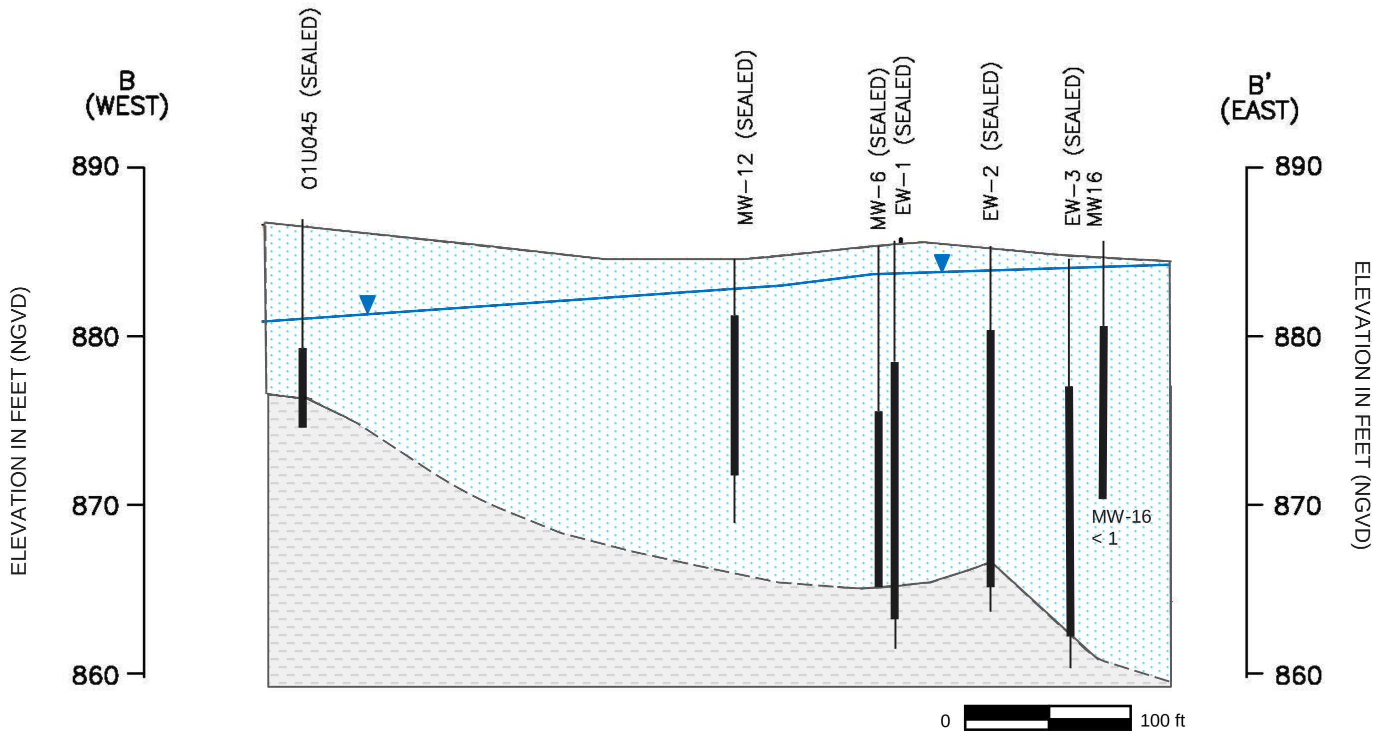


Legend

Upper Unit 1
Upper Unit 2
Water Table
Screened Interval
Geologic Contact (inferred where dashed)
MW-3 Well ID
µg/L Micrograms per Liter
15 µg/L Dissolved Lead Concentration Contour (Groundwater Cleanup Level) dashed where inferred
1.6 Dissolved Lead (µg/L) – June 2017
NGVD National Geodetic Vertical Datum

Figure 7-5
Site C Cross Section B-B’

U.S Army - TCAAP
Arden Hills, Minnesota

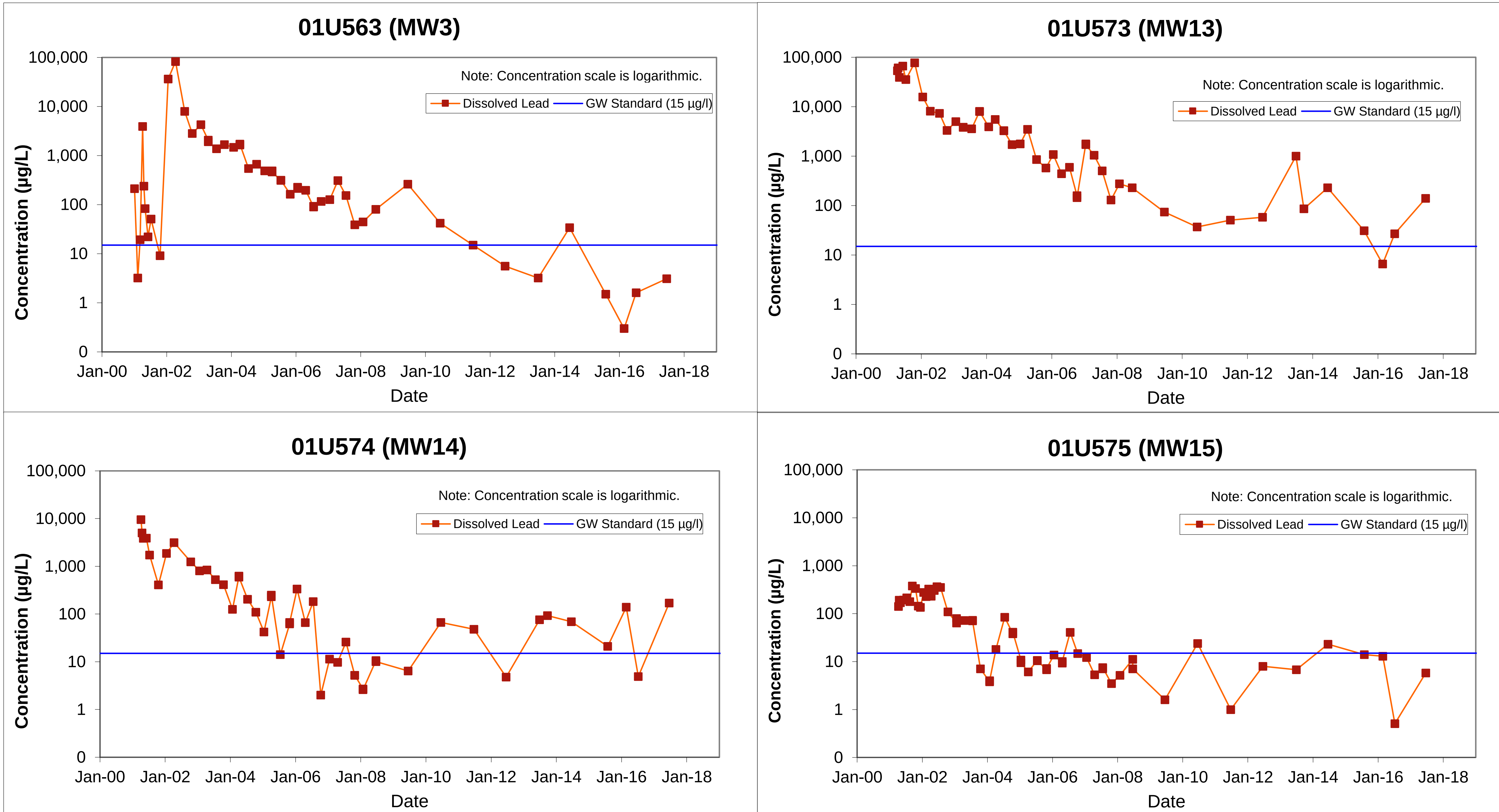


Legend

Upper Unit 1	
Upper Unit 2	
Water Table	
Screened Interval	
Geologic Contact (inferred where dashed)	
MW-6	Well ID
µg/L	Micrograms per Liter
0.30 U	Dissolved Lead (µg/L) – July 2017
NGVD	National Geodetic Vertical Datum

Figure 7-6
Dissolved Lead

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota



Acronyms and Abbreviations:
MW = monitoring well
µg/L = micrograms per liter

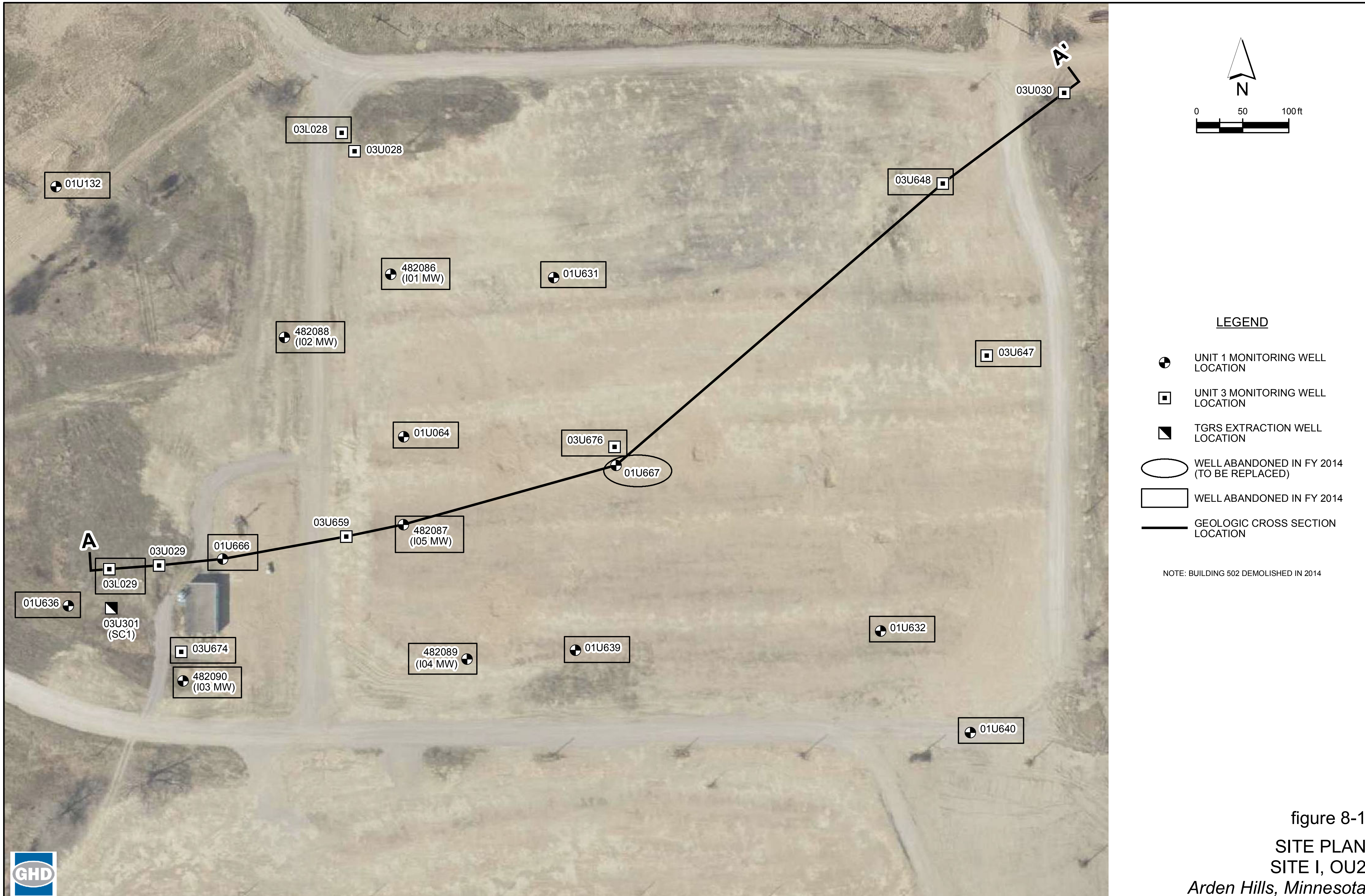
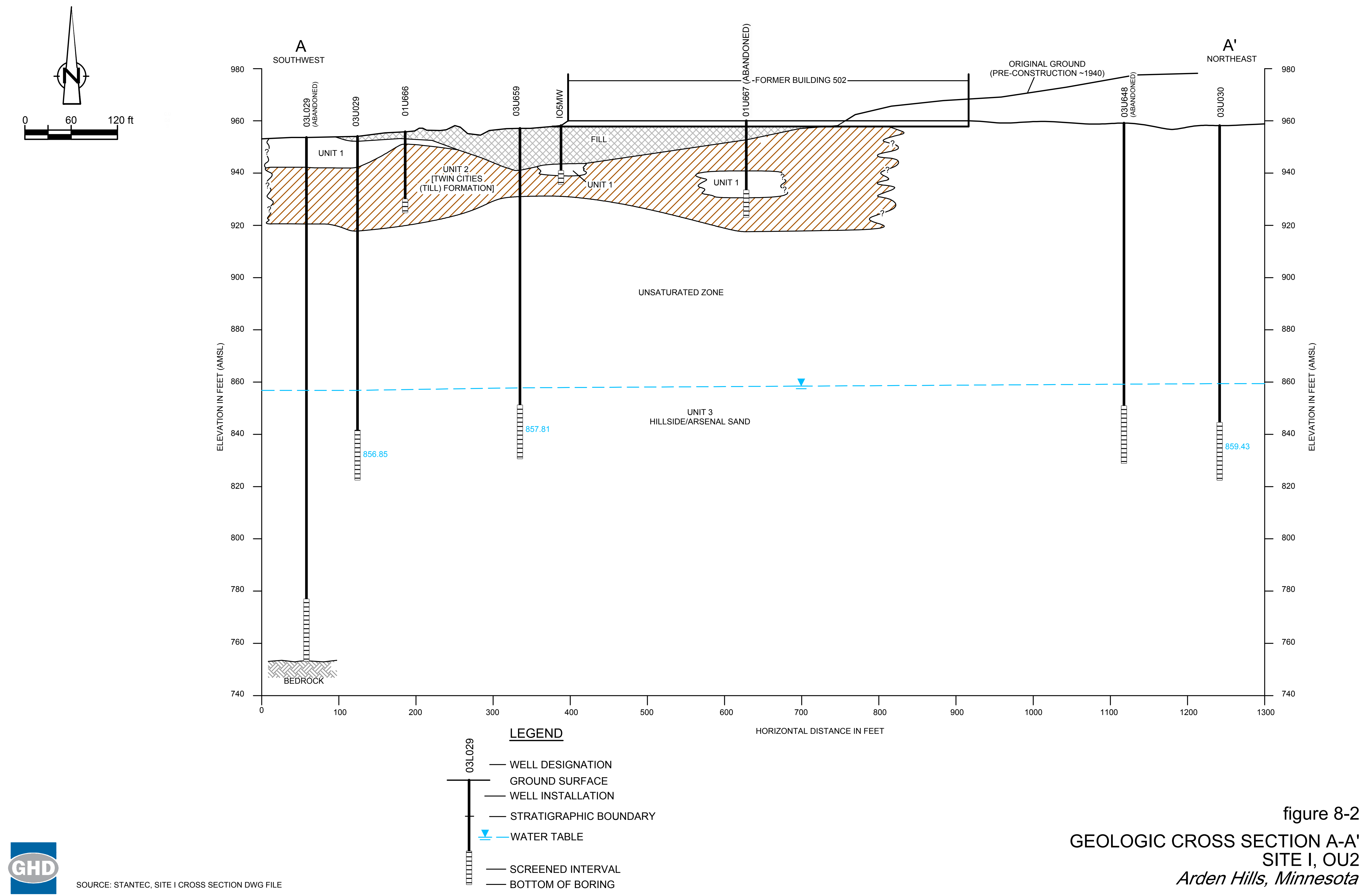


figure 8-1

SITE PLAN
SITE I, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP001 JAN 09/2018



SOURCE: STANTEC, SITE I CROSS SECTION DWG FILE

figure 8-2

GEOLOGIC CROSS SECTION A-A'
SITE I, OU2
Arden Hills, Minnesota

11155360-43(001)GN-WA001 DEC 14, 2017

LEGEND

4.7/300	FY 2013 TCE / VINYL CHLORIDE CONCENTRATION (µg/L)
J	ESTIMATED CONCENTRATION
( )	DUPLICATE RESULTS
ND	ANALYTE NOT DETECTED
NS	WELL NOT SAMPLED
⊕	UNIT 1 MONITORING WELL

figure 8-3

TCE AND VINYL CHORIDE CONCENTRATIONS - FY 2013
SITE I, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP002 JAN 22/2018

LEGEND

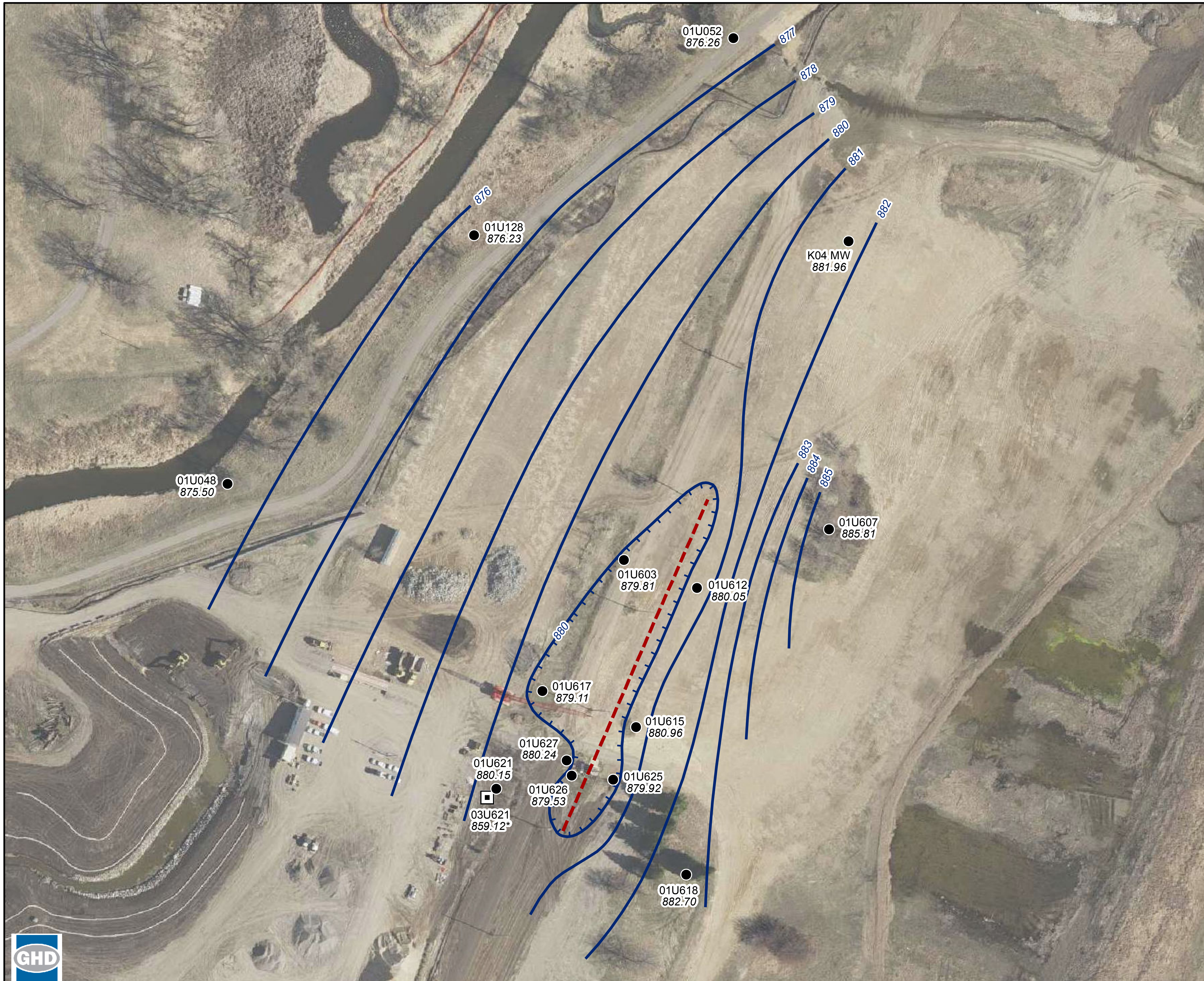
- ANNUAL UNIT 1 WATER QUALITY MONITORING WELL LOCATION
- ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION
- UNIT 3 SENTINAL WELL LOCATION
- WELL ABANDONED DURING REDEVELOPMENT
- ABANDONED WELL TO BE REPLACED
- SITE K COLLECTION TRENCH LOCATION
- HYDROGEOLOGIC CROSS SECTION LOCATION

NOTE:
BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

figure 9-1

SITE PLAN
SITE K, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP003 JAN 23/2018



N

0 40 80 120 ft

LEGEND

882.16 GROUNDWATER ELEVATION

* NOT USED FOR CONTOURING

GROUNDWATER ELEVATION CONTOUR

ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION

UNIT 3 SENTINAL WELL LOCATION

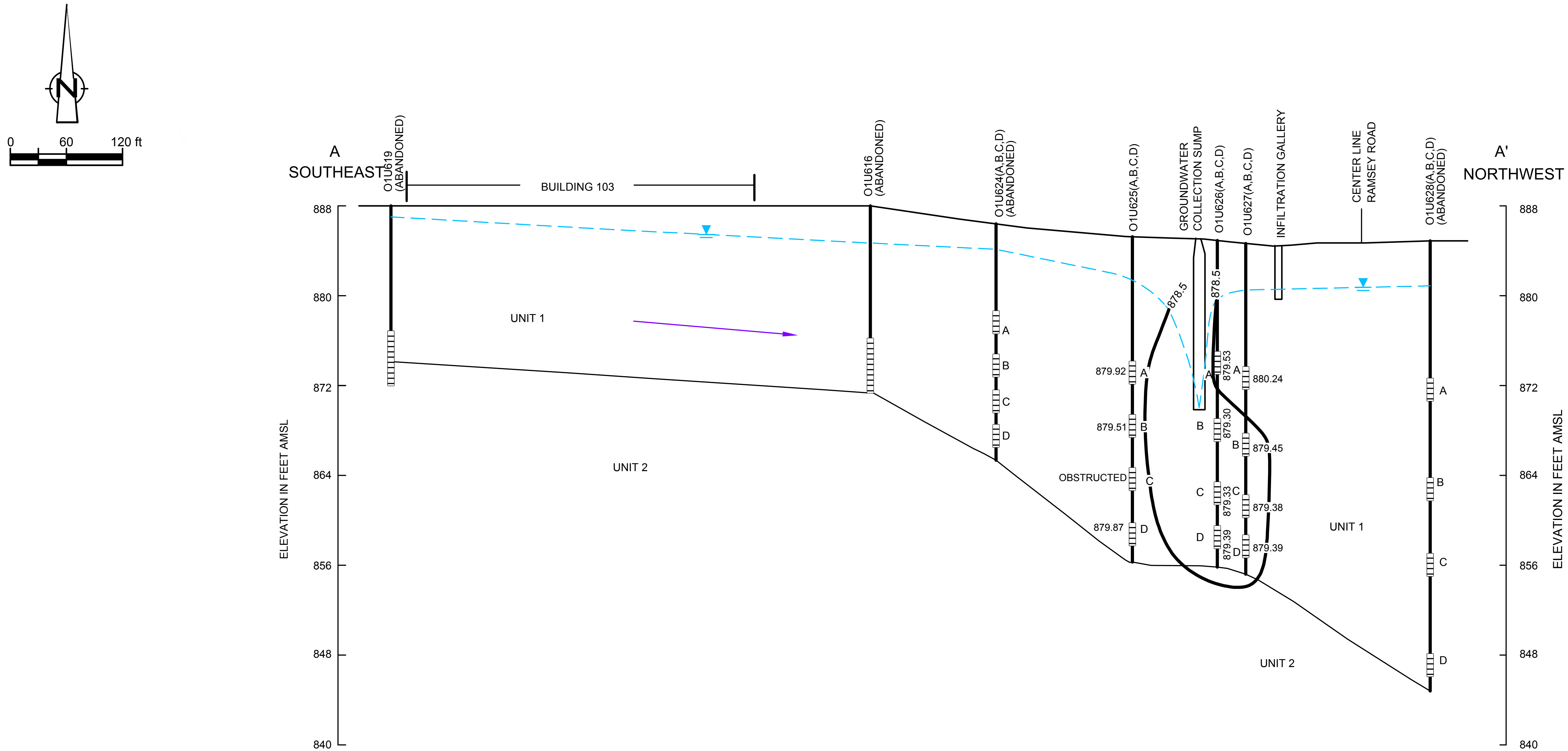
SITE K COLLECTION TRENCH LOCATION

NOTE:
BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

figure 9-2

GROUNDWATER CONTOURS
UNIT 1 - JUNE 2017
SITE K, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP004 JAN 09/2018



LEGEND

O1U619
WELL DESIGNATION
GROUND SURFACE
WELL INSTALLATION
STRATIGRAPHIC BOUNDARY
APPROXIMATE GROUNDWATER LOCATION
SCREENED INTERVAL
BOTTOM OF BORING

SOURCE: STANTEC, SITE K CROSS SECTION DWG FILE

figure 9-3

HYDROGEOLOGIC CROSS SECTION A-A'
JUNE 2017 (Q127)
SITE K, OU2
Arden Hills, Minnesota

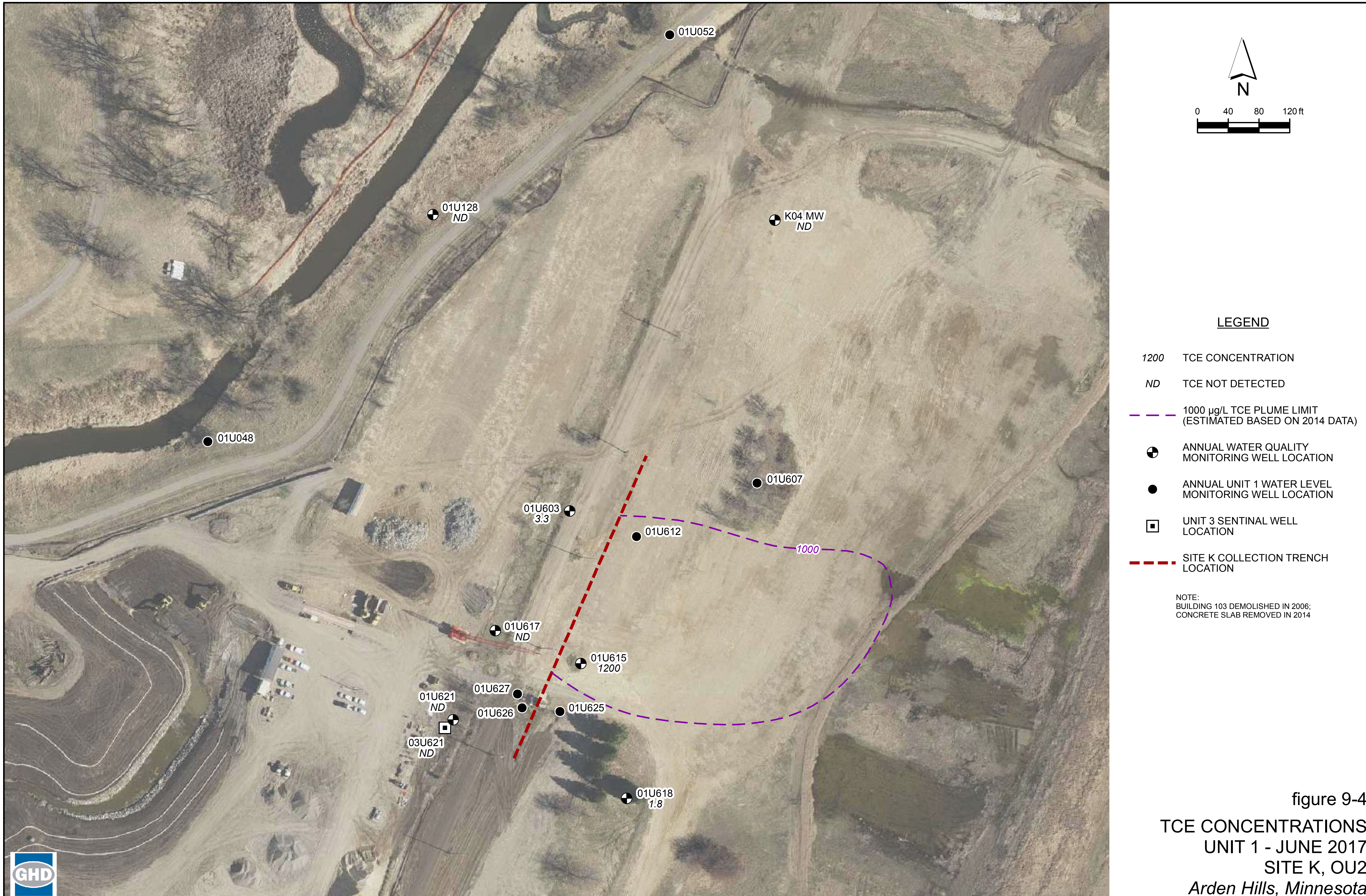


figure 9-4

TCE CONCENTRATIONS
UNIT 1 - JUNE 2017
SITE K, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP005 JAN 22/2018

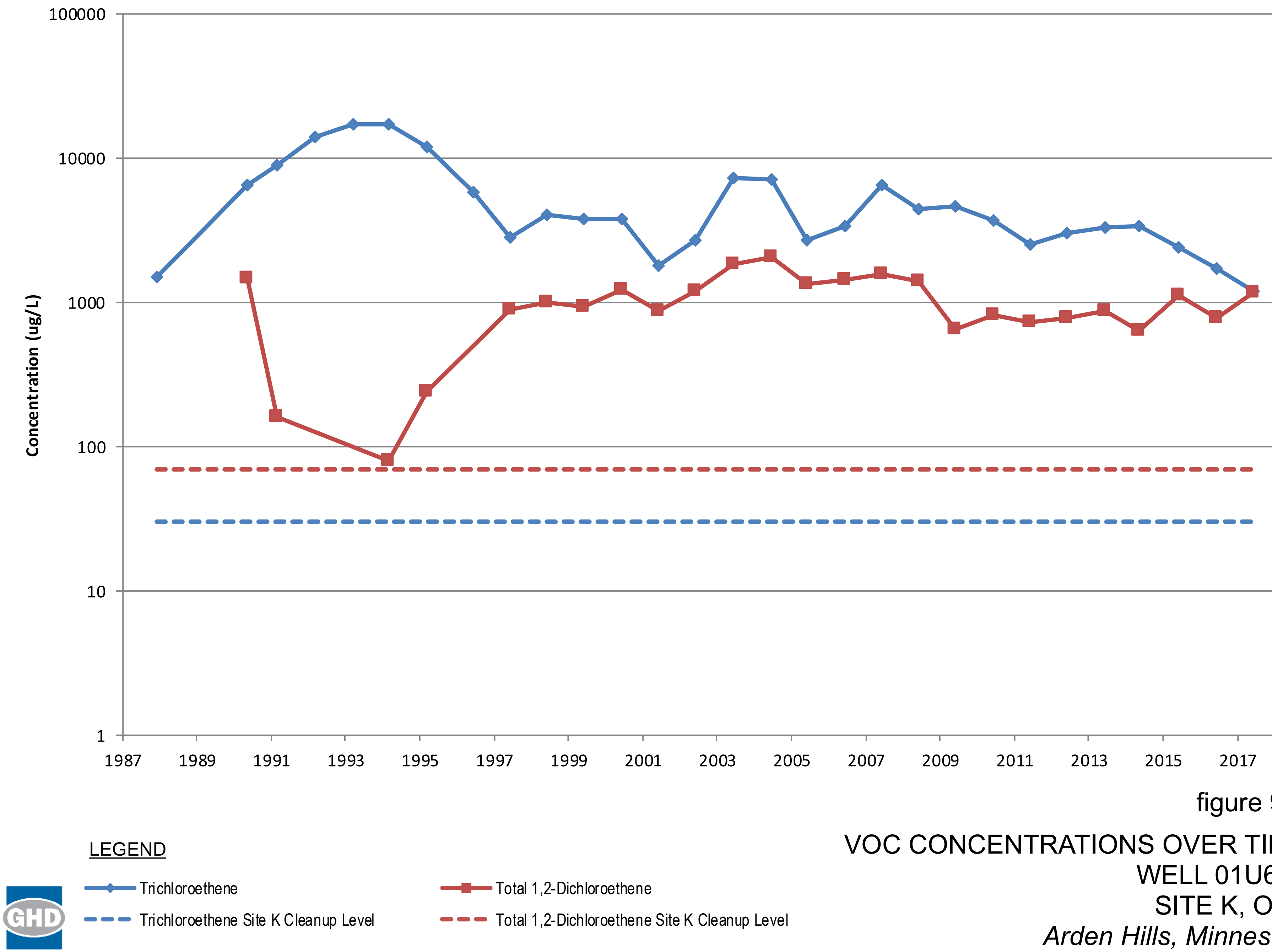
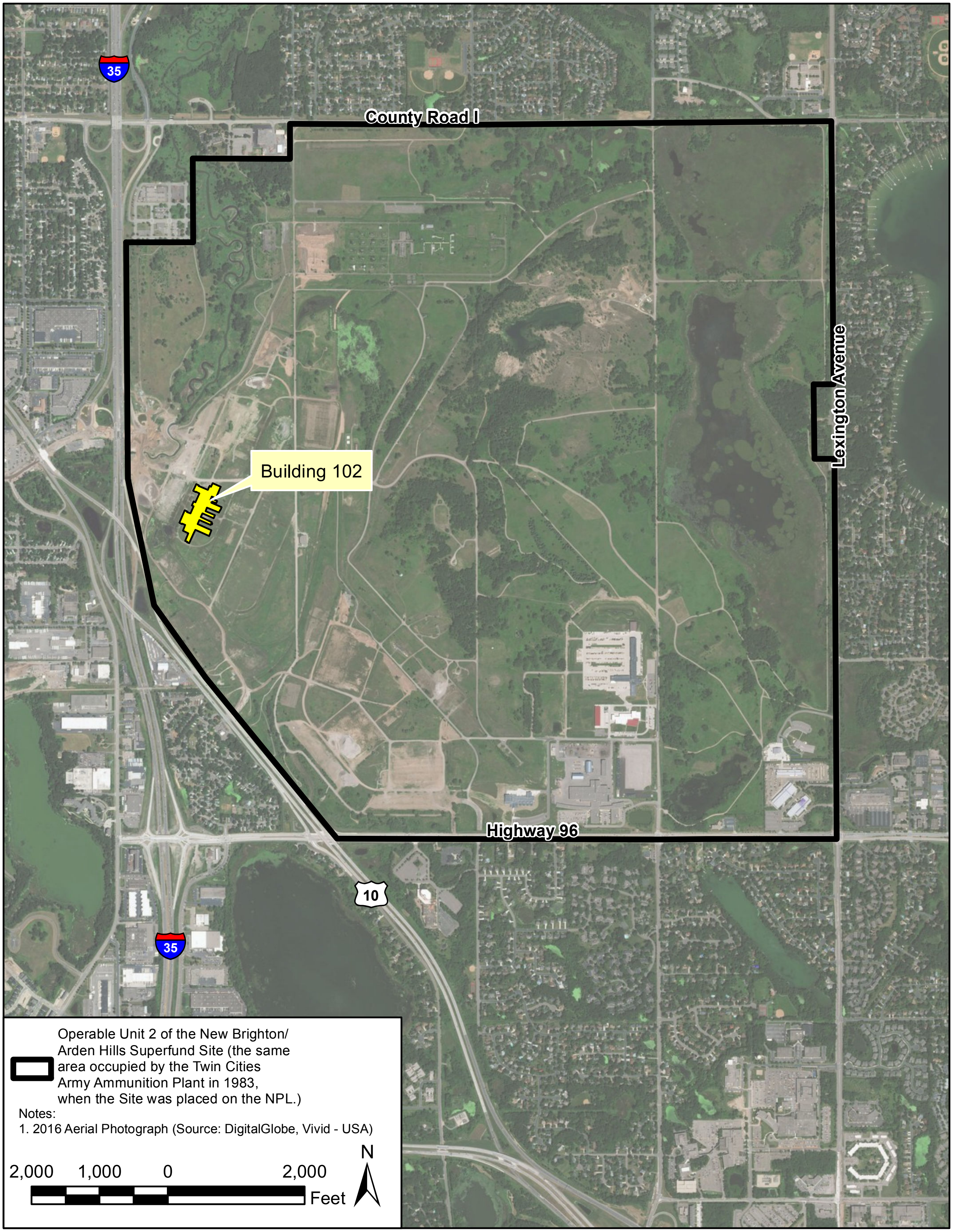


figure 9-5

VOC CONCENTRATIONS OVER TIME
WELL 01U615
SITE K, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP006 JAN 09/2018



ANNUAL PERFORMANCE REPORT

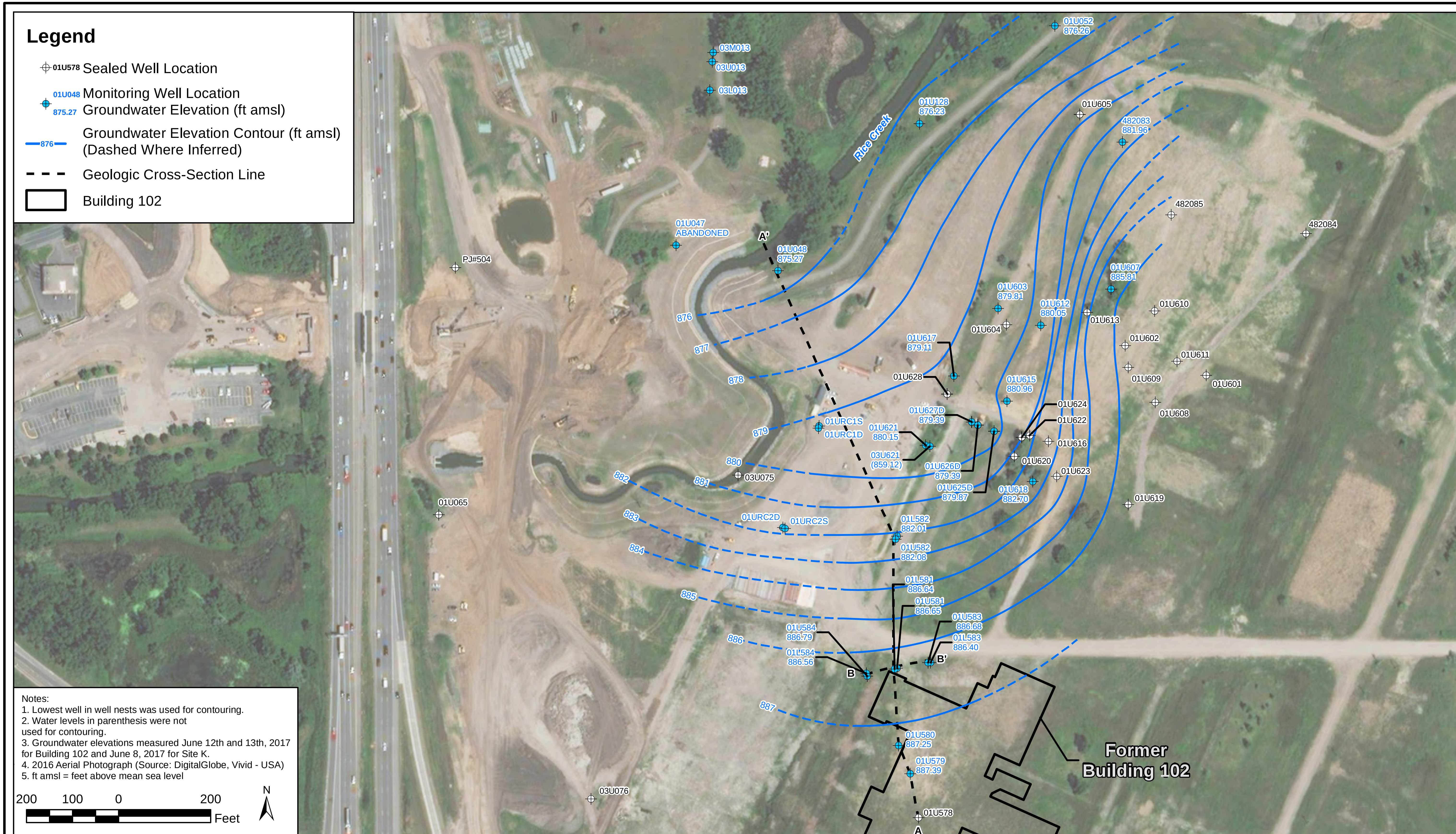
Location of Building 102

PIKA ARCADIS a joint venture

FY 2017

Figure 10-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Location Map_FY2017.mxd
Date: 1/24/2018 Time: 10:27:00 AM User: mgress



ANNUAL PERFORMANCE REPORT

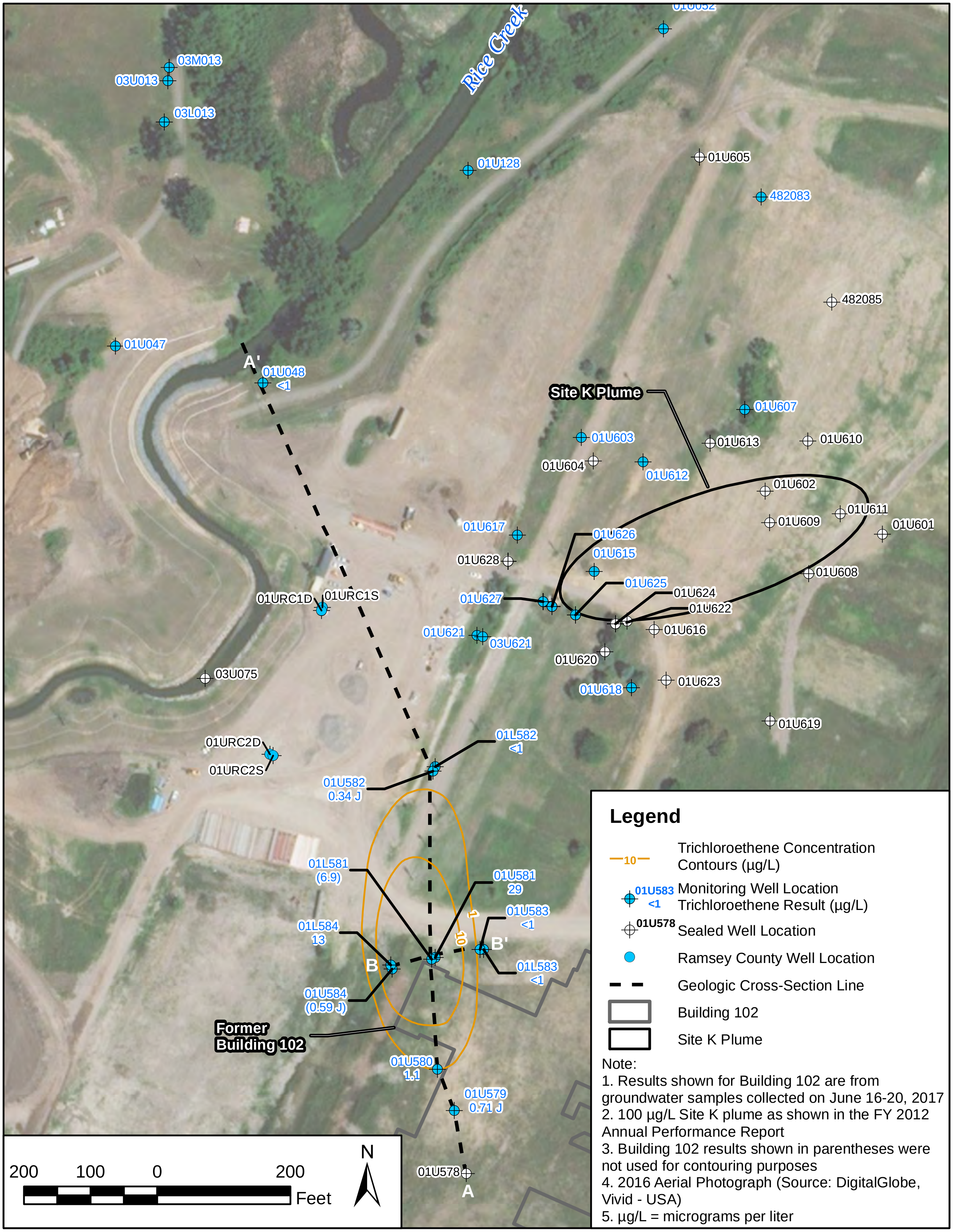
Building 102, Unit 1, Potentiometric Map, June 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 10-2

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Potentiometric Map_FY2017.mxd
Date: 1/30/2018 Time: 3:46:43 PM User: mgress



ANNUAL PERFORMANCE REPORT

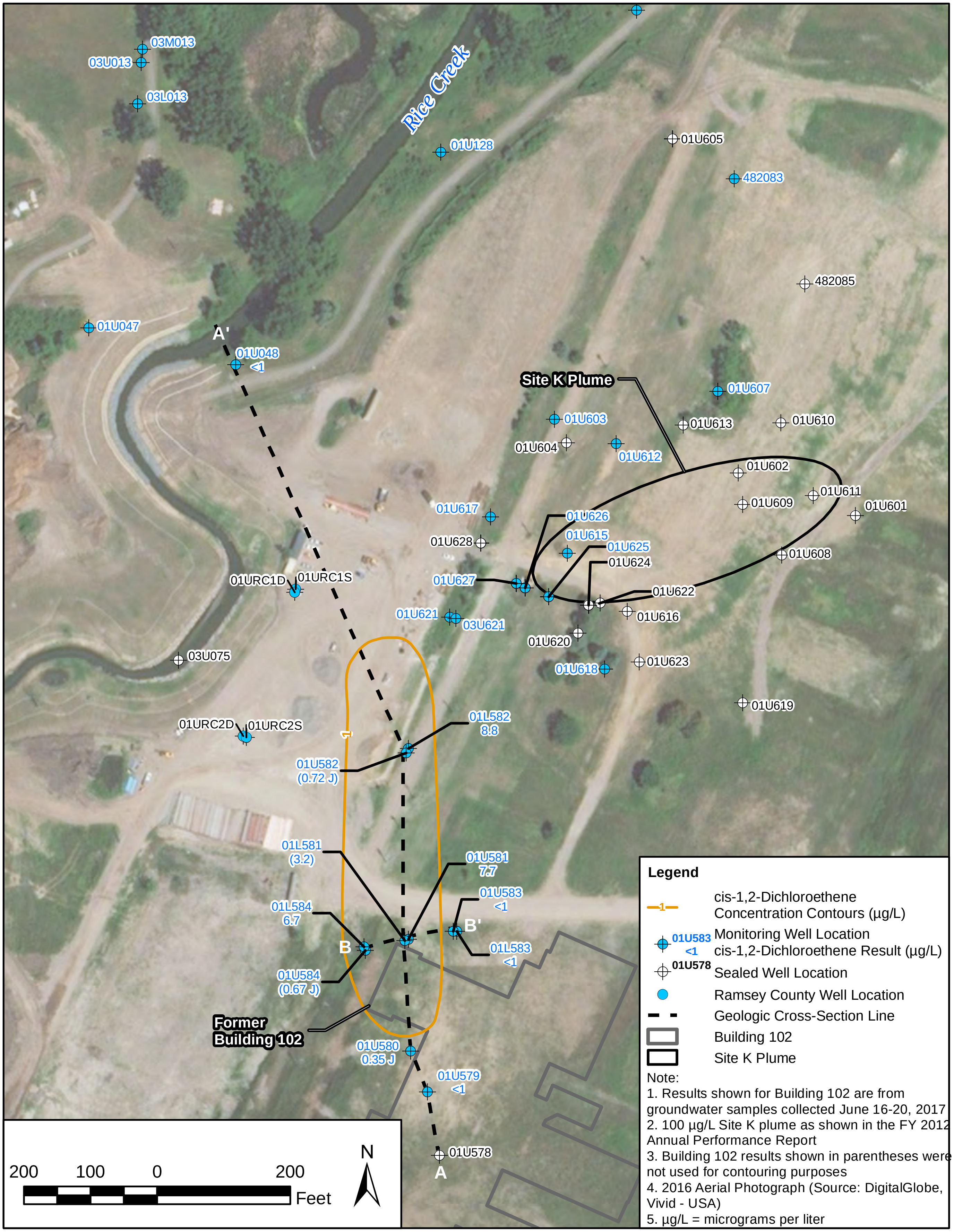
Building 102, Unit 1,
Trichloroethene Results, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 10-3

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Trichloroethene Results_FY2017.mxd
Date: 1/31/2018 Time: 8:15:37 AM User: mgress



ANNUAL PERFORMANCE REPORT

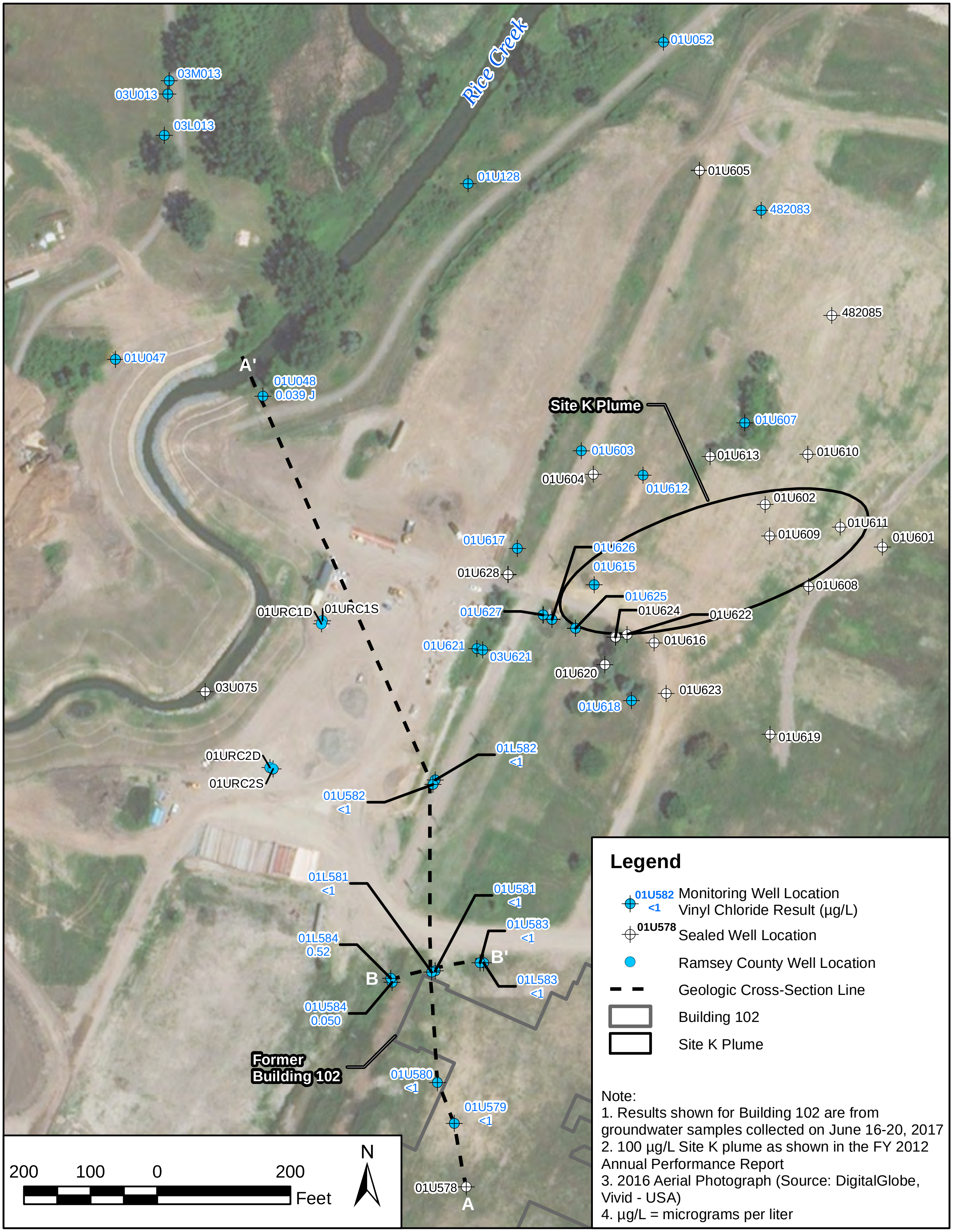
Building 102, Unit 1,
cis-1,2-Dichloroethene Results, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 10-4

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Cis Results_FY2017.mxd
Date: 1/31/2018 Time: 8:23:02 AM User: mgress



ANNUAL PERFORMANCE REPORT

Building 102, Unit 1,
Vinyl Chloride Results, Summer 2017

PIKA
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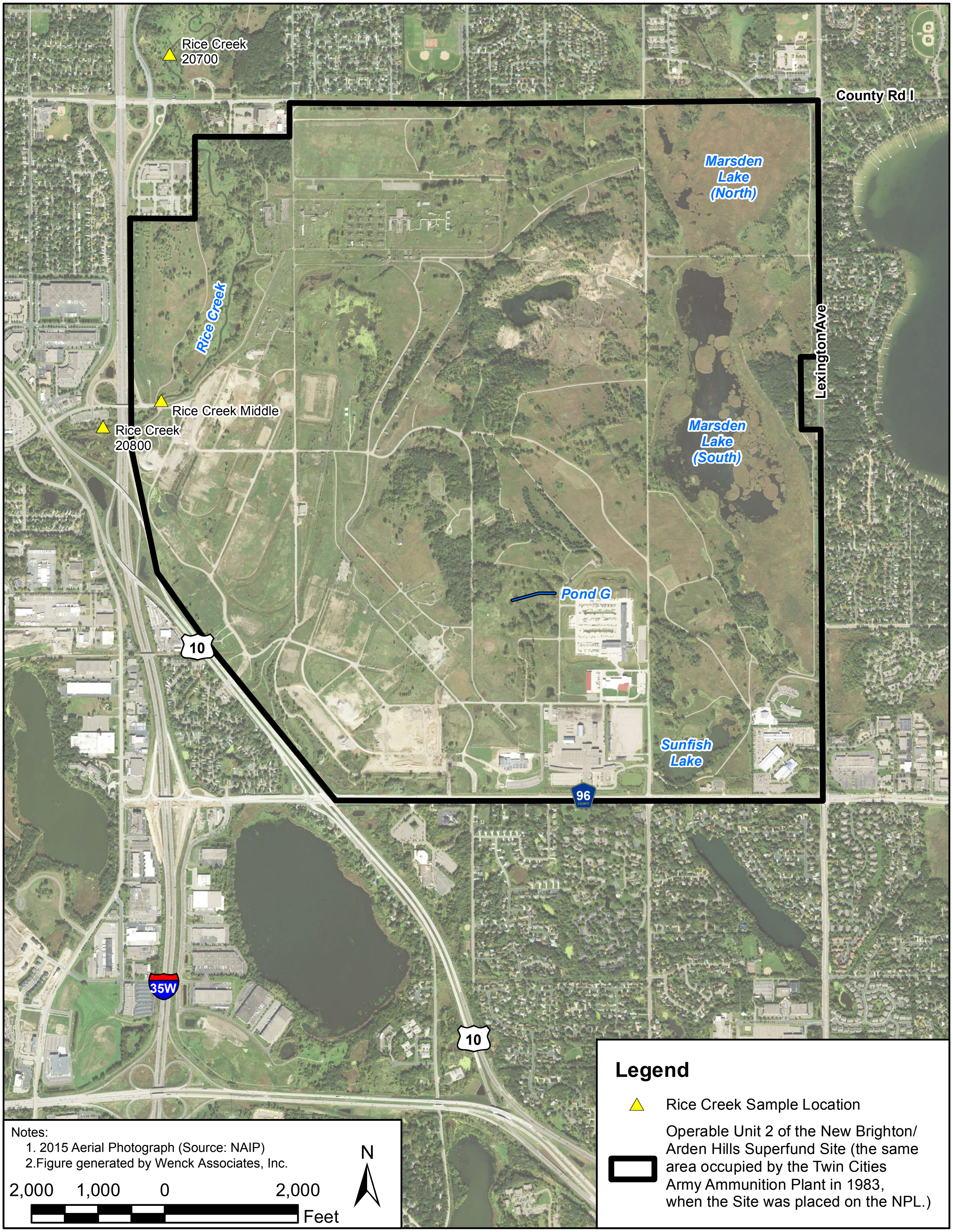
FY 2017

Figure 10-5

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Vinyl Results_FY2017.mxd
Date: 1/31/2018 Time: 8:27:18 AM User: mgress



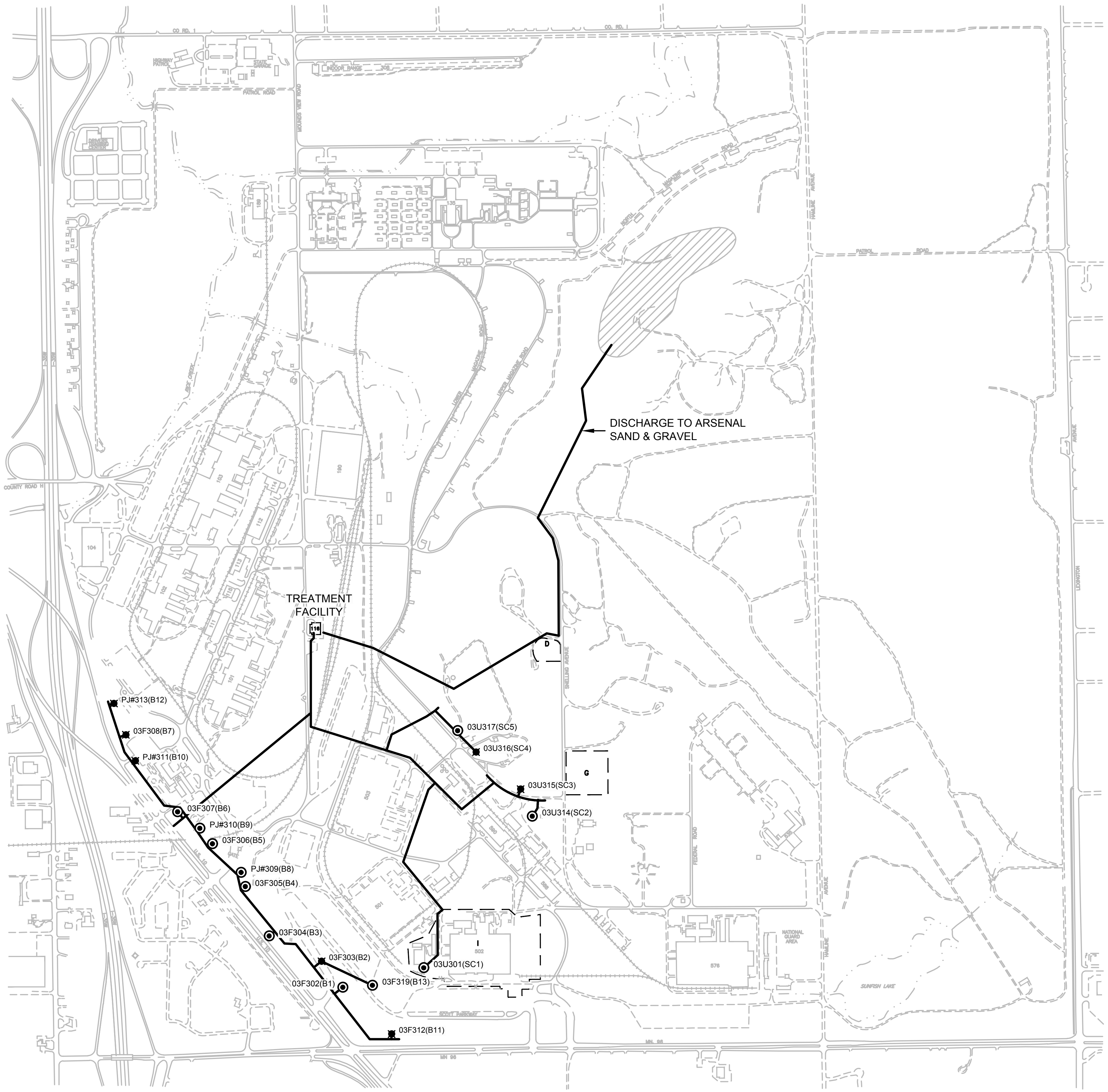
ANNUAL PERFORMANCE REPORT

OU2 Aquatic Sites and Sampling Locations

PIKA ARCADIS a joint venture

FY 2016

Figure 11-1



0 400 1200ft

LEGEND

PRIMARY ROAD
SECONDARY ROAD
RAILROAD
DRAINAGE
BUILDING
BUILDING REMOVED
SOURCE AREA
ACTIVE EXTRACTION WELL LOCATION
INACTIVE EXTRACTION WELL LOCATION

EXTRACTION WELL NAME CROSS REFERENCE

B1	03F302
B2	03F303
B3	03F304
B4	03F305
B5	03F306
B6	03F307
B7	03F308
B8	PJ#309
B9	PJ#310
B10	PJ#311
B11	03F312
B12	PJ#313
B13	03F319
SC1	03U301
SC2	03U314
SC3	03U315
SC4	03U316
SC5	03U317

figure 12-1

TGRS LAYOUT
OPERABLE UNIT 2
Arden Hills, Minnesota

GHD

11155360-43(001)GN-WA002 DEC 14, 2017

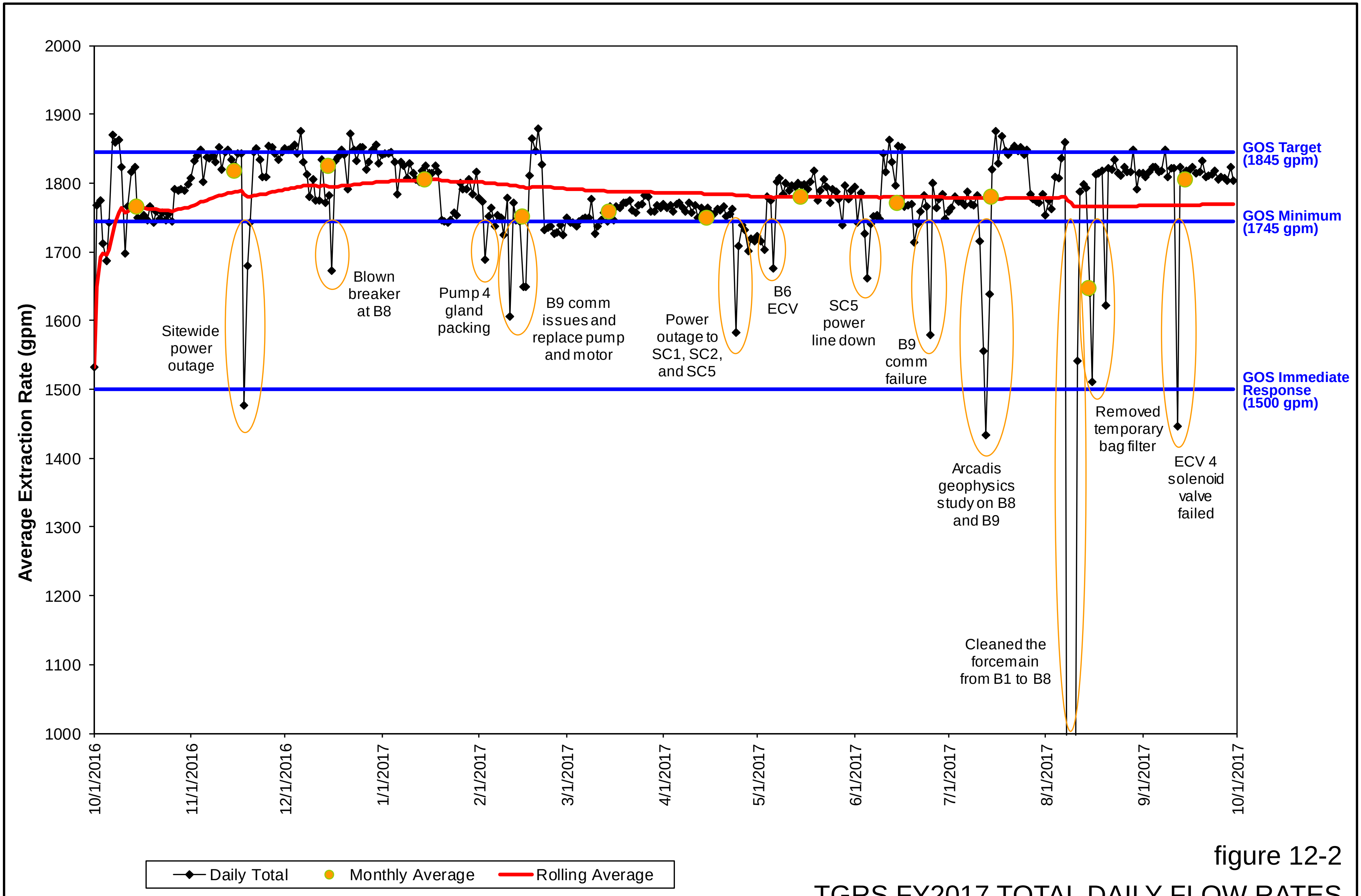
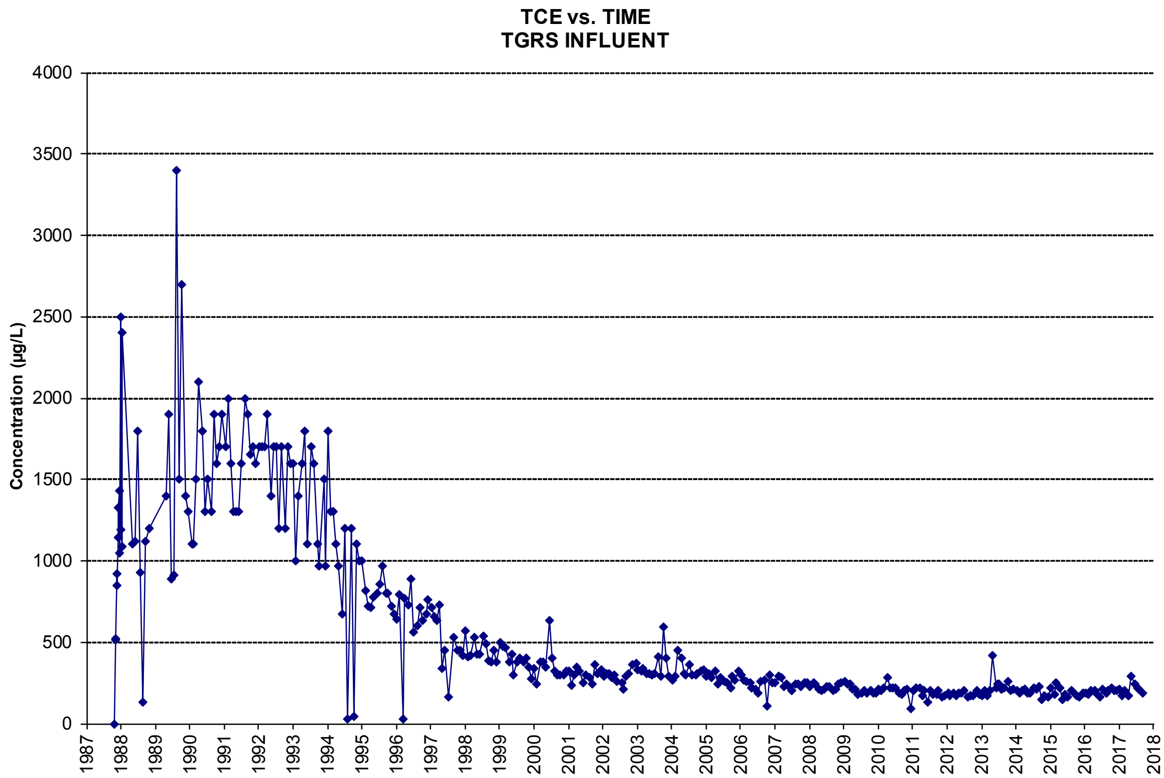
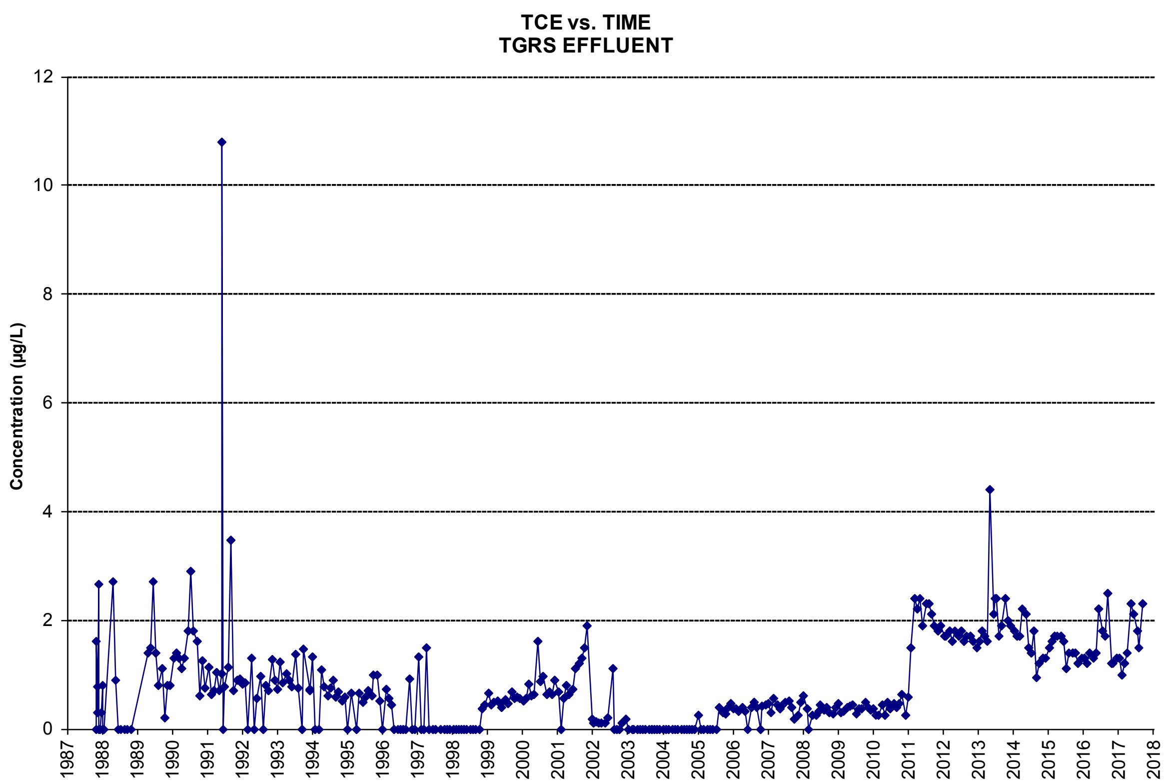


figure 12-2

TGRS FY2017 TOTAL DAILY FLOW RATES
OPERABLE UNIT 2
Arden Hills, Minnesota

11155360-43(001)GIS-SP007 JAN 10/2018





NOTE: SAMPLES REPORTING CONCENTRATIONS OF NON-DETECT WERE PLOTTED AS ZERO. WHEN DUPLICATE SAMPLES WERE COLLECTED, THE HIGHER CONCENTRATION WAS REPORTED.

