Fiscal Year 2022 Annual Performance Report
New Brighton/Arden Hills Superfund Site
Twin Cities Army Ammunition Plant

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LIST OF ACRONYMS AND ABBREVIATIONS

1,2-DCE	1,2-dichloroethene
µg/L	Microgram(s) per liter
amsl	Above mean seal level
APR	Annual Performance Report
AO	Advanced oxidation
AOP	Advanced oxidation potential
ARARs	Applicable or Relevant and Appropriate Requirements
Army	U.S. Army
BGRS	Boundary Groundwater Recovery System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	*cis*-1,2-dichloroethene
COC	Contaminant of concern
EA	EA Engineering, Science, and Technology, Inc.
EBS	Environmental Baseline Survey
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
FS	Feasibility study
ft	Foot (feet)
FY	Fiscal year
GAC	Granular activated carbon
gal	Gallon(s)
GOS	Global Operating Strategy
gpm	Gallon(s) per minute
HRL	Health Risk Limit
JV	PIKA Arcadis U.S., Inc. a Joint Venture
lb	Pound(s)
LUC	Land use control
LUCRD	Land use control remedial design
MCL	Maximum contaminant level
MDH	Minnesota Department of Health
MDL	Method detection limit
MDNR	Minnesota Department of Natural Resources
MNA	Monitored natural attenuation

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

MNARNG	Minnesota Army National Guard
MOS	Micro Operating Strategy
MPCA	Minnesota Pollution Control Agency
NB/AH	New Brighton/Arden Hills
NBCGRS	New Brighton Contaminated Groundwater Recovery System
NBM	New Brighton Municipal
ND	Non-detect
OS	Operating Strategy
OU	Operable Unit
PCE	Tetrachloroethene
PGAC	Permanent granular activated carbon
PGRS	Plume Groundwater Recovery System
POTW	Publicly Owned Treatment Works
PP	Proposed Plan
PTA	Primer/Tracer Area
QAPP	Quality Assurance Project Plan
RAO	Remedial action objective
RI	Remedial investigation
RL	Reporting limit
ROD	Record of Decision
SGRS	Source Groundwater Recovery System
Site	New Brighton/Arden Hills Superfund Site
SRI-FS	Supplemental Remedial Investigation-Feasibility Study
SWBCA	Special Well Boring and Construction Area
SWCA	Special Well Construction Area
TCAAP	Twin Cities Army Ammunition Plant
TCE	Trichloroethene
TGRS	Twin Cities Army Ammunition Plant Groundwater Recovery System
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEC	U.S. Army Environmental Command
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile organic compound

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

Wenck	Wenck Associates, Inc. (now Stantec)
WWP	Wet well pump

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ES. EXECUTIVE SUMMARY

This Fiscal Year (FY) 2022 Annual Performance Report (APR) summarizes the status of remedy implementation and addresses how the remedies are performing for each of the three operable units (OUs) related to the New Brighton/Arden Hills (NB/AH) Superfund Site. **Figure 1-1** shows the site location and **Figure 1-2** shows the approximate locations of the three OUs. This APR covers FY 2022 (1 October 2021 through 30 September 2022).

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

OU1 ROD (U.S. Army [Army] et al. 1993); signed 1993; amended 2006 (#1) (Army et al. 2006a); Explanation of Significant Difference (ESD) signed 2020 (#1) (Army 2020a)

OU2 ROD (Army et al. 1997); signed 1997; amended 2007 (#1) (Army et al. 1997), 2009 (#2 and #3) (Army, 2009 a, b), 2012 (#4) (Army et al. 2012), 2014 (#5), and 2018 (#6); ESDs signed in 2009 (#1 and #2) (Army 2009 a, b) and 2021 (#3) (Army 2021b).

OU3 ROD (Army et al. 1992); signed 1992; amended 2006 (#1) (Army et al. 2006b).

The RODs, and subsequent amendments and ESDs, present the major components of the final remedies for the mediums of concern. This APR looks at each of the major components and addresses:

Are the remedies being implemented? (Compliance check with the RODs and ROD amendments)

Are the remedies effective?

Sampling events typically occur annually during June and alternate between major and minor sampling events which affects OU1 deep groundwater, OU2 deep groundwater, and OU3 wells. Most OU1, OU2 deep groundwater, and OU3 wells are sampled during major sampling events with a small number of wells sampled during minor years. Selected wells located at Building 102, Site A, Site C, and Site K are sampled annually. Off-site industrial wells are sampled every 4 years and coincide with major sampling events. For FY 2022, a major sampling event was conducted. Details of the 2022 major sampling event are provided in the Monitoring Plan provided in Appendix A.

Table ES-1 summarizes the status of remedial actions at the end of FY 2022. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the RODs and ROD amendments. The following are summaries of the accomplishments for each OU, as well as other activities during FY 2022.

Operable Unit 1 (OU1)

Operable Unit (OU)1 consists of the “north” plume of volatile organic compound (VOC) groundwater impacts. The current remedy for OU1 consists of pumping from municipal wells within the plume, which are currently New Brighton Municipal [NBM] wells NBM #3, #4, #5, #6, #14, and #15, and treating the extracted groundwater through the permanent granular activated carbon (PGAC) and ultraviolet/peroxide advanced oxidation process (AOP) systems. The remediation system began pumping in 1990 to treat trichloroethene (TCE). The treated water is distributed by the New Brighton water supply system as potable water. Due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells, routine OU1 remedy pumping was ceased on 15 April 2015, with notice to the U.S. Environmental Protection Agency (EPA)/Minnesota Pollution Control Agency (MPCA),. Because the PGAC system does not remove 1,4-dioxane, a modification was needed. The new treatment system using ultraviolet/AOP was brought online in November 2018. ESD#1 (Army 2020a) to the 1993 OU1 ROD (Army et al. 1993) was prepared to add 1,4-dioxane to the list of contaminants of concern (COCs) and to document the addition of AOP treatment for 1,4-dioxane.

FY 2022 activities include:

The Minnesota Department of Health (MDH) Special Well Boring and Construction Area (SWBCA) 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. Well abandonments were scheduled to take place in FY 2022 (Army 2021c), though abandonment is on hold. One well (04U884) was added to the well inventory list for FY 2022 and was evaluated for abandonment or alternate water supply based on data collected at that time.

Please note that for the purposes of this report, the Special Well Construction Area (SWCA) is synonymous with the SWBCA. SWCA has historically been referenced in RODs and other reporting documents. However, in the most recent modification (MDH 2016), the MDH references this area now as the SWBCA for TCAAP.

Groundwater monitoring was conducted in accordance with the FY 2022 monitoring program. FY 2022 was a “major” sampling event, which is detailed in Appendix A.

Began evaluating the operating strategy for New Brighton Contaminated Groundwater Recovery System (NBCGRS). NBM #14 and NBM #15 VOC mass removal rates have continuously declined. A strategy moving forward could involve abandoning these locations in favor of pumping from locations more central to the plume.

Operable Unit 2 (OU2)

OU2 is defined as the TCAAP property boundary in 1983, when the NB/AH Superfund Site was placed on the National Priorities List. Sites within OU2 include Shallow Soil Sites, Deep Soil Sites, Site A Shallow Groundwater, Site C Shallow Groundwater and Surface Water, Site I Shallow Groundwater, Site K Shallow Groundwater, Building 102, Deep Groundwater, and various Aquatic Sites.

Summary of activities within OU2 during FY 2022:

Shallow Soil Sites—No activities were conducted other than ongoing Army implementation of land use controls (LUCs).

Deep Soil Sites—No activities were conducted other than ongoing Army implementation of LUCs.

Site A Shallow Groundwater:

- Tetrachloroethene (PCE) and TCE continue to degrade to *cis*-1,2-dichloroethene (*cis*-1,2-DCE) via natural attenuation at Site A. The *cis*-1,2-DCE plume does not pose potential exposure risk to the northwest residential area based on FY 2022 sampling results. In FY 2018, the OU2 ROD Amendment #6 updated the remedy for Site A to monitored natural attenuation (MNA), which remains in effect at the site.

- Monitoring results from three of the four contingency wells located along the north side of County Road I did not exceed the approved action levels, which are equal to the cleanup levels for all Site A COCs in FY 2022. Well 01U902 exceeded the trigger level, but no further contingency action is required based on the findings of the groundwater and soil vapor investigation.

- The MDH SWBCA remains in effect. In FY 2022, there were no new locations identified in need of well abandonment or alternate water supply.

Site C Shallow Groundwater:

- Lead is the primary COC at Site C with the selected remedy of groundwater extraction and treatment. In accordance with the Site C Groundwater Extraction System Evaluation Report (Wenck 2008b), and with regulatory approval, the groundwater extraction system was shut down on 13 November 2008. System operation ceased because the lead concentrations in the groundwater plume contacting extraction wells are now below groundwater cleanup levels.

- Only one monitoring well located near the source area still exceeded the groundwater cleanup level for lead in FY 2022, indicating the plume continues to shrink.

- None of the groundwater contingency locations exceeded the approved lead trigger levels in FY 2022.

- Continued monitoring is recommended with follow-up discussions to evaluate formal changes to the remedy to eliminate the groundwater extraction component.

Site I Shallow Groundwater:

- All Site I Unit 1 monitoring wells were 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 contained by the TCAAP Groundwater Recovery System (TGRS).

- The most recent groundwater quality data (from FY 2013) suggests that cleanup levels have not been attained.

- The reinstallation of 01U667 has been delayed since the location has been slated for significant redevelopment-related regrading (based on discussions with Ramsey County). It was understood that if installed, the well would again require replacement. Army intends to reinstall 01U667 during the summer of 2023. Once monitoring well 01U667 is reinstalled per agency request, it will be sampled annually in accordance with the FY 2022 – FY 2026 Monitoring Plan (Appendix A.1).

Site K Shallow Groundwater:

- The Site K groundwater extraction trench and treatment system continued to operate as designed to remove and treat VOCs. For FY 2022, the system captured and treated 3,469,396 gal of water and maintained a continuous zone of capture downgradient of the former Building 103. A total of 6.23 pounds of VOCs were removed in FY 2022.

- Appendix J.7.2 of this report provides the EPA-requested Site K Hydraulic Containment Evaluation Memorandum. The evaluation concluded that the Site K TCE plume has been contained by the collection trench during nearly all groundwater elevation conditions experienced at the Site since 2001 (and likely before). The one notable exception was in 2014, when Site K experienced historically high groundwater elevations in the spring due to flooding and TCE was detected in monitoring well (01U603) downgradient of the north portion of the trench.

- Groundwater samples were collected from nine wells scheduled for sampling in FY 2022. TCE concentrations in 01U611R and 01U615 showed increases of over 25 percent from those observed in FY 2021. The overall trend throughout the other Site K Unit 1 monitoring wells continues to show relatively stable or a gradual decrease in TCE concentrations over the last 20 plus years of sampling.

- The extracted water was treated and discharged to Rice Creek in compliance with discharge criteria.

- Fifteen Unit 1 wells at Site K were abandoned as part of redevelopment activities in FY 2014; three of these wells (01U608R, 01U609R, and 01U611R) were reinstalled during FY 2021. No additional wells were reinstalled during FY 2022.

- U.S. Geological Survey (USGS) Maryland-Delaware-DC Water Science Center continued a groundwater treatability study in FY 2022 to assess bioremediation as a destructive remedy for VOCs in the Site K groundwater plume. Groundwater injection and monitoring points were installed in September 2021 and a pilot scale biostimulation and bioaugmentation were conducted though FY 2022. A report on this work will be issued by USGS during FY 2023 and will be summarized in the FY 2023 APR.

Building 102 Shallow Groundwater:

- VOC concentrations, the primary COC at Building 102, were generally similar to those observed in the prior year, though a marked increase was observed in the source area wells 01U580 and 01U581. Historically, large fluctuations have been observed at these wells.

- MNA, the selected remedy at Building 102, continues to show that degradation of the VOC plume is ongoing and that the plume is not migrating.

- The well adjacent to Rice Creek (01U048) continued to show shallow groundwater discharging to Rice Creek with VOC levels below the site cleanup levels.

Aquatic Sites—All aquatic sites are closed except Round Lake, which is discussed as a separate site below.

Deep Groundwater—The selected remedy for the Deep Groundwater in the 1997 OU2 ROD (Army et al. 1997), subsequent amendments, and 2021 ESD #3 (Army 2021b) includes the operation of the TGRS. As detailed in 2023 Definitions of OU2 Deep Groundwater Remedy at TCAAP, a letter dated February 2, 2023, from the Army to EPA and MPCA, the TGRS is composed of the following two systems:

- The Boundary Groundwater Recovery System (BGRS), which is designed to recover and treat low concentration VOCs in groundwater along the southwest portion of the property boundary.

  - The BGRS consists of:

    - Seven operating groundwater extraction wells along the southwest portion of the property boundary (B-1, B-3, B-4, B-5, B-6, B-8, B-9, and B-13)

    - An air stripping system (located inside Building 116) to treat low VOC concentration boundary groundwater

- The Source Area Groundwater Recovery System (SGRS), which is designed to recover and treat high concentration VOCs and 1,4-dioxane in groundwater in the source areas at Sites D, G, and I.

  - The SGRS consists of:

    - Nine operating source area groundwater extraction wells at Sites D, G, and I (SC-1, SC-5, SC-6, SC-7, SC-8, SC-9, SC-10, SC-11, and SC-12)

    - One source area groundwater treatment system (located inside the SGRS treatment building) using advanced oxidation for treatment of 1,4-dioxane and TCE and air stripping for treatment of residual VOCs.

- The TGRS met the requirements of the 1997 OU2 ROD (Army et al. 1997) during FY 2022. The FY 2022 annual average extraction rate was approximately 1,723 gal per minute (gpm), or 98.7 percent of the Global Operating Strategy Total System Operational Minimum (1,745 gpm) established in 2004 using the FY 2001 data set. The lower than anticipated TGRS extraction rate was primarily due to the substantial power outage caused by the Building 116 transformer failure in August 2022. Given the significant reduction in TCE concentrations across the Site since 2001 and the reduction of the TCE plume width to 83.7 percent of the 2001 TCE plume, it is reasonable to conclude that the TCE was adequately contained during FY 2022.

- Hydraulic containment of the 5 micrograms per liter (µg/L) TCE contour in the contaminated source area, meeting the criterion in the 1997 OU2 ROD (Army et al. 1997).

- The TGRS extracted and treated 905,462,940 gal of water and removed 982 pounds of VOCs from October 2021 to September 2022. Average BGRS VOC influent concentrations decreased by 42 percent during FY 2022 due to the rerouting of SC1 and SC5 to the new SGRS treatment system.

- 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.

- During FY 2022, groundwater analytical data of all extraction wells sampled (except B2) and 51 of 78 monitoring wells sampled had 1,4-dioxane concentrations exceeding the MDH HRL value of 1.0 µg/L. It is expected that 1,4-dioxane concentrations will begin to reduce at many locations with the full operation of the SGRS (as it was designed to capture and treat this COC at the source).

- Effluent VOC concentrations were below COC-specific requirements for all sampling events.

— During FY 2023, the combined groundwater extraction and treatment for on-site Deep Groundwater within OU2 by BGRS and SGRS will result in increased mass removal of VOCs, destruction of 1,4 dioxane and more efficient hydraulic containment of the source areas.

Operable Unit 3 (OU3)

OU3 contains the South Plume of VOC groundwater impacts, which is treated by MNA. Overall, the statistical evaluation of groundwater data collected in FY 2022 indicates stable to declining concentration trends at the center and edge of the South Plume. 1,4-dioxane sampling continued in FY 2022 with results similar to those reported over the last 6 years.

Round Lake

The Army has been working with regulators, landowners, and other stakeholders since an informal dispute was resolved in 2016. After a series of collaborative meetings, the Supplemental Remedial Investigation-Feasibility Study (SRI-FS) (Army 2021a) was completed at Round Lake. The Final Proposed Plan (PP) (Army et al. 2021b) was published in July 2021. The public comment period was held from 9 July to 13 August 2021. An ROD for Round Lake was finalized in August 2022 (Army et al. 2022), detailing the selected remedy for Round Lake; dredging of contaminated sediment and disposal. A Pre-Design Investigation and remedial design will be required prior to implementation of the selected remedy of the ROD (Army et al. 2022).

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1. INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF THIS DOCUMENT

This Annual Performance Report (APR) is intended to both summarize the status of remedy implementation and address remedy performance. This APR covers remedial actions at the New Brighton/Arden Hills (NB/AH) Superfund (Site) from 1 October 2021 through 30 September 2022 (Fiscal Year [FY] 2022). The Site is divided into three designated operable units (OUs): OU1, OU2, and OU3 (**Figure 1-2**). OU1 encompasses off-site deep groundwater also referred to as the North Plume. OU2 includes over 20 sites with soil, sediment, surface water, and groundwater impacts in the area that comprised Twin Cities Army Ammunition Plant (TCAAP) in 1983, when the NB/AH Site was placed on the National Priorities List. OU3 consists of off-site deep groundwater sometimes referred to as the South Plume. Record of Decisions (RODs) were developed and signed for each OU:

OU1 ROD (Army et al. 1993); signed 1993; amended 2006 (#1) (Army et al. 2006a); Explanation of Significant Difference (ESD) signed 2020 (#1) (Army 2020a)

OU2 ROD (Army et al. 1997); signed 1997; amended 2007 (#1) (Army et al. 1997), 2009 (#2 and #3) (Army, 2009 a, b), 2012 (#4) (Army et al. 2012), 2014 (#5), and 2018 (#6); ESDs signed in 2009 (#1 and #2) (Army 2009 a, b) and 2021 (#3) (Army 2021b).

OU3 ROD (Army et al. 1992); signed 1992; amended 2006 (#1) (Army et al. 2006b).

The RODs, subsequent amendments, and 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 U.S. Army (Army), U.S. Environmental Protection Agency (EPA), 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 and subsequent modifications)

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 upon within work plans or design documents. With performance standards identified, this APR then addresses both questions discussed above through a series of sub-questions, written to facilitate a focused and user-friendly document through the utilization of figures and or graphs. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the RODs and ROD amendments.

FY 2022 represents a major sampling event in the Monitoring Plan. The 2022 major sampling event is presented in detail in Appendix A. In addition to reporting on FY 2022, 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 2022 through FY 2026, where the next year, FY 2023, will drop off and FY 2027 will be added).

This APR is organized into the following sections:

Section 1: Introduction—Summarizes the background information for the project and establishes the purpose and organization of this document.

Section 2: OU1: Deep Groundwater—Evaluates status of selected remedies at OU1: Deep Groundwater

Section 3: OU2: Shallow Soil and Dump Sites— Evaluates status of selected remedies at OU2: Shallow Soil and Dump Sites

Section 4: OU2: Deep Soil Sites— Evaluates status of selected remedies at OU2: Deep Soil Sites

Section 5: OU2: Site A Shallow Groundwater—Evaluates status of selected remedies at OU2: Site Shallow Groundwater

Section 6: OU2: Site C Shallow Groundwater—Evaluates status of selected remedies at OU2: Site C Shallow Groundwater

Section 7: OU2: Site I Shallow Groundwater— Evaluates status of selected remedies at OU2: Site I Shallow Groundwater

Section 8: OU2: Site K Shallow Groundwater—Evaluates status of selected remedies at OU2: Site K Shallow Groundwater

Section 9: OU2: Building 102 Shallow Groundwater—Evaluates status of selected remedies at OU2: Building 102 Shallow Groundwater

Section 10: OU2: Aquatic Sites— Evaluates status of selected remedies at OU2: Aquatic Sites

Section 11: OU2: Deep Groundwater—Evaluates status of selected remedies at OU2: Deep Groundwater

Section 12: OU3: Deep Groundwater— Evaluates status of selected remedies at OU3: Deep Groundwater

Section 13: Other Installation Restoration Activities during FY 2022— Evaluates status of selected remedies at Round Lake

Section 14: References—Documents the references cited in this APR.

Appendix A: FY 2021 – FY 2025 Monitoring Plans

Appendix B: Monitoring Well Index

Appendix C: Data Collection, Management and Presentation

Appendix D: Comprehensive Groundwater Quality and Groundwater Level Database

Appendix E: Well Inventory

Appendix F: Annual Site Inspection Checklist For Land Use Controls

Appendix G: Site K and Twin Cities Army Ammunition Plant Groundwater Recovery System (TGRS) Operational Data

Appendix H: TGRS Chemical Data

Appendix I: Marcos Decision Matrix

Appendix J: Historical Design and Evaluation Details

1.2 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 1-2**). 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 impacts 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, when it was determined the source of impacts and groundwater impacts were from TCAAP, the Site was placed on the National Priorities List.

Several known and potential contaminant source areas on the TCAAP property were initially identified within the original TCAAP boundary that is OU2: Sites A, B, C, D, E, F, G, H, I, J, K, 129-3, 129-5, and 129-15 (**Figure 1-3**). The 1997 OU2 ROD (Army et al. 1997) 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 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 1-3**.

Since 1983, the size of the federal portion 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 1-3** presents the OU2 property boundaries. **Figure 1-4** presents property under federal ownership at the end of FY 2021, along with the organizations responsible for control. The minimal remaining TCAAP (Base Realignment and Closure-controlled) property is currently in the process of being transferred out of federal ownership. These property transfers do not alter the responsibilities or liability of the Army under the FFA.

1.3 HYDROGEOLOGIC UNITS AND WELL NOMENCLATURE

For purposes of studies and work related to the Site, four hydrogeologic units have been designated: Unit 1 (the Fridley Formation), Unit 2 (the Twin Cities Formation), Unit 3 (the Hillside Sand), and Unit 4 (the Prairie du Chien and Jordan Formations), 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's unique well identification number. Well information includes the Army designation (Installation Restoration Data Management Information System number), Minnesota's 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 an attachment to Appendix B, which is sorted by the Minnesota's unique number. Instructions are provided in Appendix B for more information.

1.4 DATA COLLECTION, MANAGEMENT, AND PRESENTATION

Performance monitoring data were collected in accordance with the FY 2022: 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 EA Engineering, Science, and Technology, Inc. (EA) on behalf of the Army, Conestoga-Rovers & Associates, Inc.; now GHD on behalf of Northrop Grumman, and Barr Engineering 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 2022 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 2022 Monitoring Plan and verified and validated in accordance with the Quality Assurance Project Plan (QAPP) for Performance Monitoring (PIKA Arcadis U.S., Inc. a Joint Venture [JV] 2020a), which is updated as appropriate.

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 2022 data are explained in the data table footnotes. Data verification (performed on 100 percent of the data) and data validation (performed on 100 percent of 1,4-dioxane data and a minimum of 10 percent of the data, except at Site K) were provided to EPA and MPCA via submittal of quarterly Data Usability Reports covering FY 2022 information (EA 2022a, 2022b, 2023a, and 2023b). The final EPA approval letter for the FY 2022 Data Usability Reports is included in Appendix C.3.

Completeness

Appendix C.2 summarizes any deviations from the FY 2022 Monitoring Plan (Appendix A). The field and laboratory completeness goals for performance monitoring are both 95 percent, except for TGRS effluent, Site K effluent, and well inventory samples, for which field and laboratory completeness goals are 100 percent. Actual field and laboratory completeness were both 100 percent, 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 percent completeness goals was successful at 100 percent.

Quality Control

The QAPP specifies field duplicates, equipment rinse blanks, and matrix spike/matrix spike duplicates are to be collected at overall frequencies of 10 percent, 10 percent, and 5 percent, respectively. Actual quality control sample frequencies met these goals with respective frequencies of 14 percent, 11 percent, and 5 percent.

Data Validation

The performance monitoring QAPP specifies that data validation be completed at an overall rate of 10 percent, with 100 percent validation of 1,4-dioxane data and well inventory samples. The actual validation rate for volatile organic compounds (VOCs) collected in FY 2022 was 45 percent, far exceeding 10 percent, and all data requiring 100 percent data validation were fully validated, meeting the specified validation rates for performance monitoring.

FY 2022 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).

2. OPERABLE UNIT 1: DEEP GROUNDWATER

The 1993 OU1 ROD (Army et al. 1993) was amended in 2006 (Army 2006a) to formalize adoption of groundwater quality statistical analysis. In 2020, an ESD (Army 2020a) was approved for changes to the treatment system to add 1,4-dioxane as a contaminant of concern (COC).

The New Brighton Contaminated Groundwater Recovery System (NBCGRS) wells extract groundwater from the Prairie du Chien and/or Jordan Aquifers (Upper and Lower Unit 4). The New Brighton water treatment plant was upgraded to include ultraviolet/peroxide advanced oxidation potential (AOP) technology to treat 1,4-dioxane in November 2018. Appendix J.2 provides a summary of OU1 deep groundwater historical design, evaluation, and modification details.

The remedy selected based on the 1993 OU1 ROD (Army et al. 1993), OU1 ROD Amendment #1 (Army 2006a) and the 2020 ESD (Army 2020a) consists of the following six components (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 Boring and Construction Area (SWBCA).

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

    - The initial aggregate groundwater extraction rate shall be consistent with long-term NBCGRS operating history.

    - Future decreases in the aggregate extraction rate will be determined by the Army, EPA, 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.

    - Future changes to the aggregate or individual well extraction rates will 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 1993 OU1 ROD (Army et al. 1993).

    - 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 above (OU1 ROD Amendment #1 [Army et al.

2006a, pages 5-2 and
5-3]).

4) Future changes to the aggregate or individual well extraction rates will 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 1993 OU1 ROD (Army et al. 1993) and 2020 ESD (Army 2020a) and pumping the extracted groundwater to the permanent granular activated carbon (PGAC) and ultraviolet/peroxide AOP Water Treatment Facility in New Brighton for removal of 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.

Each of the remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout.

The monitoring requirement 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 (Army 2004), dated December 2004 (and any subsequent addendums or revisions approved by EPA and MPCA). There have been no revisions or addendums to the approved 2004 Technical Memorandum. The statistical analysis is conducted annually and is reported in this APR.

The six major components of the remedy prescribed by 1993 OU1 ROD (Army et al. 1993), OU1 Amendment #1 (Army et al. 2006a) and the 2020 ESD (Army 2020a) are evaluated below, including discussion of the effects of the remedy time-out noted above. Concentrations of 1,4-dioxane remain below the Minnesota Department of Health (MDH) Health Risk Limit (HRL) of 1 µg/L. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD and **Table 2-1** provides a summary of the monitoring requirements for each remedy component.

2.1 ALTERNATE WATER SUPPLY/WELL ABANDONMENT

The OU1 ROD (Army et al. 1993) established a remedy to provide an alternative water supply to residents with private wells within the North Plume. The *OU1 Alternate Water Supply Plan* (Montgomery Watson 1995) updated this remedy to include other wells in addition to residential wells, include well abandonment, and encompass OU3 and the OU2 Site A shallow groundwater plume.

For an alternate water supply, owners of the wells that meet all the following criteria are offered and provided with an alternate water supply (unless the well owners reject the offers):

- 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** provided in Appendix E

- The well is completed in an affected aquifer

- The well contains detectable concentrations of the NB/AH site-related COCs identified on page 18 of the 1993 OU1 ROD (Army et al. 1993) (or page 26 of the 1992 OU3 ROD) (Army et al. 1993), or Table 1 of the 1997 OU2 ROD (Army et al. 1997), as appropriate for the well location)

- The well is used in a manner to cause exposure (uses are defined in the OU1 Alternate Water Supply Plan (Montgomery Watson 1995)

- 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, the owners of <u>all</u> wells that meet all the following criteria are offered and provided abandonment (unless the well owners reject the offers):

- The well is located within the area affected by groundwater plumes that originate at OU2

- The well is completed in an affected aquifer

- The well contains detectable concentrations of the NB/AH Site-related COCs identified on page 18 of the 1993 OU1 ROD (Army et al. 1993) (or page 26 of the 1992 OU3 ROD [Army et al. 1992], or Table 1 of the 1997 OU2 ROD (Army et al. 1997), as appropriate for the well location)

- The well was constructed prior to the MDH SWBCA advisory

- The well is being used by the well owner or use was discontinued due to impacts

- The well is used in a manner to cause exposure (uses are defined in the Alternate Water Supply Plan [Montgomery Watson 1995]).

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, EPA, 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. Health Risk Index (HRI) values were calculated for wells sampled during FY 2022 using the MDH Water Guidance and Additivity Calculator (MDH 2022) and are presented in **Table 2-2** and Appendix D. Calculations were performed in accordance with MDH guidance with the exception of TCE in some cases. Because the MDH HRL for TCE (0.4 µg/L) is lower than the detection limit (1.0 µg/L) of samples taken in FY2022, TCE results lower than 1.0 µg/L or non-detect were omitted from the calculations. Future sampling events beginning in FY2023 will screen TCE at a lower detection limit in plume boundary wells in order to more accurately calculate HRI values. At this time, no further action is planned for wells based on the additivity calculations performed in FY2022.

The Alternate Water Supply and Well Abandonment Program have 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 updated 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 SWBCA). 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 0.25-mile buffer. The wells are grouped into categories (e.g., location relative to the area of concern, type of use, active/non-active status, sealed). 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:

- Check if the area of concern needs to be adjusted based on the extent of impacts
- Check if there are any previously unknown wells to be added to the database (coordination with the MDH as described in Appendix E)
- Sample wells on a prescribed schedule
- Take the appropriate course of action per results
- Update the well inventory database with any new information (e.g., water quality results, owner information, construction information, well re-categorizing)
- Report findings in the APR.

As shown on **Figure 2-1**, the area of concern for TCE did not change significantly during FY 2022 from the last major sampling event in FY 2020. Similarly, the area of concern did not change significantly from FY 2020 for 1,4-dioxane as depicted in **Figure 2-4**. The well inventory study area encompasses the FY 2022 area of concern.

The Army offered alternate water supply and well abandonment for four commercial wells (234421, 234544, 509052, and 537801) during FY 2021 due to exceedances of the MDH HRL for 1,4-dioxane. At that time, the owners of well 234544, R&D Systems, well 509052, Shriner's Hospital, and well 537801, Midway Industrial, requested connection to the municipal water supply and abandonment of their current wells. BioClean, the owner of well 234421 has rejected the offer for an alternate well supply.

For FY 2022, no new wells were added to the well inventory list. The next major sampling event for well inventory is scheduled for FY 2024.

2.2 DRILLING ADVISORIES

The OU1 ROD (Army et al. 1993) named drilling advisories as a remedy for OU1. It implemented drilling advisories that would regulate the installation of new private wells within the North Plume as a Special Well Construction Area (SWCA) (SWBCA).

The remedy is considered complete when the MDH has issued a SWBCA Advisory. Implementation will continue until such time that the groundwater concentrations are below the cleanup levels.

In June 1996, MDH issued a SWBCA advisory which has been in effect since implementation. In June 1999, MPCA requested the MDH extend the SWBCA boundary further southwest to the Mississippi River and Marshall Avenue ensuring the southern boundary fully encompassed the plume. The SWBCA also covers OU3, and as of April 2016, all of OU2. The current boundary of the SWBCA is shown on **Figure E-1** (Appendix E).

2.3 EXTRACT GROUNDWATER

Groundwater is extracted from the North Plume using the NBCGRS, subject to the following:

- The initial aggregate groundwater extraction rate will be consistent with the long-term operating history of the NBCGRS.

- Future decreases in the aggregate extraction rate will be determined by the Army, EPA, 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.

- Future changes to the aggregate or individual well extraction rates will 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 1993 OU1 ROD.

- The facilities comprising the NBCGRS may be modified as necessary to assure the restoration of the full aerial and vertical extent of the aquifer in a timeframe as contemplated above (OU1 ROD Amendment #1 [Army et al. 2006a], pages 5-3 to 5-5).

Through January 2008, the remedy component consisted of recovering deep (Unit 4) groundwater using three primary City of New Brighton wells (New Brighton Municipal (NBM) wells #4, #14, and #15) with three alternate wells (NBM wells #3, #5, and #6). The NBCGRS came online in 1993 and began the implementation of the remedy. NBM wells #3 and #4 were existing wells completed in both the Prairie du Chien and Jordan formations. NBM wells #5 and #6 were existing wells completed in the Jordan formation. NBM wells #14 and #15 were constructed in the Prairie du Chien formation 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 2-1**.

The extracted groundwater is used as part of the New Brighton water supply system, and as such, New Brighton took the lead on design and construction of the system and is responsible for system operation. The federal government is paying for the OU1 remedy.

In 2006, New Brighton and the Army modified the NBCGRS operation to allow more flexibility and to increase removal of contaminant mass from the aquifer. In November 2007, EPA and MPCA provided consistency approval of the revised pumping rates. Appendix A.5 (**Tables D-1 and 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 #1 (Army et al. 2006a). 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 #1 (Army et al. 2006a), the pumping allocations will revert to the previous scheme. Currently, optimizations are complete, and Army is working with New Brighton to install a well more central to the plume to increase COC mass collection (Army 2022a). As FY 2022, well installation activities are on hold.

Based on past operations, the target average daily pumping rate is 3.168 million gallons (gal) per day as shown in Appendix A.5. In FY 2022, the volume of water pumped by the NBCGRS was 1.182 billion gal, which translates to a daily average of 3.239 million gal per day.

2.4 REMOVAL OF VOCS BY PGAC AND AOP

Pumping the extracted groundwater to the PGAC Water Treatment Facility in New Brighton for removal of VOCs by a pressurized GAC system was established as a remedy of the 1993 OU1 ROD (Army et al. 1993). The PGAC came online in 1993 and began the implementation of the remedy. The 2020 ESD (Army 2020a) added removal of 1,4-dioxane by AOP.

Treatment by the PGAC and the AOP system along with iron and manganese removal and chlorination makes the recovered groundwater suitable for municipal drinking water purposes. The treatment system is located approximately 0.33 miles south of Interstate 694 near Silver Lake Road. The City of New Brighton is responsible for operation and maintenance of the

PGAC and AOP, with cost reimbursement from the Army for the operations related to the remedy.

The goal of this remedy is to treat water at or below the maximum contaminant level (MCL) and non-zero MCL goals established by the Safe Drinking Water Act for the constituents of concern, as identified on page 18 of the 1993 OU1 ROD (Army et al 1993). For FY 2022, the treated water met the MCLs and non-zero maximum contaminant level goals established by the Safe Drinking Water Act for the OU1 chemicals of concern. Sampling will continue in FY 2023 on a monthly basis.

2.5 DISCHARGE OF TREATED WATER

The connection to the New Brighton municipal supply system has been completed and all treated water is discharged through the New Brighton municipal distribution system to the residents of New Brighton and Fridley as detailed in the 1993 OU1 ROD (Army et al. 1993). The NBCGRS came online in 1993 and began the implementation of the remedy.

2.6 GROUNDWATER MONITORING WITH VERIFICATION OF CONTINUING AQUIFER RESTORATION

Groundwater monitoring is conducted at OU1 to verify the effectiveness of the remedy through measurement of overall plume shrinkage (geographically) and decreasing contaminant concentrations" (OU1 ROD Amendment #1 [Army et al. 2006a], page 5-3). The remedy will be considered complete when performance groundwater monitoring verifies aquifer restoration per the qualitative and statistical analyses discussed below.

Performance monitoring programs have been established to collect the data required to verify the effectiveness of the Remedy Components. **Table 2-1** summarizes the performance monitoring requirements, implementing parties, and the specific documents that contain the monitoring plans.

FY 2022 was a "major" sampling year. Also, with the detection of 1,4-dioxane in the NBCGRS wells, EPA and MPCA requested that the Army analyze groundwater samples for 1,4-dioxane at all scheduled OU1 sampling locations beginning in 2015 and future annual sampling events. All the required and requested sampling was completed for FY2022.

Monthly monitoring of the OU1 extraction system 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. Other groundwater monitoring is in accordance with the Groundwater Monitoring Plan included as Appendix A.1. A "major" event was conducted for FY 2022.

Historical 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. FY 2022 monitoring data are consistent with pre-shut down data. Since startup in 2018 TCE trends in the NBCGRS wells appear to be stable for wells NBM #5 and #6 and decreasing for NBM wells #3, #4, #14, and #15, (**Figure 2-2**).

Figure 2-3, **Figure 2-4**, and **Figure 2-5** show both the TCE and 1,4-dioxane plumes depicted by depth and geology to their respective HRLs (0.4 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 2022, along with cross-section lines, based on the May 2022 sampling event. The southern edge of the TCE and 1,4-dioxane contours in **Figures 2-1 and 2-4** are dashed where inferred near the southern boundary. **Figure 2-3** presents the combined Upper and Lower Unit 3 TCE plume with the highest concentrations residing near the OU2 source areas. As noted in Section 2.1, Health Risk Index (HRI) values were calculated for wells sampled during FY 2022 using the MDH Water Guidance and Additivity Calculator (MDH 2022) and are presented in **Table 2-2** and Appendix D. Calculations were performed in accordance with MDH guidance with the exception of TCE in some cases. Because the MDH HRL for TCE (0.4 µg/L) is lower than the detection limit (1.0 µg/L) of samples taken in FY2022, TCE results lower than 1.0 µg/L or non-detect were omitted from the calculations. Future sampling events will screen TCE at a lower detection limit in order to properly calculate HRI values in future sampling events. A boundary of wells with HRI values greater than 1 is depicted in **Figures 2-3 through 2-5**.

There were minor changes of the plumes in FY 2022,. The last significant changes of the plume came in FY 2019 with the Unit 3 plume shifting just downgradient of the OU2 source areas, Sites D, G, and I. The plume was updated using groundwater concentration data from the vertical aquifer profiling drilling event that took place from September through December 2019. In general, 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 formation) and bedding-plane fractures (Jordan). **Figures 2-4 and 2-5** 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.

Figure 2-1 shows the 1 µg/L TCE contour for Upper Unit 4 in 1990, 1999, 2009, and 2022. **Figures 2-6 and 2-7** overlap to some extent and should be viewed together. **Figure 2-8** depicts a cross-section showing the OU2/OU3 plume. **Figure 2-9** depicts the 100 µg/L TCE contour for Upper Unit 4 for certain years between 1990 and 2020, similar to **Figure 2-1**, 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 2-1** shows, the plume footprint remains similar to 2009. **Figure 2-9** shows a smaller plume compared to 2009 with the 2022 plume receding towards the northwest, potentially due to the NBCGRS. A slight northward shift was observed in FY 2015 and FY 2016 of the 5 µg/L and 100 µg/L TCE contours on the northwest edge of the plume, likely a result of the NBCGRS remedy time-out beginning in April 2015. This shift was first observed following the FY 2015 sampling event and was observed slightly farther north again in FY 2016. This trend appears to have reversed since the NBCGRS was started back-up and the plumes appear to have receded. The water level data from May 2022 for Upper Unit 4 are presented as a potentiometric map on **Figure 2-10**.

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 2004 Technical Memorandum (Army 2004) 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 COC concentrations."

The OU1 2004 Technical Memorandum identified five issues that need to be statistically evaluated with respect to the above objective:

Measure changing concentrations immediately downgradient of the TGRS, as this area is the first to be affected by any potential COC migration via TCAAP.

Measure changes in the geographical size of the plume over time.

Measure changes in concentrations immediately downgradient of the NBCGRS, as this is the first area to be affected by any potential COC migration outside of NBCGRS capture.

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.

Measure the long-term trends in overall VOC concentrations (as an indicator of COC mass). This provides an overall picture of remedial progress.

The OU1 2004 Technical Memorandum (Army 2004) 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 (EPA and MPCA). Appendix D.2.3 shows the factors to consider and potential additional actions that may be implemented if the statistical threshold is triggered. As Appendix D-2-3 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 discussed below.

Group 1: Downgradient of the TGRS capture zone—This zone should show reductions over time in response to TGRS mass removal and containment. Groundwater velocities may be reduced in this area and response may be slow. Furthermore, individual wells near the stagnation zone may show increases in COC 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 (less than 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 because 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 from regulators 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 monitoring wells 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 (Army 2004) and Appendix D-2.

Table 2-2 presents the FY 2022 groundwater quality data for OU1 collected to support the statistical analysis developed by the OU1 Technical Group. Historical TCE concentrations at any well can be viewed in the Appendix D Groundwater Quality: Organic Data spreadsheet included on the FY 2022 APR compact disc. The statistical analysis in Appendix D-2 follows the format described in the OU1 Technical Memorandum and Modification #1 (Army 2004).

Table 2-3 summarizes the statistical results wells sampled in FY 2022, from Appendix D-2. **Table 2-3** 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 2022 and have “increasing” or “no significant” trends are discussed below. For discussion of other wells or well groups, refer to the FY 2016 APR.

Group 2 (Plume Edge Wells):

409549 (No Significant Trend): TCE concentrations at this well have fluctuated between 4.4 µg/L and 220 µg/L since it was installed in 1985. The erratic increases and decreases in TCE concentrations over the years have resulted in a high “p-value” and results in no significant trend for this well. The concentration has been steadily increasing over the last 10 years but decreased to 23.7 µg/L in FY 2020 and 23.8 µg/L in FY 2022, which is well within the historical trend at the well.

409557 (No Significant Trend): Concentrations in this well were steadily increasing from 37 µg/L in FY 2009 to 82 µg/L in FY 2020. However, TCE concentration dropped to 2.85 µg/L in FY 2022. An apparent outlier in FY 2018 of 17 µg/L in addition to the most recent concentration results in the higher p-value preventing it from being statistically significant trend. Continued monitoring of this well is appropriate to evaluate how the plume is shifting.

03L833 (No Significant Trend): TCE concentrations show a generally decreasing trend since FY 2011 and have consistently been below 5 µg/L; therefore, a “no significant trend” result is not of concern.

03L848 (No Significant Trend): TCE concentrations show a generally decreasing trend since FY 2013 and have consistently been below 5 µg/L; therefore, a “no significant trend” result is not of concern.

03L859 (No Significant Trend): TCE concentrations show a generally decreasing trend since FY 2011 and fell below 5 µg/L in FY 2022; therefore, a “no significant trend” result is not of concern.

03U805 (Probably Increasing): TCE concentrations in this well had historically been below of 3 µg/L until FY 2013 when the concentration rose to 19 µg/L. Concentrations have since increased to 94 µg/L in FY 2020, but fell slightly in FY 2022 to 88.7 µg/L. The trend indicates an increasing trend and most likely reflects plume shift. This well is located on the southern edge of the OU1 plume immediately downgradient from the TGRS.

04U832 (No Significant Trend): TCE concentrations in this well were relatively stable, staying between 41 and 59 µg/L from 2005 to 2016. In FY 2022, the concentration fell to 14.7 µg/L.

04U833 (No Significant Trend): All results for TCE are below the 5 µg/L; therefore, a “no significant trend” result is not of concern.

04U843 (Increasing): Concentrations in this were steadily increasing from 98 µg/L in FY 2009 to 220 µg/L in FY 2018 and 207 µg/L in FY 2020. TCE concentration in FY 2022 fell significantly to 43.5 µg/L This well is in the central part of the north plume not far downgradient of the TGRS and just downgradient of 04U847, which has the highest concentration of TCE in OU1. As this area is outside of the TGRS capture zone, this well may continue to increase as migration of TCE from 04U847 continues downgradient.

04U845 (No Significant Trend): The erratic increases and decreases in TCE concentrations over the years have resulted in a high “p-value” and thus a no significant trend outcome for this well. The concentrations have ranged from 6.3 µg/L to 14 µg/L. Continued monitoring of this well is appropriate to evaluate how the plume is shifting.

04U846 (No Significant Trend): Concentrations in this well steadily increased from 10 µg/L in FY 2009 to 26 µg/L in FY 2016 and fluctuated until reaching 20.6 µg/L in FY 2022. These fluctuations in TCE concentration results in the higher p-value preventing it from being statistically significant trend. Concentrations at this well have historically been erratic, with a maximum concentration of 120 µg/L in FY 1988 and dipping down below 1 µg/L from FY 1998 through FY 2001. It is located towards the south side of the OU1 plume. The historically erratic trend is likely due to varying flow patterns created by the NBCGRS.

04U849 (No Significant Trend): Concentrations at this well appear to be stable toward decreasing. Concentrations decreased from 70.3 µg/L in FY 2020 to 39.3 µg/L in FY 2022. This well is located near the center of the plume and is expected to have stable concentrations with no significant trends.

04U854 (No Significant Trend): Concentrations at this well appear to be stable, and the overall raw trend is decreasing. Concentrations decreased from 70.3 µg/L in FY 2013 to 5.97 µg/L in FY 2022.

04U875 (No Significant Trend): Concentrations of TCE at this well have consistently been below 3 µg/L since FY 2009; therefore, a “no significant trend” result is not of concern.

04U877 (No Significant Trend): Concentrations of TCE at this well have consistently been below 2 µg/L since FY 2009; therefore, a “no significant trend” result is not of concern.

Group 5 Unit 3 Wells:

409550 (No Significant Trend): TCE concentrations were between 24.7 µg/L and 34 µg/L from FY 2009 to FY 2020. In FY 2022, the TCE concentration decreased to 17 µg/L. The raw trend for this well is slightly decreasing. The well is in the center of the north plume and therefore the likely represents slight shifts in the core of the plume.

03U822 (No Significant Trend): TCE concentrations increased from 120 µg/L in FY 2009 to 160 µg/L in FY 2013 before stabilizing at 150 µg/L in FY 2015 and FY 2016. The concentration has since fallen sharply to 42 µg/L in FY 2018 and 18.5 µg/L in FY 2020. This well is in the center of the north plume and therefore the erratic concentrations most likely represent slight shifts in the core of the plume.

Group 6 (Jordon Wells):

04J708 (Increasing): TCE concentrations at this well have increased steadily since FY 2009, though decreased slightly from 8.73 µg/L in FY 2020 to 6.45 µg/L in FY 2022. This well is located on the southern edge of the OU1 plume and may indicate a slight shift or expansion of the plume.

04J834 (No Significant Trend): Concentrations of TCE at this well have consistently been non-detect or less than 1 µg/L since FY 2009; therefore, a “no significant trend” result is not of concern.

04J836 (No Significant Trend): This well is directly downgradient from the NBCGRS. TCE concentrations have increased slightly from 10 µg/L in FY 2013 to 40 µg/L in FY 2016 and then decreased to 26 µg/L in FY 2018. Concentrations again fell in FY 2020 to 2.85 µg/L and was non-detect in FY 2022. This general increase from FY 2013 to FY 2016 may have been influenced by the NBCGRS shut down in FY 2015.