figure 12-3

TGRS TREATMENT SYSTEM PERFORMANCE
OPERABLE UNIT 2
Arden Hills, Minnesota

GHD

11155360-43(001)GIS-SP008 JAN 22/2018

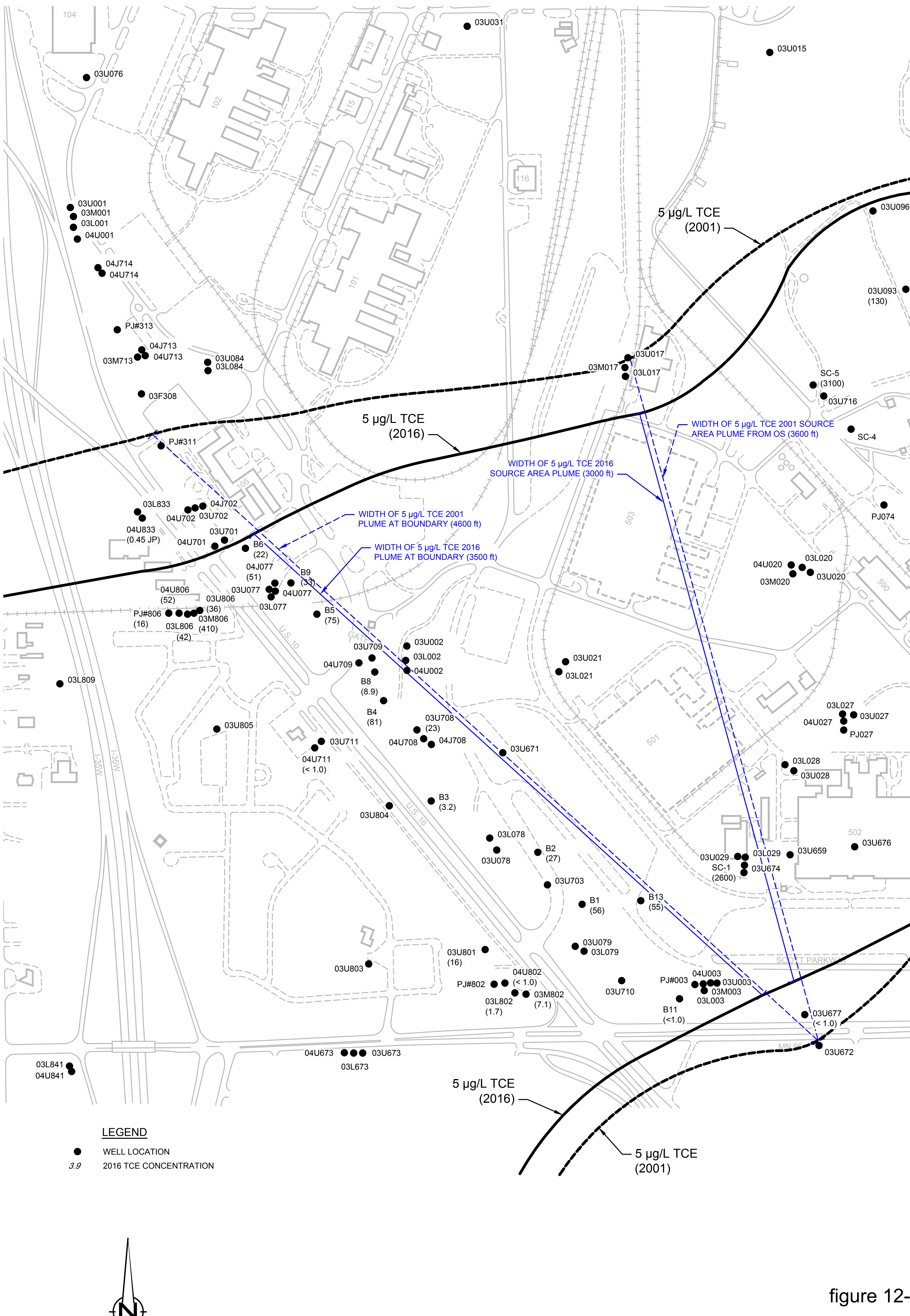


figure 12-4

TGRS ANNUAL MONITORING DATA - WEST PORTION
TCE CONCENTRATIONS (µg/L) JUNE 2017
OPERABLE UNIT 2
Arden Hills, Minnesota

11155360-43(001)GN-WA003 FEB 14, 2018

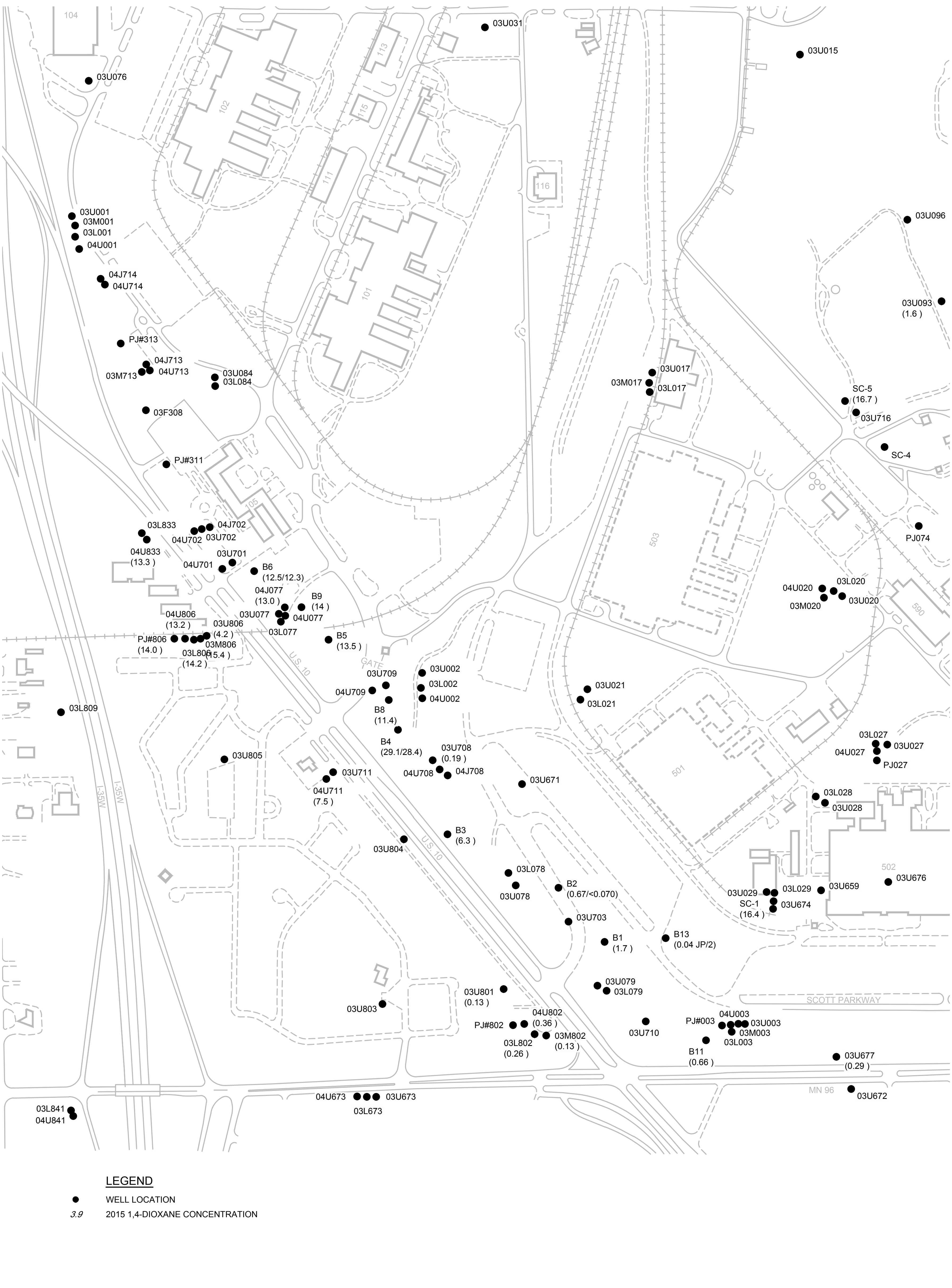
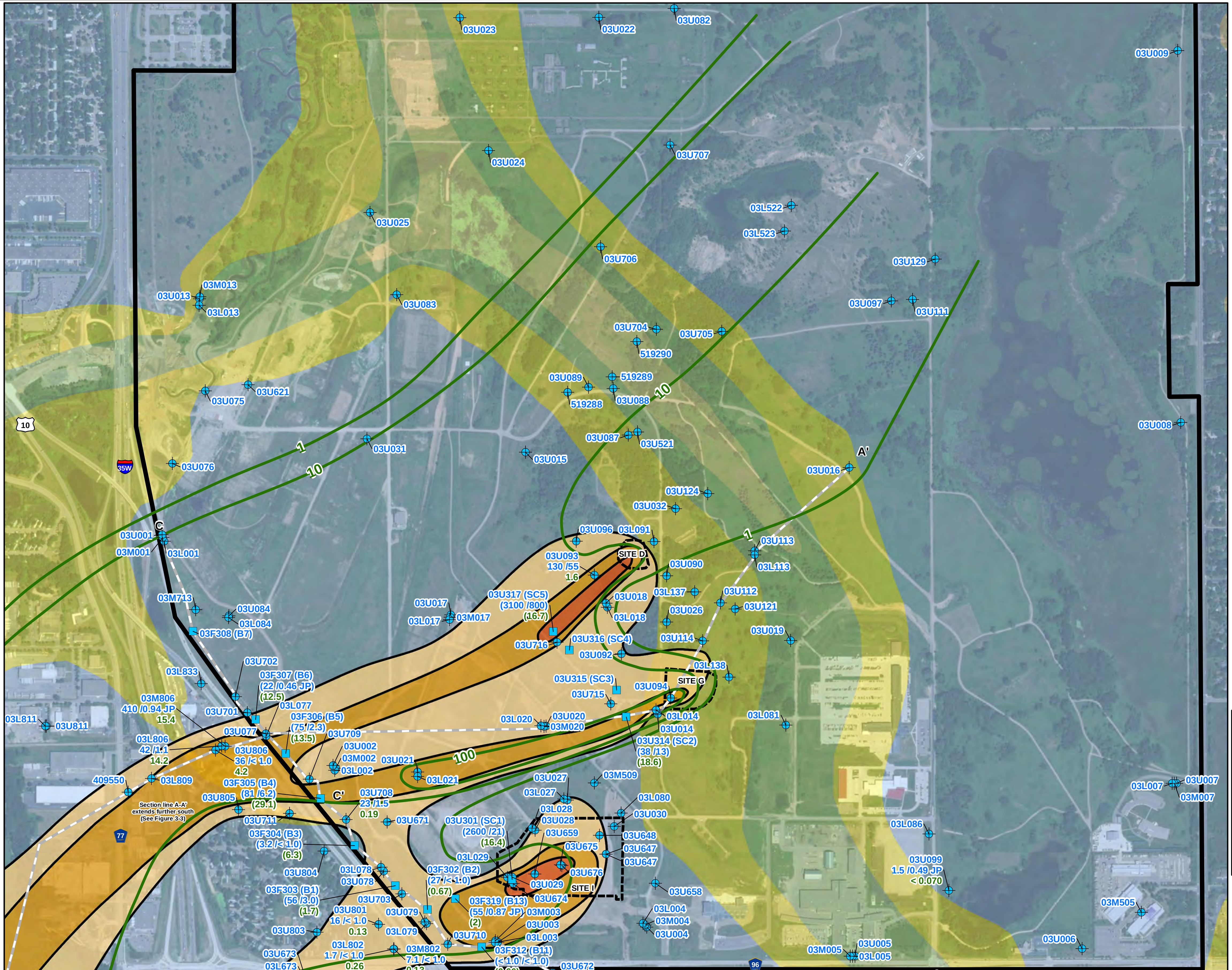


figure 12-5

TGRS ANNUAL MONITORING DATA - WEST PORTION
1,4-DIOXANE CONCENTRATIONS (μg/L) JUNE 2017
OPERABLE UNIT 2
Arden Hills, Minnesota



Legend

Monitoring Well Location

03U093 — Monitoring Well ID

130/55 — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)

1.6 — 1,4-Dioxane Concentration (µg/L)

Extraction Well Location

Cross-Section Line

Site Boundary

2017 1,4 Dioxane Concentration Contour (µg/L)

2017 Trichloroethene Concentrations (µg/L)

Upper and Lower Unit 3

5-100

100-1,000

1,000+

Operable Unit 2

Bedrock Geology

St. Peter Sandstone

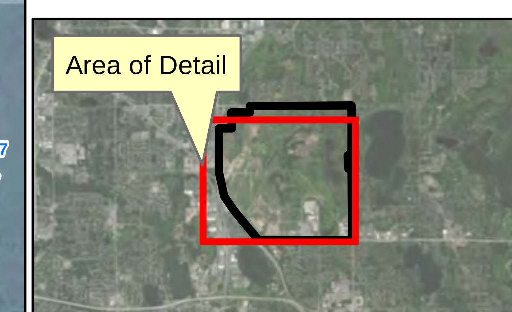
Prairie du Chien Group

Jordan Sandstone

St. Lawrence Formation

Tunnel City Group

Notes:
1. 03F and 03U extraction wells are shown with data in parentheses, but concentrations were not used for contouring (except for SC-3 and SC-4, which were used for contouring since they are being sampled as monitoring wells and since they are screened only within Upper Unit 3).
2. Results are from groundwater samples collected in June 2017.
3. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
4. Mossler, John H.. (2013). M-194 Bedrock Geology of the Twin Cities Ten-County Metropolitan Area, Minnesota. Retrieved from the University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/154925
5. µg/L = micrograms per liter



N

1,000 500 0 1,000

Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\OU2_QA_TCE_DIOX_2017.mxd

ANNUAL PERFORMANCE REPORT

OU2, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 12-6

Legend

Monitoring Well

04U806 Monitoring Well ID
52/0.88 JP Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
13.2 1,4-Dioxane Concentration (µg/L)

Extraction Well

Private Well

Cross-Section Line

Site Boundary

2017 1,4 Dioxane Concentration Contour (µg/L) (Dashed Where Inferred)

2017 Trichloroethene Concentrations (µg/L)
Upper Unit 4 (Dashed Where Inferred)

5-100

100-1,000

Operable Unit 2

Bedrock Geology

St. Peter Sandstone

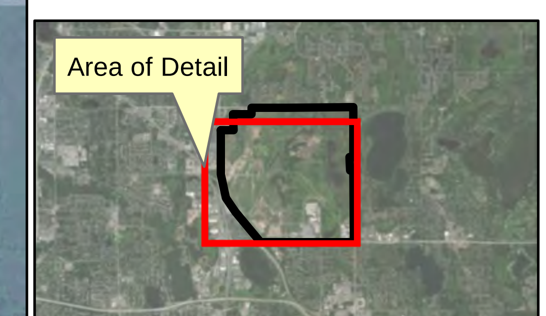
Prairie du Chien Group

Jordan Sandstone

St. Lawrence Formation

Tunnel City Group

Notes:
1. All PJ# extraction wells are shown with data in parentheses, but were not used for contouring.
2. Results are from groundwater samples collected in June 2017.
3. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
4. Mossler, John H.. (2013). M-194 Bedrock Geology of the Twin Cities Ten-County Metropolitan Area, Minnesota. Retrieved from the University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/154925
5. µg/L = micrograms per liter



N

1,000 500 0 1,000 Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\OU2_PDC_TCE_DIOX_2017.mxd

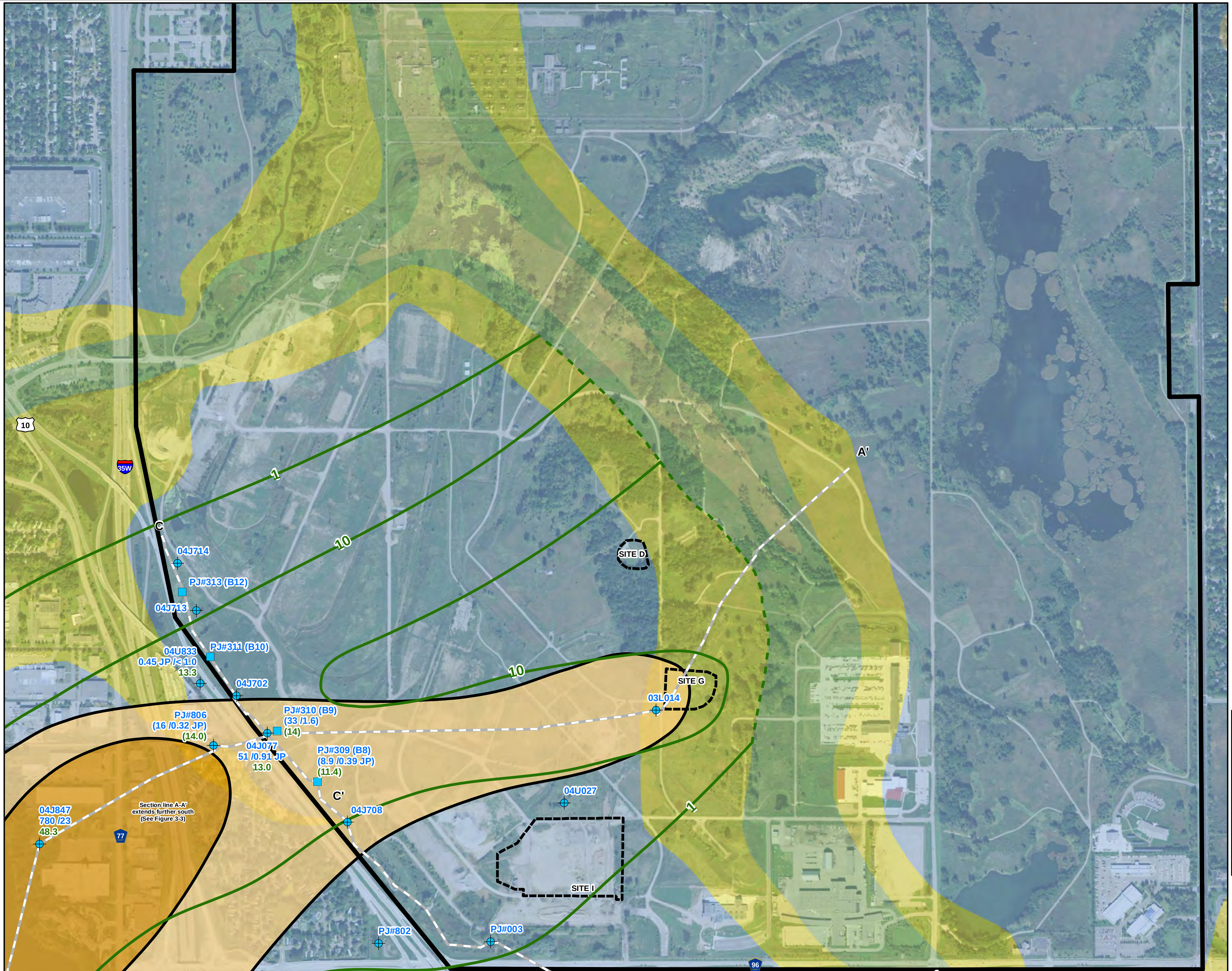
ANNUAL PERFORMANCE REPORT

OU2, Upper Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 12-7



Legend

- Monitoring Well
- 04J077 — Monitoring Well ID
- 51/0.91 JP — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 13.0 — 1,4-Dioxane Concentration (µg/L)
- Extraction Well
- Private Well
- Cross-Section Line
- Site Boundary
- 2017 1,4 Dioxane Concentration Contour (µg/L) (Dashed Where Inferred)

2017 Trichloroethene Concentrations (µg/L)

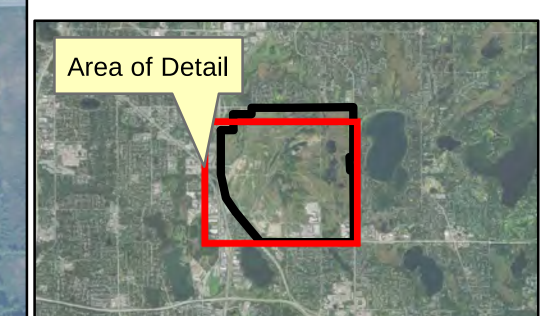
Lower Unit 4

- 5-100
- 100-1,000
- Operable Unit 2

Bedrock Geology

- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Notes:
1. All PJ# extraction wells are shown with data in parentheses, but were not used for contouring.
2. Results are from groundwater samples collected in June 2017.
3. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
4. Mossler, John H.. (2013). M-194 Bedrock Geology of the Twin Cities Ten-County Metropolitan Area, Minnesota. Retrieved from the University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/154925
5. µg/L = micrograms per liter



N

1,000 500 0 1,000 Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\OU2_Jordan_TCE_DIOX_2017.mxd

ANNUAL PERFORMANCE REPORT	PIKA ARCADIS a joint venture	FY 2017
OU2, Lower Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017		Figure 12-8

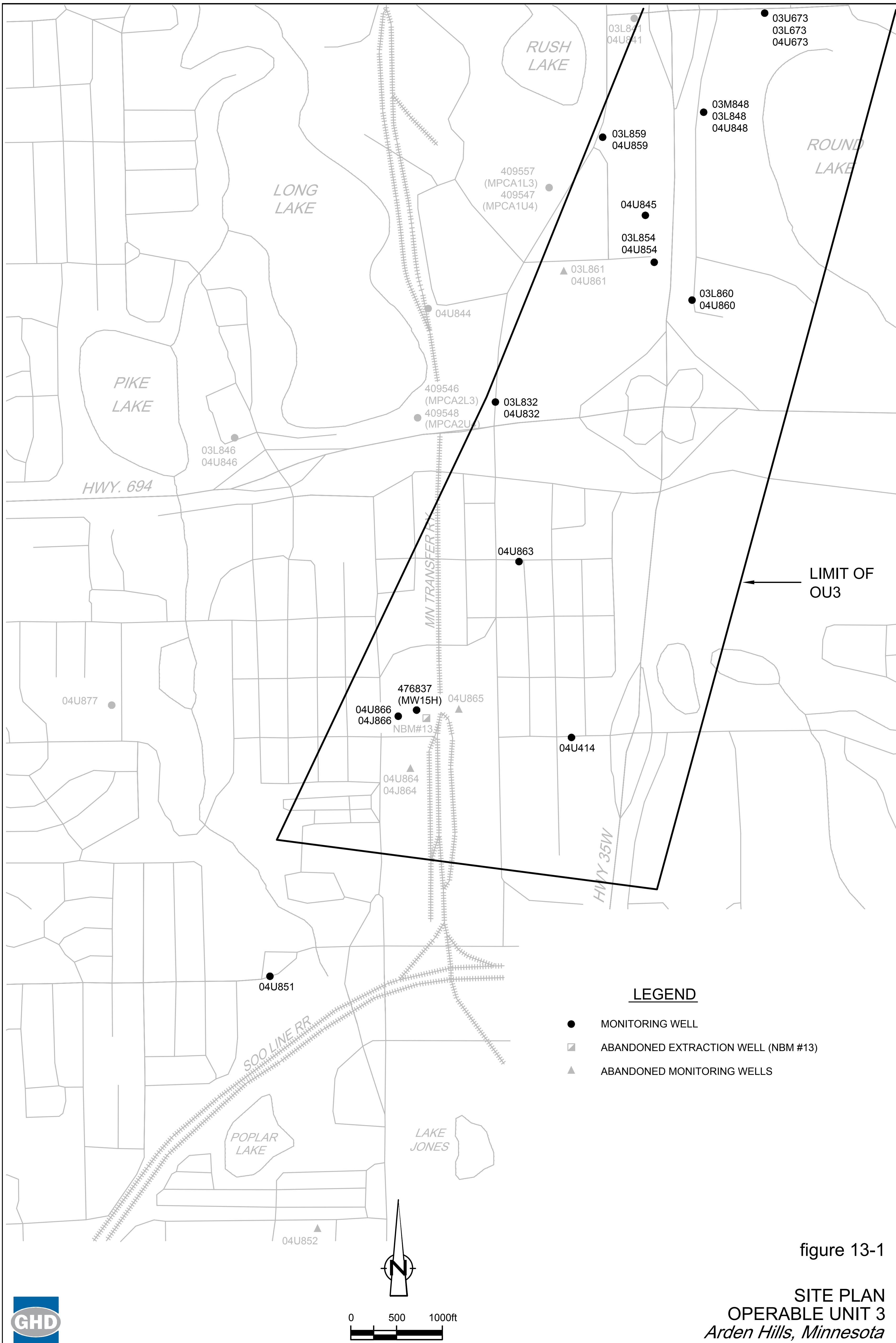


figure 13-1

SITE PLAN
OPERABLE UNIT 3
Arden Hills, Minnesota

11155360-43(001)GN-WA005 DEC 14, 2017

APPENDIX A

FY 2017 – FY 2021 Monitoring Plan

Appendix A.1
FY 2017 - FY 2021 Monitoring Plan for Groundwater Monitoring Wells
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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Unit Designations:

01U - Upper Fridley Formation	03M - Middle Hillside Formation	SL - St. Lawrence	J - Jordan
01L - Lower Fridley Formation	03L - Lower Hillside Formation	UNK - Unknown	
03U - Upper Hillside Formation	SP - St. Peter	PC - Prairie du Chien	

Notes:

(A) Indicates that the monitoring is the responsibility of Orbital ATK.
(B) Indicates that the monitoring is the responsibility of the Army.
(1) "L (A or B)" denotes a water level measurement by the appropriate party.
(2) "Q (A or B)" denotes a water quality sampling by the appropriate party. The required analyte list for each specific site is shown in Appendix A.4.
(3) The designations refer to the following purposes:

- ❖ Operable Unit 1 Water Quality
  - 1.a = To contour the perimeter of the plume which defines the area of concern for alternate water supply/well abandonment
  - OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Operable Unit 1 Water Levels
  - 3.b = To contour water levels for evaluation of containment
- ❖ Site A Water Quality
  - OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Site A Water Levels
  - OR = Overall remedy. To evaluate groundwater flow direction relative to plume location
- ❖ Site C Water Quality
  - OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Site C Water Levels
  - OR = Overall remedy. To evaluate groundwater flow direction relative to plume location
- ❖ Site I Water Quality
  - 1.a = To track remedy progress
  - OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Site I Water Levels
  - 1.a = To track remedy progress
- ❖ Site K Water Quality
  - OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Site K Water Levels
  - 3.a = To contour water levels for evaluation of containment

- Building 102 Water Quality
  - OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- Building 102 Water Levels
  - OR = Overall remedy. To evaluate groundwater flow direction relative to plume location
- TGRS Water Quality
  - OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- TGRS Water Levels
  - 1.a = To contour water levels for evaluation of containment
- Operable Unit 3 Water Quality
  - OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- Operable Unit 3 Water Levels
  - 2.a = To contour water levels for evaluation of MNA remedy

(4) Sampling performed by the City of Saint Anthony. Army collects sample only if in production and not being sampled by City of Saint Anthony; otherwise Army uses Saint Anthony data.

(5) Sample extraction well annually or biennially, as shown, since it is no longer being pumped.

(6) Wells 04U414 and 04U851 monitored every 5 years during event preceding 5-year review

(7) Sample OU1 private water supply well as late as September 30, if necessary due to temporary inaccessibility.

Appendix A.1
FY 2017 - FY 2021 Monitoring Plan for Groundwater Monitoring Wells
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
Operable Unit 1											
03U	03U811			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	MPCA recommended annual sampling
03U	03U821			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
03U	03U822			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03U	03U831			---	---	---	---	---	---	---	abandoned 2006
03U	409550	PCA 6U3		---	Q,L(B)	---	Q,L(B)	---	OR	None	
03U	409596	BS118U3		---	---	---	---	---	---	---	abandoned 2007, may need replacement
03M	03M843			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	03L811			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
03L	03L822			---	Q,L(B)	---	Q,L(B)	---	OR	None	
03L	03L832			---	Q,L(B)	---	Q,L(B)	---	OR	None	
03L	03L841			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	03L846			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	03L853			---	---	---	---	---	---	---	
03L	409556	PCA4L3		---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	409557	PCA1L3		---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	409597	BS118L3		---	---	---	---	---	---	---	abandoned 2007, may need replacement
PC	04U821			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U834			---	Q,L(B)	---	Q,L(B)	---	OR	None	
PC	04U836	MW-1		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	Also sample in January 2016
PC	04U837	MW-3		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	Also sample in January 2016
PC	04U838	MW-5		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U839	MW-7		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	Also sample in January 2016, MPCA recommended annual sampling
PC	04U841			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U843			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	3.b	
PC	04U844			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U846			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U847			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U849			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U850			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U855			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	1.a, OR	3.b	MPCA recommended annual sampling
PC	04U871			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	Also sample in January 2016
PC	04U872			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	Also sample in January 2016
PC	04U875			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	3.b	Also sample in January 2016
PC	04U877			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	
PC	04U879			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	1.a, OR	3.b	Also sample in January 2016, MPCA recommended annual sampling
PC	04U880			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	3.b	Also sample in January 2016
PC	04U881			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	Also sample in January 2016
PC	04U882			---	Q,L(B)	---	Q,L(B)	---	OR	None	
PC	04U883			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
PC	191942	BS118U4		---	---	---	---	---	---	---	abandoned 2007, may need replacement
PC	200154	UM Golf Course		---	Q(B)	---	Q(B)	---	1.a, OR	---	
PC	200814	American Linen		---	---	---	---	---	---	---	
PC	206688	Cloverpond		---	Q(B)	---	Q(B)	---	1.a, OR	---	Also sample in January 2016
PC	234547	Honeywell Ridgeway		---	---	---	---	---	---	---	
PC	409547	PCA1U4		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	409548	PCA2U4		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	409549	PCA3U4		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	409555	PCA5U4		---	Q,L(B)	---	Q,L(B)	---	1.a, OR	3.b	
PC	512761	Gross Golf Course #2		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	

Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
PC	554216	New Brighton #14									See Appendix A.2
PC	582628	New Brighton #15									See Appendix A.2
J	04J822			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	
J	04J834			---	Q,L(B)	---	Q,L(B)	---	OR	None	
J	04J835			---	---	---	---	---	---	---	
J	04J836	MW-2		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	Also sample in January 2016
J	04J837	MW-4		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	Also sample in January 2016
J	04J838	MW-6		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
J	04J839	MW-8		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	Also sample in January 2016
J	04J847			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	
J	04J849			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	
J	04J882			---	Q,L(B)	---	Q,L(B)	---	OR	None	
J	200524	St. Anthony #5		---	Q(B)	---	Q(B)	---	OR	---	Army gets St. Anthony Data
J	200803	St. Anthony #4		---	Q(B)	---	Q(B)	---	OR	---	Army gets St. Anthony Data
J	206796	New Brighton #5									See Appendix A.2
J	206797	New Brighton #6									See Appendix A.2
PC/J	200804	St. Anthony #3		---	Q(B)	---	Q(B)	---	OR	---	Army gets St. Anthony Data
PC/J	200812	Gross Golf #1		---	---	---	---	---	---	---	
PC/J	206792	New Brighton #4									See Appendix A.2
PC/J	206793	New Brighton #3									See Appendix A.2
PC/J	233221	R&D Systems, N. Well		---	---	---	---	---	---	---	
PC/J	234549	Reiner		---	---	---	---	---	1.a, OR	---	Well out of service
PC/J	PJ#318			---	Q,L(B)	---	Q,L(B)	---	OR	None	Also sample in January 2016
UNK	234546	Honeywell Ridgeway		---	Q(B)	---	Q(B)	---	OR	---	
Operable Unit 2 - Site A Shallow Groundwater											
01U	01U038			---	---	---	---	---	---	---	abandoned FY14
01U	01U039			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U040			---	---	---	---	---	---	---	abandoned FY14
01U	01U041			---	---	---	---	---	---	---	abandoned FY14
01U	01U063			L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U067			---	---	---	---	---	---	---	abandoned FY14
01U	01U102			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U103			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	Including antimony
01U	01U104			---	---	---	---	---	---	---	abandoned FY14
01U	01U105			---	---	---	---	---	---	---	abandoned FY14
01U	01U106			L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U107			---	---	---	---	---	---	---	abandoned FY14
01U	01U108			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U110			---	---	---	---	---	---	---	abandoned FY14
01U	01U115			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U116			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U117			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U118			---	---	---	---	---	---	---	abandoned FY14
01U	01U119			L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U120			L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U125			---	---	---	---	---	---	---	
01U	01U126			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U127			L(B)	L(B)	L(B)	L(B)	L(B)	OR	OR	
01U	01U133			L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U135			L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	

Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
01U	01U136			---	---	---	---	---	---	---	abandoned FY14
01U	01U137			L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U138			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U139			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U140			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U141			L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U145	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U146	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U147	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U148	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U149	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U150	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U151	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U152	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U153	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U154	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U155	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U156	Piezometer		L(B)	L(B)	L(B)	L(B)	L(B)	---	OR	
01U	01U157			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U158			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U350			---	---	---	---	---	OR	OR	Annual through FY16, then cease sampling
01U	01U351	EW-1		---	---	---	---	---	OR	OR	Annual through FY16, then cease sampling
01U	01U352	EW-2		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U353	EW-3		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U354	EW-4		---	---	---	---	---	OR	OR	Annual through FY16, then cease sampling
01U	01U355	EW-5		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U356	EW-6		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U357	EW-7		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U358	EW-8		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U901			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U902			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	Including antimony
01U	01U903			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U904			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	Including antimony
Operable Unit 2 - Site C Shallow Groundwater											
01U	01U045			---	---	---	---	---	---	---	abandoned FY14
01U	01U046			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U085			---	---	---	---	---	---	---	abandoned FY14
01U	01U551	EW-1		---	---	---	---	---	---	---	abandoned FY14
01U	01U552	EW-2		---	---	---	---	---	---	---	abandoned FY14
01U	01U553	EW-3		---	---	---	---	---	---	---	abandoned FY14
01U	01U561	MW-1		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U562	MW-2		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U563	MW-3		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U564	MW-4		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U565	MW-5		---	---	---	---	---	---	---	abandoned FY14
01U	01U566	MW-6		---	---	---	---	---	---	---	abandoned FY14
01U	01U567	MW-7		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U568	MW-8		---	---	---	---	---	---	---	abandoned FY14
01U	01U569	MW-9		---	---	---	---	---	---	---	abandoned FY14
01U	01U570	MW-10		---	---	---	---	---	---	---	abandoned FY14

Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
01U	01U571	MW-11		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U572	MW-12		---	---	---	---	---	---	---	abandoned FY14
01U	01U573	MW-13		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U574	MW-14		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U575	MW-15		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U576	MW-16		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
Operable Unit 2 - Site I Shallow Groundwater											
01U	01U064			---	---	---	---	---	---	---	abandoned FY14
01U	01U631			---	---	---	---	---	---	---	abandoned FY 14
01U	01U632			---	---	---	---	---	---	---	abandoned FY14
01U	01U636			---	---	---	---	---	---	---	abandoned FY14
01U	01U639			---	---	---	---	---	---	---	abandoned FY14
01U	01U640			---	---	---	---	---	---	---	abandoned FY14
01U	01U666			---	---	---	---	---	---	---	abandoned FY14
01U	01U667			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	OR	abandoned FY14, replaced in Spring 2016
01U	482086	I01MW		---	---	---	---	---	---	---	abandoned FY14
01U	482087	I05MW		---	---	---	---	---	---	---	abandoned FY14
01U	482088	I02MW		---	---	---	---	---	---	---	abandoned FY14
01U	482089	I04MW		---	---	---	---	---	---	---	abandoned FY14
01U	482090	I03MW		---	---	---	---	---	---	---	abandoned FY14
Note: All of the Site I shallow groundwater wells were sealed in FY14. Following soil remediation under Building 502, only 01U667 was re-installed (with annual sampling).											
Operable Unit 2 - Site K Shallow Groundwater											
01U	01U047			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U048			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U052			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U065			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U128			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	3.a	
01U	01U601			---	---	---	---	---	---	---	abandoned FY14
01U	01U602			---	---	---	---	---	---	---	abandoned FY14
01U	01U603			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	3.a	
01U	01U604			---	---	---	---	---	---	---	abandoned FY14
01U	01U605			---	---	---	---	---	---	---	abandoned FY14
01U	01U607			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U608			L(A)	L(A)	L(A)	L(A)	L(A)	---	---	abandoned FY14, replace in Spring 2016
01U	01U609			L(A)	L(A)	L(A)	L(A)	L(A)	---	---	abandoned FY14, replace in Spring 2016
01U	01U611			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	---	---	abandoned FY14, replace in Spring 2016
01U	01U612			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U613			---	---	---	---	---	---	---	abandoned FY14
01U	01U615			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	3.a	
01U	01U616			---	---	---	---	---	---	---	abandoned FY14
01U	01U617			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	3.a	
01U	01U618			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	3.a	
01U	01U619			---	---	---	---	---	---	---	abandoned FY14
01U	01U620			---	---	---	---	---	---	---	abandoned FY14
01U	01U621			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	3.a	
01U	01U624			---	---	---	---	---	---	---	abandoned FY14
01U	01U625			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U626			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U627			L(A)	L(A)	L(A)	L(A)	L(A)	---	3.a	
01U	01U628			---	---	---	---	---	---	---	abandoned FY14

Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
01U	482083	K04-MW		Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	3.a	
01U	482084	K02-MW		---	---	---	---	---	---	---	abandoned FY14
01U	482085	K01-MW		---	---	---	---	---	---	---	abandoned FY14
03U	03U621			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	3.a	
Operable Unit 2 - Building 102 Shallow Groundwater											
01U	01U048			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U578			---	---	---	---	---	---	---	abandoned FY14
01U	01U579			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U580			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U581			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U582			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U583			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01U	01U584			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01L	01L581			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01L	01L582			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01L	01L583			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
01L	01L584			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	OR	
Operable Unit 2 - Deep Groundwater (TGRS)											
03F	03F302	B1									See Appendix A.2
03F	03F303	B2	(5)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03F	03F304	B3									See Appendix A.2
03F	03F305	B4									See Appendix A.2
03F	03F306	B5									See Appendix A.2
03F	03F307	B6									See Appendix A.2
03F	03F308	B7	(5)	---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03F	03F312	B11	(5)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03F	03F319	B13									See Appendix A.2
03U	03U001			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U002			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U003			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U004			---	---	---	---	---	---	---	Abandoned FY13
03U	03U005			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U007			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
03U	03U008			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U009			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
03U	03U010			---	L(A)	---	L(A)	---	---	1.a	
03U	03U011			---	L(A)	---	L(A)	---	---	1.a	
03U	03U012			---	L(A)	---	L(A)	---	---	1.a	
03U	03U013			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U014			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U015			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U016			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U017			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U018			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U019			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U020			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U021			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U022			---	L(A)	---	L(A)	---	---	1.a	
03U	03U023			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U024			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)

Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
03U	03U025			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U026			---	L(A)	---	L(A)	---	---	1.a	
03U	03U027			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U028			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U029			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U030			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U031			---	---	---	---	---	---	---	abandoned FY14
03U	03U032			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U075			---	---	---	---	---	---	---	abandoned FY14
03U	03U076			---	---	---	---	---	---	---	abandoned FY14
03U	03U077			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U078			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U079			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U082			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U083			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U084			---	---	---	---	---	---	---	abandoned FY14
03U	03U087			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U088			---	L(A)	---	L(A)	---	---	1.a	
03U	03U089			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U090			---	L(A)	---	L(A)	---	---	1.a	
03U	03U092			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U093			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03U	03U094			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U096			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U097			---	---	---	---	---	---	---	
03U	03U099			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03U	03U111			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U112			---	L(A)	---	L(A)	---	---	1.a	
03U	03U113			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U114			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U121			---	---	---	---	---	---	---	
03U	03U129			---	---	---	---	---	---	---	
03U	03U301	SC1									See Appendix A.2
03U	03U314	SC2									See Appendix A.2
03U	03U315	SC3	(5)	---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U316	SC4	(5)	---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U317	SC5									See Appendix A.2
03U	03U521			---	---	---	---	---	---	---	
03U	03U647			---	---	---	---	---	---	---	abandoned FY14
03U	03U648			---	---	---	---	---	---	---	abandoned FY14
03U	03U658			---	---	---	---	---	---	---	abandoned FY13
03U	03U659			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U671			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U672			---	---	---	---	---	---	---	abandoned FY14, replaced by 03U677
03U	03U674			---	---	---	---	---	---	---	abandoned FY14
03U	03U675			---	---	---	---	---	---	---	
03U	03U676			---	---	---	---	---	---	---	abandoned FY14
03U	03U677			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	constructed FY14
03U	03U701			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U702			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	

Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
03U	03U703			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U704			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U705			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U706			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U707			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03U	03U708			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03U	03U709			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U710			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U711			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U715			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U716			---	L(A)	---	L(A)	---	---	1.a	
03U	03U801			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03U	03U803			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U804			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U805			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U806			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03U	519288	E101-MW		---	---	---	---	---	---	---	
03U	519289	E102-MW		---	---	---	---	---	---	---	
03U	519290	E103-MW		---	---	---	---	---	---	---	
03M	03M001			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03M	03M002			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03M	03M003			---	L(A)	---	L(A)	---	---	1.a	
03M	03M004			---	---	---	---	---	---	---	Abandoned FY13
03M	03M005			---	L(A)	---	L(A)	---	---	1.a	
03M	03M007			---	L(A)	---	L(A)	---	---	1.a	
03M	03M010			---	L(A)	---	L(A)	---	---	1.a	
03M	03M012			---	L(A)	---	L(A)	---	---	1.a	
03M	03M013			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03M	03M017			---	L(A)	---	L(A)	---	---	1.a	
03M	03M020			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03M	03M713			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03M	03M802			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03M	03M806			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03L	03L001			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03L	03L002			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L003			---	L(A)	---	L(A)	---	---	1.a	
03L	03L004			---	---	---	---	---	---	---	Abandoned FY13
03L	03L005			---	L(A)	---	L(A)	---	---	1.a	
03L	03L007			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
03L	03L010			---	L(A)	---	L(A)	---	---	1.a	
03L	03L012			---	L(A)	---	L(A)	---	---	1.a	
03L	03L013			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03L	03L014			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L017			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L018			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L020			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L021			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L027			---	---	---	---	---	---	---	abandoned FY14
03L	03L028			---	---	---	---	---	---	---	abandoned FY14
03L	03L029			---	---	---	---	---	---	---	abandoned FY14

Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
03L	03L077			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L078			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L079			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L080			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03L	03L081			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03L	03L084			---	---	---	---	---	---	---	abandoned FY14
03L	03L113			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
03L	03L802			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03L	03L806			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
03L	03L809			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L833			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U001			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
PC	04U002			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U003			---	L(A)	---	L(A)	---	---	1.a	
PC	04U007			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
PC	04U012			---	L(A)	---	L(A)	---	---	1.a	
PC	04U020			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U027			---	---	---	---	---	---	---	abandoned FY14
PC	04U077			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U510			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
PC	04U701			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U702			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U708			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U709			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U711			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
PC	04U713			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U714			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
PC	04U802			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
PC	04U806			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
PC	04U833			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
J	04J077			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
J	04J702			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
J	04J708			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
J	04J713			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
J	04J714			---	L(A)	---	L(A)	---	---	1.a	Also sample in January 2016 (Army)
PC/J	PJ#003			---	L(A)	---	L(A)	---	---	1.a	
PC/J	PJ#027			---	---	---	---	---	---	---	abandoned FY14
PC/J	PJ#309	B8									See Appendix A.2
PC/J	PJ#310	B9									See Appendix A.2
PC/J	PJ#311	B10	(5)	---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC/J	PJ#313	B12	(5)	---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC/J	PJ#802			---	L(A)	---	L(A)	---	---	1.a	
PC/J	PJ#806			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	
---	Staff Gauges			---	L(A)	---	L(A)	---	---	---	
Operable Unit 2 - Unit 1 Wells											
01U	01U035			---	---	---	---	---	---	---	
01U	01U043			---	---	---	---	---	---	---	
01U	01U044			---	---	---	---	---	---	---	
01U	01U045			---	---	---	---	---	---	---	
01U	01U046			---	---	---	---	---	---	---	

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Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
01U	01U060			---	---	---	---	---	---	---	
01U	01U072			---	---	---	---	---	---	---	
01U	01U085			---	---	---	---	---	---	---	
Operable Unit 3											
03U	03U673			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03M	03M848			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	2.a	
03L	03L673			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03L	03L832			---	L(A)	---	L(A)	---	---	2.a	
03L	03L848			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03L	03L854			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03L	03L859			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03L	03L860			---	L(A)	---	L(A)	---	---	2.a	
03L	03L861			---	---	---	---	---	---	---	Abandoned FY06
03L	476837	MW15H		---	---	---	---	---	---	---	
PC	04U414	414U4	(6)	---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U673			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U832			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	Contingency Action for FY08
PC	04U845			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	Contingency Action for FY08
PC	04U848			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U851		(6)	---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U852			---	---	---	---	---	---	---	Abandoned FY09
PC	04U854			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U859			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U860			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U861			---	---	---	---	---	---	---	Abandoned FY06
PC	04U863	323U4		Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	2.a	
PC	04U864	324U4		---	---	---	---	---	---	---	Abandoned FY09
PC	04U865	325U4		---	---	---	---	---	---	---	Abandoned FY09
PC	04U866	326U4		---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	520931	NBM #13		---	---	---	---	---	---	---	Abandoned FY07
J	04J864	324 J		---	---	---	---	---	---	---	Abandoned FY09
J	04J866	326 J		---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
Well Inventory											
(Entries under "Notes" refer to the well inventory category)											
---	249608	Rapit Printing Inc	1a	---	---	---	Q(B)	---	Well Inventory	---	2520 Larpenteur Ave
---	S00444	Minneapolis Parks & Rec Dept	1a	---	---	---	Q(B)	---	Well Inventory	---	Ontario & E River Rd (Erie), Dartmoth Triangle
---	200173	KSTP Radio TV	1b	---	---	---	Q(B)	---	Well Inventory	---	3415 University Ave
---	200180	Town & Country Golf Course	1b	---	---	---	Q(B)	---	Well Inventory	---	2279 Marshal Ave
---	200522	Windsor Green	1b	---	---	---	Q(B)	---	Well Inventory	---	Silver Lake Rd & Cty Rd E
---	200523	Windsor Green	1b	---	---	---	Q(B)	---	Well Inventory	---	Silver Lake Rd & Cty Rd E
---	234338	Bosell	1b	---	---	---	Q(B)	---	Well Inventory	---	1575 14th Ave NW
---	234421	BioClean (BioChem)	1b	---	---	---	Q(B)	---	Well Inventory	---	2151 Mustang Dr
---	234469	Palkowski, T.	1b	---	---	---	Q(B)	---	Well Inventory	---	2816 Hwy 88
---	234544	R&D Systems	1b	---	---	---	Q(B)	---	Well Inventory	---	2201 Kennedy St NE
---	249632	Montzka, Harold	1b	---	---	---	Q(B)	---	Well Inventory	---	2301 N Upland Crest NE
---	433298	Town & Country Golf Course	1b	---	---	---	Q(B)	---	Well Inventory	---	2279 Marshall Ave
---	509052	Shriners Hospital	1b	---	---	---	Q(B)	---	Well Inventory	---	2025 E River Rd
---	756236	Alcan	1c	---	---	---	Q(B)	---	Well Inventory	---	150 26th Ave SE
---	S00437	Northern Star Co	1c	---	---	---	Q(B)	---	Well Inventory	---	3171 5th St SE

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Well Information			Notes	June 17	June 18	June 19	June 20	June 21	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
---	107405	Dimmick, Kay	2a	---	---	---	Q(B)	---	Well Inventory	---	4355 Hwy 10
---	200176	Waldorf Paper Products	2b	---	---	---	Q(B)	---	Well Inventory	---	2236 Myrtle Ave
---	249007	Walton, Toni	2b	---	---	---	Q(B)	---	Well Inventory	---	4453 Old Hwy 10
---	537801	Midway Industrial	2b	---	---	---	Q(B)	---	Well Inventory	---	4759 Old Hwy 8
---	S00002	Midland Hills Country Club	2b	---	---	---	Q(B)	---	Well Inventory	---	2001 N Fulham St
---	200076	Old Dutch Foods, Inc	2c	---	---	---	Q(B)	---	Well Inventory	---	2375 Terminal Rd
---	236029	R&D Systems, South Well	2c	---	---	---	Q(B)	---	Well Inventory	---	2201 Kennedy St NE
---	236439	Waldorf Paper Products	2c	---	---	---	Q(B)	---	Well Inventory	---	2250 Wabash Ave
---	249185	Novotny, Mark	4a	---	---	---	Q(B)	---	Well Inventory	---	1706 Malvern St
---	UNK0515425	O'Neill, Julie	4a	---	---	---	Q(B)	---	Well Inventory	---	1412 Long Lake Rd
---		Amundsen, Jason & Lucy	4a	---	---	---	Q(B)	---	Well Inventory	---	2816 St. Anthony Blvd
---		Hermes, Margo	4a	---	---	---	Q(B)	---	Well Inventory	---	2935 Old Hwy 8

General Notes:

The next major sampling event for Well Inventory will be in June 2020 (conducted every 4 years)

All of the Site I shallow groundwater wells were sealed in FY14. Following soil remediation under Building 502, only 01U667 was re-installed (with annual sampling).

Appendix A-2
FY 2017-FY 2021 Monitoring Plan for Remedial Treatment Systems
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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Location	Sampling Frequency	Parameters
OU1: Deep Groundwater [1]		
● Extraction Wells NBM#4, #14, and #15	- Monthly	- Pumping Volumes
(and also NBM#3, #5, and #6)	- Monthly	- Water Quality [2]
● PGAC Effluent	- Monthly	- Water Quality [2]
OU2: Site K Remedial Action		
● Extracted Groundwater	- Monthly	- Pumping Volume
● Treatment System Effluent [Outfall 391 (010)]	- See Appendix A.3	- See Appendix A.3
OU2: TCAAP Groundwater Recovery System (TGRS)		
● Extraction Wells	- Monthly	- Pumping Volumes
	- Semi-Annually	- Water Levels
	- Semi-Annually	- Water Quality [2]
● Treatment System Influent	- Monthly	- Pumping Volumes
	- Monthly	- Water Quality [2]
● Treatment System Effluent	- Monthly	- Water Quality [2]

Footnotes:

1. Performed by the City of New Brighton using their Sampling and Analysis Plan (subject to the remedy time-out for the 1,4-dioxane issue).
2. The required analyte list for each specific site is presented in Appendix A.4.

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Analysis	Analytical Method	Units	Site K Effluent	Site C Surface Water Locations		
			(Outfall 010)	(SW-5)	(SW-6)	(NE Wetland)
Flow Rate	---	gal/day	Continuous			
Total Flow	---	gal	M			
pH	(field)	(pH)	Q			
Hardness	(field)	(pH)	Q			
Cyanide	9012A	mg/L	Q			
Copper	6020	mg/L	Q			
Lead	6020	mg/L	Q	A	A	A
Mercury	7470A	mg/L	Q			
Phosphorus (Total)	365.4	mg/L	Q			
Silver	6020	mg/L	Q			
Zinc	6020	mg/L	Q			
Trichloroethene	8260C	mg/L	Q			
1,1-Dichloroethene	8260C	mg/L	Q			
1,1-Dichloroethane	8260C	mg/L	Q			
Cis-1,2-Dichloroethene	8260C	mg/L	Q			
Trans-1,2-Dichloroethene	8260C	mg/L	Q			
Vinyl Chloride	8260C	mg/L	Q			
1,2-Dichloroethane	8260C	mg/L	Q			

Acronyms and Abberviations:

A = Annually in June
M = Measurement required once per month
mg/L = milligrams per liter
Q = Analysis required once per quarter

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Note: Cleanup Levels (in µg/L) from each Record of Decision are shown below for use in determining the required method detection limits. Also note that these lists represent the minimum list of analytes. A larger analyte list may be utilized by the monitoring organization, if so desired. In FY 2017,1,4-dioxane (Method 522) was also analyzed for at all June VOC sampling locations. December TGRS extraction well sampling and treatment system influent/effluent sampling in months other than June were analyzed for VOCs only.1,4-dioxane will continue to be monitored in OU1, OU2, and OU3 Deep Groundwater, Site A, Site K Unit 3, and TGRS extraction wells.

OU1 (DEEP GROUNDWATER) (1)

1,1-Dichloroethane	70
1,1-Dichloroethene	6
cis-1,2-Dichloroethene	70
1,1,1-Trichloroethane	200
1,1,2-Trichloroethane	3
Trichloroethene	5

SITE A (SHALLOW GROUNDWATER) (2)

Antimony*	6
1,1-Dichloroethene	6
1,2-Dichloroethane	4
Benzene	10
Chloroform	60
cis-1,2-Dichloroethene	70
Tetrachloroethene	7
Trichloroethene	30

*Antimony is only monitored at these 3 wells:
01U103, 01U902 and 01U904 (June only)

SITE C (SHALLOW GROUNDWATER) (3)

Lead	15

SITE I (SHALLOW GROUNDWATER) (2)

1,2-Dichloroethene (cis and trans)	70
Trichloroethene	30
Vinyl Chloride	0.2

BLDG 102 SHALLOW GROUNDWATER (4)

Vinyl Chloride(5)	0.18
cis-1,2-Dichloroethene	70
Trichloroethene	5
1,1-Dichloroethene	6

SITE K (SHALLOW GROUNDWATER) (2)

1,2-Dichloroethene (cis and trans)	70
Trichloroethene	30

OU2 (DEEP GROUNDWATER) (2)

1,1,1-Trichloroethane	200
1,1-Dichloroethane	70
1,1-Dichloroethene	6
1,2-Dichloroethane	4
cis-1,2-Dichloroethene	70
Tetrachloroethene	5
Trichloroethene	5

OU3 (DEEP GROUNDWATER) (6)

1,1-Dichloroethane	70
1,1-Dichloroethene	6
cis-1,2-Dichloroethene	70
1,1,1-Trichloroethane	200
1,1,2-Trichloroethane	3
Trichloroethene	5

WELL INVENTORY SAMPLING

VOCs (report full VOC list)

Notes:

(1) From Page 18 of the OU1 Record of Decision.
(2) From Table 1 of the OU2 Record of Decision.
(3) From Table 1 of Amendment #1 to the OU2 Record of Decision.
(4) From Page 2-13 of Amendment #4 to the OU2 Record of Decision.
(5) Vinyl chloride is also analyzed by SW-846 Method 8260C - SIM at wells 01U048, 01U582, and 01L582.
(6) From Page 26 of the OU3 Record of Decision.

Analytical Methods:
VOCs: SW-846 Method 8260C
Antimony & Lead: SW-846 Method 602

APPENDIX B

Monitoring Well Index

Purpose

The purpose of the well index is to identify all wells, both past and present, that:

- Have been used to collect water quality data or groundwater elevations in regard to work at the New Brighton/Arden Hills Superfund Site (including private wells and offsite monitoring wells sampled by the Army); or
- Are owned by the Army; or
- Are located within the boundaries of OU2 (the former TCAAP property)

In addition, the well index aims to identify the current status (in use, sealed, abandoned, etc.) of these wells.

The well index does not include wells identified in the Well Inventory Update (Appendix E) that have not been sampled by the Army at any point in history.

The list contained in the well index is by no means a compilation of all available data. Other data may exist regarding an individual well that was not discovered or searched out during the course of this effort. The list is intended to be a reasonable effort to gather the data concerning the wells that is readily available. Therefore, if additional data is desired concerning a certain well, it may be possible to search out and obtain that data from records not searched during the course of the investigation.

Background

OU2 and OU1/OU3 wells have been installed in four hydrogeologic units beneath the site. These hydrogeologic units, as referred to in this report, are conceptually illustrated on Figure B-1 and are described below:

Unit 1: This unit, referred to as the Fridley Formation, consists of alluvium and lacustrine deposits above the Twin Cities Formation (Unit 2). The formation is made up of fine- to medium-grained sand and clayey silt, which acts as an unconfined aquifer with an estimated hydraulic conductivity of 8.3 x 10^{-3} cm/sec (International Technology Corp. 1992). The Unit 1 deposits are discontinuous at the New Brighton/Arden Hills Superfund Site (NB/AH Site) and range in thickness from zero to 50 feet. They are predominantly limited to the north, east, and southwest portions of the site. Groundwater in Unit 1 is also discontinuous.

Unit 2: Known as the Twin Cities Formation, Unit 2 consists of Quaternary aged glacial till and, similar to Unit 1, is discontinuous at the NB/AH Site. Unit 2 is generally regarded as an aquitard to vertical migration of groundwater; however, sand and gravel lenses may contain water.

Unit 3: This unit consists primarily of the Quaternary aged Hillside Sand Formation, which is continuous beneath OU2. Near the center of OU2, the Hillside Sand Formation is overlain by the Arsenal Sand, which forms a kame. There is no distinct lithologic contact between the Hillside Sand and the Arsenal Sand, and both are considered included in Unit 3. Unit 3 ranges in thickness from 25 to 450 feet. For monitoring purposes, the Unit 3 aquifer thickness has been arbitrarily subdivided into thirds designated as upper, middle, and lower.

Unit 4: This unit consists collectively of bedrock from the Prairie du Chien Group and Jordan Formation (Ordovician and Cambrian periods, respectively). For monitoring purposes, the Prairie du Chien Group is referred to as Upper Unit 4, while the Jordan Formation is Lower Unit 4. The Jordan Formation varies from fine- to coarse-grained quartz sandstone. The Prairie du Chien Group in the NB/AH Site area consists of a finely crystalline dolomite of the Oneota Formation, as well as quartz sandstone and dolomite members of the Shakopee Formation. A more detailed description of the bedrock geology can be found in the Remedial Investigation Report (Argonne National Laboratory, 1991).

In order to identify the hydrogeologic unit in which each well is completed, the United States Army Environmental Center (USAEC), formerly the United States Army Toxic and Hazardous Materials Agency (USATHAMA), developed a standardized identification system for wells at the NB/AH Site (referred to as the Army Designation or IRDMIS number). Well designations consist of six characters, such as 03U093. The first two characters represent the hydrogeologic unit in which the well is completed, as follows:

01	-	Unit 1
03	-	Unit 3
04	-	Unit 4: Prairie du Chien Group <u>or</u> Jordan Formation
PJ	-	Unit 4: Prairie du Chien Group <u>and</u> Jordan Formation

The third character represents the relative position of the well screen or open hole within the specified hydrogeologic unit, as follows:

U	-	upper portion
M	-	middle portion
L	-	lower portion
J	-	Jordan Sandstone
F	-	fully penetrating Unit 3
#	-	open hole (total or partial thickness)

The remaining three characters represent the well number, as follows:

001 thru 500	USAEC wells and additional wells installed by others adjacent to an existing well with the 001-500 designation.
501 thru 600	NB/AH Site wells.
601 thru 800	OU2 Alliant Techsystems wells.
801 thru 999	OU1/OU3 Alliant Techsystems wells.

OU1/OU3 wells installed by parties other than USAEC, the Army, or Alliant Techsystems are designated by their Minnesota unique number. Table B-1 is sorted by unique number, but includes the IRDMIS number and any other name(s) the wells may have. The well type in this table is abbreviated as follows:

UN	-	Unknown
MUNI	-	Municipal
MON	-	Monitoring
DOM	-	Domestic
IND	-	Industrial
P.S.	-	Public Supply
COM	-	Commercial
IRR	-	Irrigation
ABAND	-	Abandoned
PIEZ.	-	Piezometer
REM	-	Remedial

In recent years, as property transfer of the remaining land that is still identified as TCAAP has progressed (and is now nearing completion), it became apparent that an updated well index with more information concerning each well would be of importance to pass on to future land owners. In addition, as groundwater quality continues to improve and contaminant plumes continue to shrink in vertical and horizontal extent, the index will function as a check to make sure that all Army owned wells are sealed and that all traces of the wells are removed from the area.

The FY 2017 Appendix B Table B-1 shows the most current well index. The well index continues to be a work in progress. Additional records regarding individual wells continue to become available as new wells are drilled and older unneeded wells are sealed and removed.

Figures B-2 and B-3 show the location of wells identified in Table B-1. With a known well name, the location of that well can be identified using the "Edit, Find" or "Edit, Search" function and then typing in the desired well name, which will highlight this well name on the figure.

The Appendix B Attachment contains available documentation for each well, including boring logs (if available). The attachment is sorted by Minnesota unique number. To view the information concerning a well, click on the desired well number in the bookmarks.

FY 2017 Update

Ramsey County wells 01URC1S, 01URC1D, 01URC2S, and 01URC2D were added to the database.

Ongoing Efforts to Update Appendix B

- The well index, Table B-1, has been compared with the wells identified in Appendix D, which contains historical water quality and groundwater elevation data. A number of wells were identified in Appendix D that do not exist in the well index. Ongoing efforts will be made to add information, as possible, concerning the location and status of these wells to the well index in Appendix B.

- The repository at the TCAAP office will continue to be utilized to obtain additional well information, where possible.

Appendix B Table B-1 contains a summary of all information available concerning a certain well, and is sorted by Minnesota unique well number.

To search for detailed records regarding a well, open the appropriate file below and select the bookmark corresponding to the Minnesota unique well number of the well being searched. If the unique number is unknown for a well, it is included and sorted in the Appendix B Attachment by IRDMIS name or OTHER. Records included in the Appendix B Attachment that may or may not be available for each well include:

- The County Well Index well log,
- Access agreement(s),
- Correspondence related to the well,
- Field notes and boring logs,
- Well construction diagrams,
- Documentation of well modifications, and
- Sealing records.

Appendix B Attachment

1. Wells Numbered 104772 through 194772
2. Wells Numbered 200070 through 225906
3. Wells Numbered 231741 through 235753
4. Wells Numbered 236066 through 257443
5. Wells Numbered 265735 through 482709
6. Wells Numbered 500248 through IRDMIS and OTHER

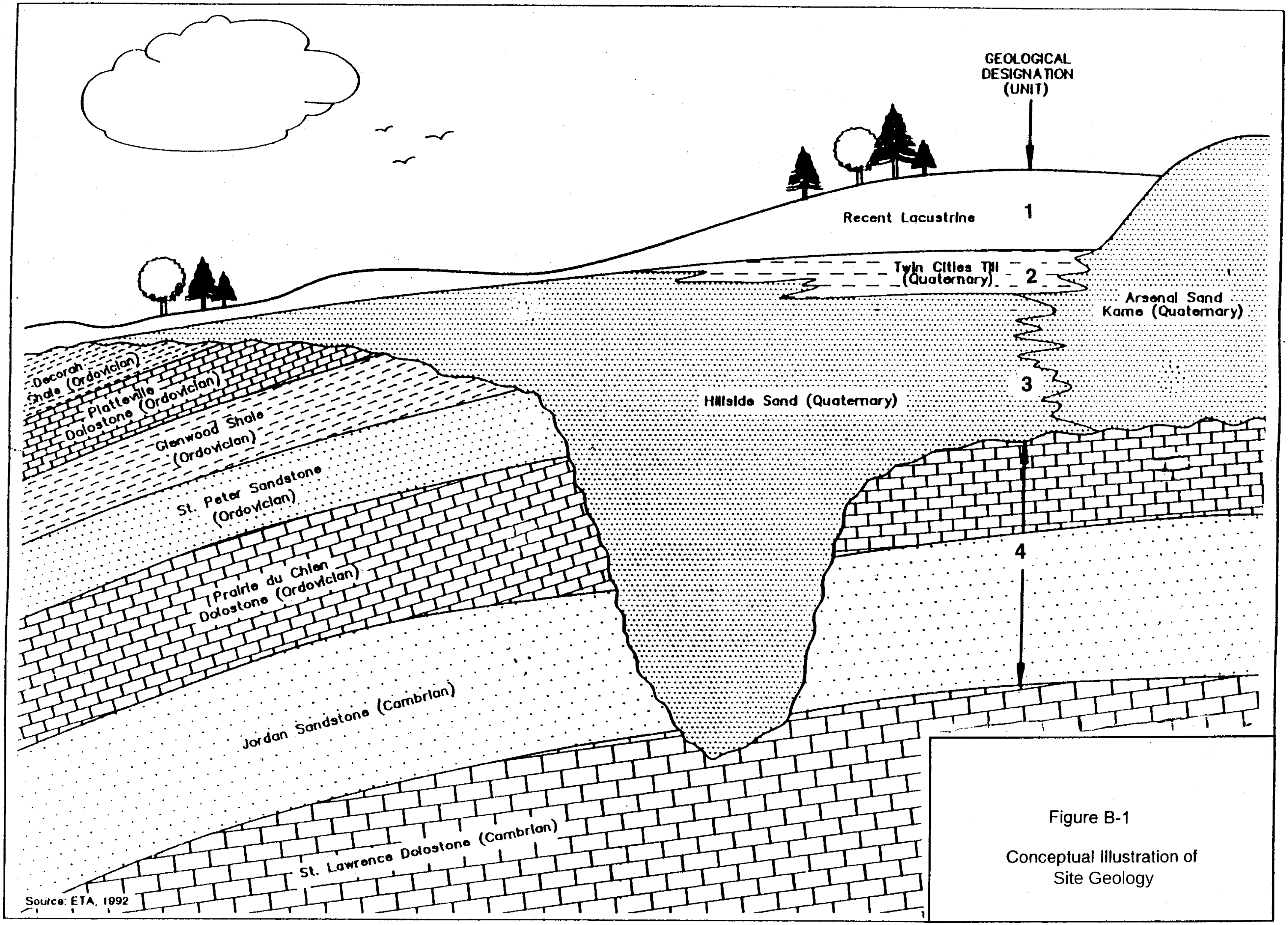

Figure B-1

Conceptual Illustration of Site Geology

ANNUAL PERFORMANCE REPORT	PIKA ARCADIS a joint venture	FY 2017
OU1 & OU3 Well Location		Figure B-2

ANNUAL PERFORMANCE REPORT

OU2 Well Location

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FY 2017

Figure B-3

APPENDIX C

Data Collection, Management, and Presentation

1.0 INTRODUCTION

A groundwater monitoring program was initiated in January 1984 to obtain water level and water quality data at OU1, OU2 and OU3. Each year has been divided into quarters with each quarter assigned a number. Accordingly, FY 2017 was comprised of Quarter 133 (October through December), Quarter 134 (January through March), Quarter 135 (April through June), and Quarter 136 (July through September). Water sampling, water level measurements, and laboratory analyses were conducted in accordance with the "Quality Assurance Project Plan (QAPP) for Performance Monitoring" (Wenck, Revision 15, February 15, 2016), which covers all sites.

Prior to November 1, 2001, data collected from OU1, OU2 and OU3 was stored in the U.S. Army Environmental Command (USAEC) Installation Restoration Data Management Information System (IRDMIS). USAEC replaced the IRDMIS System on November 1, 2001, with a new system, the Environmental Restoration Information System (ERIS), which incorporated all the data that had previously been entered into IRDMIS. The Army has continued to enter data into ERIS; however, ERIS is not being used as the primary database for the OU1, OU2 and OU3 data. The historical databases in Appendix D.1 are the primary databases.

2.0 GROUNDWATER LEVELS AND GROUNDWATER QUALITY

2.1 Data Collection and Management

Groundwater level and groundwater quality data were collected in accordance with the FY 2017 Annual Monitoring Plan (Appendix A), which established the monitoring responsibilities for both the Army and Orbital ATK (formerly Alliant Techsystems). In response to the discovery of 1,4-dioxane in the area, a "major" sampling event was conducted in June of FY 2016 as indicated in the FY 2016 Annual Monitoring Plan. The sampling event for FY 2016 would otherwise have been a "minor" event. Additionally, the Army conducted a "major" well inventory sampling event in FY 2016. Due to these changes, the monitoring plan for future years was modified accordingly to include a "major" well inventory sampling event once every four years and maintain a biennial trend of "major" sampling events at all other sites. The FY 2017 was therefore a minor sampling event. All FY 2017 sampling included 1,4-dioxane analyses at all VOC sampling locations, except as stated in Appendix A.4.

Water level monitoring and water sampling were conducted by JV for the Army and by GHD (formerly CRA) for Orbital ATK. Laboratory analysis of VOC samples from all sites was performed by ALS Laboratory Group, Salt Lake City, Utah. Laboratory analysis of 1,4-dioxane samples from all sites was performed by ALS Laboratory Group, Middletown, Pennsylvania. Appendix A.4 contains lists of required analytes, as referenced by the monitoring plans in Appendix A. The lists are site-specific, based on the chemicals of concern. At sites other than Site C, halogenated volatile organic compounds are the parameters of primary interest, though some of the sites (or specific wells at a site) are sampled for aromatic volatile organic compounds and/or metals. At Site C, dissolved lead is the only chemical of concern. Appendix C.2 presents deviations from the FY 2017 Annual Monitoring Plan.

Data verification and validation was conducted in accordance with procedures and requirements outlined in the QAPP and Addendum #1. Data qualifiers assigned to data through data verification and/or data validation appear in the data tables included within the individual sections of this report, with qualifier definitions given in footnotes to the tables. Data qualifiers are also included in the historical databases (Appendix D.1), which include a database of organic water quality, a database of inorganic water quality (excluding Site C), and a database for Site C water quality (for both groundwater and surface water). Data verification was performed by JV for the JV-collected data and by GHD for the GHD-collected data. Data validation was performed by Diane Short & Associates for the JV-collected data and by GHD for the GHD-collected data. Data verification and validation information from the two sampling firms was compiled into quarterly Data Usability Reports (DURs) that were submitted to the Minnesota Pollution Control Agency (MCPA) and United States Environmental Protection Agency (USEPA) for review. If any MPCA/USEPA-requested revisions were necessary, a final DUR was resubmitted. The final MPCA/USEPA approval letter has not yet been received for the FY 2017 DURs, but will be included in Appendix C.3.

For water level measurements, the depth to water from the surveyed top of the well casing elevation was measured. Groundwater elevations were calculated by subtracting the depths to water from the surveyed top of the well casing elevations and are included in the historical water elevation database (Appendix D.1).

2.2 Groundwater Elevation Contour Maps

The most extensive water level monitoring event performed during FY 2017 was in June (Quarter 135). This data was used to prepare groundwater elevation contour maps for shallow groundwater at Sites A, C, K and Building 102. Given that this was a minor sampling event, there was not sufficient deep groundwater elevation data to prepare groundwater elevation contour maps. Groundwater elevation contour maps are included within the individual sections of this report. There is not a comprehensive water level event for shallow groundwater at Site I, given the well sealing that has been done.

2.3 Groundwater Quality Contour Maps and Cross-Sections

The most extensive sampling event performed during FY 2017 was in June (Quarter 135). This data were used to prepare updated groundwater quality isoconcentration contour maps and/or cross-sections for deep groundwater at OU1/OU3 and OU2 (OU3 is shown with OU1 on Section 3 Figures) and shallow groundwater at Site A, Site C, Site K and Building 102. Site I is excluded, given the well sealing that has been done. Contour maps were generated by hand, based on the observed contaminant concentrations and the extent of past site contamination. These maps are included in the Figures Section of this report.

For deep groundwater at OU1/OU3 and OU2, isoconcentration maps and cross-sections are provided for trichloroethene and 1,4-dioxane, since these are the primary chemicals of concern on a concentration basis. These isoconcentration maps include individual maps for Upper and Lower Unit 3 Combined, Upper Unit 4, and Lower Unit 4. To complement the isoconcentration maps, cross-sections were prepared to illustrate the vertical distribution of trichloroethene and 1,4-dioxane. One section line passes through the source area at Site G in OU2 and follows the north plume (OU1) through well 582628 (NBM#15) of the New Brighton Contaminated Groundwater Recovery System (NBCGRS). A second section line follows the OU2/OU1 boundary.

Contaminant concentrations for Middle Unit 3 wells and wells that fully penetrate Unit 3 (03F) (including any recovery wells that fully penetrate Unit 3 and that are being sampled as a monitoring well) are shown in parentheses on the Lower Unit 3 isoconcentration maps, but were not used for contouring purposes except when no Lower Unit 3 wells are located in the vicinity.

For Site A shallow groundwater, an isoconcentration map is provided for cis-1,2-dichloroethene, since this is the chemical of concern with the largest aerial extent at Site A, and for tetrachloroethene, which illustrates the source area and contaminant degradation. Cross-sections were also prepared for Site A to illustrate the vertical distribution of cis-1,2-dichloroethene. The isoconcentration maps for Site A were prepared only for Unit 1, since this is the only contaminated aquifer.

For Site C shallow groundwater, an isoconcentration map is provided for dissolved lead, since this is the only chemical of concern at Site C. Results for surface water monitoring are also shown on the same map to show impacts to surface water are not occurring as a result of the shallow groundwater contamination. Cross-sections were also prepared for Site C to illustrate the vertical distribution of dissolved lead. The isoconcentration map for Site C was prepared only for Unit 1, since this is the only contaminated aquifer.

For Site K shallow groundwater, an isoconcentration map is provided for trichloroethene, since this is the primary chemical of concern on a concentration basis. The isoconcentration map for Site K was prepared only for Unit 1, since this is the only contaminated aquifer.

For Building 102 shallow groundwater, a concentration map is provided for vinyl chloride, since this is the chemical of concern that has historically had the largest aerial extent at Building 102, and for trichloroethene and cis-1,2-dichloroethene, to illustrate the source area and contaminant degradation. The isoconcentration maps for Building 102 were prepared only for Unit 1, since this is the only contaminated aquifer.

Contaminant concentrations for recovery wells that are actively pumping are shown in parentheses on the isoconcentration maps. These values were considered, but were generally not used alone to prepare the isoconcentration contours. Concentrations of recovery wells generally represent an average contaminant value for all groundwater being drawn to the well; hence, the concentrations do not necessarily represent a discrete location or depth. Contaminant concentrations for recovery wells that are not actively pumping are fully utilized for purposes of contouring.

All Shallow and Deep Groundwater VOC Sites

June 2017: At all well locations where volatile organic compound (VOC) samples were scheduled to be collected, samples for 1,4-dioxane were also collected at the same time, as requested by the USEPA and MPCA, in accordance with Quality Assurance Project Plan (QAPP) Addendum #1 (Wenck, May 21, 2015).

OU2: Site A Shallow Groundwater

01U039: 1,4-dioxane samples were not properly preserved. The well was not resampled, as 2016 data indicated 1,4-dioxane was not present at detectable levels at any Site A wells.
01U115: Same as above.
01U355: Same as above.
01U902: Same as above.
01U903: Same as above.
01U904: Same as above.
01U108: An obstruction prevented the sampling pump from being deployed in the well; therefore, the well could not be sampled.

OU2: Site C Shallow Groundwater

SW-5: Site C Surface Water sites were inadvertently missed during the June 2017 event.
SW-6: Same as above.
NE Wetland: Same as above.

OU2: Site K Shallow Groundwater

01U608: The well was intended to be reinstalled in 2017, but reinstallation was pushed back due to ongoing redevelopments of the Site; therefore, the well could not be sampled.
01U609: The well was intended to be reinstalled in 2017, but reinstallation was pushed back due to ongoing redevelopments of the Site; therefore, the well could not be sampled.
01U611: The well was intended to be reinstalled in 2017, but reinstallation was pushed back due to ongoing redevelopments of the Site; therefore, the well could not be sampled.
01U667: The well was intended to be reinstalled in 2017, but reinstallation was pushed back due to ongoing redevelopments of the Site; therefore, the well could not be sampled.

APPENDIX D

Groundwater Data

D.1 Comprehensive Groundwater Quality and Groundwater Level Databases

Appendix D.1
Comprehensive Groundwater Quality and Groundwater Level Databases FY 2017
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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The historical groundwater databases are located on this CD in a folder named Appendix D.1. This folder contains four Microsoft Excel files:

File	Contents
Compelev_FY17	Groundwater elevations
Comporwq_FY17	Groundwater quality: organic data
Compinwq_FY17	Groundwater quality: inorganic data (excluding Site C)
Site C wq_FY17	Groundwater quality: inorganic data (Site C only)

D.2 Operable Unit 1 Statistical Analysis

Group 1 – Downgradient of TGRS

03U806	04U806	03L802	03U801
03M806	PJ#806	04U802	03U711
03L806	03M802	PJ#802*	04U711

Group 2 – Areal Extent of Plume

03U805	409557	04U841	04U875
03U672	04U673	04U843	04U877
03L848	04U832	04U833	206688 out of service
03L673	04U845	04U846	04U849
03L833	04U854	04U861 abandoned	04U821
03L859	04U859	409549	191942 abandoned

Group 3 ** – Downgradient Sentinel

04U871	04U875	04U851	

Group 4 – Lateral Sentinel

03U831 abandoned	03L846	409556	409548
03U811	03L832	04U855	04U839
03U804	03L861 abandoned	04U879	04U838
03U673	03L854	04U860	04U848
03U672 abandoned	03L841	409547	04J839
03M843	03L811	04U863	03U677

Group 5 – Global Plume

04J077	04U702	04U848	04U877
04J702	04U709	04U851	04U879
04J708	04U711	04U852 abandoned	04U880
04J713	04U713	04U855	04U881
04J834	04U802	04U859	04U882
04J864 abandoned	04U806	04U860	200154
04J866	04U832	04U861 abandoned	234546
04J882	04U833	04U863	234549 out of service
04U002	04U834	04U864 abandoned	409547
04U020	04U841	04U865 abandoned	409548
04U027abandoned	04U843	04U866	409549
04U077	04U844	04U871	409555
04U673	04U845	04U872	512761
04U701	04U846	04U875	PJ#318

Group 5 Unit 3 wells (evaluated as individual trends)

03L822	03U821	03U822	03L822
409550	409596	409597	03U831abandoned

Group 6 – Jordan Aquifer

04J077	04J838	04U713	04U882
04J702	04J839	04U834	NBM#3
04J708	04J882	04U836	NBM#4
04J713	04J847	04U837	NBM#5
04J822	04J849	04U838	NBM#6
04J834	04U077	04U839	
04J836	04U702	04U847	
04J837	04U708	04U849	

* PJ#802 will not be monitored or used for evaluation unless 04U802 shows TCE concentrations greater than 1 ppb.

** Group 3 is analyzed as a rectangular area taken from the Group 5 contouring.

Mann-Kendall S	Mann-Kendall P	Trend Conclusion
S > 0	P < / = 0.05	Increasing
S > 0	P < / = 0.10	Probably Increasing
S = 0	P < / = 0.05	Stable
S < 0	P < / = 0.10	Probably Decreasing
S < 0	P < / = 0.05	Decreasing
Any 'S'	P > 0.05	No Significant Trend

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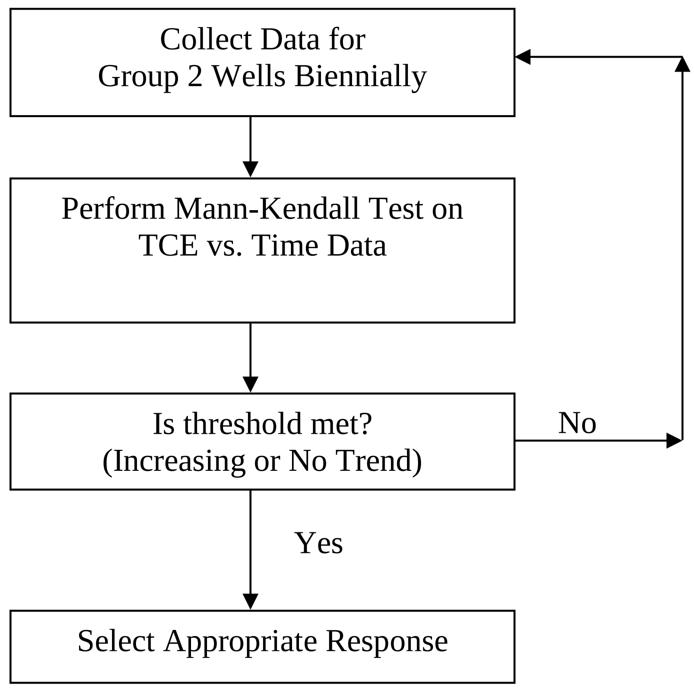
Well Group	Purpose	Measure	Time Window/ Monitoring Frequency	Test	Response Threshold
Group 1	AWC Immediately Downgradient of TGRS	AWC Trend	6 years/annual	Mann-Kendall	Stable, Increasing, or No Trend
Group 2	Defining Plume Size (Low Concentration Edges)	Individual Well Trend for TCE	12 years/biennial	Mann-Kendall	Increasing or No Trend
Group 3	AWC Immediately Downgradient of NBCGRS	AWC Trend	12 years/biennial	Mann-Kendall	Stable, Increasing, or No Trend
Group 4	Lateral (Clean) Sentinel Wells	Individual Well Concentration	12 years/biennial	Individual Concentrations	Greater than ROD goals
Group 5	Global Plume Mass Reduction	AWC Trend	12 years/biennial	Mann-Kendall	Stable, Increasing, or No Trend
Group 6	Evaluating and comparing trends in Jordan Aquifer	Individual Well Trend for TCE	12 years/biennial	Mann-Kendall	Stable, Increasing or No Trend

General Notes:
A Response Threshold is the test result(s) that triggers further response. See text for additional explanation of response process.
Acronyms and Abbreviations:
AWC = Area-Weighted Concentration


Collect Data for
Group 2 Wells Biennially
Perform Mann-Kendall Test on
TCE vs. Time Data
Is threshold met?
(Increasing or No Trend)
No
Yes
Select Appropriate Response

Appendix D.2.1.5
Responses to Threshold Indicators Fiscal Year 2017
FY 2017 Annual Report
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FACTORS TO CONSIDER

- Contaminant concentrations
- Location (vertical and horizontal)
- Surrounding data
- Risks to human health or the environment
- Need for urgency in response

POSSIBLE EVALUATION RESPONSES

- Perform additional or confirmation sampling
- Write up in the Annual Performance Report
- Perform separate evaluation and write-up (Tech Memo)

POSSIBLE LONG-TERM RESPONSES

- Increase sampling frequency
- Modify operation of remedial system(s)
- Perform new remedy evaluation
- Install additional monitoring well(s)
- Modify the Special Well Construction Area
- Control risk at the receptors

Note: Threshold responses to be described and evaluated in the Annual Performance Reports.

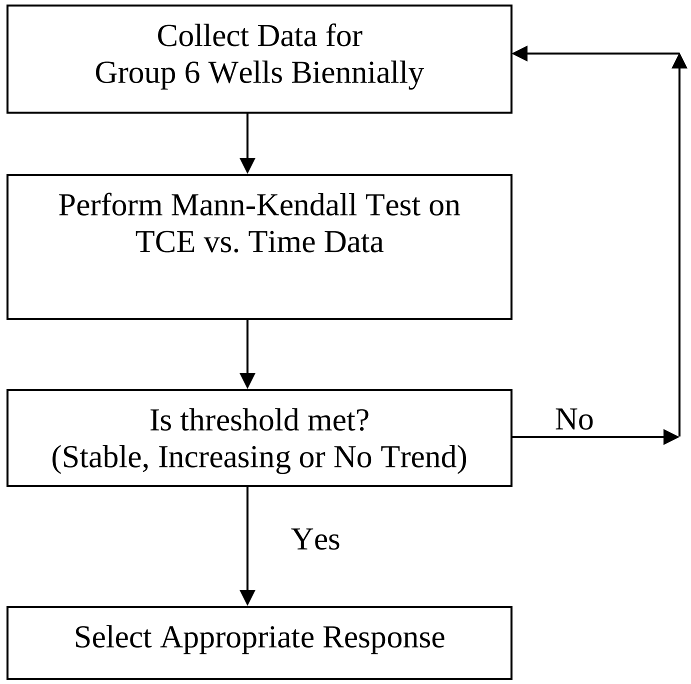
Collect Data for
Group 6 Wells Biennially
Perform Mann-Kendall Test on
TCE vs. Time Data
Is threshold met?
(Stable, Increasing or No Trend)
No
Yes
Select Appropriate Response

Table 3-3
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
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Group	S Value	P Value	R^2 Value	Fraction of Detections	Results Trend	Threshold Triggered?	Comments
Group 2 Wells:							
409549	18	0.0034	0.854	7 / 7	Increasing	Yes	Near plume center, plume shifted slightly
409557	19	0.0014	0.958	7 / 7	Increasing	Yes	Between north & south plume, lateral dispersion
03L673	-18	0.0034	0.814	7 / 7	Decreasing	No	
03L833	-13	0.0350	0.465	7 / 7	Decreasing	No	
03L848	-17	0.0054	0.776	7 / 7	Decreasing	No	
03L859	-17	0.0054	0.854	7 / 7	Decreasing	No	
03U677	NA	NA	NA	0 / 9	NA	No	All ND
03U805	15	0.0150	0.580	7 / 7	Increasing	Yes	Southern edge of north plume, plume shifted slightly
04U673	-9	0.1190	0.00155	7 / 7	No Significant Trend	Yes	Near south plume center, plume shifted slightly
04U821	-11	0.0680	0.423	7 / 7	Probably Decreasing	No	
04U832	-2	0.4430	0.00364	7 / 7	No Significant Trend	Yes	Relatively stable, between 46 and 56 µg/L since 2007
04U833	-22	0.0028	0.6075	8 / 8	Decreasing	No	
04U841	-14	0.0250	0.585	7 / 7	Decreasing	No	
04U843	20	<0.001	0.965	7 / 7	Increasing	Yes	Near plume center
04U845	-12	0.0515	0.317	7 / 7	Probably Decreasing	No	
04U846	20	<0.001	0.942	7 / 7	Increasing	Yes	Near plume center, historically erratic
04U849							See Group 6 summary.
04U854	-16	0.0102	0.738	7 / 7	Decreasing	No	
04U859	-20	<0.001	0.891	7 / 7	Decreasing	No	
04U861 (abandoned)	11	0.0280	0.752	6 / 6	NA	NA	Abandoned after 2006 sample, in New Brighton Development
04U875	-16	0.0310	0.299	4 / 8	Decreasing	No	
04U877	-1	0.5000	0.0004	8 / 8	No Significant Trend	Yes	
206688	-4	0.2980	0.007	6 / 6	No Significant Trend	Yes	
Group 1 NP	-5	0.281	0.0971	7 / 7	No Significant Trend	Yes	
Group 1 SP	0	0.563	2010	7 / 7	Stable	Yes	
Group 3	-10	0.0935	0.335	7 / 7	Probably Decreasing	No	
Group 5	11	0.068	0.463	7 / 7	Probably Increasing	Yes	
Group 5 Unit 3 Wells:							
409550	-6	0.2360	0.442	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
409597 (abandoned)	-11	0.0280	0.809	6 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
409596 (abandoned)	-8	0.1020	0.633	6 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
03U831 (abandoned)	9	0.0680	0.405	2 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
03U821	-19	0.0014	0.951	7 / 7	Decreasing	No	
03U822	2	0.4430	0.0259	7 / 7	No Significant Trend	Yes	Between 120 and 160 µg/L since 2003
03L822	-14	0.0250	0.69	7 / 7	Decreasing	No	
03L809	-8	0.1550	0.499	7 / 7	No Significant Trend	Yes	Raw trend is decreasing

Notes and Abbreviations on Page 2.

Table 3-3
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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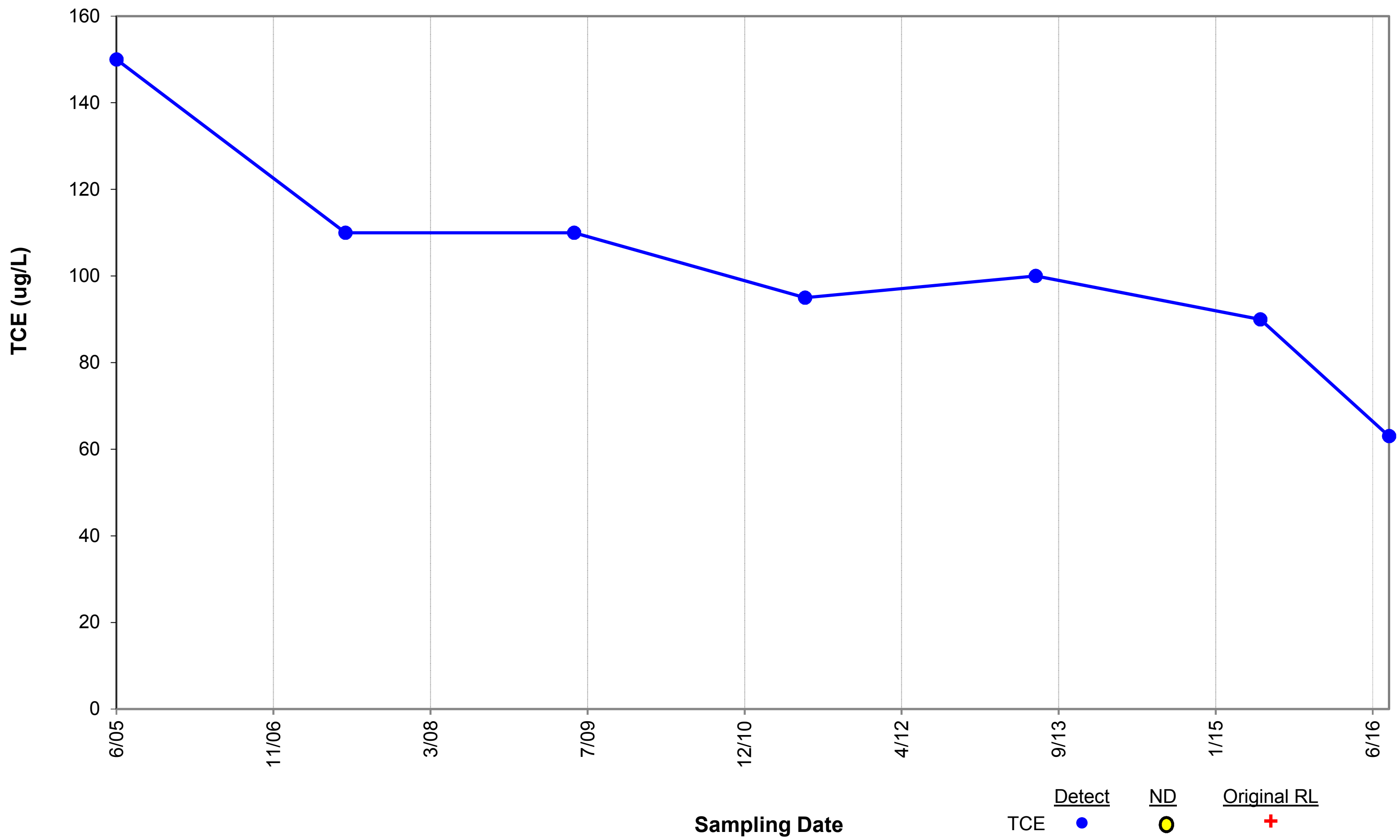
Group	S Value	P Value	R^2 Value	Fraction of Detections	Results Trend	Threshold Triggered?	Comments
Group 6 OU1 Jordan Wells:							
04J822	-12	0.0890	0.364	8 / 8	Decreasing	No	
04J834	-16	0.0102	0.702	4 / 7	Decreasing	No	
04J836	18	0.0160	0.683	8 / 8	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J838	13	0.0350	0.700	7 / 7	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J837	-9	0.1690	0.294	8 / 8	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J839	0	0.5480	0.034	8 / 8	Stable	Yes	Below 5 µg/L
04J847	24	0.0565	0.218	12 / 12	Increasing	Yes	Near plume center
04J849	18	0.0160	0.337	3 / 8	Increasing	Yes	Below 1 µg/L
04J882	NA	NA	NA	0 / 7	NA	No	All ND
04J077	-18	0.0160	0.653	8 / 8	Decreasing	No	
04J702	-18	0.0034	0.595	7 / 7	Decreasing	No	
04J708	13	0.0350	0.565	7 / 7	Increasing	Yes	Southern edge of north plume, plume shifted slightly
04J713	NA	NA	NA	0 / 7	NA	No	All ND
Group 6 Nested Unit 4 Wells:							
04U077	-21	<0.001	0.889	7 / 7	Decreasing	No	
04U702	-2	0.4430	0.0000324	7 / 7	No Significant Trend	Yes	Below 3 µg/L
04U708	-16	0.0102	0.721	4 / 7	Decreasing	No	
04U713	-11	0.0680	0.350	5 / 7	Probably Decreasing	No	
04U834	-20	<0.001	0.869	5 / 7	Decreasing	No	
04U836	1	0.5000	0.0117	8 / 8	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U837	-5	0.3170	0.357	8 / 8	No Significant Trend	Yes	Raw trend is decreasing
04U838	0	0.5630	0.374	7 / 7	Stable	Yes	Below 3 µg/L since 2009
04U839	22	0.0028	0.566	8 / 8	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U847	-5	0.2810	0.0923	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
04U849	12	0.0515	0.781	7 / 7	Probably Increasing	Yes	Near plume center, appears relatively stable since 2011
04U882	-10	0.0935	0.234	6 / 7	Probably Decreasing	No	

General Notes:

Response Threshold triggers are defined in Table D.2.1.3.

Acronyms and Abbreviations:

NA = not applicable; trend analysis not performed at this location
ND = non-detect
NBCGRS = New Brighton Contaminated Groundwater Recovery System
P Value = represents uncertainty in the trend
R^2 Value = represents the fit of the data to the regression
S Value = indicates increasing (positive S) or decreasing (negative S) trend
µg/L = micrograms per liter



Mann-Kendall Test Result: DECREASING TREND
p-value = 0.003

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND
Median Slope Estimate = -1.6E-02 ug/L per day
95% Confidence Interval = -2.7E-02 to -6.8E-03 ug/L per day

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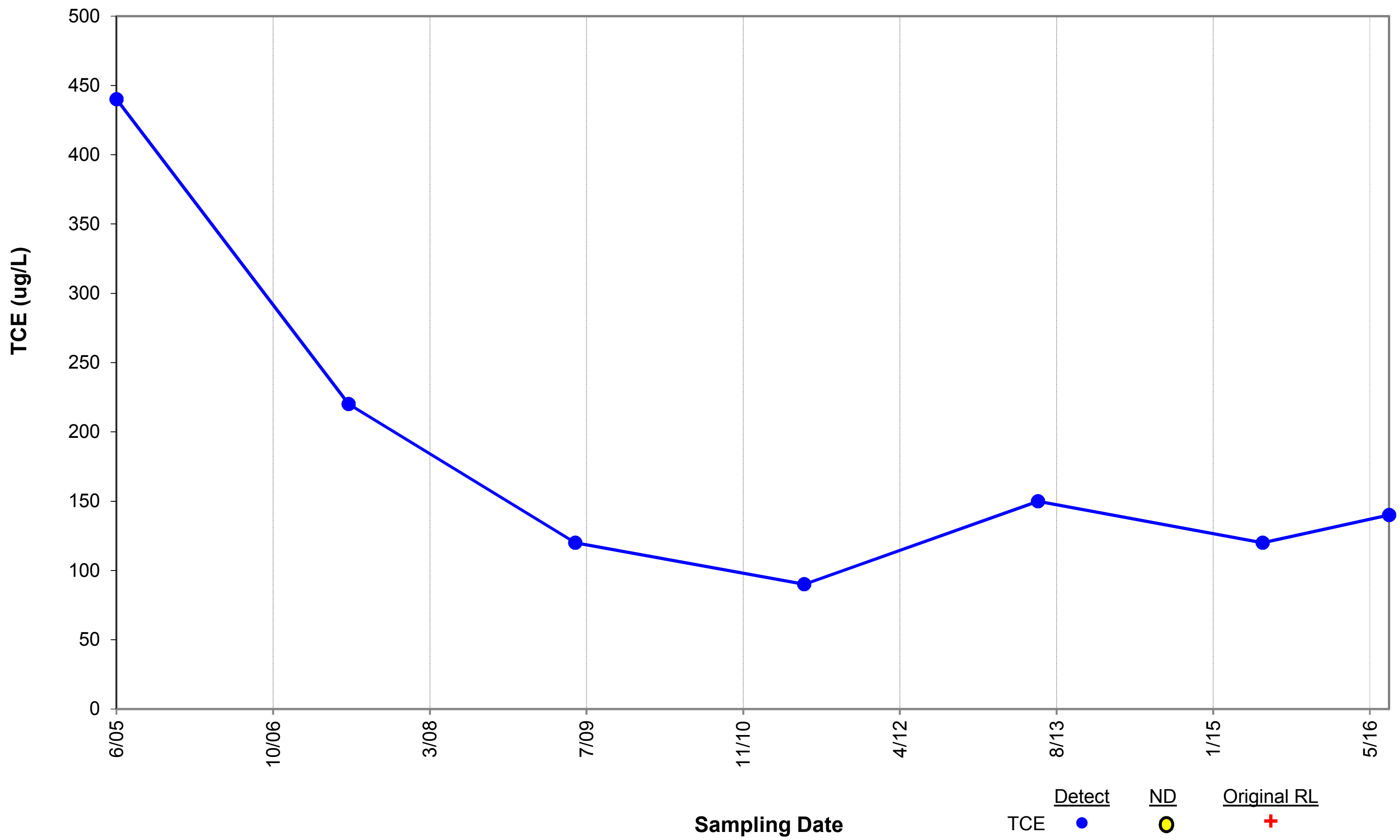
Concentration vs. Time Plot – TCE in Well 03L673
TCAAP

Figure D.2.2-1



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.155

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -3.4E-02 ug/L per day
95% Confidence Interval = -1.4E-01 to 2.0E-02 ug/L per day

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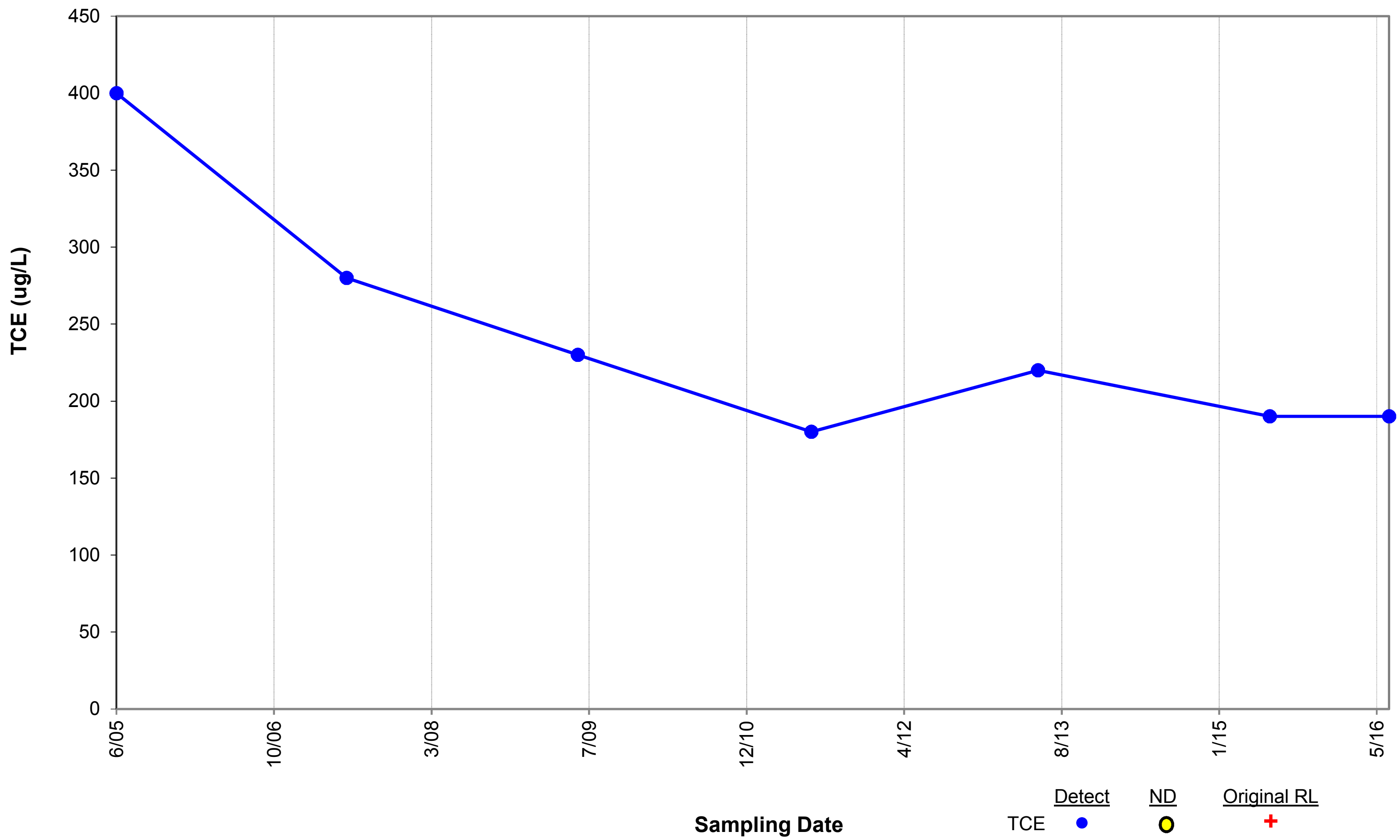
Concentration vs. Time Plot – TCE in Well 03L809
TCAAP

Figure D.2.2-2



Mann-Kendall Test Result: **DECREASING TREND**
p-value = 0.025

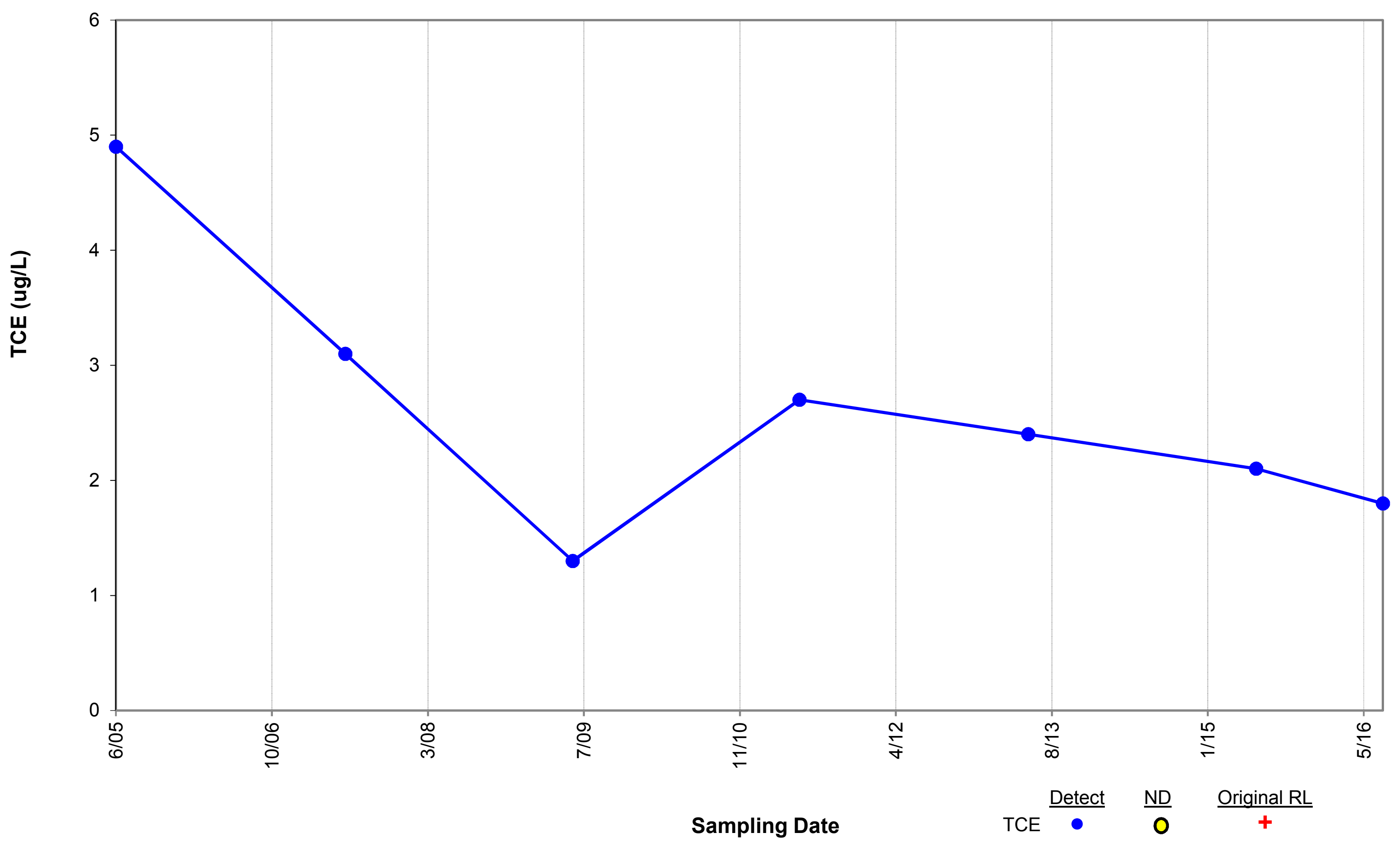
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **DECREASING TREND**
Median Slope Estimate = -3.1E-02 ug/L per day
95% Confidence Interval = -6.8E-02 to -7.3E-03 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 03L822
TCAAP

Figure D.2.2-3



Mann-Kendall Test Result: **DECREASING TREND**
p-value = 0.035

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **DECREASING TREND**
Median Slope Estimate = -4.1E-04 ug/L per day
95% Confidence Interval = -1.0E-03 to -2.6E-04 ug/L per day

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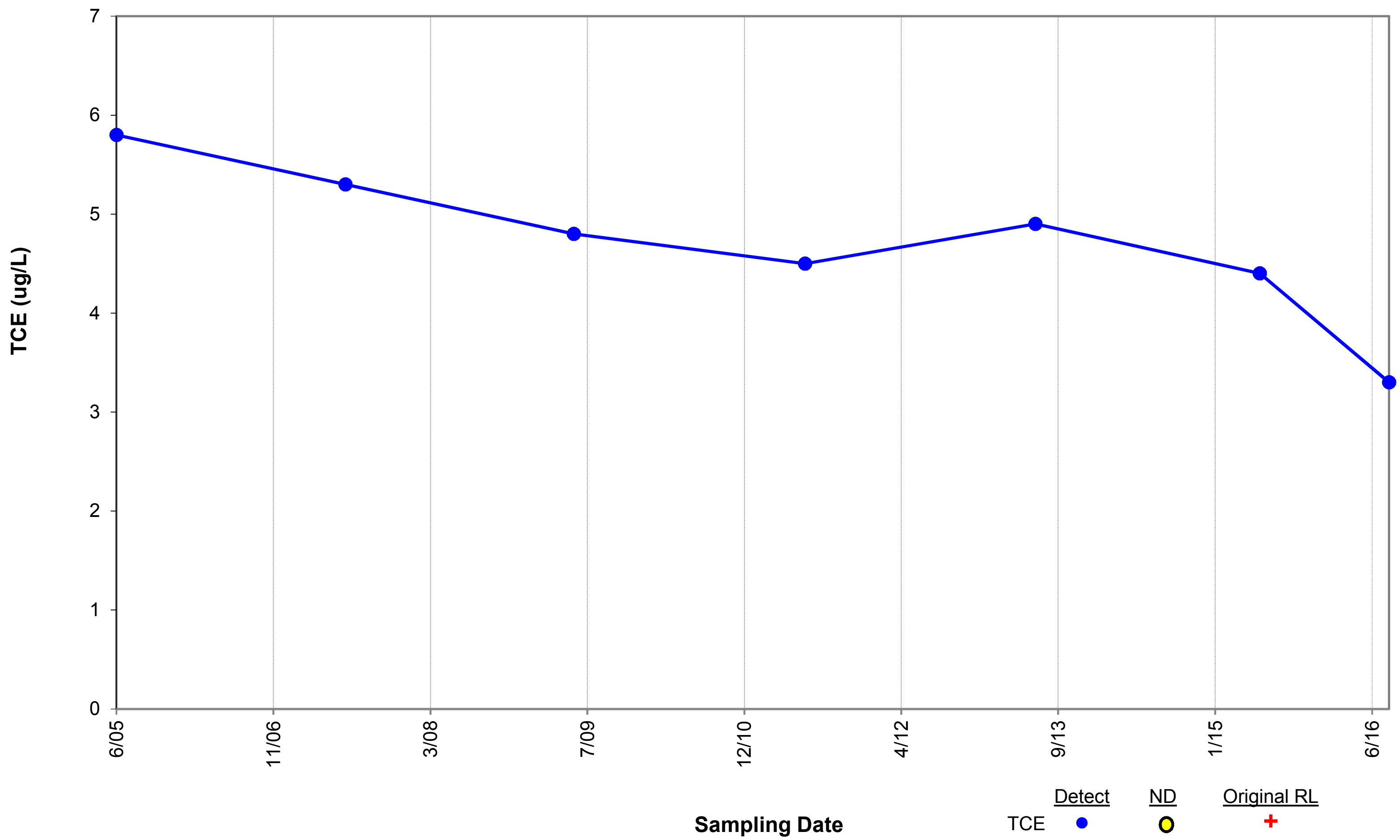
Concentration vs. Time Plot – TCE in Well 03L833
TCAAP

Figure D.2.2-4



Mann-Kendall Test Result: DECREASING TREND
p-value = 0.005

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND
Median Slope Estimate = -5.8E-04 ug/L per day
95% Confidence Interval = -6.9E-04 to -1.8E-04 ug/L per day

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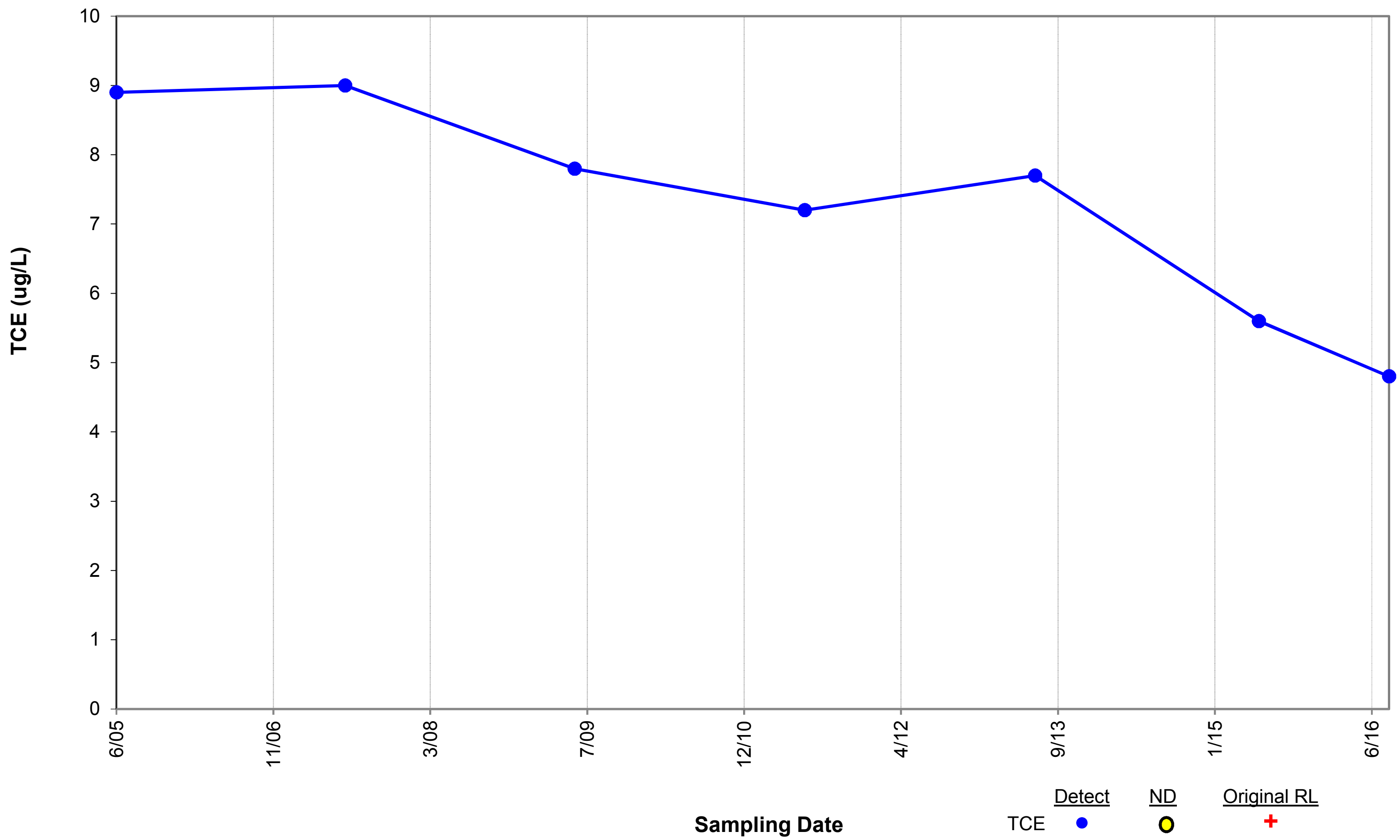
Concentration vs. Time Plot – TCE in Well 03L848
TCAAP

Figure D.2.2-5



Mann-Kendall Test Result: DECREASING TREND

p-value = 0.005

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND

Median Slope Estimate = -1.0E-03 ug/L per day

95% Confidence Interval = -1.6E-03 to -5.9E-04 ug/L per day

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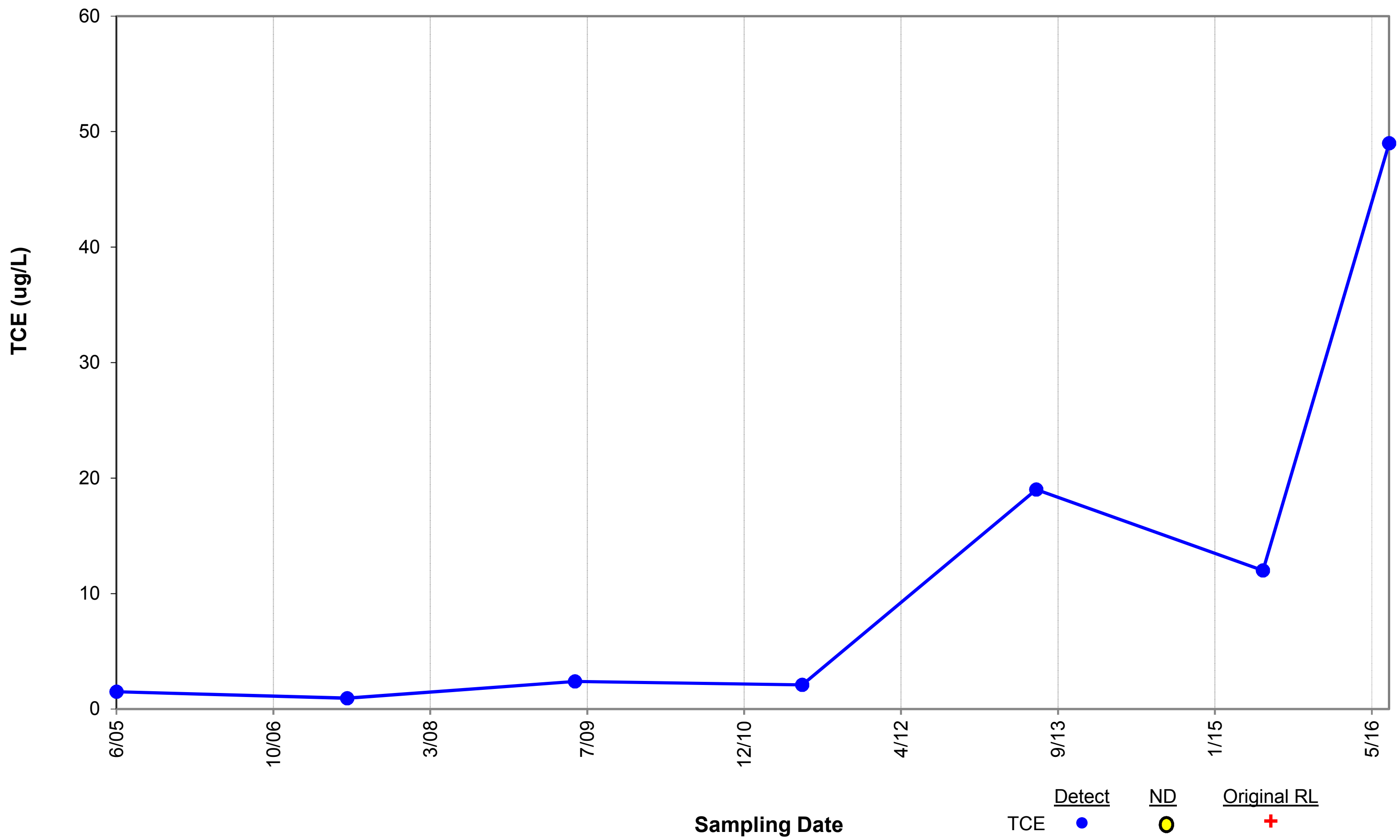
Concentration vs. Time Plot – TCE in Well 03L859

TCAAP

Figure D.2.2-6



Mann-Kendall Test Result:	INCREASING TREND			H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.015		
Theil-Sen Trend Line Result:	INCREASING TREND			
	Median Slope Estimate =	6.0E-03	ug/L per day	
	95% Confidence Interval =	2.6E-04 to 1.8E-02	ug/L per day	

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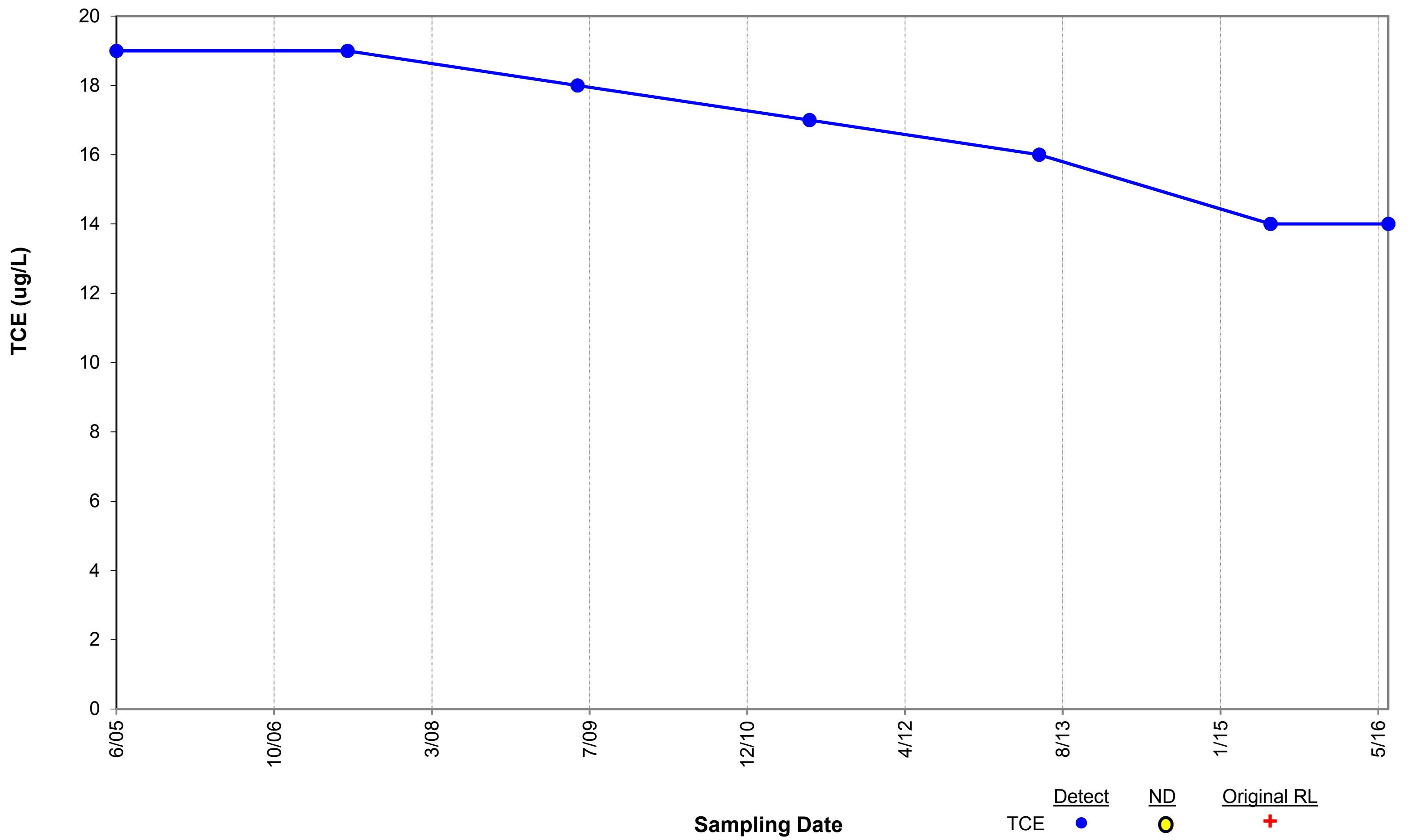
Concentration vs. Time Plot – TCE in Well 03U805

TCAAP

Figure D.2.2-7



Mann-Kendall Test Result: DECREASING TREND

p-value = 0.001

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND

Median Slope Estimate = -1.4E-03 ug/L per day

95% Confidence Interval = -1.8E-03 to -1.1E-03 ug/L per day

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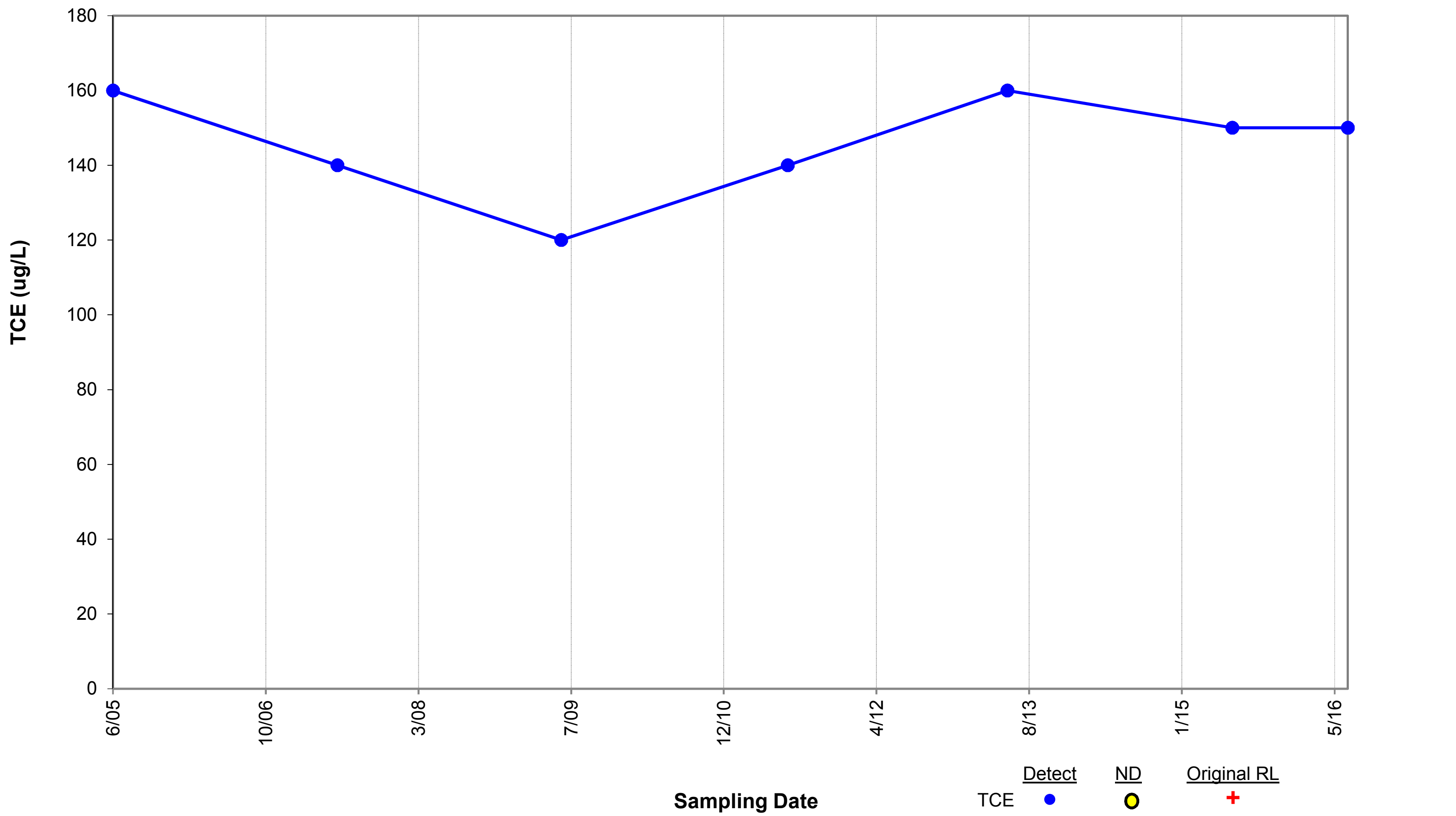
Concentration vs. Time Plot – TCE in Well 03U821

TCAAP

Figure D.2.2-8



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.443

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = 0.0E+00 ug/L per day
95% Confidence Interval = -1.3E-02 to 1.1E-02 ug/L per day

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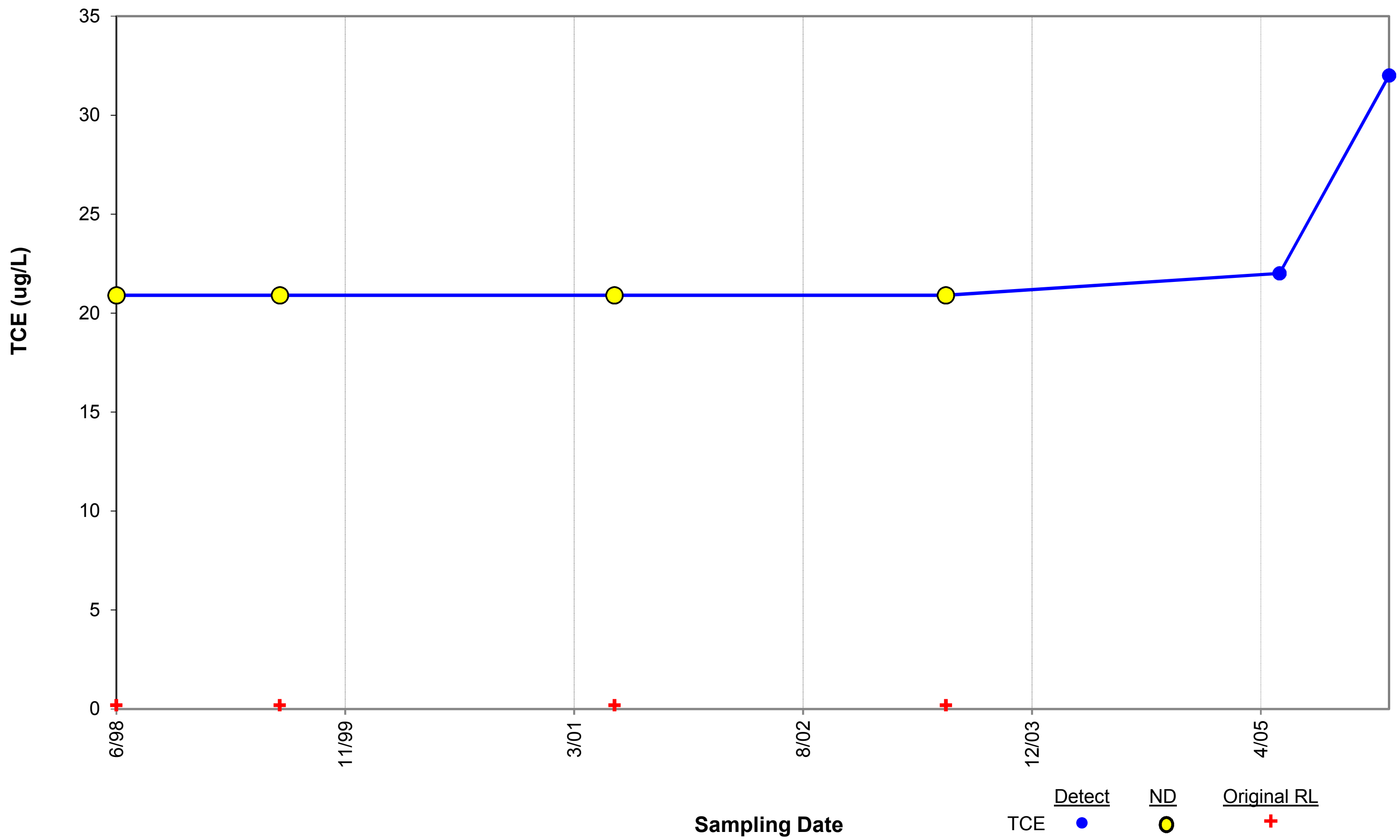
Concentration vs. Time Plot – TCE in Well 03U822
TCAAP

Figure D.2.2-9



Mann-Kendall Test Result:	**No Significant Trend** p-value = 0.068	H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
Theil-Sen Trend Line Result:	**No Significant Trend** Median Slope Estimate = 5.0E-04 ug/L per day 95% Confidence Interval = 0.0E+00 to 4.5E-03 ug/L per day	