04J837 (No Significant Trend): Concentrations of TCE at this well have consistently been less than 4 µg/L since FY 2009 with the exception of a concentration of 12 µg/L in FY 2015. The “no significant trend” result is not of concern as long as the TCE concentration continues to remain below the TCE cleanup limit of 5 µg/L.

04J838 (No Significant Trend): TCE concentrations at this well have historically been stable around 30 µg/L; however, in FY 2018 the concentration decreased to 0.91 µg/L. The concentration in FY 2022 was 45.2 µg/L, which is within the historical range.

04J839 (No Significant Trend): TCE concentrations at this well have historically been below 5 µg/L; however, in FY 2018 the concentration increased to 6.1 µg/L and again increased to 28.6 µg/L in FY 2020. The concentration once again fell below 5 µg/L in FY 2022. This well is downgradient from the NBCGRS and may show the plume is shifting northwards slightly. Continued monitoring is appropriate to further evaluate how the OU1 plume is shifting.

04J847 (No Significant Trend): This well is located just downgradient of the TGRS. TCE concentration decreased to 416 µg/L in FY 2022 from 525 µg/L in FY 2020. The overall trend is still stable or possibly slightly decreasing 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. The concentration decreased again in FY 2018 to 1.3

µg/L, 1.4 µg/L in FY 2020, and was measured at 4.13 µg/L in FY 2022. Continued annual monitoring is appropriate to further evaluate how the OU1 plume is shifting.

04U713 (No Significant Trend): Concentrations of TCE at this well have consistently been non-detect or less than 1 µg/L since FY 2009; therefore, a "no significant trend" result is not of concern.
04U834 (No Significant Trend): Concentrations of TCE at this well have consistently been non-detect or less than 2 µg/L since FY 2009 with the exception of a concentration of 6.1 µg/L in 2018. In FY 2022, the concentration was 1.19 µg/L. The "no significant trend" result is not of concern as long as the TCE concentration remains below the cleanup limit of 5 µg/L.

04U837 (No Significant Trend): This well is near the NBCGRS; therefore, greater variability is expected. TCE concentrations at this well have historically remained below 5 µg/L; therefore, a "No Significant Trend" result is not of concern.

04U838 (No Significant Trend): TCE concentrations have been below 3 µg/L since FY 2009 but increased to 47 µg/L in FY 2018. In FY 2020 and FY 2022 this concentration was once again below 3 µg/L. Continued monitoring will be conducted to assess the overall trend.

04U839 (Probably Increasing): This well is near the NBCGRS; therefore, greater variability is expected. The well is located on the west/northwest edge of the plume and has historically had concentrations below 3 µg/L; however, the concentration increased to 50 µg/L in FY 2016. The concentration has been consistently decreasing since then and measured 23.8 µg/L in FY 2022. The increase may have been influenced by the NBCGRS shut down.

04U847 (No Significant Trend): Concentrations at this well appear to be overall decreasing since FY 2013. Concentrations decreased from 359 µg/L in FY 2020 to 244 µg/L in FY 2022. Continued monitoring will be conducted to assess the overall trend.

04U849 (No Significant Trend): Concentrations at this well appear to be stable toward decreasing. Concentrations decreased from 70.3 µg/L in FY 2020 to 39.3 µg/L in FY 2022. This well is located near the center of the plume and is expected to have stable concentrations with no significant trends.

Overall Statistical Assessment:

Discussion of established threshold triggers can be found Appendix D. These triggers highlight specific areas of the plume that are changing over time. This type of behavior is expected in a large complex flow system such as OU1. The thresholds triggered do not suggest any problems with the remedial systems but suggest movement within the established plumes. Overall, the data met the statistical criteria developed in this APR for assessing the remedial progress in the OU1 aquifers. The data show continuing improvement in the OU1 plume through FY 2022. 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 removed a total of approximately 307 pounds (lb) of VOCs during FY 2022. NBM wells #3, #4, #5, #6, #14, and #15 removed 101 lb, 73 lb, 75 lb, 54 lb, 1 lb, and 1 lb, respectively. The total cumulative VOCs removed by the NBCGRS through the end of FY 2021 is 24,854 lb.

Figure 2-11 shows the annual VOC mass removed (graph top), annual pumping volumes, and annual mass removal per unit volume pumped since FY 1997 (when NBM well #14 was brought online). Mass removal in FY 2022 was similar to FY 2021, albeit slightly less than mass removal prior 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. Evaluation of the NBCGRS operating strategy began in FY 2022, with the possibility that NBM #14 and NBM #15 may be abandoned in favor of a pumping location more central to the plume.

2.7 OTHER RELATED ACTIVITY IN FY 2022

A final Well Inspection Report was submitted in September 2021 (Army 2021c). Based on the findings of the investigation and inspections, a new drinking water supply well was scheduled to be installed in May 2022, though as of FY 2022, installation is on hold.

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3. OPERABLE UNIT 2: SHALLOW SOIL AND DUMP SITES

The 1997 OU2 ROD (Army et al. 1997) and subsequent Amendments and ESDs are discussed in Sections 3 through 11 of this APR. This section specifically addresses the shallow soil and dump sites. Relevant modifications to the 1997 OU2 ROD include Amendments #1 (Army et al. 2007), #3 (Army et al. 2009), #4 (Army et al. 2012), #5 (2014), and ESD #2 (Army 2009b).

Through the OU2 Remedial Investigation (RI)/FS process, Sites A, C, E, H, 129-3, and 129-5 were found to have inorganic and/or organic COCs above the cleanup goals specified in Table 1 of the 1997 OU2 ROD. Unpermitted landfills, or dumps, were identified within Sites A, B, E, H, and 129-15. The 1997 OU2 ROD (page 2) describes nine remedy components to address the shallow soil and dump sites and the 2014 OU2 ROD Amendment #5 established the following remedy components:

1 through 9) Soil Remediation*

10) Land Use Controls

Each of the remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD.

The OU2 ROD Amendment #1 (Army et al. 2007) modified the requirements for Site C-2 soil and sediment (note that Site C groundwater and surface water is addressed separately in Section 6). 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 (ft) thick soil cover over areas where impacts remain in-place above the cleanup levels. The OU2 ROD Amendment #1 (Army et al. 2007) also specified land use controls (LUCs) as an additional remedy component for Site C-2.

The OU2 ESD Amendment #2 (Army et al. 2009a) addressed shallow groundwater at Site I, which is discussed in Section 7.

The OU2 ROD Amendment #3 (Army et al. 2009b) affected the shallow soil and dump sites in four principal ways:

OU2 ROD Amendment #3 (Army et al. 2009b) 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 1997 OU2 ROD (see Section 4 of this APR for discussion of the deep soil).

OU2 ROD Amendment #3 (Army et al. 2009b) documented the use of soil covers as part of the final remedy at Sites E, G, H, and 129-15.

OU2 ROD Amendment #3 (Army et al. 2009b) documented final remedies for five sites with soil impacts that were not originally included in the 1997 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 impacts 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.

OU2 ROD Amendment #3 (Army et al. 2009b) 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 impact 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) (Army 2020b).

ESD #1 (Army 2009a) is discussed in Section 5 (Site A shallow groundwater), Section 8 (Site K shallow groundwater), and Section 11 (OU2 deep groundwater).

ESD #2 (Army 2009b) 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.

The OU2 ROD Amendment #4 (Army et al. 2012) 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 OU2 ROD Amendment #4 (Army et al. 2012) also addressed Building 102 shallow groundwater, discussed in Section 9, and OU2 aquatic sites, discussed in Section 10.

The OU2 ROD Amendment #5 (2014) 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. At this point, remedies 1 through 9 for shallow soil and dump site are complete. It also documents that LUCs are required at these sites. Appendix J.2 provides a summary of OU2 Shallow Soil and Dump Sites historical design, evaluation, and modification details.

3.1 LAND USE CONTROLS

OU2 ROD Amendments and ESDs established LUCs as part of the remedy for shallow soil and dump sites where impacts remain-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.

Initial implementation was done when EPA 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.

EPA and MPCA provided consistency approval for the OU2 LUCRD (Army 2020b) in September 2010 and it has been implemented by the Army and revised as follows:

Revision 1 (September 2010): Final document approved.
Revision 2 (June 2011): Revised LUCs for two portions of Arden Hills Army Training Site: 1) unrestricted use for watchable wildlife area; and 2) restricted commercial use for part of the cantonment area.

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Revision 3 (March 2015): Revised LUCs for the remainder of the AHATS cantonment area and the Army Reserve Center to restricted commercial use; updated for the transfer/lease of 427 acres of U.S. Army / BRAC-controlled property to Ramsey County.

Revision 4 (August 2016): Revised LUCs to eliminate 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.

Revision 5 (Mar 2018): Revised LUCs to allow recreational use on 108 acres in the western portion of OU2 to be used as part of the Rice Creek Regional Trail Corridor.

Revision 6 (October 2020): Expanded to include descriptions of conditions and LUCs in place at OU1 and OU3. Documented the partial delisting of soil and surface water and sediment (not groundwater) at five aquatic sites located within OU2.

Figure 1-4 presents the OU2 site boundary and property owners within OU2.

On 14 June 2022, the Army, MNARNG, and GHD conducted the annual inspection of OU2 sites which ensures that the remedy is performing to standards. The checklist that was completed during the inspection is included as Appendix F. The inspection did not identify any follow-up actions needed to maintain the protectiveness of the LUCs.

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4. OPERABLE UNIT 2: DEEP SOIL SITES

For purposes of the 1997 OU2 ROD (Army et al. 2007), Sites D and G were considered deep soil sites because VOC impacts extended to depths between 50 and 170 ft. Some additional shallow soil COCs were also present at Site D, and Site G also contains a dump. The 1997 OU2 ROD (Army et al. 2007) (pages 2 to 3) describes seven remedy components to be implemented for these two sites:

1) Groundwater Monitoring
2) Restrict Site Access (During Remedial Actions)*
3) Soil Vapor Extraction (SVE) Systems*
4) Enhancements to the SVE Systems*
5) Maintain Existing Site Caps*
6) Maintain Surface Drainage Controls*
7) Characterize Shallow Soils and Dump*

Each of the remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD.

The deep soil requirements of the 1997 OU2 ROD (Army et al. 2007) have been completed. Appendix J.6 provides a summary of Site I historical design, evaluation, and modification details. There are ongoing LUC requirements for the shallow soil at Site D and the dump at Site G, as discussed in Section 3.

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5. OPERABLE UNIT 2: SITE A SHALLOW GROUNDWATER

Shallow groundwater at Site A has been impacted by VOCs and antimony. The selected remedy in the 1997 OU2 ROD (Army et al. 2007) incorporates the use of a groundwater extraction system, which began operation 31 May 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 in Appendix J.4, the groundwater system ceased operation (with regulatory approval) on 24 September 2008, while implementation of MNA was being evaluated. The remedies selected consisted of the following five components:

1) Groundwater Monitoring

3A) Land Use Controls

3B) Alternate Water Supply/Well Abandonment

5) Source Characterization/Remediation*

6) Overall Remedy for Site A Shallow Groundwater

Each of the remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD. Appendix J.4 provides a summary of Site A historical design, evaluation, and modification details.

5.1 GROUNDWATER MONITORING

Groundwater monitoring was performed in FY 2022 in accordance with the groundwater monitoring program. **Table 5-1** summarizes performance monitoring requirements, implementing parties, and monitoring plan documents. The FY 2022 Monitoring Plan is included in Appendix A, and the FY 2022 water quality monitoring locations and frequencies are also summarized on **Figure 5-1**. Any deviations are explained in Appendix C.2. **Figure 5-2** presents May 2022 measured groundwater elevations and groundwater contours.

Annual sampling of Site A groundwater monitoring wells in FY 2023 will be according to the Monitoring Plan in Appendix A.1.

5.2 LAND USE CONTROLS

OU2 ROD Amendments and ESDs established LUCs as part of the remedy for Site A. LUCs are also necessary to restrict new well installations and protect the groundwater monitoring and extraction system infrastructure.

Initial implementation was done when EPA and MPCA provided consistency approval for an OU2 LUCRD document. Implementation of LUC will continue until such time that the groundwater concentrations are below the cleanup levels.

EPA and MPCA provided consistency approval for the OU2 LUCRD (Army 2020b) in September 2010 and it has been implemented by the Army and revised as follows:

Revision 1 (September 2010): Final document approved.

Revision 2 (June 2011): Revised LUCs for two portions of Arden Hills Army Training Site: 1) unrestricted use for watchable wildlife area; and 2) restricted commercial use for part of the cantonment area.

Revision 3 (March 2015): Revised LUCs for the remainder of the AHATS cantonment area and the Army Reserve Center to restricted commercial use; updated for the transfer/lease of 427 acres of U.S. Army / BRAC-controlled property to Ramsey County.

Revision 4 (August 2016): Revised LUCs to eliminate 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.

Revision 5 (Mar 2018): Revised LUCs to allow recreational use on 108 acres in the western portion of OU2 to be used as part of the Rice Creek Regional Trail Corridor.

Revision 6 (October 2020): Expanded to include descriptions of conditions and LUCs in place at OU1 and OU3. Documented the partial delisting of soil and surface water and sediment (not groundwater) at five aquatic sites located within OU2.

MDH issued a SWBCA Advisory in June 1996 and revised it in December 1999 and April 2016; however, these revisions did not affect the boundary for Site A.

On 14 June 2022 the Army, MNARNG, and GHD conducted the annual inspection of OU2 sites which ensures that the remedy is performing to standards. The checklist that was completed during the inspection is included as Appendix F. The inspection did not identify any follow-up actions needed to maintain the protectiveness of the LUCs.

5.3 ALTERNATE WATER SUPPLY/WELL ABANDONMENT

The 1997 OU2 ROD (Army et al. 1997) (page 3) established as institutional controls to provide alternate water supplies and well abandonment as necessary as a remedy, and was later expanded to include Site A. The performance standard of the remedy is considered completed 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).

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. Section 2.1 provides further information.

In 2019, it appeared that the groundwater plume is moving in a northwestern direction past the boundary of TCAAP and contingency well locations. An investigation to delineate the Site A shallow groundwater plume and assess the potential for vapor intrusion (VI) risk to nearby receptors was conducted from March to June 2021. Findings were provided in the Site A Investigation Final Report (Army 2021d). Based on the findings of the investigation, soil vapor results were not considered to pose a risk to receptors, and it was determined that the leading edge of the groundwater plume did not extend into the residential community to the north. Sampling of the newly installed residential wells to the north in FY 2021 and FY 2022 also support this determination.

Table 5-2 presents the FY 2022 groundwater quality data for Site A. Using these data, **Figure 5-3** shows the tetrachloroethene (PCE) concentrations and **Figure 5-4** shows the *cis*-1,2-dichloroethene (*cis*-1,2-DCE) concentrations. The latter is a degradation product of the former and represents the larger aerial footprint. The plume for *cis*-1,2-DCE did not increase in size to the east and west from FY 2021 to FY 2022 as shown on **Figure 5-5**. Based on sampling of the newly installed wells to the north (01U905, 01U906, and 01U907), the plume does notpose potential exposure risk to the northwest residential area based on FY 2022 results, and both plumes have shrunk over time.

No additional water supply wells discovered within the area of concern for the Site A plume that are completed within the aquifer of concern.

5.4 SOURCE CHARACTERIZATION/ REMEDIATION

The 1997 OU2 ROD (Army et al. 1997) (page 3) established source characterization/remediation as a remedy for Site A. Characterization is required to determine whether remedial actions are necessary. Remedial actions are considered complete when all remedial action objectives (RAOs) are met, in this case when soil COC concentrations are below cleanup levels specified in Table 1 of the 1997 OU2 ROD (Army et al. 1997). Source characterization and remediation has been completed. Details of the Site A investigation and remediation activities are found in Appendix J.4.

5.5 OVERALL REMEDY FOR SITE A SHALLOW GROUNDWATER

As of FY 2022, the Site A shallow groundwater results have not attained the cleanup levels in Table 1 of the 1997 OU2 ROD (Army et al. 1997) throughout the aerial and vertical extent of the Site A plume (page 54).

Table 5-2 presents the FY 2022 groundwater quality data and highlights the values that exceed cleanup levels. The cleanup level of *cis*-1,2-DCE (70 µg/L) was exceeded at 01U139 (653 µg/L), 01U902 (99.8 µg/L), and 01U353 (81.0 µg/L). The cleanup level of PCE (7 µg/L) was exceeded at 01U126 (7.01 µg/L). None of the other COCs exceeded their respective cleanup levels in FY 2022.

As evident in **Table 5-2**, and on **Figures 5-3 and 5-4**, 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 5-6** shows the *cis*-1,2-DCE concentrations plotted on geologic cross sections to illustrate the vertical extent of impacts (the cross-section locations are illustrated on **Figure 5-4**). *Cis*-1,2-DCE continues to be degraded via an abiotic process as the plume migrates. EPA and MPCA initially evaluated attenuation at the Site using computer modeling of COC degradation, as documented in Evaluation of Natural Attenuation of Chlorinated Solvents in Ground Water at the Twin Cities Army Ammunition Plant (MPCA and EPA 2000). MPCA conducted a follow-up microcosm study (unpublished), the results of which were presented to the Army and EPA on 10 April 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 (VC), which is no longer monitored at the Site given the historical lack of detections that led to the 1997 OU2 ROD not selecting this compound as a COC.

Since September 2008 when the “first line” of extraction wells were shut off, some wells have shown decreased concentrations while others have, in some periods, shown increased concentrations (**Figures 5-7 through 5-10**). Collectively, the *cis*-1,2-DCE water quality trends evident on **Figures 5-7 through 5-10** indicate the concentrations have essentially stabilized. Historically, 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 5-10**); however, during FY 2022, contingency location 01U902 had a *cis*-1,2-DCE concentration of 99.8 µg/L while all other contingency locations remained below the cleanup level. The concentration of *cis*-1,2-DCE at 01U902 decreased significantly from the FY 2021 result of 173 µg/L. A 2021 investigation by the Army (Army 2021d) concluded through the installation of new wells that the groundwater results did not indicate the leading edge of the plume had extended into the residential community to the north.

Concentrations of *cis*-1,2-DCE in 01U901 and 01U903 have been at or near ND since 2008. Throughout their lifetime, these concentrations have been well below the cleanup level.

The concentrations of *cis*-1,2-DCE in 01U902 had stabilized between 15 and 20 µg/L by June 2013; however, concentrations began to increase in 2016. *Cis*-1,2-DCE concentrations for well 01U902 were 29 µg/L in 2016, 35 µg/L in 2017, and then exceeded the cleanup level with 92 µg/L in 2018. Since 2018, the concentration dropped below the cleanup level with 42 µg/L in FY 2019 and 37 µg/L in FY 2020, and increased above the cleanup level again in FY 2021 with 173 µg/L. The concentration remained above the cleanup level in FY 2022 (99.8 µg/L), though decreased significantly from last year's concentration.

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 stabilized between approximately 20 and 30 µg/L through FY 2017 before becoming ND since FY 2018.

Concentrations of *cis*-1,2-DCE at EW-8 have been less than 1 µg/L 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 ND in FY 2019, FY 2020, and FY 2021.

Through FY 2016, *cis*-1,2-DCE concentrations at EW-5 appeared to have stabilized below the cleanup level; however, concentrations increased from 32 µg/L in FY 2016, to 200 µg/L in FY 2017, and to 300 µg/L in FY 2018. Since FY 2018, concentrations have once again dropped below cleanup levels to 1.8 µg/L in 2019, 0.4 µg/L in 2020, 31.8 µg/L in 2021, and 12.8 µg/L in 2022.

A generally increasing trend of *cis*-1,2-DCE concentrations above the cleanup level had been observed at EW-6 from 78 µg/L in FY 2012 to 290 µg/L in FY 2017. These concentrations have since fallen below the cleanup level every year since FY 2018. The reason for this is unclear but continued monitoring of EW-6 will be performed.

In the monitoring wells located between the two rows of extraction wells (**Figure 5-8**), 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 µg/L and then to 710 µg/L in FY 2018. This upward trend did not continue as this concentration decreased in June 2019 to 180 µg/L and then increased to 389 µg/L in FY 2020 and 1,030 µg/L in FY 2021. The result decreased in FY 2022 (653 µg/L). Future monitoring will be evaluated to confirm the overall trend, as concentrations have continued to fluctuate since 2017.

Well 01U140, after showing three exceedances of the cleanup level between 80 and 100 µg/L in FY 2011 and FY 2012, has shown a steadily declining *cis*-1,2-DCE concentration to 0.60 µg/L in FY 2019, ND in FY 2020, 3.62 µg/L in FY 2021, and 3.29 µg/L in FY 2022.

Well 01U157 had two slight exceedances of the *cis*-1,2-DCE cleanup level in FY 2011 and FY 2012 of 73 and 96 µg/L and then 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. This peak was not sustained though as the concentration decreased to ND in FY 2018, 0.44 µg/L in FY 2019, and 1 µg/L in FY 2020. The concentration increased during FY 2021 to 30.6 µg/L and 44.3 µg/L in FY 2022. Future monitoring will be evaluated to confirm the overall trend.

Well 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 concentration decreased to 13 µg/L and was 12 µg/L in FY 2018. In June 2019, this concentration increased to 55 µg/L; however, this concentration then became ND in 2020. The concentration was 11.3 µg/L in FY 2021, and the result from FY 2022 was 53 µg/L. The overall trend at this location still appears to be relatively stable.

In EW-1 through EW-4 (**Figure 5-7**), concentrations of *cis*-1,2-DCE have historically been at or near ND since FY 2010 or earlier. Sampling has been discontinued at EW-1 and EW-4, as discussed in Section 5.1. In FY 2022, samples collected showed *cis*-1,2-DCE concentrations of ND in EW-2, though the concentration increased above the cleanup level at EW-3 (81 µg/L), the first time that has been observed since 2015.

The three new monitoring wells, 01U905, 01U906, and 01U907, installed in 2021 in the residential community to the north, were all near ND (0.131 J, 0.242 µg/L, and 0.141 µg/L, respectively) in FY 2022. These results were similar to those observed in 2021.

In summary, the *cis*-1,2-DCE plume has largely stabilized following shutdown of EW-1 through EW-4 in FY 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, which had been increasing since FY 2016, decreased from FY 2021 to FY 2022, though still remained above the cleanup level. This will require continued monitoring to assess this potential overall 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). The 2022 plume investigation and newly installed monitoring well results further supported the shifting of the axis of the plume by demonstrating through new monitoring well installation that the groundwater plume has not shifted to affect the residential community to the north.

The four contingency locations are 01U901, 01U902, 01U903, and 01U904, 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 01U902 had a result in FY 2022 that exceeded the cleanup level of 70 µg/L for *cis*-1,2-DCE (**Table 5-2**). As noted previously, 01U901 and 01U903 have been at or near ND for *cis*-1,2-DCE since FY 2008 and well below the cleanup level throughout their history. Concentrations of *cis*-1,2-DCE in 01U904 show a stable trend with *cis*-1,2-DCE concentrations below the cleanup level of 70 µg/L with the past four annual events being NDs. Concentrations of *cis*-1,2-DCE at 01U902 have been generally increasing since FY 2015, with FY 2018, FY 2021, and FY 2022 being the only years the well exceeded the cleanup level.

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:

The 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 exceeded).

The Army will prepare and submit a plan to address the exceedance to EPA and MPCA for approval.

The 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 prior to 2008. 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 VI risk. A VI 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 (now Stantec) Installation Support Services, May 2005. This report concluded the VI pathway for the off-site Site A plume was incomplete because the concentrations in groundwater were below the EPA generic screening criteria. However, no actual soil vapor sampling was conducted for that report. In December 2012, MPCA requested that soil vapor sampling be conducted because their 2008/2010 VI guidance is newer than the 2005 report and states that groundwater screening levels should not be used as a single line-of-evidence for decisions regarding VI risk. Based on this MPCA request, the Army prepared an investigation QAPP, which was approved by EPA and MPCA in June 2013, and then conducted the VI investigation work in July 2013. This work was documented in the 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.

Due to the shifting of the Site A plume downgradient since the June 2013 investigation work, an additional groundwater and soil vapor investigation was conducted in 2021 as a contingency action. New monitoring well installation and soil vapor sampling demonstrated that the Site A shallow groundwater plume was not affecting the residential community to the north and the soil vapor results showed that the constituents of concern were all below MPCA residential Intrusion Screening Values and did not pose a risk to receptors. These monitoring wells from the 2021 investigation continued to show that the plume did not pose a risk to receptors in the residential area in FY 2022. They will be sampled according to the Monitoring Plan in FY 2023, and the data will be further evaluated.

With regard to the first contingency action, according to the TCAAP Well Inventory and MDH records, the well at 1783 Pinewood Drive was sealed in 2014. No further action is required in this contingency action.

In the 11 November 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 VI 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) was sealed in 2014; and (3) 1,4-dioxane was not found to be present in Site A shallow groundwater. The OU2 ROD Amendment #6 (2018) was approved in FY 2018, changing the remedy to MNA for Site A shallow groundwater.

Annual monitoring of Site A wells for VOCs will continue in FY 2023 according to the Monitoring Plan in Appendix A.

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6. OPERABLE UNIT 2: SITE C SHALLOW GROUNDWATER

Impacts to Site C shallow groundwater had not occurred at the time of the 1997 OU2 ROD (Army et al. 1997). In FY 1997, the U.S. Army Environmental Command (USAEC) 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. It 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. The OU2 ROD Amendment #1 (Army et al. 2007) incorporated the existing groundwater extraction system as the final remedy which consists of the following five components:

1) Groundwater and Surface Water Monitoring

2) Groundwater Containment*

3) Discharge of Extracted Groundwater*

4) Land Use Controls

5) Overall R`1emedy for Site C Shallow Groundwater

Each of the remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD. Appendix J.5 provides a summary of Site C historical design, evaluation, and modification details.

6.1 GROUNDWATER AND SURFACE WATER MONITORING

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

Table 6-1 summarizes the performance monitoring requirements, the implementing parties, and the documents that contain the Monitoring Plans. FY 2022 monitoring was conducted in accordance with the Monitoring Plan included in Appendix A. The water quality monitoring locations and frequencies are also summarized on **Figure 6-1**, and any deviations explained in Appendix C.2.

Groundwater and surface water monitoring at Site C will continue in accordance with the Monitoring Plans shown in Appendixes A.1 and A.3, respectively. No changes to the remedy or additional actions are required at this time.

6.2 GROUNDWATER CONTAINMENT

This remedy is no longer being implemented because the area of lead concentrations that exceed the groundwater cleanup level no longer extends to the extraction wells. As such, the extraction system is no longer operating.

6.3 DISCHARGE OF EXTRACTED WATER

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

6.4 LAND USE CONTROLS

OU2 ROD Amendment #1 (Army et al. 2007) established LUCs as part of the remedy for Site C. LUCs are also necessary to restrict new well installations and protect the groundwater monitoring and extraction system infrastructure.
Initial implementation was done when EPA and MPCA provided consistency approval for an OU2 LUCRD document. Implementation of LUC will continue until such time that the groundwater concentrations are below the cleanup levels.

EPA and MPCA provided consistency approval for the OU2 LUCRD (Army 2020b) in September 2010 and it has been implemented by the Army and revised as follows:

Revision 1 (September 2010): Final document approved.

Revision 2 (June 2011): Revised LUCs for two portions of Arden Hills Army Training Site: 1) unrestricted use for watchable wildlife area; and 2) restricted commercial use for part of the cantonment area.

Revision 3 (March 2015): Revised LUCs for the remainder of the AHATS cantonment area and the Army Reserve Center to restricted commercial use; updated for the transfer/lease of 427 acres of U.S. Army / BRAC-controlled property to Ramsey County.

Revision 4 (August 2016): Revised LUCs to eliminate 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.

Revision 5 (Mar 2018): Revised LUCs to allow recreational use on 108 acres in the western portion of OU2 to be used as part of the Rice Creek Regional Trail Corridor.

Revision 6 (October 2020): Expanded to include descriptions of conditions and LUCs in place at OU1 and OU3. Documented the partial delisting of soil and surface water and sediment (not groundwater) at five aquatic sites located within OU2.

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.

On 14 June 2022 the Army, MNARNG, and GHD conducted the annual inspection of OU2 sites which ensures that the remedy is performing to standards. The checklist that was completed during the inspection is included as Appendix F. The inspection did not identify any follow-up actions needed to maintain the protectiveness of the LUCs.

6.5 OVERALL REMEDY FOR SITE C SHALLOW GROUNDWATER

As of FY 2022, the Site A shallow groundwater results have not attained the cleanup levels in Table 1 of the 1997 OU2 ROD (Army et al. 1997) throughout the aerial and vertical extent of the Site A plume (page 54). Therefore, the remedy is still ongoing.

Table 6-2 presents FY 2022 groundwater quality data and highlights the values that exceed the lead cleanup level. Surface water quality data are presented on **Table 6-3**. **Figure 6-2** presents groundwater elevation contours based on groundwater measurements at Site C wells in June 2020. **Figure 6-3** shows the lead results for groundwater and surface water locations. **Figures 6-4 and 6-5** show the lead concentrations plotted on geologic cross sections for Site C to illustrate the vertical extent of impacts (the cross-section locations are illustrated on **Figure 6-3**).

In FY 2022, lead exceeded the groundwater cleanup level of 15 µg/L in one monitoring well located near the source area (01U573). The lead concentrations at 01U573 was detected at 21.6 µg/L. The water quality trends (dissolved lead) for wells nearest the source (01U563, 01U573, 01U574, and 01U575) are shown on **Figure 6-6**. **Figure 6-6** indicates the variable concentrations observed at individual wells in FY 2022 have 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 results were all below the surface water cleanup level in FY 2022.

The Site C contingency locations and trigger levels are shown in **Table 6-4**. Depending on the location, the trigger level is either equal to the groundwater cleanup level or a surface water cleanup level. Groundwater and surface water results (**Tables 6-2 and 6-3**) show that trigger levels were not exceeded in FY 2022. If a trigger level were exceeded, the Army would implement contingency action(s) specified in the footnotes to **Table 6-4**.

Site C wells have had overall stable COC concentrations with a large decrease in the source area over the past 10 years, and the existing groundwater plume does not appear to be migrating. Since one well still exceeded the cleanup level, continued monitoring of the Site will be performed to evaluate when closure for Site C is appropriate.

7. OPERABLE UNIT 2: SITE I SHALLOW GROUNDWATER

VOCs have been identified in the Unit 1 (perched aquifer) at Site I. The selected remedy in the 1997 OU2 ROD (Army et al. 1997) consisted of the following four components:

1. Groundwater Monitoring
2. Groundwater Extraction
3. POTW discharge
4. Additional Characterization

The additional investigation and Predesign Investigation 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. Appendix J.6 provides a summary of Site I historical design, evaluation, and modification details.

The OU2 ROD Amendment #2 (Army et al. 2009a) revised the requirements for shallow groundwater to:

1. Groundwater Monitoring
2. Additional Characterization *
3. Land Use Controls (LUCs)

Each of the above remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD.

This section does not include work related to the deep groundwater at Site I. Discussion of this work is provided in Section 11, including, but not limited to: subsurface investigations, source area extraction well (SC-1) operation and re-routing from the Boundary Groundwater Recovery System (BGRS), and installation of additional source area extraction wells (SC-9, SC-10, SC-11) and their connection to and operation within the new Source Area Groundwater Recovery System (SGRS).

7.1 GROUNDWATER MONITORING

Groundwater monitoring is conducted to track remedy performance. **Table 7-1** summarizes the performance monitoring requirements, the implementing parties, and documents containing Monitoring Plans. Appendix A summarizes the FY 2022 Monitoring Plan, and any deviations are explained in Appendix C.2.

As requested by Northrup Grumman (Orbital ATK at the time) in their letter dated 12 August 2013, and approved by EPA and MPCA on 14 August 2013, all Unit 1 monitoring wells within Site I were abandoned in 2014 prior to the demolition of Building 502. In accordance with the

Northrup Grumman request and regulatory approval, monitoring well 01U667 will be reinstalled at the same location and depth.

The reinstallation of 01U667 has been delayed since the location has been slated for significant redevelopment-related regrading (based on discussions with Ramsey County). It was understood that if installed, the well would again require replacement. Army intends to reinstall 01U667 during the summer of 2023. Because well 01U667 was not replaced in FY 2022, no groundwater sampling was conducted during FY 2022. Once reinstalled, monitoring well 01U667 will be sampled annually in accordance with the FY 2022 – FY 2026 Monitoring Plan (Appendix A.1). **Figure 7-1** 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 7-2**.

7.2 LAND USE CONTROLS

LUCs were 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. Implementation of the LUCs will continue until the groundwater concentrations are below the cleanup levels.

EPA and MPCA provided consistency approval for the OU2 LUCRD (Army 2020b) in September 2010 and it has been implemented by the Army and revised as follows:

Revision 1 (September 2010): Final document approved.

Revision 2 (June 2011): Revised LUCs for two portions of Arden Hills Army Training Site: 1) unrestricted use for watchable wildlife area; and 2) restricted commercial use for part of the cantonment area.

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Revision 3 (March 2015): Revised LUCs for the remainder of the AHATS cantonment area and the Army Reserve Center to restricted commercial use; updated for the transfer/lease of 427 acres of U.S. Army / BRAC-controlled property to Ramsey County.

Revision 4 (August 2016): Revised LUCs to eliminate 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.

Revision 5 (Mar 2018): Revised LUCs to allow recreational use on 108 acres in the western portion of OU2 to be used as part of the Rice Creek Regional Trail Corridor.

Revision 6 (October 2020): Expanded to include descriptions of conditions and LUCs in place at OU1 and OU3. Documented the partial delisting of soil and surface water and sediment (not groundwater) at five aquatic sites located within OU2.

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 and 2015, the Site is now suitable for unrestricted use/unlimited exposure and soil LUCs at Site I are no longer necessary. EPA and MPCA provided consistency approval for the OU2 LUCRD Revision 5 in March 2018, which formally removed Site I soil LUCs.

On 14 June 2022, the Army, MNARNG, and GHD conducted the annual inspection of OU2 sites which ensures that the remedy is performing to standards. The checklist that was completed during the inspection is included as Appendix F. The inspection did not identify any follow-up actions needed to maintain the protectiveness of the LUCs.

7.3 OVERALL REMEDY FOR SITE I SHALLOW GROUNDWATER

The overall remedy for Site I Shallow Groundwater will be completed once the cleanup levels in Table 1 of the 1997 OU2 ROD (Army et al. 1997) have been attained throughout the aerial and vertical extent of the Site I plume. This remedy has not yet been completed.

Groundwater monitoring was not conducted in FY 2022 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 7-2** presents FY 2013 data and highlights values that 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 (1,2-DCE) and VC remained above the cleanup levels. **Figure 7-3** presents the FY 2013 Site I shallow groundwater TCE and VC sample results.

8. OPERABLE UNIT 2: SITE K SHALLOW GROUNDWATER

VOC impacts have 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. Appendix J.7 provides a summary of Site K historical design, evaluation, and modification details.

The remedy selected consisted of the following seven components:

1. Groundwater Monitoring
2. Sentinel Wells *
3. Hydraulic Containment
4. Groundwater Treatment
5. Treated Water Discharge
6. Additional Investigation *
7. Land Use Controls
8. Overall Remedy

Each of the remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout.

The remedy selected in the 1997 OU2 ROD (Army et al. 1997) consisted of the incorporation of 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 (Army 2009a) added LUCs as a remedy component in 2009. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD and ESD.

8.1 GROUNDWATER MONITORING

Groundwater monitoring is conducted to track remedy performance. Water levels are collected annually from monitoring wells and bundle piezometers in the vicinity of the groundwater collection and treatment system. **Table 8-1** summarizes the performance monitoring requirements, the implementing parties, and the monitoring plan documents. Appendix A summarizes the FY 2022 Monitoring Plan, and any deviations are explained in Appendix C.2. Monitoring in FY 2022 was consistent with the OU2 ROD.

The monitoring wells currently included in the Site K Monitoring Plan were sampled in June 2022. **Figure 8-1** presents the sampling and water level monitoring locations, as well as the location of the monitoring wells that have been abandoned. **Figure 8-1** also shows the cross-section alignment.

An 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. Piezometer monitoring was conducted to track the potential migration of dense non-aqueous phase liquid beneath the trench along the Unit 1/Unit 2 interface. **Figure 8-1** shows the location of the Upper Unit 3 sentinel well (03U621) and the piezometers.

The Unit 3 sentinel well (03U621) was sampled in June 2022 for FY 2022 with results presented in **Table 8-2**. Groundwater elevation data is presented in **Table 8-3**. Treatment system concentrations for organics and inorganics are presented in **Tables 8-4 and 8-5**, respectively. A summary of monthly VOC removal data is presented in **Table 8-6**. No Site K COCs were detected in the Unit 3 sentinel well at concentrations above the method detection limit (MDL). However, the 03U621 sample reported a 1,4-dioxane concentration of 11.9 µg/L as presented in **Table 8-7**. 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.

As shown on **Figure 8-2**, June 2022 TCE concentrations ranged from ND to 3,320 µg/L (3,150 µg/L [duplicate sample]) (reported at replacement well 01U611R). Monitoring well 01U615 and replacement wells 01U609R and 01U611R monitor the core of the plume.

Prior to abandonment, TCE concentrations at monitoring well 01U611 had been relatively stable over the previous 7 years, ranging from 4,900 to 11,000 µg/L. Both the 2022 (see above) and 2021 (2,520 µg/L [2,570 µg/L [duplicate sample]) TCE concentrations observed at 01U611R are below the previously observed range at this location.

Historical TCE concentrations observed at well 01U615 from the last 10 years of sampling have ranged from 1,200 to 3,700 µg/L. TCE concentrations at 01U615 have increased from 1,360 µg/L in 2020 to 1,770 µg/L in 2021 to 2,230 µg/L in 2022. Concentrations of *cis*-1,2-DCE at well 01U615 have increased since FY 2014 with the FY 2022 concentration of 4,710 µg/L the highest concentration ever reported for this well. Prior to 2022, the highest *cis*-1,2-DCE concentration at this well was 2,400 µg/L observed during 2021 and 2019. Recent increases in *cis*-1,2-DCE are not surprising because this compound is a known degradation product of TCE. **Figure 8-3** shows TCE and total 1,2-DCE versus time for 01U615. Water levels measured during the FY 2022 monitoring at 01U615 were 5 ft higher than FY 2021 elevations. This well has historically exhibited fluctuating groundwater elevations.

Prior to 2014, concentrations of TCE in monitoring well 01U603 had always been ND (less than 1.0 µg/L). However, in May 2014, TCE was detected at 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 2014 results confirmed that elevated concentrations of TCE and other VOCs are present in the well. Groundwater samples collected downgradient of 01U603 as part of a Site K Geoprobe investigation in September 2014 showed that high TCE concentrations were localized and had not migrated from the immediate vicinity of 01U603. 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 EPA and MPCA in a letter dated 3 February 2015. Since that time, TCE concentrations in 01U603 have steadily declined to below 5.0 µg/L (cleanup level; 30 ug/L).

Well 01U617 continues to exhibit low and relatively consistent concentrations of 1,2-DCE downgradient of the groundwater collection system's capture zone. The concentration at this well has continued to generally decrease from those measured in FY 2014 and previous years. The detected 1,2-DCE concentration is below the cleanup level for Site K of 70 µg/L.

As shown in Appendix A, select Unit 1 wells were required to be sampled for 1,4-dioxane during FY 2022. The 1,4-dioxane concentration at 03U621 increased from 9.3 µg/L (FY 2016) to 11.9 µg/L (FY 2022). 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 8-7 presents the FY 2022 1,4-dioxane sampling results. No federal MCL has been established for 1,4-dioxane; however, the MDH established an HRL value of 1.0 µg/L as shown in **Table 8-7**.

8.2 HYDRAULIC CONTAINMENT

The goal of the Site K collection trench is to contain the plume and remove impacted groundwater. 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.

Water level data are presented in **Table 8-5**. **Figure 8-4** presents a plan view of the groundwater contours from the June 2022 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 8-5**. As shown on **Figure 8-5**, 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 in Spring 2017 and 2018 and again in Spring 2019. Well 01U625C is not critical in the collection trench flow evaluation. Historically, this well has maintained a similar groundwater elevation as 01U625B and 01U625D (Appendix D). Based on FY 2016, FY 2017, FY 2018, and FY 2019 groundwater elevation data showing the return to typical levels, the abandonment of 01U625C, without subsequent replacement, is recommended.

At the request of EPA, an evaluation of hydraulic containment of TCE exceeding the cleanup level (30 µg/L) during minimum, average, and maximum groundwater elevations near the collection trench was conducted. This Site K Hydraulic Containment Evaluation Memorandum has been included as Appendix J.7.1 of this report. For this evaluation, 01U615 was used to determine minimum, average, and maximum groundwater elevations near the collection trench since 2001. Until recently, groundwater elevation measurements at 01U615 were only conducted annually during the months of May or June.

Table 1 within the Site K Hydraulic Containment Evaluation Memorandum provides the annual groundwater elevations at well 01U615 since 2001. As shown, the lowest elevation from the data set occurred in 2009 (875.59 ft above mean sea level [amsl]) and the highest in 2014 (883.71 ft amsl). The average elevation from the data set is 878.84 ft amsl, which is similar to the elevation for June 2021 (878.66 ft amsl). Attachment 1 within the Site K Hydraulic Containment Memorandum provides the hydrogeologic cross sections for 2009, 2014, and 2021. As shown, hydraulic flow was toward the trench during those events.

Table 1 within the Site K Hydraulic Containment Memorandum also provides the annual and May monthly (the month before the annual sampling event) extraction rates from the trench and the TCE concentrations from 01U615 and downgradient wells 01U603, 01U617 and 01U621). Review of the table clearly shows the following:

1. TCE concentrations at the three downgradient wells were all less than 1 µg/L until 2014 while upgradient well 01U615 had TCE concentrations ranging between 1,800 and 7,300 µg/L. During this 13-year period, 6 of the years reported average annual extraction rates less than 10 gpm including 2009 (when 01U615 experienced the lowest May/June elevation) that had an annual average extraction rate of 8.50 gpm.

2. In 2014, the historical high groundwater elevation at 01U615 (and at other Site K monitoring wells) also had a first time TCE detection at well 01U603 of 2,000 µg/L. Downgradient wells 01U617 and 01U621 continued to show non-detectable TCE concentrations (less than 1 µg/L).

3. TCE concentrations at 01U603 decreased since 2014 and all downgradient wells from the trench have been at or below the TCE cleanup level of 30 µg/L since 2016. During this 7-year period, 5 of the years reported average annual extraction rates less than 10 gpm including 2021 (when 01U615 experienced the average May/June elevation) that had an annual average extraction rate of 6.31 gpm.

Based on the above, it is clear that the Site K TCE plume has been contained by the collection trench during nearly all ground water elevation conditions experienced at the Site since 2001 (and likely before). The one notable exception was in 2014, when Site K experienced historically high ground water elevations in the spring. Attachment 2 within the Site K Hydraulic

Containment Memorandum provides a picture taken in April 2014 of the area around the Site K treatment building showing the significant flooding. Even then, no detectable concentrations of TCE were reported for wells 01U617 and 01U621 indicating that the collection trench was likely containing the southernmost portion of the plume at that time.

Figure 8-2 presents the TCE concentrations from the 2022 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, including replacement wells installed during FY 2021 (01U608R, 01U609R, and 01U611R), is used to confirm the plume contours and measure the progress of remediation. Thus, the contours on **Figure 8-2** were drawn with consideration of the extensive historical data, specifically the 2014 data from the Geoprobe investigation.

The FY 2021 APR recommended the abandonment of obstructed upgradient well 01U625C, and this has yet to be completed. The FY 2021 APR also included a recommendation for an evaluation of the need for additional monitoring wells upon completion of redevelopment plans for the area (see Appendix J.7.1 for details). No additional changes or additional actions are currently recommended for this remedy component.

8.3 GROUNDWATER TREATMENT

The overall remedy for Site K will be completed once the cleanup levels in Table 1 of the 1997 OU2 ROD have been attained throughout the aerial and vertical extent of the Site K plume. This remedy has not yet been completed. Overall, the remedy for Site K continued to operate consistent with past years and in compliance with the required performance criteria.

Treatment of contaminated groundwater is completed using air stripping. During FY 2022, the treatment system functioned and was operational 99 percent of FY 2022 (there is no formal minimum operational time requirement). A regular maintenance schedule was maintained. Appendix G.1 summarizes operational data and events at the groundwater extraction and treatment system.

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.

Treatment system monitoring during FY 2022 consisted of quarterly influent and effluent sampling. Influent and effluent analytical results are presented in Table 8-4 (organics) and **Table 8-5** (inorganics). The discharge met the treatment requirements during FY 2022.

Table 8-6 presents the VOC mass removal and monthly flow rates. The treatment system captured and treated 3,469,396 gal of water resulting in the removal of 6.23 lb of VOCs from the aquifer in FY 2022. The cumulative VOC mass removal is 416.3 lb of VOCs.

8.4 LAND USE CONTROLS

LUCs were 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. EPA and MPCA provided consistency approval for the OU2 LUCRD (Army 2020b) in September 2010 and it has been implemented by the Army and revised as follows:

Revision 1 (September 2010): Final document approved.

Revision 2 (June 2011): Revised LUCs for two portions of Arden Hills Army Training Site: 1) unrestricted use for watchable wildlife area; and 2) restricted commercial use for part of the cantonment area.

Revision 3 (March 2015): Revised LUCs for the remainder of the AHATS cantonment area and the Army Reserve Center to restricted commercial use; updated for the transfer/lease of 427 acres of U.S. Army / BRAC-controlled property to Ramsey County.

Revision 4 (August 2016): Revised LUCs to eliminate 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.

Revision 5 (Mar 2018): Revised LUCs to allow recreational use on 108 acres in the western portion of OU2 to be used as part of the Rice Creek Regional Trail Corridor.

Revision 6 (October 2020): Expanded to include descriptions of conditions and LUCs in place at OU1 and OU3. Documented the partial delisting of soil and surface water and sediment (not groundwater) at five aquatic sites located within OU2.