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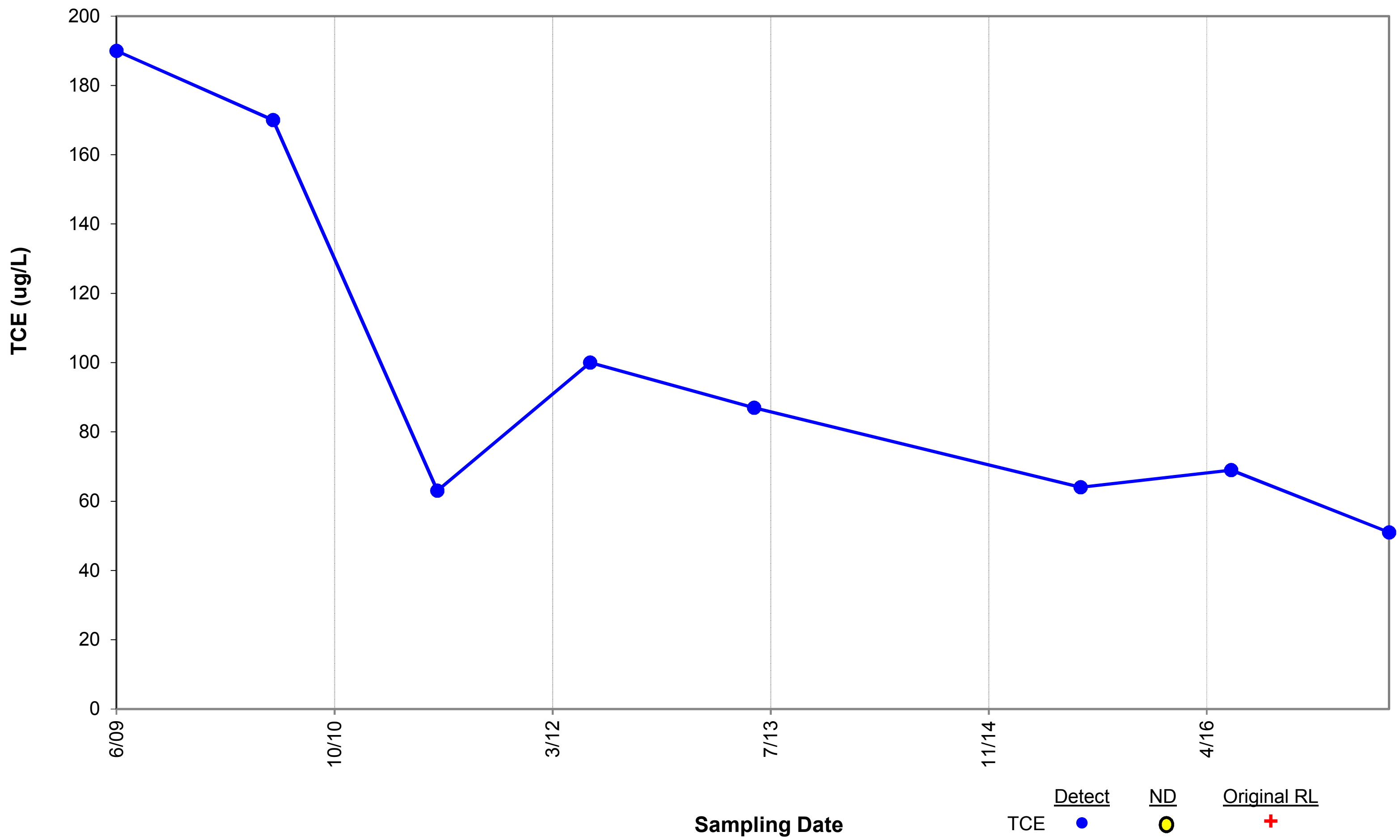
Concentration vs. Time Plot – TCE in Well 03U831
TCAAP

Figure D.2.2-10



Mann-Kendall Test Result: DECREASING TREND

p-value = 0.016

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND

Median Slope Estimate = -4.0E-02 ug/L per day

95% Confidence Interval = -6.9E-02 to -1.7E-02 ug/L per day

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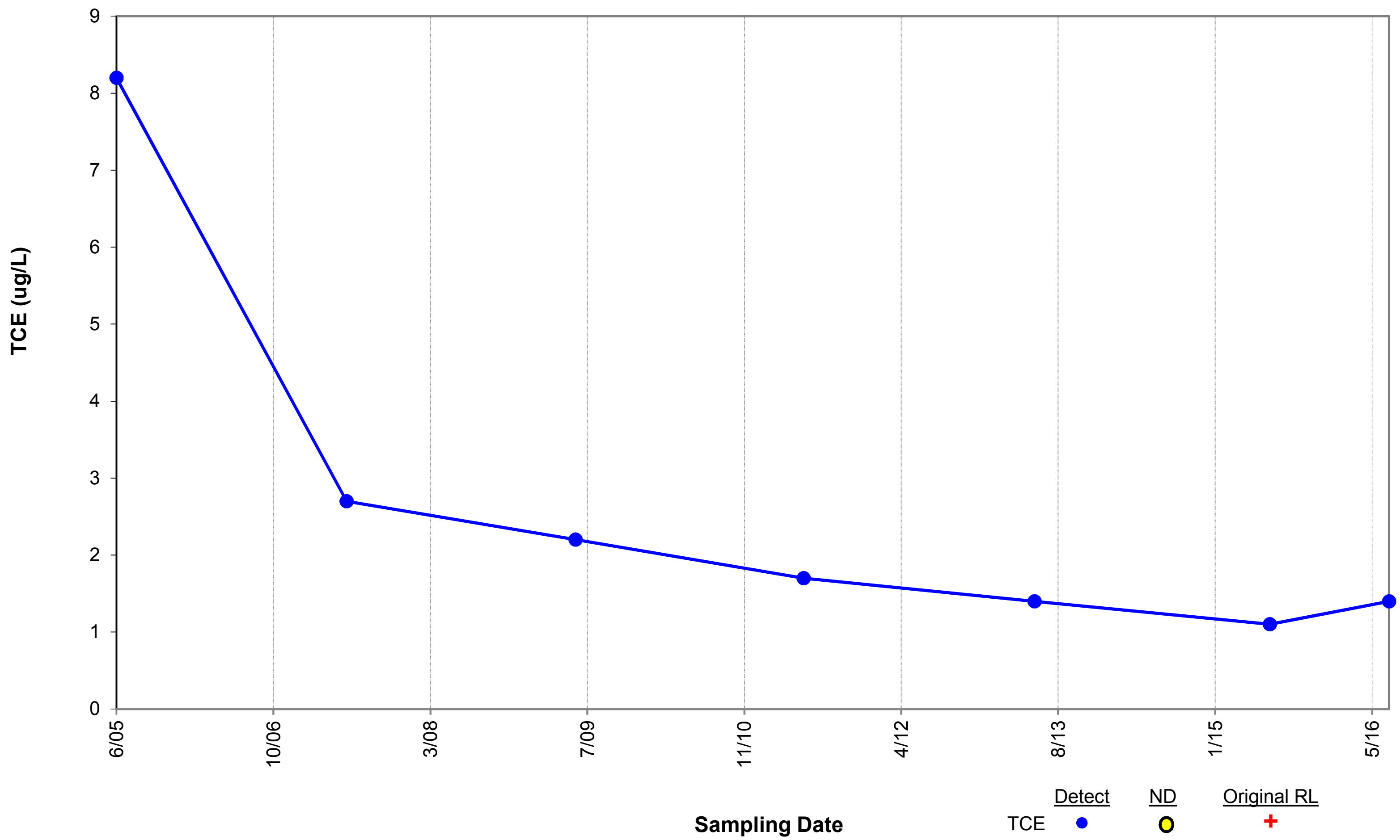
Concentration vs. Time Plot – TCE in Well 04J077

TCAAP

Figure D.2.2-11



Mann-Kendall Test Result: DECREASING TREND
p-value = 0.003

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND
Median Slope Estimate = -5.5E-04 ug/L per day
95% Confidence Interval = -2.3E-03 to -3.9E-04 ug/L per day

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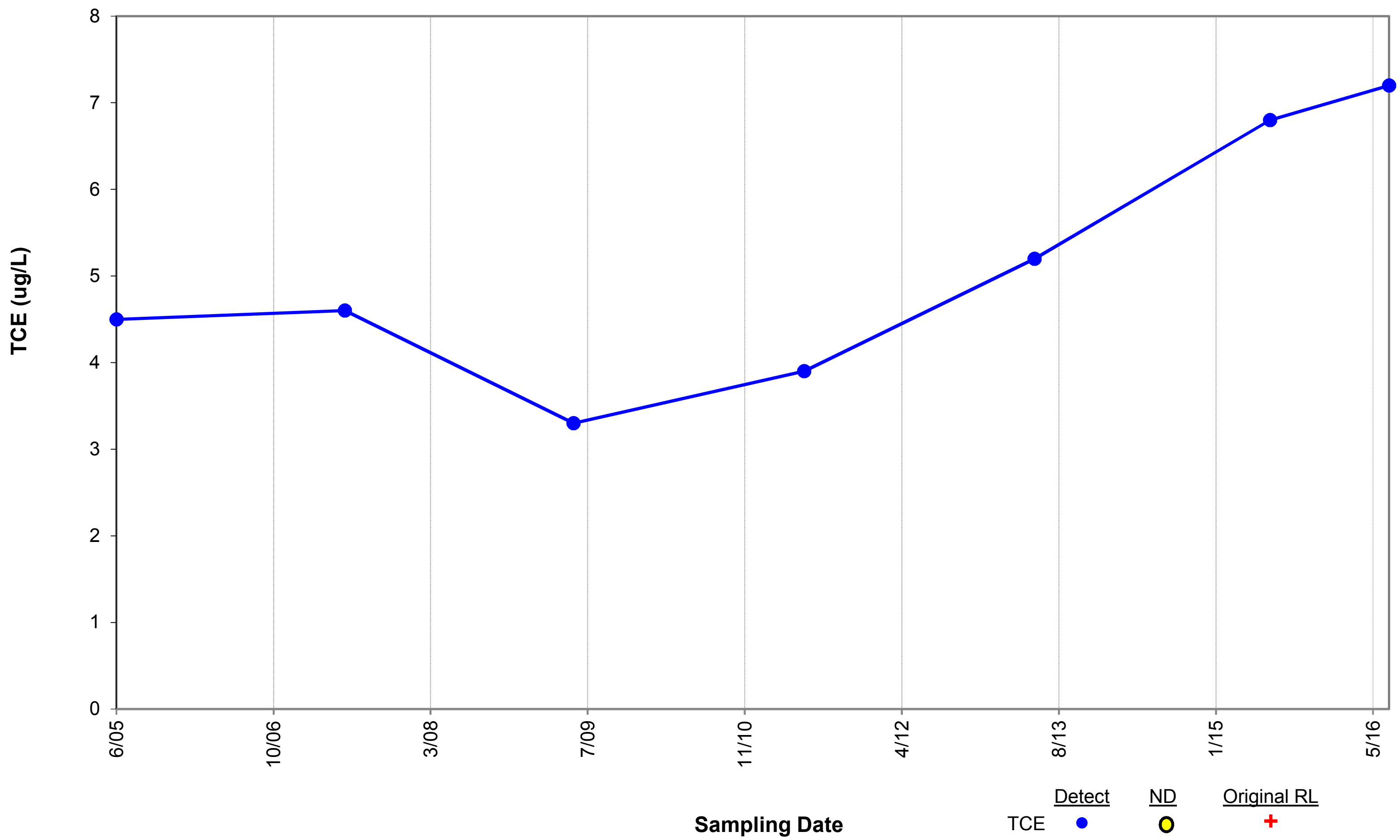
Concentration vs. Time Plot – TCE in Well 04J702
TCAAP

Figure D.2.2-12



Mann-Kendall Test Result: INCREASING TREND

p-value = 0.035

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**

Median Slope Estimate = 7.8E-04 ug/L per day

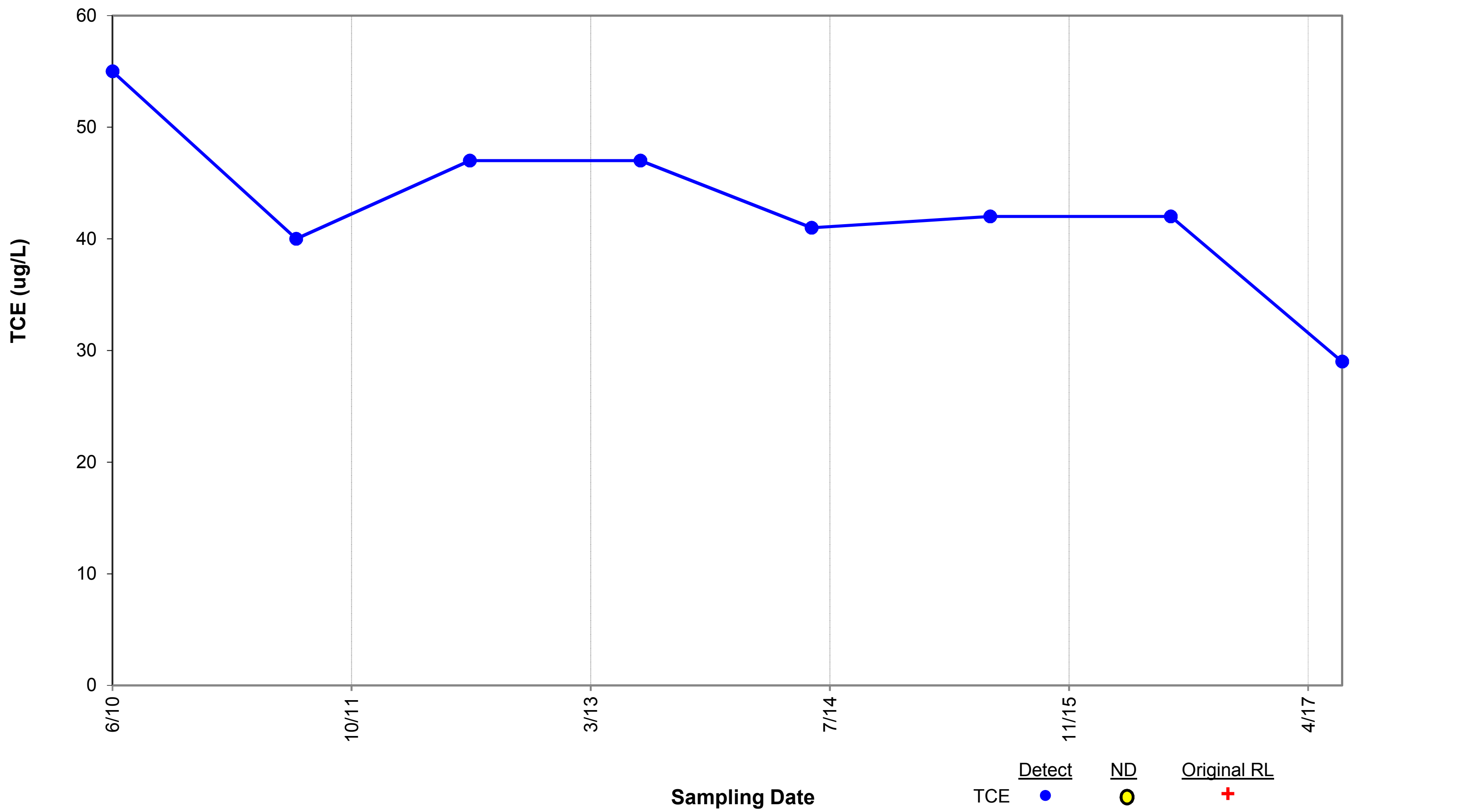
95% Confidence Interval = -2.8E-04 to 1.8E-03 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04J708

TCAAP

Figure D.2.2-13



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.089

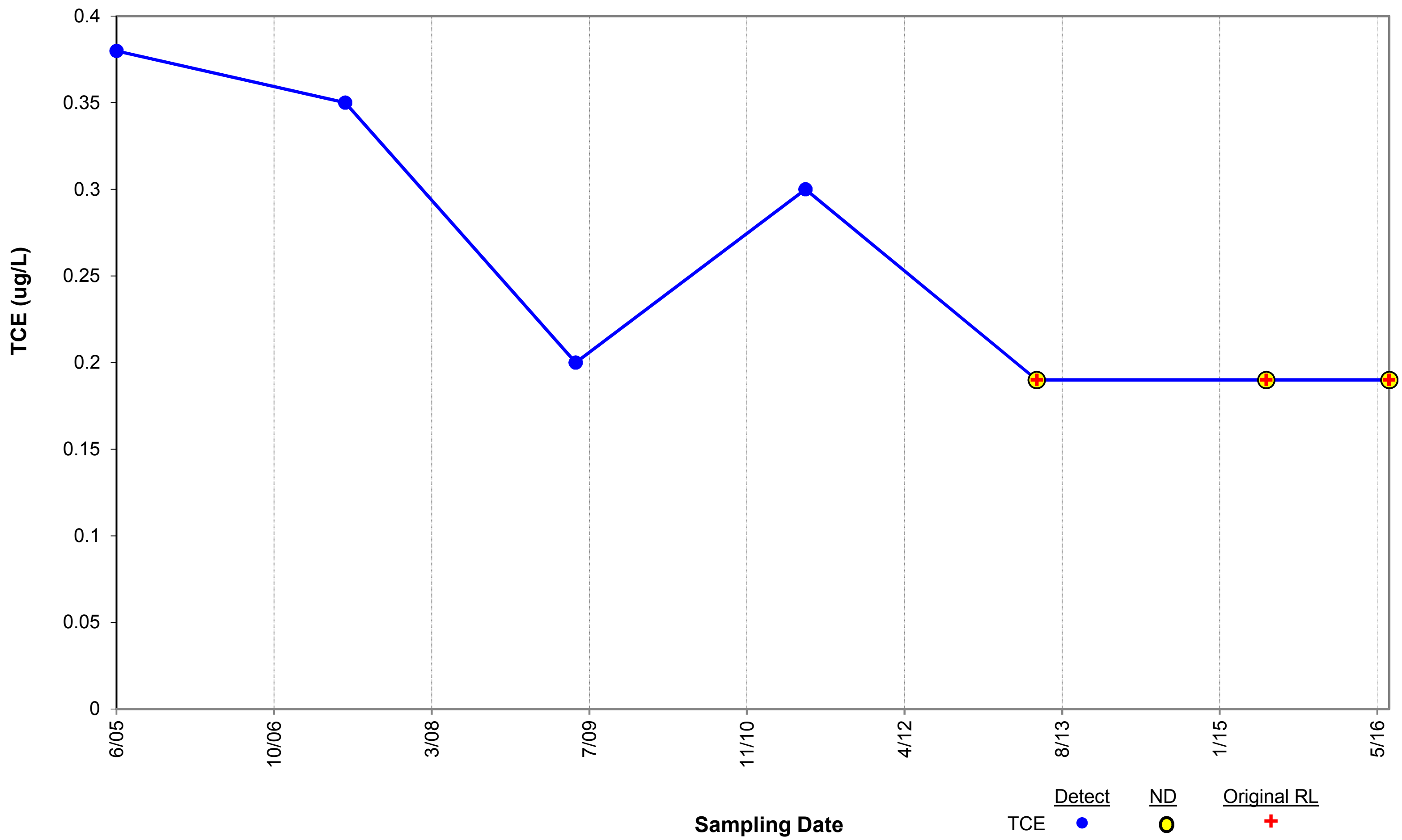
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -6.4E-03 ug/L per day
95% Confidence Interval = -1.1E-02 to 7.4E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04J822
TCAAP

Figure D.2.2-14



Mann-Kendall Test Result: DECREASING TREND

p-value = 0.010

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND

Median Slope Estimate = -4.7E-05 ug/L per day

95% Confidence Interval = -7.5E-05 to -4.0E-06 ug/L per day

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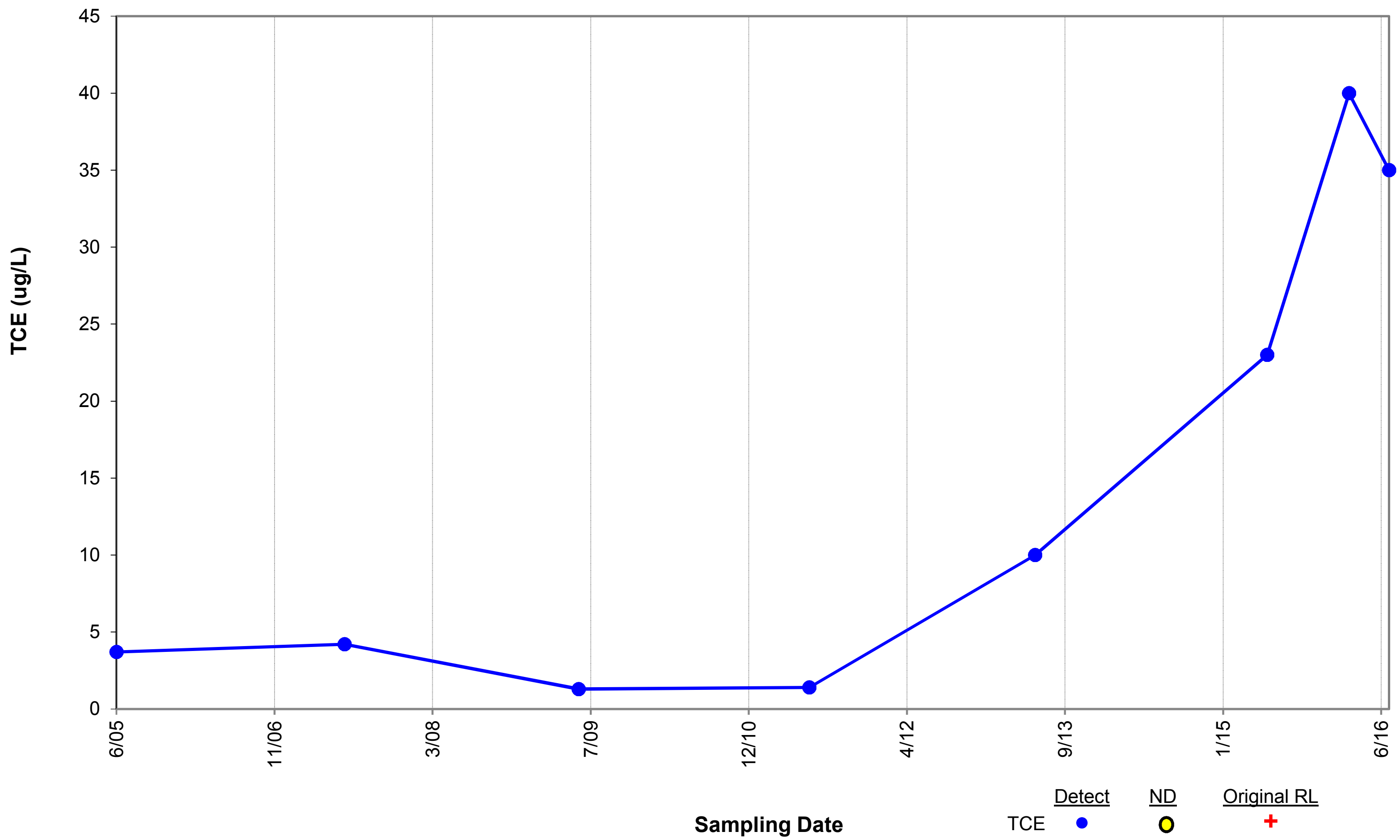
Concentration vs. Time Plot – TCE in Well 04J834

TCAAP

Figure D.2.2-15



Mann-Kendall Test Result: INCREASING TREND

p-value = 0.016

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: INCREASING TREND

Median Slope Estimate = 9.3E-03 ug/L per day

95% Confidence Interval = 1.8E-04 to 1.8E-02 ug/L per day

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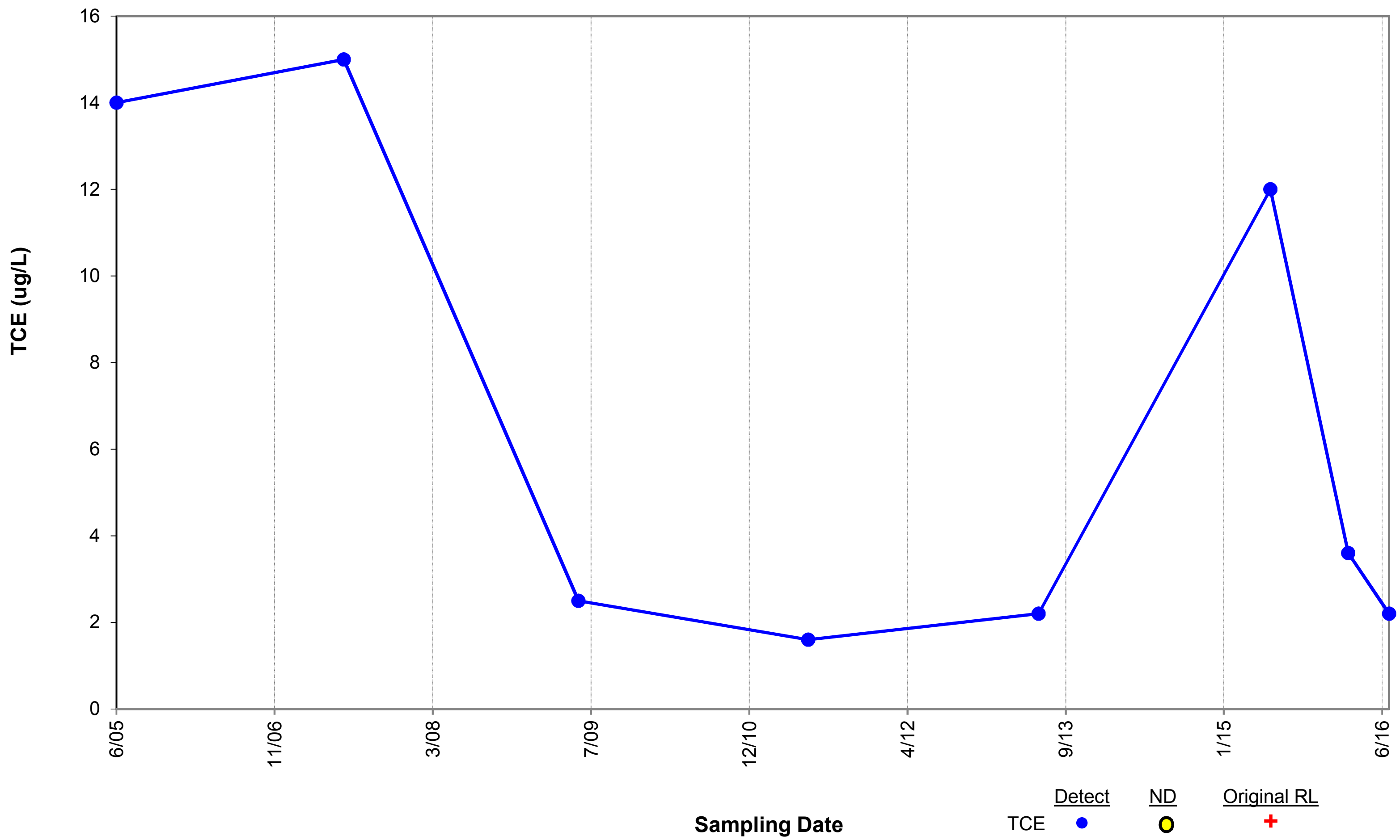
Concentration vs. Time Plot – TCE in Well 04J836

TCAAP

Figure D.2.2-16



Mann-Kendall Test Result:	**No Significant Trend** p-value = 0.169	H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
Theil-Sen Trend Line Result:	**No Significant Trend** Median Slope Estimate = -1.1E-03 ug/L per day 95% Confidence Interval = -7.6E-03 to 7.7E-04 ug/L per day	

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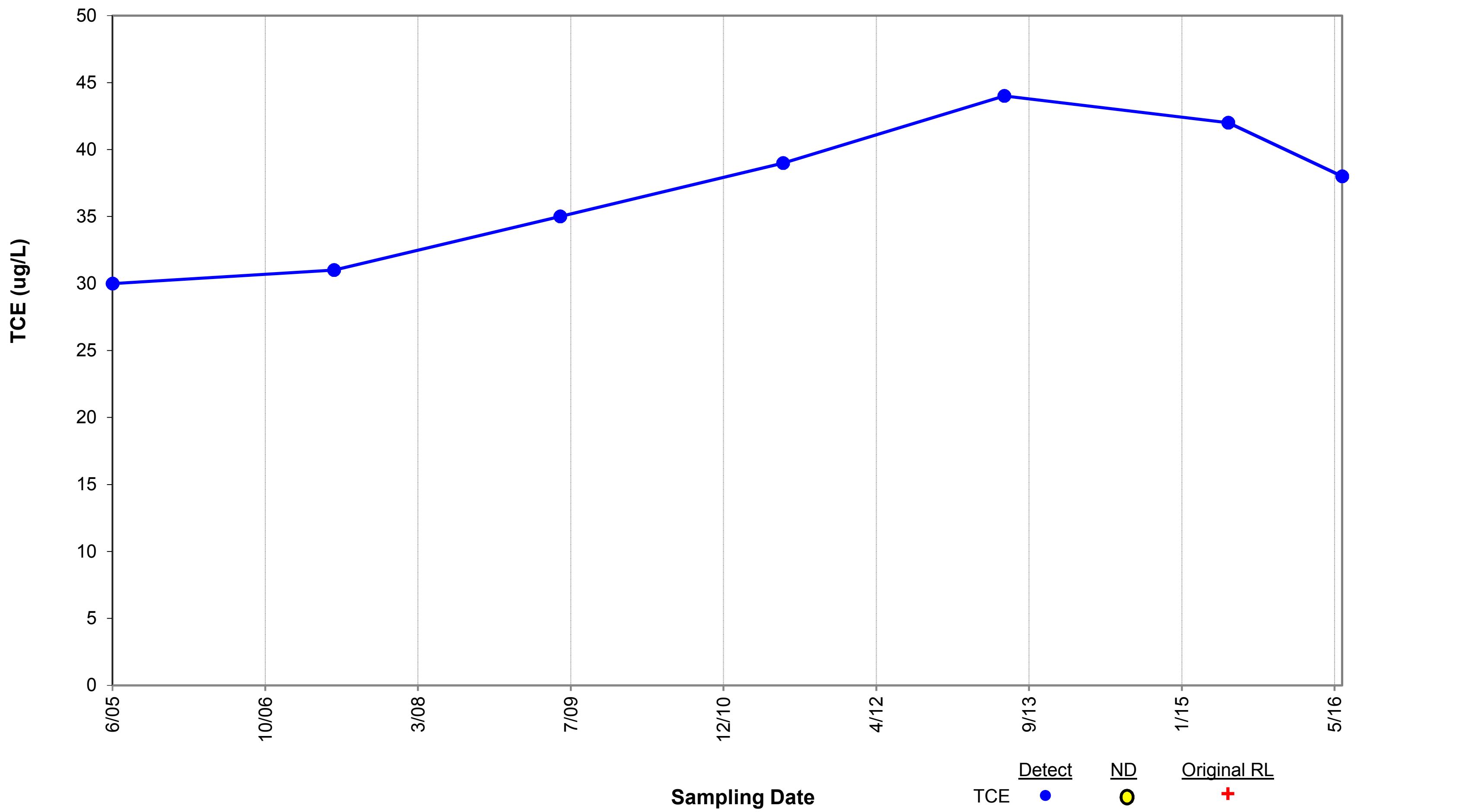
Concentration vs. Time Plot – TCE in Well 04J837
TCAAP

Figure D.2.2-17



Mann-Kendall Test Result: INCREASING TREND
p-value = 0.035

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = 3.3E-03 ug/L per day
95% Confidence Interval = -6.0E-04 to 5.4E-03 ug/L per day

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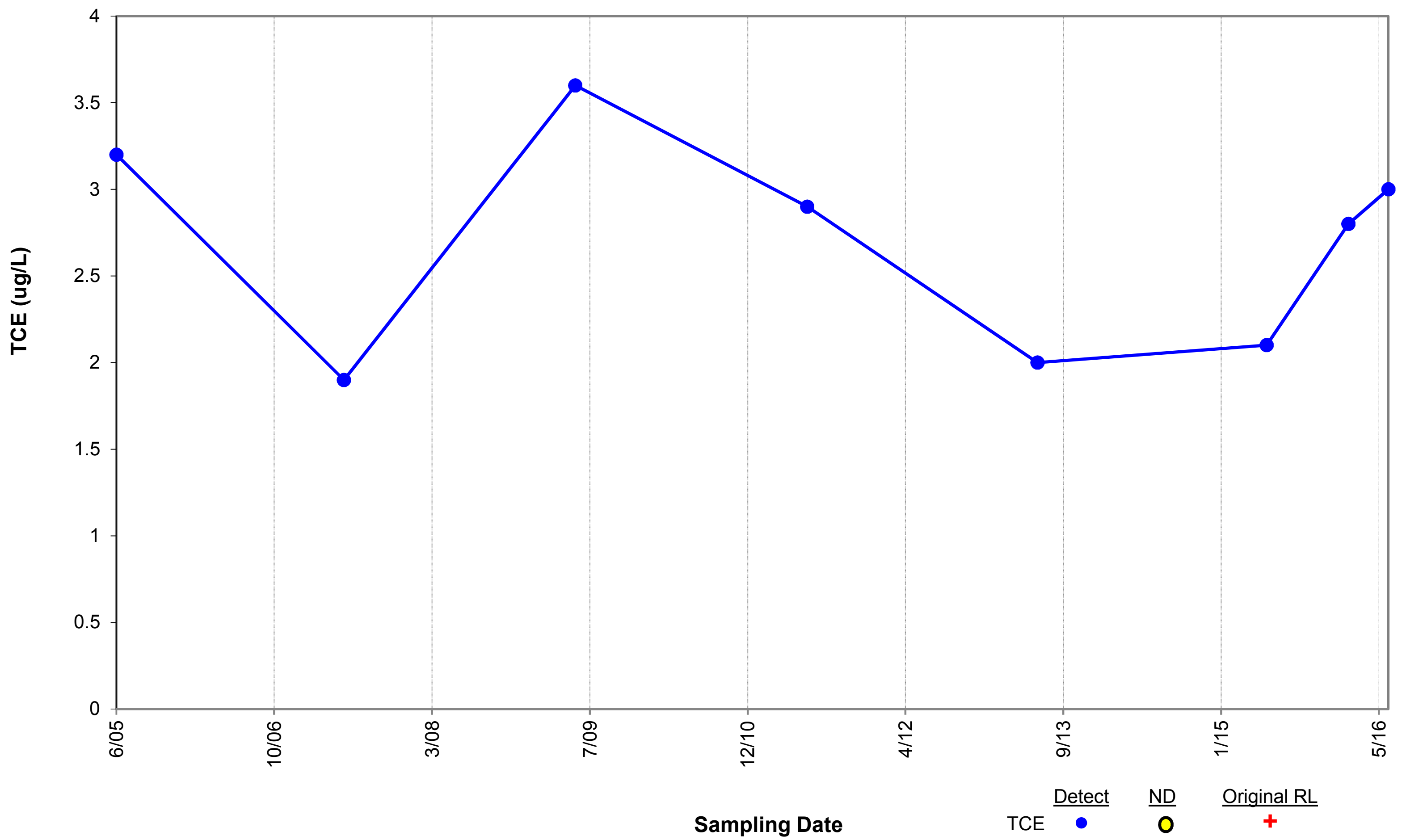
Concentration vs. Time Plot – TCE in Well 04J838
TCAAP

Figure D.2.2-18



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.548

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -2.1E-06 ug/L per day
95% Confidence Interval = -5.4E-04 to 6.5E-04 ug/L per day

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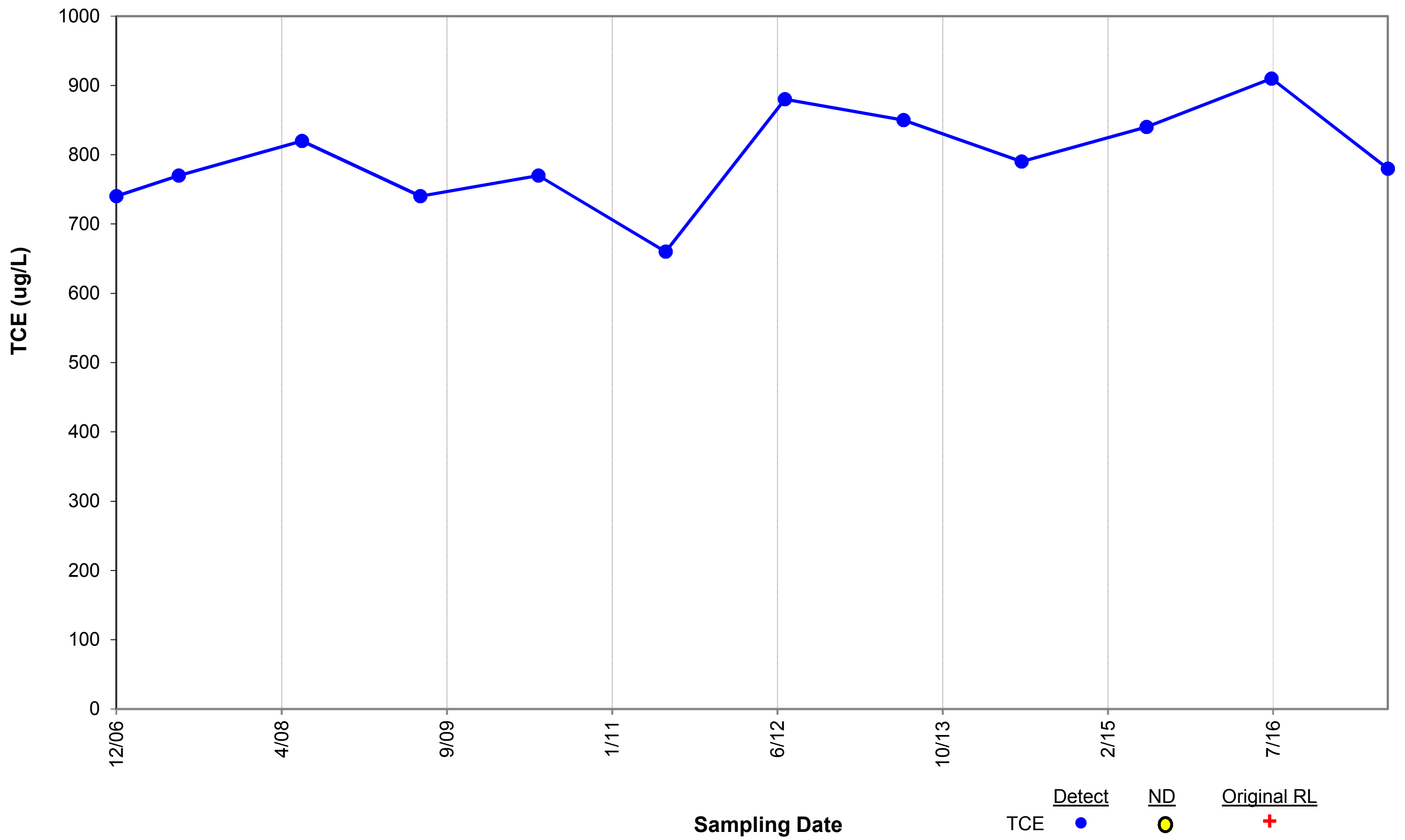
Concentration vs. Time Plot – TCE in Well 04J839
TCAAP

Figure D.2.2-19



Mann-Kendall Test Result:	**No Significant Trend**			H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.057		
Theil-Sen Trend Line Result:	**No Significant Trend**			
	Median Slope Estimate =	2.4E-02	ug/L per day	
	95% Confidence Interval =	-1.2E-02	to 6.1E-02	ug/L per day

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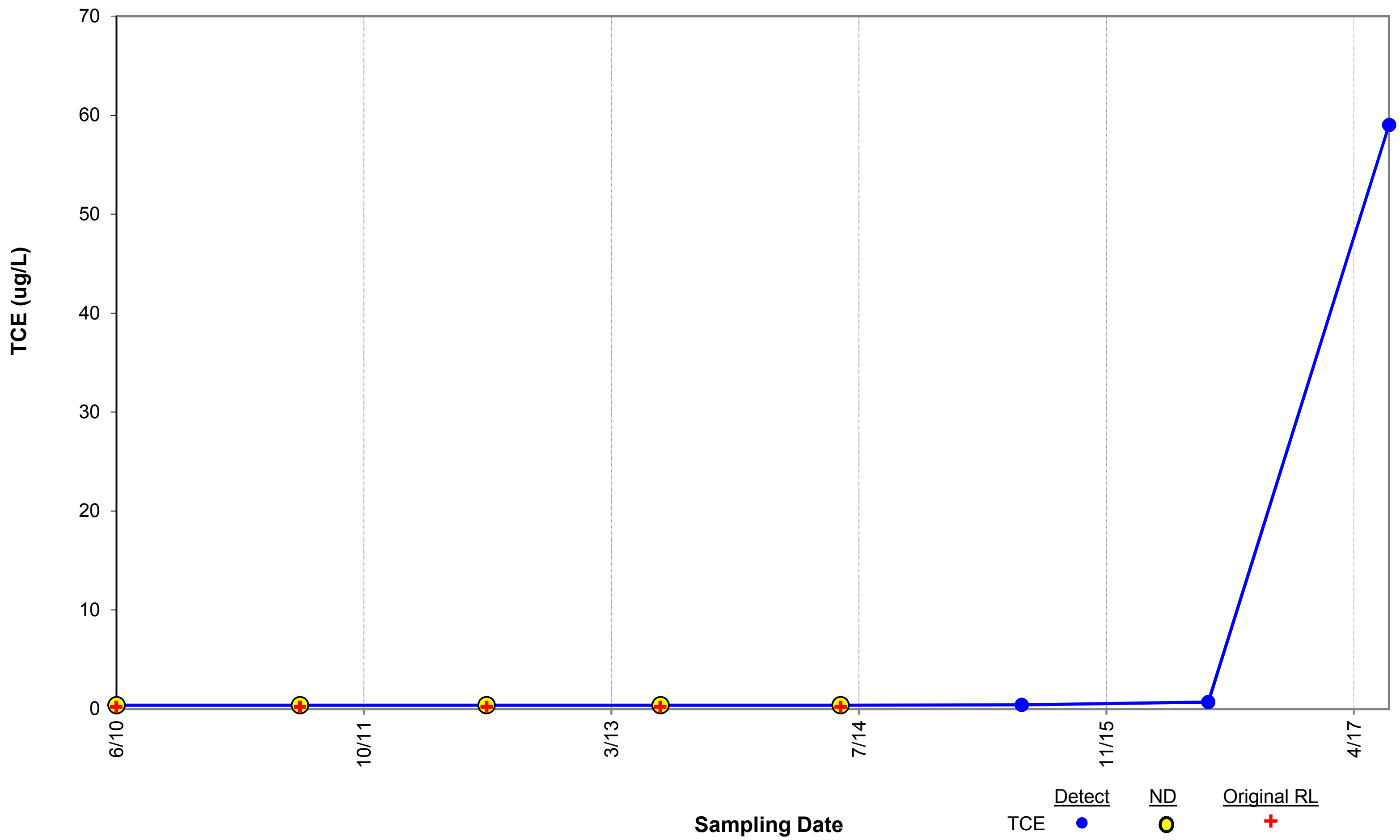
Concentration vs. Time Plot – TCE in Well 04J847

TCAAP

Figure D.2.2-20



Mann-Kendall Test Result: INCREASING TREND

p-value = 0.016

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**

Median Slope Estimate = 4.3E-05 ug/L per day

95% Confidence Interval = 0.0E+00 to 6.9E-04 ug/L per day

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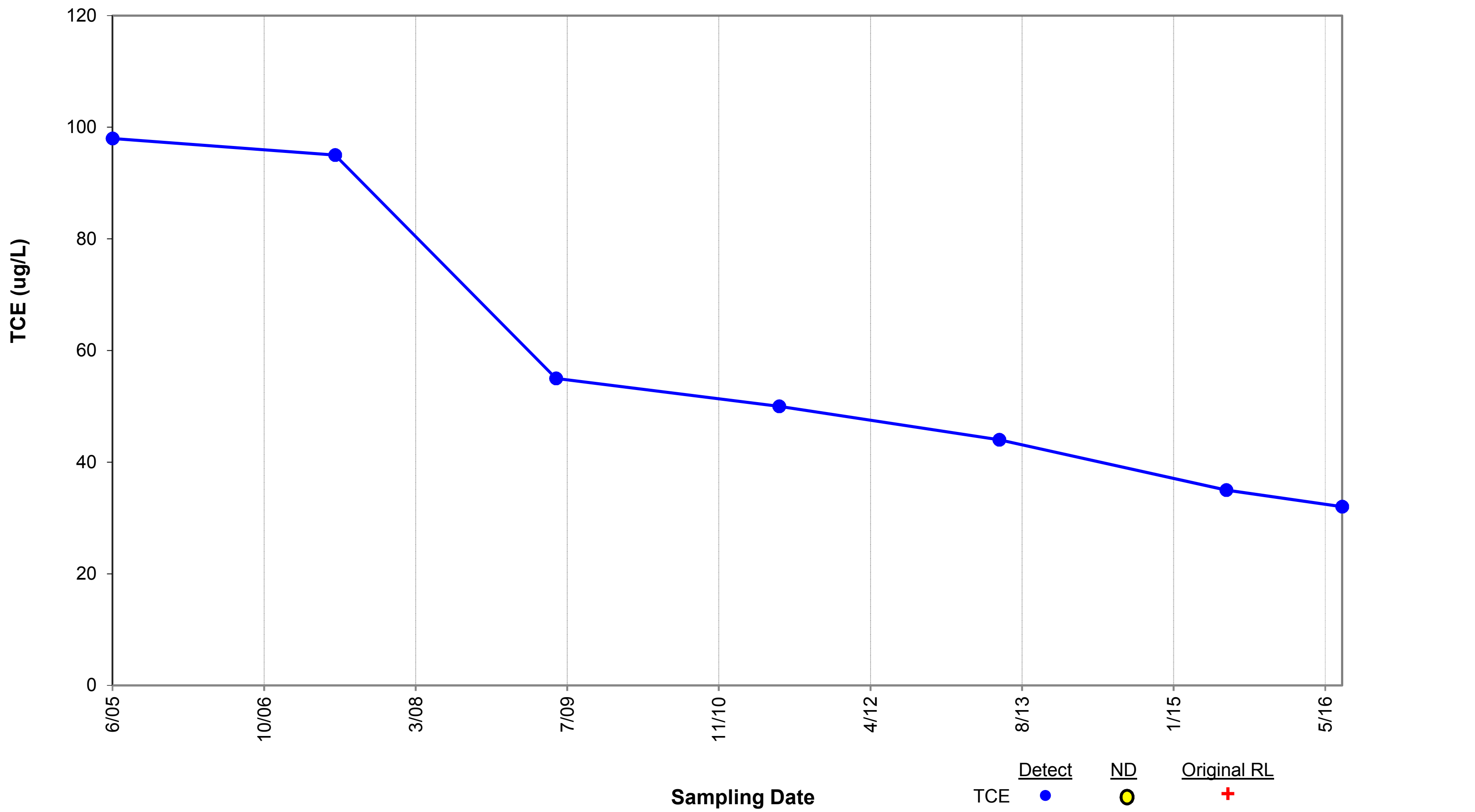
Concentration vs. Time Plot – TCE in Well 04J849

TCAAP

Figure D.2.2-21



Mann-Kendall Test Result:	**DECREASING TREND**		H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).		
	p-value =	<0.001			
Theil-Sen Trend Line Result:	**DECREASING TREND**				
	Median Slope Estimate =	-1.2E-02	ug/L per day		
	95% Confidence Interval =	-2.3E-02	to	-8.3E-03	ug/L per day

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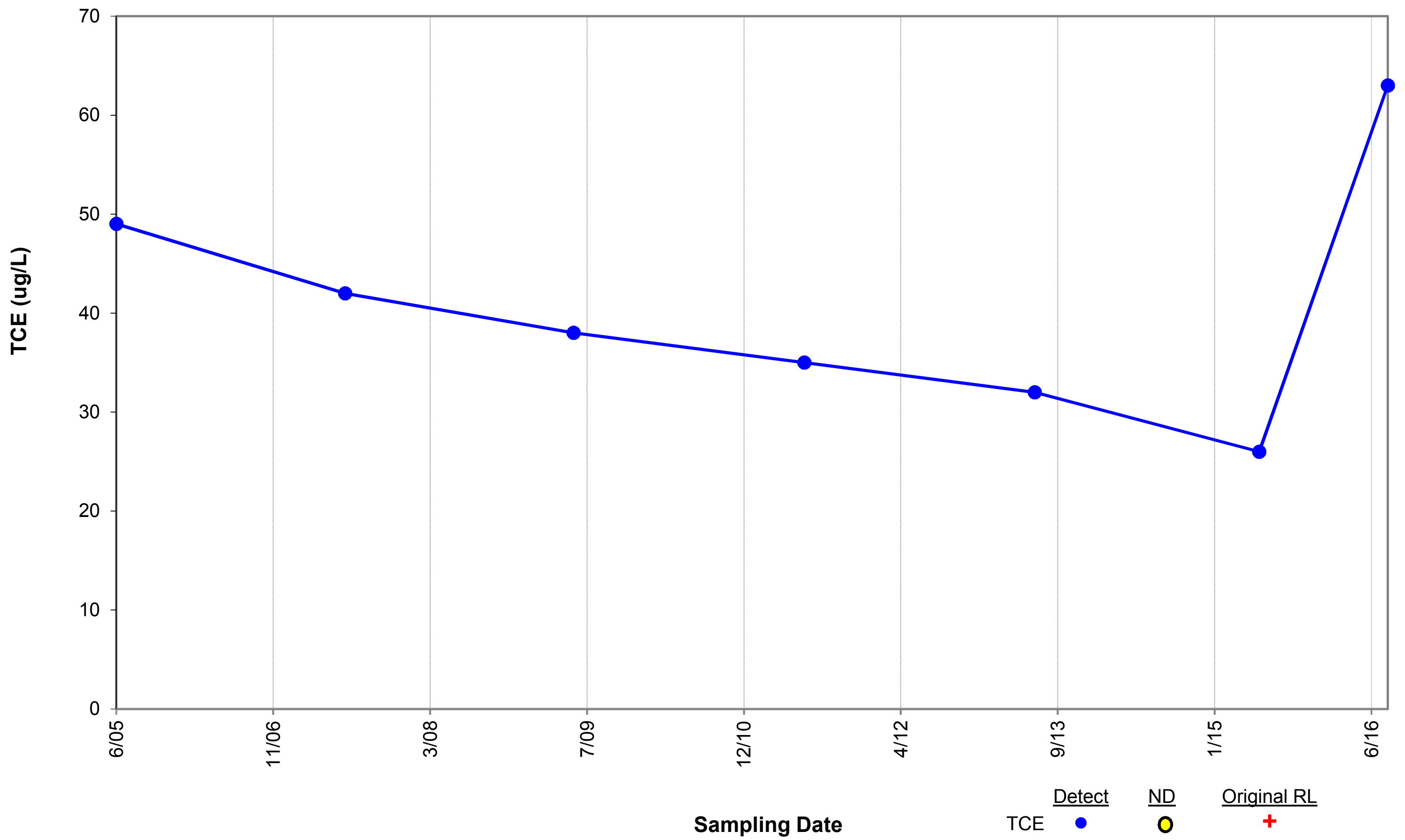
Concentration vs. Time Plot – TCE in Well 04U077

TCAAP

Figure D.2.2-22



Mann-Kendall Test Result:	**No Significant Trend**		H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.119	
Theil-Sen Trend Line Result:	**No Significant Trend**		
	Median Slope Estimate =	-4.8E-03	ug/L per day
	95% Confidence Interval =	-6.4E-03 to 6.4E-03	ug/L per day

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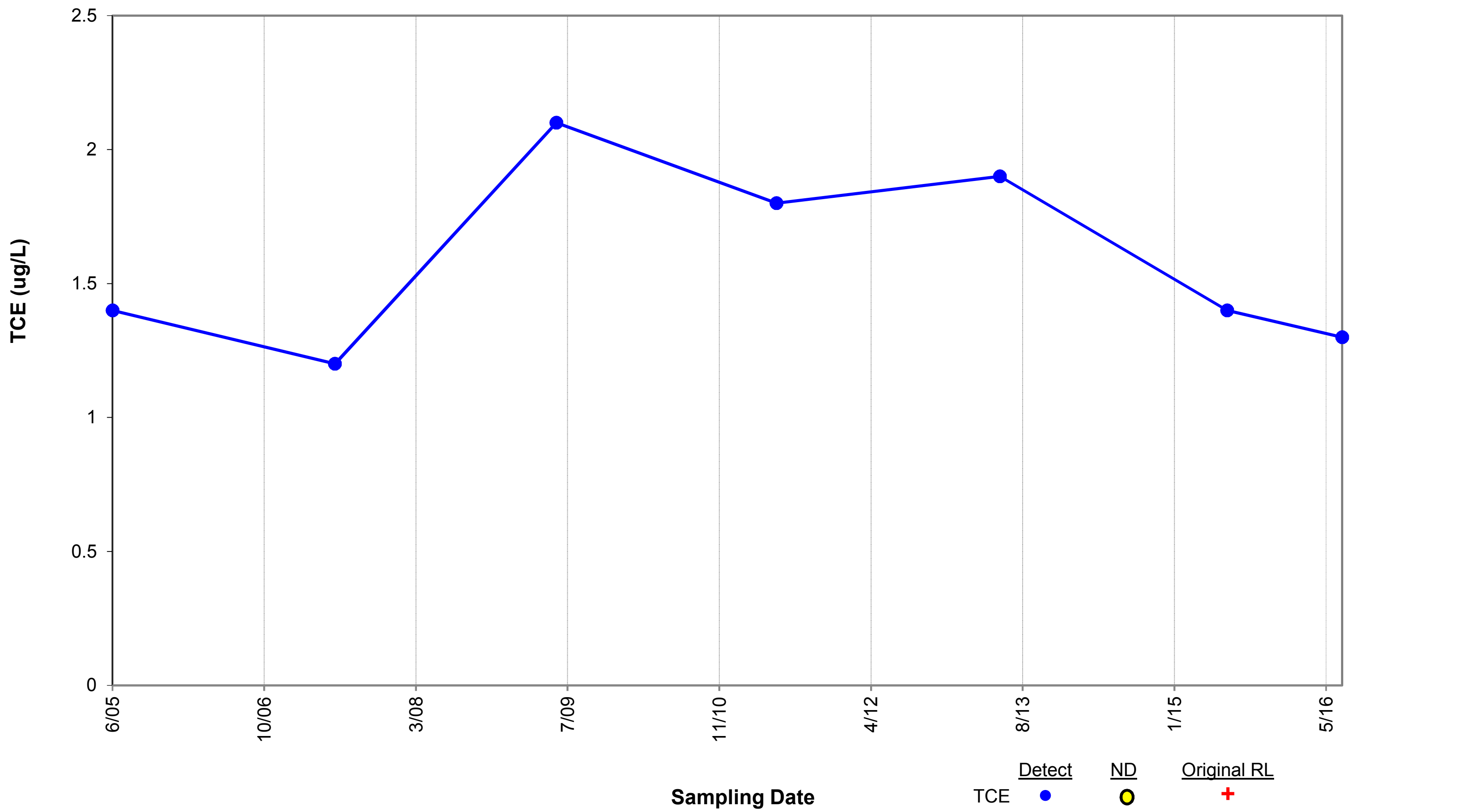
Concentration vs. Time Plot – TCE in Well 04U673

TCAAP

Figure D.2.2-23

G:\PROJECTS\TCAAP\Documents\Annual Performance Reports\FY17 Annual Performance Report - Internal Draft\Appendices\Appendix D\Appendix D.2.2 Mann Kendall\TCAAP 95%C Trend Analysis2_2018_01_30 - 1/31/2018



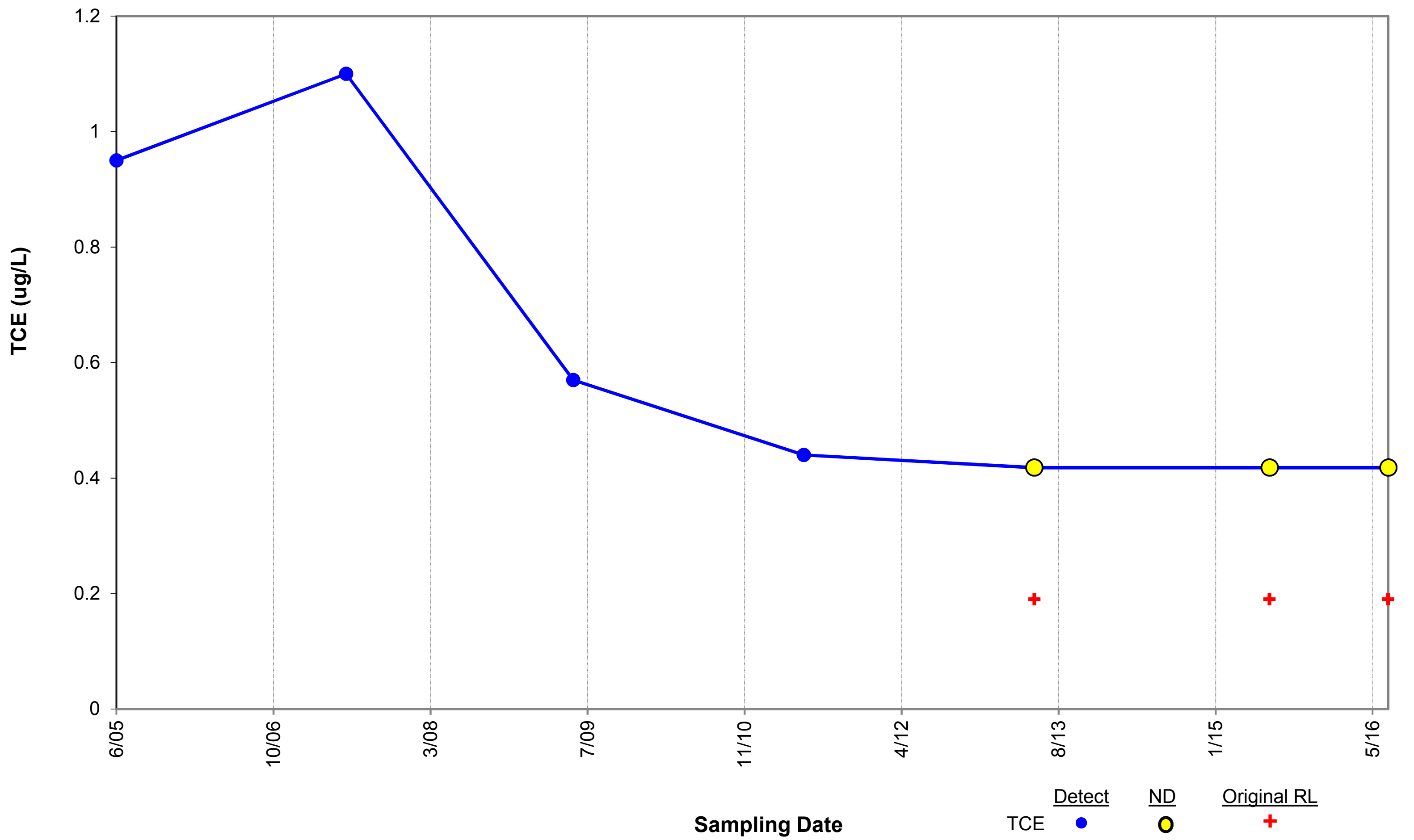
Mann-Kendall Test Result:	**No Significant Trend**		H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).	
	p-value =	0.443		
Theil-Sen Trend Line Result:	**No Significant Trend**			
	Median Slope Estimate =	-2.5E-05	ug/L per day	
	95% Confidence Interval =	-3.2E-04	to	1.8E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U702

TCAAP

Figure D.2.2-24



Mann-Kendall Test Result: **DECREASING TREND**
p-value = 0.010

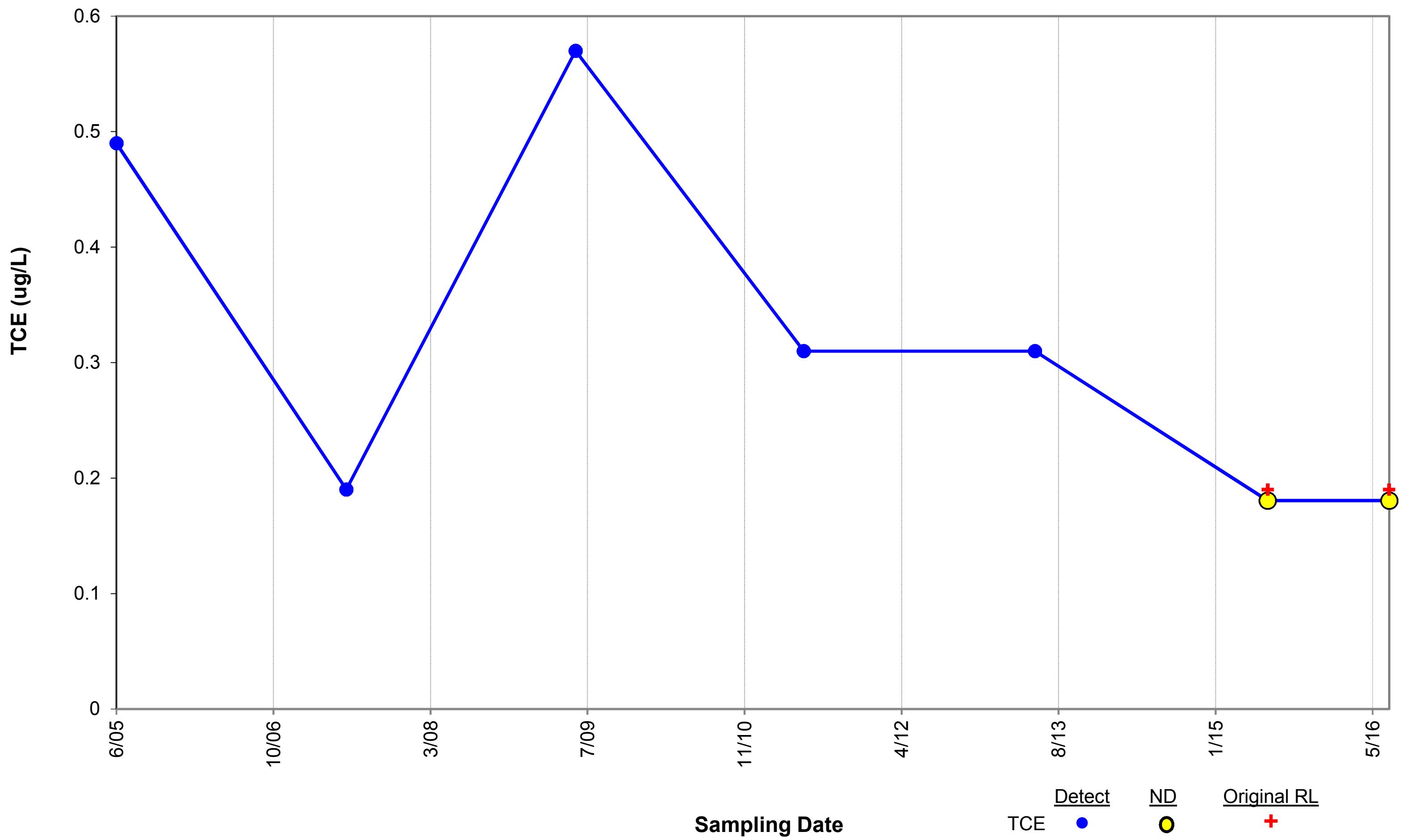
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **DECREASING TREND**
Median Slope Estimate = -1.3E-04 ug/L per day
95% Confidence Interval = -2.5E-04 to -1.3E-05 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U708
TCAAP

Figure D.2.2-25



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.068

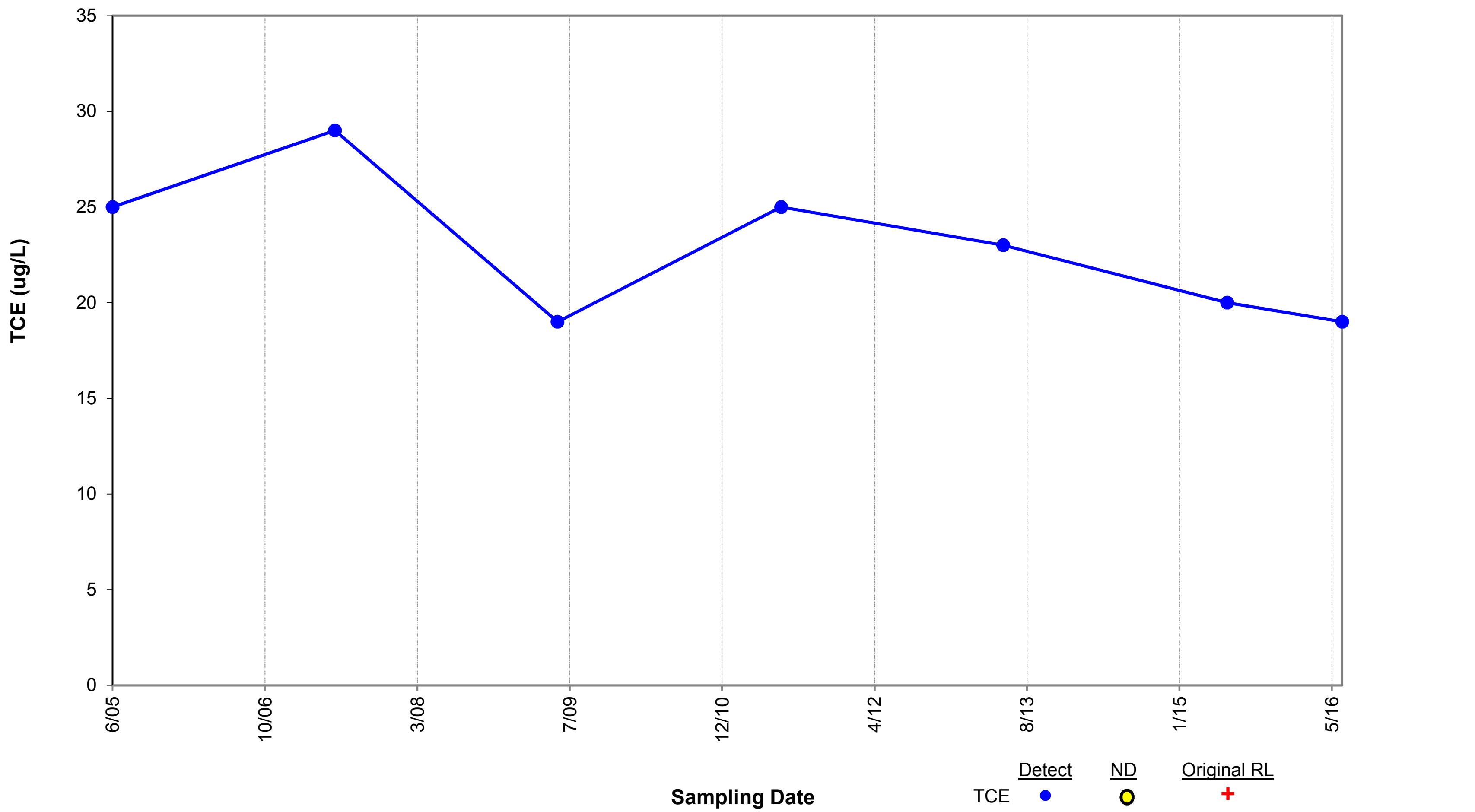
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -7.6E-05 ug/L per day
95% Confidence Interval = -1.8E-04 to 0.0E+00 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U713
TCAAP

Figure D.2.2-26



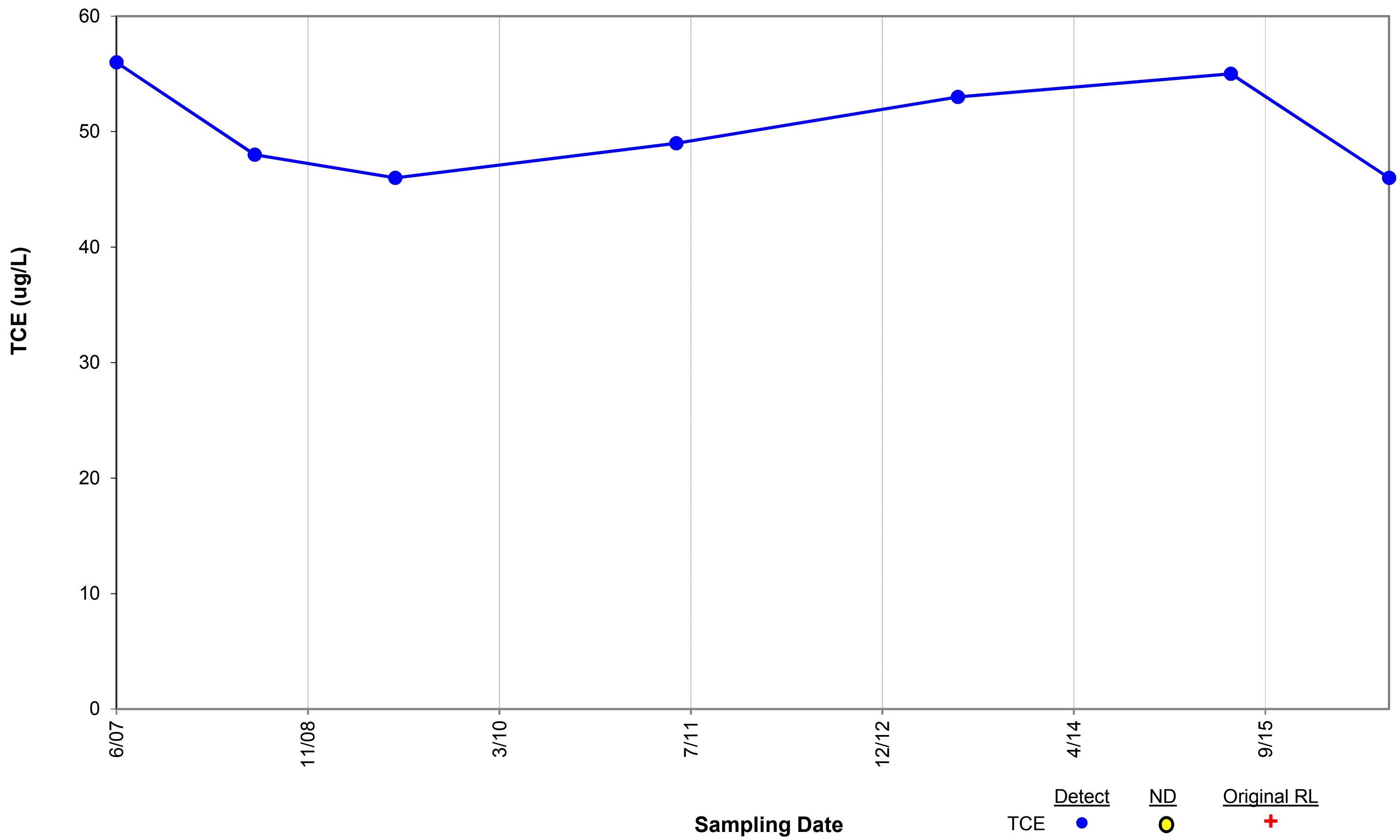
Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.068
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -2.7E-03 ug/L per day
95% Confidence Interval = -3.6E-03 to 0.0E+00 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U821
TCAAP

Figure D.2.2-27



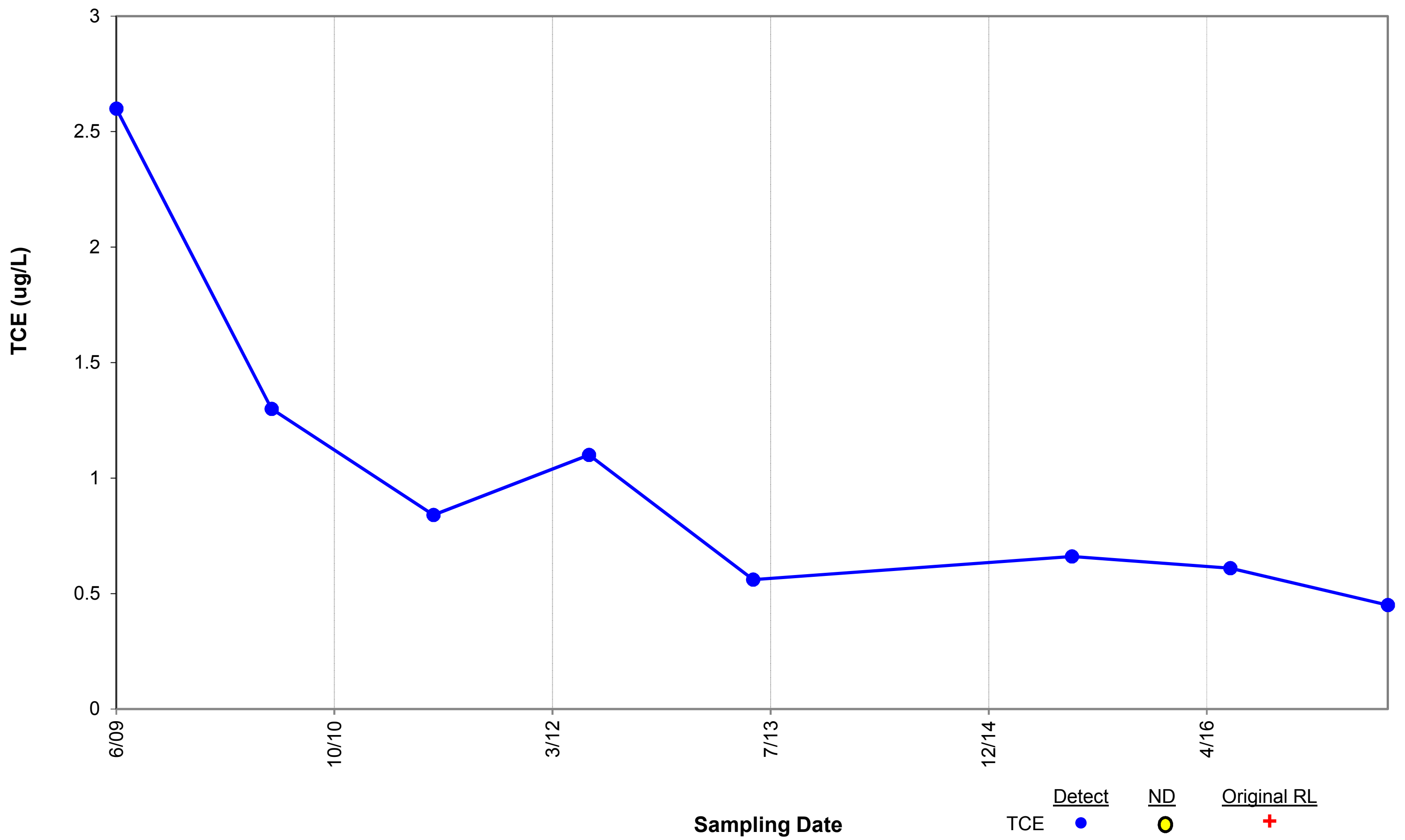
Mann-Kendall Test Result:	**No Significant Trend**			H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).		
	p-value =	0.443				
Theil-Sen Trend Line Result:	**No Significant Trend**					
	Median Slope Estimate =	-3.4E-04	ug/L per day			
	95% Confidence Interval =	-6.2E-03	to	4.0E-03	ug/L per day	

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U832

TCAAP

Figure D.2.2-28



Mann-Kendall Test Result: DECREASING TREND

p-value = 0.003

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND

Median Slope Estimate = -3.5E-04 ug/L per day

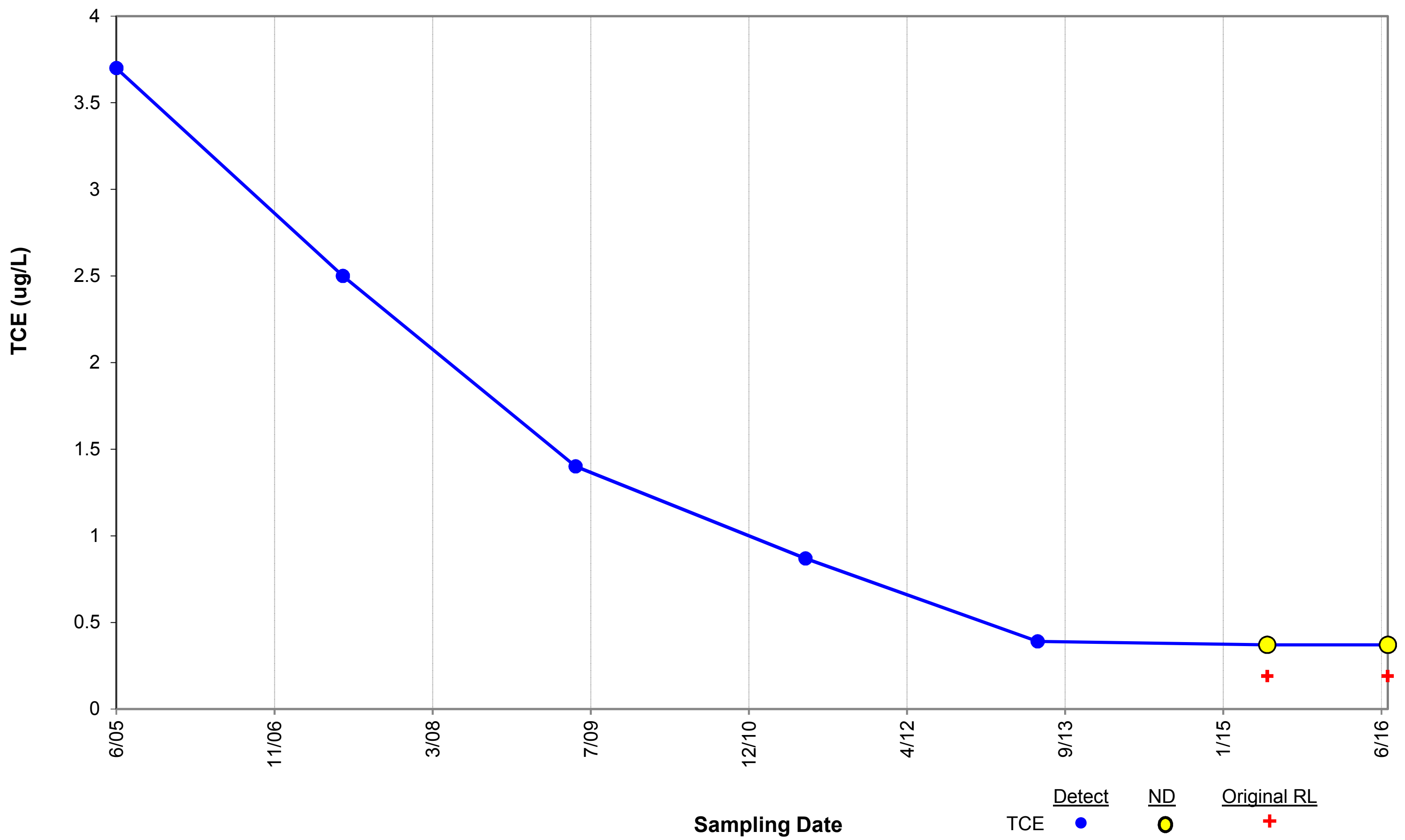
95% Confidence Interval = -1.2E-03 to -1.4E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U833

TCAAP

Figure D.2.2-29



Mann-Kendall Test Result: DECREASING TREND

p-value = <0.001

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND

Median Slope Estimate = -7.3E-04 ug/L per day

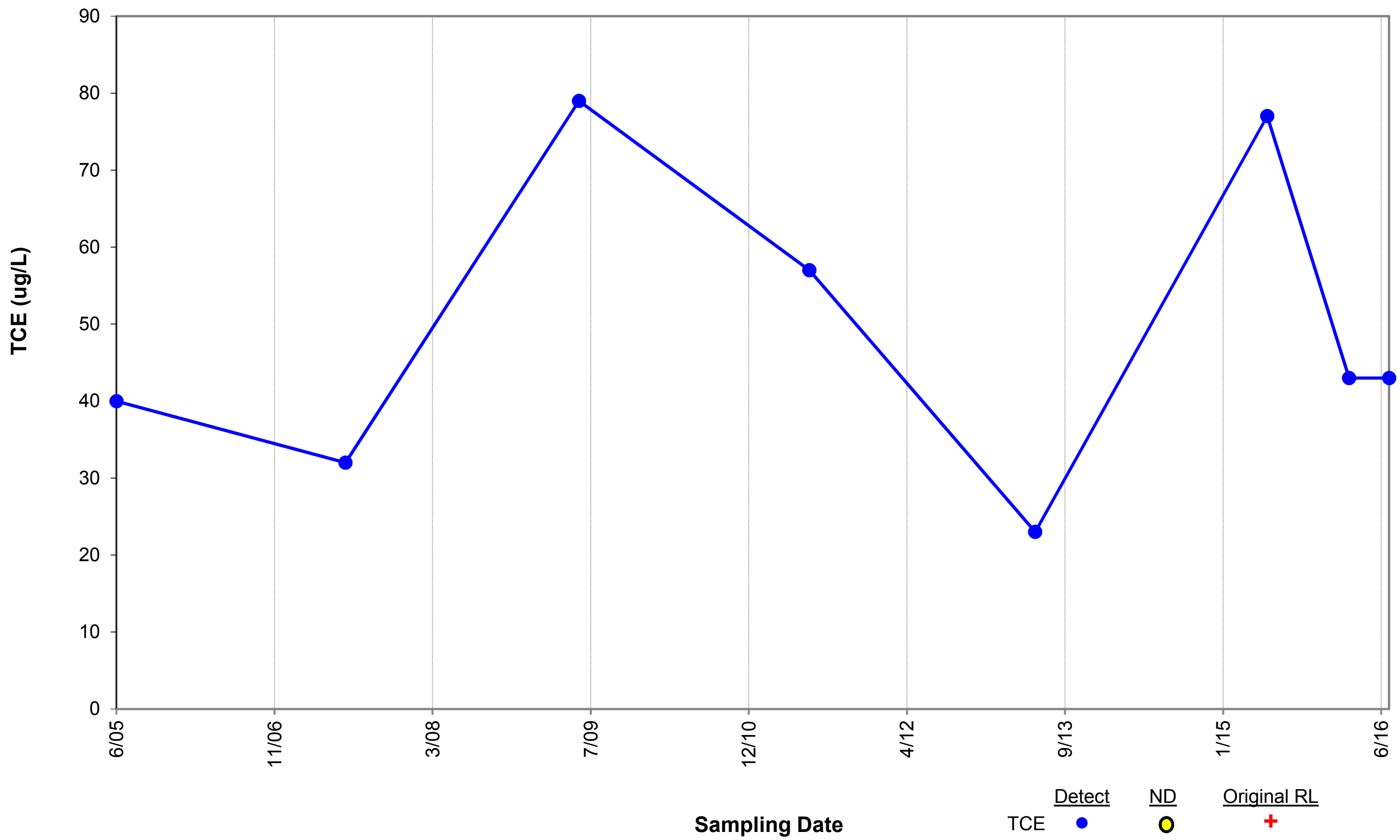
95% Confidence Interval = -1.3E-03 to -3.5E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U834

TCAAP

Figure D.2.2-30



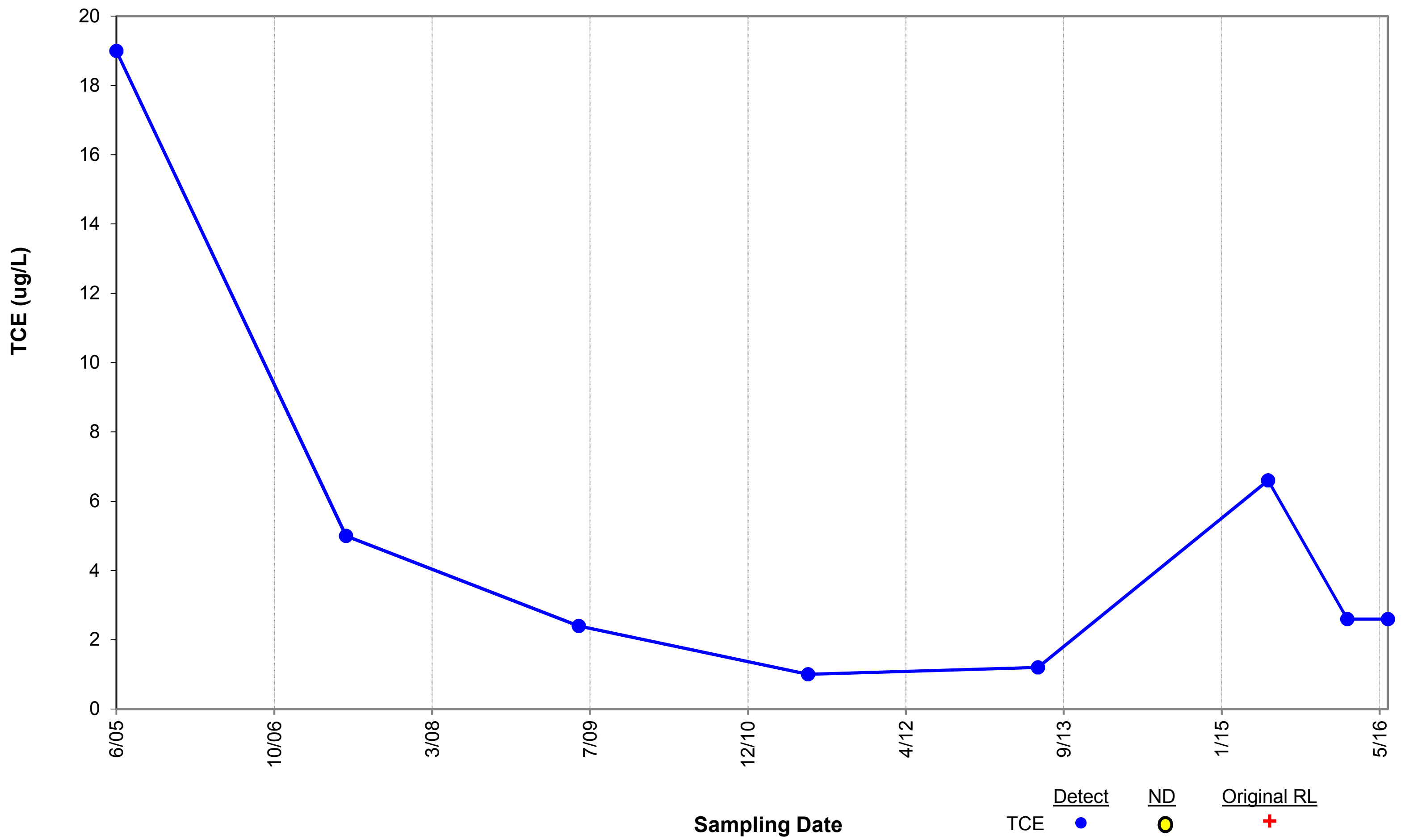
Mann-Kendall Test Result:	**No Significant Trend**				H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.500			
Theil-Sen Trend Line Result:	**No Significant Trend**				
	Median Slope Estimate =	3.7E-04	ug/L per day		
	95% Confidence Interval =	-1.5E-02	to	1.5E-02	ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U836

TCAAP

Figure D.2.2-31



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.317

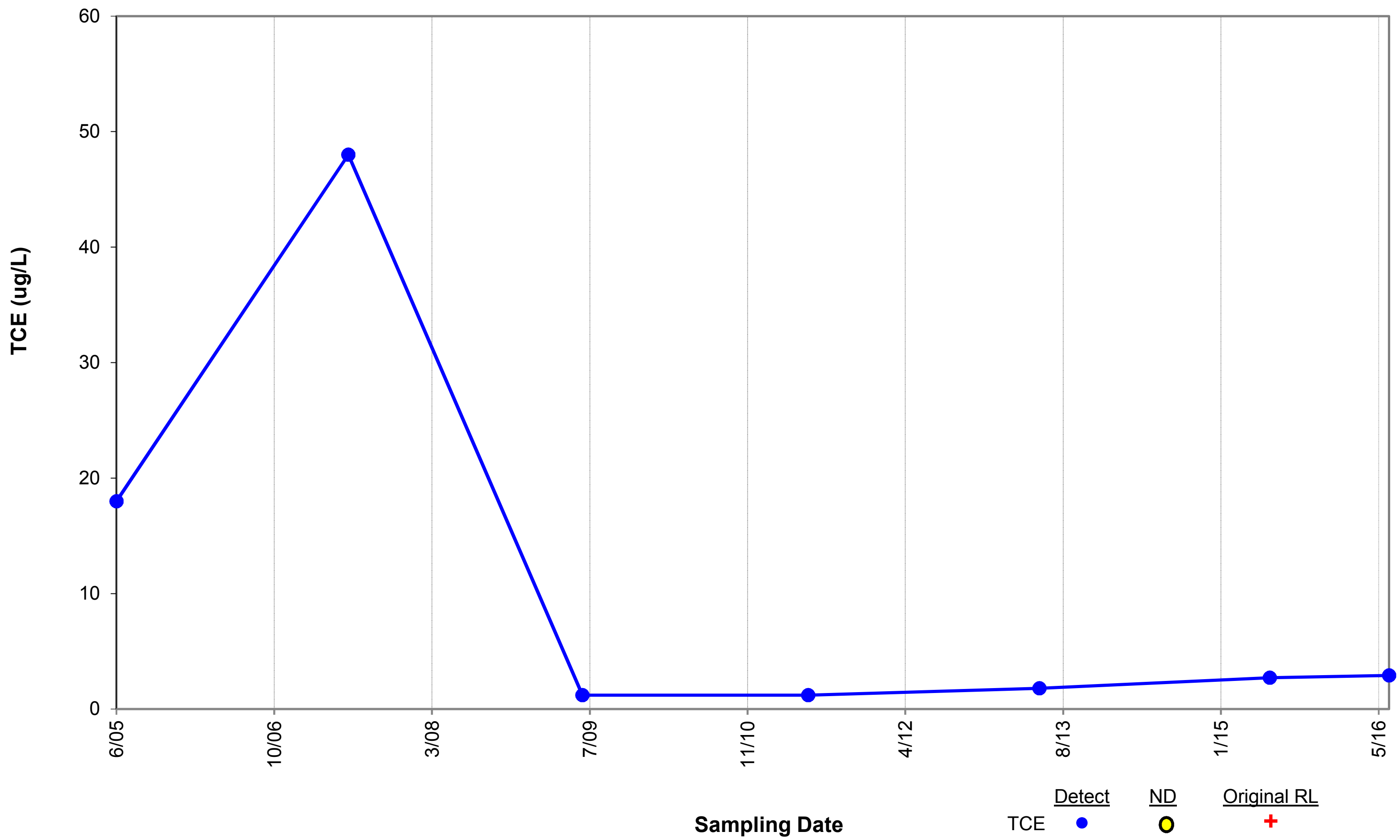
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -7.9E-04 ug/L per day
95% Confidence Interval = -5.8E-03 to 8.3E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U837
TCAAP

Figure D.2.2-32



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.563

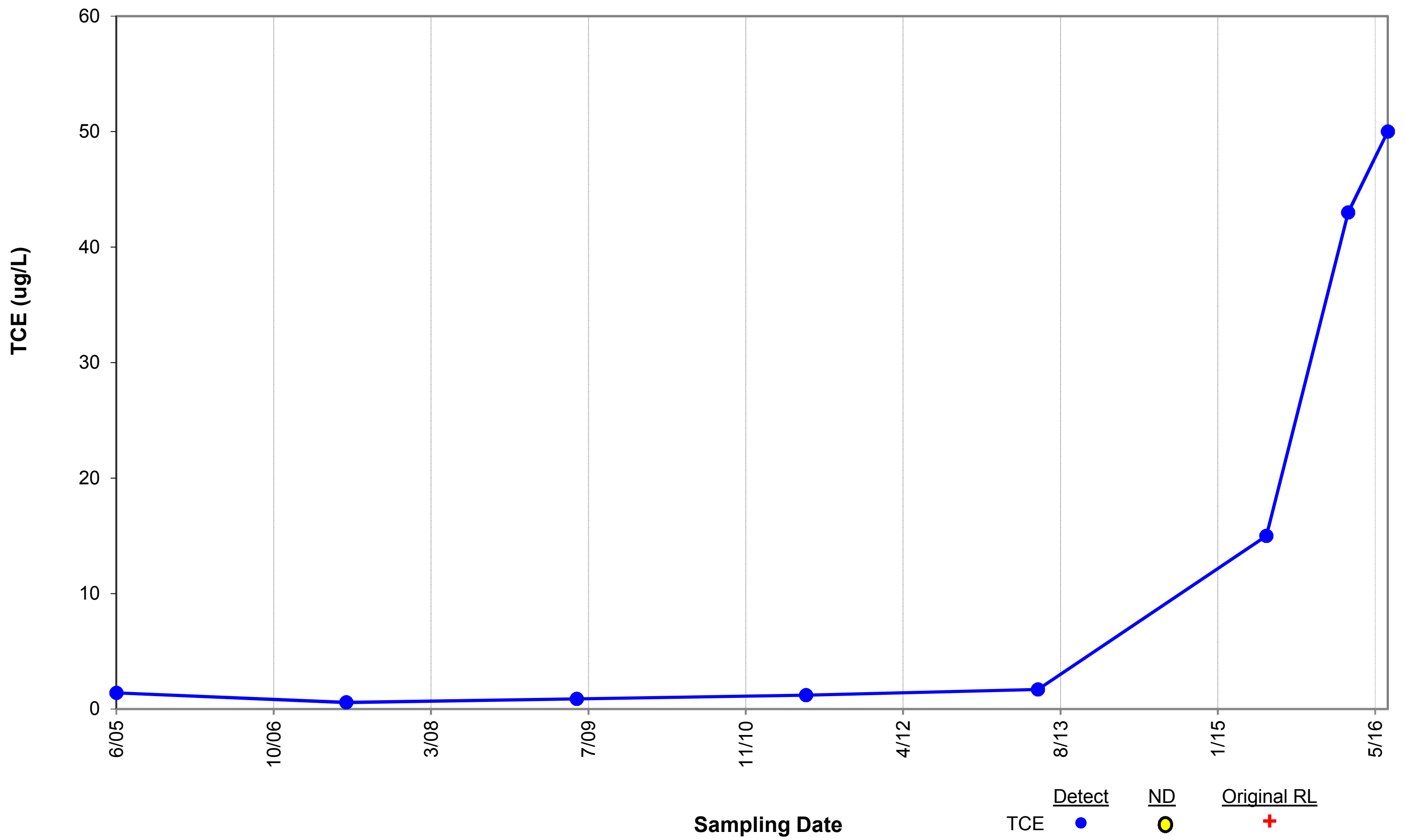
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = 0.0E+00 ug/L per day
95% Confidence Interval = -1.5E-02 to 9.2E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U838
TCAAP

Figure D.2.2-33



Mann-Kendall Test Result: INCREASING TREND
p-value = 0.003

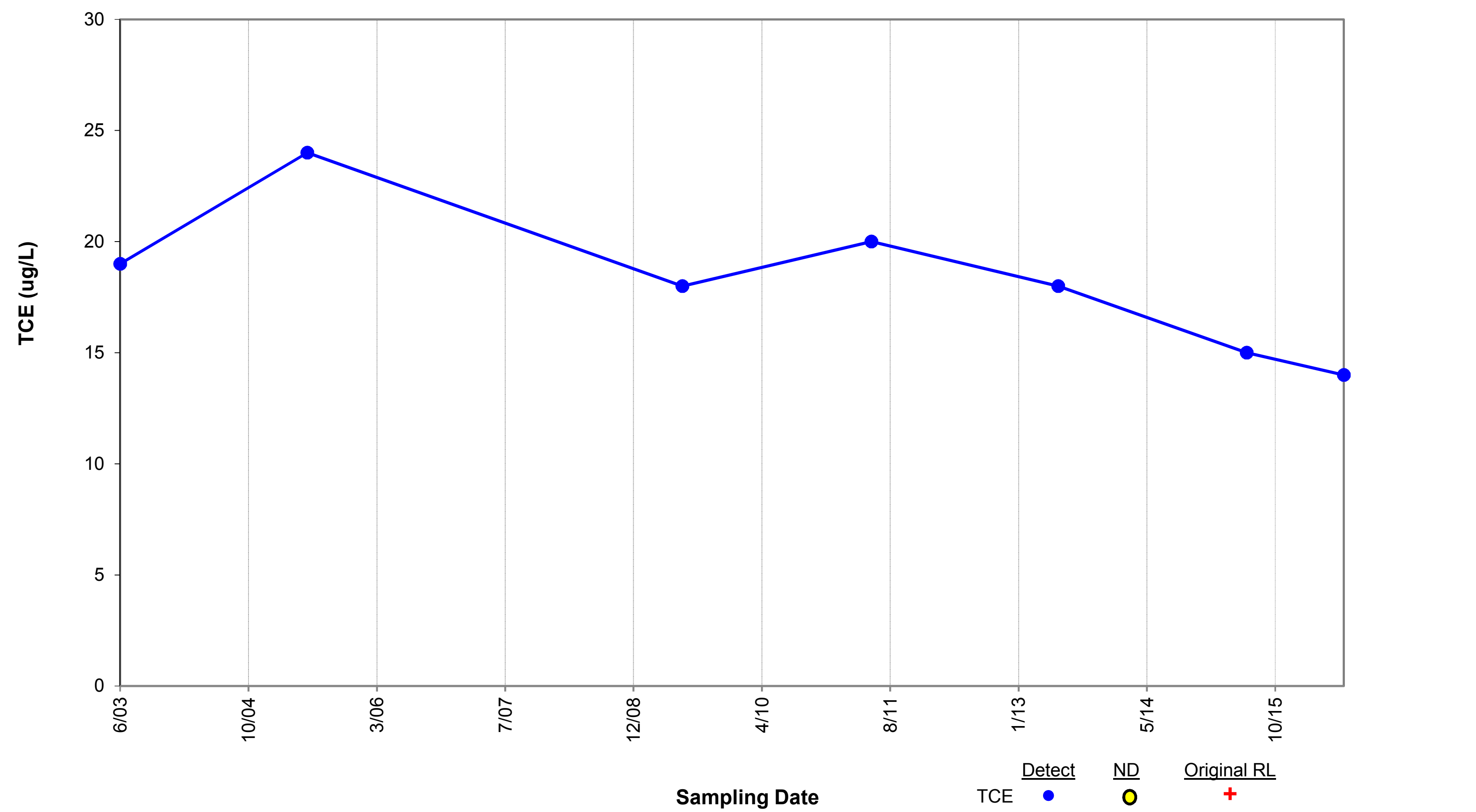
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: INCREASING TREND
Median Slope Estimate = 1.0E-02 ug/L per day
95% Confidence Interval = 4.3E-04 to 2.4E-02 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U839
TCAAP

Figure D.2.2-34



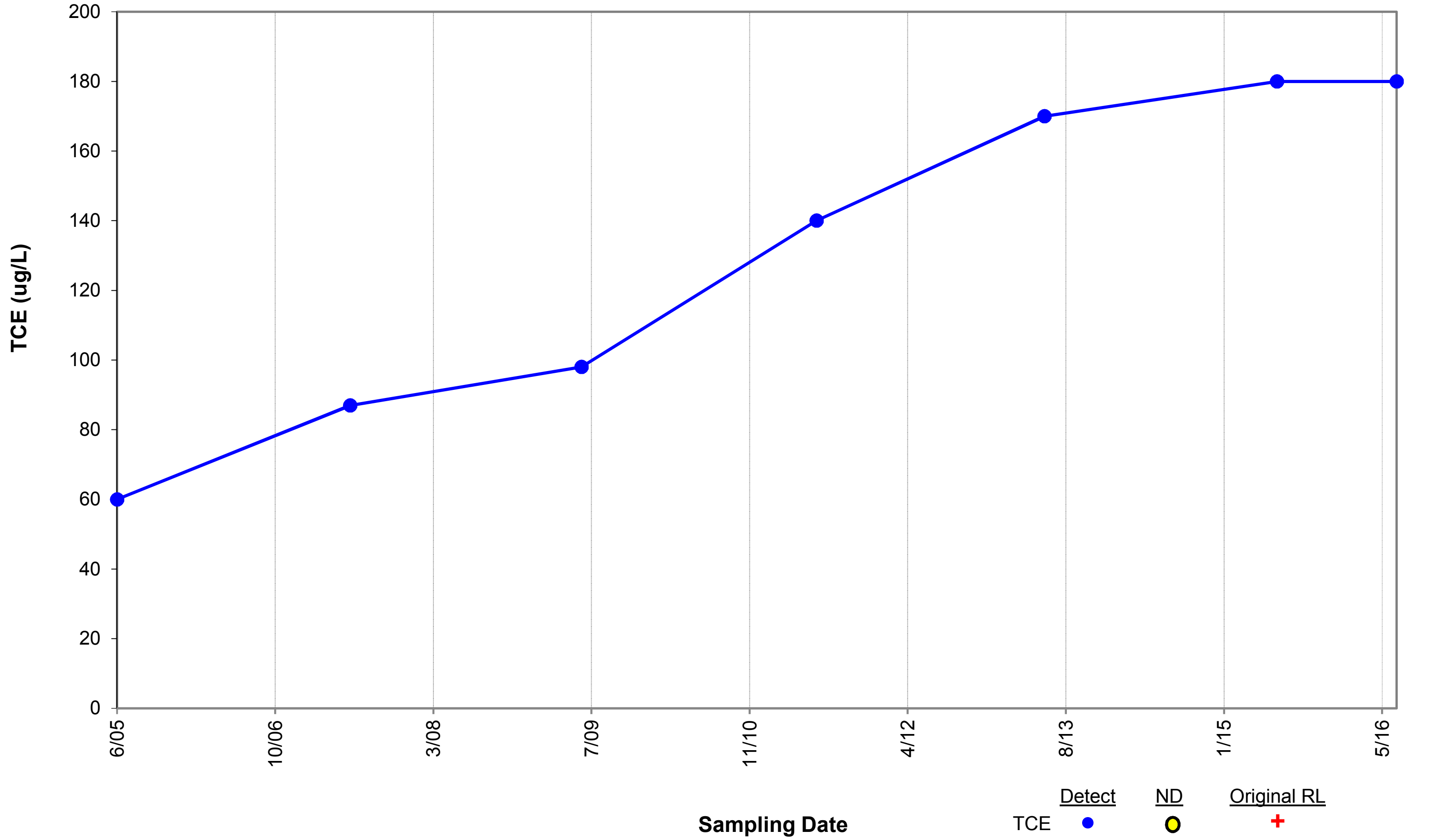
Mann-Kendall Test Result:	**DECREASING TREND**			H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.025		
Theil-Sen Trend Line Result:	**DECREASING TREND**			
	Median Slope Estimate =	-1.8E-03	ug/L per day	
	95% Confidence Interval =	-3.4E-03	to	-2.8E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U841

TCAAP

Figure D.2.2-35



Mann-Kendall Test Result: INCREASING TREND

p-value = <0.001

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: INCREASING TREND

Median Slope Estimate = 3.2E-02 ug/L per day

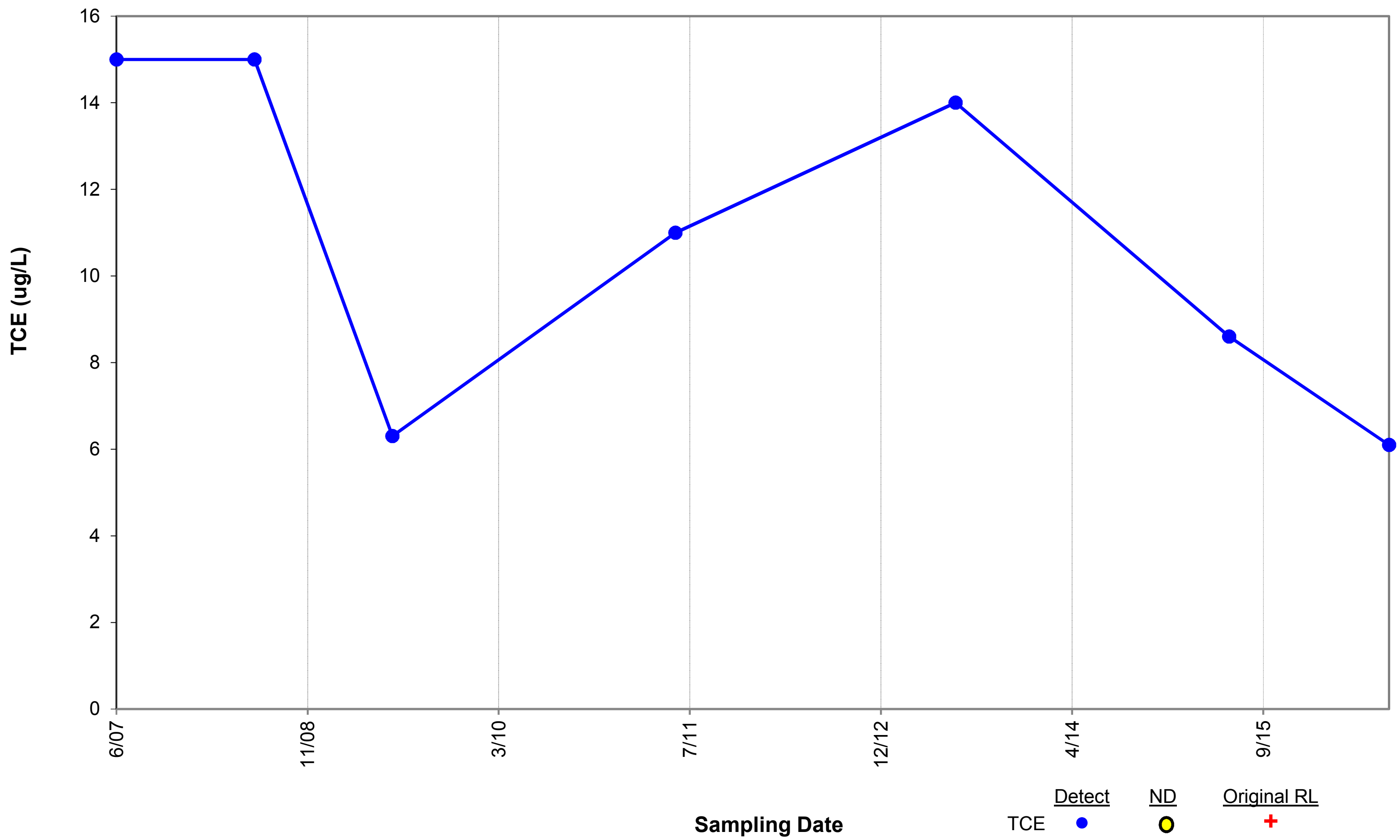
95% Confidence Interval = 1.5E-02 to 3.7E-02 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U843

TCAAP

Figure D.2.2-36

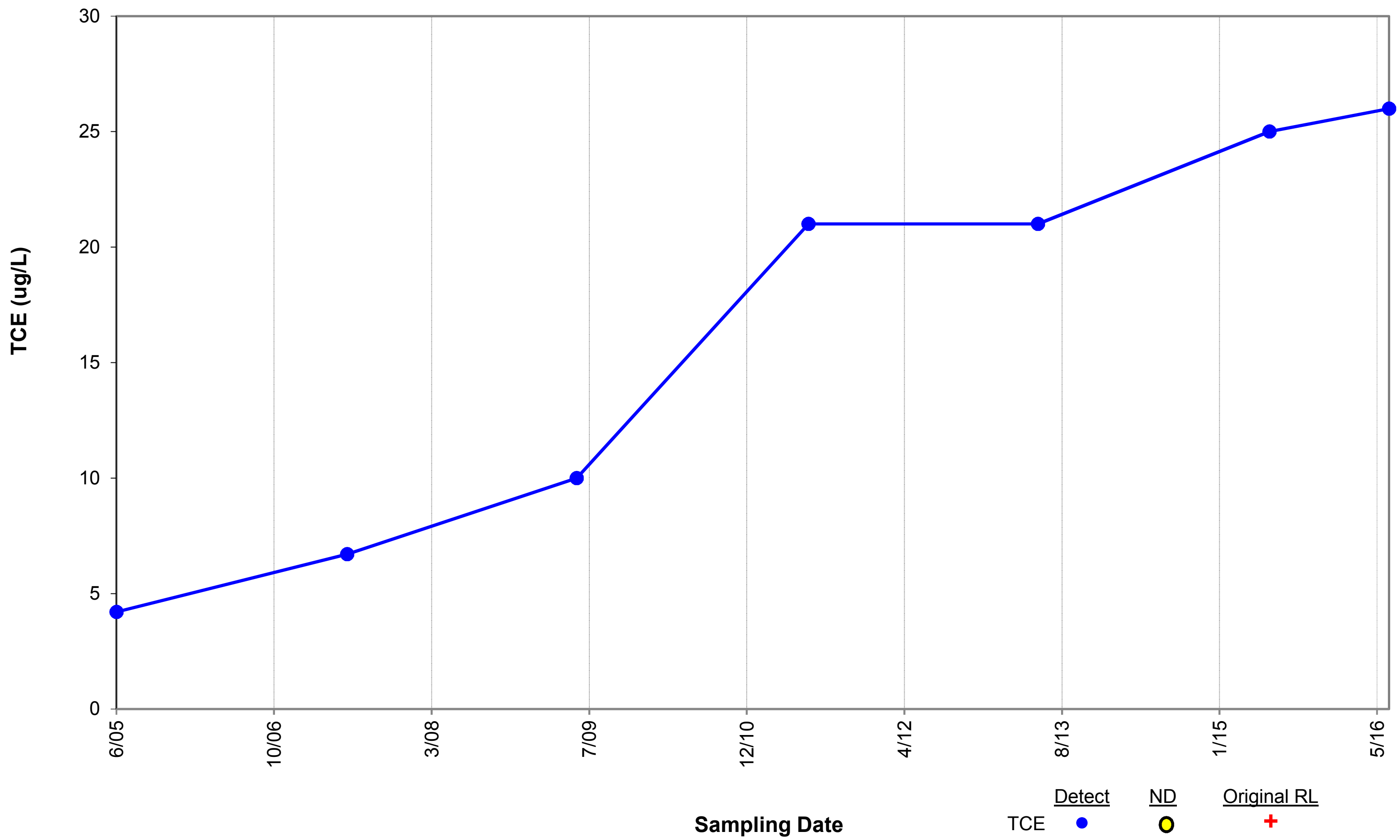


Mann-Kendall Test Result:	**No Significant Trend**		H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).		
	p-value =	0.052			
Theil-Sen Trend Line Result:	**DECREASING TREND**				
	Median Slope Estimate =	-2.5E-03	ug/L per day		
	95% Confidence Interval =	-6.9E-03	to	-3.8E-06	ug/L per day

PIKA ARCADIS
a joint venture

Concentration vs. Time Plot – TCE in Well 04U845
TCAAP

Figure D.2.2-37



Mann-Kendall Test Result: INCREASING TREND

p-value = <0.001

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: INCREASING TREND

Median Slope Estimate = 5.7E-03 ug/L per day

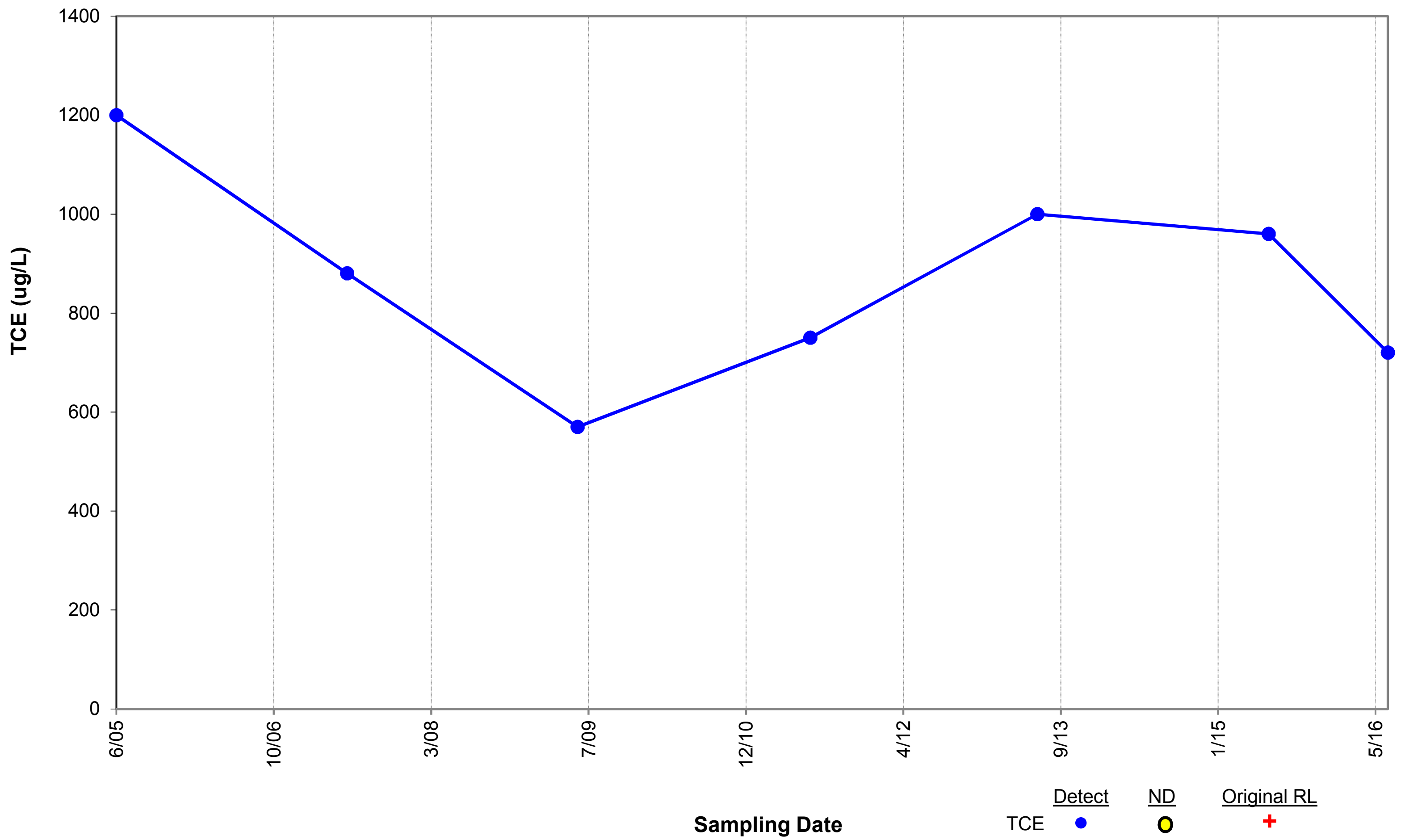
95% Confidence Interval = 2.8E-03 to 6.8E-03 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U846

TCAAP

Figure D.2.2-38



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.281

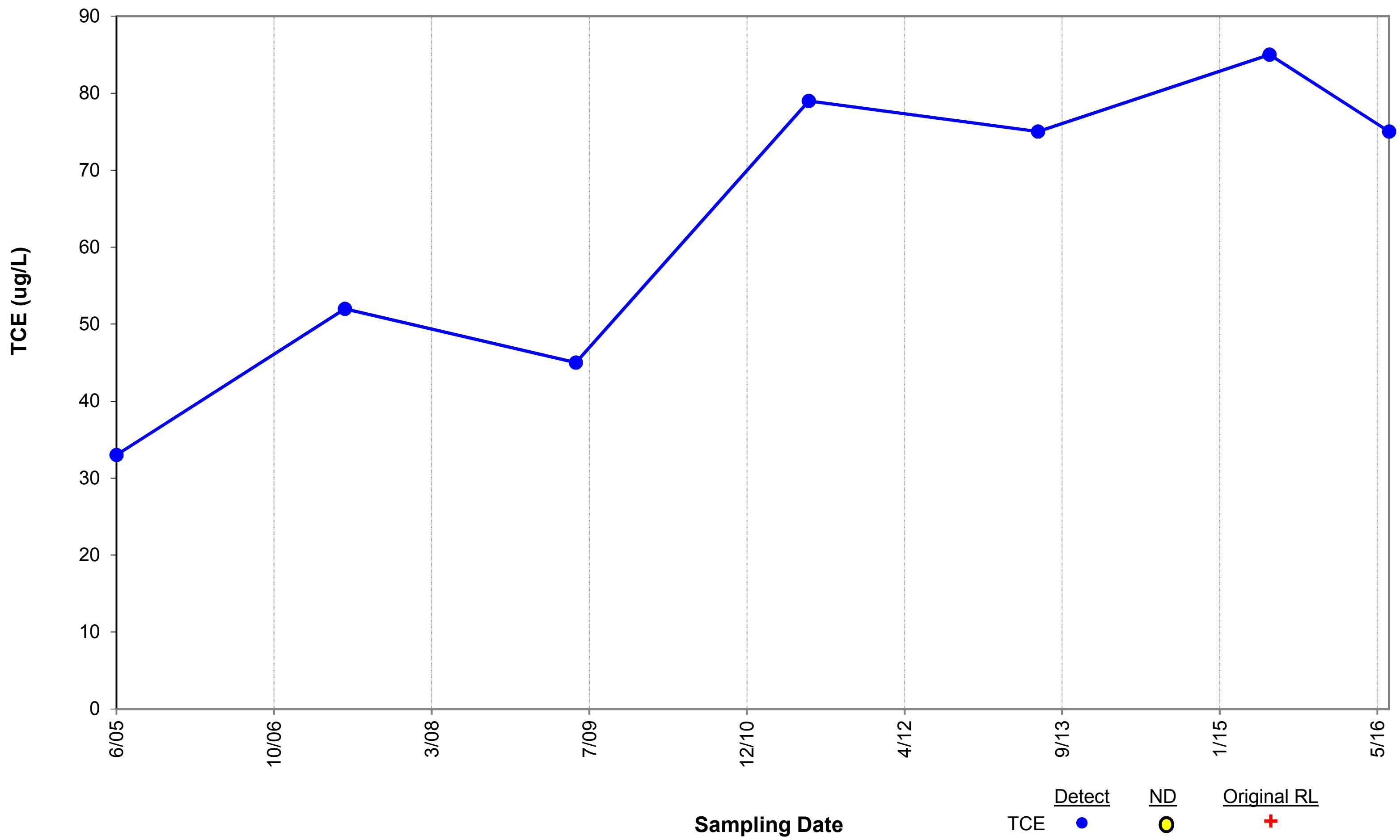
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -5.4E-02 ug/L per day
95% Confidence Interval = -4.2E-01 to 1.5E-01 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U847
TCAAP

Figure D.2.2-39



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.052

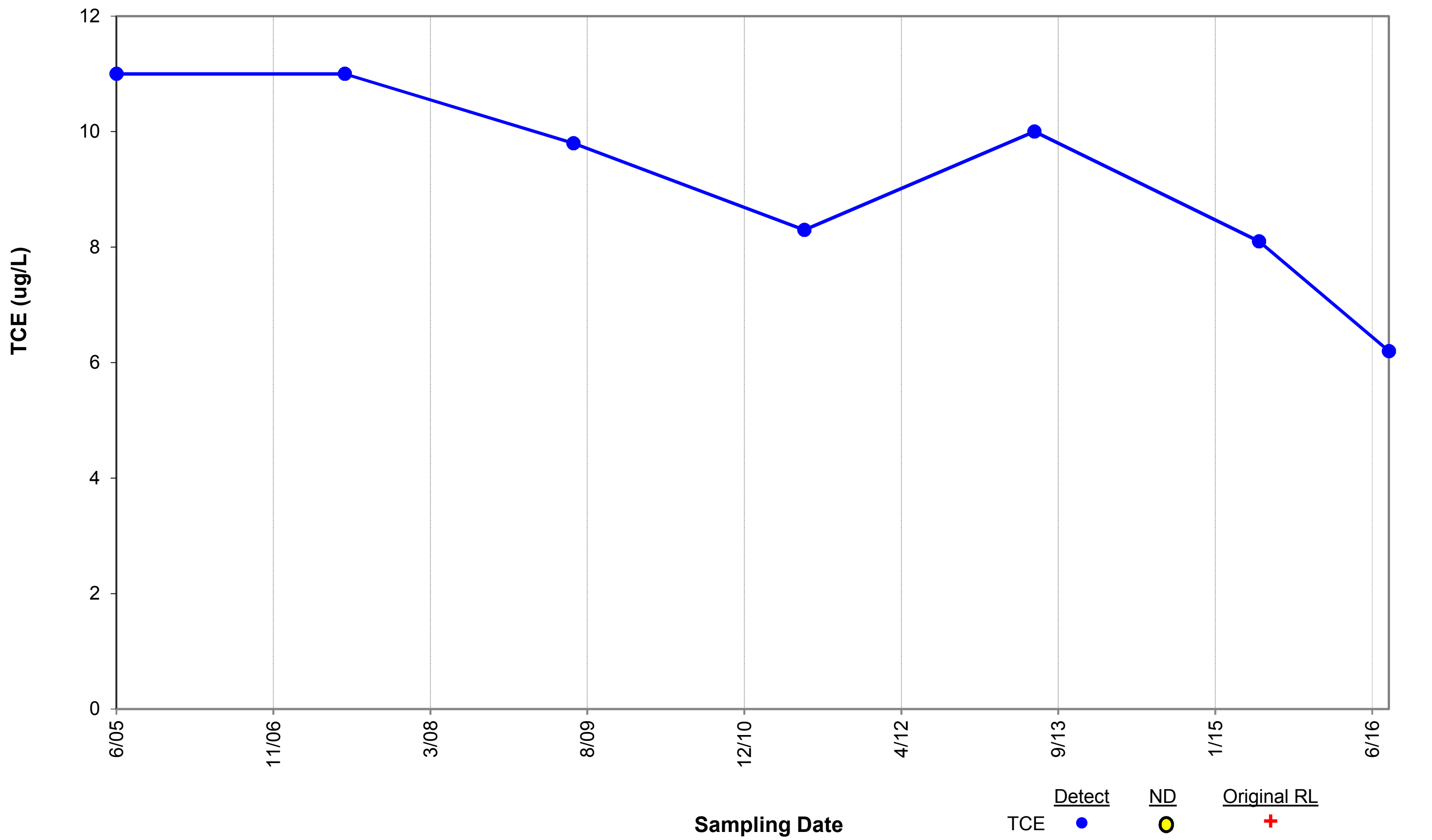
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = 1.1E-02 ug/L per day
95% Confidence Interval = -2.1E-03 to 1.8E-02 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U849
TCAAP

Figure D.2.2-40



Mann-Kendall Test Result: **DECREASING TREND**
p-value = 0.010

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

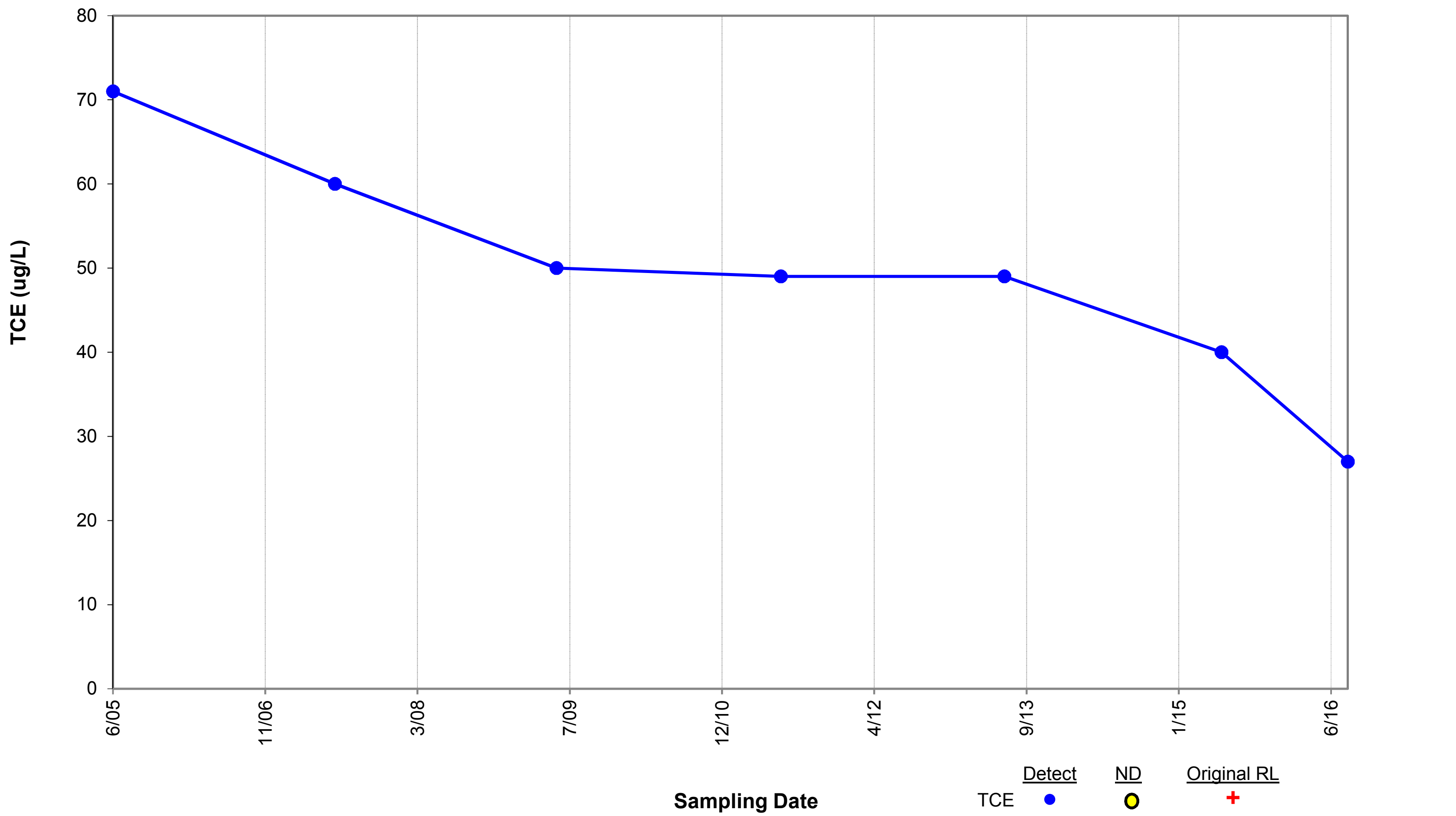
Theil-Sen Trend Line Result: **DECREASING TREND**
Median Slope Estimate = -1.1E-03 ug/L per day
95% Confidence Interval = -2.0E-03 to -3.5E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U854
TCAAP

Figure D.2.2-41

G:\PROJECTS\TCAAP\Documents\Annual Performance Reports\FY17 Annual Performance Report - Internal Draft\Appendices\Appendix D\Appendix D.2.2 Mann Kendall\TCAAP 95%C Trend Analysis2_2018_01_30 - 1/31/2018



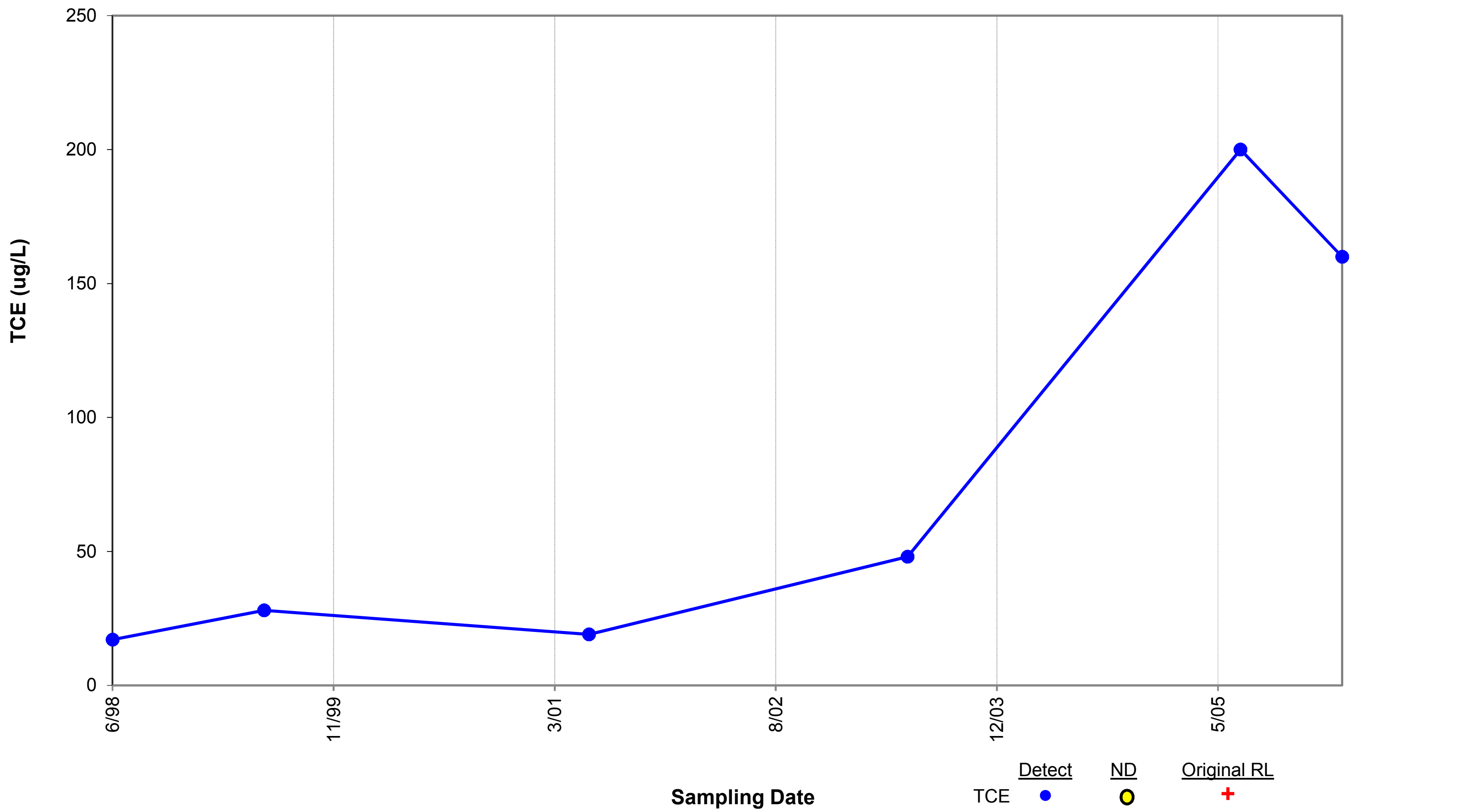
Mann-Kendall Test Result: DECREASING TREND
p-value = <0.001
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND
Median Slope Estimate = -8.9E-03 ug/L per day
95% Confidence Interval = -1.4E-02 to -5.1E-03 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U859
TCAAP

Figure D.2.2-42



Mann-Kendall Test Result: INCREASING TREND
p-value = 0.028

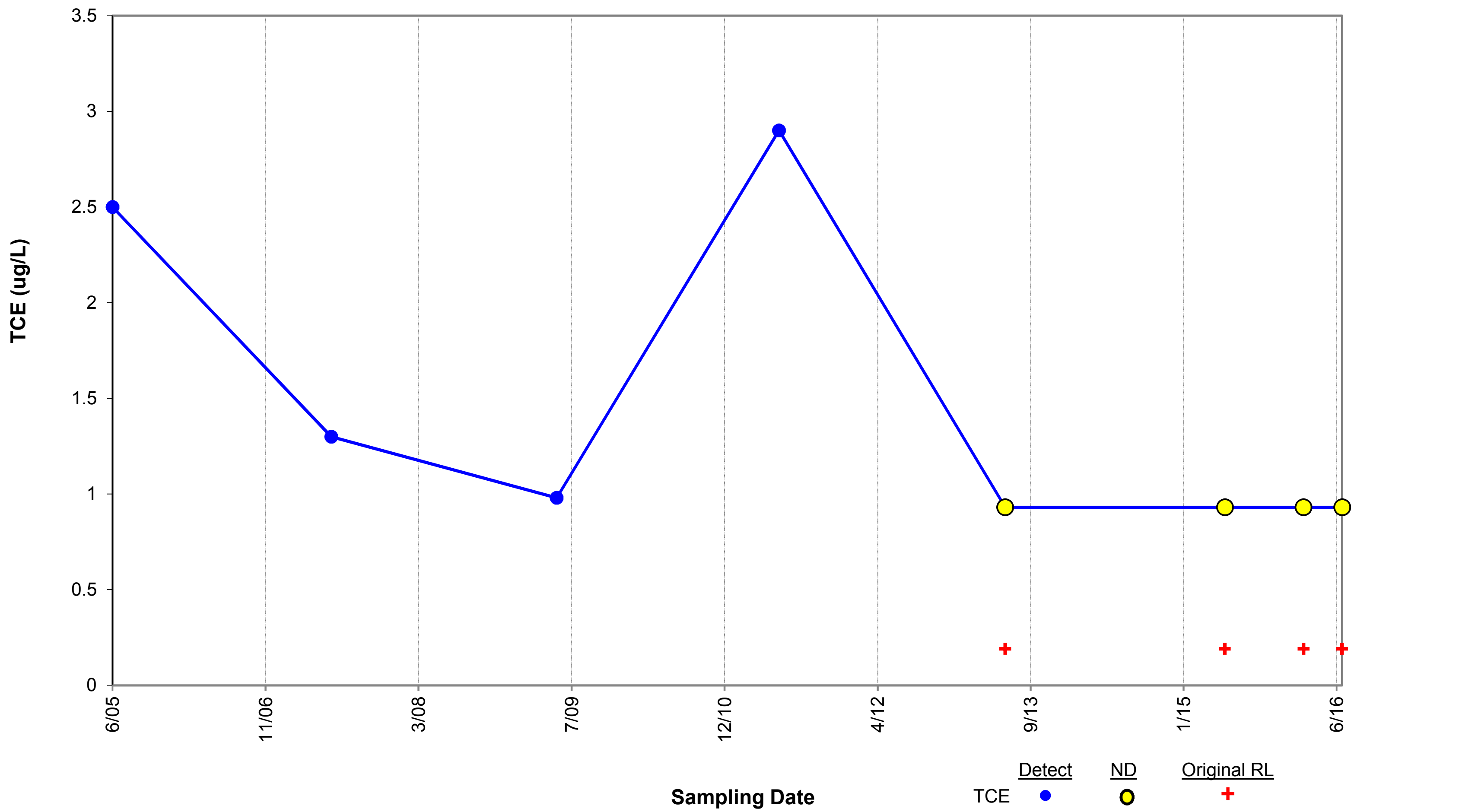
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = 5.1E-02 ug/L per day
95% Confidence Interval = -8.3E-03 to 1.1E-01 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U861
TCAAP