Implementation of the LUCs will continue until such time the groundwater concentrations are below the cleanup levels. On 14 June 2022, the Army, MNARNG, and GHD conducted the annual inspection of OU2 sites which ensures that the remedy is performing to standards. The checklist that was completed during the inspection is included as Appendix F. The inspection did not identify any follow-up actions needed to maintain the protectiveness of the LUCs.

8.5 OVERALL REMEDY FOR SITE K

The overall remedy for Site K Shallow Groundwater will be completed once the cleanup levels in Table 1 of the 1997 OU2 ROD have been attained throughout the aerial and vertical extent of the Site K plume. This remedy has not yet been completed.

Overall, the remedy for Site K continued to operate consistent with past years and in compliance with the required performance criteria. A low extraction rate from the collection trench was observed during FY 2022 due primarily to low groundwater elevations near the extraction trench causing frequent cycling of the extraction pump. The Hydraulic Containment Evaluation provided in Appendix J.7.2 of this report concluded that the Site K TCE plume has been contained by the collection trench during nearly all groundwater elevation conditions experienced at the Site since 2001, including during low groundwater elevation conditions.

8.6 OTHER RELATED ACTIVITY IN FY 2022

USGS Maryland-Delaware-DC Water Science Center continued a groundwater treatability study in FY 2022 to assess bioremediation as a destructive remedy for VOCs in Site K groundwater plume. Laboratory tests on Site K soil and groundwater samples indicated that a bioremediation injection program could accelerate remediation of Site K groundwater. Groundwater injection and monitoring points were installed in September 2021 and pilot scale biostimulation and bioaugmentation were conducted through FY 2022. A report on this work will be issued by USGS during FY 2023 and will be summarized in the FY 2023 APR.

9. OPERABLE UNIT 2: BUILDING 102 SHALLOW GROUNDWATER

The former Building 102, shown on **Figure 9-1**, 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 impact was discovered emanating from beneath Building 102 (discovered during the Phase I and Phase II Environmental Site Assessment in support of a future TCAAP property transfer). Appendix J.8 provides a summary of Building 102 historical design, evaluation, and modification details.

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). The OU2 ROD Amendment #4 (Army et al. 2012) formally documented selection of MNA and LUCs for the Building 102 groundwater remedy; and thereby, added this site to the OU2 remedy. The selected remedy consists of the following 4 components:

1) Monitored Natural Attenuation

2) Groundwater Monitoring

3) Land Use Controls

4) Overall Remedy for Building 102 Shallow Groundwater

Each of the remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD.

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

9.1 MONITORED NATURAL ATTENUATION

The OU2 ROD Amendment #4 prescribed use of naturally-occurring abiotic degradation to limit plume mobility and to ultimately restore the aquifer (OU2 ROD Amendment #4 [Army et al. 2012], page 4-1). A monitoring program was established to achieve the remedy, and monitoring is in compliance with the regulator approved Annual Monitoring Plan.

Appendix A summarizes the FY 2022 Monitoring Plan, and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in the next section.

9.2 REMEDY COMPONENT #2: GROUNDWATER MONITORING

Groundwater monitoring is performed to track remedy performance and to verify that groundwater reaching Rice Creek does not exceed state surface water standards in accordance OU2 ROD Amendment #4 (Army et al. 2012, page 4-1). A monitoring program was established to achieve the remedy, and monitoring is in compliance with the regulator-approved Annual Monitoring Plan.

Table 9-1 summarizes performance monitoring requirements, implementing parties, and the documents that contain the Monitoring Plans. The FY 2022 Monitoring Plan is included in Appendix A, documenting the water quality monitoring locations and frequencies. Building 102 groundwater level data collected in May 2022 are shown as groundwater elevation contours on **Figure 9-2**. Groundwater quality data collected in FY 2022 are shown in **Table 9-2**. Groundwater quality data for FY 2022 are also shown on an aerial view of Building 102 for three of the COCs: TCE (**Figure 9-3**), *cis*-1,2-DCE (**Figure 9-4**), and VC (**Figure 9-5**). **Figure 9-6** shows the VC concentrations plotted on a geologic cross section for Building 102 to illustrate the vertical extent of impact (the cross-section location is illustrated on **Figure 9-5**.)

9.3 REMEDY COMPONENT #3: LAND USE CONTROLS

OU2 ROD Amendment #1 (Army et al. 2007) established LUCs as part of the remedy for Building 102. LUCs are necessary to restrict new well installations and protect the groundwater monitoring and the infrastructure related to monitoring wells.

EPA and MPCA provided consistency approval for an OU2 LUCRD (Army 2020b) in September 2010 and is being implemented by the Army. Subsequent revisions of the LUCRD have not changed the groundwater LUCs for Building 102. Implementation of LUC will continue until such time that the groundwater concentrations are below the cleanup levels.

On 14 June 2022 the Army, MNARNG, and GHD conducted the annual inspection of OU2 sites which ensures that the remedy is performing to standards. The checklist that was completed during the inspection is included as Appendix F. The inspection did not identify any follow-up actions needed to maintain the protectiveness of the LUCs.

9.4 REMEDY COMPONENT #4: OVERALL REMEDY FOR BUILDING 102 SHALLOW GROUNDWATER

As of FY 2022, the Building 102 shallow groundwater results have not attained the cleanup levels in OU2 ROD Amendment #4 (Army et al. 2012) throughout the aerial and vertical extent of the Building 102 plume (OU2 ROD Amendment #4 [2012], pages 2–13). Therefore, the remedy is still ongoing.

As shown in **Table 9-2**, cleanup levels have not been reached throughout the aerial extent of the plume and the Site cannot be closed. Well 01U581 exceeded the cleanup level for *cis*-1,2-DCE and TCE concentrations exceed the cleanup level in three monitoring wells (01L584, 01U580, and 01U581). Wells 01U580 and 01U584 also exceed the cleanup level for VC.

Natural attenuation continues to occur, with the highest concentrations of TCE being present in the source area vicinity, and primary degradation products being present in downgradient wells (e.g., primarily *cis*-1,2-DCE and VC in 01L584 and 01U584). Significant changes that were noted in the FY 2022 groundwater quality results include:

01U579 and 01U580 (source area)—Historically, concentrations in these two wells have shown relatively large increases and decreases. Large increases from FY 2021 to FY 2022 were observed at 01U580; TCE increased from 2.08 to 191 µg/L and *cis*-1,2-DCE increased from 11.3 to 166 µg/L. Concentrations at 01U579 slightly increased; *cis*-1,2-DCE slightly increased from 4.51 to 4.79 µg/L, and TCE increased from 1.50 to 6.99 µg/L, above the 5 µg/L cleanup level. VC was detected at a value of 1.22 µg/L in 01U584 and a value of 22.7 µg/L in 01U580. These concentrations exceed the cleanup level for VC of 0.18 µg/L. Please note that the Pace (TN) reporting limit (RL) for VC of 1 µg/L does not meet the project RL goal of 0.1/0.09 µg/L. The MDL for VC is 0.234 µg/L, which Pace (TN) reports detections between the MDL and RL. Per the 2020 QAPP (Revision 18), the Pace (TN) RL of 1 µg/L and MDL of 0.30 µg/L is considered acceptable for the project at this time. A QAPP Revision 19 is currently in progress.

Well 01L582 (further downgradient of the source area): Concentration of *cis*-1,2-DCE slightly increased (12.4 to 12.6 ug/L). This well appears to be stable and is still below the cleanup level of 70 µg/L. The VC concentration continued to be ND.

Wells 01L581 and 01U581 both exceeded the cleanup level for TCE of 5 µg/L in FY 2021. Both wells seemed to stay relatively stable if not slightly decreasing from FY 2021 to FY 2022. Well 01L581 decreased below the cleanup level from 5.90 µg/L in FY 2021 to 4.73 µg/L in FY 2022. Well 01U581 decreased from 15.0 to 6.99 µg/L.

In FY 2022, TCE remained below the cleanup level (5 µg/L) at 01U584, decreasing from 3.97 µg/L in FY2021 to 2.02 µg/L. 01L584 remained above the cleanup level, but decreased from 10.4 µg/L in FY 2021 to 8.02 µg/L in FY 2022.

No trigger levels were exceeded in FY 2022. The contingency location is 01U048, located next to Rice Creek. The trigger level is equal to groundwater cleanup levels. No COCs for Building 102 shallow groundwater were detected in FY 2022 at well 01U048 (**Table 9-2**).

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10. OPERABLE UNIT 2: AQUATIC SITES

All aquatic sites are closed except Round Lake. Appendix J.9 provides a summary of aquatic sites historical design, evaluation, and modification details. The selected remedy for aquatic sites consisted of only surface water hardness adjustment and has undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the OU2 ROD Amendment #4 (Army et al. 2012).

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11. OPERABLE UNIT 2: DEEP GROUNDWATER

The selected remedy for the deep groundwater in the 1997 OU2 ROD (Army et al. 1997), subsequent amendments, and 2021 ESD #3 (Army 2021b) includes the operation of the TGRS, which is composed of the following two systems:

BGRS, which is designed to recover and treat low concentration VOCs in groundwater along the southwest portion of the property boundary. The BGRS consists of:

- Seven operating groundwater extraction wells along the southwest portion of the property boundary (B-1, B-3, B-4, B-5, B-6, B-8, B-9, and B-13)
- One air stripping system (located inside Building 116) to treat low VOC concentration boundary groundwater

- SGRS, which is designed to recover and treat high concentration VOCs and 1,4-dioxane in groundwater in the source areas at Site D, Site G, and Site I. The SGRS consists of:
  - Nine operating source area groundwater extraction wells at Site D, Site G, and Site I (SC-1, SC-5, SC-6, SC-7, SC-8, SC-9, SC-10, SC-11, and SC-12)
  - One source area groundwater treatment system (located inside the SGRS treatment building) using AO for treatment of 1,4-dioxane and TCE and air stripping for treatment of residual VOCs

The TGRS layout is presented on **Figure 11-1**. The BGRS operated throughout FY 2022 with some contributions from SGRS wells SC-1 and SC-5 until September 2022. The SGRS construction was substantially completed and SGRS wells were operated during system debugging in September 2022. The SGRS became fully operational during FY 2023. Appendix J.10 provides a summary of TGRS historical design, evaluation, and modification details.

The selected remedy for OU2 Deep Groundwater consists of the following remedial components that include continued use of the TGRS:

- Hydraulic Containment and Contaminant Removal from the Source Area
- Groundwater Treatment
- Treated Water Discharge
- Institutional Controls
- Groundwater Monitoring.

The selected remedy also includes an annual review of new and emerging technologies potentially applicable to the deep groundwater. Each of the remedy components are being implemented. During FY 2022, each component performed as required. None of the remedy components have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD, subsequent amendments, and ESD. This APR documents all performance and monitoring data collected from October 2021 through September 2022.

11.1 FY 2022 TGRS SYSTEM MODIFICATIONS

As stated earlier, the TGRS is composed of the BGRS and SGRS. The SGRS construction was substantially completed and SGRS wells were operated during system debugging in September 2022. The SGRS consists of the following:

Nine operating source area groundwater extraction wells at Site D, Site G, and Site I (SC-1, SC-5, SC-6, SC-7, SC-8, SC-9, SC-10, SC-11, and SC-12)

One source area groundwater treatment system (located inside the SGRS treatment building) using AO for treatment of 1,4-dioxane and TCE and air stripping for treatment of residual VOCs.

The SGRS became fully operational during FY 2023. Details of the SGRS construction will be contained in the Construction Completion Report that will be issued in FY 2023. The addition of the SGRS will result in increased mass removal of VOCs, destruction of 1,4-dioxane, and more efficient hydraulic containment of the source areas. Long-term operating conditions of the TGRS (combined BGRS/SGRS) will be determined during FY 2023.

11.2 TGRS HYDRAULIC CONTAINMENT

Groundwater extraction is conducted by the TGRS to hydraulically contain the contaminated source area to the 5 µg/L TCE concentration contour and optimize the removal of COCs from the source area through pumping of select wells. The TGRS operated in FY 2022 consistent with the requirements of the 1997 OU2 ROD. **Table 11-1** presents the TGRS cleanup requirements per the 1997 OU2 ROD.

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 regulators that 1997 OU2 ROD requirements are met with an adequate safety factor. This approved approach also included a Micro Operating Strategy (MOS) (last revised in February 2004) for selected well groups as follows:

Well Group B1, B11, B13 MOS Operational Minimum: 415 gpm

Well Group B4, B5, B6 MOS Operational Minimum: 600 gpm

Well Group B4, B5, B6, B8, B9 MOS Operational Minimum: 1,010 gpm

Since the agencies approved discontinuing the pumping at Well B11 in 2013 (due to the low TCE concentration in the well, less than 5 ug/L), the first group has not met the MOS minimum rate.

During FY 2022, the TGRS average extraction rate was approximately 1,723 gpm, as shown in **Table 11-2**. This extraction rate was 98.7 percent of the Global Operating Strategy (GOS) Total System Operational Minimum (1,745 gpm) established in 2004 (based on the TCE plume width of 3,600 ft determined from the FY 2001 groundwater sampling event). The Army and regulators have historically agreed that the 1,745-gpm extraction rate meets the 1997 OU2 ROD requirements with an adequate safety factor. The lower than anticipated TGRS extraction rate was primarily due to the substantial power outage caused by the Building 116 transformer failure in August 2022. However, given the significant reduction in TCE concentrations across the site since 2001 and reduction of the TCE plume width to approximately 3,000 ft (or 83 percent of the 2001 TCE plume width, as discussed in Section 11.9), it is reasonable to conclude that the TCE was adequately contained by the average extraction rate of 1,723 gpm.
Two of the three individual well groupings were above their respective Micro Operating Strategy (MOS) minimums for FY 2022. The B1, B11, and B13 well grouping was below the MOS minimum of 415 gpm due to an approved shutdown well B11 (since the well had been extracting groundwater with TCE concentrations less than 2 µg/L for a number of years). B11 will continue to be monitored to verify containment.

Figure 11-2 plots the TGRS daily average flow rate from 1 October 2021 through 30 September 2022 and shows operation above the operational minimum for the majority of the time (279 days or 76 percent of the time) in FY 2022. Significant loss of extraction water volume occurred during the failure and replacement of the Building 116 transformer. This issue has since been remedied. Appendix G.2 provides additional information on the various BGRS downtimes throughout FY 2022.

The monthly and annual volume of water pumped is presented in **Table 11-2**. **Table 11-2** 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 FY.

As shown on **Table 11-2**, the TGRS successfully captured and treated approximately 905,462,940 gal of contaminated water from October 2021 through September 2022 based on the sum of the individual pumphouse flow meters. This volume converts to an average flow rate of 1,723 gpm.

Groundwater elevation measurements were collected in June 2022. Appendix D contains the water level database for the monitoring wells. **Figures 11-3 through 11-5** present the groundwater elevations for Upper Unit 3, Lower Unit 3, and Unit 4 during this time period. These figures present the potentiometric contours from three vertical portions of the aquifer. The groundwater elevation contours and limits of capture in the three portions of the aquifer are similar to those observed in FY 2003 after the modification to the Operating Strategy (OS) was implemented. The zone of capture created by the TGRS extends beyond the 5 µg/L TCE contour (as defined in 2001) in both the Unit 3 and Unit 4 aquifers.

Monthly Flow Reports

Each month, a Monthly TGRS 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 BGRS FY 2022 operational notes is presented in Appendix G.2. Since SGRS only operated during September 2022, and operation was not continuous during this startup period, a compilation of SGRS operational notes is not presented in this report.

During FY 2022, the sum of the individual BGRS pumphouse flow meters was used to measure total flow volumes in monthly reports for comparison with OS limits. Daily variation in readings at individual wells is primarily due to differences in the time of day when meter readings were taken.

11.3 TGRS MASS REMOVAL

As discussed above, the TGRS extracted and treated 905,462,940 gal of water from October 2021 through September 2022. Based on the monthly influent and effluent VOC concentrations and the monthly flow totals as measured by the extraction well flow meters, the BGRS removed a total of 982 lb of VOCs from October 2021 through September 2022. The VOC mass removal in FY 2021 was 1,746 lb. When comparing the FY 2022 to FY 2021 and past years and taking into account operational downtime (especially the downtimes from SC-1 and SC-5), the trend still depicts an overall reduction in mass removal.

Average VOC influent concentrations decreased dramatically during FY 2022 due to the construction-related downtime and rerouting of SC1 and SC5 to the new SGRS treatment system. Influent concentrations decreased from 227.4 µg/L in FY 2021 to 131.9 µg/L in FY 2022. **Table 11-3** summarizes the individual VOC mass contribution of each extraction well and the entire system. Overall, the total TGRS (including extraction and treatment by the SGRS) has removed over 113 tons (225,209 lb) of VOCs from the deep groundwater since 1987 and 24.3 tons of VOCs since the end of FY 2001 (the TGRS OS was based on data through 2001).

The total mass removed is based on the monthly 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 and the semi-annual VOC results from each well. Mass removed from new SGRS wells (SC-6 to SC-12) was based on SGRS startup sampling data and September 2022 extraction volumes.

VOC samples were collected semi-annually (December 2021 and June 2022) from the operating extraction wells. Wells B2 and B11 are shut down but were temporarily operated for June 2022 sampling. **Table 11-4** summarizes 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 when dilutions are required due to the high concentrations of some analytes. The locations of the extraction wells are presented on **Figure 11-1**.

Appendix H.1 presents TCE concentrations 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:

SC3 (5.5 µg/L in FY 2001 to 0.409 µg/L in FY 2022 – 93 percent reduction)

B10 (5.1 µg/L in FY 2001 to 0.218 JP µg/L [RL: 1.0 µg/L] in FY 2022 – 96 percent reduction)

B6 (230 µg/L in FY 2001 to 23.8 µg/L in FY 2022 – 90 percent reduction)

B4 (490 µg/L in FY 2001 to 48.0 µg/L in FY 2022 – 90 percent reduction)

B5 (410 µg/L in FY 2001 to 59.8 µg/L in FY 2022 – 85 percent reduction)

SC2 (100 µg/L in FY 2001 to 28 µg/L in FY 2018 – 72 percent reduction)

B3 (7.8 µg/L in FY 2001 to 2.47 µg/L in FY 2022 – 68 percent reduction)

B9 (110 µg/L in FY 2001 to 18.8 µg/L in FY 2022 – 83 percent reduction)

SC4 (6.9 µg/L in FY 2001 to 3.16 µg/L in FY 2022 – 54 percent reduction)

B8 (21 µg/L in FY 2001 to 5.15 µg/L in FY 2022 – 75 percent reduction)

B1 (180 µg/L in FY 2001 to 89.3 µg/L in FY 2022 – 50.4 percent reduction)

Only four extraction wells (B2, B11, SC5, and SC1) have shown less than a 50 percent reduction in TCE concentrations since FY 2001.

Table 11-3 illustrates seven extraction wells, B1, B4, B5, B9, B13, SC1, and SC5, that are located in the centers of the plume (see **Figures 11-6, 11-7, and 11-8**) and achieve the largest rates of VOC removal. These seven wells together accounted for over 94 percent of the VOC mass removed.

During FY 2022, the source control wells, SC1 through SC5, together accounted for over 62 percent of the VOC mass removed while accounting for only 3.0 percent of the water pumped by the system. SC5, in particular, removed 61.7 percent of the total VOC mass at a rate of only approximately 53 gpm (2.9 percent of the total water pumped by the system). This illustrates the efficiency of extracting groundwater from near the source areas.

11.4 OPERATION & MAINTENANCE OF THE BGRS

In summary, the priority of operation of the BGRS 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 wet well pumps (WWP)#1 and WWP#2 pumping rates equal to or slightly above the combined pumping rate of the extraction well field.

Maintain treatment center WWP#3 and WWP#4 pumping rate equal to or slightly above the WWP#1 and WWP#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).

11.4.1 FY 2022 BGRS Maintenance and Inspection Activity

During FY 2022, the following inspection and maintenance activities occurred at the BGRS:

Preventive Maintenance—The extensive preventative maintenance 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 FY 2022 preventative maintenance. 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 preventative maintenance, 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 the early identification of failing equipment. By early detection of flow rate changes, equipment repair was typically scheduled before a failure occurred.

11.4.2 BGRS Extraction Well Down Time

The downtime for each BGRS extraction well over the last 5 years is presented in **Table 11-5**. A summary of average downtime for the pumphouses and the treatment center by the category of failure is presented in **Table 11-6**. A description of each downtime event, organized chronologically, is presented in Appendix G.2. The same descriptions organized by affected pumphouse, treatment center, and force main are presented in Appendix G.3.

Routine treatment center and extraction well downtimes resulted primarily from planned preventative maintenance and planned modification of components in the pumphouses, treatment center, and electrical service. Total downtime in FY 2022 increased from FY 2021 (from 12.0 days in FY 2021 to 59.6 days in FY 2022). The increase in total downtime is primarily due to more downtime in the electrical service (Building 116 transformer failure and replacement) and system modification categories.

Description of Down Time Categories

Pumphouse component failures accounted for an average of 3.1 days downtime per pumphouse. The major pumphouse repairs causing downtime were:

Pump and motor replacements (B1, B4, B5, and B6)
Electrical issues including faulting of variable frequency drives (B4 and B5).

Electrical service system failures accounted for an average of 7.7 days down time per pumphouse. Primary causes of downtime were the failure and replacement of the Building 116 main power transformer (including the failure of a rental generator), an electrical short at a pole west of Building 116, sitewide power failure due to damage to an off-site power pole, and Wet Well Pump 3 motor and starter issues.

System modifications accounted for an average of 48.7 days of respective down time in FY 2022. Most of this down time was related to the temporary shutdown of SC1 and SC5 to complete work needed for SGRS construction, including but not limited to force main work, installation of isolation valves, and the capping of Line W. In addition, SGRS construction-related excavation added additional downtime due to damage to and repair of the SC1 discharge line. For the most part, other preventative maintenance was performed without interruptions to the treatment system. Preventative maintenance procedures are described in the project Operation and Maintenance Manual.

Treatment center components and force main failures did not account for any down time in FY 2022.

There were no additional days of down time assigned to the miscellaneous category for FY 2022.

11.5 OPERATION & MAINTENANCE OF THE SGRS

Construction of the SGRS was conducted throughout FY 2022 and was substantially completed in September 2022. New SGRS wells (SC-6 through SC-12) were operated during system debugging in September 2022 and removed 2,507,425 gal of groundwater (see **Table 11-2**) Details of the SGRS construction and startup testing will be contained in the Construction Completion Report that will be issued in FY 2023.

Although not an operation/maintenance issue, during testing of new SGRS piping connections on 7 December 2021, approximately 4,500 gal of untreated water from well SC-5 was discharged inside the SGRS building's earthen footprint. The discharge was caused by failure of a cap intended to isolate the SC-5 water while testing connections for leaks. The water was pumped to the ground surface outside of the building footprint to avoid freezing of the foundation subgrade. The Army notified EPA and MPCA immediately. The amount of TCE released was calculated between 0.007 lb and 0.023 lb, which is orders of magnitude less than the reportable quantity of 100 lb.

Operation and maintenance of the fully operational SGRS in FY 2023 will be conducted in accordance with the SGRS Operations and Maintenance Manual that will be finalized in FY 2023.

11.6 GROUNDWATER TREATMENT

During FY 2022, treatment of contaminated groundwater was primarily completed using air stripping at the BGRS. The SGRS was under construction during FY 2022, and only operated intermittently during startup activities in September 2022. Some contaminated groundwater was treated using the SGRS AOP/air stripping system during this time. Details of the SGRS construction and startup testing will be contained in the Construction Completion Report that will be issued in FY 2023.

BGRS influent and effluent water were sampled on a monthly basis during FY 2022. The BGRS influent and effluent database for FY 2022 is provided in Appendix H.2. **Figure 11-9** presents a graph of BGRS influent TCE versus time. This graph is cumulative and includes data from before 1989, when the system consisted of six extraction wells. The average FY 2022 BGRS influent TCE concentration (131.9 µg/L) dramatically decreased (by 42 percent) from FY 2021 (227.4 µg/L), due primarily to the construction-related downtime and rerouting of SC1 and SC5 to the new SGRS treatment system.

Table 11-9 presents the results of the 1,4-dioxane sampling for the BGRS influent, effluent, and extraction wells. The BGRS influent and effluent were sampled in June 2022 where 1,4-dioxane concentrations were virtually identical in influent and effluent samples, indicating no concentration reduction from the treatment system. No federal MCL has been established for 1,4-dioxane; however, the MDH has established an HRL value of 1.0 µg/L. All extraction wells sampled except extraction well B2 had 1,4-dioxane concentrations exceeding the HRL. It is expected that 1,4-dioxane concentrations will begin to reduce at many locations with the full operation of the SGRS in FY 2023 that has been designed to capture and treat 1,4-dioxane at the source.

FY 2022 represents the twenty-second year since the TGRS was reconfigured to pump more in the center 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.

Figure 11-9 also presents a graph of the BGRS effluent TCE concentration versus time. As indicated, the BGRS effluent was below 5 µg/L TCE for all sampling events in FY 2022. A review of the FY 2022 database indicates that the effluent remained below the treatment requirements for all other VOC compounds specified in the 1997 OU2 ROD. Comparison of BGRS influent and effluent concentrations for all specified VOC compounds indicates an average removal efficiency of 99.2 percent. As expected, effluent concentrations of TCE increased slightly after the treatment was changed to two-tower operation (the two-tower operation was tested in February 2011 and went into full operation in March 2011). The maximum effluent TCE concentration in FY 2022 was 2.070 JL µg/L and the average was 0.940 µg/L, which are both well below the discharge limit. The JL qualifier indicates that the data is estimated due to outlying laboratory control sample recovery.

The BGRS air stripping towers remove VOCs with an efficiency of approximately 99.2 percent. The BGRS air emissions are equal to the VOC mass removal rates presented in **Table 11-3**. Total BGRS VOC air emissions averaged 2.7 lb per day based on the VOC mass removal rates. The total BGRS VOC emissions from October 2021 through September 2022 were 984 lb.

Once the SGRS becomes fully operational in FY 2023, VOC air emissions will be significantly reduced by the destruction of VOCs (especially TCE) through the AO treatment system.

Groundwater treated by the BGRS and SGRS is discharged to the on-site gravel pit. Based on visual observations during FY 2022, there were no noticeable changes in gravel pit performance. The gravel pit is accommodating the discharge of treated water as designed and is allowing it to recharge to the aquifer.

11.7 INSTITUTIONAL CONTROLS

Institutional controls are implemented to restrict access to contaminated aquifers and prevent exposure to contaminated groundwater. A special well construction area and alternate water supply have been established and private wells in impacted areas have been sealed. A special well construction area and alternate water supply have been established and private wells in impacted areas have been sealed.

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

11.8 REVIEW OF NEW TECHNOLOGIES

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. 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 when no technologies are considered. It is envisioned that at any time, any interested party (Army, EPA, and MPCA) can suggest new technologies for consideration. If a technology is agreed to have merit by the Army, EPA, 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

Any planned evaluations for the following year.

Since the FY 1997 APR, the Army reports annually on the status of any reviews of emerging technologies.

In September 2002, EPA and MPCA announced they would be conducting a natural attenuation microcosm study using carbon dating. In October 2002, the Army drilled a boring at Site G to collect soil for the study. The study results were published in 2004.

MPCA identified a study involving the addition of vegetable oil to groundwater that is being monitored at the U.S. Navy site in Fridley, Minnesota, as a potential technology of interest.

In FY 2022, the Army substantially implemented ESD #3 that consists of the following improvements for the deep groundwater remedy:

Operation of new source area extraction wells at Site D, Site G, and Site I.

Routing of the new source area extraction wells and existing source area extraction wells to a new AO system, SGRS, to remove and treat 1,4-dioxane and TCE.

Routing of the effluent from the SGRS to a co-located new air stripper to remove residual VOC contaminants.

Discharge of the treated groundwater from the SGRS to the gravel pit.

No new technologies were identified and considered to have merit during FY 2022. MPCA continued its research into natural attenuation processes at TCAAP. EPA and MPCA published the results of the microcosm study for deep groundwater sediments in 2004 showing that abiotic degradation of *cis*-1,2-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.)

After construction of the SGRS is completed, the capabilities of the combined groundwater extraction system will be evaluated to best achieve the OU2 deep groundwater objectives of hydraulic containment of the source areas and optimizing mass contaminant removal. Updated air emissions modelling is also planned.

11.9 GROUNDWATER MONITORING

Groundwater monitoring is completed to track remedy performance. Monitoring in FY 2022 was consistent with the 1997 OU2 ROD. Water level measurements and water quality samples were collected as stated in Appendix A.1. Appendix A summarizes the FY 2022 Monitoring Plan, and any deviations are explained in Appendix C.2. Monitoring was completed as follows.

Groundwater

TGRS groundwater level measurements were collected during December 2021 and June 2022 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 (8260D) analysis and 1,4-dioxane (8270 Selected Ion Monitoring).

FY 2022 was a major sampling event year in the biennial sampling program and samples were collected from a select list of wells. **Table 11-7** presents the groundwater quality data for FY 2022. **Figures 11-6 through 11-8** present plan views of the TCE and 1,4-dioxane plumes and **Figures 11-10 through 11-13** present a cross sectional view of the plume along the property boundary.

Long-term trends in monitoring wells

The majority of wells on and off TCAAP exhibit decreasing trends in TCE concentration since FY 2001, 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. **Table 11-7** illustrates VOC concentrations from monitoring wells sampled during FY 2022.

Several wells were identified in previous APRs, or when reviewing the FY 2022 database that have inconsistent or upward trends in TCE concentrations that warrant further observation and discussion.

Well	Operable Unit	Trend Observation
03L806	OU2	Trend identified in FY 2001 APR. TCE concentrations have steadily decreased from 620 µg/L in 2013 to 20.8 µg/L in FY 2022. Reduce sampling frequency to biennial (once every 2 years). Next sampling event in June 2024.
04U806	OU2	Trend identified in FY 2001 APR. Dropped from 1,000s of µg/L in early to mid-1990s. TCE steadily decreased from 470 µg/L in FY 2001 to 96 µg/L in FY 2007. In FY 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 FY 2009 with a notable steadily decreasing trend (18.3 µg/L, and 18.2 µg/L duplicate in 2022). Reduce sampling frequency to biennial (once every 2 years). Next sampling event in June 2024.
03U094	OU2	Trend identified during FY 2004 data review. TCE increased from 170 µg/L in FY 2003 to 470 µg/L in FY 2005. From FY 2005 to FY 2013, TCE concentrations decreased to 80 µg/L in FY 2013, a historical low concentration. The TCE concentration increased to 610 µg/L in FY 2015, the highest concentration since 1996. Since then, the TCE concentration decreased to 360 µg/L in FY 2016 and 203 µg/L in FY 2022. Maintain biennial sampling frequency (next event FY 2024).
03M806	OU2	Trend identified during FY 2003 data review. TCE concentrations dropped from approximately 900 µg/L in FY 1987, to less than 100 µg/L from FY 1993 through FY 1996. In FY 2003, TCE increased to 1,300 µg/L, a historical high concentration. TCE concentrations decreased from 680 µg/L in FY 2008 to 295 µg/L in FY 2022. Reduce sampling frequency to biennial (once every 2 years). Next sampling event in June 2024.
03U711	OU2	Trend identified in FY 2001 APR. TCE concentrations decreased from approximately 1,000 µg/L in FY 1994 to 75 µg/L in FY 1999 but rebounded to 250 µg/L by FY 2004. Since FY 2004, concentrations have steadily decreased to 27 µg/L in FY 2016 and 27.8 µg/L in FY 2022. Maintain biennial sampling frequency (next event FY 2024).
03L809	OU2	Trend identified in FY 2001 APR. TCE concentrations decreased from over 3,000 to 67 µg/L through 1998 but rebounded to 520 µg/L by FY 2001. Since FY 2001, concentrations have decreased to 85.5 µg/L in FY 2022. Maintain biennial sampling frequency (next event FY 2024).

Results from the FY 2022 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 FY 2000 to 18.3 µg/L in FY 2022), 03U708 (steady decrease from 120 µg/L in FY 2005 to 35.6 µg/L in FY 2022), 03L806 (620 µg/L in FY 2013 to 20.8 µg/L in FY 2022), 04J077 (610 µg/L in FY 2001 to 34.4 µg/L in FY 2022), and PJ#806 (220 µg/L in FY 2000 to 9.51 µg/L in FY 2022).

Although the general trend at most wells since 1999 appears to be declining or stable, the monitoring well listed below had a notable increase in TCE concentration in FY 2022:

03U029 (9.13 µg/L [1.00 JP µg/L, duplicate] in 2020 to 121 µg/L in 2022).

The increase observed and reported for 03U029 is not considered significant when considering the last 25 years of data (160 µg/L in 1999 and 79 µg/L in 2001) but was an increase from concentrations reported from 2003 through 2020 (maximum of 21 µg/L in 2011). Well 03U029 is within the capture zone of the TGRS extraction system; therefore, the significance of this increase is minimal.

In 2022, monitoring wells proposed for sampling in the FY 2022 Monitoring Plan were sampled for 1,4-dioxane. The monitoring well sampling results are presented on **Table 11-10.**

A majority of the monitoring wells sampled (51 of 78) had 1,4-dioxane concentrations exceeding the HRL, with the highest concentrations found in the samples at 03U094 (41.1 µg/L), 03U021 (38.6 µg/L), 03U020 (31.0 µg/L), 03U014 (29.9 µg/L), 04J077 (22.5 µg/L), 03M806 (21.4 µg/L), PJ#806 (20.5 µg/L), and 04U077 (20.1 µg/L). **Figure 11-15** shows the 1,4-dioxane concentrations in plan view for the west portion of OU2. **Figures 11-12 and 11-13** present cross sectional views of the plume along the property boundary. It is expected that 1,4-dioxane concentrations will begin to reduce at many locations with the full operation of the SGRS in FY 2023 that has been designed to capture and treat 1,4-dioxane at the source.

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 ft (this value was then rounded up to 4,000 ft to determine an operating minimum flow rate noted in Section 11-2). Since that time, 24.3 tons of VOCs have been removed from groundwater. TCE concentrations are decreasing across the Site, especially at the following wells that 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 FY 2001 to not detectable (less than 1 µg/L) from FY 2003 until it was abandoned in FY 2014. Well 03U677 replaced 03U672 in September 2014 and has never contained detectable concentrations of VOCs (including TCE). As a result, the TCE plume width is narrowing. **Figure 11-14** shows FY 2022 TCE data with the 5 µg/L TCE contours for FY 2001 and FY 2022. The overall FY 2022 sample results are similar, or lower compared to the previous sample results.

Based on these contours, the estimated width of the source area TCE plume has decreased approximately 17 percent from 3,600 to 3,000 ft 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 ft. As shown on **Figure 11-14**, the TCE plume narrowing along the southwest corner boundary of the Site is more pronounced, having decreased approximately 24 percent from 4,600 to 3,500 ft, which represents an approximately 76 percent decrease from the FY 2001 width.

The operation of the SGRS extraction wells in the Site D, Site G, and Site I source areas is expected to significantly increase mass removal and accelerate the shrinking of the TCE plume.

No additional monitoring for FY 2023 is proposed beyond what is presented in the Monitoring Plan (Appendix A) of the FY 2022 APR. **Table 11-8** and Appendix A of this APR provide the FY 2022 to FY 2026 Monitoring Plan. New extraction wells operating during FY 2023 will be monitored consistent with an approved work plan.

11.10 OVERALL REMEDY FOR DEEP GROUNDWATER

The TGRS met the requirements of the 1997 OU2 ROD (Army et al. 1997) during FY 2022. As detailed in Section 11.2, the FY 2022 annual average extraction rate was approximately 1,723 gpm, or 98.7 percent of the GOS Total System Operational Minimum (1,745 gpm) established in 2004 using the FY 2001 data set. The lower than anticipated TGRS extraction rate was primarily due to the substantial power outage caused by the Building 116 transformer failure in August 2022. However, given the significant reduction in TCE concentrations across the Site since 2001 and the reduction of the TCE plume width to 83.7 percent of the 2001 TCE plume, it is reasonable to conclude that the TCE was adequately contained during FY 2022.

These 1997 OU2 ROD requirements were also achieved by the TGRS during FY 2022:

Hydraulic containment of the 5 µg/L TCE contour in the contaminated source area, meeting the criterion in the 1997 OU2 ROD (Army et al. 1997).

The TGRS extracted and treated 905,462,940 gal of water and removed 982 lb of VOCs from October 2021 to September 2022. Average BGRS VOC influent concentrations decreased by 42 percent during FY 2022 due to the construction-related downtime and rerouting of SC1 and SC5 to the new SGRS treatment system.

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 COC-specific requirements for all sampling events.

During FY 2023, the combined groundwater extraction and treatment for on-site deep groundwater within OU2 by BGRS and SGRS will result in increased mass removal of VOCs, destruction of 1,4-dioxane and more efficient hydraulic containment of the source areas.

12. OPERABLE UNIT 3: DEEP GROUNDWATER

The Plume Groundwater Recovery System (PGRS) was an off-site 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 impacts 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 remedy selected in the 1992 OU3 ROD (Army et al. 1992) included extraction of groundwater at the leading edge of the South Plume, treatment of extracted groundwater, municipal use of treated groundwater, and groundwater monitoring.

An amendment to 1992 OU3 ROD (Army et al. 1992) was developed, amended, and finalized in August 2006 that significantly changed the OU3 remedy. The basis for the OU3 ROD Amendment #1 (Army et al. 2006b) was the Groundwater Statistical Evaluation, OU3 Technical Memorandum, which received consistency from the regulators on 2 May 2005. This document presented a statistical evaluation showing that the South Plume has been receding since at least 1996, including the period after the PGRS was shut off in 2001. The South Plume had a receded well upstream of the PGRS, which was basically pumping clean water. The OU3 ROD Amendment #1 (Army et al. 2006b) removed the need for a pump and treat remedy, eliminating the PGRS extraction well and treatment train.

To summarize, the selected remedy for OU3 Deep Groundwater consists of the following remedial components:

1. Monitored Natural Attenuation
2. Groundwater Monitoring
3. Drilling Advisories
4. Overall Remedy

Each of the remedy components are being implemented. During FY 2022, each component performed as required. None of the remedy components have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD. Appendix J.11 provides a summary of OU3 historical design, evaluation, and modification details.

12.1 MONITORED NATURAL ATTENUATION

It has been demonstrated that the South Plume is being remediated with the assistance of the TGRS and natural attenuation factors. Appendix A summarizes the FY 2022 Monitoring Plan, and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in Section 12.2. **Figure 12-1** presents an OU3 site plan.

12.2 GROUNDWATER MONITORING

Groundwater monitoring for VOCs is conducted to verify the effectiveness of the selected remedy and the natural attenuation of the South Plume. Groundwater samples were collected from 18 OU3 wells in FY 2022 as part of the OU1, OU2, and OU3 major sampling event. Samples were collected as specified in the Monitoring Plan and analyzed for VOCs and 1,4-dioxane at locations shown on **Figure 12-1**. 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 12-1 summarizes the analytical results for the monitoring wells that were sampled in FY 2022. The wells sampled contained TCE concentrations similar to those reported for the previous sampling events.

The TCE concentration in downgradient sentry well 04U863 remained less than 1.0 µg/L or not detectable (less than 1.0 µg/L) for the ninth consecutive year, after rising above 1.0 µg/L for the first time since December 1999 in FY 2012 (1.2 µg/L).

Included within the 18 locations monitored during FY 2022 were two wells (04U414 and 04U851) that are required to be sampled every 5 years during the sampling event preceding Five-Year Review. The FY 2022 samples collected from these wells reported ND (less than 1.0 µg/L) for VOCs, just as they did when sampled during FY 2018.

Table 12-2 provides a summary of the updated Mann-Kendall statistical analysis that has historically been completed for 10 edge-of-plume and center-of-plume wells. A spreadsheet and graph presenting the updated Mann-Kendall test results for these ten wells (each was sampled in FY 2022) are provided in Appendix I.

The trend for 03M848, which has historically been the center of the South Plume, remained as no trend or stable as concentrations have remained relatively constant over the last six 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 the current concentration of 77.8 µg/L in FY 2022. In summary, the data collected in FY 2022 from the center of the South Plume represented by 03M848, indicates stable concentration trends.

The OU3 ROD Amendment #1 (2006b) 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. No additional actions are necessary for OU3 because no increasing trends for TCE at the edge of the plume were identified by the updated FY 2022 statistical analysis. The wells analyzed in FY 2022 showed a decreasing or stable trend.

The FY 2022 annual sampling round indicates that the TCE South Plume footprint appears to be decreasing or at least stable, with a stable to decreasing trend at the center of the plume. Proposed OU3 monitoring requirements are presented in **Table 12-3** and Appendix A.

12.3 DRILLING ADVISORIES

Drilling advisories are implemented to regulate the installation of new private wells within OU3 as a Special Well Construction Area. The MDH issued a Special Well Construction Area Advisory (SWBCA) in June 1996. In June 1999, via the MDH, the SWBCA boundary extended southwest including the Mississippi River and Marshall Avenue to ensure plume coverage. The SWBCA also covers OU3 and all of OU2 as of April 2016, with the current boundary shown on **Figure E-1** (Appendix E). No additional changes or additional actions are currently recommended for this remedy component.

12.4 OVERALL REMEDY FOR OU3

In FY 2022, groundwater monitoring took place as prescribed in the Monitoring Plan. The annual sampling complete in FY 2022 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. No additional actions are necessary because no increasing trends at the edge of the plume were identified by the statistical analysis.

12.5 OTHER RELATED ACTIVITY IN FY 2022

In FY 2022, samples from 18 wells were collected for 1,4-dioxane analysis for OU3 annual sampling as presented in **Table 12-4**. The wells sampled contained 1,4-dioxane concentrations similar to those reported for the previous sampling events.

Included within the 18 locations monitored during FY 2022 were two wells that are required to be sampled every five years (04U414 and 04U851) during the sampling event preceding the Five-Year Review. The FY 2022 samples collected from these wells reported 1,4-dioxane concentrations similar to those reported during the FY 2018 sampling event (the last time these wells were sampled).

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13. OTHER INSTALLATION RESTORATION ACTIVITIES DURING FY 2022

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.

Round Lake

The Army has been working with regulators, landowners, and other stakeholders since an informal dispute was resolved in 2016. Appendix J.12 provides a summary of Round Lake historical design, evaluation, and modification details. After a series of collaborative meetings, a Final SRI-FS (Army 2021a) was submitted to regulators in March 2021. A Draft Proposed Plan (PP) was submitted to regulators in April 2021. Comments received were incorporated, and a Final PP (Army et al. 2021b) was submitted on 7 July 2021. An open house and public meeting were held in July 2021, with comments received.

An ROD for Round Lake was finalized in August 2022 (Army et al. 2022), detailing the selected remedy for Round Lake which consisted of the following components:

1) Dredging of Contaminated Sediment

2) Disposal of Contaminated Sediment

Each of the remedy components are being implemented. During FY 2022, each component performed as required. The remedy components marked with an asterisk (*) have undergone final closeout. **Table ES-2** provides a summary of remedy components, performance standards, and compliance with the ROD. A Pre-Design Investigation and remedial design will be required prior to implementation of the selected remedy of the ROD (Army et al. 2022).