Figure D.2.2-43



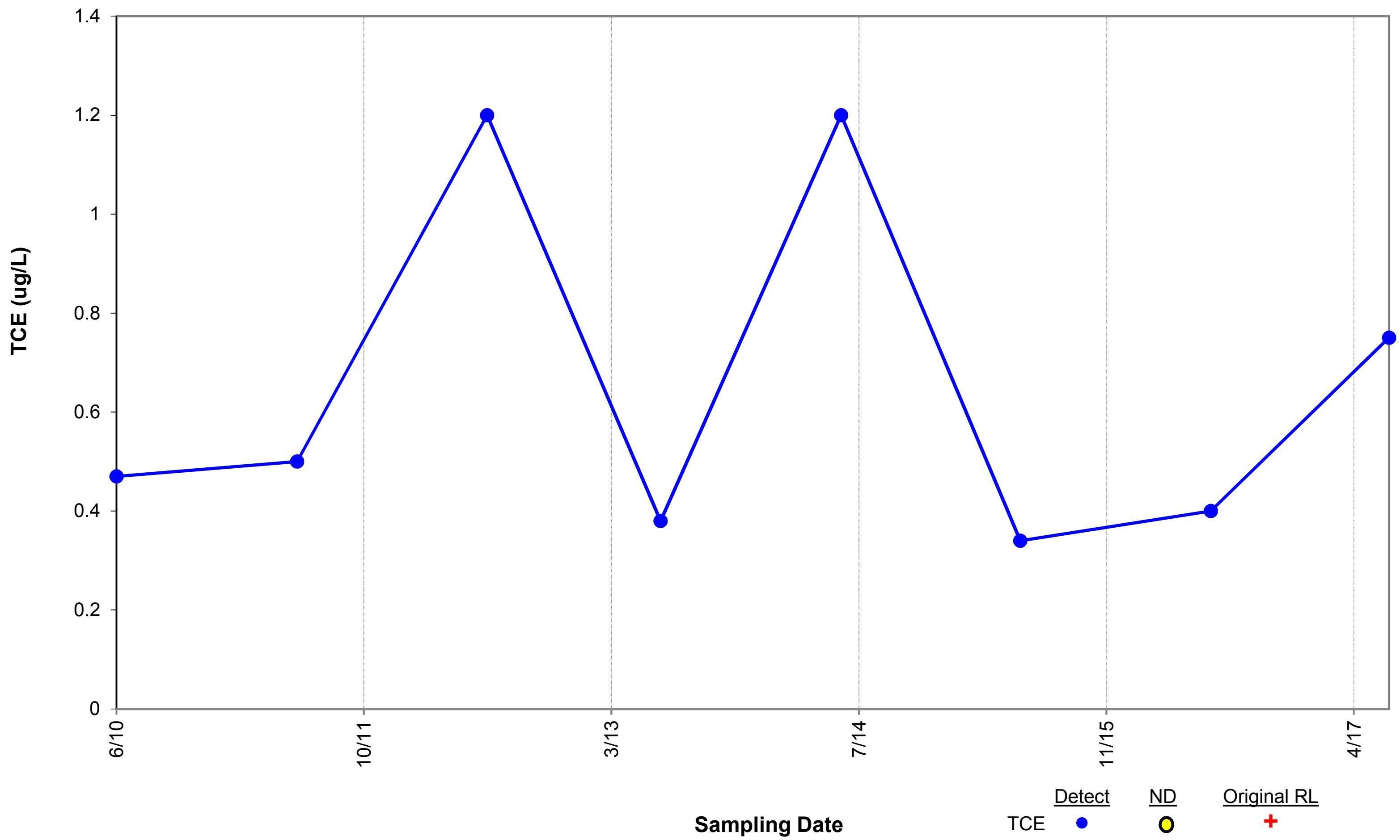
Mann-Kendall Test Result:	**DECREASING TREND**		H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).		
	p-value =	0.031			
Theil-Sen Trend Line Result:	**No Significant Trend**				
	Median Slope Estimate =	-1.1E-04	ug/L per day		
	95% Confidence Interval =	-7.3E-04	to	0.0E+00	ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U875

TCAAP

Figure D.2.2-44



Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.500

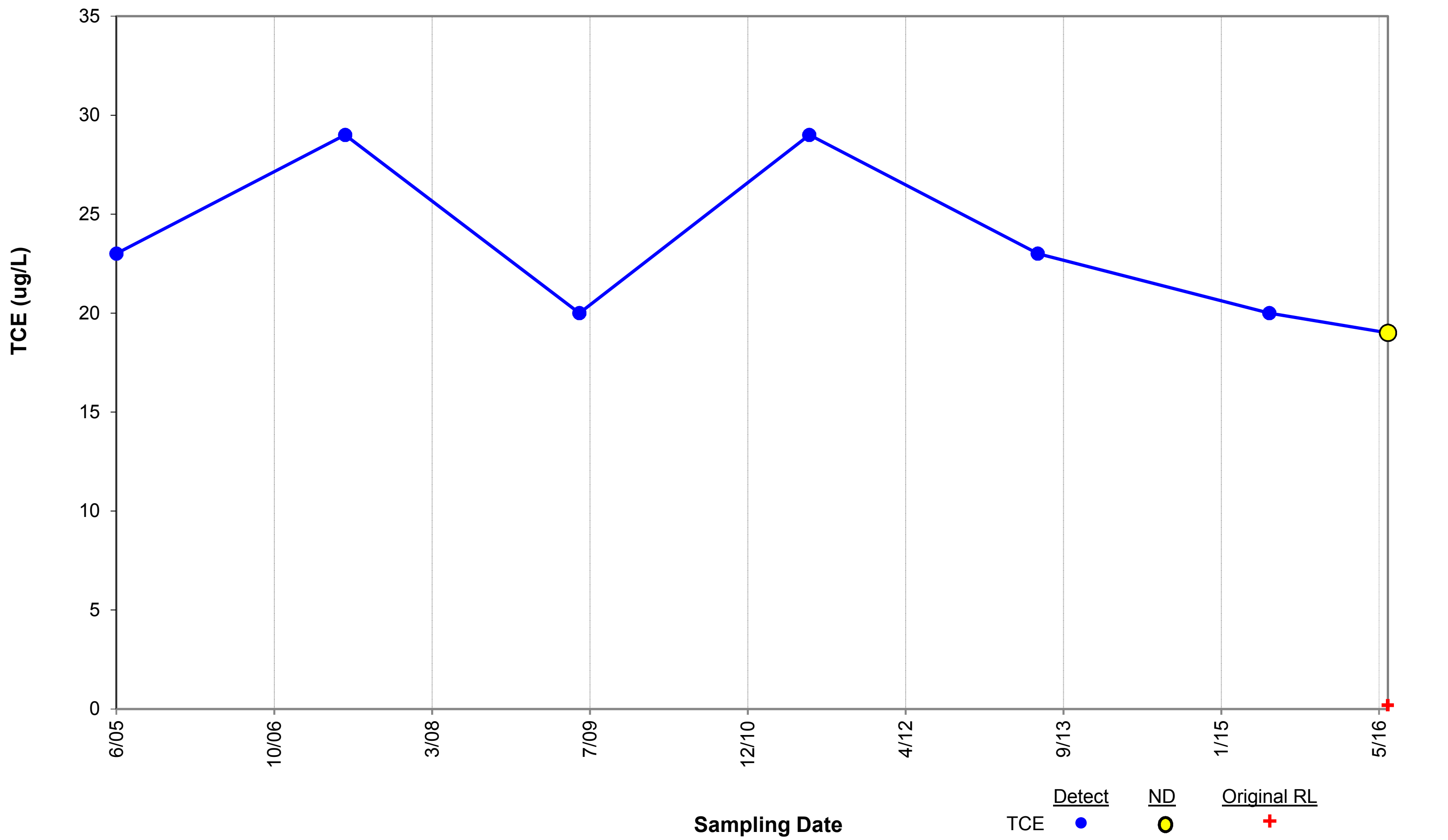
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -1.6E-05 ug/L per day
95% Confidence Interval = -3.8E-04 to 4.6E-04 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U877
TCAAP

Figure D.2.2-45



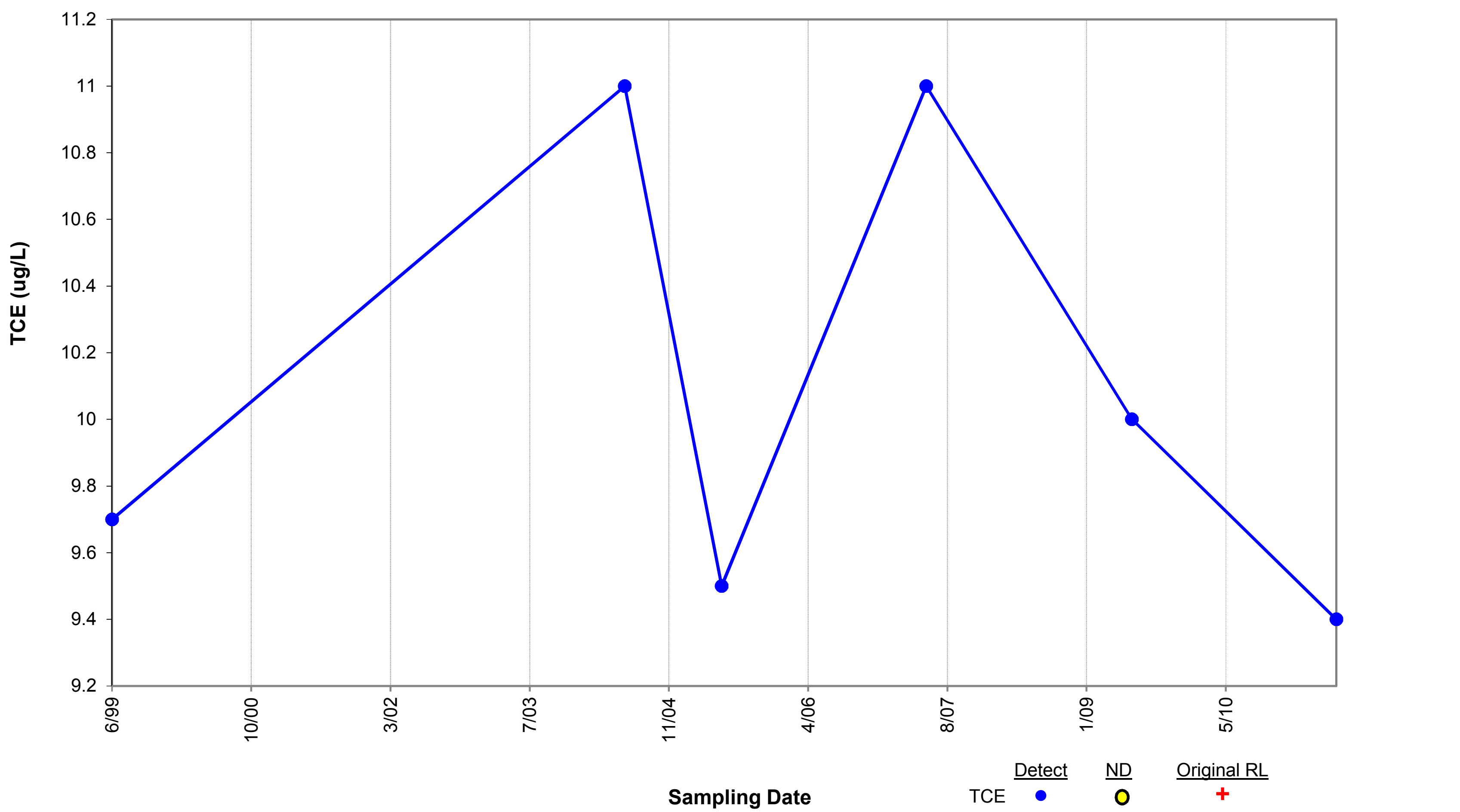
Mann-Kendall Test Result:	**No Significant Trend**			H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.094		
Theil-Sen Trend Line Result:	**No Significant Trend**			
	Median Slope Estimate =	-2.0E-03	ug/L per day	
	95% Confidence Interval =	-5.2E-03	to 0.0E+00	ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 04U882

TCAAP

Figure D.2.2-46



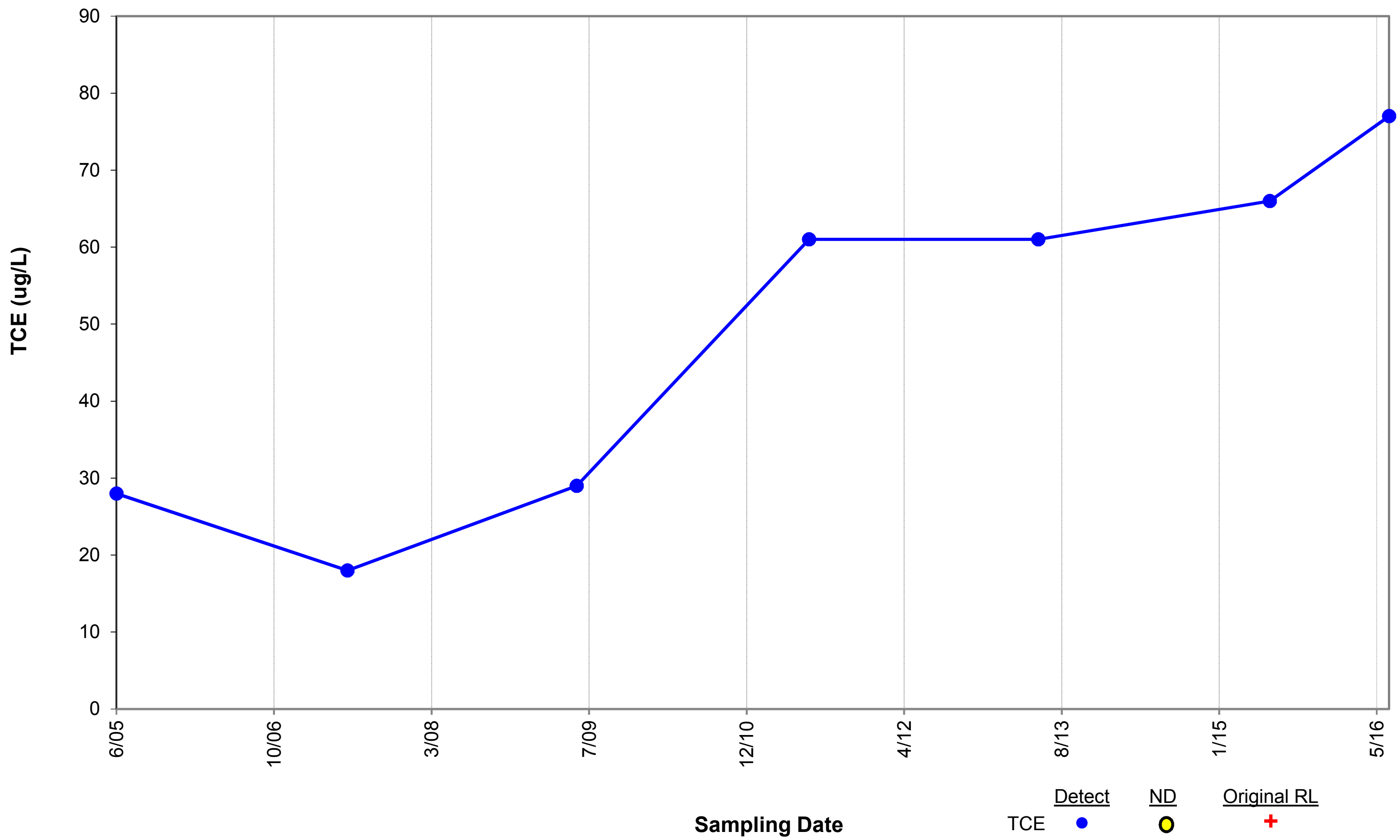
Mann-Kendall Test Result:	**No Significant Trend**				H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.298			
Theil-Sen Trend Line Result:	**No Significant Trend**				
	Median Slope Estimate =	-6.8E-05	ug/L per day		
	95% Confidence Interval =	-1.3E-03	to	4.0E-04	ug/L per day

PIKA
ARCADIS
a joint venture

Concentration vs. Time Plot – TCE in Well 206688

TCAAP

Figure D.2.2-47



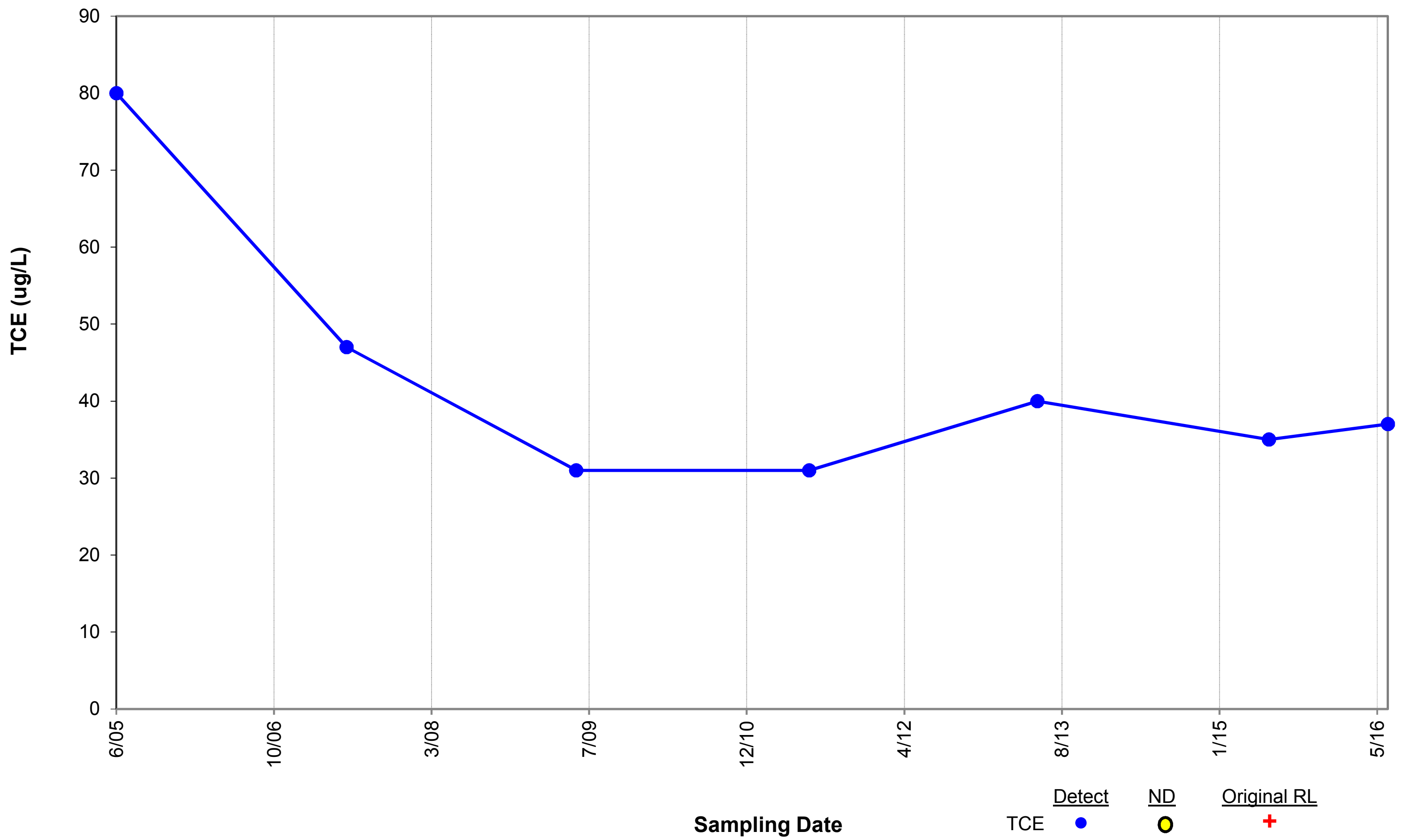
Mann-Kendall Test Result:	INCREASING TREND			H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.003		
Theil-Sen Trend Line Result:	INCREASING TREND			
	Median Slope Estimate =	1.5E-02	ug/L per day	
	95% Confidence Interval =	3.6E-03	to	2.0E-02 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 409549

TCAAP

Figure D.2.2-48



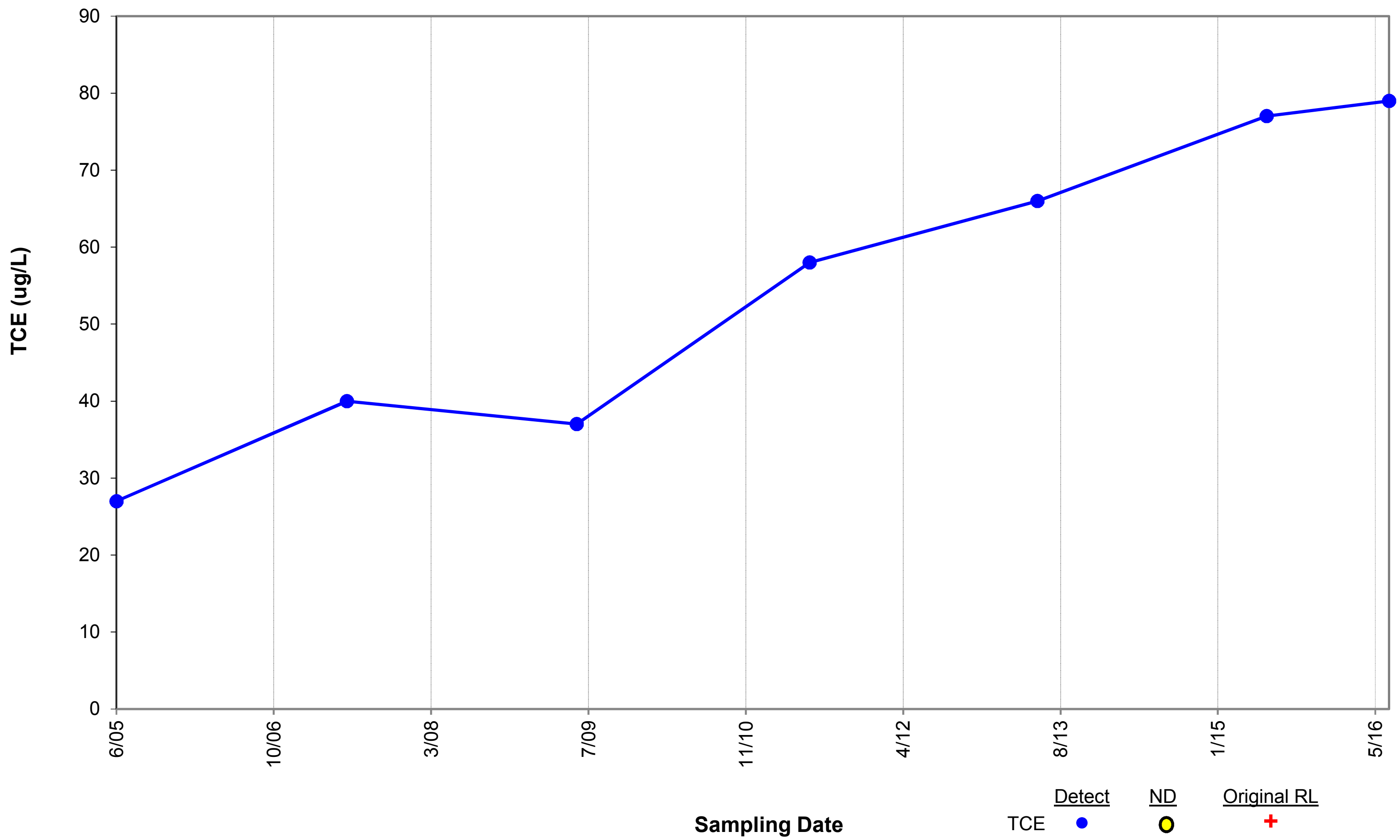
Mann-Kendall Test Result: **No Significant Trend**
p-value = 0.236
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: **No Significant Trend**
Median Slope Estimate = -3.2E-03 ug/L per day
95% Confidence Interval = -2.2E-02 to 2.7E-03 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 409550
TCAAP

Figure D.2.2-49



Mann-Kendall Test Result: INCREASING TREND
p-value = 0.001

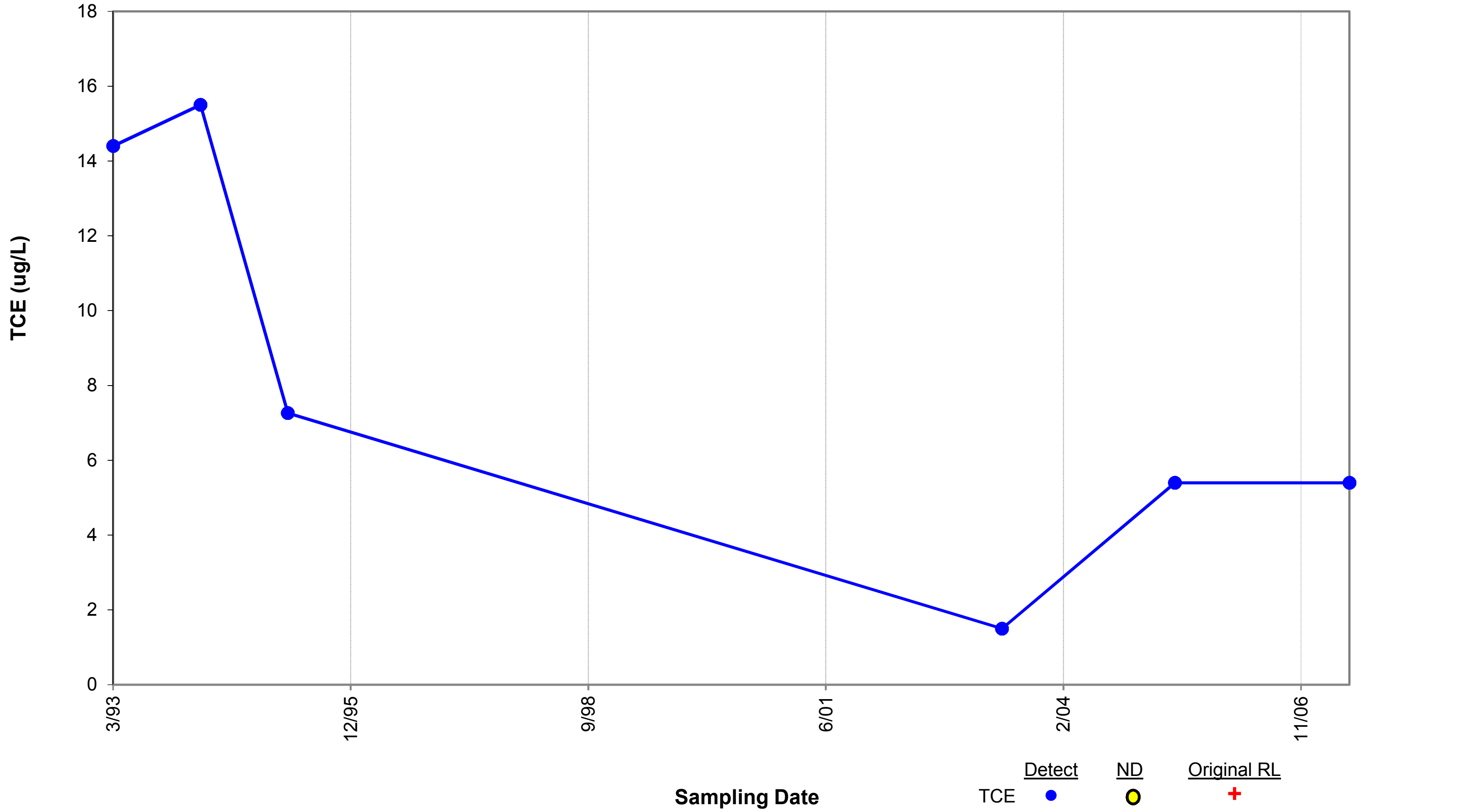
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: INCREASING TREND
Median Slope Estimate = 1.3E-02 ug/L per day
95% Confidence Interval = 1.1E-02 to 1.6E-02 ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 409557
TCAAP

Figure D.2.2-50



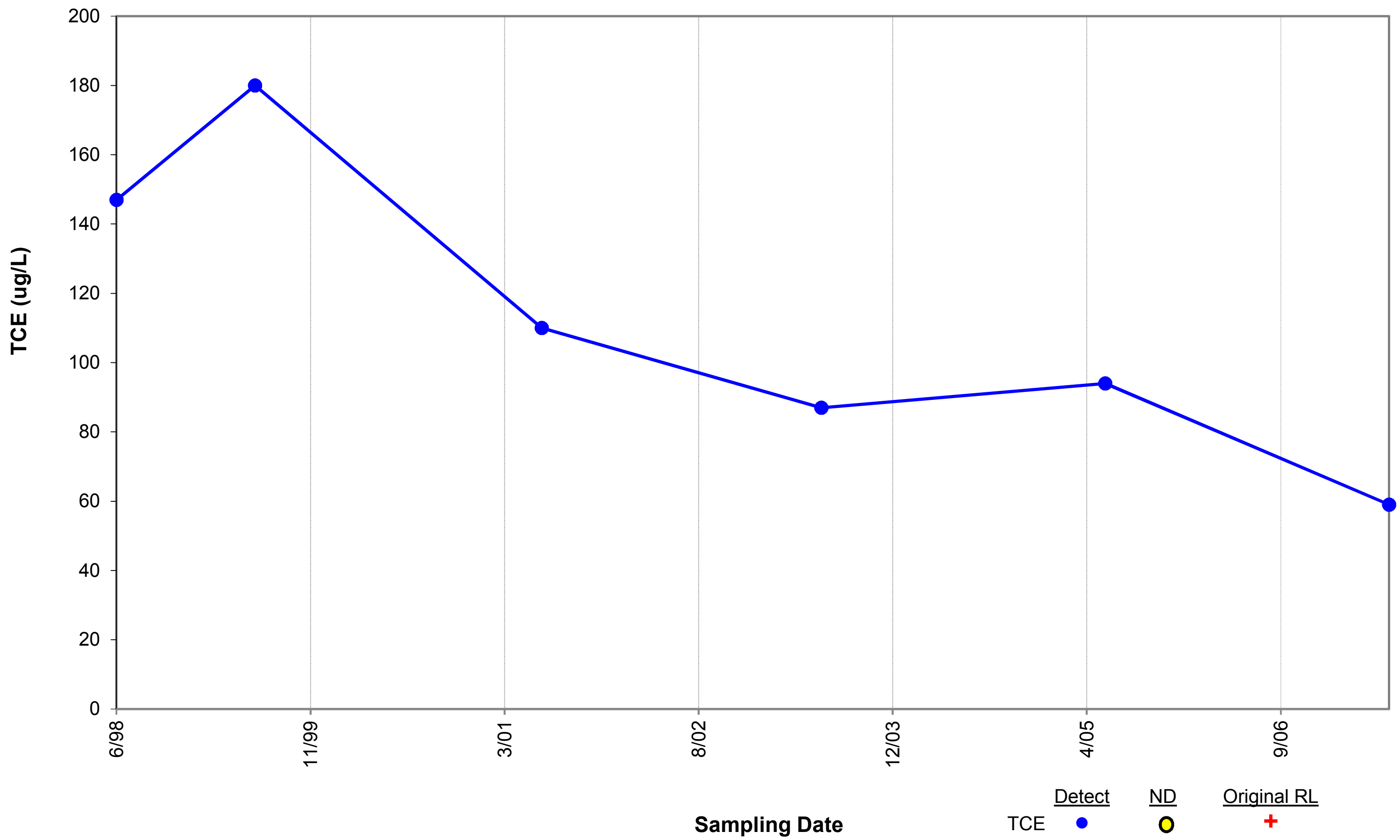
Mann-Kendall Test Result:	**No Significant Trend**				H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).
	p-value =	0.102			
Theil-Sen Trend Line Result:	**No Significant Trend**				
	Median Slope Estimate =	-1.9E-03	ug/L per day		
	95% Confidence Interval =	-7.6E-03	to	1.7E-03	ug/L per day

PIKA ARCADIS a joint venture

Concentration vs. Time Plot – TCE in Well 409596

TCAAP

Figure D.2.2-51



Mann-Kendall Test Result: DECREASING TREND
p-value = 0.028

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

Theil-Sen Trend Line Result: DECREASING TREND
Median Slope Estimate = -3.2E-02 ug/L per day
95% Confidence Interval = -5.9E-02 to -1.3E-02 ug/L per day

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Concentration vs. Time Plot – TCE in Well 409597
TCAAP

Figure D.2.2-52

Figure D.2.3-1
New Brighton Municipal Wells: Regression Analysis Since 1998: Trichloroethene

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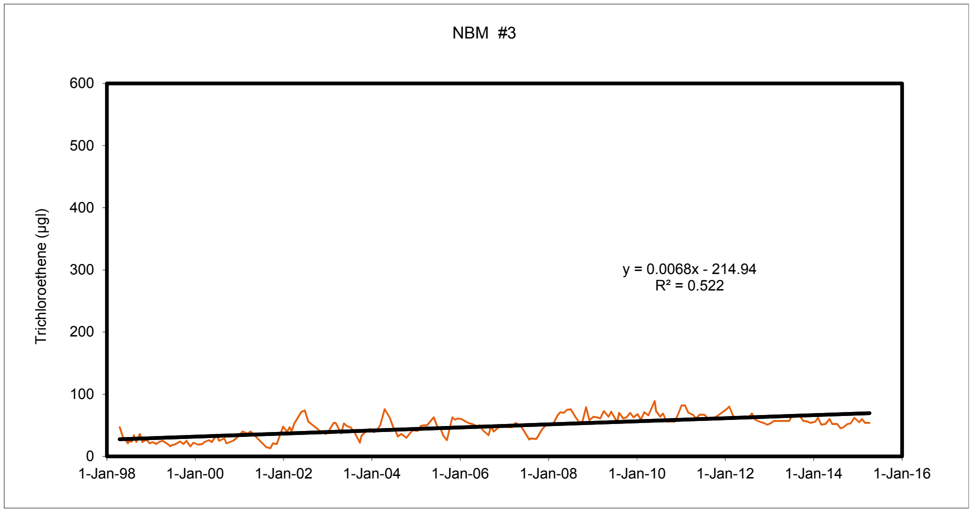

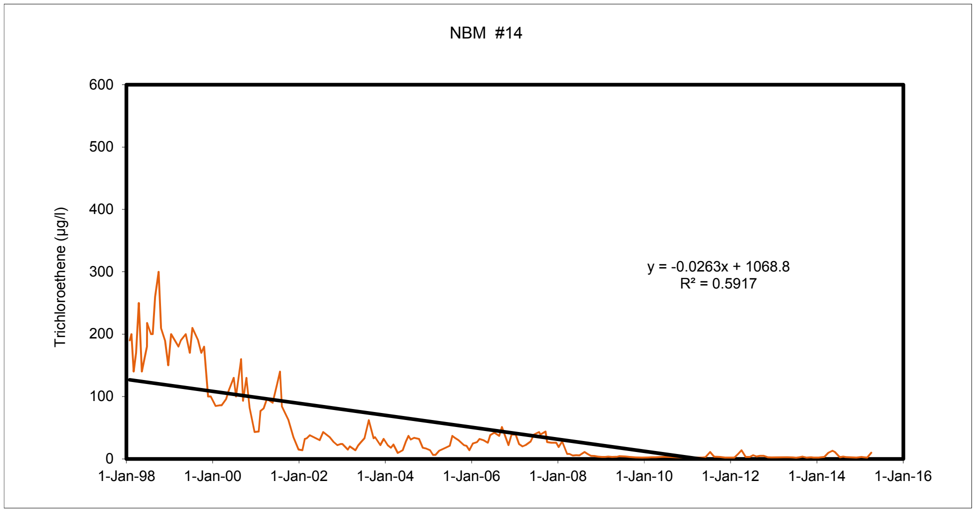

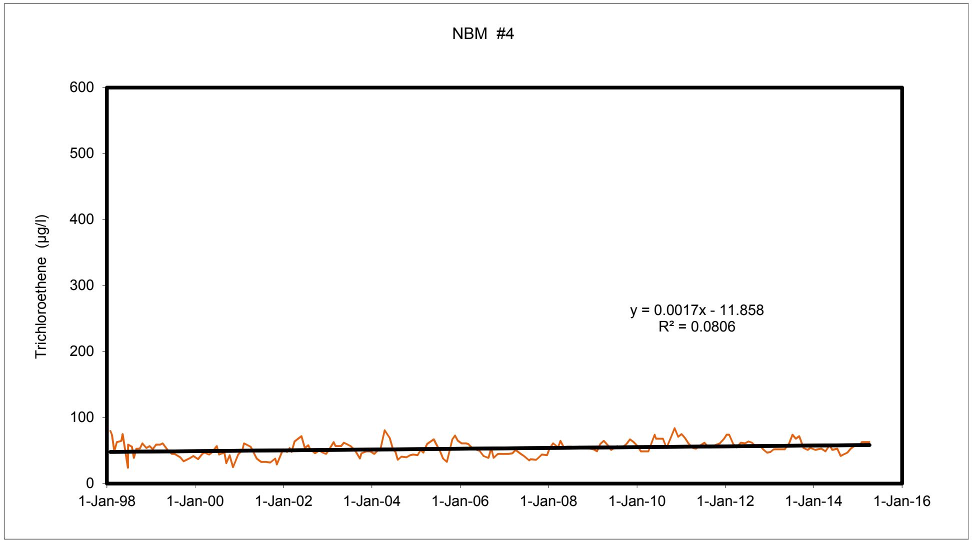

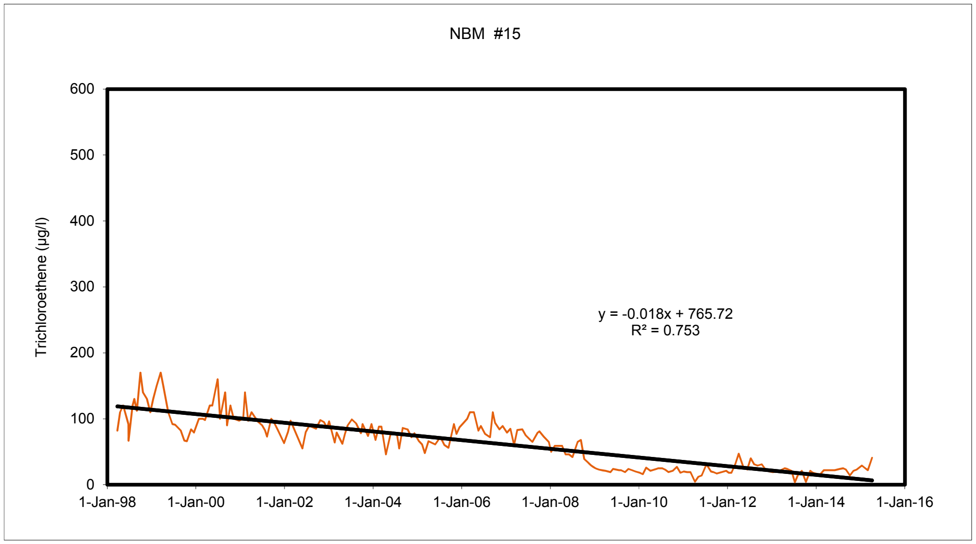

Figure D.2.3-2
New Brighton Municipal Wells: Regression Analysis Since 1998: Trichloroethene

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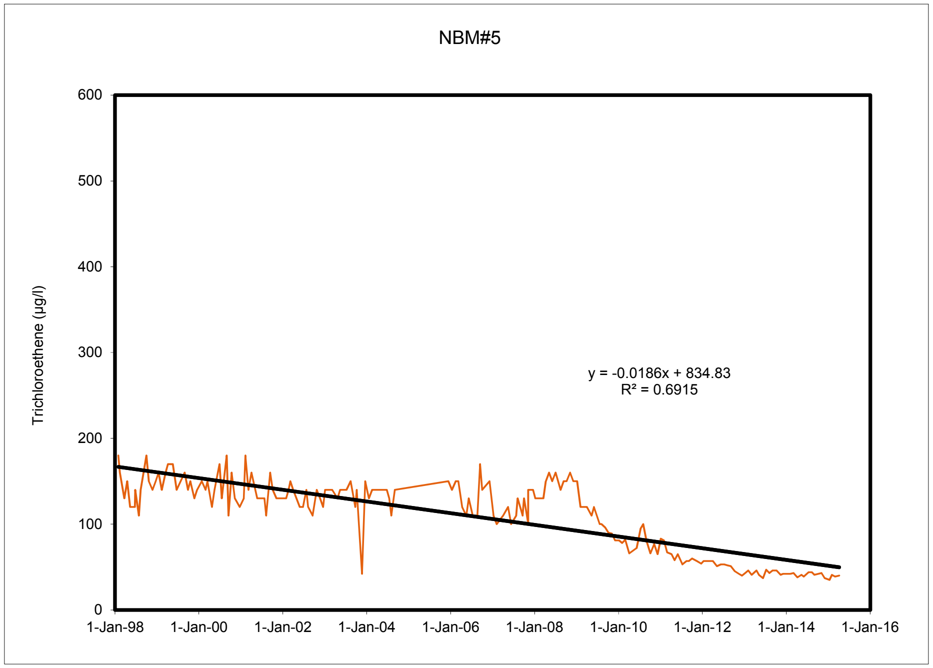

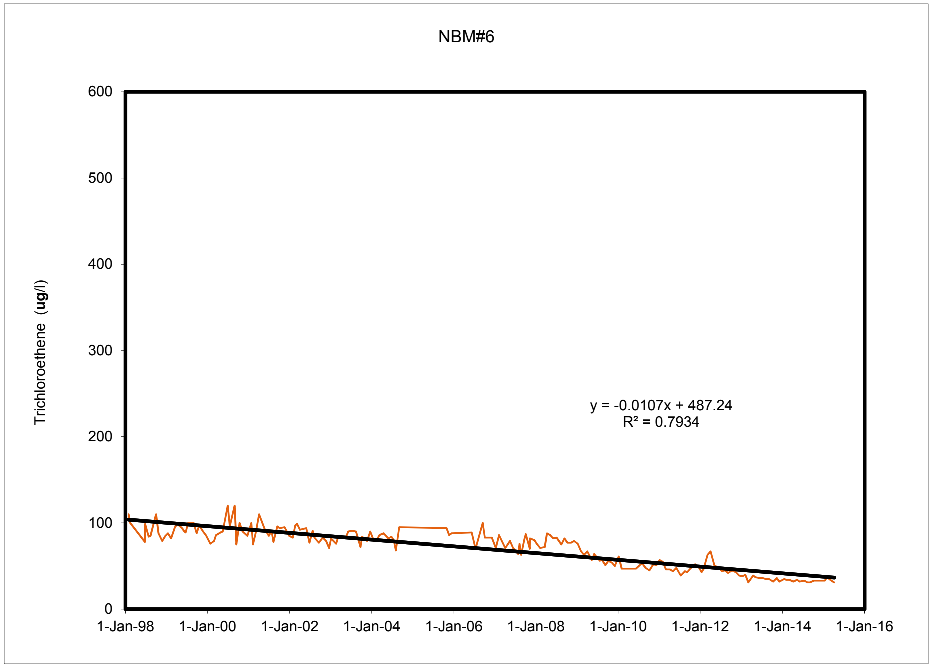

APPENDIX E

Well Inventory

1.0 PURPOSE

The purpose of well inventory is to identify wells that have been impacted or could potentially be impacted by contaminants from the New Brighton/Arden Hills Superfund Site.

2.0 BACKGROUND

Developing and maintaining the well inventory is a process that was initiated in 1991, with the work efforts documented in several update reports since that time. Beginning in FY 1999, the update reporting was incorporated into the Annual Performance Reports.

The well inventory "study area," as defined by the Minnesota Pollution Control Agency, is shown on Figure E-1, and coincides with the Minnesota Department of Health (MDH) Special Well Construction Area.

The aquifers of concern are defined by the 1 µg/L trichloroethene contour for the Unit 3 and Unit 4 aquifers, and the 1 µg/L cis-1,2-dichloroethene contour for the Unit 1 aquifer at the north end of OU2.

The "area of concern" for the Unit 3 and Unit 4 aquifers is created by adding a quarter mile buffer area outside the 1 µg/L trichloroethene contour. The area of concern for the Unit 3 and Unit 4 aquifers is shown on Figure E-2.

The area of concern for the Unit 1 aquifer on the north side of OU2 is delineated by city streets. The area of concern for the Unit 1 aquifer is shown on Figure E-3.

Wells within the study area are categorized based on location, depth/aquifer, and use. Well categories for the well inventory are described in Table E-1.

3.0 PROGRAM REQUIREMENTS

The well inventory program requirements have evolved over time, with changes documented through the update reports. A flowchart that describes the annual requirements for maintaining the well inventory database is shown on Figure E-4. Requirements are summarized below.

Near the beginning of each fiscal year, a database of study area wells is acquired from the MDH. This MDH database query is limited to study area wells that were constructed, sealed, or disclosed in the previous fiscal year. The MDH database consists of three lists:

- Constructed Wells (generated through drillers submitting Water Well Records);
- Sealed Wells (generated through drillers submitting Well Sealing Records); and
- Disclosed Wells (made known through property transfer).

With the new MDH information, the well inventory database is updated by recategorizing wells, as necessary, and by adding any new wells that are within the study area. Any new wells found in Categories 1a, 1b, 1c, 2a, 2b, 2c, or 4a are targeted for sampling in that fiscal year; however, an attempt to reclassify any new category 4a wells will be made prior to sampling. Wells that are not sampled due to non-responsive well owners are targeted for sampling in the next major sampling event.

Category 4 wells are those with an unknown depth or unknown location, or both. Ideally, there should be no wells in Category 4. Each year, an attempt is made to reclassify Category 4 wells into one of the other categories. This is accomplished through phone calls, letters, and/or site visits to obtain additional information. Any wells which are re-classified as Category 1a, 1b, 1c, 2a, 2b, or 2c are targeted for sampling in that fiscal year.

“Major” well inventory sampling events occur every four years and are shown in Appendix A.1. The major sampling events are scheduled to coincide with the biennial sampling events for performance purposes as delineated in the APR. For each major event, all wells in Categories 1a, 1b, 1c, 2a, 2b, 2c, and 4a are targeted for sampling. After every sampling event, each well owner is mailed a copy of their testing results. Wells that are not sampled due to non-responsive well owners are targeted for sampling in the next major sampling event.

For each sampling event, if any well has a detection which exceeds the applicable New Brighton/Arden Hills Superfund Site groundwater cleanup level for that contaminant (or an additivity of 1.0, similar to the MDH Hazard Index calculation), the well is evaluated using the flow chart presented in Figure E-4 to determine the timing of additional sampling. Wells that are used for drinking water are sampled again within one month of data validation. Wells that are not used for drinking water, but have possible contact exposure risks, are sampled the next fiscal year. If a cleanup level exceedance is confirmed (two consecutive events), and the contaminant concentrations in the well are proportional to contaminant concentrations of the New Brighton/Arden Hills Superfund Site OU1 plume, the Army offers to abandon the well and/or provide an alternate water supply.

The annual reporting requirements for the New Brighton/Arden Hills Superfund Site well inventory will include:

- A list of any wells found or reclassified.
- Analytical results and a summary of sampling efforts from that fiscal year.
- Recommendations for participation in the Well Abandonment/Alternate Water Supply Program.
- An updated well inventory database that lists wells by well category.
- An updated database listing water quality of wells.

4.0 FY 2017 UPDATE

The updated MDH database was provided to Arcadis on January 22, 2018. MDH generates the database from specific Township, Range, and Section data. This comprehensive database was screened to extract the lists of wells that were constructed, disclosed, or sealed between October 1, 2015 and September 30, 2016. Further investigative efforts were primarily focused on determining each well’s location (inside or outside the study area and/or area of concern), status (active, inactive, or sealed), and water use (supply/non-supply).

Newly constructed active and inactive wells, and wells of unknown status that were determined to be located within the study area, are presented in Table E-2. Thirty-one wells were identified within the study area. Two of the wells were elevator shaft boreholes, 28 were monitoring wells, and one was unknown. All wells were classified into Category 6, except the unknown well which was classified into Category 4b.

Disclosed wells that were identified as being in use, inactive, or of unknown status (but not sealed) and that were determined to be located within the study area are identified in Table E-3. There were 36 (non-sealed) wells disclosed during FY17 that are located within the study area. None of these wells were previously in the database and could not be categorized due to a lack of information about their use.

Sealed wells were found by reviewing the MDH sealed well list, by screening the MDH disclosed and new construction lists (which also contain sealed wells), and by talking with well owners. Wells identified as sealed are shown in Table E-4. Disclosed wells that were located within the area of concern and that the MDH identified as having a change in status from active or inactive to sealed were further investigated for confirmation of their sealed status. Any wells that were already in the well inventory database that the MDH identified as having a change in status from active or inactive to sealed are shown in Table E-4 with strikeouts through the old well category entry. Wells identified as sealed in the MDH database updates were assigned to Category 7a (documented as sealed/abandoned). Wells that were determined to be sealed through conversations with well owners were assigned to Category 7b (undocumented as sealed, or improperly abandoned).

FY 2017 was not a “major” well inventory sampling event, which occur every four years and which target the wells in Categories 1a, 1b, 1c, 2a, 2b, 2c, and 4a. The next major well inventory sampling event will occur in 2020.

Information contained in Tables E-2 through E-4 has been updated in the well inventory database (Filename “Well Inventory Main Database FY 2017”, an Excel file included on this CD).

WELL INVENTORY DATABASE

The Well Inventory Database is located on
this CD in the following Microsoft Excel file:

Well Inventory Main Database FY 2017.xls

Table E-1
Well Inventory Category Descriptions
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
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Category	Subcategory	Explanation
1		Water supply wells screened in an aquifer of concern, inside the 1 µg/l contour. Wells are divided into the following subcategories:
	1a	Drinking water well
	1b	Nondrinking but possible contact water
	1c	Nondrinking, noncontact water
	1d	Well is inoperable or has not been used for several years
	1e	Well for which the owner has refused (or has been unresponsive to) an Army offer for abandonment, or for which the water use has been deemed acceptable
2		Water supply wells in an area of concern, inside the buffer lines, but outside the 1 µg/l contour, screened in an aquifer of concern. Wells are divided into the following subcategories:
	2a	Drinking water well
	2b	Nondrinking but possible contact water
	2c	Nondrinking, noncontact water
	2d	Well is inoperable or has not been used for several years
3		Water supply wells within the Study Area that are either outside the area of concern, or are within the area of concern but are not screened in an aquifer of concern.
4		Water supply wells with missing information, divided into the following subcategories:
	4a	Unknown depth or aquifer, but located in the area of concern.
	4b	Unknown location, but potentially located within the Study Area. Wells with both an unknown depth and an unknown location are included in 4b.
5		Wells that are in the study area, but that have been field checked and not located. No further action is recommended for these wells.
6		Nonsupply wells (primarily monitoring wells).
7		Sealed or abandoned wells. Wells are divided into the following subcategories:
	7a	Documented as sealed/abandoned
	7b	Undocumented as sealed, or improperly abandoned

Table E-2
Constructed Wells
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Twin Cities Army Ammunitions Plant
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Unique Number	Category	Last Name or Business Name	Street	City	Use	Depth	Date Drilled	Well in Database?
813336	6	University of Minnesota	2088 Larpenteur Avenue W	Falcon Heights	Elevator Shaft Boring	38	6/16/2016	Yes
816345	6	Ramsey County	1661 Highway 96	Arden Hills	Monitoring Well	16	11/24/2015	Yes
816346	6	Ramsey County	1661 Highway 96	Arden Hills	Monitoring Well	37	11/24/2015	Yes
816347	6	Ramsey County	1661 Highway 96	Arden Hills	Monitoring Well	17	11/24/2015	Yes
816348	6	Ramsey County	1661 Highway 96	Arden Hills	Monitoring Well	37	11/23/2015	Yes
810045	6	General Milles, Inc.	1084 22nd Avenue SE	Minneapolis	Monitoring Well	23	11/4/2015	Yes
805467	4b	Metropolitan Council		Fridley	Unknown	UK	5/10/2016	Yes
799341	6	University of Minnesota		Minneapolis	Monitoring Well	17	10/15/2015	Yes
799340	6	University of Minnesota		Minneapolis	Monitoring Well	18	10/16/2015	Yes
799339	6	University of Minnesota		Minneapolis	Monitoring Well	22	10/14/2015	Yes
799338	6	University of Minnesota		Minneapolis	Monitoring Well	19	10/14/2015	Yes
799337	6	University of Minnesota		Minneapolis	Monitoring Well	18	10/15/2015	Yes
818840	6	Pik Terminal Co.	2690 Prior Avenue	Roseville	Monitoring Well	20	5/10/2016	Yes
818841	6	Pik Terminal Co.	2690 Prior Avenue	Roseville	Monitoring Well	20	5/10/2016	Yes
818842	6	Pik Terminal Co.	2690 Prior Avenue	Roseville	Monitoring Well	20	5/10/2016	Yes
818843	6	Pik Terminal Co.	2690 Prior Avenue	Roseville	Monitoring Well	20	5/10/2016	Yes
813337	6	University of Minnesota	2088 Larpenteur Avenue W	Falcon Heights	Elevator Shaft Boring	41	6/15/2016	Yes
817711	6	Minnesota DOT		New Brighton	Monitoring Well	15	6/15/2016	Yes
817712	6	Minnesota DOT		New Brighton	Monitoring Well	13	6/15/2016	Yes
817713	6	Minnesota DOT		New Brighton	Monitoring Well	5	6/15/2016	Yes
817714	6	Minnesota DOT		New Brighton	Monitoring Well	5	6/15/2016	Yes
817715	6	Minnesota DOT		New Brighton	Monitoring Well	4	6/14/2016	Yes
821478	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	20	9/10/2016	Yes
821480	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	18	9/9/2016	Yes
821481	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	18	9/11/2016	Yes
821482	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	18	9/12/2016	Yes
821483	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	18	9/12/2016	Yes
821484	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	18	9/10/2016	Yes
821485	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	18	9/10/2016	Yes
821477	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	20	9/13/2016	Yes
821476	6	Univar USA, Inc.	111 22nd Avenue NE	Minneapolis	Monitoring Well	20	9/13/2016	Yes

Table E-3
Wells Disclosed through Property Transfer
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Unique Number	Category	Last Name or Business Name	Street	City	Status	Date Sealed	Depth	Date Drilled
UNK0526143	UK	Reinhart	3058 Wilder St N	Roseville	In Use	NA	NA	NA
UNK0526946	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526947	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526948	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526949	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526950	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526951	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526952	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526953	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526954	UK	Jakris, Ltd	111 22nd Ave NE	Minneapolis	In Use	NA	NA	NA
UNK0526995	UK	Kangas	5592 Schutta Rd	Shoreview	In Use	NA	NA	NA
UNK0527967	UK	Delaocarbello	1705 Rose Pl	Roseville	Not In Use	NA	NA	NA
UNK0528721	UK	Eckart	5511 Erickson Rd	Mounds View	In Use	NA	NA	NA
UNK0528846	UK	Vinuezaguachichulca	6301 Monroe St	Fridley	In Use	NA	NA	NA
UNK0529841	UK	Stanek Properties, LLC	390 66th Ave NE	Fridley	In Use	NA	NA	NA
UNK0530561	UK	Siemens Water Technologies	2430 Rose Pl	Roseville	Not In Use	NA	NA	NA
UNK0530563	UK	Siemens Water Technologies	2430 Rose Pl	Roseville	Not In Use	NA	NA	NA
UNK0530564	UK	Siemens Water Technologies	2430 Rose Pl	Roseville	Not In Use	NA	NA	NA
UNK0530565	UK	Siemens Water Technologies	2430 Rose Pl	Roseville	Not In Use	NA	NA	NA
UNK0530568	UK	Strand	2849 County Rd H	Mounds View	Not In Use	NA	NA	NA
UNK0530570	UK	Cahill	5746 Schutta Rd	Shoreview	In Use	NA	NA	NA

Table E-4
Sealed Wells
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Twin Cities Army Ammunitions Plant
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Unique Number	Category	Last Name or Business Name	Street	City	Use	Date Sealed
462526	7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/2/2015
575346	7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/2/2015
582968	7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/3/2015
582975	~~6~~ 7a	Canadian Pacific	2805 Polk St NE	Minneapolis	Monitoring	11/2/2015
660019	7a	Hard Chrome	2631 2nd Ave NE	Minneapolis	Water Supply	3/3/2016
660020	7a	Hard Chrome	2631 2nd Ave NE	Minneapolis	Water Supply	3/3/2016
660021	7a	Hard Chrome	2631 2nd Ave NE	Minneapolis	Water Supply	3/3/2016
696892	7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/2/2015
701951	~~6~~ 7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/2/2015
702840	~~6~~ 7a	City of Roseville	2680 Prior Ave N	Roseville	Monitoring	3/31/2016
705484	~~6~~ 7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/3/2015
716453	~~6~~ 7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/2/2015
717707	7a		2800 Central Ave NE	Minneapolis	Monitoring	11/2/2015
718154	~~6~~ 7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/3/2015
718155	~~6~~ 7a	Canadian Pacific	2800 Central Ave NE	Minneapolis	Monitoring	11/2/2015
730143	~~6~~ 7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
730142	~~6~~ 7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
730141	~~6~~ 7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
730140	~~6~~ 7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
737659	~~6~~ 7a	Canadian Pacific	2733 Central Ave	Minneapolis	Monitoring	11/2/2015
742739	~~6~~ 7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
742740	~~6~~ 7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/9/2016
740244	~~6~~ 7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
767630	~~6~~ 7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/9/2016
799879	~~6~~ 7a	Davis Frost, Inc.		Minneapolis	Monitoring	3/8/2016
799877	~~6~~ 7a	Davis Frost, Inc.		Minneapolis	Monitoring	3/8/2016
799878	~~6~~ 7a	Davis Frost, Inc.		Minneapolis	Monitoring	3/8/2016
200173	~~6~~ 7a	Hubbard Broadcasting	3415 University Ave	St. Paul		1/8/2016
H000329280	7a	Jabs	2230 Rainbow Ave	New Brighton	Water Supply	1/8/2016
H000333591	7a	Donnelly	5022 Jefferson St NE	Columbia Heights	Water Supply	10/13/2015
H000332898	7a	Ramsey County		New Brighton	Monitoring	10/14/2015
H000327249	7a	Wagar	1643 Maple Knoll Dr	Falcon Heights	Water Supply	10/20/2015
H000335344	7a	McKenzie	2501 County Rd C2 W	Roseville	Water Supply	11/4/2015
H000335345	7a	McKenzie	2501 County Rd C2 W	Roseville	Water Supply	11/4/2015
H000335003	7a	Randall	1210 Mississippi St NE	Fridley	Water Supply	10/7/2015
H000335009	7a	Palmer	1717 Gramsie Rd	Arden Hills	Water Supply	10/29/2015
H000335011	7a	Sherman	3946 Dellview Ave	Arden Hills	Water Supply	10/30/2015
H000335726	7a	Carello	796 Carla Ln	Little Canada	Water Supply	11/8/2015
H000331121	7a	Boutin	1600 Lake Johanna Blvd	Arden Hills	Water Supply	11/3/2015
H000331854	7a	City of Fridley	7011 University Ave	Fridley	Monitoring	10/30/2015
H000322692	7a	Venture Bank	1223 73rd Ave NE	Fridley	Monitoring	11/7/2015
H000335391	7a	Danielson	5060 Eastwood Rd	Mounds View	Water Supply	11/30/2015

Table E-4
Sealed Wells
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Unique Number	Category	Last Name or Business Name	Street	City	Use	Date Sealed
H000311299	7a	Reiter	2728 Woodcrest Dr	Mounds View	Water Supply	12/17/2015
H000335529	7a	Minnesota DOT		Roseville	Monitoring	12/3/2015
H000335531	7a	Minnesota DOT		Arden Hills	Monitoring	12/3/2015
H000335532	7a	Minnesota DOT		New Brighton	Monitoring	12/10/2015
H000335533	7a	Minnesota DOT		Arden Hills	Monitoring	12/10/2015
H000335534	7a	Minnesota DOT		Mounds View	Monitoring	12/8/2015
H000335535	7a	Minnesota DOT		Mounds View	Monitoring	12/9/2015
H000335536	7a	Minnesota DOT		Arden Hills	Monitoring	12/9/2015
H000335537	7a	Minnesota DOT		Mounds View	Monitoring	12/9/2015
H000335538	7a	Minnesota DOT		Arden Hills	Monitoring	12/3/2015
H000335539	7a	Minnesota DOT		Shoreview	Monitoring	12/7/2015
H000335017	7a	Genosky	1610 66th Ave NE	Fridley	Water Supply	11/30/2015
H000332469	7a	Allrude	1705 Rose Pl	Roseville		12/2/2015
H000331877	7a	City of Fridley	400 71st Ave NE	Fridley	Monitoring	12/9/2015
H000335546	7a	Minnesota DOT		New Brighton	Monitoring	12/11/2015
H000335410	7a	Presbyterian Homes	3163 Lake Johanna Blvd	Arden Hills	Water Supply	12/15/2015
H000333021	7a	University of Minnesota Regents	516 Ontario St SE	Minneapolis	Water Supply	10/13/2015
H000327486	7a	Hildreth	7490 Stinson Blvd	Fridley	Water Supply	3/10/2016
H000325014	7a		2225 Draper Ave	Roseville	Water Supply	1/26/2016
H000333513	7a		861 E Hennepin Ave	Minneapolis	Other	1/4/2016
H000320991	7a	Murphy Warehouse Co.	701 24th Ave SE	Minneapolis	Monitoring	10/28/2015
H000320992	7a	Minnesota Pollution Control Agency	1900 Central Ave NE	Minneapolis	Other	10/28/2015
H000327483	7a	Ames Construction		Arden Hills	Other	11/30/2015
H000335025	7a	Larson	6740 4th St NE	Fridley	Water Supply	1/20/2016
H000336019	7a	Hermann	500 Old Highway 8	New Brighton	Monitoring	1/26/2016
H000326114	7a	Quattro Acquisition Corp.	427 Harrison St NE	Minneapolis	Other	10/29/2015
H000336023	7a	Rosenberger	5329 Clifton Dr	Mounds View	Water Supply	2/2/2016
H000337594	7a	Revival, LLC	807 Broadway Ave NE	Minneapolis	Other	12/28/2015
234217	~~6~~ 7a	Ramsey County Public Works	1661 Highway 96	Arden Hills	Monitoring	9/29/2016
234241	~~6~~ 7a	Ramsey County Public Works	1661 Highway 96	Arden Hills	Monitoring	2/8/2016
H000331872	7a	Minnesota DOT		Minneapolis	Other	11/12/2015
H000331873	7a	Minnesota DOT		Minneapolis	Other	11/12/2015
H000331874	7a	Minnesota DOT		Minneapolis	Other	11/12/2015
H000331842	7a	Minnesota DOT			Other	10/6/2015
H000311298	7a	CPM Cos.	501 Huron Blvd	Minneapolis	Other	11/20/2015
H000331841	7a	Minnesota DOT			Other	10/6/2015
H000331840	7a	Minnesota DOT			Other	10/6/2015
H000337617	7a	Ardrus	2570 Herschel St	Roseville	Water Supply	3/23/2016
H000336852	~~6~~ 7a	St. Paul Leased Housing Associates	2300 Territorial Rd	St. Paul	Monitoring	3/7/2016
H000337411	7a	Hanson	1321 Hillcrest Dr NE	Fridley	Water Supply	3/16/2016
H000331862	7a	Minnesota DOT		Minneapolis	Other	11/9/2015
H000331863	7a	Minnesota DOT		Minneapolis	Other	11/9/2015

Table E-4
Sealed Wells
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Unique Number	Category	Last Name or Business Name	Street	City	Use	Date Sealed
H000331865	7a	Minnesota DOT		Minneapolis	Other	11/11/2015
H000331866	7a	Minnesota DOT		Minneapolis	Other	11/11/2015
H000331868	7a	Minnesota DOT		Minneapolis	Other	11/11/2015
H000331867	7a	Minnesota DOT		Minneapolis	Other	11/11/2015
H000331869	7a	Minnesota DOT		Minneapolis	Other	11/11/2015
H000337218	7a	Peckels	1678 Hillview Rd	Shoreview	Water Supply	3/16/2016
H000338658	7a	Minnesota DOT		Fridley	Monitoring	3/18/2016
H000338874	7a	Winter	2424 27th Ave NE	St. Anthony	Water Supply	4/5/2016
H000337334	7a	US Bank	6670 Lucia Ln NE	Fridley	Other	3/23/2016
H000338660	7a	Minnesota DOT		Roseville	Monitoring	3/31/2016
H000338661	7a	Minnesota DOT		Arden Hills	Monitoring	6/13/2016
H000338664	7a	Minnesota DOT		Arden Hills	Monitoring	3/29/2016
H000338665	7a	Minnesota DOT		Shoreview	Monitoring	3/29/2016
H000338666	7a	Minnesota DOT		Shoreview	Monitoring	3/31/2016
H000338667	7a	Minnesota DOT		Shoreview	Monitoring	3/31/2016
H000338200	7a	Zimmerman	1657 Lois Dr	Shoreview	Water Supply	4/12/2016
H000337417	7a	Holm	1338 Hillcrest Dr NE	Fridley	Water Supply	4/7/2016
H000335071	7a	Anoka Hennepin Credit Union	1921 County Rd D W	Arden Hills	Water Supply	4/13/2016
H000331870	7a	Minnesota DOT		Minneapolis	Other	11/11/2015
H000331871	7a	Minnesota DOT		Minneapolis	Other	11/11/2015
H000338932	7a	SB Specialty Metals Holdings, LLC	2911 Como Ave SE	Minneapolis	Monitoring	4/19/2016
H000337424	7a	Stanek Properies, LLC	390 66th Ave NE	Fridley	Water Supply	4/27/2016
H000335517	7a	Micom Corp.	475 Old Highway 8	New Brighton	Monitoring	5/4/2016
H000335518	7a	Micom Corp.	475 Old Highway 8	New Brighton	Monitoring	5/4/2016
H000338950	7a	Turan	4701 Jefferson St NE	Columbia Heights	Water Supply	4/28/2016
H000338271	7a	Abbott	1663 Lois Dr	Shoreview	Water Supply	5/26/2016
H000338115	7a	Trilogy	203 10th St NW	New Brighton	Water Supply	5/13/2016
H000338451	7a	Dagg, LLC	700 Emerald St SE	St. Paul	Monitoring	5/17/2016
H000338452	7a	Dagg, LLC	700 Emerald St SE	St. Paul	Monitoring	5/16/2016
H000337972	7a	Teetzel	7433 Concereto Curve NE	Fridley	Water Supply	5/13/2016
H000339087	7a	Knilas	1711 Terrace Dr	Shoreview	Water Supply	5/20/2016
H000336245	7a	Forest Properties	2243 Thorndale Ave	New Brighton	Water Supply	6/8/2016
H000338680	7a	US Army TCAAP	1500 Old Highway 8	Arden Hills	Monitoring	6/7/2016
H000338683	7a	Minnesota DOT		Arden Hills	Monitoring	6/13/2016
H000338684	7a	Minnesota DOT		New Brighton	Monitoring	6/13/2016
H000339804	7a	MS Relocation Service	2591 Charlotte St	Roseville	Water Supply	6/10/2016
H000340953	7a	Hall	760 8th Ave NW	New Brighton	Water Supply	6/22/2016
H000339815	7a	Moundsview MHC	1046 Montclair Ave	Mounds View	Monitoring	6/22/2016
H000338126	7a	Bright	5066 Red Oak Dr	Mounds View	Water Supply	6/23/2016
H000325025	7a	Grudnoske	4445 Old Highway 10	Arden Hills	Water Supply	7/5/2016
H000339885	7a	Husmann	4336 Quincy St NE	Columbia Heights	Water Supply	7/1/2016
110564	7a	Grudnoske	4405 Old Highway 10	Arden Hills	Water Supply	7/12/2016