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Tables

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Table ES-1. Status of Remedial Actions: FY 2022 Annual Report

Remedy Component		Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
OU1: Deep					
#1	Alternate Water Supply/Well Abandonment	Yes	Yes	No	
#2	Drilling Advisories	Yes	Yes	No	
#3	Extract Groundwater	Yes	Yes	No	NBCGRS pumping has resumed as of November 2018
#4	Removal of VOCs by GAC (Discharge Quality)	Yes	Yes	No	
#5	Discharge of Treated Water	Yes	Yes	No	
#6	Groundwater Monitoring with Verification of Continuing Aquifer	Yes	Yes	No	
#7	Overall Remedy	Yes	Yes	No	
OU2: Shallow Soil					
#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	
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.
#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.
					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 Site G dump) are addressed by Remedy Component #8.
#5	Maintain Existing Site Caps	Yes	Yes	Yes	
#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	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.
#2	Groundwater Containment/Mass Removal	No	Not Applicable	No	
#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	EPA and MPCA have approved a formal change of the remedy to MNA. A Record of Decision amendment was prepared and approved in FY 2017.
#6	Overall Remedy	Yes	Yes	No	

Table ES-1. Status of Remedial Actions: FY 2022 Annual Report

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 if the Site
#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.
#5	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.
#4	Overall Remedy	Yes			
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.
#9	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.
#4	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Aquatic Sites					
#1	Pond G Surface Water Treatment	Yes	Yes	Yes	
#2	Pond G Surface Water Monitoring	Yes	Yes	Yes	
#3	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	
#7	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	
#4	Overall Remedy	Yes	Yes	No	

Notes:

EPA = U.S. Environmental Protection Agency
GAC = Granular activated carbon
LUCRD = Land Use Control Remedial Design Record of Decision
MNA = Monitored natural attenuation
MPCA = Minnesota Pollution Control Agency
NBCGRS = New Brighton Contaminated Groundwater Recovery System
OU = Operable unit
ROD = Record of Decision
SVE = Soil vapor extraction
TGRS = TCAAP Groundwater Recovery System
VOC = Volatile organic compound

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (OU1 Deep Groundwater)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU1	1993 OU1 ROD	Operable Unit 1: Deep Groundwater	#1 - Alternate Water Supply/Well Abandonment	Providing an alternative water supply and well abandonment to private wells within the OU1 North Plume, OU3, and OU2 Site A Shallow Groundwater Plume.	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): •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 provided in Appendix E •The well is completed in an affected aquifer •The well contains detectable concentrations of the NB/AH site-related COCs identified on page 18 of the 1993 OU1 ROD (or page 26 of the 1992 OU3 ROD, or Table 1 of the 1997 OU2 ROD, as appropriate for the well location) •The well is used in a manner to cause exposure (uses are defined in the OU1 Alternate Water Supply Plan) •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): •The well is located within the area affected by groundwater plumes that originate at OU2 •The well is completed in an affected aquifer •The well contains detectable concentrations of the NB/AH Site-related COCs identified on page 18 of the 1993 OU1 ROD (or page 26 of the 1992 OU3 ROD, or Table 1 of the 1997 OU2 ROD, as appropriate for the well location) •The well was constructed prior to the MDH SWBCA advisory •The well is being used by the well owner or use was discontinued due to impacts •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.	Yes, the remedy is ongoing. The Army offered alternate water supply and well abandonment for four commercial wells (234421, 234544, 509052, and 537801) during FY 2021 due to exceedances of the MDH HRL for 1,4-dioxane. At that time, the owners of well 234544, R&D Systems, and well 509052, Shriner's Hospital, requested connection to the municipal water supply. BioClean, the owner of well 234421 has rejected the offer for an alternate well supply. The Army is still awaiting a response from the remaining well owners.	No.	Section 2.1 of the FY 2022 APR: OU1: Deep Groundwater, Alternate Water Supply/Well Abandonment Appendix E of the FY 2022 APR: Well Inventory Update, Figure E-1 "Well Inventory Study Area" Figure E-2 "Areas of Concern (Upper Unit 4)" Figure E-3 "Areas of Concern (Unit 1)"
OU1	1993 OU1 ROD	Operable Unit 1: Deep Groundwater	#2 - Drilling Advisories	Implementing drilling advisories that would regulate the installation of new private wells within the North Plume as a special well construction area (SWCA) (special well boring and construction area [SWBCA]).	For initial implementation, when the MDH has issued a SWBCA Advisory. Implementation will continue until such time that the groundwater concentrations are below the cleanup levels.	Yes, the remedy was implemented In June 1996 and is ongoing. In June 1999, MPCA requested the MDH extend the SWBCA boundary further southwest to the Mississippi River and Marshall Avenue ensuring the southern boundary fully encompassed the plume. The SWBCA also covers OU3, and as of April 2016, all of OU2. The current boundary of the SWBCA is shown on Figure E-1 (Appendix E).	No.	Section 2.2 of the FY 2022 APR: OU1: Deep Groundwater, Drilling Advisories Appendix E of the FY 2022 APR: Well Inventory Update, Figure E-1 "Well Inventory Study Area"
OU1	1993 OU1 ROD	Operable Unit 1: Deep Groundwater	#3 - Extract Groundwater	Extracting groundwater from the North Plume using the NBCGRS	When the NBCGRS is operating consistently with long-term NBCGRS operating rates and meeting applicable remedial goals.	Yes, the remedy is ongoing. Based on past operations, the target average daily pumping rate is 3.168 million gallons (gal) per day as shown in Appendix A.5. In FY 2022, the volume of water pumped by the NBCGRS was 1.182 billion gal, which translates to a daily average of 3.239 million gal per day.	No.	Section 2.3 of the FY 2022 APR: OU1: Deep Groundwater, Extract Groundwater
OU1	1993 OU1 ROD 2020 ESD	Operable Unit 1: Deep Groundwater	#4 - Removal of VOCs and 1,4-Dioxane by PGAC and AOP	Pumping the extracted groundwater to the PGAC Water Treatment Facility in New Brighton for removal of VOCs and 1,4-Dioxane by treatment by PGAC and AOP.	When the treated water at or below the maximum contaminant level (MCL) and non-zero MCL goals established by the Safe Drinking Water Act for the constituents of concern, as identified on page 18 of the 1993 OU1 ROD	Yes, the remedy is ongoing. The treated water met the MCLs and non-zero maximum contaminant level goals established by the Safe Drinking Water Act for the OU1 chemicals of concern	No.	Section 2.4 of the FY 2022 APR: OU1: Deep Groundwater, Removal of VOCs by PGAC and AOP
OU1	1993 OU1 ROD	Operable Unit 1: Deep Groundwater	#5 - Discharge of Treated Water	Discharging all of the treated water to the New Brighton municipal distribution system.	When the connection to the New Brighton municipal supply system has been completed and water is being discharged.	Yes, the remedy is ongoing. Treated water is being discharged to the New Brighton municipal distribution system	No.	Section 2.5 of the FY 2022 APR: OU1: Deep Groundwater, Discharge of Treated Water
OU1	1993 OU1 ROD Amendment #1	Operable Unit 1: Deep Groundwater	#6 - Groundwater Monitoring with Verification of Continuing Aquifer Restoration	Monitoring the groundwater to verify the effectiveness of the remedy through measurement of overall plume shrinkage (geographically) and decreasing contaminant concentrations	When performance groundwater monitoring verifies aquifer restoration per the qualitative and statistical analyses discussed below.	Yes, the remedy is ongoing. FY 2022 was a "major" sampling year. Also, with the detection of 1,4-dioxane in the NBCGRS wells, EPA and MPCA requested that the Army analyze groundwater samples for 1,4-dioxane at all scheduled OU1 sampling locations beginning during the summer FY2021 and future annual sampling events. All the required and requested sampling was completed for FY2022.	No.	Section 2.6 of the FY 2022 APR: OU1: Deep Groundwater, Groundwater Monitoring with Verification of Continuing Aquifer Restoration

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Shallow Soil and Dump Sites)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 ROD	Operable Unit 2: Shallow Soil and Dump Sites	#1 through #9 - Soil Remediation	Soil Remediation	When a monitoring plan has been established and ongoing monitoring is in compliance with the plan.	Yes. The nine remedy components specified in the 1997 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 OU2 ESD #2 (2009) and OU2 ROD Amendment #3 (2009), respectively.	No.	Section 3 of the FY 2022 APR: OU2: Shallow Soil and Dump Sites Appendix J.2: Historical Design And Evaluation Details OU2 – Shallow Soil And Dump Sites
OU2	1997 ROD Amendment #5 (2014) OU2 LUCRD (2010)	Operable Unit 2: Shallow Soil and Dump Sites	#10 - Land Use Controls	OU2 ROD Amendments and ESDs established LUCs as part of the remedy for shallow soil and dump sites where impacts remain-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.	Implementation of LUCs will continue indefinitely unless further action is taken that would allow for unlimited use and unrestricted exposure.	Yes, the remedy is ongoing. On 14 June 2022 the Army, MNARNG, and JV conducted the annual inspection of OU2 sites. The checklist that was completed during the inspection is included as Appendix F.	No changes to the remedy are required at this time.	Section 3.1 of the FY 2022 APR: OU2: Shallow Soil and Dump Sites, Land Use Controls Appendix F: FY 2022 LUC Annual OU2 Site Inspection Checklist

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Deep Soil Sites)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 OU2 ROD	Operable Unit 2: Deep Soil Sites	#1 Groundwater Monitoring	Groundwater Monitoring	Groundwater Monitoring is completed as part of OU2 deep groundwater monitoring.	Yes, the remedy is ongoing. See Section 11.9 of FY 2022 APR and Appendix J.10 - Operable Unit 2 Deep Groundwater	No.	Section 11.9 of the FY 2022 APR: OU2: Deep Groundwater, Groundwater Monitoring Appendix J.10 of the FY 2022 APR: Historical Design And Evaluation Details OU2 – TGRS Deep Groundwater
OU2	1997 OU2 ROD	Operable Unit 2: Deep Soil Sites	#2: Restrict Site Access (During Remedial Actions) #3: Soil Vapor Extraction (SVE) Systems #4: Enhancements to the SVE Systems #5: Maintain Existing Site Caps #6: Maintain Surface Drainage Controls	Operation of the SVE systems.	Continued operation of the SVE systems installed in 1986 and shut down in 1998.	Yes. Remedy components #2 through #6 were completed upon removal of the SVE systems in 1998.	No.	Section 4 of the FY 2022 APR: OU2: Deep Soil Sites Appendix J.3 of the FY 2022 APR: Historical Design and Evaluation Details OU2 – Deep Soil Sites
OU2	1997 OU2 ROD	Operable Unit 2: Deep Soil Sites	#7 - Characterize Shallow Soils and Dump.	Additional shallow soil investigation at Site D and characterization of the dump at Site G.	Additional shallow soil investigation at Site D and characterization of the dump at Site G.	Yes. Investigation/characterization work was finished, completing 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 the OU2 ROD Amendment #3 (2009).	No.	Section 4 of the FY 2022 APR: OU2: Deep Soil Sites Appendix J.3 of the FY 2022 APR: Historical Design and Evaluation Details OU2 – Deep Soil Sites OU2 ROD Amendment #3 (2009)

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Site A)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 OU2 ROD	Operable Unit 2: Site A Shallow Groundwater	#1 Groundwater Monitoring	Groundwater Monitoring to track plume migration and remedy performance.	When a performance groundwater monitoring program has been established and ongoing monitoring is compliant with the program	Yes, the remedy is ongoing. Groundwater monitoring was performed in FY 2022 in accordance with the groundwater monitoring program.	No.	Section 5.1 of the FY 2022 APR: OU2: Site A Shallow Groundwater, Groundwater Monitoring Table 5-1: Summary of Site A Shallow Groundwater Monitoring Requirements Table 5-2: Site A Groundwater Quality Data Figure 5-1: Site A, Groundwater Monitoring Plan Figure 5-2: Site A, Unit 1, Potentiometric Map Appendix C.2: Deviations from Monitoring Program Appendix J.4: Historical Design and Evaluation Details, OU2 – Site A Shallow Groundwater
OU2	1997 OU2 ROD	Operable Unit 2: Site A Shallow Groundwater	#3A: Land Use Controls	Institutional controls to restrict new well installations and protect the groundwater monitoring and extraction system infrastructure.	Implementation of LUC will continue until such time that the groundwater concentrations are below the cleanup levels.	Yes, the remedy is ongoing. On 14 June 2022, the Army, MNARNG, and JV conducted the OU2 site annual inspection, with a completed checklist included as Appendix F.	No.	Section 5.2 of the FY 2022 APR: OU2: Site A Shallow Groundwater, Land Use Controls Appendix F: LUC Inspection Forms
OU2	1997 OU2 ROD	Operable Unit 2: Site A Shallow Groundwater	#3B: Alternate Water Supply/Well Abandonment	Institutional controls to provide alternate water supplies and well abandonment as necessary.	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).	Yes, the remedy is ongoing. 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.	No.	Section 2.1 of the FY 2022 APR: OU1: Deep Groundwater, Alternate Water Supply/Well Abandonment Section 5.3 of the FY 2022 APR: OU2: Site A Shallow Groundwater, Alternate Water Supply/Well Abandonment Table 5-2: Site A Groundwater Quality Data Figure 5-3: Site A, Unit 1, Tetrachloroethene Isoconcentration Map Figure 5-4: Site A, Unit 1, *cis* -1,2-Dichloroethene Isoconcentration Map Figure 5-5: Site A, Unit 1, *cis* -1,2-Dichloroethene Plume Comparison
OU2	1997 OU2 ROD	Operable Unit 2: Site A Shallow Groundwater	#5: Source Characterization/Remediation	Source Characterization/Remediation	Characterization is required to determine whether remedial actions are necessary. Remedial actions are considered complete when all remedial action objectives (RAOs) are met, in this case when soil COC concentrations are below cleanup levels specified in Table 1 of the 1997 OU2 ROD.	Yes. Source Characterization/Remediation has been completed.	The three new wells added during the FY 2021 groundwater investigation have been added to the annual monitoring program. No additional vapor intrusion activities are required.	Section 5.4 of the FY 2022 APR: OU2: Site A Shallow Groundwater, Source Characterization/Remediation Appendix J.4: Historical Design and Evaluation Details, OU2 – Site A Shallow Groundwater
OU2	1997 OU2 ROD Amendment #6 (2018)	Operable Unit 2: Site A Shallow Groundwater	#6: Overall Remedy for Site A Shallow Groundwater	Overall Remedy for Site A	When the cleanup levels in Table 1 of the 1997 OU2 ROD have been attained throughout the aerial and vertical extent of the Site A plume (1997 OU2 ROD, page 54).	No, the remedy is ongoing . The Cleanup levels in Table 1 of the 1997 OU2 ROD have not been attained throughout the aerial and vertical extent of the Site A plume.	No.	Section 5.5 of the FY 2022 APR: OU2: Site A Shallow Groundwater, Overall Remedy for Site A Shallow Groundwater Table 5-2: Site A Groundwater Quality Data Figure 5-3: Site A, Unit 1, Tetrachloroethene Isoconcentration Map Figure 5-4: Site A, Unit 1, *cis* -1,2-Dichloroethene Isoconcentration Map Figure 5-7: Site A, *cis* -1,2-Dichloroethene Water Quality Trends: Extraction Wells 1 to 4 Figure 5-8: Site A, *cis* -1,2-Dichloroethene Water Quality Trends: Monitoring Wells Figure 5-9: Site A, *cis* -1,2-Dichloroethene Water Quality Trends: Extraction Wells 5 to 8 Figure 5-10: Site A, *cis* -1,2-Dichloroethene Water Quality Trends: Contingency Locations Appendix A: FY 2022 to 2026 Monitoring Plans

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Site C)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 OU2 ROD Amendment #1 (2007)	Operable Unit 2: Site C Shallow Groundwater	#1 Groundwater and Surface Water Monitoring	Groundwater Monitoring to track plume migration and remedy performance.	When a performance groundwater and surface water monitoring program has been established and ongoing monitoring is in compliance with the program.	Yes, the remedy is ongoing. All groundwater and surface water samples were collected as per the FY 2022 monitoring plan in Appendix A.	No.	Section 6.1 of the FY 2022 APR: OU2: Site C Shallow Groundwater, Groundwater and Surface Water Monitoring Table 6-1: Summary of Site C Shallow Groundwater Monitoring Requirements Figure 6-1: Site C Monitoring Plan Appendix A.1: FY 2022 to 2026 Monitoring Plan for Groundwater Monitoring Wells Appendix A.3: FY 2022 to 2026 Monitoring Plan for Surface Water Appendix C.2: Deviations From Monitoring Program Appendix J.5: Historical Design and Evaluation Details, OU2 - Site C Shallow Groundwater
OU2	1997 OU2 ROD Amendment #1 (2007)	Operable Unit 2: Site C Shallow Groundwater	#2: Groundwater Containment	Three extraction wells, EW-1 through EW-3, will continue collecting contaminated groundwater	Collection of contaminated groundwater via the extraction system.	N/A. This remedy is no longer being implemented because the area of lead concentrations that exceed the groundwater cleanup level no longer extends to the extraction wells. As such, the extraction system is no longer operating.	No.	Section 6.2 of the FY 2022 APR: OU2: Site C Shallow Groundwater, Groundwater Containment Appendix J.5: Historical Design and Evaluation Details, OU2 - Site C Shallow Groundwater
OU2	1997 OU2 ROD Amendment #1 (2007)	Operable Unit 2: Site C Shallow Groundwater	#3: Discharge of Extracted Groundwater	Extracted groundwater will be pretreated onsite (as necessary) to meet the sanitary sewer discharge limit	Discharged groundwater must meet the sanitary sewer discharge limit.	N/A. This remedy is no longer being implemented because the area of lead concentrations that exceed the groundwater cleanup level no longer extends to the extraction wells. As such, the extraction system is no longer operating.	No.	Section 6.3 of the FY 2022 APR: OU2: Site C Shallow Groundwater, Discharge of Extracted Water Appendix J.3: Historical Design and Evaluation Details, OU2 - Deep Soil Sites
OU2	1997 OU2 ROD Amendment #1 (2007)	Operable Unit 2: Site C Shallow Groundwater	#4: Land Use Controls	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	For initial implementation, when EPA and MPCA have provided consistency approval for an OU2 LUCRD document. Implementation will continue until such time the groundwater concentrations are below the cleanup levels.	Yes, the remedy is ongoing. On 14 June 2022, the Army, MNARNG, and JV conducted the OU2 site annual inspection, with a completed checklist included as Appendix F.	No.	Section 6.4 of the FY 2022 APR: OU2: Site C Shallow Groundwater, Land Use Controls Appendix F: FY 2022 LUC Annual OU2 Site Inspection Checklist
OU2	1997 OU2 ROD Amendment #1 (2007)	Operable Unit 2: Site C Shallow Groundwater	#5: Overall Remedy for Site C Shallow Groundwater	Overall Remedy for Site C Shallow Groundwater	When the cleanup levels in Table 1 of the OU2 ROD Amendment #1 (2007) have been attained throughout the aerial and vertical extent of the Site C plume.	No, the remedy is ongoing. The Cleanup levels in Table 1 of the 1997 OU2 ROD have not been attained throughout the aerial and vertical extent of the Site C plume.	No. Site C wells have had stable COC concentrations, and the existing groundwater plume does not appear to be migrating. Continued monitoring of the site will be performed to evaluate when closure for Site C is appropriate	Section 6.5 of the FY 2022 APR: OU2: Site C Shallow Groundwater, Overall Remedy for Site C Shallow Groundwater Table 6-2: Water Quality Data for Site C Groundwater Table 6-3: Water Quality Data for Site C Surface Water Table 6-4: Contingency Locations for Site C Monitoring Figure 6-2: Site C, Unit 1, Potentiometric Map Figure 6-3: Site C, Unit 1, Lead Results Figure 6-4: Site C, Cross Section A-A' Figure 6-5: Site C, Cross Section B-B' Appendix J.5: Historical Design and Evaluation, OU2 - Site C Shallow Groundwater

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Site I)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 OU2 ROD	Operable Unit 2: Site I - Shallow Groundwater	#1 - Groundwater Monitoring	Groundwater Monitoring	When a monitoring plan has been established and ongoing monitoring is in compliance with the plan.	Yes, the remedy is ongoing. The monitoring program has been implemented but groundwater monitoring was not conducted in FY 2022 due to the approved 2014 abandonment of all Unit 1 wells within Site I to allow demolition of Building 502 and related soil cleanup activities by Ramsey County. Table 7-1 summarizes the performance monitoring requirements, the implementing parties, and documents containing monitoring plans. Appendix A summarizes the FY 2022 monitoring plan, and any deviations are explained in Appendix C.2.	Yes. Once reinstalled, monitoring well 01U667 will be sampled annually in accordance with the FY 2022 - FY 2026 Monitoring Plan (Appendix A.1). Figure 7-1 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 7-2.	Section 7.1 of the FY 2022 APR: OU2: Site I Shallow Groundwater, Groundwater Monitoring Table 7-1: Summary of Site I Groundwater Monitoring Requirements Table 7-2: Most Recent Site I Groundwater Quality Data, Fiscal Year 2013 Figure 7-1: Site I Site Plan Figure 7-3: Site I TCE and Vinyl Chloride Concentrations - FY 2013 Appendix A.1: FY 2022 to 2026 Monitoring Plan, Groundwater Monitoring Wells Appendix C.2: Deviations from Monitoring Program Appendix D: Comprehensive Groundwater Quality and Water Level Database
OU2	1997 OU2 ROD	Operable Unit 2: Site I - Shallow Groundwater	#2 - Additional Investigation	Additional characterization of the Unit 1 and Unit 2 soil and groundwater.	When the Remedial Action Objectives (RAOs), namely the site cleanup levels outlined in the ROD have been achieved.	Yes. The remedy component has been implemented. 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 OU2 ROD Amendment #2 (2009) removed the groundwater extraction and POTW discharge component of the remedy.	No.	Predesign Investigation Work Plan (January 1999) Predesign Investigation Report (March 2001)
OU2	1997 OU2 ROD	Operable Unit 2: Site I - Shallow Groundwater	#3 - Land Use Controls (LUCs)	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.	Implementation of the LUCs will continue until the groundwater concentrations are below the cleanup levels.	U.S. Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) provided approval for the OU2 LUC Remedial Design (LUCRD) document in September 2010 and it is being implemented by the Army. Subsequent revisions of the LUCRD have not changed the groundwater LOCs for Site I. Following additional soil investigation and remediation completed by Ramsey County in 2014 and 2015, Site I is now suitable for unrestricted use/unlimited exposure and soil LUCs at Site I are no longer necessary. EPA and MPCA provided consistency approval for the OU2 LUCRD Revision 5 in March 2018, which formally removes Site I soil LUCs. On June 14, 2022, the Army, MNARNG, and GHD conducted the annual OU2 site inspection. The completed checklist is included as Appendix F.	No. The inspection did not identify any follow up actions needed to maintain the protectiveness of the LUCs at Site I.	Section 7.2 of the FY 2022 APR: OU2: Site I Shallow Groundwater, Land Use Controls Appendix F: FY 2022 LUC Annual OU2 Site Inspection Checklist
OU2	1997 OU2 ROD	Operable Unit 2: Site I - Shallow Groundwater	#4 - Overall Remedy for Site I Shallow Groundwater	See Remedy Components above	Once the cleanup levels in Table 1 of the 1997 OU2 ROD have been attained throughout the aerial and vertical extent of the Site I plume.	This remedy component has not yet been completed. Groundwater monitoring was not conducted in FY 2022 due to the approved 2014 abandonment of all Unit 1 wells within Site I to allow demolition of Building 502 and related soil cleanup activity by Ramsey County; however, the most recent groundwater quality data (from FY 2013) suggests that cleanup levels have not been attained.	Yes. As requested by Northrup Grumman (Orbital ATK at the time) in their letter dated 12 August 2013, and approved by EPA and MPCA on 14 August 2013, all Unit 1 monitoring wells within Site I were abandoned in 2014. In accordance with the Northrup Grumman request and regulatory approval, monitoring well 01U667 will be reinstalled at approximately the same location and depth.	Section 7.3 of the FY 2022 APR: OU2: Site I Shallow Groundwater, Overall Remedy for Site I Shallow Groundwater Table 7-2: Most Recent Site I Groundwater Quality Data, Fiscal Year 2013 Figure 7-3: Site I TCE and Vinyl Chloride Concentrations - FY 2013

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Site K)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 OU2 ROD	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#1 - Groundwater Monitoring	Groundwater monitoring to track remedy performance.	When a regulator-approved monitoring plan is in place and monitoring is conducted according to the plan.	Yes. Monitoring in FY 2022 was consistent with the 1997 OU2 ROD. Water level measurements and water quality samples were collected as stated in Appendix A.1. Appendix A summarizes the FY 2022 monitoring plan, and any deviations are explained in Appendix C.2.	No.	Section 8.1 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Groundwater Monitoring Table 8-1: Summary of Site K Groundwater Monitoring Requirements Table 8-7: Site K 1,4-Dioxane Sampling Results Appendix A.1: FY 2022 - FY 2026 Monitoring Plan Appendix C.2: Deviations from Monitoring Program Appendix D: Comprehensive Groundwater Quality and Water Level Database
OU2	1997 OU2 ROD	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#2 - Sentinel Wells	Installation of sentinel wells at the bottom of Unit 1 and top of Unit 3.	When the sentinel wells have been installed in accordance with a regulator-approved work plan.	Yes, this remedy component has been completed. The Upper Unit 3 sentinel well was installed in February 2000 to monitor potential VOC migration through the Unit 2 till aquitard into the Unit 3 aquifer. Existing piezometers were used to accomplish the deep Unit 1 sentry monitoring.	No.	Section 8.1 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Groundwater Monitoring Table 8-2: Site K Groundwater Quality Data Table 8-3: Site K Groundwater Elevation Monitoring Table 8-7: Site K 1,4-Dioxane Sampling Results
OU2	1997 OU2 ROD	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#3 - Hydraulic Containment	Use of existing collection trench to contain the plume and remove impacted groundwater.	When the Remedial Action Objectives (RAOs) have been achieved, namely that the trench is operating as designed and capturing all groundwater exceeding the cleanup levels as presented in Table 1 of the 1997 OU2 ROD.	Yes. The groundwater collection system continues to provide capture of the Unit 1 groundwater, upgradient of the trench and beneath the former Building 103 footprint, as designed. Low extraction rates were due primarily to low groundwater elevations near the extraction trench causing frequent cycling of the extraction pump. Appendix J.7.2 of this report provides the USEPA-requested hydraulic containment evaluation, related to groundwater elevations. The evaluation concluded that the Site K TCE plume has been contained by the collection trench during nearly all groundwater elevation conditions experienced at the site since 2001 (and likely before). The one notable exception was in 2014, when Site K experienced historically high ground water elevations in the spring due to flooding and TCE was detected in a monitoring well (01U603) downgradient of the north portion of the trench.	No; however, the abandonment of obstructed upgradient well 01U625C is recommended.	Section 8.2 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Hydraulic Containment Table 8-2: Site K Groundwater Quality Data Table 8-3: Site K Groundwater Elevation Monitoring Figure 8-4: Unit 1 Groundwater Contours Figure 8-5: Hydrogeologic Cross Section Appendix J.7.1: Summary of Historical Site K Design and Evaluation Details Appendix J.7.2: Site K Hydraulic Containment Evaluation Memo
OU2	1997 OU2 ROD	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#4 - Groundwater Treatment	Treatment of contaminated groundwater using air stripping.	When the treatment system operates and meets discharge limits.	During FY 2022 the treatment system functioned and was operational 99 percent of FY 2022. During FY 2022, a regular maintenance schedule was maintained.	No.	Section 8.3 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Groundwater Treatment Table 8-4 and 8-5: Site K Treatment System Organic and Inorganic Concentrations Appendix G.1: Inspection and Maintenance Activities, Fiscal Year 2022, Site K, OU2
OU2	1997 OU2 ROD	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#5 - Treated Water Discharge	Discharge of treated groundwater to Rice Creek.	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.	Yes. See below for Remedy Component #5 discussion.	No.	Section 8.3 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Groundwater Treatment Table 8-4: Treatment System Concentrations (Organics), Fiscal Year 2022, Site K, OU2 Table 8-5: Treatment System Concentrations (Inorganics), Fiscal Year 2022, Site K, OU2
OU2	1997 OU2 ROD	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#6 - Discharge Monitoring	Monitoring to track compliance with discharge requirements	Treat water using the air stripping treatment facility to meet the cleanup requirements in Table 1 of the 1997 OU2 ROD.	Yes. Treatment system monitoring consisted of quarterly influent and effluent sampling. Influent and effluent analytical results are presented in Table 8-4 (organics) and Table 8-5 (inorganics). The discharge met the treatment requirements during FY 2022.	No.	Section 8.3 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Groundwater Treatment Table 8-4: Treatment System Concentrations (Organics), Fiscal Year 2022, Site K, OU2 Table 8-5: Treatment System Concentrations (Inorganics), Fiscal Year 2022, Site K, OU2
OU2	1997 OU2 ROD	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#7 - Additional Investigation	Additional characterization of the unsaturated Unit 1 soil.	When the additional investigation has been completed according to a regulator-approved work plan.	A report of the investigation results received a consistency determination from regulators on 6 December 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.	No.	Consistency Determination dated 6 December 2001
OU2	1997 OU2 ROD, Amended 2007 (#1)	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#8 - Land Use Controls (LUCs)	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.	Implementation of the established LUCs will continue until such time the groundwater concentrations are below the cleanup levels.	Yes. EPA 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. On June 14, 2022, the Army, MNARNG, and GHD conducted the annual OU2 site inspection. The completed checklist is included as Appendix F.	The 2022 LUC inspection did not identify any follow up actions needed to maintain the protectiveness of the LUCs at Site K.	Section 8.4 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Land Use Controls Appendix F: FY 2022 LUC Annual OU2 Site Inspection Checklist
OU2	1997 OU2 ROD, Explanation of Significant Differences (ESD) Signed 2009 (#1)	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	#9 - Overall Remedy for Site K	See Remedy Components above	Once the cleanup levels in Table 1 of the 1997 OU2 ROD have been attained throughout the aerial and vertical extent of the Site K plume.	This remedy component has not yet been completed. Overall, the remedy for Site K continued to operate consistent with past years and in compliance with the required performance criteria. A low extraction rate was observed during FY 2022 due primarily to low groundwater elevations near the collection trench causing frequent cycling of the extraction pump. As noted above, the Appendix J.7.2 hydraulic containment evaluation concluded that the Site K TCE plume has been contained by the collection trench during nearly all groundwater elevation conditions experienced at the Site since 2001, including during low groundwater elevation conditions.	No.	Section 8.5 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Overall Remedy for Site K Table 8-6: Summary of Monthly Site K VOC Removal Figure 8-2: June 2022 Unit 1 TCE Concentrations Appendix J.7.2: Site K Hydraulic Containment Evaluation Memo
OU2	1997 OU2 ROD, Explanation of Significant Differences (ESD) Signed 2009 (#1)	Operable Unit 2: Site K - Perched Aquifer (Unit 1) at Building 103	Other Related Activity	USGS groundwater bioremediation treatability pilot study	No formal standards required for this work. Goal of reduction on groundwater COCs	USGS continued a groundwater bioremediation treatability pilot study in FY 2022. Additional work, including quarterly groundwater monitoring, continued throughout FY 2022. Laboratory tests on Site K soil and groundwater samples indicated that a bioremediation injection program could accelerate remediation of Site K groundwater.	The report on this work will be issued by USGS in FY 2023.	Section 8.6 of the FY 2022 APR: OU2: Site K Shallow Groundwater, Other Related Activity in FY 2022

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Building 102)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 OU2 ROD Amendment # 4 (2012)	Operable Unit 2: Building 102 Shallow Groundwater	#1 - Monitored Natural Attenuation	Use of naturally-occurring abiotic degradation to limit plume mobility and to ultimately restore the aquifer.	When a monitoring program is established, and monitoring is in compliance with the regulator approved Annual Monitoring Plan.	Yes, the remedy is ongoing. Monitoring in FY 2021 was consistent with the 1997 OU2 ROD. Water level measurements and water quality samples were collected as stated in Appendix A.1. Appendix A summarizes the FY 2021 monitoring plan, and any deviations are explained in Appendix C.2.	No.	Section 9.1 of the FY 2022 APR: OU2: Building 102 Shallow Groundwater, Monitored Natural Attenuation Appendix A.1: FY 2022 – FY 2026 Monitoring Plans, Groundwater Monitoring Wells Appendix C.2: Deviations From Monitoring Program
OU2	1997 OU2 ROD Amendment # 4 (2012)	Operable Unit 2: Building 102 Shallow Groundwater	#2 - Groundwater Monitoring	Groundwater monitoring to track remedy performance and to verify that groundwater reaching Rice Creek does not exceed state surface water standards	When a monitoring program is established, and monitoring is in compliance with the regulator approved Annual Monitoring Plan.	Yes, the remedy is ongoing. Monitoring in FY 2021 was consistent with the 1997 OU2 ROD. Water level measurements and water quality samples were collected as stated in Appendix A.1. Appendix A summarizes the FY 2021 monitoring plan, and any deviations are explained in Appendix C.2.	No.	Section 9.2 of the FY 2022 APR: OU2: Building 102 Shallow Groundwater, Remedy Component #2: Groundwater Monitoring Table 9-1: Summary of Building 102 Shallow Groundwater Monitoring Requirements Table 9-2: Building 102 Groundwater Quality Data Figure 9-2: Building 102, Unit 1, Potentiometric Map Figure 9-3: Building 102, Unit 1, Trichloroethene Results Figure 9-4: Building 102, Unit 1, *cis-1*, 2-Dichloroethene Results Figure 9-5: Building 102, Unit 1, Vinyl Chloride Results Figure 9-6: Building 102, Vinyl Chloride Cross Section B-B' Appendix J.8: Historical Design and Evaluation Details, OU2 - Building 102 Shallow Groundwater
OU2	1997 OU2 ROD Amendment # 4 (2012)	Operable Unit 2: Building 102 Shallow Groundwater	#3 - Land Use Controls	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)	Implementation of the LUCs will continue until such time that the groundwater concentrations are below the cleanup levels.	Yes, the remedy is ongoing. On 14 June 2022, the Army, MNARNG, and JV conducted the OU2 site annual inspection, with a completed checklist included as Appendix F.	No.	Section 9.3 of the FY 2022 APR: OU2: Building 102 Shallow Groundwater, Remedy Component #3: Land Use Controls Appendix F: FY 2022 LUC Annual OU2 Site Inspection Checklist
OU2	1997 OU2 ROD Amendment # 4 (2012)	Operable Unit 2: Building 102 Shallow Groundwater	#4 - Overall Remedy for Building 102 Shallow Groundwater	Overall Remedy for Building 102 Shallow Groundwater	When the cleanup levels in OU2 ROD Amendment #4 (2012) have been attained throughout the aerial and vertical extent of the Building 102 plume	No, the remedy is ongoing. As shown in Table 9-2, cleanup levels have not been reached throughout the aerial extent of the plume and the site cannot be closed.	No.	Section 9.4 of the FY 2022 APR: OU2: Building 102 Shallow Groundwater, Remedy Component #4: Overall Remedy for Building 102 Shallow Groundwater Table 9-2: Building 102 Groundwater Quality Data

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Aquatic Sites)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 OU2 ROD Amendment # 4 (2012)	Operable Unit 2: Pond G	#1 - Surface Water Hardness Adjustment	Surface water hardness adjustment	When surface water hardness has been adjusted to meet compliance with the Minnesota surface water standard for lead (Class 2Bd chronic standard).	Yes, the remedy is complete. EPA and MPCA provided consistency for the Pond G Remedial Design/Remedial Action Work Plan in March 2012, and the pond was treated in June 2012. The pond surface water was then monitored in FY 2012 and FY 2013, and results verified compliance with the surface water standard for lead.	No.	Section 9.1 of the FY 2022 APR: Appendix A.1: FY 2022 to 2026 Monitoring Plan for Groundwater Monitoring Wells Appendix C.2: Deviations From Monitoring Program

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (TGRS)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU2	1997 OU2 ROD, ESD Signed 2021 (#3)	TGRS - Deep Groundwater	#1 - Hydraulic Containment and Contaminant Removal from the Source Area	Groundwater extraction to hydraulically contain the contaminated source area to the 5 µg/L TCE concentration contour and optimize the removal of Contaminants of Concern (COCs) from the source area through pumping of select wells.	Hydraulically contain the contaminated source area to the 5 µg/L TCE concentration contour and optimize the removal of COCs from the source area through pumping of select wells.	Yes. During FY 2022, the TGRS average extraction rate was approximately 1,723 gpm, as shown in Table 11-2. Thi extraction rate was 98.7% of the GOS Total System Operational Minimum (1,745 gpm) established in 2004 (based o the TCE plume width of 3,600 feet determined from the FY 2001 groundwater sampling event). The Army and regulators have historically agreed that the 1,745-gpm extraction rate meets the 1997 OU2 ROD requirements with a adequate safety factor. The lower than anticipated TGRS extraction rate was primarily due to the substantial power outage caused by the Building 116 transformer failure in August 2022. However, given the significant reduction in TCE concentrations across the site since 2001 and reduction of the TCE plume width to approximately 3,000 feet (o 83% of the 2001 TCE plume width, as discussed in Section 11.9), it is reasonable to conclude that the TCE was adequately contained by the average extraction rate of 1,723 gpm.	No.	Section 11.2 of the FY 2022 APR Table 11-1: TGRS Groundwater Cleanup Requirements Table 11-2: TGRS Extraction Well Water Pumped Figure 11-1: TGRS Layout
		TGRS - Deep Groundwater	#2 - Groundwater Treatment	Groundwater treatment using air stripping of VOCs for boundary wells (BGRS). Advanced Oxidation (AO) for treatment of 1,4-dioxane and TCE and air stripping for VOCs in source area wells (SGRS)	Treat extracted groundwater from boundary wells using the BGRS air stripping treatment facility to meet the cleanup requirements in Table 1 of the 1997 OU2 ROD. Treat extracted groundwater from source area wells at the SGRS treatment facility using AO for treatment of 1,4-dioxane and TCE and air stripping for VOCs to meet the discharge level of 1 µg/L for 1,4-dioxane and cleanup requirements in Table 1 of the 1997 OU2 ROD prior to mixing with discharge from the BGRS.	Yes. During FY 2022, the BGRS effluent was below 5 µg/L TCE for all sampling events. A review of the FY 2022 database indicates that the effluent remained below the treatment requirements for all other VOC compounds specified in the 1997 OU2 ROD. Comparison of BGRS influent and effluent concentrations for all specified VOC compounds indicates an average removal efficiency of 99.2 percent. Total BGRS VOC air emissions averaged 2.7 pounds per day based on the VOC mass removal rates. The total BGRS VOC air emissions from October 2021 through September 2022 were 984 pounds. The SGRS was under construction during FY 2022, and only operated intermittently during startup activities in September 2022. Details of the SGRS construction and startup testing will be contained in the Construction Completion Report that will be issued in FY 2023. The SGRS began full operation in FY 2023.	No.	Section 11.6 of the FY 2022 APR: OU2: Deep Groundwater, Groundwater Treatment Table 11-3: TGRS VOC Mass Loading Summary Figure 11-9: BGRS (Building 116) Treatment System Performance (Influent & Effluent TCE vs Time) Graphs Appendix H.2: TGRS Influent and Effluent Database
		TGRS - Deep Groundwater	#3 - Treated Water Discharge	Discharge of treated water to the on-Site gravel pit.	The gravel pit is accommodating the discharge from the treatment system and allowing it to recharge into the aquifer.	Yes. Based on visual observation during FY 2022, there were no noticeable changes in gravel pit performance. The gravel pit is accommodating the TGRS discharge as designed.	No.	Section 11.6 of the FY 2022 APR: OU2: Deep Groundwater, Groundwater Treatment
		TGRS - Deep Groundwater	#4 - Institutional Controls	Institutional controls to restrict access to contaminated aquifers and prevent exposure to contaminated groundwater.	Implement institutional controls to restrict access to contaminated aquifers and prevent exposure to contaminated groundwater. Establish a special well construction area and alternate water supply, and seal private wells in impacted areas.	Yes. There are no private users of groundwater on the property and no potable water supply using Site groundwater. There are institutional controls in place for future groundwater use associated with upcoming property redevelopment	Yes. On 20 April 2016, the MDH issued a memorandum updating the SWBCA that noted the rezoning of the TCAAP facility for future development and updated the SWBCA boundary to include the entirety of TCAAP (MDH 2016). As such, all wells and borings constructed or modified within the SWBCA must first be approved by the MDH.	Section 11.7 of the FY 2022 APR: OU2: Deep Groundwater, Institutional Controls
		TGRS - Deep Groundwater	#5 - Review of New Technologies	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 Federal Facility Agreement (FFA).	When the Army reports on the status of any reviews of emerging technologie in the annual monitoring report.	Yes. Since the FY 1997 APR, the Army reports annually on the status of any reviews of emerging technologies. No new technologies were identified and considered to have merit during FY 2021.	Yes. After the SGRS is in full operation in FY 2023, the capabilities of the combined groundwater extraction system will be evaluated to best achieve the OU2 Deep Groundwater objectives o hydraulic containment of the source areas and optimizing mass contaminant removal. After optimization, air emissions modelling will be conducted.	Section 11.8 of the FY 2022 APR: OU2: Deep Groundwater, Review of New Technologies
OU2	1997 OU2 ROD	TGRS - Deep Groundwater	#6 - Groundwater Monitoring	Groundwater monitoring to track remedy performance.	When a regulator approved monitoring plan is in place and monitoring is conducted according to the plan.	Yes. Monitoring in FY 2022 was consistent with the 1997 OU2 ROD. Water level measurements and water quality samples were collected as stated in Appendix A.1. Appendix A summarizes the FY 2021 monitoring plan, and any deviations are explained in Appendix C.2.	No.	Section 11.9 of the FY 2022 APR: OU2: Deep Groundwater, Groundwater Monitoring Table 11-7: Groundwater Quality Data, Fiscal Year 2022, TGRS, OU2 Figure 11-6: OU2, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map Figure 11-7: OU2, Upper Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map Figure 11-8: OU2, Lower Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map Appendix A.1: FY 2022 - FY 2026 Monitoring Plan Appendix C.2: Deviations from Monitoring Plan Appendix D: Comprehensive Groundwater Quality and Water Level Database
OU2	1997 OU2 ROD, ESD Signed 2021 (#3)	TGRS - Deep Groundwater	#7 - Overall Remedy for Deep Groundwater	See Remedy Components #1 through #6 above, and the addition of 1,4-dioxane to the list of COCs.	See Performance Standards listed above and the addition of 1,4-dioxane to the list of COCs.	Yes. The TGRS met the requirements of the 1997 OU2 ROD during FY 2022. As detailed in Section 11.2, the FY 2022 annual average extraction rate was approximately 1,723 gpm, or 98.7% of the GOS Total System Operational Minimum (1,745 gpm) established in 2004 using the FY 2001 data set. The lower than anticipated TGRS extraction rate was primarily due to the substantial power outage caused by the Building 116 transformer failure in August 2022. However, given the significant reduction in TCE concentrations across the Site since 2001 and the reduction of the TCE plume width to 83.7% of the 2001 TCE plume, it is reasonable to conclude that the TCE was adequately contained during FY 2022. These 1997 OU2 ROD requirements were also achieved by the TGRS during FY 2022: • Hydraulic containment in Units 3 and 4 extends upgradient within OU2 beyond the 5 µg/L contour, meeting the VOC criterion in the 1997 OU2 ROD. • The TGRS extracted and treated 905,462,940 gallons of water and removed 982 pounds of VOCs from October 2021 to September 2022. Average BGRS VOC influent concentrations decreased by 42 percent during FY 2022 due to the construction-related downtime and rerouting of SC1 and SC5 to the new SGRS treatment system. • 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 COC-specific requirements for all sampling events.	The combined groundwater extraction and treatment for on-site Deep Groundwater within OU2 by BGRS and SGRS (together composing the TGRS) will result in increased mass removal of VOCs, destruction of 1,4-dioxane and more efficient hydraulic containment of the source areas.	Section 11.10 of the FY 2022 APR: OU2: Deep Groundwater, Overall Remedy for Deep Groundwater Also see supporting content listed above and below.
OU2	1997 OU2 ROD, ESD Signed 2021 (#3)	TGRS - Deep Groundwater	Other related activity in FY 2022	Addition of 1,4-dioxane to the list of COCs	MDH Health Risk Limit: 1.0 µg/L for 1,4-dioxane	In 2022, monitoring wells proposed for sampling in the FY 2022 Monitoring Plan were sampled for 1,4-dioxane. Table 11-9 presents the results of the 1,4-dioxane sampling for the BGRS influent, effluent, and extraction wells. No Federal MCL has been established for 1,4-dioxane; however, the MDH has established an HRL value of 1.0 µg/L. All extraction wells sampled except extraction well B2 had 1,4-dioxane concentrations exceeding the HRL. The BGRS influent and effluent were sampled in June 2022 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 11-10. A majority of the monitoring wells sampled (51 of 78) had 1,4-dioxane concentrations exceeding the HRL, with the highest concentrations found in the samples at 03U094 (41.1 µg/L), 03U021 (38.6 µg/L), 03U020 (31.0 µg/L), 03U014 (29.9 µg/L), 04J077 (22.5 µg/L), 03M806 (21.4 µg/L), PJ#806 (20.5 µg/L), and 04U077 (20.1 µg/L). Figure 11-15 shows the 1,4-dioxane concentrations in plan view for the west portion of OU2. Figures 11-12 and 11-13 present cross-sectional views of the plume along the property boundary.	No. Continue to monitor in accordance with the plan provided in Appendix A of the APR.	Section 11.11 of the FY 2022 APR: OU2: Deep Groundwater, Other Related Activity in FY 2022 Table 11-9: TGRS & Extraction Well 1,4-Dioxane Concentrations Table 11-10: TGRS Monitoring Well 1,4-Dioxane Concentrations Figures 11-6 through 11-8: TCE and 1,4-Dioxane Isoconcentration Maps Figure 11-12: Groundwater 1,4-Dioxane Data, Cross Section C-C' Figure 11-13: Groundwater 1,4-dioxane Data, Cross Section C'-C'' Figure 11-15: 1,4-Dioxane Concentrations - West Portion of OU2

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (OU 3 Deep Groundwater)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Component Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
OU3	1992 OU3 ROD, Amendment #1 (2006b)	Operable Unit 3: Deep Groundwater	#1 - Monitored Natural Attenuation	Monitored Natural Attenuation	When a monitoring program is established, and monitoring is in compliance with the regulator-approved Annual Monitoring Plan.	Yes. Appendix A summarizes the FY 2022 monitoring plan, and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in Section 12.2.	No.	Section 12.1 of the FY 2022 APR Table 12-1: OU3 Groundwater Quality Data Table 12-3: Summary of OU3 Groundwater Monitoring Requirements Table 12-4: OU3 1,4-Dioxane Groundwater Sampling Results Figure 12-1: OU3 Site Plan Appendix A.1: FY 2022 - FY 2026 Monitoring Plan Appendix C.2: Deviations from Monitoring Program Appendix D: Comprehensive Groundwater Quality and Water Level Database
OU3	1992 OU3 ROD, Amendment #1 (2006b)	Operable Unit 3: Deep Groundwater	#2 - Groundwater Monitoring	Monitoring of the groundwater for VOCs to verify the effectiveness of the selected remedy and the natural attenuation of the South Plume	When a monitoring program is established, and monitoring is in compliance with the regulator approved Annual Monitoring Plan.	Yes. Appendix A summarizes the FY 2022 monitoring plan, and any deviations are explained in Appendix C.2.	No. The OU3 ROD Amendment #1 (2006b) 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 2022 showed a decreasing or stable trend.	Section 12.2 of the FY 2022 APR Table 12-1: OU3 Groundwater Quality Data Table 12-2: OU3 Mann-Kendall Statistical Summary Table 12-3: Summary of OU3 Groundwater Monitoring Requirements Table 12-4: OU3 1,4-Dioxane Groundwater Sampling Results Figure 12-1: OU3 Site Plan Appendix A.1: FY 2022 - FY 2026 Monitoring Plan Appendix C.2: Deviations from Monitoring Program Appendix D: Comprehensive Groundwater Quality and Water Level Database Appendix I: Maros Decision Matrix
OU3	1992 OU3 ROD, Amendment #1 (2006b)	Operable Unit 3: Deep Groundwater	#3 - Drilling Advisories	Continued implementation of the drilling advisories that regulates the installation of new private wells within OU3 as a Special Well Construction Area (SWCA).	When a special well boring and construction area (SWBCA) Advisory is issued.	Yes. Minnesota Department of Health (MDH) issued a SWCA Advisory in June 1996. In June 1999, via the MDH, the SWBCA boundary extended southwest including the Mississippi River and Marshall Avenue to ensure plume coverage. The SWBCA also covers OU3 and all of OU2 as of April 2016, with the current boundary shown on Figure E-1 (Appendix E).	No.	Section 12.3 of the FY 2022 APR Appendix E.1: Well Inventory Study Area
OU3	1992 OU3 ROD, Amendment #1 (2006b)	Operable Unit 3: Deep Groundwater	#4 - Overall Remedy for OU3	See Remedy Components #1 through #3 above.	Remedial Action Objectives for OU3 groundwater include: * - Restore the contaminated aquifer for future use by reducing contaminant levels to those that will adequately protect human health and the environment. * - Control contaminant migration to prevent further spread of the VOC plume. * - Prevent the near-term and future exposure of human receptors to contaminated groundwater above Maximum Contaminant Levels (MCLs), both on and off Site. * - Monitor groundwater in a manner to verify effectiveness of remedial measures.	In FY 2022, groundwater monitoring took place as prescribed in the Annual Monitoring Plan. The annual sampling round of FY 2022 indicates that the South TCE Plume footprint appears to be decreasing or at least stable, with a stable to decreasing trend at the center of the plume.	No.	Section 12.4 of the FY 2022 APR See above for Remedy Components #1 through #3.
OU3	1992 OU3 ROD, Amendment #1 (2006b)	Operable Unit 3: Deep Groundwater	Other Related Activity	1,4-dioxane results	MDH Health Risk Limit: 1.0 µg/L for 1,4-dioxane	In FY 2022, samples were collected for 1,4-dioxane analysis for OU3 annual sampling as presented in Table 12-4. The wells sampled contained 1,4-dioxane concentrations similar to those reported for the previous sampling events.	No.	Table 12-3: Summary of OU3 Groundwater Monitoring Requirements Table 12-4: OU3 1,4-Dioxane Groundwater Sampling Results

Table ES-2. Summary of Remedy Components, Performance Standards, and Compliance (Round Lake)

Operable Unit (OU)	Record of Decision (ROD)	Operable Unit/Site	Remedy Components	Remedy Description	Performance Standards	Performance Standard Met?	Changes or Additional Actions Required?	Supporting Content
Round Lake	2022 ROD	Round Lake	#1 - Dredging of Contaminated Sediment	Dredging of contaminated sediment exceeding the CUL of 0.6 mPEC-Q	Dredging of contaminated sediment exceeding the CUL of 0.6 mPEC-Q	A pre-design investigation and remedial design are still required before the implementation of the selected remedy	No.	Section 13 of the FY 2022 APR
Round Lake	2022 ROD	Round Lake	#2 - Disposal of Contaminated Sediment	Characterization, dewatering, stabilization (if necessary), and disposal of contaminated sediment at an offsite landfill	Characterization, dewatering, stabilization (if necessary), and disposal of contaminated sediment at an offsite landfill	A pre-design investigation and remedial design are still required before the implementation of the selected remedy	No.	Section 13 of the FY 2022 APR

Table 2-1. Summary of OU1 Monitoring Requirements

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

Notes:

Army = U.S. Army

MDH = Minnesota Department of Health

N/A = Not applicable

New Brighton = City of New Brighton

OU1 = Operable Unit 1

VOC = Volatile organic compound

Table 2-2 OU1 Groundwater Quality Data

		1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,4-Dioxane	*cis*-1,2-Dichloroethene	Trichloroethene	Health Risk Index (3)
OU1 Cleanup Level (µg/L) (1)		200	3	70	6	---	70	5	
MDH HRL (µg/L) (2)		---	---	---	---	1	---	---	
Sample Location	Date								
03U821	5/17/2022	<1.00	<1.00	0.457 J	0.323 J	13.1	0.619 J	6.65	16.6
03U822	5/16/2022	<1.00	<1.00	1.65	1.69	9.58	34.0	6.77	16.9
409550	5/17/2022	<1.00	<1.00	0.535 J	0.339 J	7.66	1.93	17.0	42.5
03M843	5/17/2022	<1.00	<1.00	<1.00	<1.00	13.7	<1.00	<1.00	13.7
03L822	5/16/2022	<1.00	<1.00	2.36	2.81	18.5	5.31	91.6	229.0
03L832	5/17/2022	<1.00	<1.00	0.136 J	<1.00	0.475	0.238 J	2.51	6.3
03L841	5/16/2022	<1.00	<1.00	0.212 J	0.228 J	4.18	0.525 J	<1.00	4.2
03L846	5/17/2022	<1.00	<1.00	10.5	7.31	17.7	25.6	0.656 J	17.7
409556	5/17/2022	<1.00	<1.00	<1.00	<1.00	<0.400	<1.00	<1.00	0.0
409557	5/16/2022	0.924 J	<1.00	6.42	6.51	6.37	1.54	2.85	7.8
04U821	5/17/2022	<1.00	<1.00	0.999 J	0.912 J	15.1	9.04	1.54	15.9
04U821 (FD)	5/17/2022	<1.00	<1.00	0.934 J	0.860 J	13.5	8.13	1.37	14.2
04U834	5/16/2022	<1.00	<1.00	0.122 J	<1.00	1.23	<1.00	1.19	3.0
04U834 (FD)	5/16/2022	<1.00	<1.00	0.123 J	<1.00	0.554	<1.00	0.919 J	0.6
04U836	5/17/2022	<1.00	<1.00	2.15	2.13	5.72	12.4	8.90	22.3
04U837	5/16/2022	<1.00	<1.00	1.52	<1.00	2.55	0.165 J	0.523 J	2.6
04U838	5/17/2022	<1.00	<1.00	<1.00	<1.00	0.701	<1.00	0.306 J	0.7
04U839	5/17/2022	0.550 J	<1.00	1.89	1.36	5.31	0.442 J	23.8	59.5
04U839 (FD)	5/17/2022	0.505 J	<1.00	1.89	0.880 J	5.05	0.427 J	22.8	57.0
04U841	5/16/2022	0.243 J	<1.00	0.758 J	0.851 J	4.78	0.241 J	5.02	12.6
04U843	5/17/2022	2.46	<1.00	3.99	5.86	19.0	0.679 J	43.5	108.8
04U844	5/17/2022	4.84	0.188 J	11.1	12.6	11.8	4.52	141	352.6
04U846	5/17/2022	<1.00	<1.00	12.8	10.2	16.5	28.0	20.6	51.5
04U847	9/22/2022	1.87	<1.00	10.3	10.7	27.0	2.49	244	610.0
04U849	5/17/2022	1.19	<1.00	3.50	4.14	4.17	0.568 J	39.3	98.3
04U850	5/17/2022	0.334 J	<1.00	3.71	3.93	8.51	10.6	33.5	83.8
04U850 (FD)	5/17/2022	0.299 J	<1.00	2.86	2.94	7.34	5.94	28.7	71.8
04U855	5/17/2022	0.152 J	<1.00	0.576 J	0.774 J	2.49	0.163 J	9.19	23.0
04U871	5/16/2022	2.83	<1.00	3.17	5.08	7.10	0.958 J	76.7	191.8
04U872	5/16/2022	0.204 J	<1.00	0.675 J	0.480 J	1.99	1.50	7.32	18.3
04U875	5/12/2022	<1.00	<1.00	<1.00	<1.00	<0.400	<1.00	<1.00	0.0
04U875 (FD)	5/12/2022	<1.00	<1.00	<1.00	<1.00	0.204 J	<1.00	<1.00	0.2
04U877	5/17/2022	<1.00	<1.00	1.90	<1.00	2.37	0.174 J	0.358 J	2.4
04U879	5/17/2022	<1.00	<1.00	0.188 J	<1.00	1.76	<1.00	1.19	3.0
04U880	5/16/2022	<1.00	<1.00	<1.00	<1.00	<0.400	<1.00	<1.00	0.0
04U881	5/16/2022	0.212 J	<1.00	1.35	<1.00	2.01	0.269 J	7.39	18.5
04U882	5/16/2022	<1.00	<1.00	0.439 J	0.402 J	1.81	0.155 J	4.31	10.8
04U883	5/16/2022	<1.00	<1.00	<1.00	<1.00	0.374 J	<1.00	<1.00	0.4
200154	5/12/2022	<1.00	<1.00	<1.00	<1.00	0.193 J	<1.00	<1.00	0.2
409547	5/16/2023	0.474 J	<1.00	2.85	3.68	4.38	2.98	22.2	55.5
409547	5/20/2022	1.67	0.184 J	7.28	11.1	3.84	3.87	61.1	152.8
409548	5/16/2022	<1.00	<1.00	0.287 J	<1.00	3.25	0.994 J	0.369 J	3.3
409549	5/17/2022	0.810 J	<1.00	2.99	3.07	9.70	0.590 J	23.8	59.5
409555	5/16/2022	<1.00	<1.00	<1.00	<1.00	0.432	<1.00	<1.00	0.4
512761	5/20/2022	0.380 J	<1.00	0.382 J	0.779 J	0.394 J	<1.00	10.1	25.3
04J822	5/16/2022	<1.00	<1.00	0.666 J	0.370 J	<0.400	0.663 J	0.914 J	0.1
04J834	5/16/2022	<1.00	<1.00	<1.00	<1.00	<0.400	<1.00	<1.00	0.0
04J836	5/17/2022	<1.00	<1.00	0.159 J	<1.00	1.29	<1.00	1.67	4.2
04J837	5/16/2022	<1.00	<1.00	0.272 J	<1.00	1.16	0.367 J	1.22	3.1
04J838	5/17/2022	0.884 J	<1.00	2.26	3.32	4.39	2.22	45.2	113.0
04J839	5/17/2022	<1.00	<1.00	0.122 J	0.231 J	0.532	<1.00	2.86	7.2
04J847	9/22/2022	2.16	<1.00	9.51	8.47	32.2	3.07	416	1040.0
04J849	5/17/2022	1.55	<1.00	1.12	2.11	0.705	<1.00	4.13	10.3
04J882	5/16/2022	<1.00	<1.00	<1.00	<1.00	<0.400	<1.00	<1.00	0.0
04J882 (FD)	5/16/2022	<1.00	<1.00	<1.00	<1.00	<0.400	<1.00	<1.00	0.0
PJ#318	5/12/2022	<1.00	<1.00	<1.00	<1.00	0.304 J	<1.00	0.403 J	0.3
234546	5/20/2022	<1.00	<1.00	0.415 J	0.376 J	0.762	<1.00	5.06	12.7

Notes:

(1) All values are given in micrograms per liter (µg/L) unless otherwise noted. The cleanup level for OU1 Groundwater is from page 18 of OU1 Record of Decision.

(2) 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.

(3) Health Risk Index is the chronic Cancer value calculated using MDH Guidance Additivity Workbook updated November 2022. In cases where trichloroethene results were lower than the detection limit or non-detect, these results were omitted from the calculations.

--- = No relevant cleanup level or HRL for this compound.
Gray shading = Exceedance of cleanup level, HRL, or Hazard Risk Index > 1
µg/L = Microgram(s) per liter
FD = Field duplicate
J = Reported value is between the MDL and the Reporting Limit
MDL = Method detection limit
OU = Operable Unit

Table 2-3. Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1

Group	No. Samples	No. Detects	Fraction of Detections	S Value	Exact Two-Tailed P Value	Results Trend	Threshold Triggered?	Comments
Group 1 NP								
Group 1 SP								
Group 2								
409549	8	8	8 / 8	-7	0.4675	No Significant Trend	Yes	Near plume center, plume shifted slightly
409557	8	8	8 / 8	4	0.7195	No Significant Trend	Yes	Between north & south plume, lateral dispersion
03L673	6	6	6 / 6	-11	0.0556	Probably Decreasing Trend (p<0.1)	No	
03L833	6	6	6 / 6	-5	0.4694	No Significant Trend	Yes	TCE concentrations consistently below 5 µg/L; therefore, no significant trend not of concern.
03L848	6	6	6 / 6	-5	0.4694	No Significant Trend	Yes	TCE concentrations consistently below 5 µg/L; therefore, no significant trend not of concern.
03L859	6	6	6 / 6	-9	0.1361	No Significant Trend	Yes	TCE concentration below 5 µg/L; Near eastern edge of the plume, plume shifted.
03U805	6	6	6 / 6	11	0.0556	Probably Increasing Trend (p<0.1)	Yes	Southern edge of north plume, plume shifted slightly
04U673	7	7	7 / 7	-15	0.0302	Decreasing Trend (p<0.05)	No	
04U821	8	8	8 / 8	-19	0.0200	Decreasing Trend (p<0.05)	No	
04U832	5	5	5 / 5	3	0.6333	No Significant Trend	Yes	Relatively stable, between 41 and 59 µg/L from 2005 to 2016. 2022 result decreased to 14.7 µg/L.
04U833	9	8	8 / 9	-14	0.1802	No Significant Trend	Yes	All results below cleanup level.
04U841	8	8	8 / 8	-23	0.0028	Decreasing Trend (p<0.05)	No	
04U843	11	11	11 / 11	15	0.1454	No Significant Trend	Yes	Near plume center
04U845	6	6	6 / 6	-3	0.7194	No Significant Trend	Yes	Continued monitoring is appropriate to evaluate how the plume is shifting.
04U846	8	8	8 / 8	7	0.4675	No Significant Trend	Yes	Near plume center, historically erratic
04U849	9	9	9 / 9	-10	0.2681	No Significant Trend	Yes	See Group 6 summary.
04U854	6	6	6 / 6	-9	0.1361	No Significant Trend	Yes	Raw trend is decreasing
04U859	6	6	6 / 6	-14	0.0056	Decreasing Trend (p<0.05)	No	
04U875	9	2	2 / 9	-11	0.1071	No Significant Trend	Yes	TCE concentrations consistently below 3 µg/L; therefore, no significant trend not of concern.
04U877	13	13	13 / 13	-3	0.9044	No Significant Trend	Yes	On east plume boundary, raw trend decreasing. Last two results below cleanup level and HRL.
Group 3								
Group 5								
Group 5 Unit 3 Wells								
409550	9	9	9 / 9	-13	0.1376	No Significant Trend	Yes	Raw trend is decreasing
03L822	9	9	9 / 9	-19	0.0200	Decreasing Trend (p<0.05)	No	
03U821	8	8	8 / 8	-25	0.0007	Decreasing Trend (p<0.05)	No	
03U822	8	8	8 / 8	-13	0.1376	No Significant Trend	Yes	Between 120 and 160 µg/L 2003 - 2016. Decreasing since 2016 from 150 µg/L to 6.77 µg/L in 2022.
Group 6								
04J077	9	9	9 / 9	-22	0.0247	Decreasing Trend (p<0.05)	No	
04J702	6	6	6 / 6	-12	0.0278	Decreasing Trend (p<0.05)	No	
04J708	6	6	6 / 6	15	0.0028	Increasing Trend (p<0.05)	Yes	Southern edge of north plume, plume shifted slightly
04J822	13	13	13 / 13	-60	0.0001	Decreasing Trend (p<0.05)	No	
04J834	8	3	3 / 8	-6	0.4940	No Significant Trend	Yes	TCE concentrations consistently ND or less than 1 µg/L; therefore, a no significant trend result is not of concern
04J836	9	9	9 / 9	8	0.3988	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown

Group	No. Samples	No. Detects	Fraction of Detections	S Value	Exact Two-Tailed P Value	Results Trend	Threshold Triggered?	Comments
04J837	9	9	9 / 9	-10	0.2751	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J838	8	8	8 / 8	8	0.3988	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J839	9	9	9 / 9	5	0.6294	No Significant Trend	Yes	Below 5 µg/L
04J847	14	14	14 / 14	-22	0.1526	No Significant Trend	Yes	Near plume center
04J849	14	8	8 / 14	50	0.0005	Increasing Trend (p<0.05)	Yes	Below 1 µg/L
04U077	6	6	6 / 6	-15	0.0028	Decreasing Trend (p<0.05)	No	
04U702	6	6	6 / 6	-13	0.0167	Decreasing Trend (p<0.05)	No	
04U708	6	2	2 / 6	-9	0.0667	Probably Decreasing Trend (p<0.1)	No	
04U713	6	4	4 / 6	-5	0.4556	No Significant Trend	Yes	TCE concentrations consistently ND or less than 1 µg/L; therefore, a no significant trend result is not of concern
04U834	8	6	6 / 8	1	1.0000	No Significant Trend	Yes	TCE concentrations consistently ND or less than 1 µg/L; therefore, a no significant trend result is not of concern
04U836	10	9	9 / 10	-16	0.0610	Probably Decreasing Trend (p<0.1)	No	
04U837	9	9	9 / 9	-6	0.5484	No Significant Trend	Yes	Raw trend is decreasing
04U838	8	8	8 / 8	1	1.0000	No Significant Trend	Yes	Below 3 µg/L since 2009
04U839	11	11	11 / 11	18	0.0752	Probably Increasing Trend (p<0.1)	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U847	9	9	9 / 9	-12	0.1789	No Significant Trend	Yes	Raw trend is decreasing
04U849	9	9	9 / 9	-10	0.2681	No Significant Trend	Yes	Near plume center, appears relatively stable to decreasing since 2011
04U882	8	7	7 / 8	-15	0.0798	Probably Decreasing Trend (p<0.1)	No	

Notes:
µg/L = Microgram(s) per liter
AWC =
HRL = MDH Health Risk Limit
NBCGRS = New Brighton Contaminated Groundwater Recovery System
ND = Non-detect
OU = Operable Unit
P Value = represents uncertainty in the trend
S Value = indicates increasing (positive S) or decreasing (negative S) trend
TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System

Table 5-1. Summary of Site A Shallow Groundwater Monitoring Requirements

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 was approved in 2017 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. VOC-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

Notes:

VOC = Volatile organic compound

Table 5-2 Site A Groundwater Quality Data

		1,2-Dichloroethane	1,1-Dichloroethene	Antimony (dissolved)	Benzene	Chloroform (Trichloromethane)	*cis* -1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Health Risk Index[2]
Site A Cleanup Level (µg/L) [1]		70	6	5	10	60	70	7	30	
Sample Location	Date									
01U039	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	0.480 J	<1.00	<1.00	0.1
01U102	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00	0.0
01U103	05/12/2022	<1.00	<1.00	2.18 J	<1.00	<5.00	<1.00	<1.00	<1.00	0.4
01U115	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	4.50	<1.00	1.08	2.7
01U116	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	0.793 J	<1.00	0.656 J	0.1
01U117	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	45.3	1.95	0.380 J	7.6
01U126	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	0.406 J	7.01	0.737 J	1.8
01U138	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00	0.0
01U139	05/12/2022	<1.00	0.696 J	N/A	7.36	0.130 J	653	<1.00	0.288 J	108.8
01U140	05/12/2022	<1.00	<1.00	N/A	0.230 J	<5.00	3.29	<1.00	0.253 J	0.5
01U157	05/12/2022	<1.00	<1.00	N/A	0.490 J	<5.00	44.3	<1.00	0.658 J	7.4
01U158	05/12/2022	<1.00	<1.00	N/A	0.517 J	<5.00	53.0	<1.00	0.819 J	8.8
01U350	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	0.856 J	<1.00	0.2
01U352	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00	0.0
01U352 (FD)	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00	0.0
01U355	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	12.8	<1.00	<1.00	2.1
01U356	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	20.1	<1.00	<1.00	3.4
01U357	05/12/2022	<1.00	<1.00	N/A	0.219 J	<5.00	3.24	<1.00	<1.00	0.5
01U358	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00	0.0
01U358 (FD)	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00	0.0
01U902	05/11/2022	<1.00	<1.00	<4.00	1.52	<5.00	99.8	<1.00	<1.00	16.6
01U902 (FD)	05/11/2022	<1.00	<1.00	<4.00	1.51	<5.00	103	<1.00	<1.00	17.2
01U903	05/11/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00	0.0
01U904	05/11/2022	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00	0.0
01U905	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	0.131 J	<1.00	<1.00	0.0
01U906	05/11/2022	<1.00	<1.00	N/A	<1.00	<5.00	0.242 J	<1.00	<1.00	0.0
01U907	05/12/2022	<1.00	<1.00	N/A	<1.00	<5.00	0.141 J	<1.00	<1.00	0.0
01U901	05/11/2022	<1.00	<1.00	N/A	<1.00	<5.00	0.176 J	<1.00	<1.00	0.0
01U353	05/12/2022	<1.00	<1.00	N/A	2.15	<5.00	81.0	<1.00	<1.00	13.5

Notes:

(1) All values are given in micrograms per liter (µg/L) unless otherwise noted. The cleanup level for Site A Groundwater is from Table 2 of OU2 Record of Decision.

(2) Health Risk Index is the chronic Cancer value calculated using MDH Guidance Additivity Workbook updated November 2022. In cases where trichloroethene results were lower than the detection limit or non-detect, these results were omitted from the calculations.

Gray shading indicates exceedance of cleanup level.
µg/L = Microgram(s) per liter

FD = Field Duplicate

J = Reported value is between the Method Detection Limit and the Reporting Limit
N/A = Not applicable
OU = Operable Unit

Table 6-1. Summary of Site C Shallow Groundwater Monitoring Requirements

Remedy Component	Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1: Groundwater 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 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 6-2. Water Quality Data for Site C Groundwater

		Lead (dissolved)
Site C Cleanup Level (µg/L) (1)		15
Sample Location	**Date**	
01U046	05/09/2022	<2.00
01U561	05/09/2022	<2.00
01U561 (FD)	05/09/2022	<2.00
01U562	05/09/2022	<2.00
01U563	05/09/2022	<2.00
01U564	05/09/2022	<2.00
01U567	05/09/2022	<2.00
01U567 (FD)	05/09/2022	<2.00
01U571	05/09/2022	<2.00
01U573	05/09/2022	21.6
01U574	05/09/2022	<2.00
01U575	05/09/2022	9.18
01U576	05/09/2022	<2.00

Notes:

(1) All values are given in µg/L unless otherwise noted. The cleanup level for Site C Groundwater is from Table 1 of OU2 Record of Decision Amendment #1.

Gray shading indicates exceedance of cleanup level.

µg/L = Micrograms per liter

FD = Field duplicate

OU = Operable Unit

Table 6-3. Water Quality Data for Site C Surface Water

		Lead (dissolved)
Surface Water Cleanup Level (µg/L) (1)		6.9
Sample Location	Date	
NE Wetland	05/09/2022	<2.00
NE Wetland	05/10/2022	<2.00
NE Wetland	05/11/2022	<2.00
SW-5	05/09/2022	<2.00
SW-5	05/10/2022	<2.00
SW-5	05/11/2022	<2.00
SW-6	05/09/2022	<2.00
SW-6	05/10/2022	<2.00
SW-6	05/11/2022	<2.00

Notes:

(1) All values are given in µg/L unless otherwise noted. The cleanup level for Site C surface water is from Table 1 of OU2 Record of Decision Amendment #1.

µg/L = Microgram(s) per liter

OU = Operable Unit

Table 6-4. Contingency Locations for Site C Monitoring

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)
NE Wetland (2)	If one sampling event > 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)

Notes:

(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 EPA/MPCA within 1 week from receipt of data and submit an evaluation report within 30 days from notification.

(4) Army notify EPA/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 EPA/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.

MPCA = Minnesota Pollution Control Agency

EPA = U.S. Environmental Protection Agency

Table 7-1. Summary of Groundwater Monitoring Requirements, Fiscal Year 2022, Site I, OU2

Remedy Component		Monitoring Requirements	Responsible Party	Documents Containing the Monitoring Plan
#1	Groundwater Monitoring	a. Groundwater quality and water levels to track remedy progress	Northrop Grumman Space Systems	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	Northrop Grumman Space Systems	Site I Monitoring Plan in Annual Performance Report

Notes:
OU = Operable Unit
Source: GHD

Table 7-2. Most Recent Groundwater Quality Data (FY 2013), Site I, OU2

			cis-1,2-Dichloroethene	*trans*-1,2-Dichloroethene	Trichloroethene	Vinyl Chloride	Health Risk Index[2]
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	0.7
01U632	4/26/2013		27	0.35 JP	120	<1.0	300.0
01U636	4/26/2013		<1.0	<1.0	<1.0	<1.0	0.0
01U639	4/26/2013		<1.0	<1.0	9.5	<1.0	23.8
01U640	4/26/2013		<1.0	<1.0	<1.0	<1.0	0.0
I01MW	4/26/2013		<1.0	<1.0	0.33 JP	<1.0	0.0
I02MW	4/26/2013		<1.0	<1.0	0.62 JP	<1.0	0.0
I02MW	4/26/2013	D	<1.0	<1.0	0.76 JP	<1.0	0.0
I05MW	4/26/2013		<1.0	<1.0	1.6	<1.0	4.0
01U667	8/13/2013		500	1.4	4.7	300	1502.4

Notes:

(1) Cleanup levels for Site I are from the OU2 ROD.

(2) Health Risk Index is the chronic Cancer value calculated using MDH Guidance Additivity Workbook updated November 2022. In cases where trichloroethene results were lower than the detection limit or non-detect, these results were omitted from the calculations.

µg/L = micrograms per liter
D = Field Duplicate
JP = Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit
OU = Operable Unit
Shading indicates exceedance of the cleanup level
Source: GHD

Table 8-1. Summary of Groundwater Monitoring Requirements, Fiscal Year 2022, Site K, OU2

Remedy Component		Monioring Requirements	Responsible Party	Docments Containing the Monitoring Plan
#1	Groundwater Monitoring	• Outlined below		
#2	Sentinel Wells	a. Water quality to monitor potential migration	Northrop Grumman Space Systems	Site K Monitoring Plan in Annual Performance Report
#3	Hydraulic Containment	a. Water levels for use in drawing contour maps showing capture	Northrop Grumman Space Systems	Site K Monitoring Plan in Annual Performance Report
		b. Pumping volumes and rates for reporting	Northrop Grumman Space Systems	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	Northrop Grumman Space Systems	Site K Monitoring Plan in Annual Performance Report
#7	Additional Investigation	a. None (completed)		
#8	Land Use Controls	a. None		
#9	Overall Remedy	a. Water quality data to evaluate attainment of the cleanup levels in Table 1 of the 1997 OU2 ROD throughout the aerial and vertical extent of the Site K plume.	Northrop Grumman Space Systems	Site K Monitoring Plan in Annual Performance Report

Notes:
OU = Operable Unit
Source: GHD

Table 8-2. Groundwater Quality Data, Fiscal Year 2022, Site K, OU2

			cis-1,2-Dichloroethene	*trans*-1,2-Dichloroethene	Trichloroethene	Health Risk Index (2)
Site K Cleanup Level (1)			70 (Total DCE)		30	
Location	**Date**	**Dup**	**ug/L**	**ug/L**	**ug/L**	
01U128	06/20/22		< 1.00	0.209 JPJD62.9	< 1.00	0.0
01U603	06/20/22		3.92	0.483 JP	2.70	6.8
01U611R	06/20/22		395	143	3150	7890.9
01U611R	06/20/22	D	419	143	3320	8315.9
01U615	06/21/22		4710	176	2230	5594.6
01U617	06/20/22		1.84	0.222 JP	< 1.00	0.3
01U618	06/20/22		1.01	0.307 JP	1.11	2.8
01U621	06/20/22		< 1.00	< 1.00	< 1.00	0.0
03U621	06/20/22		< 1.00	< 1.00	< 1.00	11.9
K04-MW (482083)	06/20/22		< 1.00	< 1.00	0.284 JP	0.0

Notes:
(1) Cleanup levels for Site K are from the OU2 Record of Decision (ROD).
(2) Health Risk Index is the chronic Cancer value calculated using MDH Guidance Additivity Workbook updated November 2022. In cases where trichloroethene results were lower than the detection limit or non-detect, these results were omitted from the calculations.
Shading indicates exceedence of the cleanup level.
ug/L = Microgram(s) per liter
DCE = Dichlororethene
JP = Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit.
JD# = Result is qualified as estimated due to outlying relative percent difference from matrix spike analyses. The following numerical value is the associated relative percent difference.
OU = Operable Unit
Source: GHD

Table 8-3. Groundwater Elevation Monitoring Fiscal Year 2022, Site K, OU2

Well ID	Groundwater Elevation (1) (June 2021)	Groundwater Elevation (1) (Historical Maximum)	Groundwater Elevation (1) (June 2022)
01U047	Abandoned	875.75	Abandoned
01U048	873.42	876.61	874.43
01U052	875.60	876.64	876.18
01U065	Abandoned	874.91	Abandoned
01U128	874.87	878.33	875.77
01U601	Abandoned	886.65	Abandoned
01U602	Abandoned	886.37	Abandoned
01U603	877.52	882.86	879.86
01U604	Abandoned	879.79	Abandoned
01U605	Abandoned	879.61	Abandoned
01U607	887.03	887.56	887.08
01U608	Abandoned	888.06	Abandoned
01U608R	883.45	888.11	888.11
01U609	Abandoned	886.83	Abandoned
01U609R	883.53	887.61	887.61
01U611	Abandoned	887.16	Abandoned
01U611R	883.66	888.12	888.12
01U612	879.87	884.70	880.56
01U613	Abandoned	886.15	Abandoned
01U615	878.66	883.71	881.79
01U616	Abandoned	882.75	Abandoned
01U617	877.07	883.22	879.71
01U618	881.51	885.58	883.77
01U619	Abandoned	886.60	Abandoned
01U620	Abandoned	881.93	Abandoned
01U621	878.59	883.87	880.98
01U624A	Abandoned	881.66	Abandoned
01U624B	Abandoned	881.63	Abandoned
01U624C	Abandoned	881.64	Abandoned
01U624D	Abandoned	881.64	Abandoned
01U625A	877.99	883.95	880.87
01U625B	877.97	883.90	880.83
01U625C	Obstructed	887.91	Obstructed
01U625D	877.96	883.91	880.81
01U626A	877.44	882.77	881.24
01U626B	877.36	883.50	880.25

Table 8-3. Groundwater Elevation Monitoring
Fiscal Year 2022, Site K, OU2

Well ID	Groundwater Elevation (1) (June 2021)	Groundwater Elevation (1) (Historical Maximum)	Groundwater Elevation (1) (June 2022)
01U626C	877.42	883.58	880.27
01U626D	877.48	883.61	880.31
01U627A	878.26	883.14	882.18
01U627B	877.57	883.57	880.36
01U627C	877.50	883.56	880.28
01U627D	877.50	883.57	880.29
01U628A	Abandoned	880.39	Abandoned
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)	881.96	885.38	883.79
03U621	861.11	862.73	859.48

Notes:
(1) All elevations are in feet.
OU = Operable Unit
Source: GHD

Table 8-4. Treatment System Concentrations (Organics), Fiscal Year 2022, Site K, OU2

			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	12/10/2021		<1.00	<1.00	<1.00	9.51	0.354 JP	0.938 JP	<1.00
Effluent	12/10/2021	D	<1.00	<1.00	<1.00	10.6	0.441 JP	1.13	<1.00
Effluent	3/4/2022		<1.00	<1.00	<1.00	10.7	0.556 JP	1.51	<1.00
Effluent	6/6/2022		<1.00	<1.00	<1.00	6.35	0.317 JP	0.881 JP	<1.00
Effluent	6/6/2022	D	<1.00	<1.00	<1.00	6.31	0.296 JP	0.701 JP	<1.00
Effluent	9/7/2022		<1.00	<1.00	<1.00	4.56	0.188 JP	0.237 JP	<1.00
Effluent	9/7/2022	D	<1.00	<1.00	<1.00	4.69	<1.00	0.289 JP	<1.00
Influent	12/10/2022		<1.00	0.463 JP	<1.00	178	<1.00	40.5	1.58
Influent	3/4/2022		<1.00	0.633 JP	<1.00	219	29.6	61.4	2.48
Influent	3/4/2022	D	<1.00	0.607 JP	<1.00	222	28.0	64.1	2.57
Influent	6/6/2022		<1.00	0.296 JP	<1.00	151	16.5	25.0	1.76
Influent	9/7/2022		<1.00	0.214 JPJL129	<1.00	164	17.2	19.3	1.49

Notes:
(1) Substantive Requirement Document Concentration Limit, Maximum Daily Effluent Concentration
µg/L = Microgram(s) per liter
D = Field duplicate
JP = Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit
JL# = Result is qualified as estimated due to outlying percent recovery from lab control sample analyses. The following numerical value is the associated percent recovery.
OU = Operable Unit
Source: GHD

Table 8-5. Treatment System Concentrations (Inorganics), Fiscal Year 2022, Site K, OU2

		Copper	Cyanide	Lead	Mercury	Silver	Zinc	Total Phosphorus
	Effluent Limit (1)	**21**	**17**	**106**	**0.20**	**3.4**	**134**	**1**
Location	**Date**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**
Effluent	12/10/2021	< 5.00	< 5.00	< 2.00	< 0.200	< 2.00	< 25.0	< 0.281
Effluent	03/04/2022	< 5.00	< 5.00	< 2.00	< 0.200	< 2.00	< 25.0	0.242
Effluent	06/06/2022	< 10.0	< 5.00	< 6.00	< 0.200	< 5.00	< 50.0	0.103
Effluent	09/07/2022	1.97 JP	< 5.00	< 2.00	< 0.200	< 2.00	3.92 JP	0.250

Notes:

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

Shading indicates exceedence of effluent limit.

µg/L - Microgram(s) per liter

JP = Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit

mg/L = Milligram(s) per liter

OU = Operable Unit

Source: GHD

Table 8-6. Summary of Monthly VOC Removal, Fiscal Year 2022, Site K, OU2

Month	Total Monthly Flow (gallons)	Total VOC Influent (µg/L)	Total VOC Effluent (µg/L)	Total VOCs Treated (pounds)	Total VOCs Remaining (pounds)	Total VOC Mass Removed (pounds)
Cumulative as of September 30, 2021						410.1
October(1)	265,913	220.54	11.49	0.49	0.03	0.46
November	230,756	220.54	11.49	0.42	0.02	0.40
December	235,566	220.54	11.49	0.43	0.02	0.41
January	224,730	315.20	12.77	0.59	0.02	0.57
February	177,203	315.20	12.77	0.47	0.02	0.45
March	227,684	315.20	12.77	0.60	0.02	0.57
April	430,246	194.56	7.43	0.70	0.03	0.67
May	449,089	194.56	7.43	0.73	0.03	0.70
June	428,235	194.56	7.43	0.70	0.03	0.67
July	322,280	202.20	4.98	0.54	0.01	0.53
August	246,882	202.20	4.98	0.42	0.01	0.41
September	230,814	202.20	4.98	0.39	0.01	0.38
Total = Fiscal Year 2022						**6.23**
Cumulative To Date						**416.3**

Notes:

(1) Influent and Effluent VOC concentrations from the quarterly VOC samples collected on 12/10/2021, 3/4/2022, 6/6/2022, and 9/7/2022.

µg/L = Microgram(s) per liter

VOC = Volatile organic compound

Source: GHD

**Table 8-7. 1,4-Dioxane Groundwater Sampling Results
Fiscal Year 2022, Site K, OU2**

		1,4-Dioxane
Screening Criteria (HRL)		1.0
Location	Date	µg/L
03U621	6/20/2022	11.9

Notes:
µg/L = Microgram(s) per liter
HRL = Health Risk Limit (Minnesota Department of Health)
OU = Operable Unit
Shading indicates exceedence of the HRL.
Source: GHD

Table 9-1. Summary of Building 102 Shallow Groundwater Monitoring Requirements

Remedy Component	Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1: Monitored Natural Attenuation (Abiotic Degradation)	Outlined below		
#2: Groundwater Monitoring	Outlined below		
#3: Land Use Controls to Restrict Well Installation and to Protect the Remedy Infrastructure	None		
OR: Overall Remedy (Attainment of Cleanup Goals)	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 9-2. Building 102 Groundwater Quality Data

		1,1-Dichloroethene	*cis* -1,2-Dichloroethene	Trichloroethene	Vinyl chloride (2)	Health Risk Index(3)
Building 102 Cleanup Level (µg/L) (1)		**6**	**70**	**5**	**0.18**	
Sample Location	**Date**					
01L581	05/11/2022	<1.00	3.89	4.73	<1.00	11.8
01L582	05/09/2022	<1.00	12.6	<1.00	<1.00	2.1
01L583 (FD)	05/09/2022	<1.00	12.6	<1.00	<1.00	2.1
01L583	05/11/2022	<1.00	<1.00	<1.00	<1.00	0.0
01L583 (FD)	05/11/2022	<1.00	<1.00	<1.00	<1.00	0.0
01L584	05/11/2022	<1.00	7.46	8.02	<1.00	20.1
01U048	05/10/2022	<1.00	<1.00	<1.00	<1.00	0.0
01U579	05/11/2022	<1.00	4.79	0.456 J	<1.00	0.8
01U580	05/11/2022	1.21	166	191	22.7	477.5
01U581	05/11/2022	<1.00	30.9	6.99	<1.00	17.5
01U582	05/10/2022	<1.00	0.160 J	<1.00	<1.00	0.0
01U583	05/11/2022	<1.00	<1.00	<1.00	<1.00	0.0
01U584	05/11/2022	<1.00	9.66	2.02	1.22	5.1

Notes:

(1) All values are given in µg/L unless otherwise noted. The cleanup levels for Building 102 Groundwater are from page 2-13 of OU2 Record of Decision Amendment #4.

(2) The Pace (TN) reporting limit (RL) for vinyl chloride of 1 µg/L does not meet the project RL goal of 0.1/0.09 µg/L. Per the 2020 QAPP (rev 18) the Pace (TN) RL of 1 µg/L is considered acceptable for the project at this time.

(3) Health Risk Index is the chronic Cancer value calculated using MDH Guidance Additivity Workbook updated November 2022. In cases where trichloroethene results were lower than the detection limit or non-detect, these results were omitted from the calculations.

Gray shading indicates exceedance of cleanup level.

µg/L = Microgram(s) per liter

FD = Field duplicate

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

OU = Operable Unit

Table 11-1. Groundwater Cleanup Levels, TGRS, OU2

Substance Volatile Organic Compounds (VOCs)	Expected Level in Discharge (ppb)	OU2 ROD Requirements (ppb)
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

Notes:

OU = Operable unit

ppb = Part(s) per billion

ROD = Record of Decision

TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System

Source: GHD

Table 11-2. Extraction Well Water Pumped, Fiscal Year 2022, TGRS, OU2

	Volume of Water Pumped (gallons)																	
Date Pumped	**BGRS Extraction Wells**								**SGRS Extraction Wells**									**Total**
	B1	**B3**	**B4**	**B5**	**B6**	**B8**	**B9**	**B13**	**SC1**	**SC5**	**SC6**	**SC7**	**SC8**	**SC9**	**SC10**	**SC11**	**SC12**	
October 2021	9,387,700	5,997,900	16,719,820	15,090,120	9,417,550	7,183,980	9,020,650	3,338,300	434,300	2,227,160	0	0	0	0	0	0	0	78,817,480
(gpm)	210	134	375	338	211	161	202	75	10	50	0	0	0	0	0	0	0	1,766
November 2021	8,904,070	6,839,000	15,681,020	14,509,480	6,762,290	8,646,790	9,602,530	3,001,400	4,400	0	0	0	0	0	0	0	0	73,950,980
(gpm)	206	158	363	336	157	200	222	69	0	0	0	0	0	0	0	0	0	1,712
December 2021	9,151,040	9,498,400	16,876,580	15,185,520	7,547,070	7,266,430	9,111,430	3,067,400	0	720	0	0	0	0	0	0	0	77,704,590
(gpm)	205	213	378	340	169	163	204	69	0	0	0	0	0	0	0	0	0	1,741
January 2022	8,996,710	9,379,600	16,970,400	15,125,040	7,588,500	8,616,910	9,158,800	3,023,800	0	640,380	0	0	0	0	0	0	0	79,500,140
(gpm)	202	210	380	339	170	193	205	68	0	14	0	0	0	0	0	0	0	1,781
February 2022	8,139,200	8,656,800	15,290,660	13,649,000	6,830,320	5,635,700	8,254,670	2,732,300	0	3,171,900	0	0	0	0	0	0	0	72,360,550
(gpm)	202	215	379	339	169	140	205	68	0	79	0	0	0	0	0	0	0	1,795
March 2022	8,654,850	9,294,200	16,282,700	14,499,740	7,282,450	5,999,580	8,787,560	2,937,900	0	3,329,970	0	0	0	0	0	0	0	77,068,950
(gpm)	194	208	365	325	163	134	197	66	0	75	0	0	0	0	0	0	0	1,726
April 2022	8,541,540	9,468,500	16,463,200	11,588,160	7,328,850	6,727,460	9,425,430	2,948,300	0	3,041,910	0	0	0	0	0	0	0	75,533,350
(gpm)	198	219	381	268	170	156	218	68	0	70	0	0	0	0	0	0	0	1,748
May 2022	8,331,740	9,812,600	16,498,300	14,875,520	6,961,740	7,045,580	9,386,580	3,010,900	0	3,527,360	0	0	0	0	0	0	0	79,450,320
(gpm)	187	220	370	333	156	158	210	67	0	79	0	0	0	0	0	0	0	1,780
June 2022	8,907,480	9,531,400	12,127,480	14,328,320	6,473,000	7,347,020	9,430,020	2,949,900	0	3,079,520	0	0	0	0	0	0	0	74,174,140
(gpm)	206	221	281	332	150	170	218	68	0	71	0	0	0	0	0	0	0	1,717
July 2022	8,776,660	9,516,150	16,969,920	14,807,120	6,374,660	7,381,950	9,164,360	3,001,675	0	3,557,840	0	0	0	0	0	0	0	79,550,335
(gpm)	197	213	380	332	143	165	205	67	0	80	0	0	0	0	0	0	0	1,782
August 2022	6,783,960	6,919,900	12,089,080	12,770,560	4,159,340	5,491,610	6,667,120	2,879,600	0	3,003,190	0	0	0	0	0	0	0	60,764,360
(gpm)	152	157	271	286	93	123	149	65	0	67	0	0	0	0	0	0	0	1,363
September 2022	8,756,960	8,454,700	16,244,920	14,698,480	5,803,120	7,423,270	9,134,000	2,850,700	147,050	567,120	865,540	86,482	466,885	144,343	62,173	155,020	726,981	76,587,745
(gpm)	203	198	376	340	134	172	211	66	11	48	70	4	27	10	4	11	42	1,930
Total FY 2022	**103,331,910**	**103,369,150**	**188,214,080**	**171,127,060**	**82,528,890**	**84,766,280**	**107,143,150**	**35,742,175**	**585,750**	**26,147,070**	**865,540**	**86,482**	**466,885**	**144,343**	**62,173**	**155,020**	**726,981**	**905,462,940**
Operational Minimum (gpm)	225	170	195	195	210	135	275	110	20	100								1,745
					B1, B11, B13		**B4, B5, B6**	**B4, B5, B6, B8, B9**										**Total System**
FY 2022 Average Flow Rate (gpm)					265		841	1,206										1,723
MOS Operational Minimum (gpm)					415		600	1,010										1,745

Notes:
BGRS = Boundary Groundwater Recovery System
FY = Fiscal year
gpm = Gallon(s) per minute
MOS = Micro Operating Strategy
OU = Operable unit
SGRS = Source Groundwater Recovery System
TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System
B11 and SC2 did not operate during FY 2022.
Source: GHD

Table 11-3. VOC Mass Loading Summary, Fiscal Year 2022, TGRS, OU2

Well	Percent Contribution to VOC Mass Removal	FY 2022 Total Pounds VOCs Mass Removed
B1	8.7%	85.4
B2[1]	0.0%	0.00
B3	0.3%	2.82
B4	8.7%	85.4
B5	9.8%	96.5
B6	1.6%	15.7
B7[1]	0.0%	0.00
B8	0.4%	4.14
B9	2.0%	19.2
B10[1]	0.0%	0.00
B11[1]	0.0%	0.00
B12[1]	0.0%	0.00
B13	3.2%	31.7
SC1[2]	0.8%	7.40
SC2[1]	0.0%	0.00
SC3[1]	0.0%	0.00
SC4[1]	0.0%	0.00
SC5	61.7%	607.0
SC6[3]	2.5%	24.6
SC7[3]	0.0%	0.4
SC8[3]	0.1%	0.6
SC9[3]	0.0%	0.3
SC10[3]	0.1%	0.5
SC11[3]	0.1%	1.2
SC12[3]	0.1%	0.5
Fiscal Year 2022 Total (pounds)		**984**
Daily Average (pounds per day)		**2.7**

Notes:

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

[2] Extraction well was only operational during a portion of the fiscal year.

[3] SGRS extraction well was only operational during September 2022.