Table E-4
Sealed Wells
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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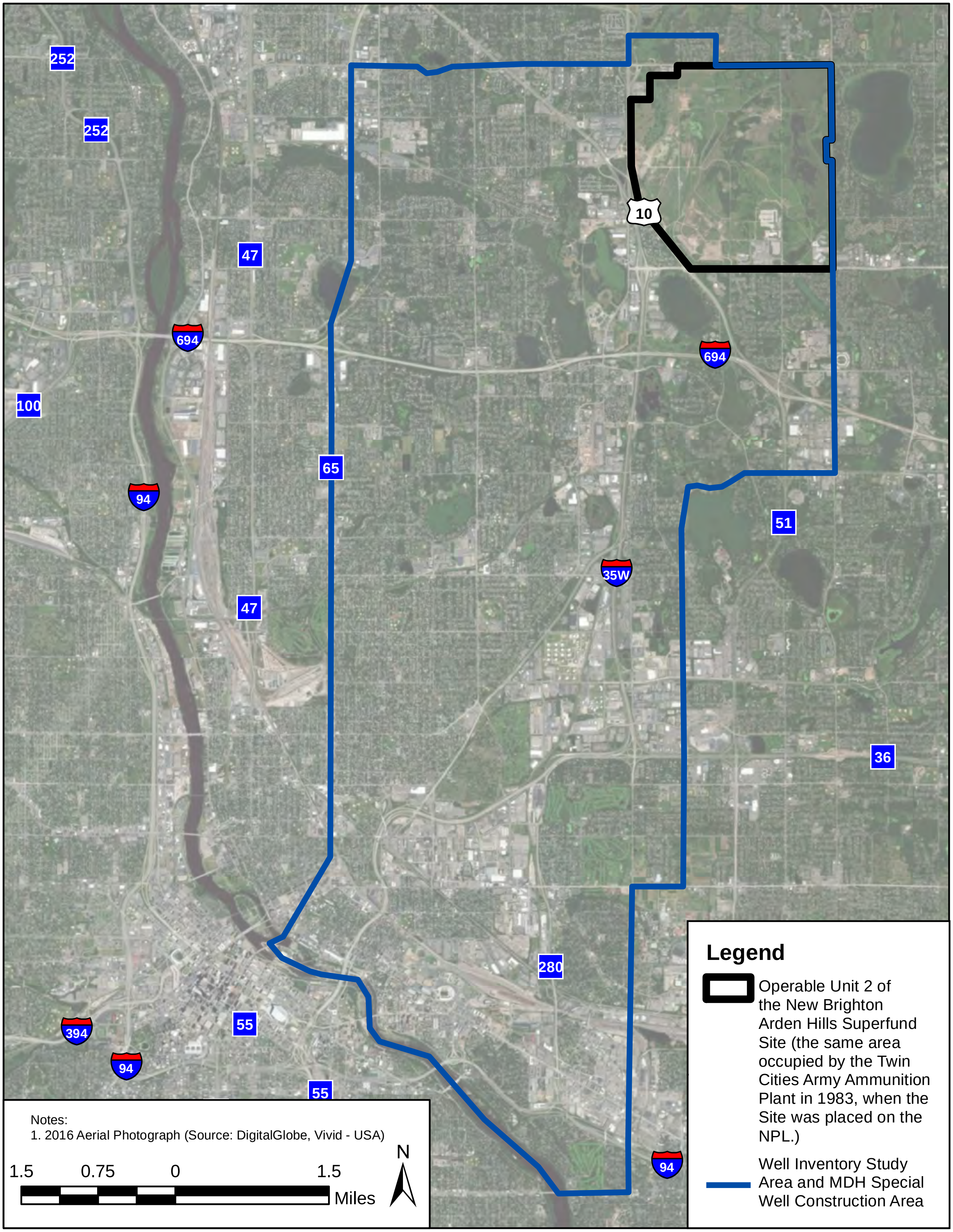
Unique Number	Category	Last Name or Business Name	Street	City	Use	Date Sealed
H000341068	7a	Wehmhoff	4765 Main St NE	Fridley	Water Supply	7/26/2016
H000341006	7a	Tomas	2501 Lowry Ave NW	St. Anthony	Monitoring	7/27/2016
H000338135	7a	Pidany	5053 Greenwood Dr	Mounds View	Water Supply	8/17/2016
277826	7a	Arden Hills Fire Department	3246 New Brighton Rd	Arden Hills	Water Supply	8/31/2016
H000337183	7a	Arden Hills Fire Department	3246 New Brighton Rd	Arden Hills	Water Supply	8/31/2016
H000341688	7a	Hoffman Construction	2021 County Rd H	Mounds View	Monitoring	9/13/2016
H000342160	7a	Lyon Contracting Inc.	5951 University Ave NE	Fridley	Water Supply	9/9/2016
H000341786	7a	Minnesota DOT	4797 US Highway 10	Arden Hills	Monitoring	9/15/2016
H000341711	7a	Saba	2441 Woodale Dr	Mounds View	Water Supply	9/16/2016
H000341557	7a	Norside Home Improvements	1857 Noble Rd	Arden Hills	Water Supply	7/12/2016
H000337316	7a	Bremer Bank	4821 Mustang Dr	Mounds View	Monitoring	9/19/2016
H000340981	7a	Chann	5083 Long Lake Rd	Mounds View	Water Supply	9/21/2016
H000342819	7a	Sloma	7301 Van Buren St NE	Fridley	Water Supply	9/22/2016
H000341374	7a	Del Plaine	1555 E River Terrace	Minneapolis	Env. Boring	9/2/2016
H000342477	7a	City of Roseville			Env. Boring	6/1/2016
80863	7a	Minnesota DOT			Env. Boring	6/23/2016
H000341004	7a	Hennepin Business Center	1001 Tench Ave SE	Minneapolis	Monitoring	6/27/2016
H000319494	7a	Al Tigers, LLC	336 Hoover St NE	Minneapolis	Monitoring	9/8/2016
H000335479	7a	Hawkins Chemical, Inc.	3101 Talmage Ave SE	Minneapolis	Monitoring	7/26/2016
H000320994	7a	BNSF Railway Co.	700 23rd Ave SE	Minneapolis	Monitoring	12/4/2015
H000336828	7a	Interstate Partners	2425 Kennedy St NE	Minneapolis	Monitoring	2/4/2016
H000335563	7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
H000335564	7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
H000335565	7a	Davis Frost, Inc.	1209 Tyler St NE	Minneapolis	Monitoring	3/8/2016
453863	7a	Hard Chrome	2631 2nd St NE	Minneapolis	Monitoring	3/3/2016
453864	7a	Hard Chrome	2631 2nd St NE	Minneapolis	Monitoring	3/3/2016
453865	7a	Hard Chrome	2631 2nd St NE	Minneapolis	Monitoring	3/3/2016
H000335641	7a	Minnesota Pollution Control Agency	Hoover St NE	Minneapolis	Monitoring	12/10/2015
H000335672	7a	Minnesota Pollution Control Agency	Hoover St NE	Minneapolis	Monitoring	12/9/2015
H000340820	7a	Ramsey County HRA		Arden Hills	Env. Boring	5/16/2016
H000341721	7a	Kevitt Excavating	815 9th Ave SE	Minneapolis	Water Supply	9/26/2016



ANNUAL PERFORMANCE REPORT

Well Inventory Study Area

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FY 2017

Figure E-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Well Inventory Study Area_FY2017.mxd
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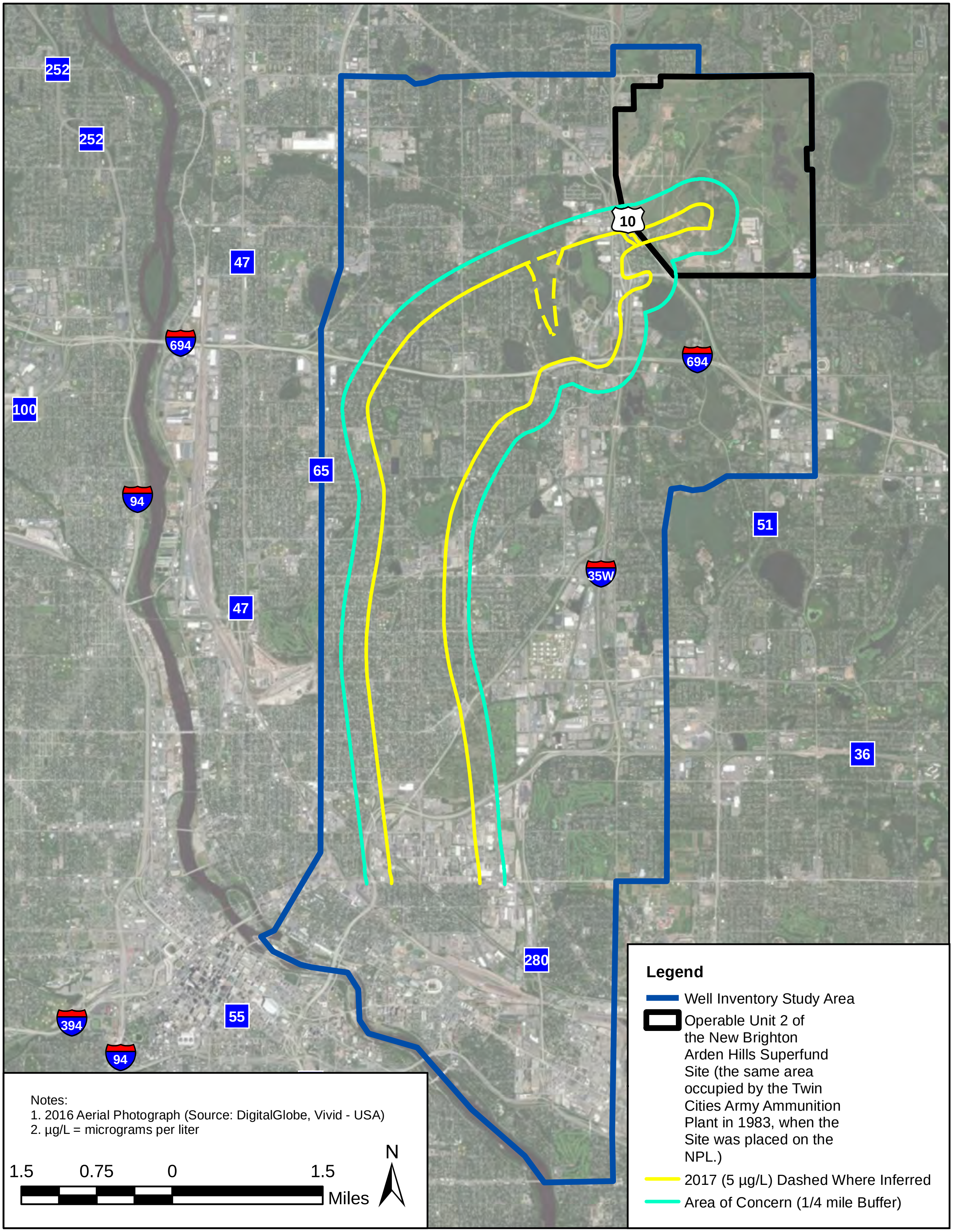

Notes:
1. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
2. µg/L = micrograms per liter

1.5 0.75 0 1.5
Miles

Legend

- Well Inventory Study Area
- Operable Unit 2 of the New Brighton Arden Hills Superfund Site (the same area occupied by the Twin Cities Army Ammunition Plant in 1983, when the Site was placed on the NPL.)
- 2017 (5 µg/L) Dashed Where Inferred
- Area of Concern (1/4 mile Buffer)

ANNUAL PERFORMANCE REPORT

Areas of Concern (Upper Unit 4)

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Figure E-2

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Areas of Concern (Unit 3 and Unit 4)_FY2017.mxd
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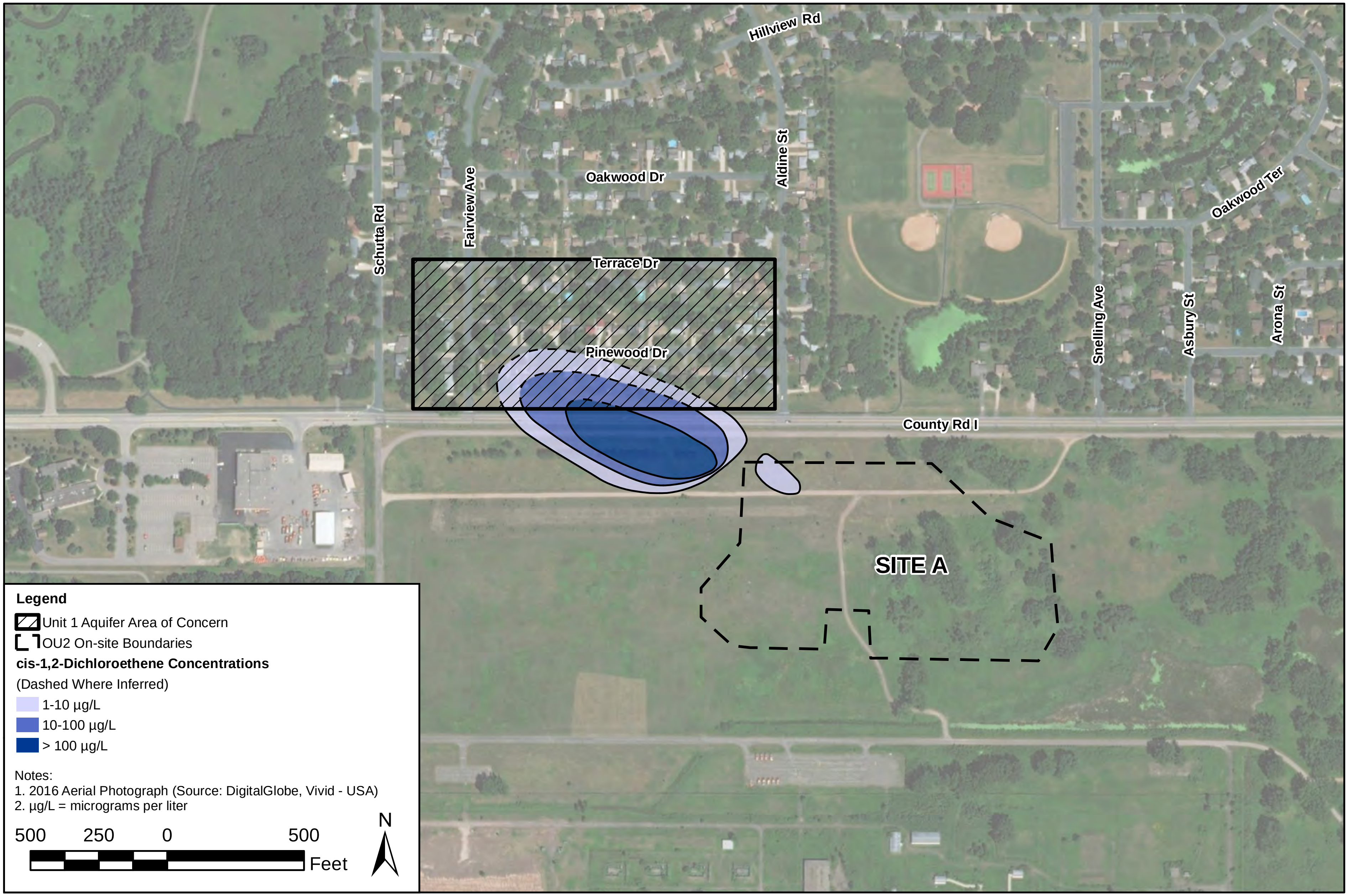

ANNUAL PERFORMANCE REPORT

Area of Concern (Unit 1)

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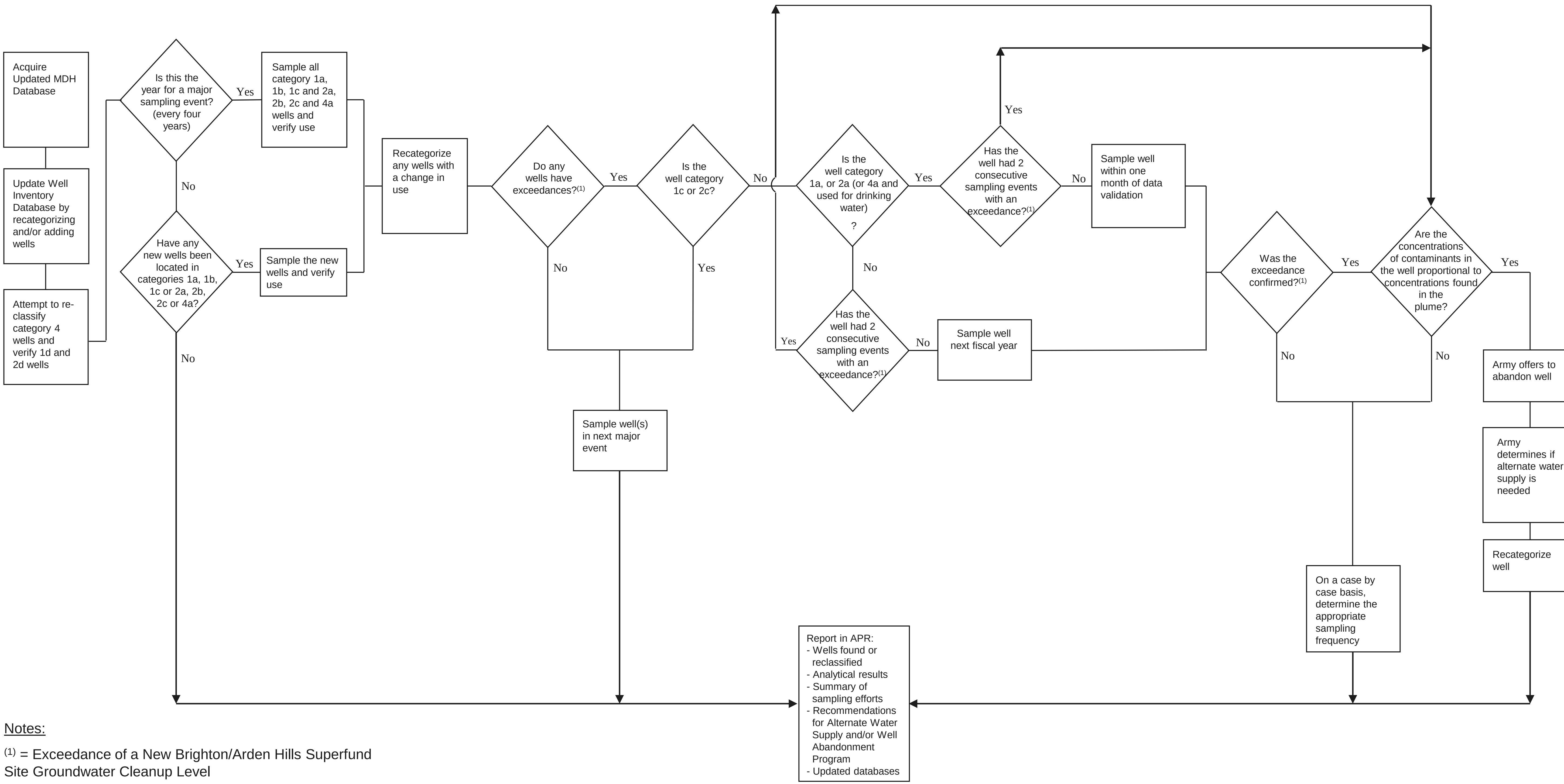
FY 2017

Figure E-3

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Areas of Concern (Unit 1)_FY2017.mxd
Date: 2/1/2018 Time: 11:02:46 AM User: mgress

Figure E-4
Annual Requirements for Maintaining Well Inventory Database

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota



Notes:

(1) = Exceedance of a New Brighton/Arden Hills Superfund Site Groundwater Cleanup Level

Figure generated by Wenck Associates, Inc.

APPENDIX F

Inspection Checklist

ANNUAL SITE INSPECTION CHECKLIST FOR LAND USE CONTROLS

Operable Unit 2, New Brighton/Arden Hills Superfund Site

Date: August 24, 2017

Inspected by: Mary Lee, Roger Walton, Hoa Voscott, Katy Grant

Period Covered: From prior annual inspection (8/10/2016) to above date

	BLANKET LUCs				OTHER LUC AREAS	SITES WITH ADDITIONAL LUCs FOR SOIL COVERS							
					Area w/Restricted Commercial Use	C	D	E	G	H	I	129-15	Outdoor Firing Range
Property owner:	BRAC	N.G.	Reserve	R.C.	N.G.	BRAC	N.G.	N.G.	N.G.	N.G.	R.C.	N.G.	N.G.
Soil LUCs													
Are there any land uses that result in a non-compliant exposure versus the exposure assumptions described in the LUCRD?	No	No	No	No	No	(Soil LUCs are covered under the Blanket LUCs)							
Soil Cover LUCs													
Has there been any excavation activity or any other man-made soil disturbance at the site?	N/A	N/A	N/A	N/A	N/A	No	No	No	No	No	N/A	No	No
Are there any areas of the soil cover that have inadequate vegetative cover?	N/A	N/A	N/A	N/A	N/A	No	No	No	No	No	N/A	No	No
Has there been any damage to run-on/runoff controls (swales, berms, riprap, etc.)?	N/A	N/A	N/A	N/A	N/A	No	No	No	No	No	N/A	No	No
Has there been any damage to or removal of the signs marking the edge of the soil cover?	N/A	N/A	N/A	N/A	N/A	No	No	No	No	No	N/A	No	No
If the soil cover has a permeability requirement, is there any woody vegetation present that exceeds 2-inch diameter?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A
Has there been any damage to or removal of the concrete slab that serves as a protective cover?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No*	N/A	N/A
Groundwater LUCs													
Have any wells been installed that withdraw water from a contaminated aquifer, without MDH/MPCA/USEPA approval?	No	No	No	No	(Groundwater LUCs are covered under the Blanket LUCs)								
Has there been any damage to or interference with any groundwater remedy infrastructure (wells, piping, treatment systems, etc.)?	No	No	No	No									

Comments (Attach additional pages as necessary):

BRAC = Base Realignment and Closure Division   N.G. = MN Army National Guard/National Guard Bureau   Reserve = U.S. Army Reserve   R.C. = Ramsey County

*LUC to be removed following formal approval.

Certification:

Based on the annual site inspection, the undersigned hereby certifies that the above-named property owners and above-described land use controls have been complied with for the period noted. Alternatively, any known deficiences and completed or planned actions to address such deficiencies are described in the attached Explanation of Deficiency(ies).

Roger Walton, P.E., U.S. Army Environmental Command

Description of Deficiency(ies) attached? ☐ Yes ☑ No (none were identified)

APPENDIX G

Site K and TGRS Operational Data

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

October 2016

10/5/2016	Rain fell overnight. Minimal ponded water was present around the treatment system. Down time: None.
10/8/2016	Exercised and reset the influent and effluent flow control valves. Decreased the influent Down time: None.
10/9/2016	Increased the influent flow rate slightly. Adjusted the effluent flow rate. Down time: None.
10/13/2016	Closed the effluent flow valve slightly to increase the sump level. Down time: None.
10/23/2016	Exercised and reset the influent and effluent flow control valves. Down time: None.
10/30/2016	Increased the influent flow rate. Down time: None.

November 2016

11/6/2016	Set the clock back one hour. The flow rate reading was estimated. Down time: None.
11/10/2016	Increased the influent flow rate from 9.6 gpm to 10.6 gpm. Down time: None.
11/18/2016	No power to the treatment system. Contacted Xcel Energy. They found a power pole that Down time: 3.5 hours.
11/19/2016	Decreased the influent airflow rate slightly and increased the effluent flow rate. Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

11/21/2016	Increased the influent flow rate slightly. Opened the breaker to the building fresh air intake Down time: None.
11/22/2016	Increased the influent flow rate slightly and increased the effluent flow rate slightly. Down time: None.
11/23/2016	Increased the effluent flow rate. Down time: None.
11/29/2016	Monthly maintenance work performed. Down time: None.

December 2016

12/8/2016	Increased the influent flow rate slightly. Down time: None.
12/11/2016	Increased the influent flow rate slightly. Down time: None.
12/13/2016	Increased the influent flow rate slightly. Exercised the effluent flow control valve and reset Down time: None.
12/17/2016	Exercised the influent flow control valve and increased the influent flow rate slightly. Down time: None.
12/20/2016	The pump was unable to maintain the required flow rate. Troubleshooting indicated Down time: 6 hours.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

12/25/2016	The inspection was not performed due to the Christmas Day holiday. Meter readings were Down time: None.
12/29/2016	Increased the influent flow rate slightly. Exercised the effluent flow control valve and reset Down time: None.
12/31/2016	Increased the influent flow rate slightly. Down time: None.
January 2017	
1/3/2017	Exercised and reset the influent flow control valve. Exercised and reset the effluent flow. Down time: None.
1/4/2017	Increased the influent flow rate and adjusted the effluent flow rate. Down time: None.
1/5/2017	Increased the influent flow rate and adjusted the effluent flow rate. Down time: None.
1/11/2017	Increased the influent flow rate and exercised and reset the effluent flow control valve. Down time: None.
1/20/2017	Increased the influent flow rate slightly. Down time: None.
1/22/2017	The influent flow rate dropped since the last reading. Exercised the influent flow control valve and increased the influent flow rate. Normal operation observed. Down time: 5 hours.
1/23/2017	Increased the influent flow rate slightly. Down time: None.
1/24/2017	Increased the influent flow rate slightly. Down time: None.
1/27/2017	Performed the monthly maintenance. Increased the influent flow rate. Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

1/28-31/2017 The system cycled due to low groundwater recharge.
Down time: None.

February 2017

2/1- 23/2017 The system cycled normally during this period due to insufficient groundwater recharge.
Down time: None.

2/2/2017 Exercised the effluent flow control valve and reset the effluent flow rate.
Down time: None.

2/5/2017 The system was off upon arrival and the high/high water alarm was on. While adjusting the effluent flow valve the previous day, inadvertently closed the valve too much which caused the effluent water to increase in the tower which triggered the high water alarm which turned the system off. Restarted the system and reset the effluent flow valve. Normal operation was observed.

Down time: 25 hours.

2/6/2017 Increased the influent flow rate slightly.
Down time: None.

2/7/2017 Exercised the influent flow control valve and reset the influent flow rate.
Down time: None.

2/9/2017 Increased the effluent flow rate slightly.
Down time: None.

2/12/2017 Exercised the effluent flow control valve and increased the effluent flow rate.
Down time: None.

2/21/2017 Exercised the effluent flow control valve and increased the effluent flow rate.
Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

2/25/2017	Increased the influent flow rate slightly. Down time: None.
2/28/2017	Exercised the effluent valve and reset the effluent flow rate. Down time: None.

March 2017

3/1/2017	Exercised and reset the influent flow control valve. Down time: None.
3/2/2017	Collected quarterly treatment system samples. Also, lowered the influent flow rate to 7.5 gpm so the system would not cycle overnight. Down time: None.
3/3/2017	Collected a metals sample from the effluent port to be held for possible future analysis. Increased the influent flow rate to 11.1 gpm. Down time: None.
3/11/2017	Exercised the influent flow control valve and reset the influent flow rate. Exercised and reset the effluent flow control valve as well. Down time: None.
3/12/2017	The system was off upon arrival and the High/High Water Level light was lit on the control panel. Inadvertently closed the effluent flow control valve too much yesterday. Reset the system and the influent and effluent flow rates and observed normal operation. Down time: 22 hours.
3/14/2017	Closed the effluent flow valve slightly to increase the sump level. Turned the building heater temperature down. Down time: None.
3/19/2017	Increased the influent flow rate slightly. Down time: None.
3/22/2017	Increased the influent flow rate slightly. Installed new polyethylene tubing from the duct work to the airflow meter. Collected samples of the Turboid packing from the lower port window. Down time: 3.5 hours.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

3/26/2017	The system cycled overnight. Lowered the influent flow rate from 11.9 gpm to 10.9 gpm. Exercised and adjusted the effluent flow control valve. Down time: None.
3/28/2017	Increased the influent flow rate slightly. Down time: None.
3/30/2017	Increased the influent flow rate slightly. Down time: None.
April 2017	
4/1/2017	Increased the influent flow rate from 10.2 gpm to 11.0 gpm. Down time: None.
4/2/2017	Increased the influent flow rate from 8.2 gpm to 11.0 gpm. Returned to the treatment system approximately 1 hour after the inspection and the flow rate was 10.7 gpm. Down time:None.
4/3/2017	The sump level was at 10 inches. Increased the effluent flow rate to bring the sump level to 6 inches. Down time:None.
4/4/2017	Turned the system off and removed the packing from the tower. Inspected the condition of the packing. Cleaned the tower, sight glasses, sump and returned the good packing to the tower. Down time: 5 hours.
4/6/2017	The upper window port was leaking. Turned the system off and recaulked the upper port window. Down time: None.
4/7/2017	During the daily inspection, the system was off due to normal system cycling. Returned to the treatment system approximately 1 hour after the inspection and the system was operating normally. Down time: None.
4/8/2017	Water was leaking out of the lower window port. Turned the system off and recaulked the lower port window. Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

4/10/2017	Increased the influent flow rate and the airflow rate. Down time: None.
4/12/2017	Turned the system off and cleaned out the sump and installed the lower grate. Down time: 2 hours.
4/13/2017	Turned the system off. Removed the top port window and installed the less degraded pieces of the old packing. Down time: None.
4/14/2017	Decreased the effluent flow rate slightly. Down time: None.
4/16/2017	Easter Holiday. No inspection conducted. Meter readings were estimated. Down time: None.
4/21/2017	Exercised and reset the effluent flow rate control valve. Down time: None.
4/23/2017	Exercised and reset the influent flow rate control valve. Down time: None.
4/26/2017	Exercised and reset the influent flow rate control valve. Down time: None.
4/28/2017	Exercised and reset the influent flow rate control valve. Down time: None.
4/29/2017	Exercised and reset the influent flow rate control valve. Down time: None.
4/29/2017	Exercised and reset the influent flow rate control valve. Down time: None.
4/30/2017	Increased the effluent flow rate slightly. Down time: None.
May 2017	
5/2/2017	Exercised the influent flow control valve and increased the influent flow rate. Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

5/10/2017	Exercised the influent and effluent flow control valves and increased the influent flow rate. Down time: None.
5/11/2017	Increased the influent flow rate. Down time: None.
5/13/2017	Exercised the influent flow control valve and increased the influent flow rate. Down time: None.
5/14/2017	Increased the influent flow rate. Down time: None.
5/18/2017	Exercised the influent flow control valve and increased the influent flow rate. Exercised and decreased the effluent flow rate. Substantial rainfall lately. Some ponding present around treatment building. Down time: None.
5/21/2017	Exercised the influent and effluent flow control valves and increased the influent flow rate. Down time: None.
5/29/2017	Memorial Day. No inspection-meter readings estimated. Down time: None.
5/31/2017	Exercised the influent and effluent flow control valves and increased the influent flow rate. Down time: None.

June 2017

6/6/2017	Cleaned the air intake screen. Down time: None.
6/10/2017	Increased the influent flow rate. Down time: None.
6/15/2017	Exercised the influent flow control valve and increased the influent flow rate. Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

6/17-19/2017	Each day the system was off upon arrival and the "Pump Seal Fail" light was illuminated on the control panel. Reset the PLC and re-started the system each day. The system re-started normally each day. On 6/19/2017, unlanded the pump seal wires from the terminals and re-started the system. The pump re-started normally. Down time: 53 hours.
6/20/2017	Decreased the influent flow rate slightly. Down time: None.
6/24/2017	The influent flow rate decreased from 11.0 gpm to 8.6 gpm between daily readings possibly due to mineral build-up on the influent flow control valve. Exercised the influent flow control valve and reset the influent flow rate. Down time: 3 hours.
6/26/2017	Increased the influent flow rate and decreased the effluent flow rate. Down time: None.
6/27/2017	Increased the influent flow rate slightly and decreased the effluent flow rate. Down time: None.

July 2017

7/3/2017	Exercised the influent and effluent flow control valves and increased their flow rates. Down time: None.
7/4/2017	Independence Day - No inspection performed. Meter readings were estimated. Down time: None.
7/9/2017	Increased the influent flow rate. Down time: None.
7/12-16/2017	Exercised the influent flow control valve and increased the influent flow rate each day during the inspection. Down time: None.
7/18-19/2017	The system was off during the inspection due to normal system cycling from low groundwater flow into the trench and manhole. Down time: None.
7/21-23/2017	Exercised the influent and effluent valves and increased the influent flow rate each day. Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

7/24/2017	Decreased the influent flow rate. Down time: None.
7/26/2017	Performed treatment system maintenance. Down time: None.
7/27/2017	Increased the influent flow rate. Down time: None.
7/28/2017	Decreased the influent flow rate. Down time: None.
7/31/2017	Increased the influent flow rate. Down time: None.

August 2017

8/1/2017	Decreased the influent flow rate and decreased the effluent flow rate. Down time: None.
8/3/2017	The system was off during the inspection due to normal system cycling. Down time: None.
8/4/2017	The system was off during the inspection due to normal system cycling. Down time: None.
8/5/2017	The system was off during the inspection due to normal system cycling. Down time: None.
8/7/2017	Increased the influent flow rate. Down time: None.
8/8/2017	The air stripper high/high water level light was on. Reset the system and restarted the pump. Reset the influent and effluent flow rates. Observed normal operation. Down time: 3.5 hours.
8/11/2017	Increased the influent flow rate. Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

8/16/2017 The system was off during the inspection due to normal system cycling.
Down time: None.

8/19/2017 Increased the influent flow rate and decreased the effluent flow rate.
Down time: None.

8/22/2017 Increased the influent flow rate.
Down time: None.

8/23/2017 Decreased the influent flow rate and increased the effluent flow rate.
Down time: None.

8/27/2017 The air stripper high/high water level light was on. Reset the system and restarted the pump. Reset the influent and effluent flow rates. Observed normal operation.
Down time: 24.5 hours.

8/29/2017 Performed the monthly maintenance.
Down time: None.

September 2017

9/2/2017 Increased the influent flow rate and decreased the effluent flow rate.
Down time: None.

9/3/2017 Increased the influent flow rate.
Down time: None.

9/5/2017 Increased the influent flow rate.
Down time: None.

9/10/2017 Increased the influent flow rate and decreased the effluent flow rate.
Down time: None.

9/11/2017 Increased the influent flow rate.
Down time: None.

9/13/2017 The air stripper high/high water level alarm light was lit and the system was off. Reset the
Down time: 4.5 hours.

9/14/2017 Increased the influent and effluent flow control rates.
Down time: None.

Appendix G-1

Inspection and Maintenance Activities
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

9/16/2017 The system was off upon arrival and the flow meter low water flow rate light was on.
Down time: 5.5 hours.

9/19/2017 Increased the influent flow rate and decreased the effluent flow rate.
Down time: None.

9/28/2017 Increased the influent flow rate.
Down time: None.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

October 2016

9/30-10/1/2016 Treatment System; Call from Time Communication "TGRS Fail". ECV 4 failed to open on command. The well field cycled. Exercised the opening and closing speed control valves and flushed the control piping. The opening speed control valve is bad. Replaced with new from inventory. Reset the control valves and cycled the valve and normal operation was observed. Reset the PLC and the auto dialer.

Down time: 3.5 hours at B3, 5 hours at B8, 10.5 hours at B13 and B9.

10/4/2016 Treatment System; Turned the TGRS off to install pressure gauges on the 6-inch diameter HDPE discharge lines into the sand and gravel pit with the Army Corps of Engineers. Following installation, turned the TGRS back on. Normal operation was observed.

Down time: 1 hour at B13, 1.5 hours at B6 and 2 hours at SC5.

10/5/2016 Pumphouse SC5; There was a storm last night and the light was flashing on the PLC. Reset the PLC and the light relit normally. At the pumphouse, the pump was running normally.

Down time: 17.5 hours.

10/6/2016 Treatment System; Installed new piping and valves to the pressure gauge on Tower 3.

Down time: None.

10/6/2016 Treatment System; Inspected the condition of the water distribution systems of Towers 3 and 4. There is a buildup of particles and sediment in both systems. Tower 3 is more restricted than Tower 4.

Down time: 4 hours.

10/10-11/2016 Treatment System; Decreased the flow rates at B3, B4, B5 and B8 and closed the Tower 3 gate valve. Removed and cleaned the heads and 4-inch laterals of Tower 3. Flushed the 8-inch piping and reinstalled the 4-inch laterals and heads. Opened the Tower 3 gate valve and observed normal operation.

Down time: None.

10/11-12/2016 Treatment System; Closed the Tower 4 gate valve. Removed and cleaned the heads and 4-inch laterals of Tower 4. Flushed the 8-inch piping and reinstalled the 4-inch laterals and heads. Opened the Tower 4 gate valve and observed normal operation.

Down time: None.

10/12/2016 The ARV between pumphouses B2 and B3 was leaking. Closed the ball valve to the ARV. The ARV will be removed and repaired or replaced at a later date.

Down time: None.

10/14/2016 Pumphouse SC2; Changed out the cold water flow meter with one from inventory. Removed the existing one at 52031600 at 10:40 am. Installed the new meter at 92609000 at 11:40.

Down time: None.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

November 2016

11/18/2016	Treatment system and well field; Winter storm and no power to the Site. Xcel Energy found the top of a power pole burned. They repaired the components. Restarted the treatment system and well field. Everything restarted normally except SC1, SC2 and SC5 did not turn on. Re-contacted Xcel Energy but they were not able to respond due to the storm. They would inform us when they were able to respond. Down time: 5.5 hours at B1, B6 and B13; 2 hours at B4.
11/18-20/2016	Pumphouse SC1, SC2 and SC5; Power remained out to the pumphouses until Xcel Energy could respond. They installed a new fuse and the fuse blew. They searched for the source of the problem but did not find any problems. They installed another fuse and the fuse did not blow. Restarted the pumphouses and observed normal operation. Down time: 44.5 hours at SC1; 43 hours at SC2; and 48.5 hours at SC5.
11/24/2016	Thanksgiving Day - The inspection was not performed. Meter readings were estimated. Down time: None.
11/25/2016	Pumphouses SC2 and SC5; The lights were flashing on the well field panel. Reset the PLC and the lights relit normally. At the pumphouses, the pumps were operating normally. Down time: 15 hours at SC5.
11/29/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was operating normally. Down time: 5 hours.

December 2016

12/6/2016	Pumphouse B8; The heater was not operating. The heating element was broken. Contacted Preferred Electric and they provided and installed a new heater. Down time: None.
12/8/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally. Down time: 6.5 hours.
12/9/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally. Down time: 20 hours.
12/10/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally. Down time: 15 hours.
12/11/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was running normally. Down time: 24.5 hours.
12/11/2016	Approximately 6" of snow fell overnight. DK Concrete was on site to plow snow. Down time: None.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

12/12-15/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came on normally but was flickering rapidly. At the pumphouse, occassionally the starter would turn on then off rapidly. Eventually, the pump turned off. Turned the pump on in "HAND". Troubleshooting indicated a blown resistor in the data line protector located in the control panel in Building 116. Replaced the data line protector, turned the pump on in Auto and the pump restarted normally. Down time: 64 hours.
12/16/2016	Pumphouse B8; The main breaker was tripped which cut electricity to the pump and heater. It was very cold inside the pumphouse. Reset the breaker and turned the pump on. The pump restarted normally. Installed a milk house heater and redirected the RPZ leak into the drain piping. Also thawed the RPZ drain pipe that drains to the outside. Down time: 16.5 hours.
12/20/2016	Pumphouse B8; Jayhawk Mechanical on site to rebuild the RPZ. Following the rebuild, the pump was turned on and normal operation was observed. Down time: None.
12/25/2016	The inspection was not performed due to the Christmas Day holiday. Meter readings were estimated. Down time: None.
January 2017	
1/5/2017	Pumphouse B6; Removed the 3" ECV and installed a new 3" ECV from inventory. Restarted the pump and observed normal operation. Down time: 5.5 hours.
1/12/2017	Treatment System; Installed a new cell phone for the autodialer. Activated the cell phone and observed normal operation. Down time: None.
1/12/2017	Pumphouse B9; Removed the ECV from the forcemain piping and rotated it 180 degrees. Rebuilt portions of the ECV control piping as necessary. Actuated the ECV and the ECV performed normally. Down time: 3 hours.
1/12/2017	Treatment System; Installed a new effluent water line to the slop sink and installed a new slop sink faucet. Down time: None.
1/19/2017	Pumphouse B5; Increased the ECV pressure to slow the flow rate slightly. Down time: None.
1/19/2017	Pumphouse B8; Increased the ECV pressure to slow the flow rate slightly. Down time: None.
1/22-31/2017	Pumphouse B13; The flow meter was not totaling correctly. Installed a new meter from inventory and recorded the flow rate. Meter readings estimated. Down time: None.
1/27/2017	Treatment System; Installed a new battery backup for the new autodialer cell phone. Down time: None.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

February 2017

2/2/2017	Pumphouse B5; Turned the pump off and removed the pilot on the ECV control piping. Disassembled the pilot, cleaned the parts, installed a new rebuild kit and reinstalled the pilot. Also, the downstream check valve was not working. Replaced the check valve and reinstalled it on horizontal piping. Restarted the pump and set the operating pressure and flow rate. Normal operation was observed. Down time: None.
2/2/2017	Pumphouse B8; Turned the pump off and removed the pilot on the ECV control piping. Cleaned the parts and installed a new rebuild kit. Reinstalled the pilot and removed and reinstalled the downstream check valve. Restarted the pump and set the operating pressure and flow rate. Normal operation was observed. Down time: None.
2/2/2017	Treatment System; ECV 4 would not close on command. Turned off B5 and B8 to minimize well field cycling with only Pump 3 running. Turned off Pump 4 and removed and replaced the operating solenoid. Turned Pump 4 back on and observed normal operation. Down time: None.
2/2/2017	AHATS removed the gate and installed fence fabric and barbed wire in its place. The gate was located east of the northeast corner of former Building 502. Down time: None.
2/11/2017	Pumphouse B9; The light was flashing on the PLC in Building 116. Reset the PLC and the light came back on. At the pumphouse, the pump was operating normally. However, the pump turned off and then back on rapidly while in the pumphouse. Down time: 15 hours.
2/1-15/2017	Pumphouse B13; The meter was totaling incorrectly. Removed and reinstalled a new meter and observed normal operation. Meter readings were estimated. Down time: None.
2/13-17/2017	Pumphouse B9; The pump was off on arrival. Turned the pump on and there was a whooshing sound coming from the well. Thein Well removed the lift system. The pump had spun off the drop pipe and was hanging from the electrical wire and electric tape. Installed a new pump and motor and re-started the pump. Normal operation observed. Down time: 51 hours.
2/15/2017	Pumphouse B1; The meter stopped totaling. Installed a new meter and observed normal operation. Down time: None.
2/20/2017	Treatment System; Water was leaking from the Pump 4 gland shaft. Turned the pumps in B8 and B9 off so the well field would not cycle. Removed and replaced the gland packing in the Pump 4 gland shaft. Restarted Pump 4 and observed normal operation. Down time: None.
2/21/2017	Pumphouse B3; Closed the ECV to slow the flow rate. Down time: None.
2/21/2017	Pumphouse B8; Closed the ECV to slow the flow rate. Down time: None.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

2/23/2017 Pumphouse B1; There are deep erosion ruts at the beginning of the roadway to pumphouse B1 making travel difficult. A portion of the erosion is being deposited in front of the pumphouse door.

Down time: None.

2/27/2017 Pumphouse B8; The flushing valve on the control piping was leaking. Replaced the valve with a new one from inventory.

Down time: None.

March 2017

3/3/2017 Pumphouse SC2; The flow meter was not totaling; Removed, cleaned and reinstalled the flow meter. Normal operation observed. Meter reading for 3/3/2017 was estimated.

Down time: None.

3/3/2017 Pumphouse B9; Opened the ECV all the way to increase the flow rate to maximum.

Down time: None.

3/8/2017 Pumphouse B8; Removed portions of the ECV control piping and removed sand from the piping. Reset the pilot to increase the flow rate and observed normal operation.

Down time: None.

3/9/2017 Pumphouse SC5; The flow meter was not totaling correctly. Removed, cleaned and reinstalled the flow meter and observed normal operation.

Down time: None.

3/10/2017 Pumphouse B8; Opened the ECV all the way to increase the flow rate to maximum.

Down time: None.

3/15/2017 Pumphouse B3; Opened the pilot slightly to increase the flow rate.

Down time: None.

April 2017

4/16/2017 Easter holiday. No inspection performed. Meter readings were estimated.

Down time: None.

4/23-24/2017 Pumphouses SC1, SC2 and SC5; The lights were not lit on the well field panel. At the pumphouses, the lights were dim and the pumps were off. Turned the pumps to off, closed the gate valves and opened the 480 volt breakers. Contacted Xcel Energy and directed them to where a fuse was open on a power pole near the old substation. They installed a new fuse and left the Site. Closed the breakers and turned the pumps to Auto. The pumps turned on normally and normal operation was observed.

Down time: 17 hours at SC1 and SC2. 21 hours at SC5.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

4/23-24/2017	Pumphouse B1; Water was leaking out the RPZ emergency discharge. Exercised valves and cycled the pump off and back on but was unable to stop the leak. Turned the pump off and contacted Jayhawk Mechanical. They repaired the problem. Closed the breaker and turned the pump back on. Observed normal operation. Down time: 17 hours.
4/23-24/2017	Pumphouse B8; Water was leaking out the RPZ. Exercised valves and cycled the pump off and back on. The leak lessened. Contacted Jayhawk Mechanical. Sand was found in the working mechanism of the valve. They repaired the problem. Closed the breaker and turned the pump back on for normal service. Observed normal operation. Down time: None.
4/24-27/2017	Pumphouse SC5; Turned the pump off, pulled the lift system and redeveloped the well with chemicals. Following the redevelopment work, turned the well on for normal service. Down time: 66 hours.
4/27-30/2017	Pumphouse B6; Turned the pump off, pulled the lift system and redeveloped the well with chemicals. Redevelopment work continued into May. May down time will be reported in the month of May. Down time: 77.5 hours.

May 2017

5/1-3/2017	Pumphouse B6; The pump was turned off to redevelop the well with acid. Down time: 74 hours.
5/1-3/2017	Preferred Electric was on site performing the annual electrical inspection. Down time: None.
5/2/2017	Pumphouse B9; There was a lot of chatter coming from the starter in the control panel. Unlanded the communication wires in the B10 control cabinet and the chatter stopped. The B9 light no longer illuminates on the well field panel in Building 116 but the pump in B9 works normally in "Auto". Down time: None.
5/6/2017	Pumphouse B6; The pump was off and the ECV was fully closed. Removed and replaced the strainer screen, flushed the control piping and reset the pilot pressure. Restarted the pump and observed normal operation. Down time: 17 hours.
5/28/2017	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse the pump was operating normally. Down time: 1.5 hours.
5/29/2017	Memorial Day Holiday; The inspection was not performed and the meter readings were estimated. Down time: None.

June 2017

6/4-9/2017	Pumphouse SC5; The light was not lit on the well field panel. At the pumphouse, there was no power and the overhead electrical line to the pumphouse was not present. During a training run on the evening of 6/4/2017, one of the National Guard vehicles accidentally hit the power line and brought it down to the ground. The National Guard hired Premier Electric to install a new electrical cable and Xcel Energy energized the new line. Switched the pump to Auto and the pump ran normally. Down time: 129.5 hours.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

6/14/2017	Pumphouse B3; The light was off on the well field panel. At the pumphouse, the pump was off and the the I/O adapter card was flashing rapidly between red and green. Cycled power to the control panel and reset the starter and turned the pump on. The pump restarted normally. Down time: 4 hours.
6/14/2017	Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing. Down time: None.
6/16-19/2017	Pumphouse SC2; The meter stopped totaling. Installed a new meter and observed normal operation. Meter readings were estimated. Down time: None.
6/16/2017	Pumphouse B8; Increased the pressure on the ECV to slow the flow rate slightly. Down time: None.
6/16/2017	Pumphouse B6; Increased the pressure on the ECV to slow the flow rate slightly. Down time: None.
6/20/2017	Treatment System and Well Field; Call from Time Communications - TGRS Fail. Upon arriving at the site, the TGRS was operating normally and no faults were present on the PDU. An accident on Highway 10 caused an electrical/data cable failure which may have been the reason for the failure. Down time: None.
6/21-23/2017	Pumphouse SC1; The meter stopped totaling. Removed the flow meter and cleaned it with acid. Re-installed the flow meter, turned the pump on and the meter totaled normally. Meter readings were estimated. Down time: None. Meter readings were estimated.
6/25/2017	Pumphouse B9; The light was flashing on the well field panel on arrival. Reset the PLC and the light turned on normally. At the pumphouse, the pump was running normally. Down time: 22 hours.
6/30/2017	Pumphouse SC5; The light was off on the well field panel. At the pumphouse, troubleshooting indicated the I/O adapter was blown. Swapped out the I/O adapter with one from inventory and reset the breaker in the control cabinet. Turned the pump to on and observed normal operation. Down time: 3 hours.
July 2017	
7/1-3/2017	Pumphouse SC2; The flow meter was not totaling. Removed and cleaned the flow meter and reinstalled it. Turned the pump on and observed normal operation. Meter readings were estimated. Down time: None.
7/3/2017	Pumphouse B1; The RPZ was leaking. Vented the line and exercised the RPZ valves. Restarted the pump and observed normal operation. Down time: None.
7/6/2017	Building 116; Vandals broke into the lower bathroom window and entered the building. They opened some control panels from the old water treatment plant controls. Nothing else was vandalized or stolen.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

	Down time: None.
7/11-13/2017	Pumphouse B8; Turned the pump off and removed the lift system from the well so Arcadis could do a geophysical study on the bedrock formation. They installed a new pump and motor when they reinstalled the lift system. Restarted the pump and observed normal operation. Down time: 65 hours.
7/12-15/2017	Pumphouse B9; Turned the pump off and removed the lift system from the well so Arcadis could perform a geophysical study on the bedrock formation. Following the study, they reinstalled the lift system. Restarted the pump and observed normal operation. Down time: 68.5 hours.
7/13/2017	Pumphouses SC1, SC2 and SC5, The lights were not lit on the well field panel. At the pumphouses, the pumps were off and the lights were dim. Located a blown fuse on a power pole near the old Lind Road electrical substation. Contacted Xcel Energy and they replaced the fuse. Turned the pumps on and observed normal operation. Down time: 9.5 hours at SC1, 14 hours at SC2 and 11.5 hours at SC5.
7/19/2017	Pumphouse B1; The RPZ valve was leaking. Turned the pump off and exercised the valves and bled off the pressure. Restarted the pump and observed normal operation. Down time: 1 hour.
7/28/2017	Pumphouse SC2; The flow meter was not totaling. Turned the pump off and cleaned the flow meter. Reinstalled the flow meter and turned the pump on. Observed normal operation. Down time: 1 hour.
7/28/2017	Pumphouse SC5; Installed a new fan motor and fan blade in the vent fan housing. Turned the vent fan on and observed normal operation. Down time: None.
7/29/2017	The daily inspection was not performed. Meter readings were estimated. Down time: None.
7/31/2017	Pumphouse SC1; Vandals removed portions of the siding on the north side of the building. No entry was made into the building and no other damage was noticed. Repaired the damaged areas with new siding. Down time: None.
August 2017	
8/4/2017	Pumphouses B3, B6 and B8; Decreased the pressures on the ECV to increase the flow rates to maximum. Down time: None.
8/7-11/2017	Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8. Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.
8/11/2017	Pumphouses SC1, SC2 and SC5; Turned the pumphouses off overnight. Only wanted to pump water from the boundary wells through the cleaned forcemain and through the bag filter system prior to reaching the water distribution system at the top of the towers. Down time: 17 hours at SC1, SC2 and SC5.

Appendix G-2

Maintenance Activities
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

8/11/2017 Pumphouse B9; Turned the pump off to remove formation sand from the ECV.

Down time: 1.5 hours.

8/14/2017 Pumphouse B5; The RPZ is leaking. Turned the pump off and Jayhawk Mechanical repaired it. Turned the pump on and observed normal operation.

Down time: 17.5 hours.

8/16/2017 Pumphouses B4, B5, B9, SC1 and SC5; Turned the pumps off to removed the bag filter system from the influent line and to reinstall the influent forcemain line to normal operation. Turned the pumps back on and observed normal operation.

Down time: 1 hour at SC5; 3 hours at B4; 4 hours at B5; 4.5 hours at B9 and SC1.

8/19/2017 TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally.

Down time: 2 hours at B9 and 1 hour at SC1.

September 2017

9/12/2017 Treatment System; ECV 4 was flashing on the pump director unit. The solenoid valve would not open. Removed the solenoid valve and disassembled the valve. Cleaned the valve with acid, reassembled and reinstalled the valve. Cycled ECV 4, and observed normal operation.

Down time: 8.5 hours at B8, 10.5 hours at B3, 14 hours at B13 and 15 hours at B9.

9/19/2017 Treatment System; There was no cell phone service to the autodialer cell phone. Contacted AT&T and resolved the issue. Phoned the autodialer and the autodialer worked normally.

Down time: None.

Appendix G-3

Maintenance Activities By Location
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Pumphouse B1

11/18/2016	Treatment system and well field; Winter storm and no power to the Site. Xcel Energy found the top of a power pole burned. They repaired the components. Restarted the treatment system and well field. Everything restarted normally except SC1, SC2 and SC5 did not turn on. Re-contacted Xcel Energy but they were not able to respond due to the storm. They would inform us when they were able to respond. Down time: 5.5 hours at B1, B6 and B13; 2 hours at B4.
2/15/2017	Pumphouse B1; The meter stopped totaling. Installed a new meter and observed normal operation. Down time: None.
2/23/2017	Pumphouse B1; There are deep erosion ruts at the beginning of the roadway to pumphouse B1 making travel difficult. A portion of the erosion is being deposited in front of the pumphouse door. Down time: None.
4/23-24/2017	Pumphouse B1; Water was leaking out the RPZ emergency discharge. Exercised valves and cycled the pump off and back on but was unable to stop the leak. Turned the pump off and contacted Jayhawk Mechanical. They repaired the problem. Closed the breaker and turned the pump back on. Observed normal operation. Down time: 17 hours.
6/14/2017	Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing. Down time: None.
7/3/2017	Pumphouse B1; The RPZ was leaking. Vented the line and exercised the RPZ valves. Restarted the pump and observed normal operation. Down time: None.
7/19/2017	Pumphouse B1; The RPZ valve was leaking. Turned the pump off and exercised the valves and bled off the pressure. Restarted the pump and observed normal operation. Down time: 1 hour.
8/7-11/2017	Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8. Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.
8/19/2017	TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally. Down time: 2 hours at B9 and 1 hour at SC1.

Appendix G-3

Maintenance Activities By Location
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Pumphouse B3

9/30-10/1/2016	Treatment System; Call from Time Communication "TGRS Fail". ECV 4 failed to open on command. The well field cycled. Exercised the opening and closing speed control valves and flushed the control piping. The opening speed control valve is bad. Replaced with new from inventory. Reset the control valves and cycled the valve and normal operation was observed. Reset the PLC and the auto dialer. Down time: 3.5 hours at B3, 5 hours at B8, 10.5 hours at B13 and B9.
2/21/2017	Pumphouse B3; Closed the ECV to slow the flow rate. Down time: None.
3/15/2017	Pumphouse B3; Opened the pilot slightly to increase the flow rate. Down time: None.
6/14/2017	Pumphouse B3; The light was off on the well field panel. At the pumphouse, the pump was off and the the I/O adapter card was flashing rapidly between red and green. Cycled power to the control panel and reset the starter and turned the pump on. The pump restarted normally. Down time: 4 hours.
6/14/2017	Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing. Down time: None.
8/4/2017	Pumphouses B3, B6 and B8; Decreased the pressures on the ECV to increase the flow rates to maximum. Down time: None.
8/7-11/2017	Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8. Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.
8/19/2017	TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally. Down time: 2 hours at B9 and 1 hour at SC1.
9/12/2017	Treatment System; ECV 4 was flashing on the pump director unit. The solenoid valve would not open. Removed the solenoid valve and disassembled the valve. Cleaned the valve with acid, reassembled and reinstalled the valve. Cycled ECV 4, and observed normal operation. Down time: 8.5 hours at B8, 10.5 hours at B3, 14 hours at B13 and 15 hours at B9.

Appendix G-3

Maintenance Activities By Location
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Pumphouse B4

11/18/2016	Treatment system and well field; Winter storm and no power to the Site. Xcel Energy found the top of a power pole burned. They repaired the components. Restarted the treatment system and well field. Everything restarted normally except SC1, SC2 and SC5 did not turn on. Re-contacted Xcel Energy but they were not able to respond due to the storm. They would inform us when they were able to respond. Down time: 5.5 hours at B1, B6 and B13; 2 hours at B4.
6/14/2017	Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing. Down time: None.
8/7-11/2017	Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8. Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.
8/16/2017	Pumphouses B4, B5, B9, SC1 and SC5; Turned the pumps off to removed the bag filter system from the influent line and to reinstall the influent forcemain line to normal operation. Turned the pumps back on and observed normal operation. Down time: 1 hour at SC5; 3 hours at B4; 4 hours at B5; 4.5 hours at B9 and SC1.
8/19/2017	TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally. Down time: 2 hours at B9 and 1 hour at SC1.

Pumphouse B5

1/19/2017	Pumphouse B5; Increased the ECV pressure to slow the flow rate slightly. Down time: None.
2/2/2017	Pumphouse B5; Turned the pump off and removed the pilot on the ECV control piping. Disassembled the pilot, cleaned the parts, installed a new rebuild kit and reinstalled the pilot. Also, the downstream check valve was not working. Replaced the check valve and reinstalled it on horizontal piping. Restarted the pump and set the operating pressure and flow rate. Normal operation was observed. Down time: None.
6/14/2017	Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing. Down time: None.
8/7-11/2017	Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8. Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.

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Maintenance Activities By Location
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TGRS, OU2
Arden Hills, Minnesota

8/14/2017 Pumphouse B5; The RPZ is leaking. Turned the pump off and Jayhawk Mechanical repaired it. Turned the pump on and observed normal operation.

Down time: 17.5 hours.

8/16/2017 Pumphouses B4, B5, B9, SC1 and SC5; Turned the pumps off to removed the bag filter system from the influent line and to reinstall the influent forcemain line to normal operation. Turned the pumps back on and observed normal operation.

Down time: 1 hour at SC5; 3 hours at B4; 4 hours at B5; 4.5 hours at B9 and SC1.

8/19/2017 TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally.
Down time: 2 hours at B9 and 1 hour at SC1.

Pumphouse B6

10/4/2016 Treatment System; Turned the TGRS off to install pressure gauges on the 6-inch diameter HDPE discharge lines into the sand and gravel pit with the Army Corps of Engineers. Following installation, turned the TGRS back on. Normal operation was observed.

Down time: 1 hour at B13, 1.5 hours at B6 and 2 hours at SC5.

11/18/2016 Treatment system and well field; Winter storm and no power to the Site. Xcel Energy found the top of a power pole burned. They repaired the components. Restarted the treatment system and well field. Everything restarted normally except SC1, SC2 and SC5 did not turn on. Re-contacted Xcel Energy but they were not able to respond due to the storm. They would inform us when they were able to respond.

Down time: 5.5 hours at B1, B6 and B13; 2 hours at B4.

1/5/2017 Pumphouse B6; Removed the 3" ECV and installed a new 3" ECV from inventory. Restarted the pump and observed normal operation.

Down time: 5.5 hours.

4/27-30/2017 Pumphouse B6; Turned the pump off, pulled the lift system and redeveloped the well with chemicals. Redevelopment work continued into May. May down time will be reported in the month of May.

Down time: 77.5 hours.

5/1-3/2017 Pumphouse B6; The pump was turned off to redevelop the well with acid.
Down time: 74 hours.

5/6/2017 Pumphouse B6; The pump was off and the ECV was fully closed. Removed and replaced the strainer screen, flushed the control piping and reset the pilot pressure. Restarted the pump and observed normal operation.

Down time: 17 hours.

6/14/2017 Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing.

Down time: None.

6/16/2017 Pumphouse B6; Increased the pressure on the ECV to slow the flow rate slightly.
Down time: None.

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8/4/2017 Pumphouses B3, B6 and B8; Decreased the pressures on the ECV to increase the flow rates to maximum.

Down time: None.

8/7-11/2017 Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8.

Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.

8/19/2017 TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally.
Down time: 2 hours at B9 and 1 hour at SC1.

Pumphouse B8

9/30-10/1/2016 Treatment System; Call from Time Communication "TGRS Fail". ECV 4 failed to open on command. The well field cycled. Exercised the opening and closing speed control valves and flushed the control piping. The opening speed control valve is bad. Replaced with new from inventory. Reset the control valves and cycled the valve and normal operation was observed. Reset the PLC and the auto dialer.

Down time: 3.5 hours at B3, 5 hours at B8, 10.5 hours at B13 and B9.

12/6/2016 Pumphouse B8; The heater was not operating. The heating element was broken. Contacted Preferred Electric and they provided and installed a new heater.

Down time: None.

12/16/2016 Pumphouse B8; The main breaker was tripped which cut electricity to the pump and heater. It was very cold inside the pumphouse. Reset the breaker and turned the pump on. The pump restarted normally. Installed a milk house heater and redirected the RPZ leak into the drain piping. Also thawed the RPZ drain pipe that drains to the outside.
Down time: 16.5 hours.

1/19/2017 Pumphouse B8; Increased the ECV pressure to slow the flow rate slightly.

Down time: None.

2/2/2017 Pumphouse B8; Turned the pump off and removed the pilot on the ECV control piping. Cleaned the parts and installed a new rebuild kit. Reinstalled the pilot and removed and reinstalled the downstream check valve. Restarted the pump and set the operating pressure and flow rate. Normal operation was observed.

Down time: None.

2/21/2017 Pumphouse B8; Closed the ECV to slow the flow rate.

Down time: None.

2/27/2017 Pumphouse B8; The flushing valve on the control piping was leaking. Replaced the valve with a new one from inventory.

Down time: None.

3/8/2017 Pumphouse B8; Removed portions of the ECV control piping and removed sand from the piping. Reset the pilot to increase the flow rate and observed normal operation.

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Down time: None.

3/10/2017 Pumphouse B8; Opened the ECV all the way to increase the flow rate to maximum.

Down time: None.

4/23-24/2017 Pumphouse B8; Water was leaking out the RPZ. Exercised valves and cycled the pump off and back on. The leak lessened. Contacted Jayhawk Mechanical. Sand was found in the working mechanism of the valve. They repaired the problem. Closed the breaker and turned the pump back on for normal service. Observed normal operation.

Down time: None.

6/14/2017 Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing.

Down time: None.

6/16/2017 Pumphouse B8; Increased the pressure on the ECV to slow the flow rate slightly.

Down time: None.

7/11-13/2017 Pumphouse B8; Turned the pump off and removed the lift system from the well so Arcadis could do a geophysical study on the bedrock formation. They installed a new pump and motor when they reinstalled the lift system. Restarted the pump and observed normal operation.

Down time: 65 hours.

8/4/2017 Pumphouses B3, B6 and B8; Decreased the pressures on the ECV to increase the flow rates to maximum.

Down time: None.

8/7-11/2017 Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8.

Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.

8/19/2017 TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally.

Down time: 2 hours at B9 and 1 hour at SC1.

9/12/2017 Treatment System; ECV 4 was flashing on the pump director unit. The solenoid valve would not open. Removed the solenoid valve and disassembled the valve. Cleaned the valve with acid, reassembled and reinstalled the valve. Cycled ECV 4, and observed normal operation.

Down time: 8.5 hours at B8, 10.5 hours at B3, 14 hours at B13 and 15 hours at B9.

Pumphouse B9

9/30-10/1/2016 Treatment System; Call from Time Communication "TGRS Fail". ECV 4 failed to open on command. The well field cycled. Exercised the opening and closing speed control valves and flushed the control piping. The opening speed control valve is bad. Replaced with new from inventory. Reset the control valves and cycled the valve and normal operation was observed. Reset the PLC and the auto dialer.

Down time: 3.5 hours at B3, 5 hours at B8, 10.5 hours at B13 and B9.

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1/12/2017	Pumphouse B9; Removed the ECV from the forcemain piping and rotated it 180 degrees. Rebuilt portions of the ECV control piping as necessary. Actuated the ECV and the ECV performed normally. Down time: 3 hours.
2/11/2017	Pumphouse B9; The light was flashing on the PLC in Building 116. Reset the PLC and the light came back on. At the pumphouse, the pump was operating normally. However, the pump turned off and then back on rapidly while in the pumphouse. Down time: 15 hours.
2/13-17/2017	Pumphouse B9; The pump was off on arrival. Turned the pump on and there was a whooshing sound coming from the well. Thein Well removed the lift system. The pump had spun off the drop pipe and was hanging from the electrical wire and electric tape. Installed a new pump and motor and re-started the pump. Normal operation observed. Down time: 51 hours.
3/3/2017	Pumphouse B9; Opened the ECV all the way to increase the flow rate to maximum. Down time: None.
5/2/2017	Pumphouse B9; There was a lot of chatter coming from the starter in the control panel. Unlanded the communication wires in the B10 control cabinet and the chatter stopped. The B9 light no longer illuminates on the well field panel in Building 116 but the pump in B9 works normally in "Auto". Down time: None.
6/14/2017	Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing. Down time: None.
6/25/2017	Pumphouse B9; The light was flashing on the well field panel on arrival. Reset the PLC and the light turned on normally. At the pumphouse, the pump was running normally. Down time: 22 hours.
7/12-15/2017	Pumphouse B9; Turned the pump off and removed the lift system from the well so Arcadis could perform a geophysical study on the bedrock formation. Following the study, they reinstalled the lift system. Restarted the pump and observed normal operation. Down time: 68.5 hours.
8/7-11/2017	Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8. Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.
8/11/2017	Pumphouse B9; Turned the pump off to remove formation sand from the ECV. Down time: 1.5 hours.
8/16/2017	Pumphouses B4, B5, B9, SC1 and SC5; Turned the pumps off to removed the bag filter system from the influent line and to reinstall the influent forcemain line to normal operation. Turned the pumps back on and observed normal operation. Down time: 1 hour at SC5; 3 hours at B4; 4 hours at B5; 4.5 hours at B9 and SC1.

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8/19/2017	TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally. Down time: 2 hours at B9 and 1 hour at SC1.
9/12/2017	Treatment System; ECV 4 was flashing on the pump director unit. The solenoid valve would not open. Removed the solenoid valve and disassembled the valve. Cleaned the valve with acid, reassembled and reinstalled the valve. Cycled ECV 4, and observed normal operation. Down time: 8.5 hours at B8, 10.5 hours at B3, 14 hours at B13 and 15 hours at B9.