OU = Operable unit

TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System

VOC = Volatile organic compound

Source: GHD

Table 11-3. VOC Mass Loading Summary, Fiscal Year 2022, TGRS, OU2

Historical Total		
Fiscal Year		**Pounds VOC Mass Removed**
2022		984
2021		1,746
2020		2,013
2019		1,807
2018		1,911
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		**225,209**

Table 11-4. VOC Concentrations in BGRS Extraction Well Samples, Fiscal Year 2022, BGRS, OU2

				Substance							
				1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	*cis*-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	
Location	**Alias**	**Date**	**Dup**	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	**Health Risk Index (1)**
03F302	B1	12/10/2021		4.81	0.650 JP	0.867 JP	< 1.00	4.87	1.96	91.4	228.5
03F302	B1	06/17/2022		5.60	0.830 JP	1.30	< 1.00	6.00	1.57	89.3	223.3
03F303	B2	06/17/2022		0.232 JP	0.172 JP	0.927 JP	0.416 JP	2.13	0.984 JP	28.1	70.3
03F304	B3	12/10/2021		< 1.00	0.160 JP	0.195 JP	< 1.00	0.135 JP	< 1.00	2.24	5.6
03F304	B3	06/17/2022		< 1.00	0.193 JP	0.265 JP	< 1.00	0.180 JP	< 1.00	2.47	6.2
03F305	B4	12/10/2021		3.07	1.25	1.42	< 1.00	1.09	0.558 JP	50.2	125.5
03F305	B4	06/17/2022		3.84	1.62	1.85	< 1.00	1.33	0.473 JP	48.0	120.0
03F306	B5	12/10/2021		2.63	1.55	1.92	< 1.00	0.727 JP	4.02	59.3	148.3
03F306	B5	12/10/2021	D	2.31	1.49	1.76	< 1.00	0.745 JP	4.24	62.4	156.0
03F306	B5	06/17/2022		2.83	1.93	2.36	< 1.00	0.892 JP	3.75	59.8	149.5
03F306	B5	06/17/2022	D	2.71	1.91	2.14	< 1.00	0.947 JP	3.34	59.5	148.8
03F307	B6	12/10/2021		0.478 JP	0.203 JP	0.356 JP	< 1.00	0.165 JP	< 1.00	21.4	53.5
03F307	B6	06/17/2022		0.497 JP	0.258 JP	0.420 JP	< 1.00	0.227 JP	< 1.00	23.8	59.5
03F308	B7	06/17/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.65	4.1
03F312	B11	06/17/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.98	7.5
03F319	B13	12/10/2021		4.91	1.79	1.37	< 1.00	9.68	0.452 JP	114	285.0
03F319	B13	06/17/2022		3.73	1.84	1.12	< 1.00	8.07	< 1.00	76.7	191.8
03U301	SC1	12/09/2020		24.9 JP	5.15 JP	< 50.0	< 50.0	133	< 50.0	1380	3450.0
03U301	SC1	06/08/2021		20.9 JP	< 50.0	< 50.0	< 50.0	102	< 50.0	1500	3750.0
03U315	SC3	06/03/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.409 JP	0.0
03U316	SC4	06/03/2022		0.357 JP	< 1.00	< 1.00	< 1.00	<1.00	< 1.00	3.16	7.9
03U317	SC5	06/03/2022		593	19.5	42.3	1.46	7.32	5.14	2270	5675
PJ#309	B8	12/10/2021		0.246 JP	0.195 JP	0.290 JP	< 1.00	0.132 JP	< 1.00	4.66	11.7
PJ#309	B8	06/17/2022		0.260 JP	0.240 JP	0.319 JP	< 1.00	<1.00	< 1.00	5.15	12.9
PJ#310	B9	12/10/2021		0.745 JP	0.849 JP	1.13	< 1.00	0.321 JP	< 1.00	19.4	48.5
PJ#310	B9	06/17/2022		0.816 JP	0.986 JP	1.21	< 1.00	0.419 JP	< 1.00	18.8	47.0
PJ#311	B10	06/17/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.218 JP	0.0
PJ#313	B12	06/17/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.0

Notes:
(1) Health Risk Index is the chronic Cancer value calculated using MDH Guidance Additivity Workbook updated November 2022. In cases where trichloroethene results were lower than the detection limit or non-detect, these results were omitted from the calculations.
µg/L = Microgram(s) per liter
BGRS = Boundary Groundwater Recovery System
D = Field Duplicate
JP = Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit.
SC1 was not sampled in December 2021 and June 2022 and SC5 was not sampled in December 2021 due to ongoing SGRS construction.
Source: GHD

Table 11-5. Pumphouse Down Time, Fiscal Year 2022, TGRS, OU2

Well Name	FY22 Down Time (Days)	FY21 Down Time (Days)	FY20 Down Time (Days)	FY19 Down Time (Days)	FY18 Down Time (Days)
B1	14.4	23.0	10.4	11.4	10.9
B2	(1)	(1)	(1)	(1)	(1)
B3	10.2	38.6	31.6	3.9	3.6
B4	22.0	4.0	10.2	0.8	13.8
B5	13.7	3.9	9.4	0.8	32.0
B6	19.9	5.4	9.9	4.5	17.9
B7	(1)	(1)	(1)	(1)	(1)
B8	12.4	14.4	26.5	16.8	8.1
B9	13.0	7.8	28.6	10.8	14.8
B10	(1)	(1)	(1)	(1)	(1)
B11	(1)	(1)	(1)	(1)	(1)
B12	(1)	(1)	(1)	(1)	(1)
B13	3.4	7.4	8.6	2.1	18.8
SC1	346.2 (2)	5.4	8.5	2.9	6.2
SC3	(1)	(1)	(1)	(1)	(1)
SC4	(1)	(1)	(1)	(1)	(1)
SC5	140.9 (2)	9.8	8.8	6.6	4.3

Notes:

(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 due to ongoing SGRS construction.

FY = Fiscal year

TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System

Wells SC6 - SC12 were operating for a portion of FY22 and are not reflected in this table

Source: GHD

Table 11-6. Down Time by Category, Fiscal Year 2022, TGRS, OU2

Category	Down Time (Days)
Pumphouse Component	3.1
Treatment Center Component	0.0
Electrical Service	7.7
Miscellaneous	0.0
Preventive Maintenance	0.1
System Modification	48.7
Forcemain	0.0
Total System Equivalent	59.6
Anticipated Down Time for Fiscal Year 2023	
Pumphouse Component	4.0
Treatment Center Component	1.5
Electrical Service	2.0
Miscellaneous	1.0
Preventive Maintenance	1.0
System Modification	20.0
Forcemain	1.0

Source: GHD

Table 11-7. Groundwater Quality Data, Fiscal Year 2022, TGRS, OU2

			Substrate	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	*cis*-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Health Risk Index Value (2)
			TGRS Cleanup Level (1)	200	70	6	4	70	5	5	
Location	Date	Sample ID	Dup	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	
03L002	06/10/2022	W-220610-EM-49		0.333 JP	0.373 JP	0.664 JP	<1.00	0.193 JP	<1.00	11.3	28.3
03L007	06/08/2022	W-220608-EM-30		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0
03L014	06/21/2022	W-220621-EM-110		0.321 JP	<1.00	<1.00	<1.00	<1.00	<1.00	0.648 JP	5.4
03L017	06/16/2022	W-220616-EM-85		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	17.3
03L018	06/22/2022	W-220622-EM-118		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	11.2
03L020	06/15/2022	W-220615-EM-78		0.256 JP	0.120 JP	<1.00	<1.00	<1.00	<1.00	5.60	15.6
03L021	06/15/2022	W-220615-EM-81		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.929 JP	7.9
03L077	06/10/2022	W-220610-EM-55		0.843 JP	0.120 JP	0.629 JP	<1.00	0.149 JP	<1.00	17.6	44.0
03L078	06/09/2022	W-220609-EM-40		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	2.5
03L079	06/09/2022	W-220609-EM-37		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.567 JP	1.1
03L802	06/08/2022	W-220608-EM-27		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.02	2.6
03L806	06/07/2022	W-220607-EM-18		0.609 JP	0.154 JP	0.293 JP	<1.00	0.219 JP	<1.00	20.8	52.0
03L809	06/06/2022	W-220606-EM-04		2.01	0.636 JP	1.17	<1.00	0.720 JP	<1.00	85.5	213.8
03L833	06/07/2022	W-220607-EM-20		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.32	19.8
03M002	06/10/2022	W-220610-EM-51		0.512 JP	1.02	1.12	<1.00	0.469 JP	<1.00	18.7	46.8
03M020	06/15/2022	W-220615-EM-74		1.01	0.278 JP	<1.00	<1.00	<1.00	<1.00	13.1	32.8
03M020	06/15/2022	W-220615-EM-75	D	0.874 JP	0.277 JP	<1.00	<1.00	<1.00	<1.00	12.9	32.3
03M802	06/08/2022	W-220608-EM-28		0.156 JP	<1.00	<1.00	<1.00	<1.00	<1.00	7.76	19.4
03M806	06/07/2022	W-220607-EM-11		<10.0	26.0	23.1	0.430 JP	7.53	<1.00	295	737.5
03U002	06/10/2022	W-220610-EM-52		2.22	0.173 JP	0.603 JP	<1.00	0.698 JP	<1.00	15.7	39.3
03U003	06/08/2022	W-220608-EM-34		12.2	1.08	2.38	<1.00	3.74	<1.00	60.7	151.8
03U005	06/15/2022	W-220615-EM-83		<1.00	<1.00	<1.00	<1.00	0.322 JP	<1.00	0.328 JP	0.1
03U007	06/08/2022	W-220608-EM-32		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0
03U009	06/16/2022	W-220616-EM-89		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0
03U014	06/21/2022	W-220621-EM-112		18.3 JL129/132	1.99	1.25	<1.00	1.17	<1.00	59.9	149.8
03U017	06/16/2022	W-220616-EM-84		0.434 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.99	18.2
03U018	06/22/2022	W-220622-EM-117		21.0 JL126/127	0.139 JP	1.98	<1.00	8.27	<1.00	20.7	51.8
03U020	06/15/2022	W-220615-EM-76		42.1	4.16	5.93	<1.00	5.40	<1.00	98.6	246.5
03U021	06/15/2022	W-220615-EM-82		5.74	2.40	2.00	<1.00	3.26	<1.00	58.6	146.5
03U027	06/14/2022	W-220614-EM-71		0.308 JP	<1.00	0.238 JP	<1.00	0.984 JP	<1.00	10.9	27.3
03U028	06/14/2022	W-220614-EM-72		<1.00	<1.00	<1.00	<1.00	0.275 JP	<1.00	8.71	21.8
03U029	06/15/2022	W-220615-EM-80		15.2	1.16	2.88	<1.00	16.2	<1.00	121	302.5
03U030	06/14/2022	W-220614-EM-70		<1.00	<1.00	<1.00	<1.00	0.158 JP	<1.00	3.89	9.7
03U032	06/21/2022	W-220621-EM-107		0.655 JL129/132	<1.00	<1.00	<1.00	<1.00	<1.00	0.211 JP	0.5
03U032	06/21/2022	W-220621-EM-108	D	0.644 JL129/132	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.7

Table 11-7. Groundwater Quality Data, Fiscal Year 2022, TGRS, OU2

			Substrate	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	*cis*-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Health Risk Index Value (2)
			TGRS Cleanup Level (1)	200	70	6	4	70	5	5	
Location	Date	Sample ID	Dup	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	
03U077	06/10/2022	W-220610-EM-57		0.548 JP	<1.00	<1.00	<1.00	<1.00	<1.00	10.4	26.0
03U078	06/09/2022	W-220609-EM-41		0.972 JP	<1.00	0.711 JP	<1.00	1.04	10.2	38.4	96.0
03U079	06/09/2022	W-220609-EM-35		6.43	0.378 JP	1.64	<1.00	1.74	<1.00	51.5	128.8
03U079	06/09/2022	W-220609-EM-36	D	5.86	0.360 JP	1.80	<1.00	1.59	<1.00	49.3	123.3
03U092	06/22/2022	W-220622-EM-115		0.592 JL126/127	<1.00	<1.00	<1.00	0.963 JP	<1.00	9.52	23.8
03U093	06/22/2022	W-220622-EM-119		154 JL126/127	1.43	9.89	<1.00	13.5	<1.00	182	455.0
03U094	06/21/2022	W-220621-EM-109		246	6.97	12.9	<1.00	8.73	0.312 JP	203	507.5
03U096	06/22/2022	W-220622-EM-120		6.62	0.459 JP	1.11	<1.00	<1.00	<1.00	14.2	35.5
03U099	06/16/2022	W-220616-EM-86		0.862 JP	<1.00	<1.00	<1.00	0.211 JP	<1.00	1.88	4.7
03U114	06/16/2022	W-220616-EM-91		0.804 JP	<1.00	<1.00	<1.00	<1.00	<1.00	4.48	11.2
03U659	06/14/2022	W-220614-EM-73		8.43	0.728 JP	1.57	<1.00	8.02	<1.00	100	250.0
03U671	06/09/2022	W-220609-EM-43		1.49	<1.00	0.673 JP	<1.00	0.645 JP	11.6	34.7	86.8
03U677	06/08/2022	W-220608-EM-33		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.6
03U701	06/13/2022	W-220613-EM-59		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.749 JP	10.8
03U702	06/13/2022	W-220613-EM-61		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.529 JP	9.4
03U703	06/09/2022	W-220609-EM-39		0.397 JP	<1.00	<1.00	<1.00	<1.00	2.22	2.84	7.1
03U708	06/09/2022	W-220609-EM-46		1.31	<1.00	0.387 JP	<1.00	1.88	16.1	35.6	89.0
03U709	06/10/2022	W-220610-EM-53		1.89	0.407 JP	0.599 JP	<1.00	0.979 JP	<1.00	20.5	51.3
03U710	06/09/2022	W-220609-EM-42		1.46	<1.00	0.218 JP	<1.00	0.445 JP	<1.00	13.5	33.8
03U711	06/07/2022	W-220607-EM-22		4.12	0.729 JP	1.30	<1.00	0.561 JP	0.684 JP	27.8	69.5
03U715	06/22/2022	W-220622-EM-113		7.12 JL126/127JFD30	0.593 JP	0.920 JP	<1.00	0.398 JP	<1.00	28.4	71.0
03U715	06/22/2022	W-220622-EM-114	D	5.25 JL126/127JFD30	0.485 JP	0.549 JP	<1.00	0.648 JP	<1.00	22.4	56.0
03U801	06/08/2022	W-220608-EM-24		<1.00	<1.00	<1.00	<1.00	0.248 JP	<1.00	13.5	33.8
03U801	06/08/2022	W-220608-EM-25	D	<1.00	<1.00	<1.00	<1.00	0.254 JP	<1.00	13.8	34.5
03U803	06/06/2022	W-220606-EM-05		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.07	2.7
03U804	06/06/2022	W-220606-EM-09		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0
03U805	06/06/2022	W-220606-EM-06		0.176 JP	8.50	9.45	<1.00	5.25	2.26	88.7	221.8
03U805	06/06/2022	W-220606-EM-07	D	0.182 JP	8.36	8.87	<1.00	5.37	2.22	84.5	211.3
03U806	06/07/2022	W-220607-EM-10		<1.00	0.517 JP	0.438 JP	<1.00	0.269 JP	0.609 JP	31.7	79.3
04J077	06/10/2022	W-220610-EM-58		0.356 JP	0.916 JP	1.02	<1.00	0.420 JP	<1.00	34.4	86.0
04J702	06/13/2022	W-220613-EM-65		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.355 JP	15.2
04J708	06/09/2022	W-220609-EM-44		0.408 JP	0.710 JP	0.579 JP	<1.00	0.175 JP	<1.00	6.45	16.1
04J713	06/14/2022	W-220614-EM-66		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	11.9

Table 11-7. Groundwater Quality Data, Fiscal Year 2022, TGRS, OU2

			Substrate	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	*cis*-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Health Risk Index Value (2)
			TGRS Cleanup Level (1)	200	70	6	4	70	5	5	
Location	Date	Sample ID	Dup	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	
04J713	06/14/2022	W-220614-EM-67	D	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	12.0
04U002	06/10/2022	W-220610-EM-47		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.909 JP	16.2
04U002	06/10/2022	W-220610-EM-48	D	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.989 JP	16.5
04U007	06/08/2022	W-220608-EM-31		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0
04U020	06/15/2022	W-220615-EM-79		<1.00	0.119 JP	<1.00	<1.00	<1.00	<1.00	1.64	13.1
04U077	06/10/2022	W-220610-EM-56		0.725 JP	0.198 JP	0.665 JP	<1.00	0.254 JP	<1.00	18.1	45.3
04U510	06/16/2022	W-220616-EM-87		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0
04U510	06/16/2022	W-220616-EM-88	D	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0
04U701	06/13/2022	W-220613-EM-60		0.163 JP	<1.00	<1.00	<1.00	<1.00	<1.00	2.94	17.2
04U702	06/13/2022	W-220613-EM-62		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.02	14.7
04U702	06/13/2022	W-220613-EM-63	D	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.06	15.2
04U708	06/09/2022	W-220609-EM-45		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	7.3
04U709	06/10/2022	W-220610-EM-54		0.430 JP	0.324 JP	0.740 JP	<1.00	0.184 JP	<1.00	11.0	27.5
04U711	06/07/2022	W-220607-EM-23		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.208 JP	6.1
04U713	09/07/2022	W-220907-EM-01		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.279 J	15.1
04U713	09/07/2022	W-220907-EM-02	D	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.276 J	15.6
04U802	06/08/2022	W-220608-EM-29		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.311 JP	0.6
04U806	06/07/2022	W-220607-EM-16		0.544 JP	0.180 JP	0.309 JP	<1.00	0.288 JP	<1.00	18.3	45.8
04U806	06/07/2022	W-220607-EM-17	D	0.511 JP	0.191 JP	0.286 JP	<1.00	0.273 JP	<1.00	18.2	45.5
04U833	06/07/2022	W-220607-EM-21		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.463 JP	19.9
PJ#806	06/07/2022	W-220607-EM-12		0.222 JP	<1.00	<1.00	<1.00	<1.00	<1.00	9.51	25.3

Notes:

(1) Cleanup levels for TGRS are from the OU2 ROD. Shading indicates exceedance of the cleanup level.

(2) Health Risk Index is the chronic Cancer value calculated using MDH Guidance Additivity Workbook updated November 2022. In cases where trichloroethene results were lower than the detection limit or non-detect, these results were omitted from the calculations.

µg/L = Microgram(s) per liter
D = Field Duplicate
JP = Result is qualified as estimated since the detection is below the laboratory reporting limit.
JL# = Result is qualified as estimated due to outlying laboratory control sample recovery or recoveries. The following numerical value is the associated percent laboratory control sample recovery or recoveries.
JFD# = Result is qualified as estimated due to outlying field duplicate RPD result. The following numerical value is the associated RPD value.
OU = Operable unit
ROD = Record of Decision
TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System
Source: GHD

Table 11-8. Summary of OU2 Deep Groundwater Monitoring Requirements, TGRS, OU2

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	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
	b. Pumping volumes and rates for comparison to design rates	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
	c. Influent and extraction well water quality for overall mass removal calculations	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
#2 Groundwater Treatment	• Outlined below	NA	NA
#3 Treated Water Discharge	• Effluent monitoring to verify attainment of treatment requirements	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
#4 Land Use Controls	• None	NA	NA
#5 Review of New Technologies	• None	NA	NA
#6 Groundwater Monitoring	a. Water levels to draw contour maps showing hydraulic zone of capture	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
	b. Groundwater quality to verify attainment of clean up goals	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
Overall Remedy	a. Groundwater quality to verify attainment of clean up goals	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report

Notes:
NA = Not applicable
OU = Operable unit
TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System
Source: GHD

Table 11-9. 1,4-Dioxane Concentrations in Extraction Wells, Fiscal Year 2022, TGRS, OU2

				1,4-Dioxane
		Screening Criteria (HRL)		1.0
Location	**Alias**	**Date**	**Dup**	**µg/L**
03F302	B1	06/17/2022		3.70
03F303	B2	06/17/2022		< 0.400
03F304	B3	06/17/2022		5.98
03F305	B4	06/17/2022		21.1
03F306	B5	06/17/2022		16.7
03F306	B5	06/17/2022	D	16.4
03F307	B6	06/17/2022		15.3
03F308	B7	06/17/2022		19.0 JP
PJ#309	B8	06/17/2022		13.6
PJ#310	B9	06/17/2022		23.4
PJ#311	B10	06/17/2022		16.3
03F312	B11	06/17/2022		1.11
PJ#313	B12	06/17/2022		14.3
03F319	B13	06/17/2022		10.6
03U315	SC3	06/03/2022		11.9
03U316	SC4	06/03/2022		12.2
03U317	SC5	06/03/2022		11.4
TGRSE		06/06/2022		10.9
TGRSI		06/06/2022		10.0
TGRSI		06/06/2022	D	9.82

Notes:
µg/L = Microgram(s) per liter
D = Field duplicate
HRL = Health Risk Limit (Minnesota Department of Health).
JP = Value is estimated; result is less than the reporting limit but greater than the method detection limit.
OU = Operable unit
TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System
SC1 was not sampled in June 2022 due to ongoing SGRS construction.
Shading indicates exceedance of the HRL
Source: GHD

Table 11-10. 1,4-Dioxane Concentrations in Monitoring Wells, Fiscal Year 2022, TGRS, OU2

			1,4-Dioxane
Screening Criteria (HRL)			1.0
Location	Date	Dup	µg/L
03L002	06/10/2022		16.2
03L007	06/08/2022		<0.400
03L014	06/21/2022		5.40
03L017	06/16/2022		17.3
03L018	06/22/2022		11.2
03L020	06/15/2022		12.8
03L021	06/15/2022		7.91
03L077	06/10/2022		19.3
03L078	06/09/2022		2.50
03L079	06/09/2022		1.14
03L802	06/08/2022		0.571
03L806	06/07/2022		19.3
03L809	06/06/2022		18.1
03L833	06/07/2022		19.1
03M002	06/10/2022		16.4
03M020	06/15/2022		14.5
03M020	06/15/2022	D	13.2
03M802	06/08/2022		<0.400
03M806	06/07/2022		21.4
03U002	06/10/2022		3.57
03U003	06/08/2022		0.550
03U005	06/15/2022		<0.400
03U007	06/08/2022		<0.400
03U009	06/16/2022		<0.400
03U014	06/21/2022		29.9
03U017	06/16/2022		17.2
03U018	06/22/2022		0.155 JP
03U020	06/15/2022		31.0
03U021	06/15/2022		38.6
03U027	06/14/2022		1.25
03U028	06/14/2022		0.458
03U029	06/15/2022		2.07
03U030	06/14/2022		<0.400
03U032	06/21/2022		0.478
03U032	06/21/2022	D	0.660
03U077	06/10/2022		9.99
03U078	06/09/2022		<0.400
03U079	06/09/2022		<0.400
03U079	06/09/2022	D	<0.517

Table 11-10. 1,4-Dioxane Concentrations in Monitoring Wells, Fiscal Year 2022, TGRS, OU2

			1,4-Dioxane
Screening Criteria (HRL)			1.0
Location	Date	Dup	µg/L
03U092	06/22/2022		5.74
03U093	06/22/2022		1.81
03U094	06/21/2022		41.1
03U096	06/22/2022		2.64
03U099	06/16/2022		<0.400
03U114	06/16/2022		<0.400
03U659	06/14/2022		2.35
03U671	06/09/2022		<0.400
03U677	06/08/2022		0.579
03U701	06/13/2022		10.8
03U702	06/13/2022		9.37
03U703	06/09/2022		0.739
03U708	06/09/2022		<0.400
03U709	06/10/2022		11.6
03U710	06/09/2022		0.548
03U711	06/07/2022		3.58
03U715	06/22/2022		6.42 JFD56
03U715	06/22/2022	D	3.60 JFD56
03U801	06/08/2022		0.528
03U801	06/08/2022	D	0.505
03U803	06/06/2022		<0.437
03U804	06/06/2022		<0.400
03U805	06/06/2022		4.82
03U805	06/06/2022	D	4.87
03U806	06/07/2022		12.3
04J077	06/10/2022		22.5
04J702	06/13/2022		15.2
04J708	06/09/2022		11.2
04J713	06/14/2022		11.9
04J713	06/14/2022	D	12.0
04U002	06/10/2022		16.2
04U002	06/10/2022	D	16.5
04U007	06/08/2022		<0.400
04U020	06/15/2022		12.3
04U077	06/10/2022		20.1
04U510	06/16/2022		<0.400

Table 11-10. 1,4-Dioxane Concentrations in Monitoring Wells, Fiscal Year 2022, TGRS, OU2

			1,4-Dioxane
Screening Criteria (HRL)			1.0
Location	Date	Dup	µg/L
04U510	06/16/2022	D	<0.400
04U701	06/13/2022		15.7
04U702	06/13/2022		14.2
04U702	06/13/2022	D	14.7
04U708	06/09/2022		7.26
04U709	06/10/2022		17.9
04U711	06/07/2022		6.06
04U713	09/07/2022		15.1
04U713	09/07/2022	D	15.6
04U802	06/08/2022		0.600
04U806	06/07/2022		19.8
04U806	06/07/2022	D	18.9
04U833	06/07/2022		19.9
PJ#806	06/07/2022		20.5

Notes:
µg/L = Microgram(s) per liter
HRL = Health Risk Limit (Minnesota Department of Health)
D = Field Duplicate
JP = Result is qualified as estimated since the detection is below the laboratory reporting limit.
JFD = Result is qualified as estimated due to outlying field duplicate RPD result. The following numerical value is the associated RPD value.
OU = Operable unit
TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System
Shading indicates exceedance of the HRL.

Table 12-1. Groundwater Quality Data, Fiscal Year 2022, OU3

			1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	*cis*-1,2-Dichloroethene	Trichloroethene	Health Risk Index[2]
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**	
03L673	06/03/2022		<1.00	<1.00	0.410 JP	0.373 JP	5.70	59.6	149.0
03L848	06/03/2022		<1.00	<1.00	<1.00	<1.00	1.99	0.463 JP	0.9
03L854	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.1
03L859	06/03/2022		0.654 JP	<1.00	2.42	4.72	0.986 JP	4.33	10.8
03M848	06/03/2022		<1.00	<1.00	0.235 JP	0.441 JP	7.10	77.8	194.5
03U673	06/03/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0
04J866	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0
04U414	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0
04U673	06/03/2022		<1.00	<1.00	<1.00	<1.00	1.20	20.1	50.3
04U832	06/02/2022		<1.00	<1.00	0.781 JP	0.735 JP	1.05	14.7	36.8
04U845	06/02/2022		<1.00	<1.00	<1.00	<1.00	0.343 JP	7.07	17.7
04U848	06/03/2022		<1.00	<1.00	<1.00	<1.00	<1.00	2.89	7.2
04U851	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0
04U851	06/02/2022	D	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0
04U854	06/02/2022		<1.00	<1.00	<1.00	<1.00	0.223 JP	5.97	14.9
04U859	06/03/2022		0.930 JP	<1.00	1.52	1.66	0.681 JP	14.3	35.8
04U860	06/03/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0
04U860	06/03/2022	D	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0
04U863	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0
04U866	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.0

Notes:

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

(2) Health Risk Index is the chronic Cancer value calculated using MDH Guidance Additivity Workbook updated November 2022. In cases where trichloroethene results were lower than the detection limit or non-detect, these results were omitted from the calculations.

µg/L = Microgram(s) per liter

JP = Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit.

Source: GHD

Table 12-2. Mann-Kendall Statistical Summary, Fiscal Year 2022, OU3

Well	Kendall S	Number of Data Points	Raw Trend	Confidence	Coefficient of Variance	Raw Trend Decision	MAROS Conclusion	TCE Concentration 2022
Edge of Plume Wells								
03L673	-10	6	Decreasing	95.20%	0.2205	Definite	Decreasing	59.6
03L848	-14	6	Decreasing	99.51%	0.5653	Definite	Decreasing	0.463
04U673	-9	6	Decreasing	93.20%	0.2397	Probable	Decreasing	20.1
04U832	-7	6	Decreasing	86.40%	0.3540	Stable or No Trend	Stable	14.7
04U845	-7	6	Decreasing	86.40%	0.3271	Stable or No Trend	Stable	7.07
04U848	-15	6	Decreasing	99.86%	0.2206	Definite	Decreasing	2.89
04U854	-11	6	Decreasing	97.20%	0.1987	Definite	Decreasing	5.97
Center of Plume Wells								
03L859	-8	6	Decreasing	89.81%	0.2192	Stable or No Trend	Stable	4.33
03M848	-7	6	Decreasing	86.40%	0.1210	Stable or No Trend	Stable	77.8
04U859	-15	6	Decreasing	99.86%	0.4318	Definite	Decreasing	14.3

Notes:
OU = Operable Unit
TCE = Trichloroethene
Source: GHD

Table 12-3. Groundwater Quality Data, Fiscal Year 2022, OU3

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.	Northrop Grumman Space Systems	OU3 Monitoring Plan in Annual Report
		b. Groundwater sampling to track progress of clean-up and attenuation of plume.	Northrop Grumman Space Systems	OU3 Monitoring Plan in Annual Report
#3	Drilling Advisories	a. Verification that drilling advisories are in place and functioning as intended.	Army/MDH	N/A
OR:	Overall Remedy	a. Water quality monitoring to verify attainment of clean-up goals.	Northrop Grumman Space Systems	OU3 Monitoring Plan in Annual Report

Notes:
MDH = Minnesota Department of Health
N/A = Not Applicable
OU = Operable Unit
Source: GHD

Table 12-4. 1,4-Dioxane Groundwater Sampling Results
Fiscal Year 2022, OU3

			1,4-Dioxane
	Screening Criteria (HRL)		1.0
Location	Date	Dup	µg/L
03L673	06/03/2022		2.11
03L848	06/03/2022		0.854
03L854	06/02/2022		0.141 JP
03L859	06/03/2022		3.50
03M848	06/03/2022		0.778
03U673	06/03/2022		< 0.400
04J866	06/02/2022		< 0.400
04U414	06/02/2022		< 0.400
04U673	06/03/2022		0.890
04U832	06/02/2022		1.35
04U845	06/02/2022		0.666
04U848	06/03/2022		0.745
04U851	06/02/2022		< 0.400
04U851	06/02/2022	D	0.119 JP
04U854	06/02/2022		0.713
04U859	06/03/2022		4.36
04U860	06/03/2022		< 0.400
04U860	06/03/2022	D	< 0.400
04U863	06/02/2022		0.136 JP
04U866	06/02/2022		0.158 JP

Notes:
(1) HRL = Health Risk Limit (Minnesot Department of Health)
Shading indicates an exceedence of the HRL.
µg/L = Microgram(s) per liter
D = Field Duplicate
JP = Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit.
Source: GHD

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Figures

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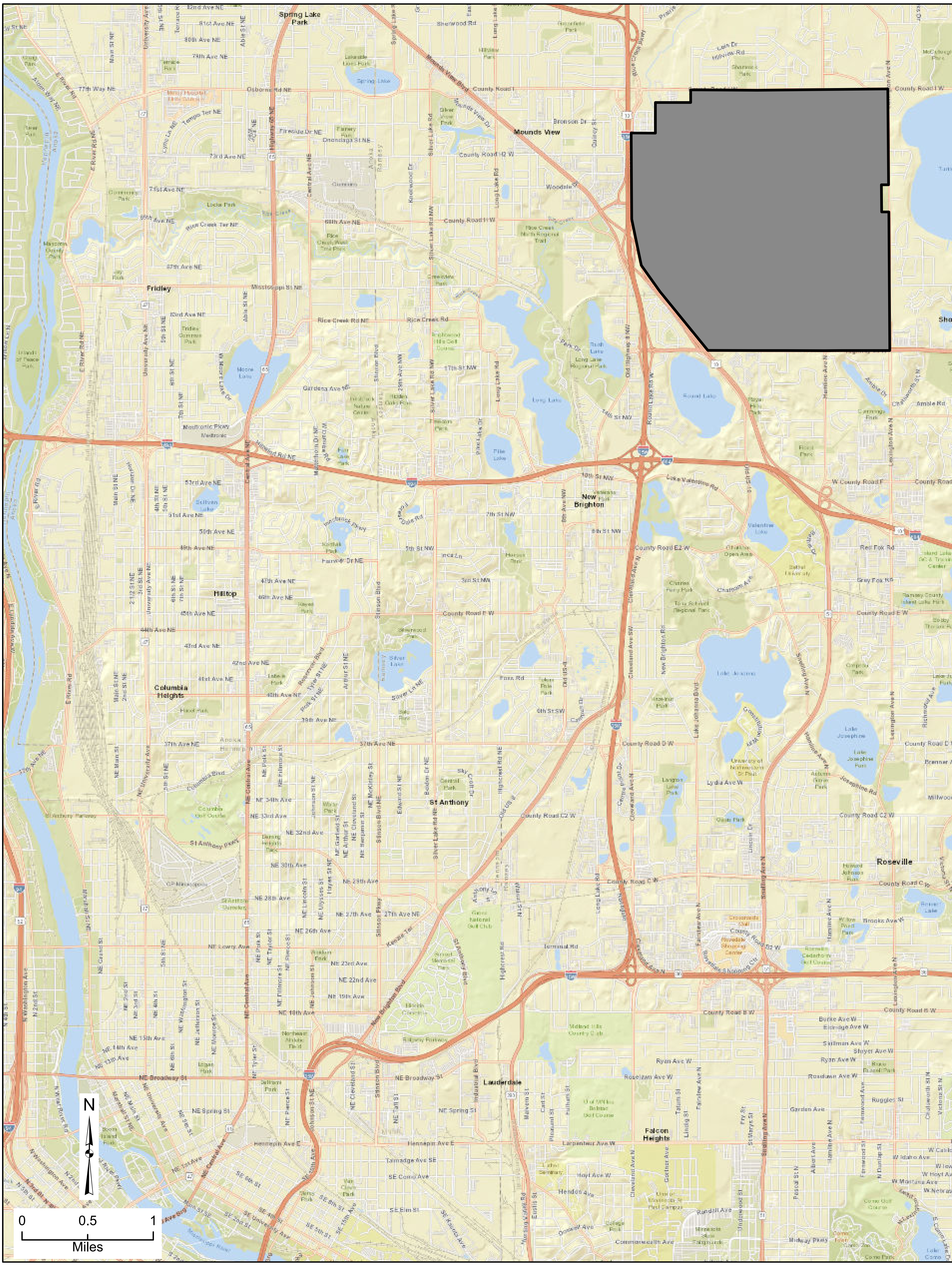
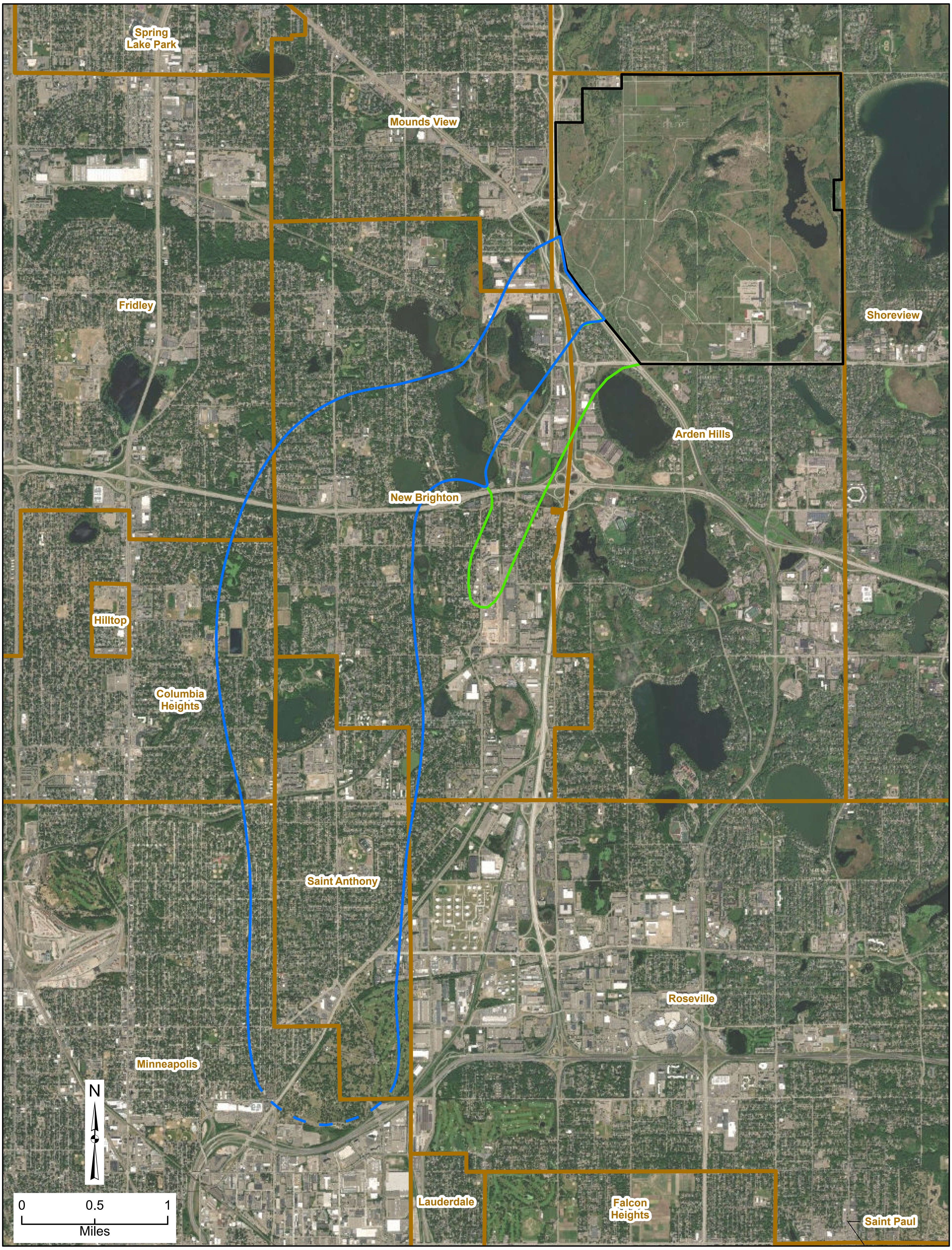


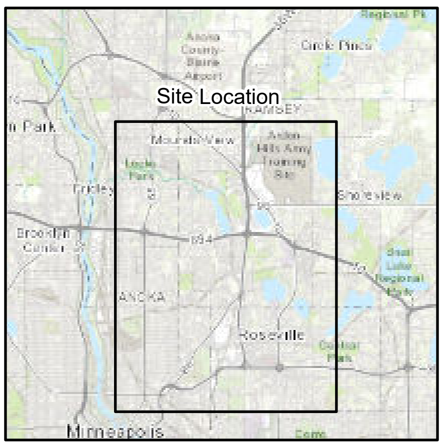
Legend

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.)

Figure 1-1
FY 2022 Annual Performance Report
Site Location Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx



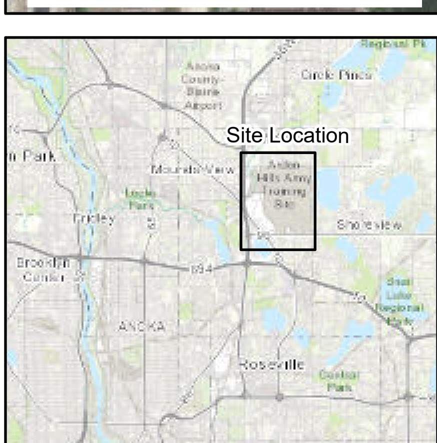


Legend

- Operable Unit 1 (North Plume) (Dashed Where Inferred)
- 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.)
- Operable Unit 3 (South Plume)
- Municipal Boundary

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure 1-2
FY 2022 Annual Performance Report
Conceptual Illustration of OUs 1, 2, and 3
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota



Legend

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.)

General NPL Site Boundary

Figure 1-3
FY 2022 Annual Performance Report
OU2 Site Boundaries
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
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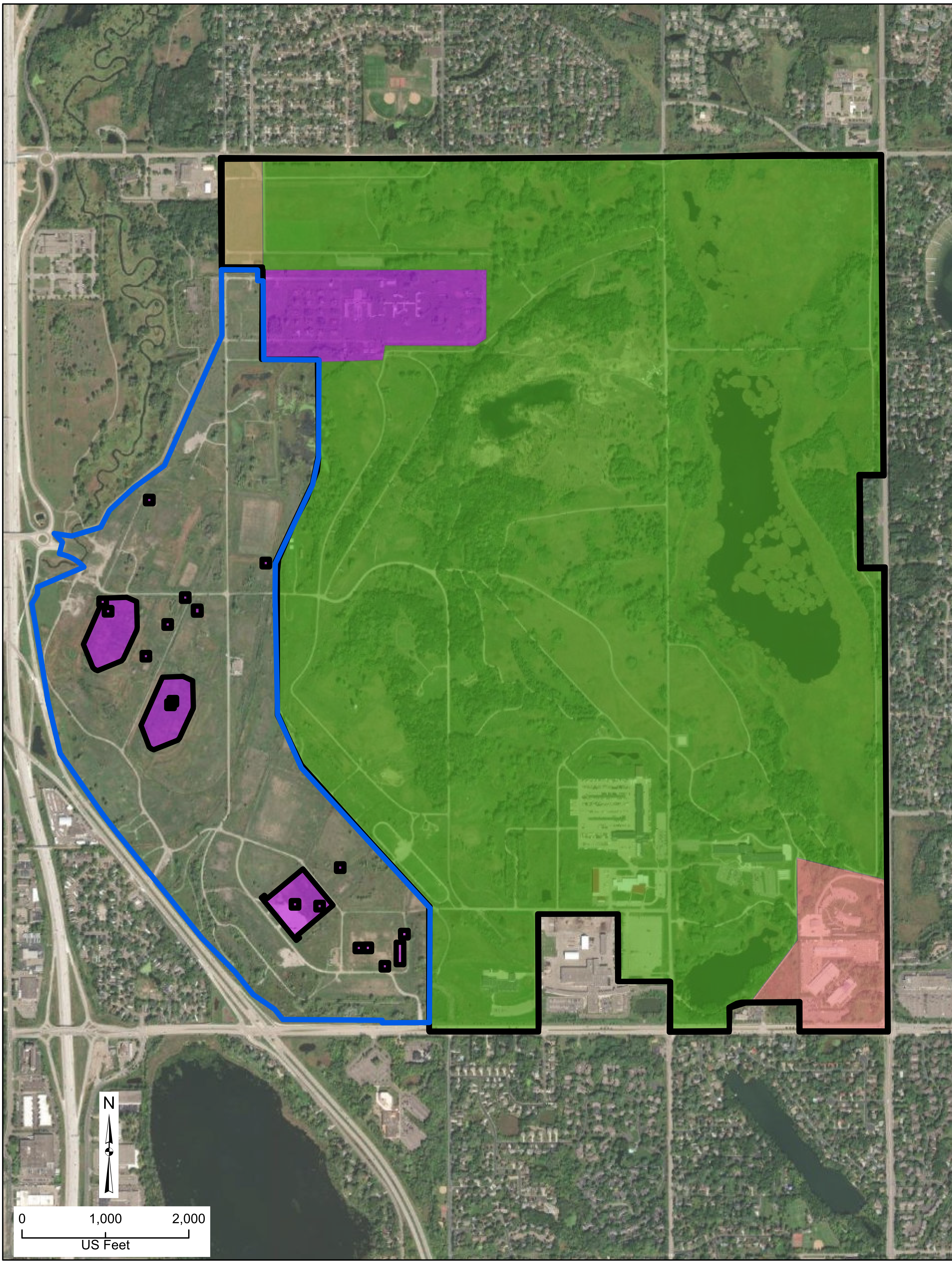
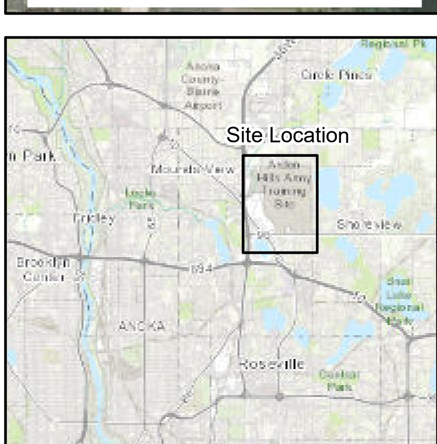


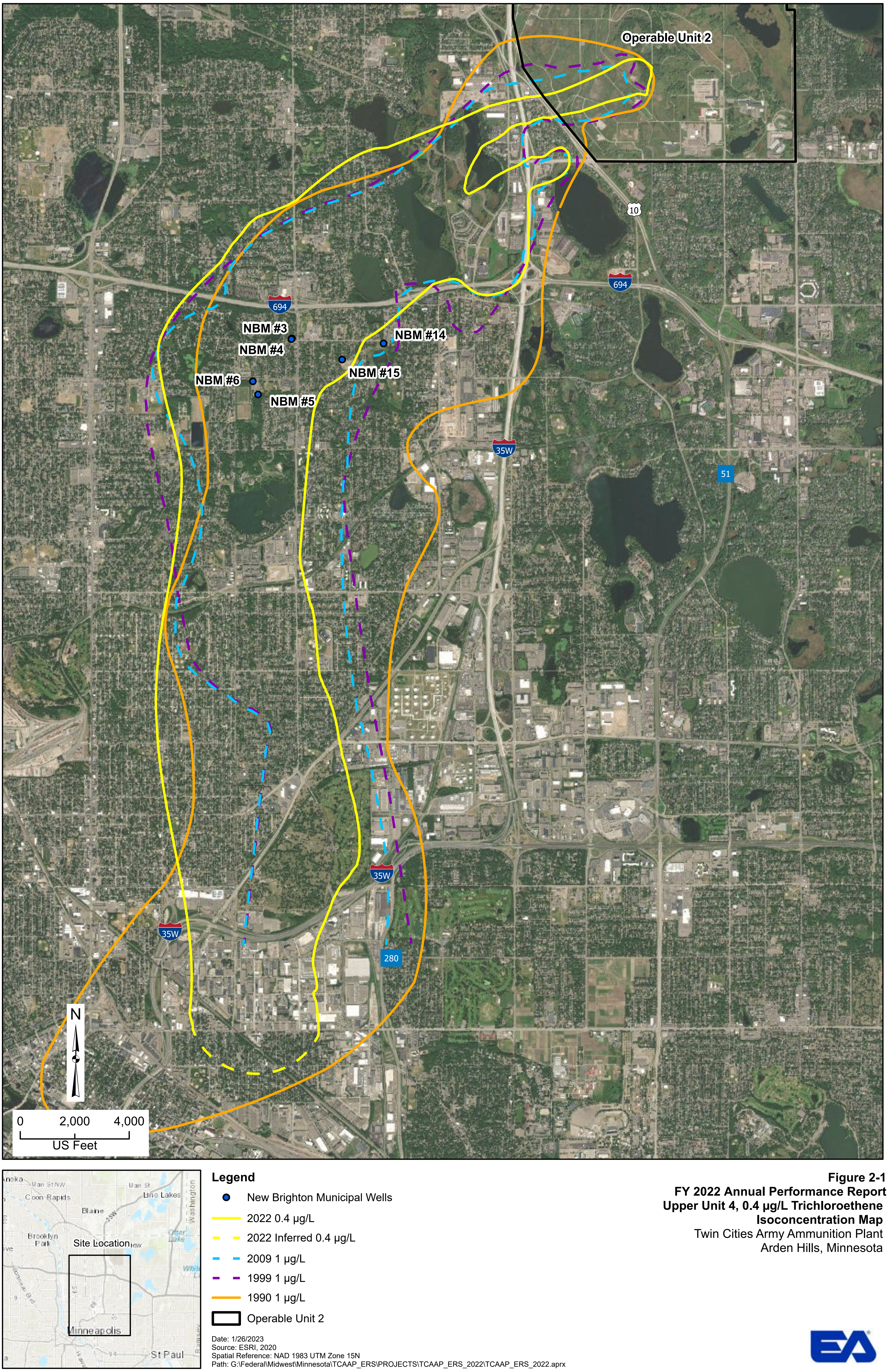


Legend

- Ramsey County Owned
- 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

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure 1-4
FY 2022 Annual Performance Report
OU2 Site Boundary
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota



Legend

- New Brighton Municipal Wells
- 2022 0.4 µg/L
- 2022 Inferred 0.4 µg/L
- 2009 1 µg/L
- 1999 1 µg/L
- 1990 1 µg/L
- Operable Unit 2

Date: 1/26/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure 2-1
FY 2022 Annual Performance Report
Upper Unit 4, 0.4 µg/L Trichloroethene Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

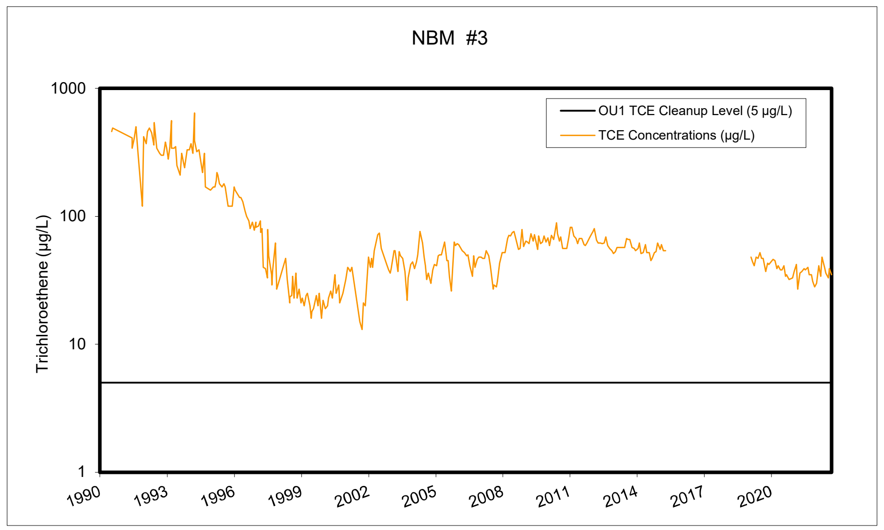
Figure 2-2

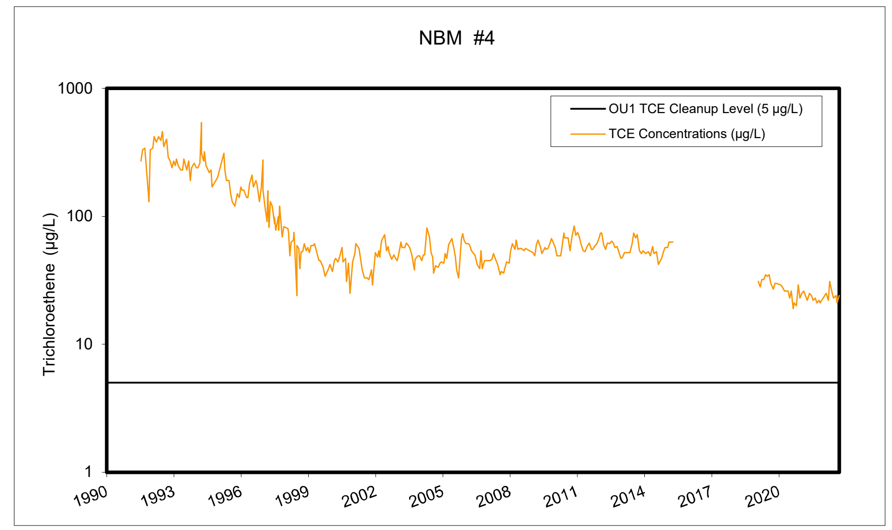
FY 2022 Annual Performance Report

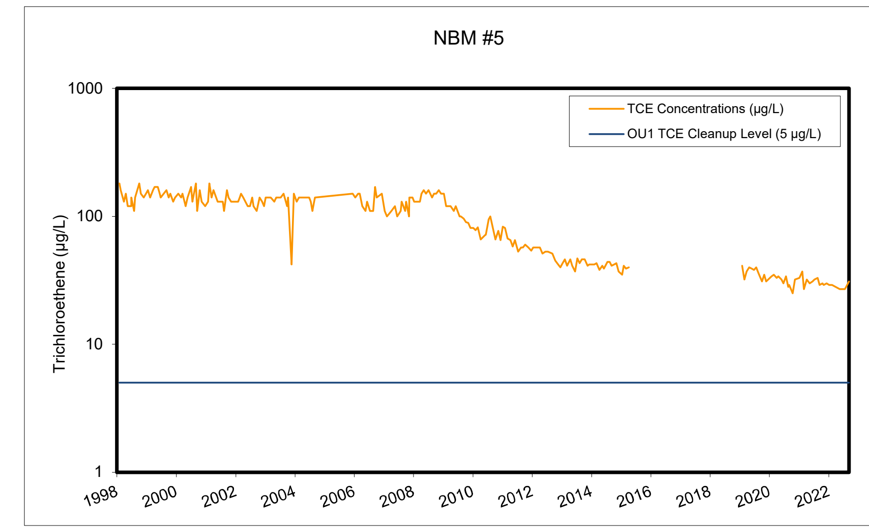
New Brighton Municipal Wells: Trichloroethene Water Quality Trends

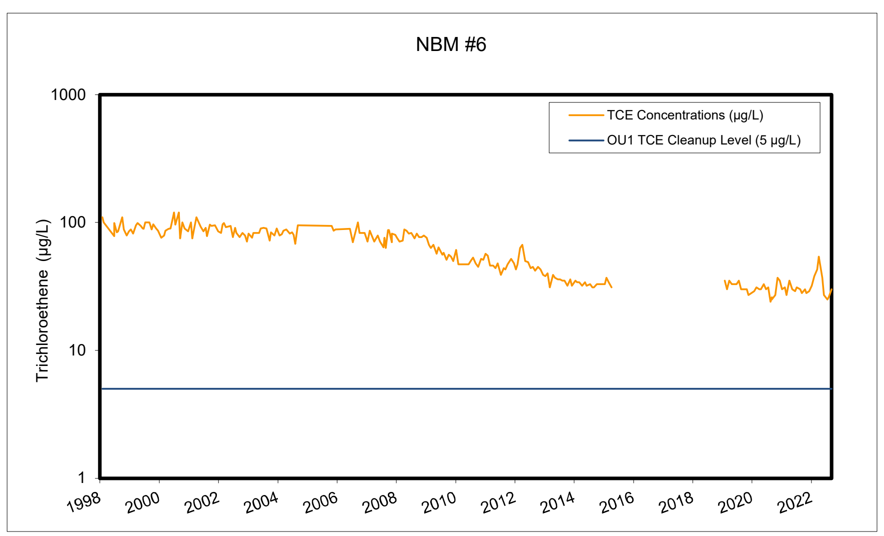
Twin Cities Army Ammunition Plant

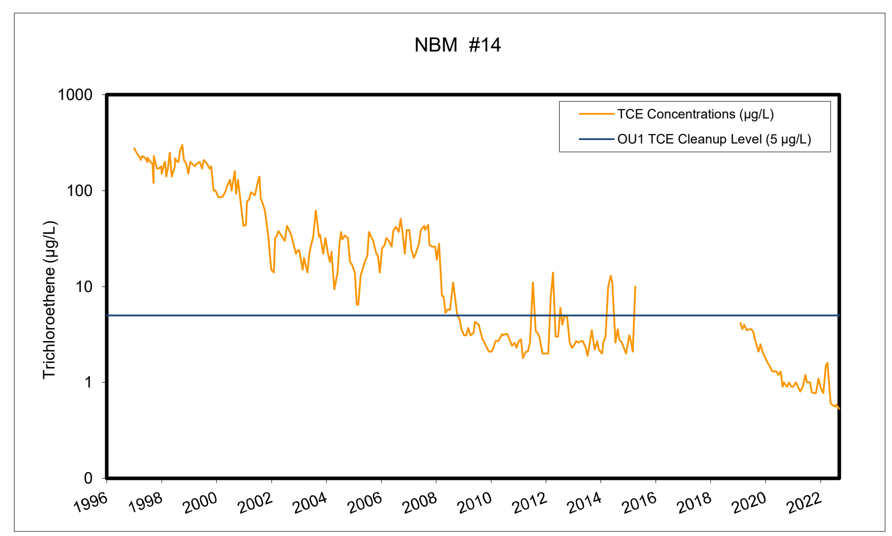
Arden Hills, Minnesota

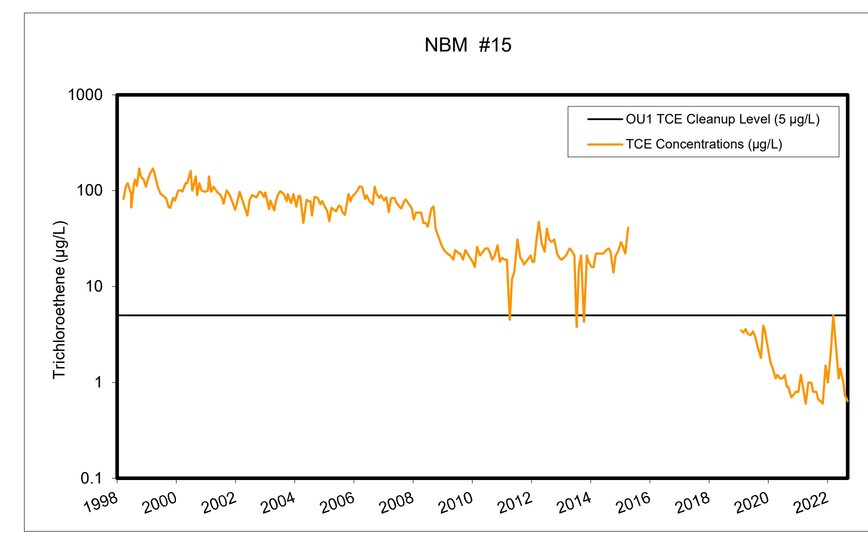






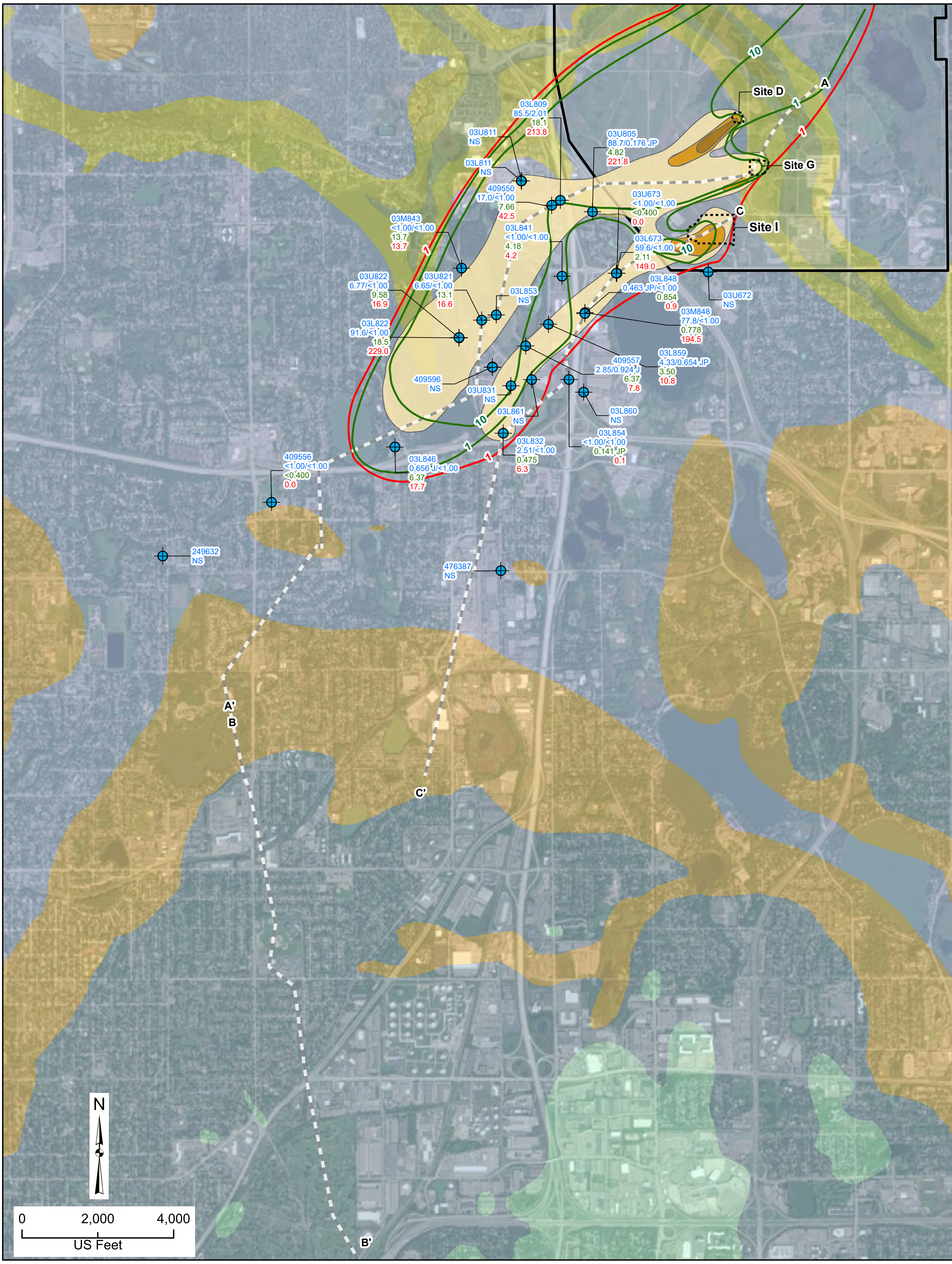






Note: Routine pumping of the NBCGRS was ceased on April 15, 2015, with notice to the USEPA/MPCA, due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells. Since the granular activated carbon (GAC) does not remove 1,4-dioxane, New Brighton is preferentially pumping deep 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.

Update: The routine pumping of the NBCGRS began again in 2019 following the implementation of a treatment system for 1,4-dioxane.



Legend

- Monitoring Well Locations
- 03L822 — Monitoring Well ID
- 91.6 — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 18.5 — 1,4-Dioxane Concentration (µg/L)
- 17.7 — Health Risk Index
- Cross-Section Line
- Site Boundary
- 2022 1,4 Dioxane Concentration Contour (µg/L
- Health Risk Index = 1

2022 Trichloroethene Concentrations

- > 0.4 µg/L
- > 100 µg/L
- > 1,000 µg/L
- Operable Unit 2

Bedrock Geology

- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Figure 2-3
Annual Performance Report
OU1 and OU3,
Upper and Lower Unit 3
Trichloroethene and 1, 4- Dioxane
Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 6/23/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N

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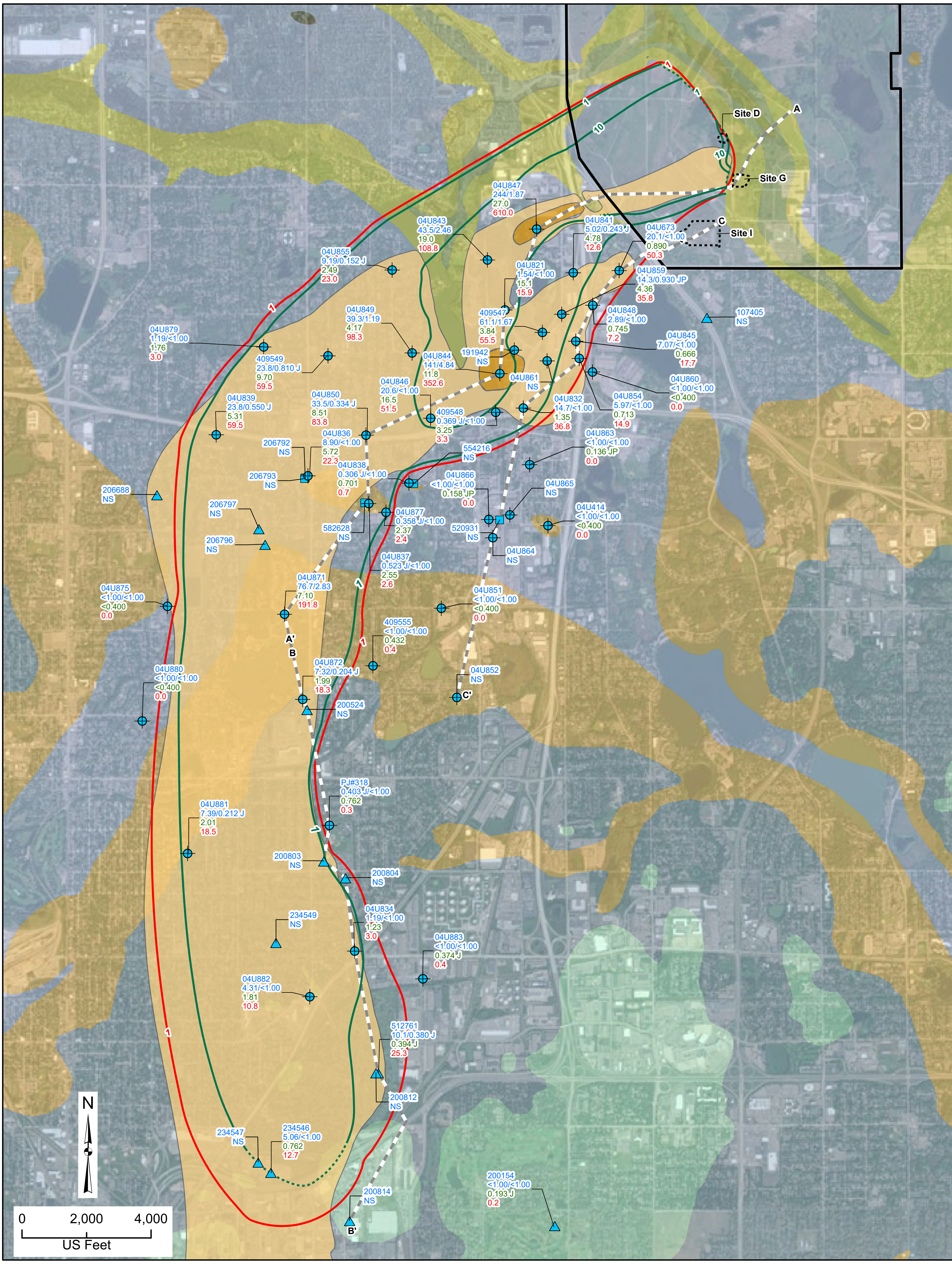

Legend

- Monitoring Well
- 04U871 Monitoring Well ID
- 76.7 Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 7.10 1,4-Dioxane Concentration (µg/L)
- 12.7 Health Risk Index
- Extraction Well
- Private Well
- Cross-Section Line
- Site Boundary
- 2022 1,4 Dioxane Concentration Contour (µg/L)
- 2022 1,4 Dioxane Concentration Inferred Contour (µg/L)
- Health Risk Index =1

2022 Trichloroethene Concentrations (µg/L)

- > 0.4 µg/L
- > 100 µg/L
- Operable Unit 2

Bedrock Geology

- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Figure 2-4
Annual Performance Report
OU1 and OU3, Upper Unit 4
Trichloroethene and 1, 4-Dioxane
Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 6/23/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N

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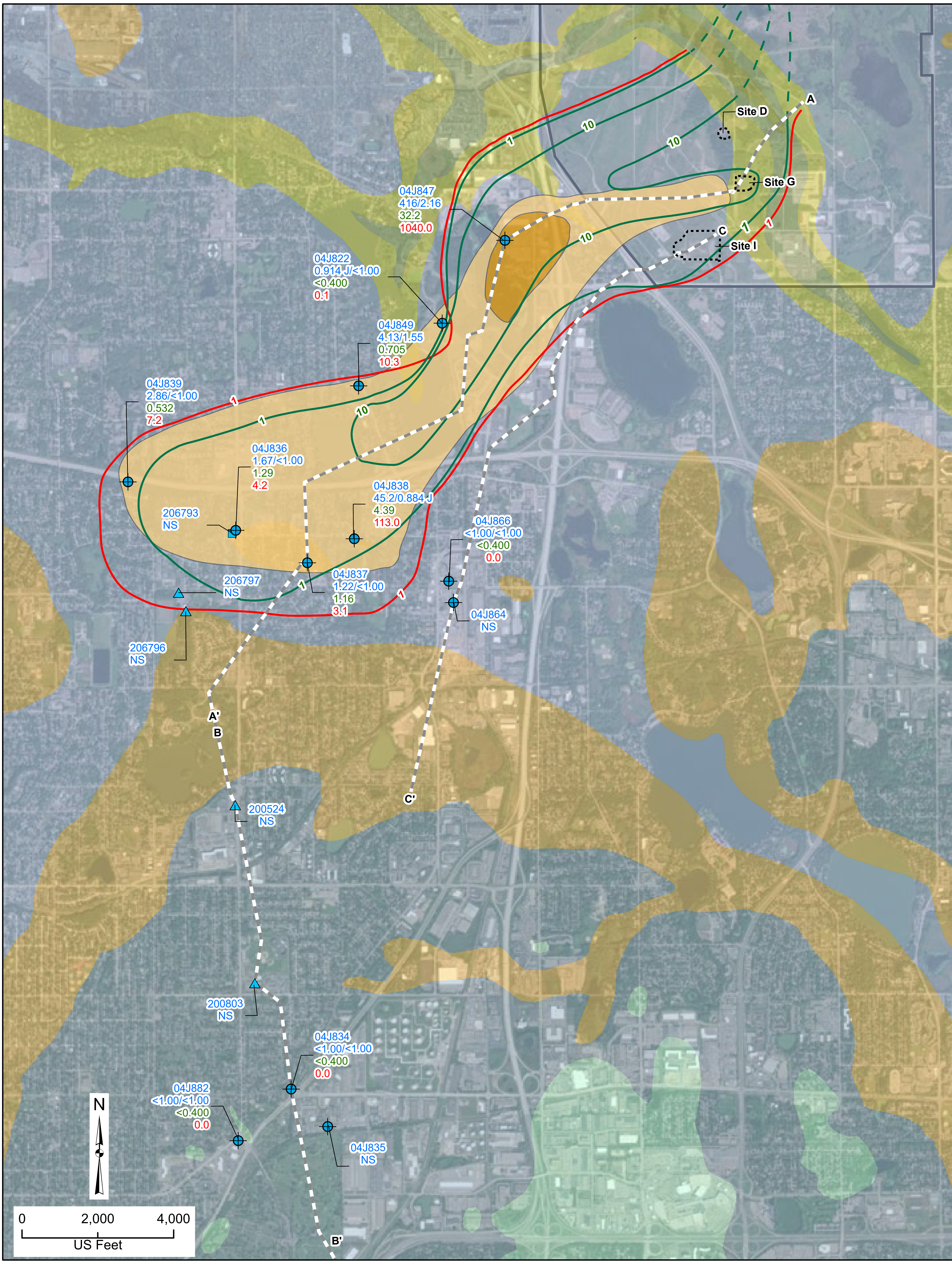

Legend

- Monitoring Well
- 04J849 — Monitoring Well ID
- 4.13/1.55 — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 0.705 — 1,4-Dioxane Concentration (µg/L)
- 10.3 — Health Risk Index
- Extraction Well
- Private Well
- Cross-Section Line
- Site Boundary
- 2022 1,4 Dioxane Concentration Contour (µg/L)
- 2022 1,4 Dioxane Concentration Inferred Contour (µg/L)
- Health Risk Index = 1

2022 Trichloroethene Concentrations (µg/L)

- > 0.4 µg/L
- > 100 µg/L
- Operable Unit 2

Bedrock Geology

- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Figure 2-5
Annual Performance Report
Lower Unit 4 Trichloroethene and 1,4 Dioxane Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 9/12/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N

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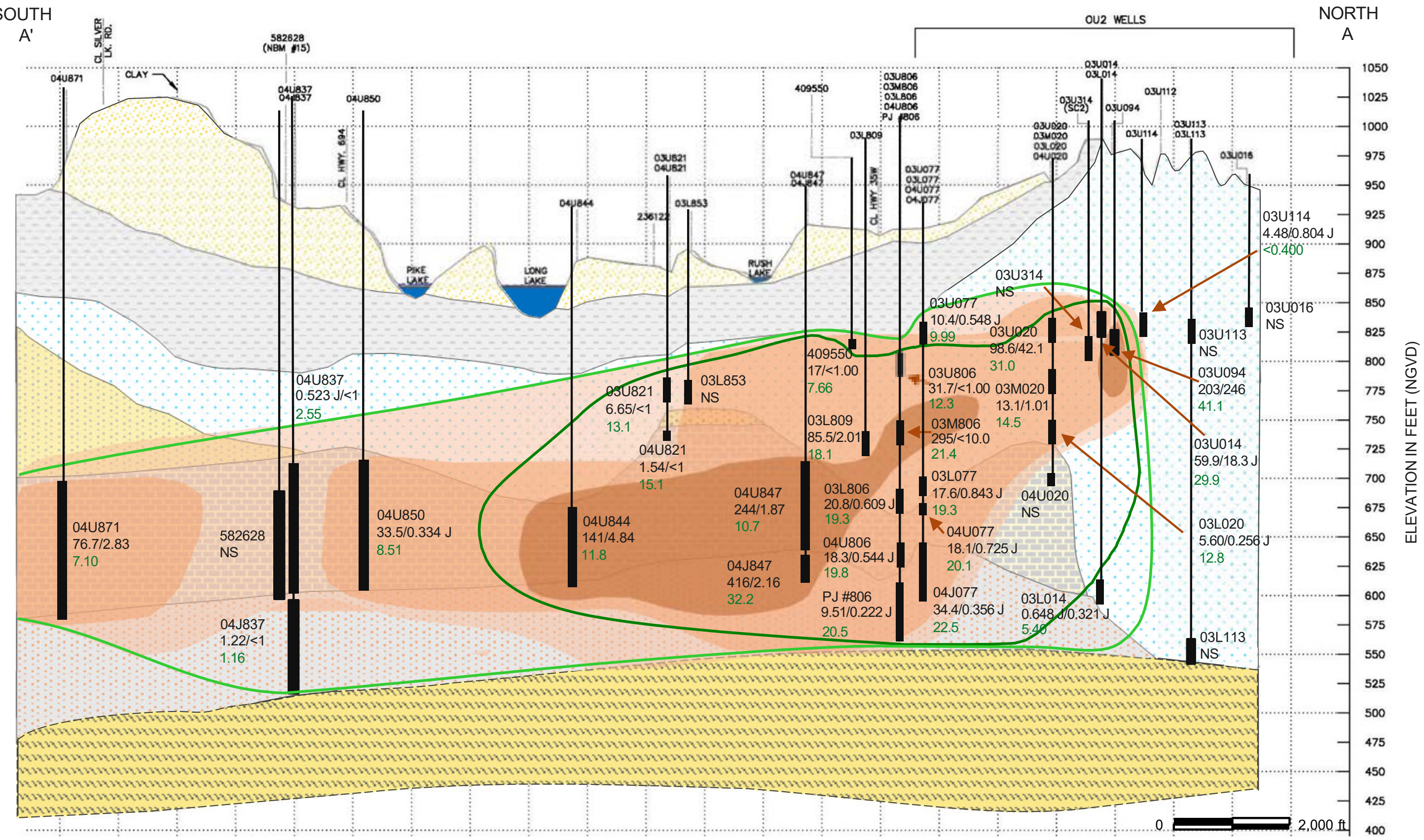
FY 2022 Annual Performance Report
Figure 2-6
OU2-OU1 Trichloroethene Cross Section A-A'

U.S Army - TCAAP
Arden Hills, Minnesota



Legend

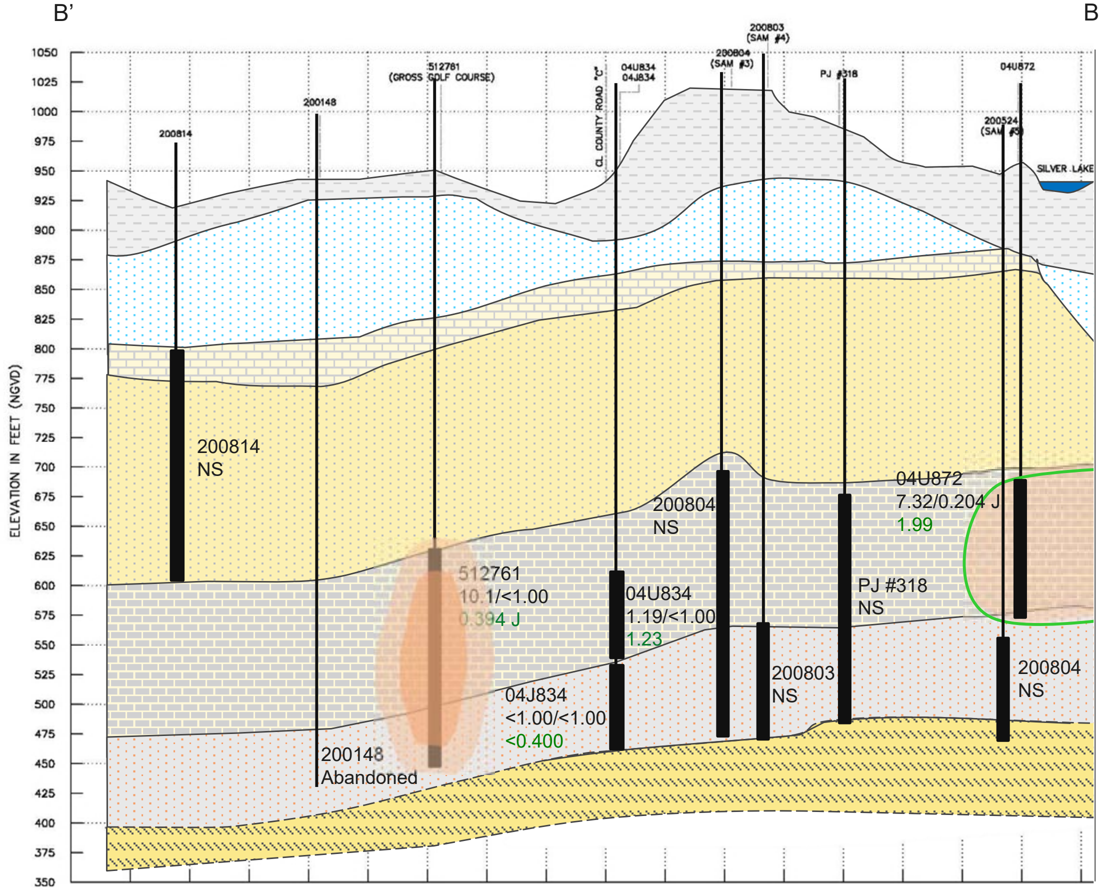
04J077	Well ID
NS	Not Sampled
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
69/1.5	Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
36.9	1,4-Dioxane concentration (µg/L)
J	Reported value is between the method detection limit and reporting limit
—	Geologic Contact (inferred where dashed)
▌	Screened Interval

Trichloroethene Concentration (µg/L)
- 5-10
- 10-100
- >100

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

FY 2022 Annual Performance Report
Figure 2-7
OU2-OU1 Trichloroethene Cross Section B-B'
U.S Army - TCAAP
Arden Hills, Minnesota



Legend

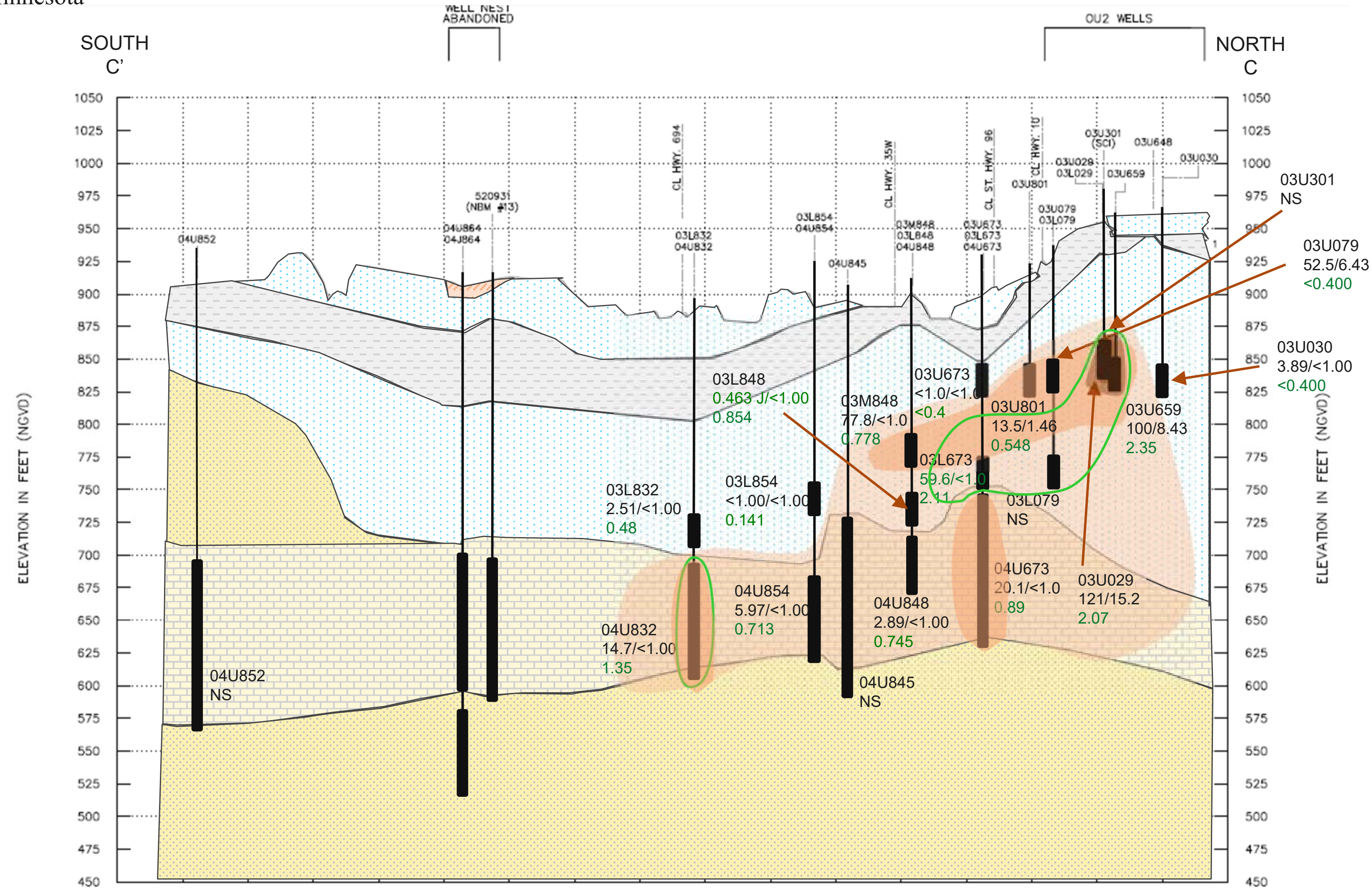
512761	Well ID
NS	Not Sampled
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
J	Reported value is between the method detection limit and reporting limit
2.6/ND	Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
3.4	1,4-Dioxane concentration* (µg/L)
—	Geologic Contact (inferred where dashed)
▌	Screened Interval

Trichloroethene Concentration (µg/L)
- 5-10
- 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

FY 2021 Annual Performance Report
Figure 2-8
OU2-OU3 Trichloroethene Cross Section C-C’
U.S Army - TCAAP
Arden Hills, Minnesota



Legend

03U079 Well ID
NS Not Sampled
μg/L Micrograms per Liter
NGVD National Geodetic Vertical Datum
55/8.2 Trichloroethene/1,1,1-Trichloroethane Concentration (μg/L)
0.25 1,4-Dioxane concentration* (μg/L)

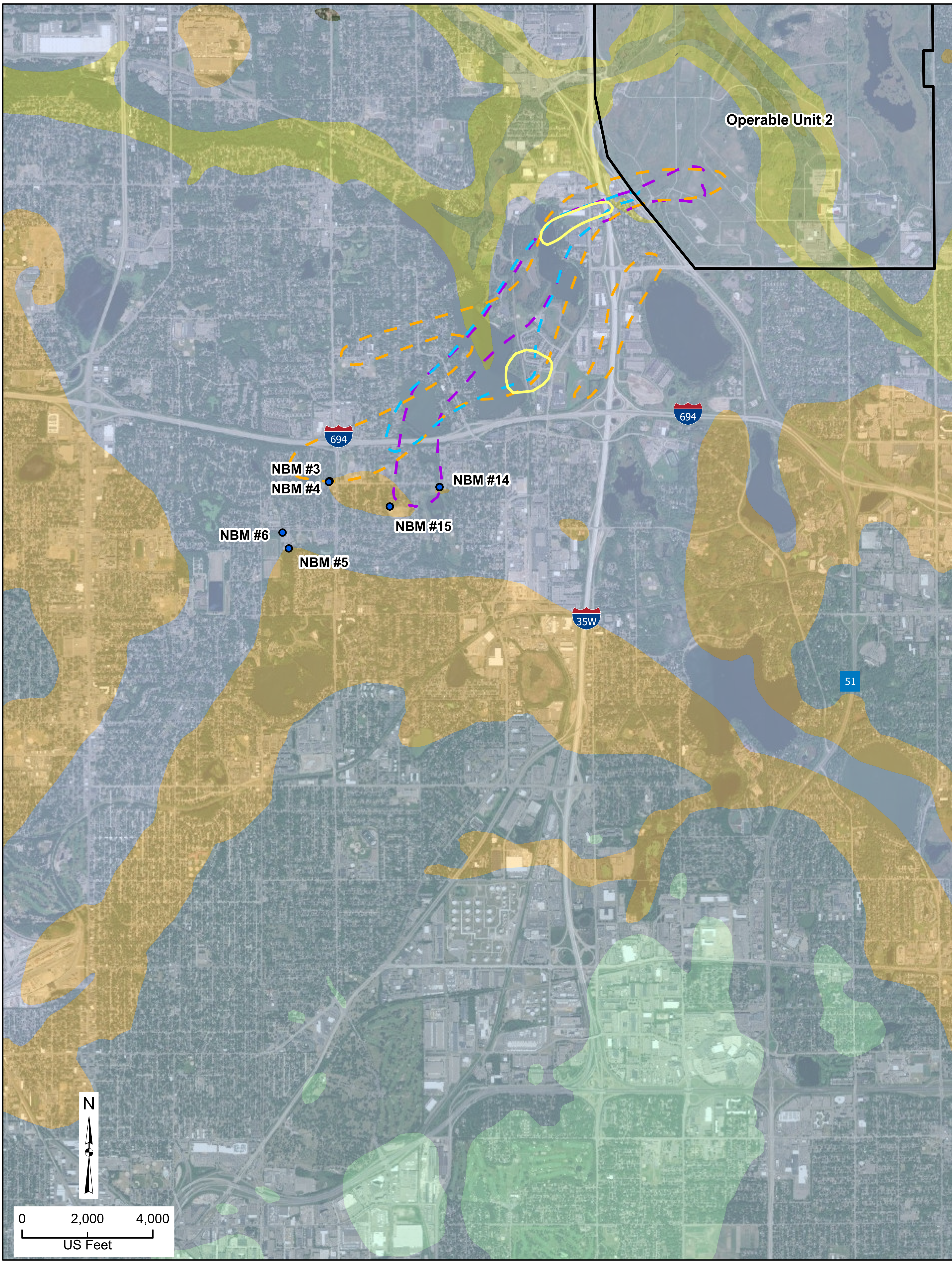
J Reported value is between the method detection limit and reporting limit
Geologic Contact (inferred where dashed)
Screened Interval

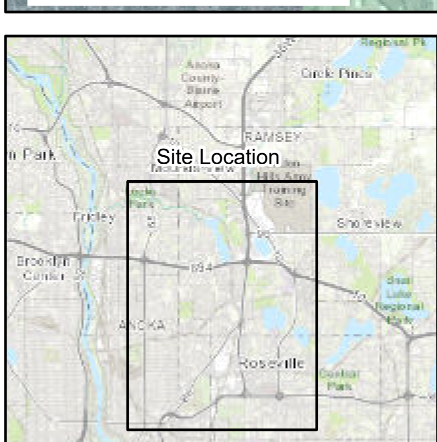
Trichloroethene Concentration (μg/L)
5-10
10-100
> 100

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

Fill
Unit 1
Unit 2
Unit 3
Platteville Limestone

St. Peter Sandstone
Upper Unit 4
Lower Unit 4
St. Lawrence Formation





Legend

- New Brighton Municipal Wells
- 2022 100 µg/L
- 2009 100 µg/L
- 1999 100 µg/L
- 1990 100 µg/L
- Operable Unit 2

Bedrock Geology

- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
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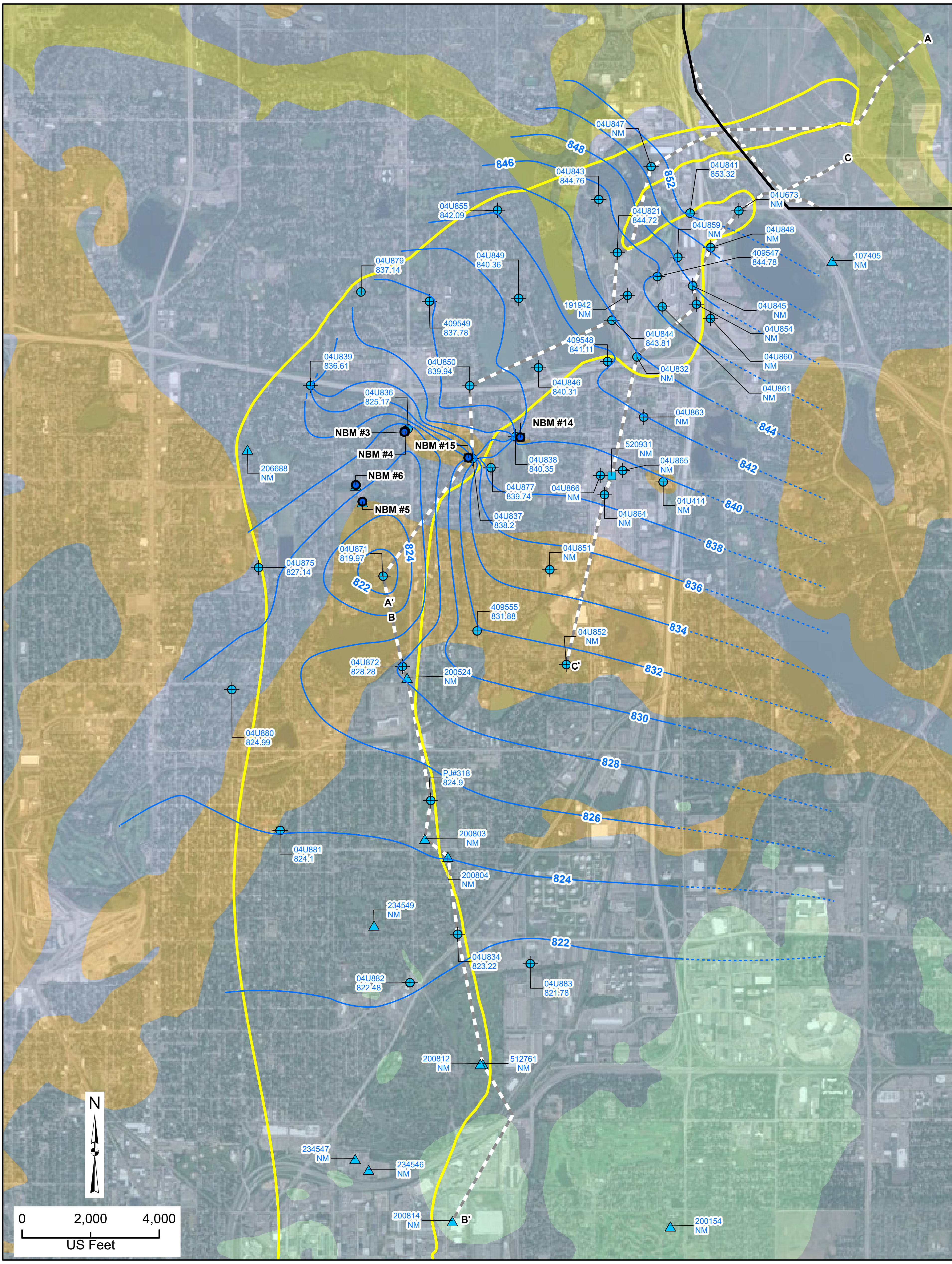
Figure 2-9
FY 2022 Annual Performance Report
Upper Unit 4, 100 µg/L Trichloroethene Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota



Legend

- Monitoring Well
- Extraction Well
- Private Well
- NM Not Measured
- 840 Groundwater Elevation
- New Brighton Municipal Wells
- Cross-Section Line
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- 2022 0.4 ug/L Trichloroethene Contour in Upper Unit 4

Bedrock Geology

- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group
- 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.)