Pumphouse B13

9/30-10/1/2016	Treatment System; Call from Time Communication "TGRS Fail". ECV 4 failed to open on command. The well field cycled. Exercised the opening and closing speed control valves and flushed the control piping. The opening speed control valve is bad. Replaced with new from inventory. Reset the control valves and cycled the valve and normal operation was observed. Reset the PLC and the auto dialer. Down time: 3.5 hours at B3, 5 hours at B8, 10.5 hours at B13 and B9.
10/4/2016	Treatment System; Turned the TGRS off to install pressure gauges on the 6-inch diameter HDPE discharge lines into the sand and gravel pit with the Army Corps of Engineers. Following installation, turned the TGRS back on. Normal operation was observed. Down time: 1 hour at B13, 1.5 hours at B6 and 2 hours at SC5.
11/18/2016	Treatment system and well field; Winter storm and no power to the Site. Xcel Energy found the top of a power pole burned. They repaired the components. Restarted the treatment system and well field. Everything restarted normally except SC1, SC2 and SC5 did not turn on. Re-contacted Xcel Energy but they were not able to respond due to the storm. They would inform us when they were able to respond. Down time: 5.5 hours at B1, B6 and B13; 2 hours at B4.
1/22-31/2017	Pumphouse B13; The flow meter was not totaling correctly. Installed a new meter from inventory and recorded the flow rate. Meter readings estimated. Down time: None.
2/1-15/2017	Pumphouse B13; The meter was totaling incorrectly. Removed and reinstalled a new meter and observed normal operation. Meter readings were estimated. Down time: None.
8/7-11/2017	Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8. Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.
8/19/2017	TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally. Down time: 2 hours at B9 and 1 hour at SC1.

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9/12/2017 Treatment System; ECV 4 was flashing on the pump director unit. The solenoid valve would not open. Removed the solenoid valve and disassembled the valve. Cleaned the valve with acid, reassembled and reinstalled the valve. Cycled ECV 4, and observed normal operation.

Down time: 8.5 hours at B8, 10.5 hours at B3, 14 hours at B13 and 15 hours at B9.

Pumphouse SC1

11/18-20/2016 Pumphouse SC1, SC2 and SC5; Power remained out to the pumphouses until Xcel Energy could respond. They installed a new fuse and the fuse blew. They searched for the source of the problem but did not find any problems. They installed another fuse and the fuse did not blow. Restarted the pumphouses and observed normal operation.

Down time: 44.5 hours at SC1; 43 hours at SC2; and 48.5 hours at SC5.

4/23-24/2017 Pumphouses SC1, SC2 and SC5; The lights were not lit on the well field panel. At the pumphouses, the lights were dim and the pumps were off. Turned the pumps to off, closed the gate valves and opened the 480 volt breakers. Contacted Xcel Energy and directed them to where a fuse was open on a power pole near the old substation. They installed a new fuse and left the Site. Closed the breakers and turned the pumps to Auto. The pumps turned on normally and normal operation was observed.

Down time: 17 hours at SC1 and SC2. 21 hours at SC5.

6/14/2017 Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing.

Down time: None.

6/21-23/2017 Pumphouse SC1; The meter stopped totaling. Removed the flow meter and cleaned it with acid. Re-installed the flow meter, turned the pump on and the meter totaled normally. Meter readings were estimated.

Down time: None. Meter readings were estimated.

7/13/2017 Pumphouses SC1, SC2 and SC5, The lights were not lit on the well field panel. At the pumphouses, the pumps were off and the lights were dim. Located a blown fuse on a power pole near the old Lind Road electrical substation. Contacted Xcel Energy and they replaced the fuse. Turned the pumps on and observed normal operation.

Down time: 9.5 hours at SC1, 14 hours at SC2 and 11.5 hours at SC5.

7/31/2017 Pumphouse SC1; Vandals removed portions of the siding on the north side of the building. No entry was made into the building and no other damage was noticed. Repaired the damaged areas with new siding.

Down time: None.

8/11/2017 Pumphouses SC1, SC2 and SC5; Turned the pumphouses off overnight. Only wanted to pump water from the boundary wells through the cleaned forcemain and through the bag filter system prior to reaching the water distribution system at the top of the towers.

Down time: 17 hours at SC1, SC2 and SC5.

8/16/2017 Pumphouses B4, B5, B9, SC1 and SC5; Turned the pumps off to removed the bag filter system from the influent line and to reinstall the influent forcemain line to normal operation. Turned the pumps back on and observed normal operation.

Down time: 1 hour at SC5; 3 hours at B4; 4 hours at B5; 4.5 hours at B9 and SC1.

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8/19/2017	TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally. Down time: 2 hours at B9 and 1 hour at SC1.

Pumphouse SC2

10/14/2016	Pumphouse SC2; Changed out the cold water flow meter with one from inventory. Removed the existing one at 52031600 at 10:40 am. Installed the new meter at 92609000 at 11:40. Down time: None.
11/18-20/2016	Pumphouse SC1, SC2 and SC5; Power remained out to the pumphouses until Xcel Energy could respond. They installed a new fuse and the fuse blew. They searched for the source of the problem but did not find any problems. They installed another fuse and the fuse did not blow. Restarted the pumphouses and observed normal operation. Down time: 44.5 hours at SC1; 43 hours at SC2; and 48.5 hours at SC5.
11/25/2016	Pumphouses SC2 and SC5; The lights were flashing on the well field panel. Reset the PLC and the lights relit normally. At the pumphouses, the pumps were operating normally. Down time: 15 hours at SC5.
3/3/2017	Pumphouse SC2; The flow meter was not totaling; Removed, cleaned and reinstalled the flow meter. Normal operation observed. Meter reading for 3/3/2017 was estimated. Down time: None.
4/23-24/2017	Pumphouses SC1, SC2 and SC5; The lights were not lit on the well field panel. At the pumphouses, the lights were dim and the pumps were off. Turned the pumps to off, closed the gate valves and opened the 480 volt breakers. Contacted Xcel Energy and directed them to where a fuse was open on a power pole near the old substation. They installed a new fuse and left the Site. Closed the breakers and turned the pumps to Auto. The pumps turned on normally and normal operation was observed. Down time: 17 hours at SC1 and SC2. 21 hours at SC5.
6/14/2017	Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing. Down time: None.
6/16-19/2017	Pumphouse SC2; The meter stopped totaling. Installed a new meter and observed normal operation. Meter readings were estimated. Down time: None.
7/1-3/2017	Pumphouse SC2; The flow meter was not totaling. Removed and cleaned the flow meter and reinstalled it. Turned the pump on and observed normal operation. Meter readings were estimated. Down time: None.

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7/13/2017	Pumphouses SC1, SC2 and SC5, The lights were not lit on the well field panel. At the pumphouses, the pumps were off and the lights were dim. Located a blown fuse on a power pole near the old Lind Road electrical substation. Contacted Xcel Energy and they replaced the fuse. Turned the pumps on and observed normal operation. Down time: 9.5 hours at SC1, 14 hours at SC2 and 11.5 hours at SC5.
7/28/2017	Pumphouse SC2; The flow meter was not totaling. Turned the pump off and cleaned the flow meter. Reinstalled the flow meter and turned the pump on. Observed normal operation. Down time: 1 hour.
8/11/2017	Pumphouses SC1, SC2 and SC5; Turned the pumphouses off overnight. Only wanted to pump water from the boundary wells through the cleaned forcemain and through the bag filter system prior to reaching the water distribution system at the top of the towers. Down time: 17 hours at SC1, SC2 and SC5.
8/19/2017	TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally. Down time: 2 hours at B9 and 1 hour at SC1.

Pumphouse SC5

10/4/2016	Treatment System; Turned the TGRS off to install pressure gauges on the 6-inch diameter HDPE discharge lines into the sand and gravel pit with the Army Corps of Engineers. Following installation, turned the TGRS back on. Normal operation was observed. Down time: 1 hour at B13, 1.5 hours at B6 and 2 hours at SC5.
10/5/2016	Pumphouse SC5; There was a storm last night and the light was flashing on the PLC. Reset the PLC and the light relit normally. At the pumphouse, the pump was running normally. Down time: 17.5 hours.
11/18-20/2016	Pumphouse SC1, SC2 and SC5; Power remained out to the pumphouses until Xcel Energy could respond. They installed a new fuse and the fuse blew. They searched for the source of the problem but did not find any problems. They installed another fuse and the fuse did not blow. Restarted the pumphouses and observed normal operation. Down time: 44.5 hours at SC1; 43 hours at SC2; and 48.5 hours at SC5.
11/25/2016	Pumphouses SC2 and SC5; The lights were flashing on the well field panel. Reset the PLC and the lights relit normally. At the pumphouses, the pumps were operating normally. Down time: 15 hours at SC5.
11/29/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was operating normally. Down time: 5 hours.
12/8/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally.

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	Down time: 6.5 hours.
12/9/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally. Down time: 20 hours.
12/10/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally. Down time: 15 hours.
12/11/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was running normally. Down time: 24.5 hours.
12/12-15/2016	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light came on normally but was flickering rapidly. At the pumphouse, occassionally the starter would turn on then off rapidly. Eventually, the pump turned off. Turned the pump on in "HAND". Troubleshooting indicated a blown resistor in the data line protector located in the control panel in Building 116. Replaced the data line protector, turned the pump on in Auto and the pump restarted normally. Down time: 64 hours.
3/9/2017	Pumphouse SC5; The flow meter was not totaling correctly. Removed, cleaned and reinstalled the flow meter and observed normal operation. Down time: None.
4/23-24/2017	Pumphouses SC1, SC2 and SC5; The lights were not lit on the well field panel. At the pumphouses, the lights were dim and the pumps were off. Turned the pumps to off, closed the gate valves and opened the 480 volt breakers. Contacted Xcel Energy and directed them to where a fuse was open on a power pole near the old substation. They installed a new fuse and left the Site. Closed the breakers and turned the pumps to Auto. The pumps turned on normally and normal operation was observed. Down time: 17 hours at SC1 and SC2. 21 hours at SC5.
4/24-27/2017	Pumphouse SC5; Turned the pump off, pulled the lift system and redeveloped the well with chemicals. Following the redevelopment work, turned the well on for normal service. Down time: 66 hours.
5/28/2017	Pumphouse SC5; The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse the pump was operating normally. Down time: 1.5 hours.
6/4-9/2017	Pumphouse SC5; The light was not lit on the well field panel. At the pumphouse, there was no power and the overhead electrical line to the pumphouse was not present. During a training run on the evening of 6/4/2017, one of the National Guard vehicles accidentally hit the power line and brought it down to the ground. The National Guard hired Premier Electric to install a new electrical cable and Xcel Energy energized the new line. Switched the pump to Auto and the pump ran normally. Down time: 129.5 hours.
6/14/2017	Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical on site performing annual RPZ testing. Down time: None.

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TGRS, OU2
Arden Hills, Minnesota

6/30/2017 Pumphouse SC5; The light was off on the well field panel. At the pumphouse, troubleshooting indicated the I/O adapter was blown. Swapped out the I/O adapter with one from inventory and reset the breaker in the control cabinet. Turned the pump to on and observed normal operation.

Down time: 3 hours.

7/13/2017 Pumphouses SC1, SC2 and SC5, The lights were not lit on the well field panel. At the pumphouses, the pumps were off and the lights were dim. Located a blown fuse on a power pole near the old Lind Road electrical substation. Contacted Xcel Energy and they replaced the fuse. Turned the pumps on and observed normal operation.

Down time: 9.5 hours at SC1, 14 hours at SC2 and 11.5 hours at SC5.

7/28/2017 Pumphouse SC5; Installed a new fan motor and fan blade in the vent fan housing. Turned the vent fan on and observed normal operation.

Down time: None.

8/11/2017 Pumphouses SC1, SC2 and SC5; Turned the pumphouses off overnight. Only wanted to pump water from the boundary wells through the cleaned forcemain and through the bag filter system prior to reaching the water distribution system at the top of the towers.

Down time: 17 hours at SC1, SC2 and SC5.

8/19/2017 TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally.

Down time: 2 hours at B9 and 1 hour at SC1.

Treatment System

9/30-10/1/2016 Treatment System; Call from Time Communication "TGRS Fail". ECV 4 failed to open on command. The well field cycled. Exercised the opening and closing speed control valves and flushed the control piping. The opening speed control valve is bad. Replaced with new from inventory. Reset the control valves and cycled the valve and normal operation was observed. Reset the PLC and the auto dialer.

Down time: 3.5 hours at B3, 5 hours at B8, 10.5 hours at B13 and B9.

10/4/2016 Treatment System; Turned the TGRS off to install pressure gauges on the 6-inch diameter HDPE discharge lines into the sand and gravel pit with the Army Corps of Engineers. Following installation, turned the TGRS back on. Normal operation was observed.

Down time: 1 hour at B13, 1.5 hours at B6 and 2 hours at SC5.

10/6/2016 Treatment System; Installed new piping and valves to the pressure gauge on Tower 3.

Down time: None.

10/6/2016 Treatment System; Inspected the condition of the water distribution systems of Towers 3 and 4. There is a buildup of particles and sediment in both systems. Tower 3 is more restricted than Tower 4.

Down time: 4 hours.

Appendix G-3

Maintenance Activities By Location
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

10/10-11/2016	Treatment System; Decreased the flow rates at B3, B4, B5 and B8 and closed the Tower 3 gate valve. Removed and cleaned the heads and 4-inch laterals of Tower 3. Flushed the 8-inch piping and reinstalled the 4-inch laterals and heads. Opened the Tower 3 gate valve and observed normal operation. Down time: None.
10/11-12/2016	Treatment System; Closed the Tower 4 gate valve. Removed and cleaned the heads and 4-inch laterals of Tower 4. Flushed the 8-inch piping and reinstalled the 4-inch laterals and heads. Opened the Tower 4 gate valve and observed normal operation. Down time: None.
11/18/2016	Treatment system and well field; Winter storm and no power to the Site. Xcel Energy found the top of a power pole burned. They repaired the components. Restarted the treatment system and well field. Everything restarted normally except SC1, SC2 and SC5 did not turn on. Re-contacted Xcel Energy but they were not able to respond due to the storm. They would inform us when they were able to respond. Down time: 5.5 hours at B1, B6 and B13; 2 hours at B4.
11/24/2016	Thanksgiving Day - The inspection was not performed. Meter readings were Down time: None.
12/11/2016	Approximately 6" of snow fell overnight. DK Concrete was on site to plow snow. Down time: None.
12/25/2016	The inspection was not performed due to the Christmas Day holiday. Meter readings were estimated. Down time: None.
1/12/2017	Treatment System; Installed a new cell phone for the autodialer. Activated the cell phone and observed normal operation. Down time: None.
1/12/2017	Treatment System; Installed a new effluent water line to the slop sink and installed a new slop sink faucet. Down time: None.
1/27/2017	Treatment System; Installed a new battery backup for the new autodialer cell phone. Down time: None.
2/2/2017	Treatment System; ECV 4 would not close on command. Turned off B5 and B8 to minimize well field cycling with only Pump 3 running. Turned off Pump 4 and removed and replaced the operating solenoid. Turned Pump 4 back on and observed normal operation Down time: None.
2/2/2017	AHATS removed the gate and installed fence fabric and barbed wire in its place. The gate was located east of the northeast corner of former Building 502. Down time: None.
2/20/2017	Treatment System; Water was leaking from the Pump 4 gland shaft. Turned the pumps in B8 and B9 off so the well field would not cycle. Removed and replaced the gland packing in the Pump 4 gland shaft. Restarted Pump 4 and observed normal operation Down time: None.
4/16/2017	Easter holiday. No inspection performed. Meter readings were estimated.

Appendix G-3

Maintenance Activities By Location
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

	Down time: None.
5/1-3/2017	Preferred Electric was on site performing the annual electrical inspection. Down time: None.
5/29/2017	Memorial Day Holiday; The inspection was not performed and the meter readings were estimated. Down time: None.
6/20/2017	Treatment System and Well Field; Call from Time Communications - TGRS Fail. Upon arriving at the site, the TGRS was operating normally and no faults were present on the PDU. An accident on Highway 10 caused an electrical/data cable failure which may have been the reason for the failure. Down time: None.
7/6/2017	Building 116; Vandals broke into the lower bathroom window and entered the building. They opened some control panels from the old water treatment plant controls. Nothing else was vandalized or stolen. Down time: None.
7/29/2017	The daily inspection was not performed. Meter readings were estimated. Down time: None.
8/19/2017	TGRS and Well Field; The TGRS was off and there was only minimal power to the lights in Building 116. Inspected the power lines and located a fuse open on the power pole across Highway 10 from Scherer Bros. Lumber Company. Contacted Xcel Energy. They installed a new fuse. Turned the TGRS on and the system started normally. Down time: 2 hours at B9 and 1 hour at SC1.
9/12/2017	Treatment System; ECV 4 was flashing on the pump director unit. The solenoid valve would not open. Removed the solenoid valve and disassembled the valve. Cleaned the valve with acid, reassembled and reinstalled the valve. Cycled ECV 4, and observed normal operation. Down time: 8.5 hours at B8, 10.5 hours at B3, 14 hours at B13 and 15 hours at B9.
9/19/2017	Treatment System; There was no cell phone service to the autodialer cell phone. Contacted AT&T and resolved the issue. Phoned the autodialer and the autodialer worked normally. Down time: None.

Forcemain

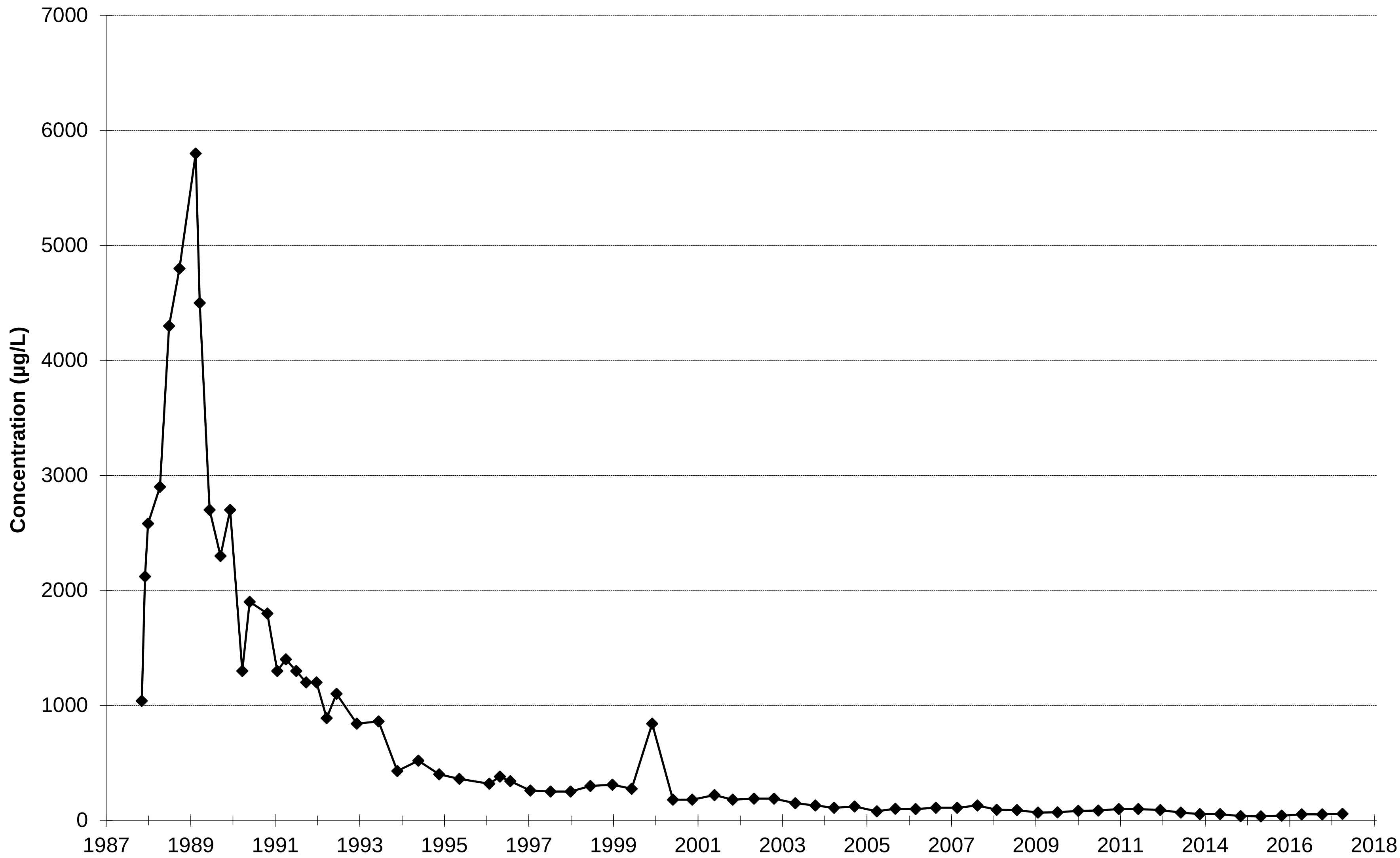
10/12/2016	The ARV between pumphouses B2 and B3 was leaking. Closed the ball valve to the ARV. The ARV will be removed and repaired or replaced at a later date. Down time: None.
8/7-11/2017	Pumphouses B1, B13, B3, B4, B5, B6, B8 and B9; Turned the pumphouses off to jet scale from the inside of the forcemain between B1 and B8. Down time: 25.5 hours at B6; 71 hours at B3; 73 hours at B1 and B13; 74.5 hours at B8; 77.5 hours at B4 and B5; 79 hours at B9.

APPENDIX H

TGRS Chemical Data

APPENDIX H-1

EXTRACTION WELL B1 - TCE VS.TIME

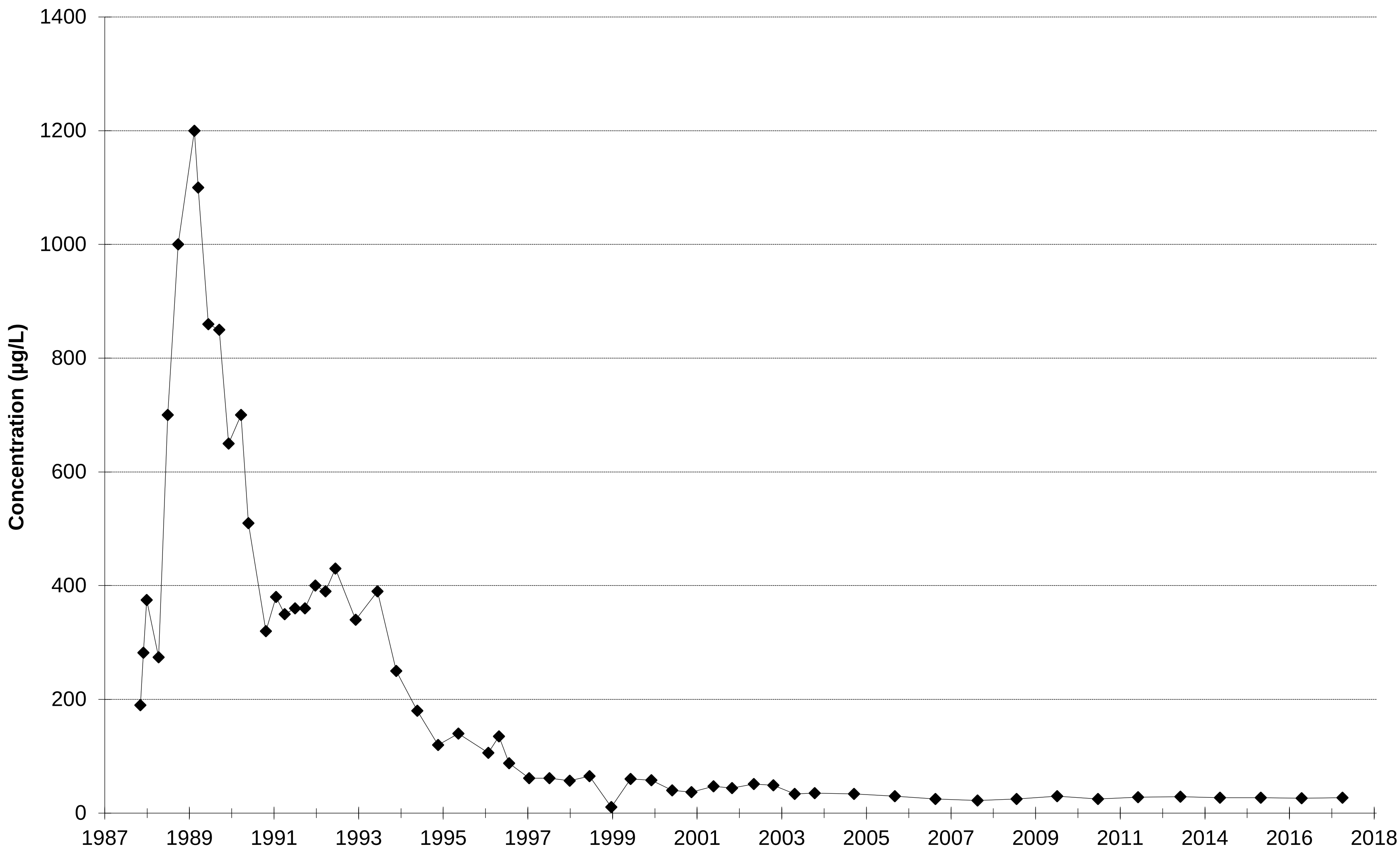


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11129230 (1)

APPENDIX H-1

EXTRACTION WELL B2 - TCE VS. TIME

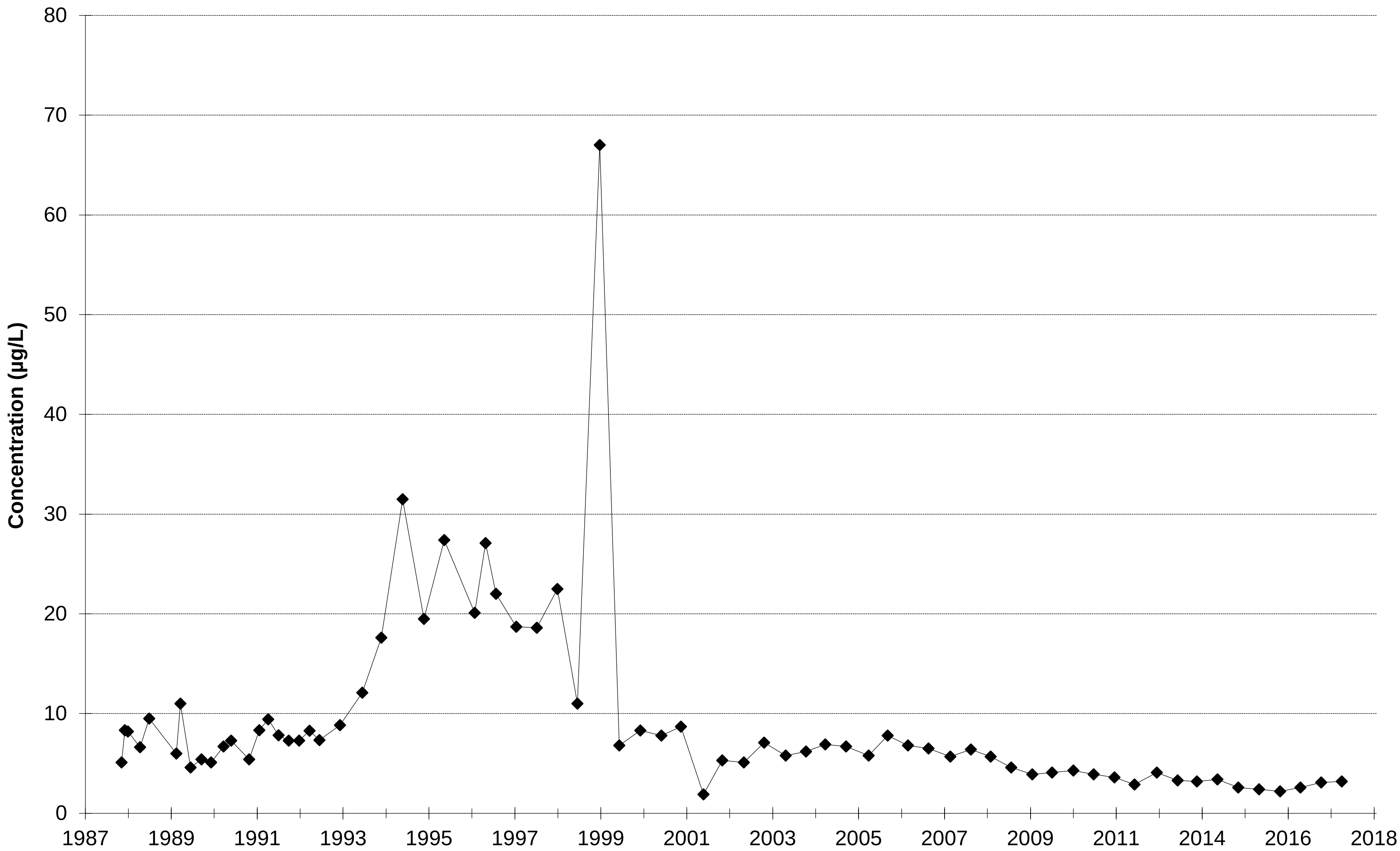


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

APPENDIX H-1

EXTRACTION WELL B3 - TCE VS. TIME

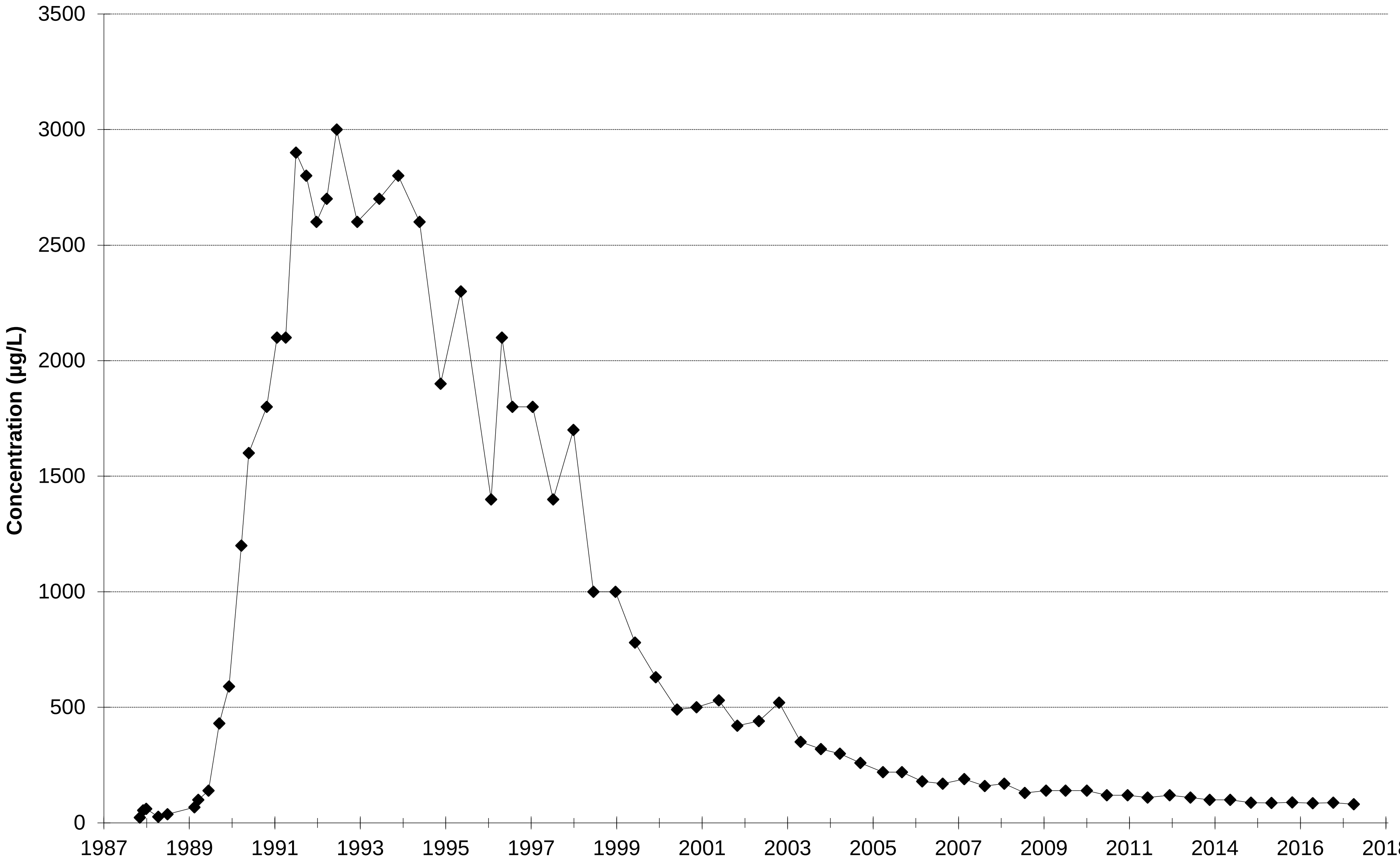


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

APPENDIX H-1

EXTRACTION WELL B4 - TCE VS. TIME

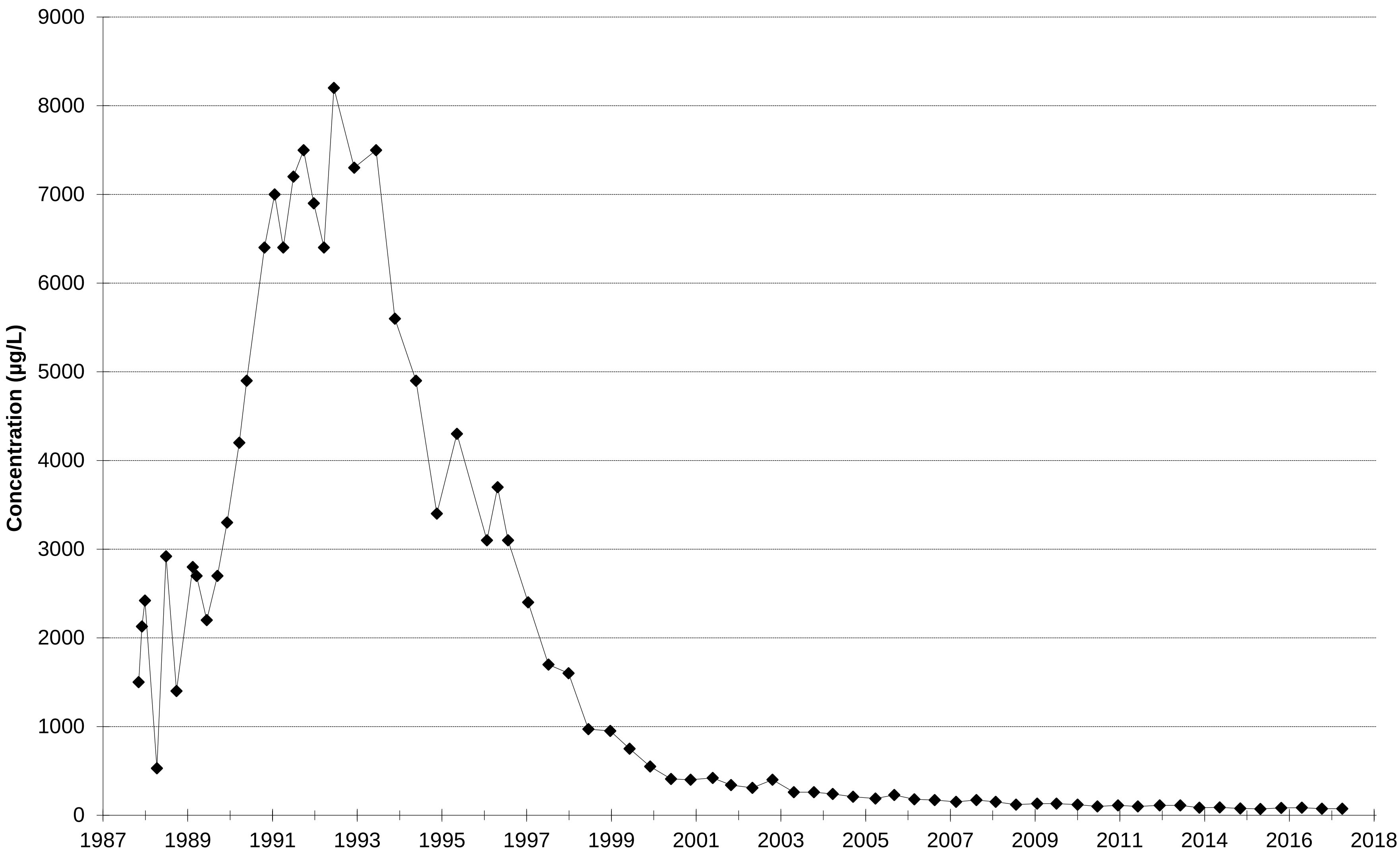


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

APPENDIX H-1

EXTRACTION WELL B5 - TCE VS. TIME

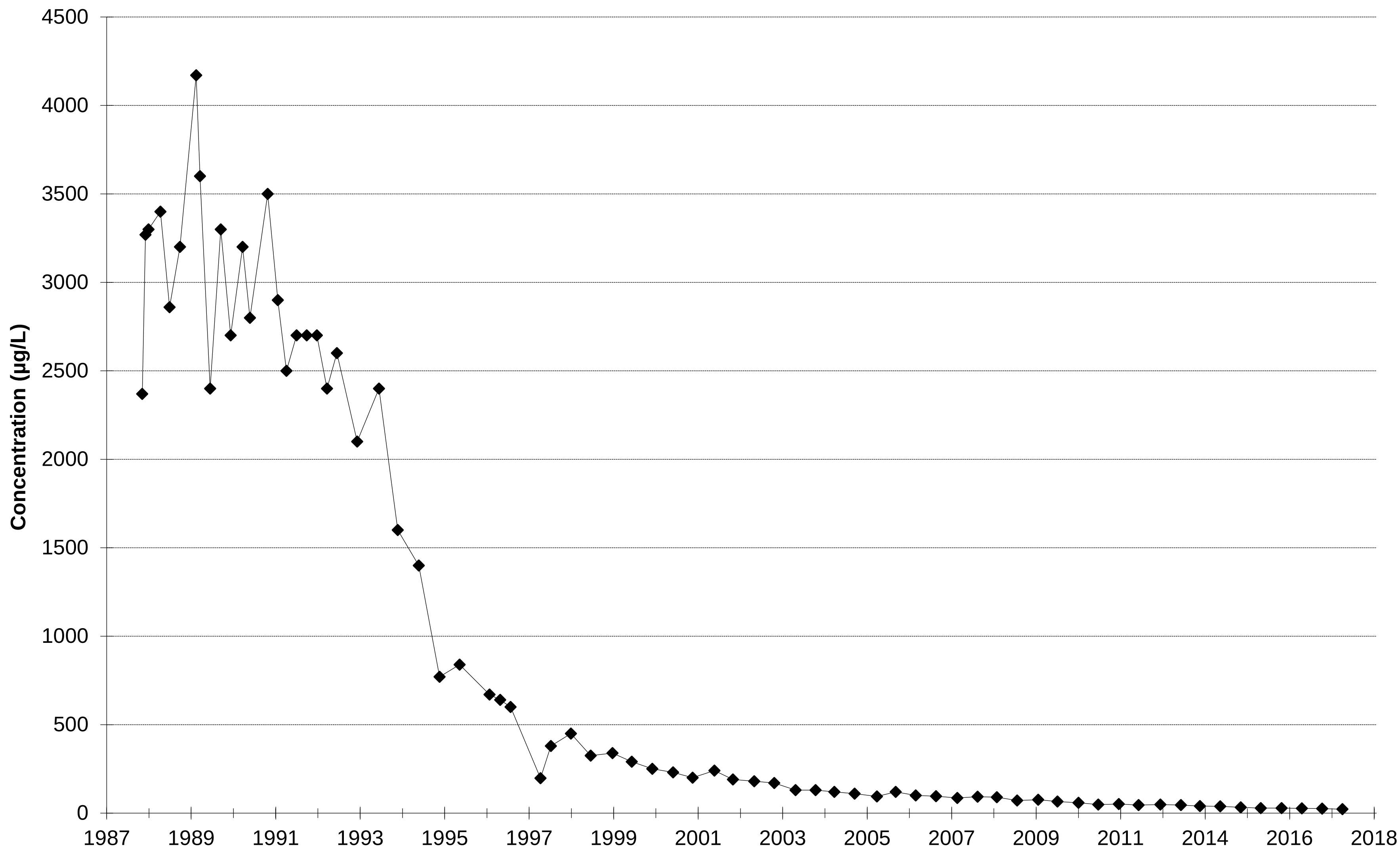


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

APPENDIX H-1

EXTRACTION WELL B6 - TCE VS. TIME

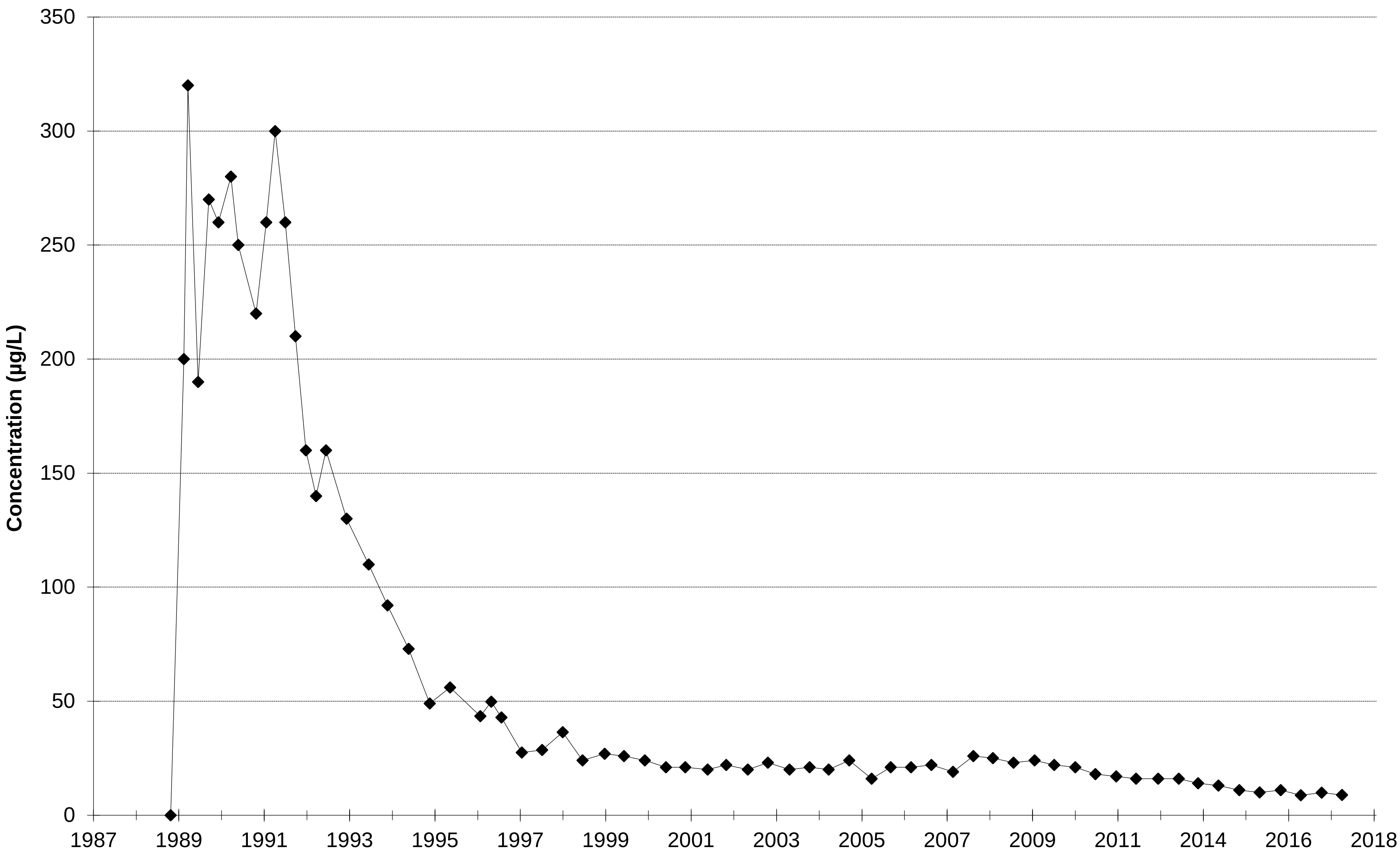


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

APPENDIX H-1

EXTRACTION WELL B8 - TCE VS. TIME

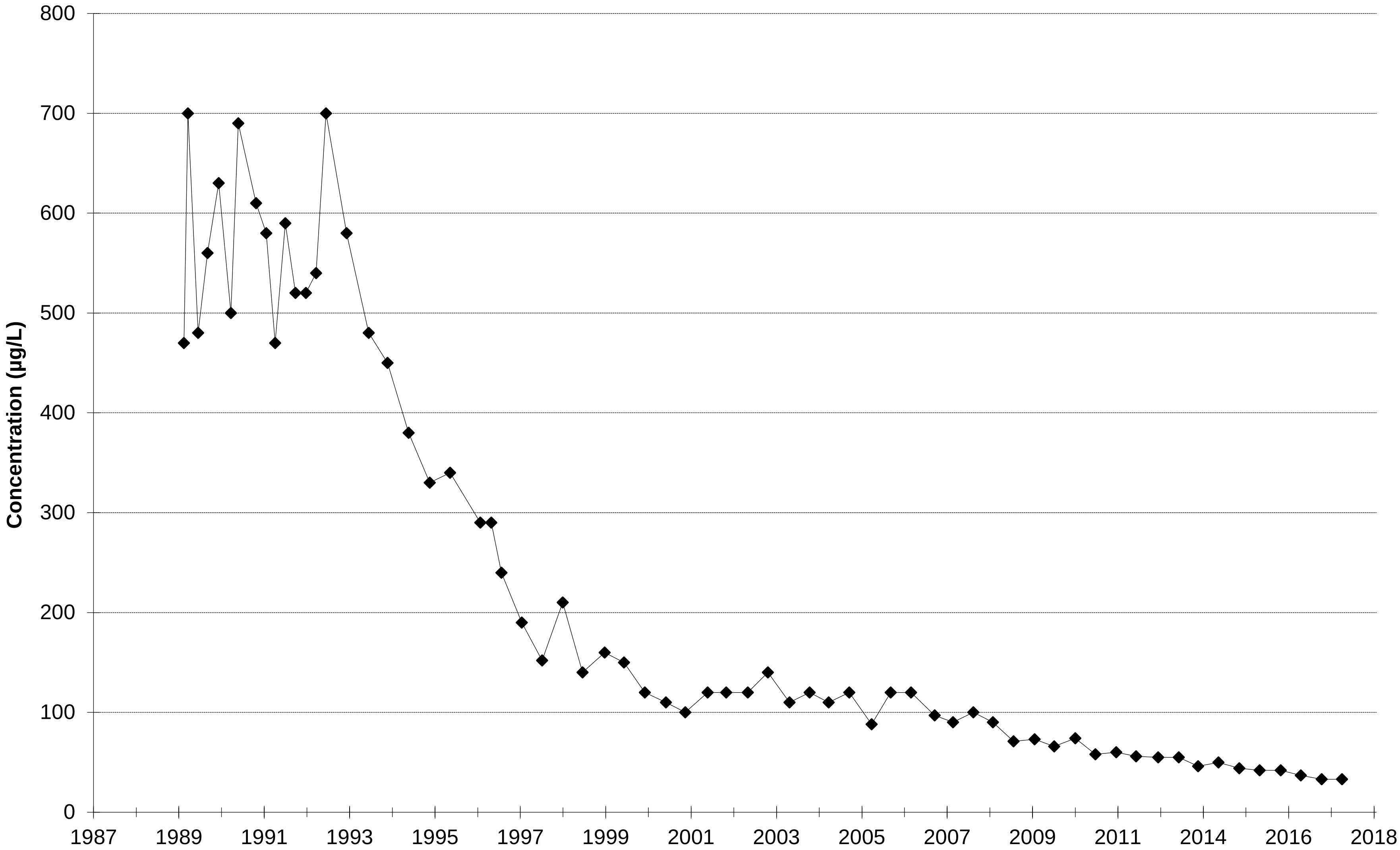


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

APPENDIX H-1

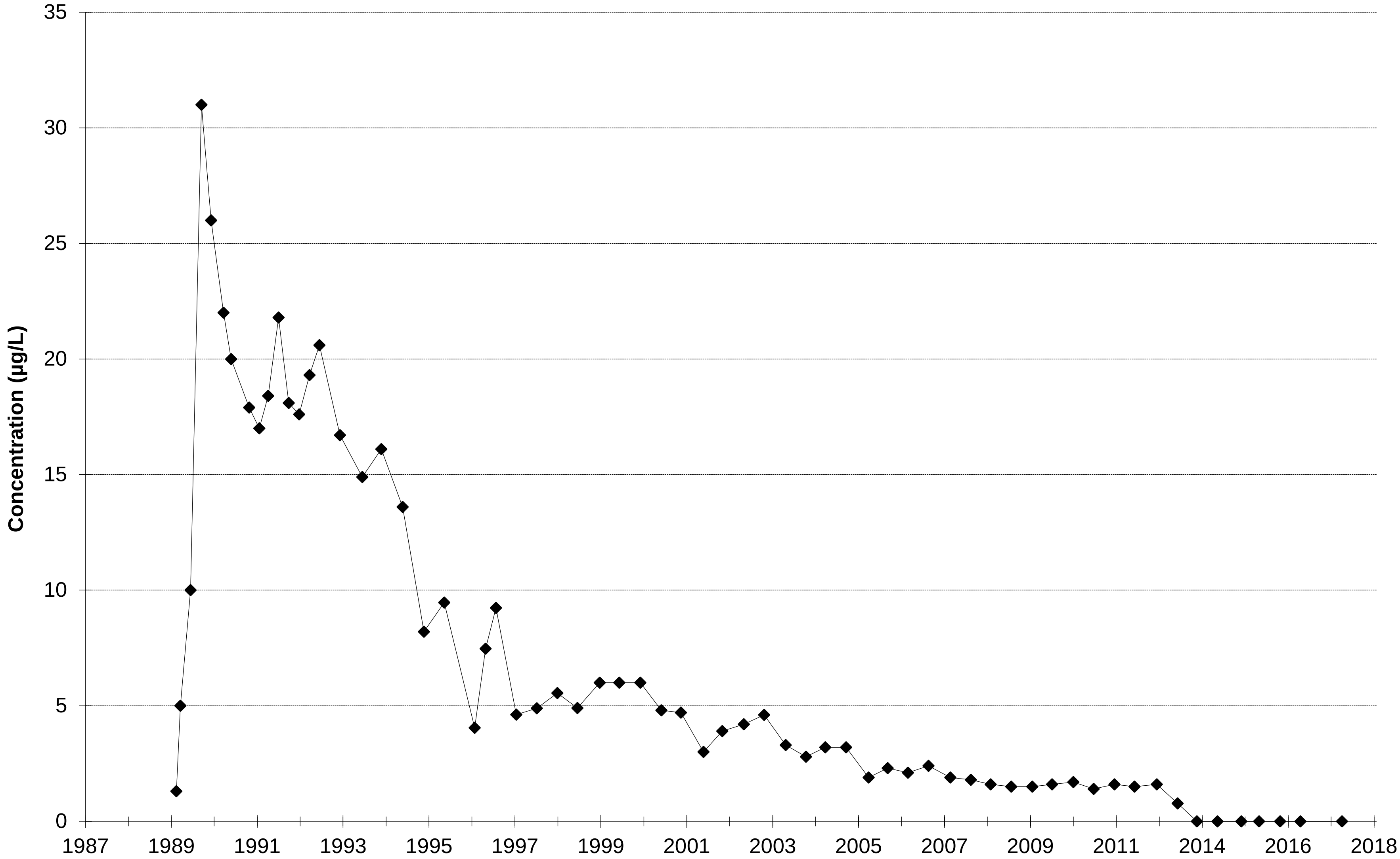
EXTRACTION WELL B9 - TCE VS. TIME



Note: Samples reporting concentrations less than the detection limit were plotted as zero.

APPENDIX H-1

EXTRACTION WELL B11 - TCE VS. TIME

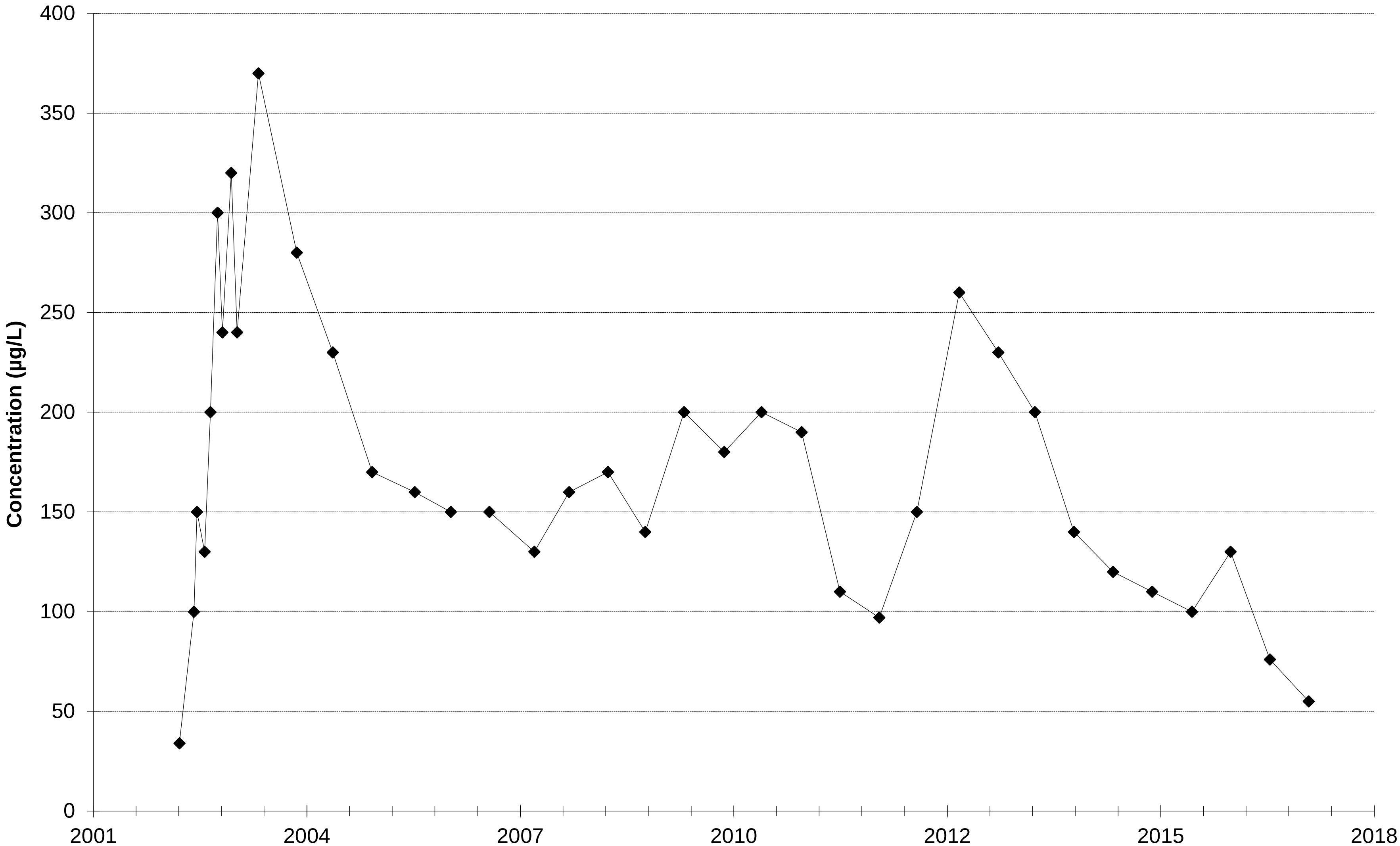


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

APPENDIX H-1

EXTRACTION WELL B13 - TCE VS. TIME

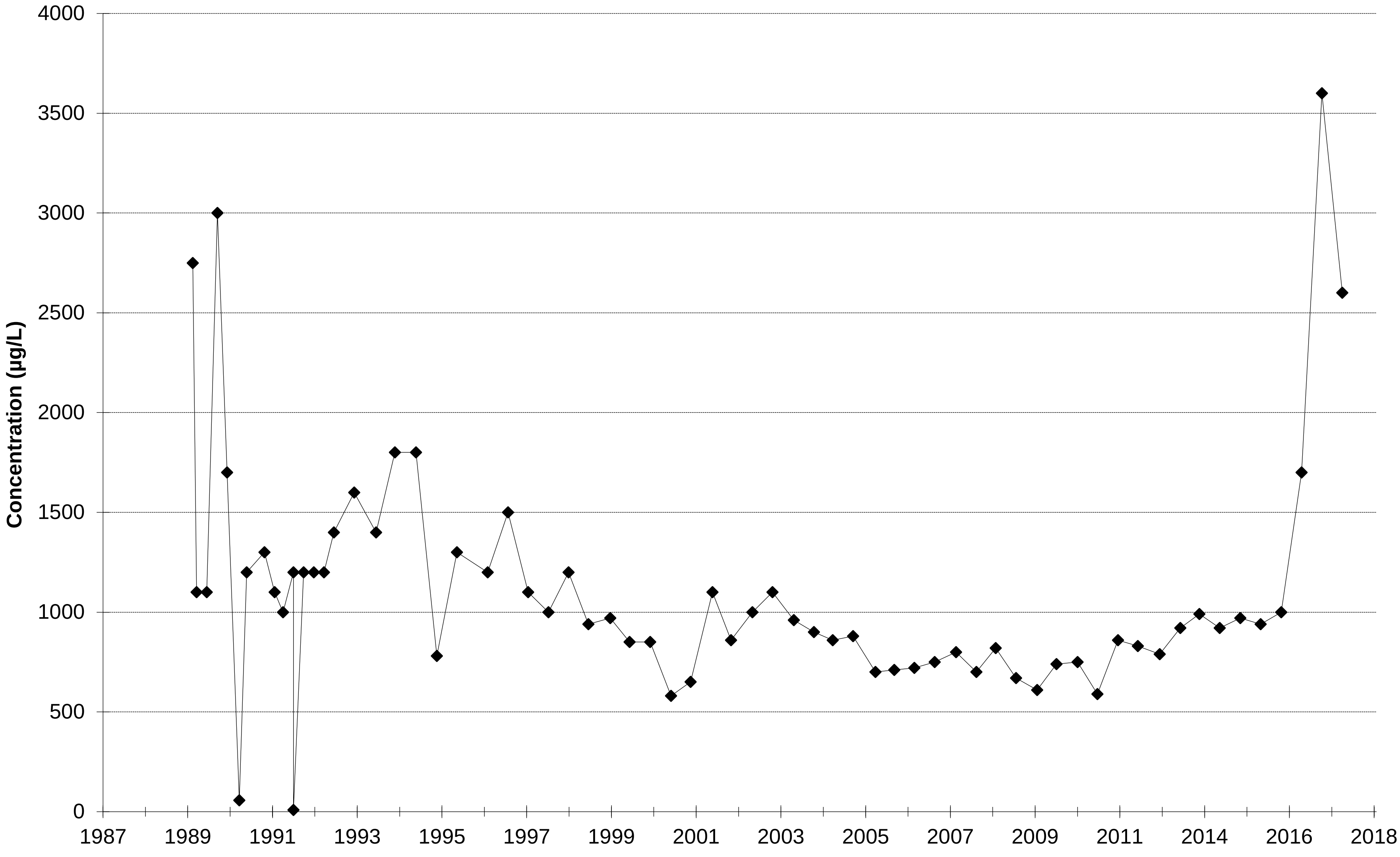


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360(1)

APPENDIX H-1

EXTRACTION WELL SC1 - TCE VS. TIME

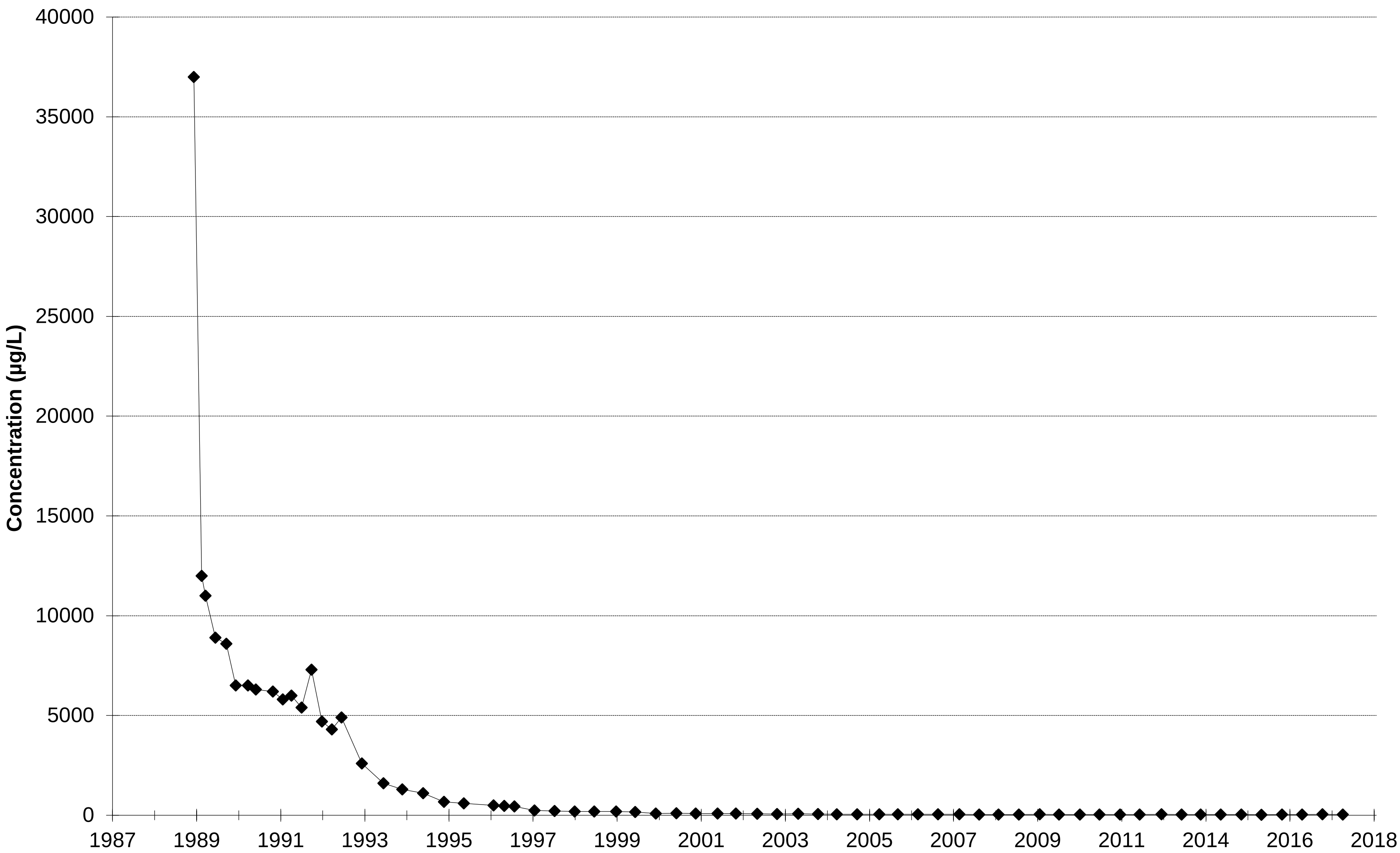


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

APPENDIX H-1

EXTRACTION WELL SC2 - TCE VS. TIME



Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11155360 (1)

Appendix H-2

Influent/Effluent Database
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

			1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
	TGRS Cleanup Level(1)		200	70	6.0	4.0	70	5.0	5.0
Location	Date		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
TGRSE	10/14/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2
TGRSE	10/14/2016	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2
TGRSE	11/6/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2
TGRSE	12/7/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2
TGRSE	12/7/2016	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3
TGRSE	1/9/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3
TGRSE	1/9/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2
TGRSE	2/2/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	0.99 JP
TGRSE	2/2/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1
TGRSE	3/2/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2
TGRSE	3/2/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2
TGRSE	4/6/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.4
TGRSE	5/8/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.1
TGRSE	5/8/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.3
TGRSE	6/12/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.1
TGRSE	6/12/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.1
TGRSE	7/11/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.8
TGRSE	7/11/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.8
TGRSE	8/3/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0 JMS73.0	1.5
TGRSE	9/12/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.3
TGRSE	9/12/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.3

Appendix H-2

Influent/Effluent Database
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

			1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
	TGRS Cleanup Level(1)		200	70	6.0	4.0	70	5.0	5.0
Location	Date		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
TGRSI	10/14/2016		37	2.2	2.4	< 1.0	3.1	0.95 JP	220
TGRSI	11/6/2016		32	2	3.5	< 1.0	2.6	0.99 JP	200
TGRSI	11/6/2016	D	33	2.1	4.3	< 1.0	2.8	0.97 JP	200
TGRSI	12/7/2016		35	2.3	4	< 1.0	2.7	0.98 JP	200
TGRSI	1/9/2017		35	2.1	4.5	< 1.0	2.9	1.1	210
TGRSI	2/2/2017		30	1.7	2.3	< 1.0	2.6	1.1	170
TGRSI	3/2/2017		33	1.9	3.5	< 1.0	3.3	1.1	200
TGRSI	4/6/2017		28	1.8	3.3	< 1.0	2.7	0.94 JP	160
TGRSI	4/6/2017	D	27	1.9	2.8	< 1.0	2.9	1	170
TGRSI	5/8/2017		61	2.4	6.3	< 1.0	3.1	0.99 JP	290
TGRSI	6/12/2017		50	2.3	3.3	< 1.0	2.9	1.1	240
TGRSI	7/11/2017		40	2.1	3	< 1.0	3.2	1.1	220
TGRSI	8/3/2017		36	2	4.1	< 1.0	2.8	0.87 JP	210
TGRSI	8/3/2017	D	39	2.2	4.2	< 1.0	3.2	0.84 JP	210
TGRSI	9/12/2017		35	1.9	3.9	< 1.0	3	0.88 JP	190

Notes:

(1) Cleanup levels for TGRS are from the OU2 ROD.

D - Field Duplicate

JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit.

JMS - Result is qualified as estimated based on outlying matrix spike sample recovery (# following JMS is actual % recovery)

APPENDIX I

Maros Decision Matrix

Table I.1

Maros Decision Matrix

Kendall S	Confidence	Coefficient of Varience	Trend
S > 0	> 95%	NA	Definitely Increasing
S > 0	90-95%	NA	Probably Increasing
S > 0	< 90%	NA	No Trend
S</= 0	< 90%	>/= 1	No Trend
S </= 0	< 90%	< 1	Stable
S < 0	90-95%	NA	Probably Decreasing
S < 0	>95%	NA	Definitely Decreasing

Table H.2

Confidence Values for Six Data Pairs

Kendall S	Confidence
1	50.00%
3	64.00%
5	76.50%
7	86.40%
9	93.20%
11	97.20%
13	99.17%
15	99.86%

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