Note: Values in parentheses were not used for contouring.
Date: 2/20/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
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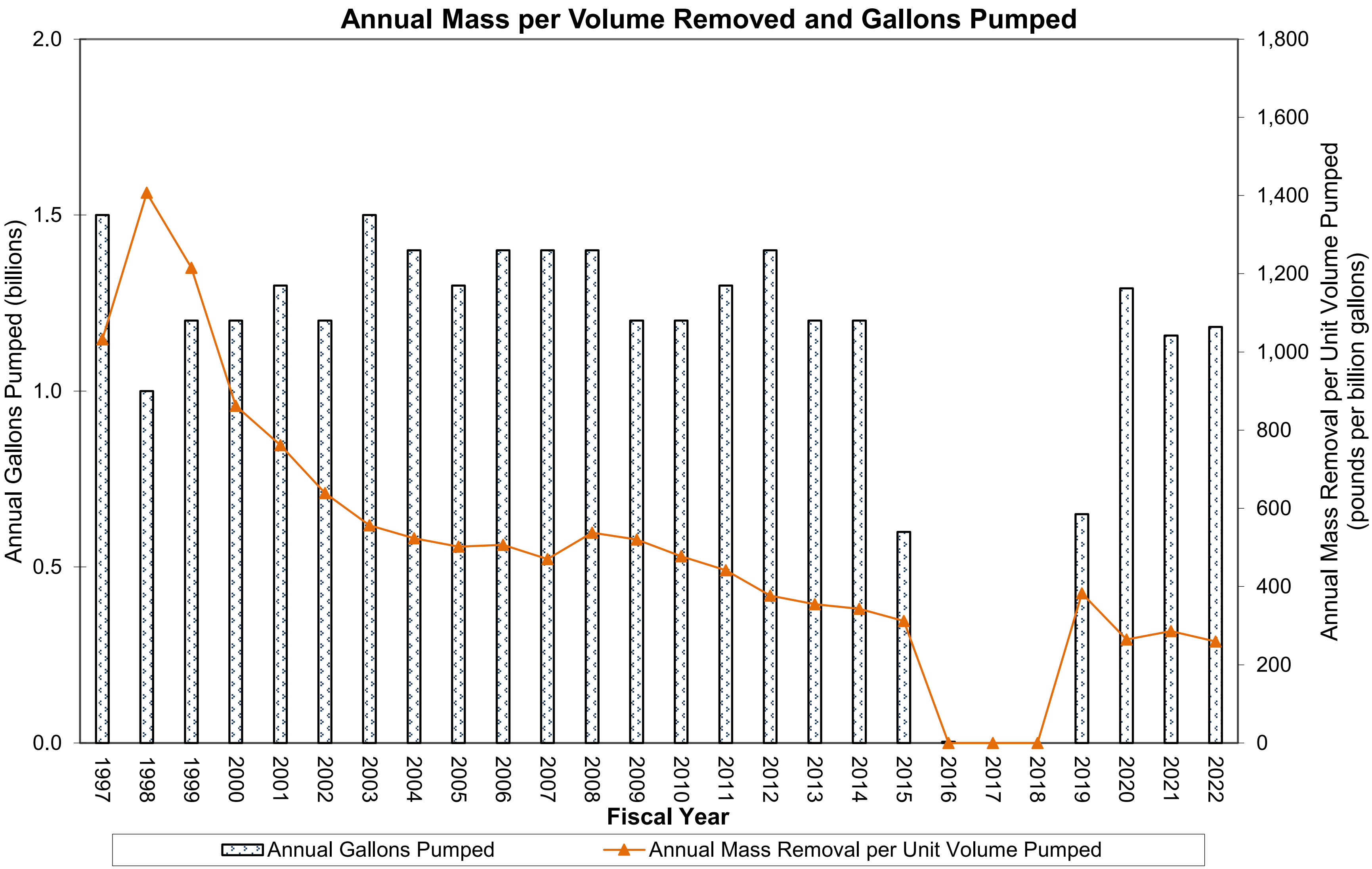
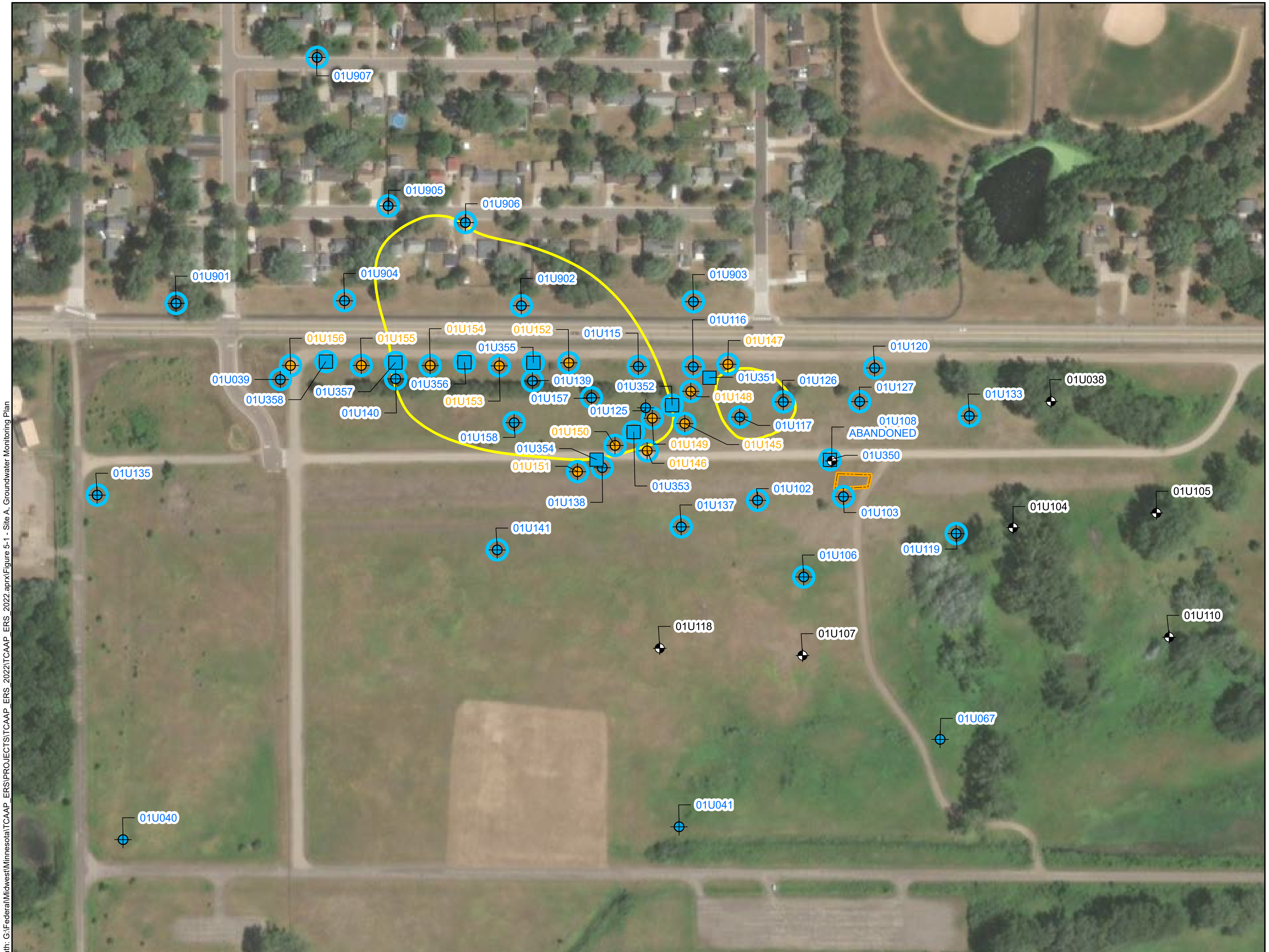
Figure 2-10
Annual Performance Report
OU1 and OU3, Upper Unit 4
Potentiometric Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

FIGURE 2-11
OU1, NBCGRS MASS REMOVAL HISTORY

FY 2022 Annual Performance Report





Legend

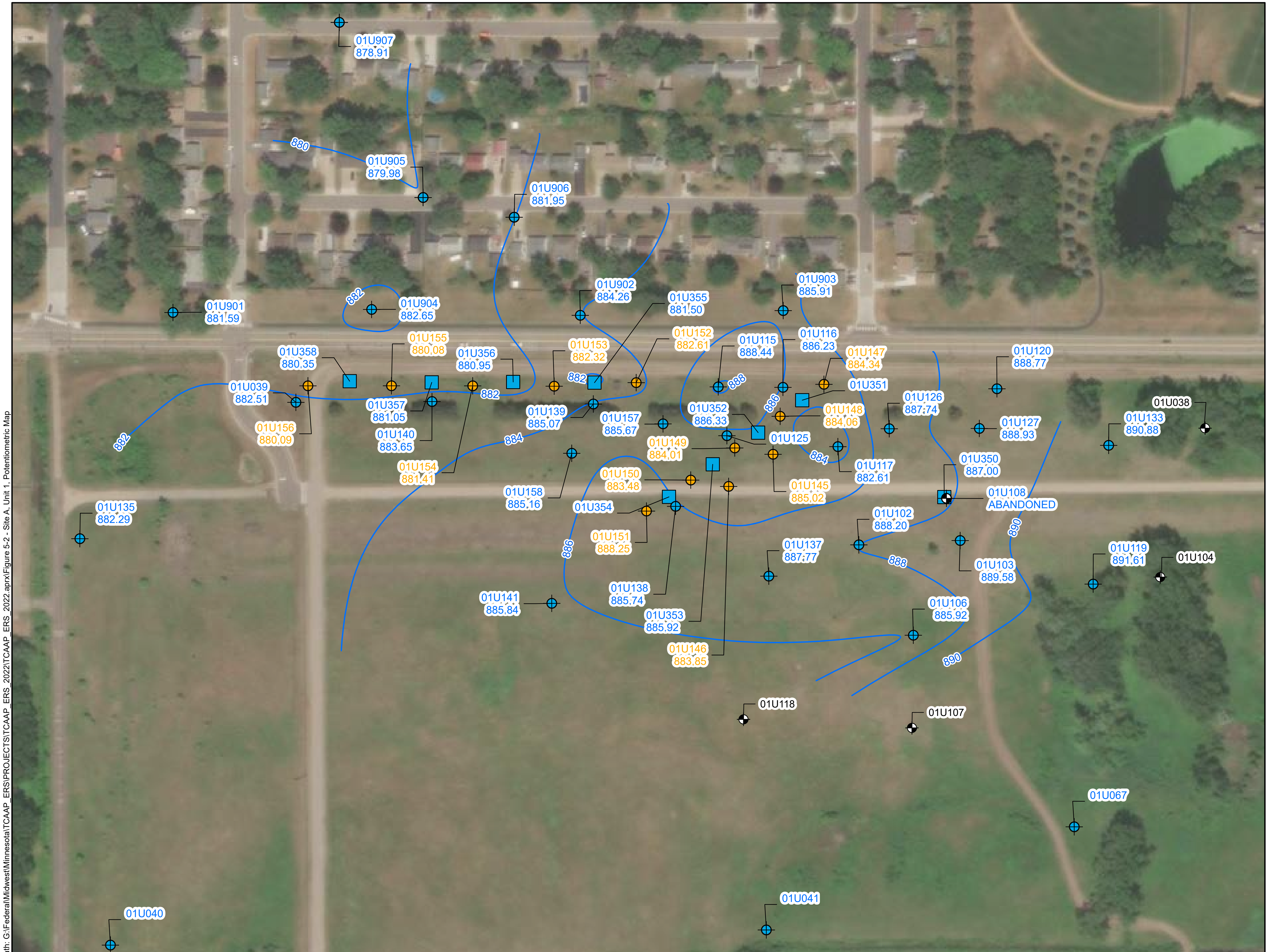
- Monitoring Well Location
- Piezometer Location
- Extraction Well Location
- Sealed Well Location
- Annual Water Quality
- 1 µg/L cis-1,2-Dichloroethene Contour (2022)
- 1945 Trench

Map Date: 2/20/2023
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-1
Site A, Groundwater Monitoring Plan
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx\Figure 5-1 - Site A, Groundwater Monitoring Plan



Legend

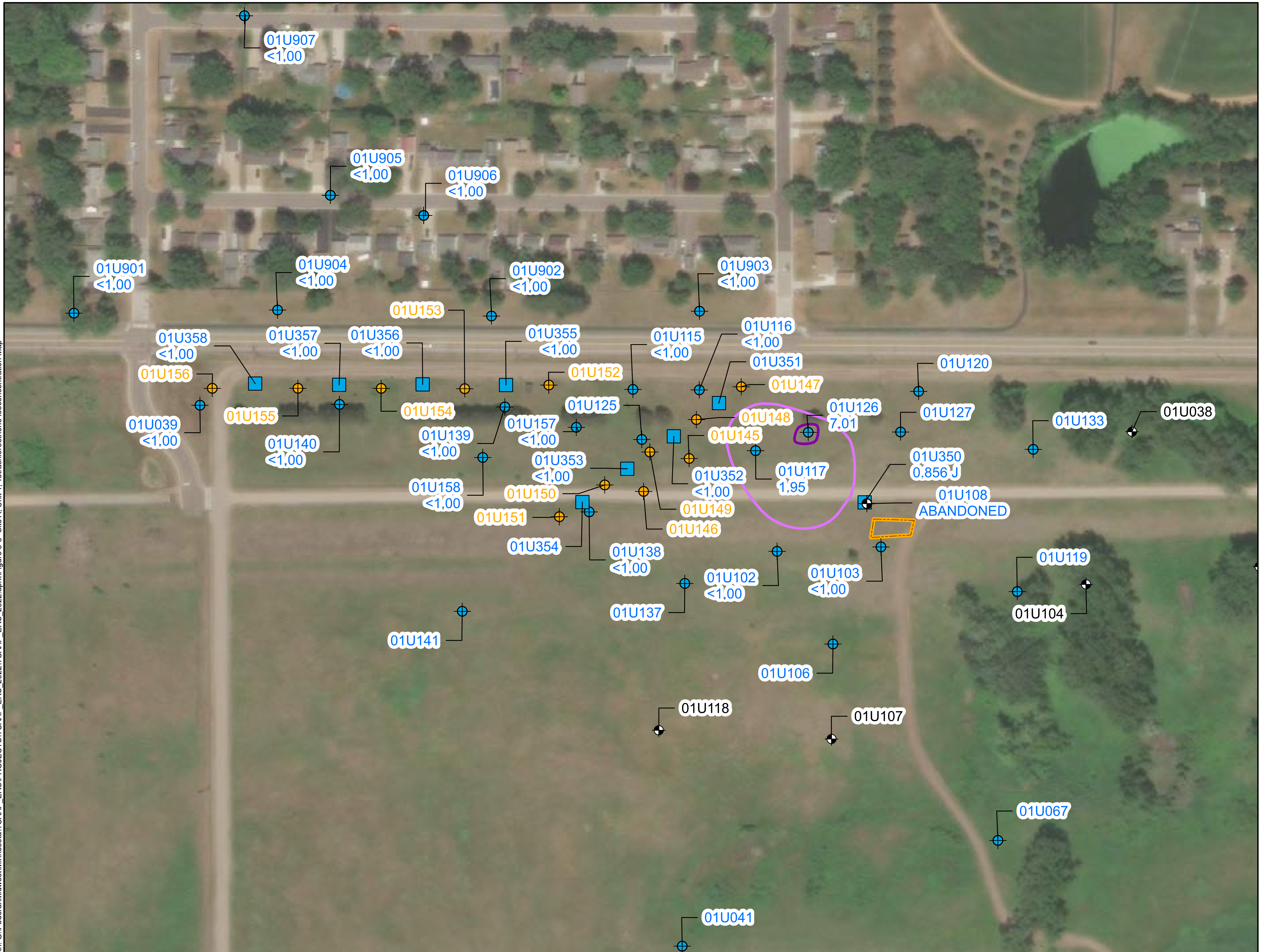
- Sealed Well Location
- Monitoring Well Location (01U127 / 888.93) Groundwater Elevation (ft amsl)
- Piezometer Location (01U145 / 885.33) Groundwater Elevation (ft amsl)
- Extraction Well Location (01U350 / 886.02) Groundwater Elevation (ft amsl)
- 2' Groundwater Contour - 2022

Map Date: 9/12/2023
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-2
Site A, Unit 1, Potentiometric Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx\Figure 5-2 - Site A, Unit 1, Potentiometric Map



Legend

01U126 / 7.01 — Tetrachloroethene Concentration (µg/L)

- Monitoring Well Location
- Piezometer Location
- Extraction Well Location
- Sealed Well Location
- 1945 Trench

Tetrachloroethene Concentrations 2022

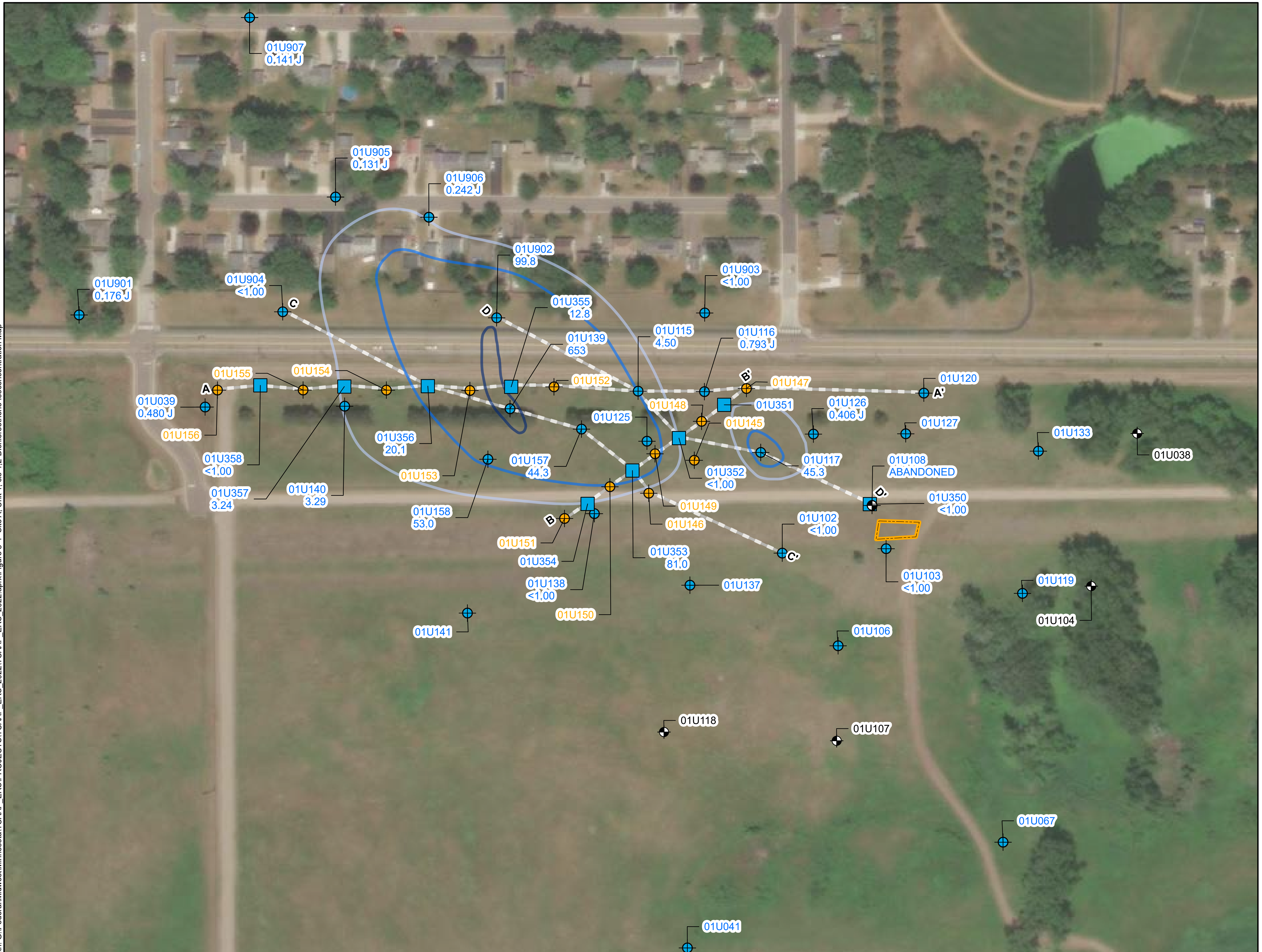
- 1 µg/L
- 5 µg/L

Map Date: 9/12/2023
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-3
Site A, Unit 1, Tetrachloroethene Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx\Figure 5-3 -Site A, Unit 1, Tetrachloroethene Isoconcentration Map



Legend

01U117 45.3 — cis-1,2-Dichloroethene Concentration (µg/L)

- Monitoring Well Location
- Piezometer Location
- Extraction Well Location
- Sealed Well Location
- 1945 Trench
- Cross Section

cis-1,2-Dichloroethene Concentrations - 2022

- 1 µg/L
- 10 µg/L
- 100 µg/L

Map Date: 9/12/2023
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-4
Site A, Unit 1, cis-1,2-Dichloroethene Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx\Figure 5-4 -Site A, Unit 1, cis-1,2-Dichloroethene Isoconcentration Map

Legend

- Monitoring Well Location
- Piezometer Location
- Extraction Well Location
- Sealed Well Location
- 1945 Trench
- Cross Section

cis-1,2-Dichloroethene Concentrations - 2021

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

cis-1,2-Dichloroethene Concentrations - 2022

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

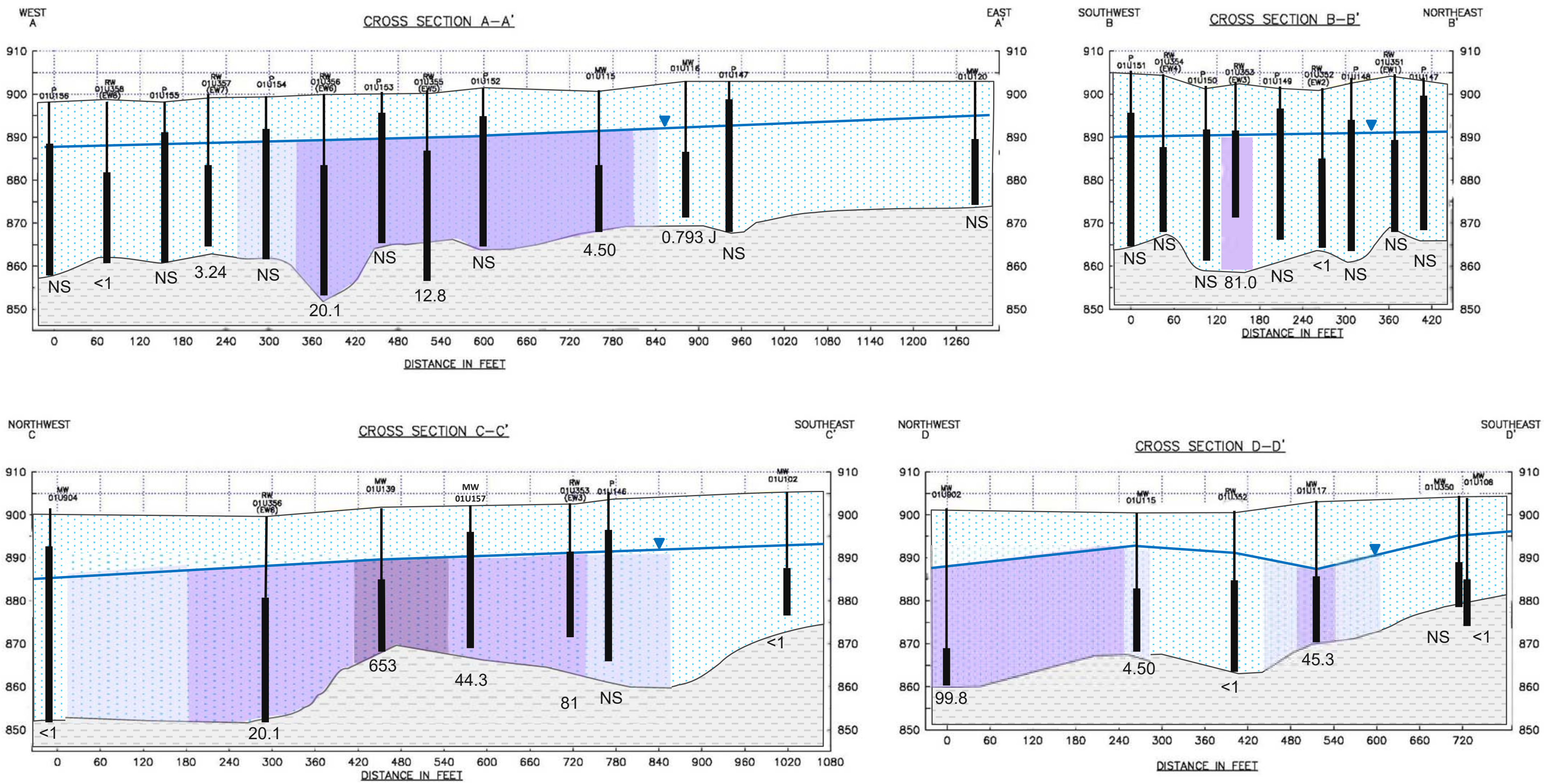
Map Date: 9/12/2023
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-5
Site A, Unit 1, cis-1,2-Dichloroethene Plume Comparison
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

FY 2022 Annual Performance Report
Figure 5-6
Site A *cis*-1,2-Dichloroethene Cross Sections A, B, C, and D

U.S Army - TCAAP
Arden Hills, Minnesota



Legend

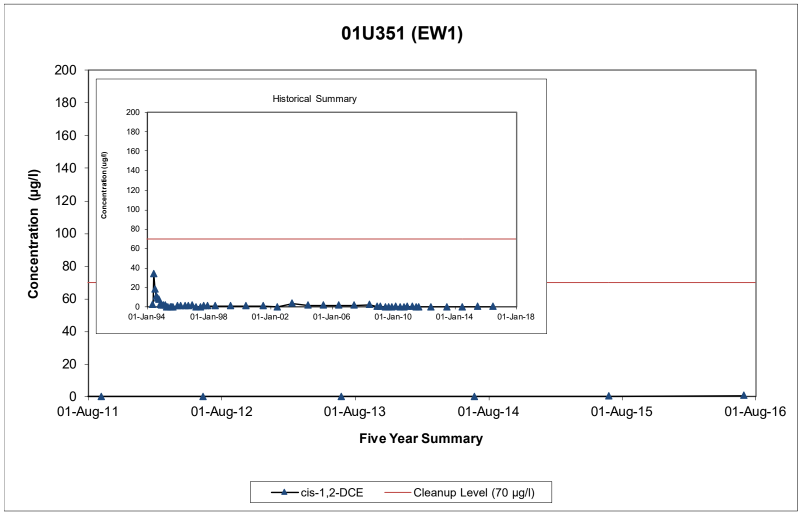
cis-1,2-Dichloroethene Plume Concentration (µg/L)

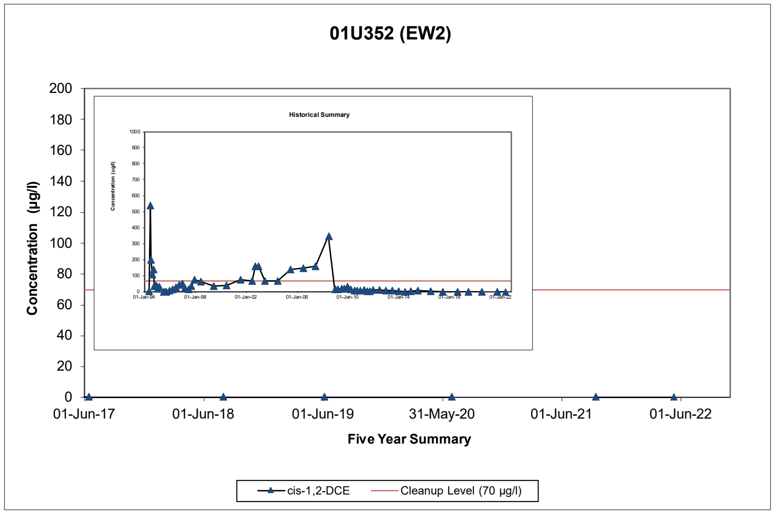
- 1-10
- 10-100
- > 100

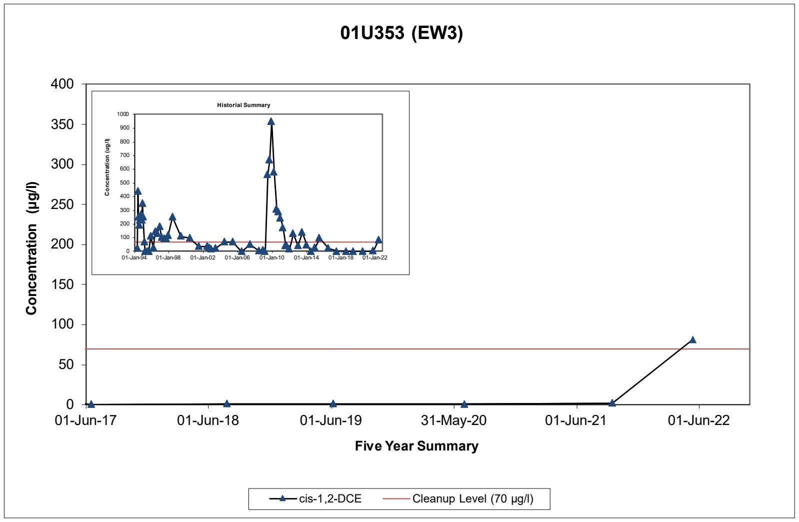
J Reported value is between the method detection limit and reporting limit
µg/L Micrograms per Liter
24 *cis*-1,2-Dichloroethene Concentration (µg/L) – May 2022
Water Table
Screened Interval

Figure 5-7
Site A, *cis*-1,2-Dichloroethene Water Quality Trends: Extraction Wells 1 - 4

FY 2022 Annual Performance Report







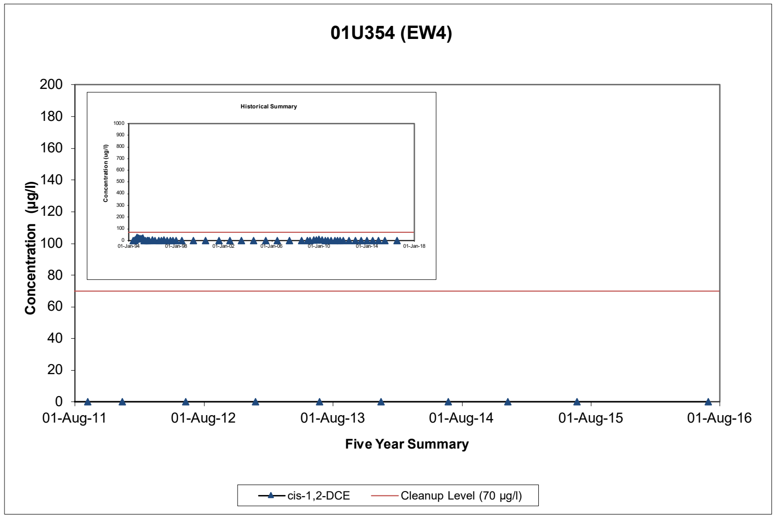
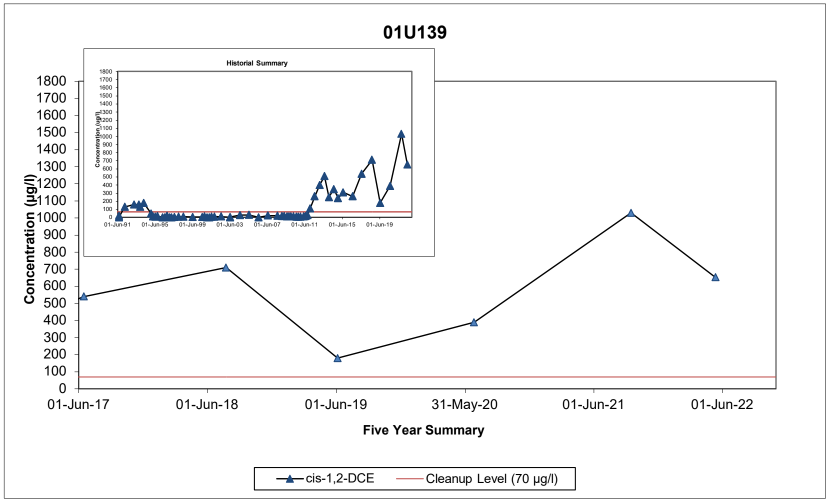
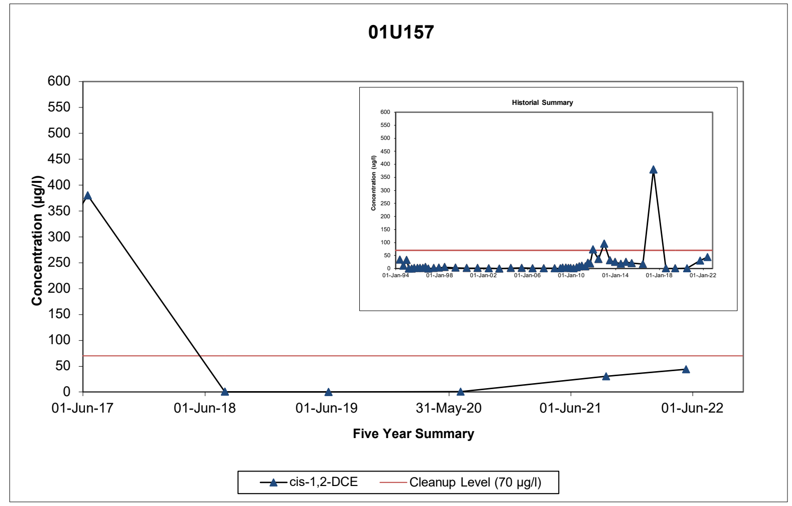
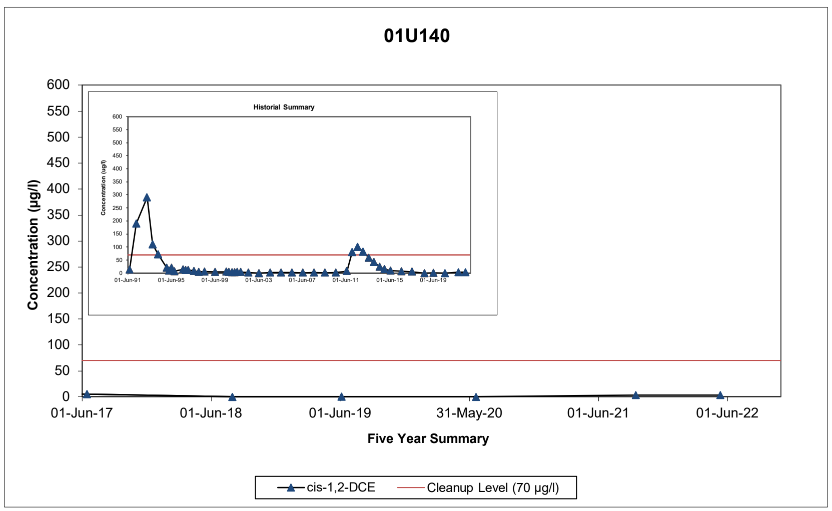


Figure 5-8
Site A, *cis*-1,2-Dichloroethene Water Quality Trends: Monitoring Wells

FY 2022 Annual Performance Report







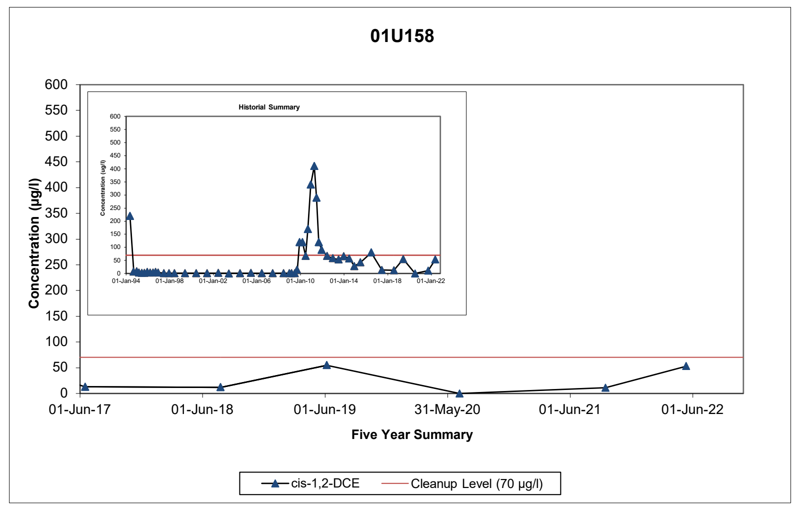
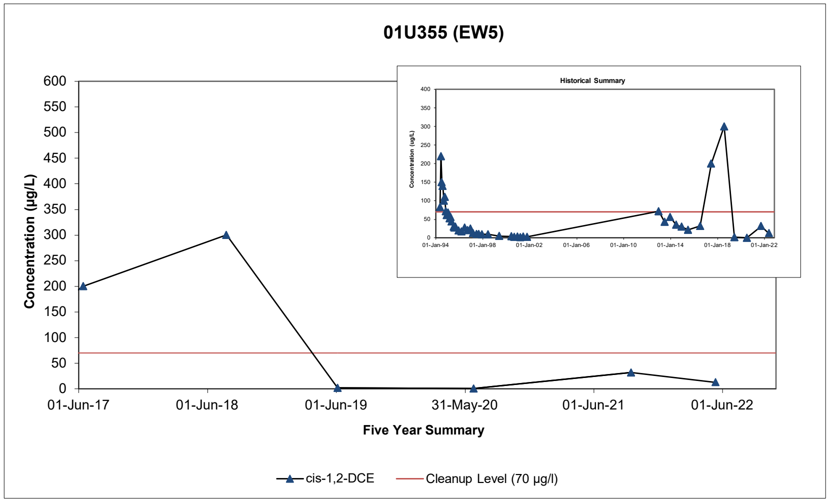
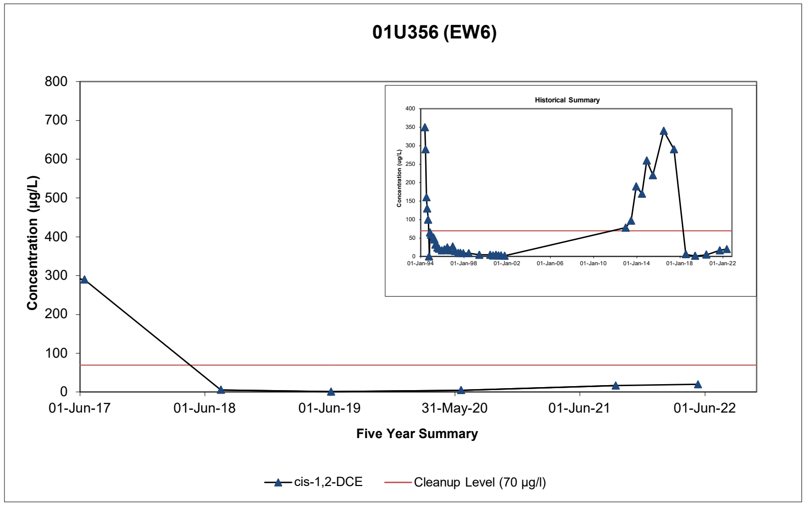
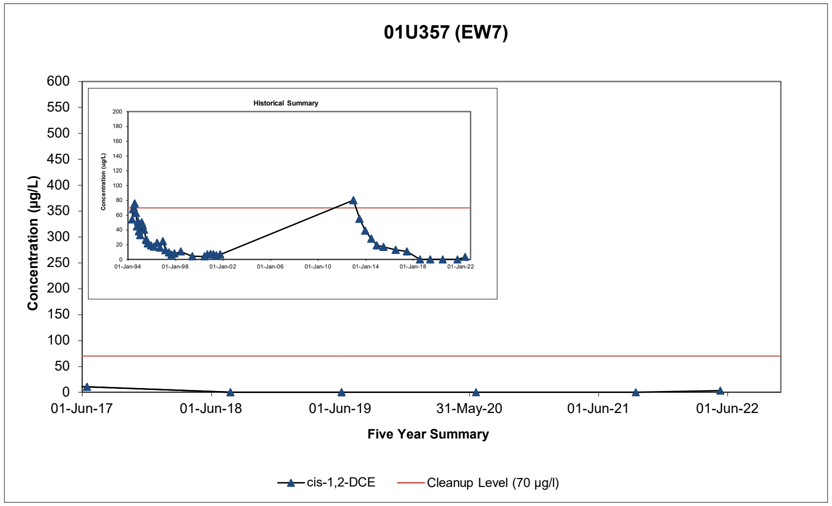


Figure 5-9
Site A, *cis*-1,2-Dichloroethene Water Quality Trends: Extraction Wells 5 - 8

FY 2022 Annual Performance Report







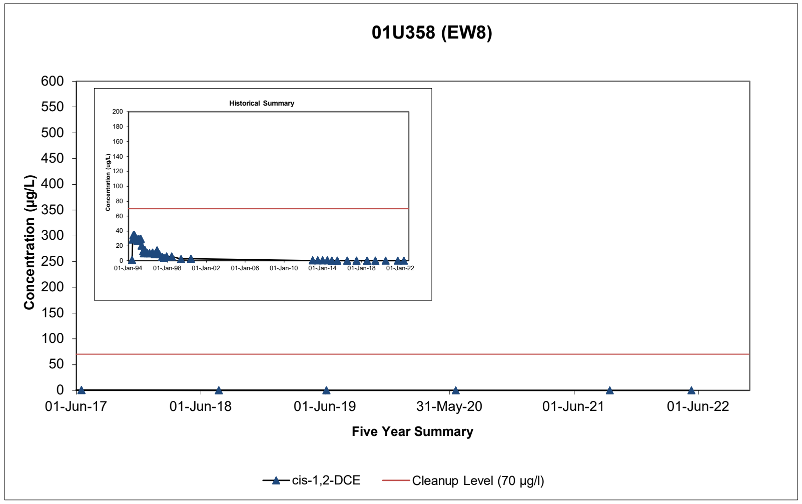
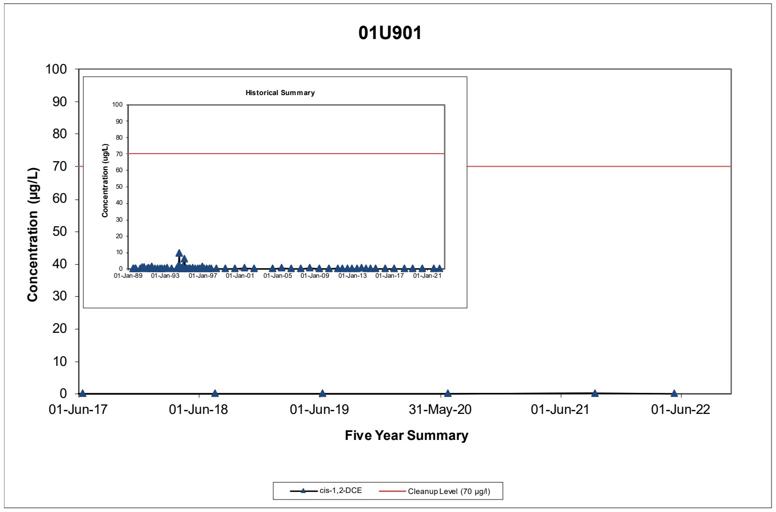
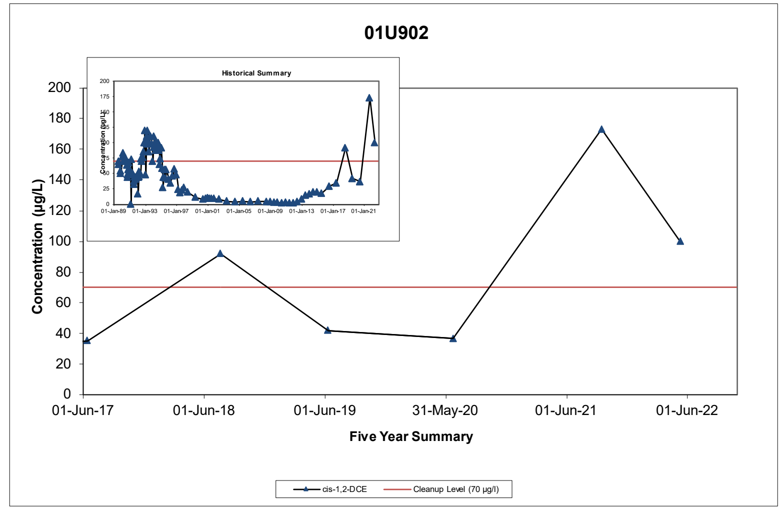
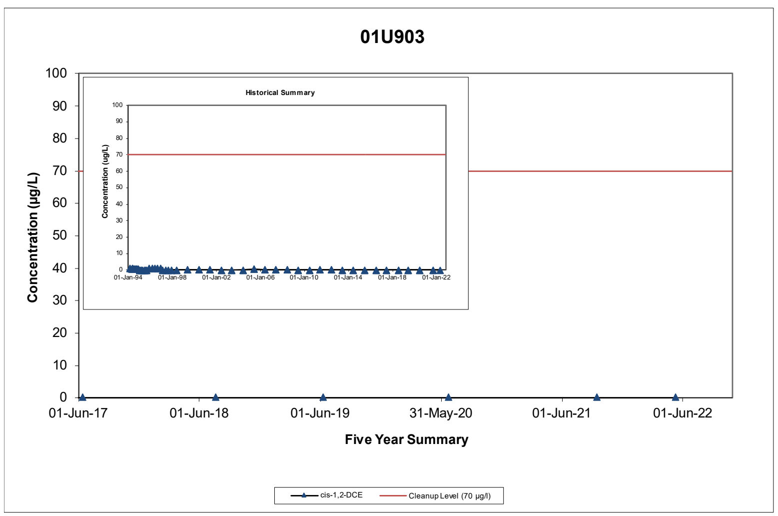


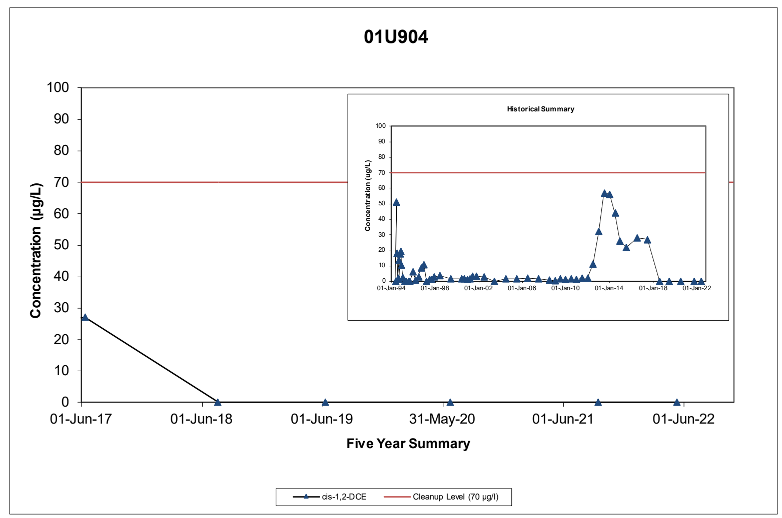
Figure 5-10
Site A, *cis*-1,2-Dichloroethene Water Quality Trends: Contingency Locations

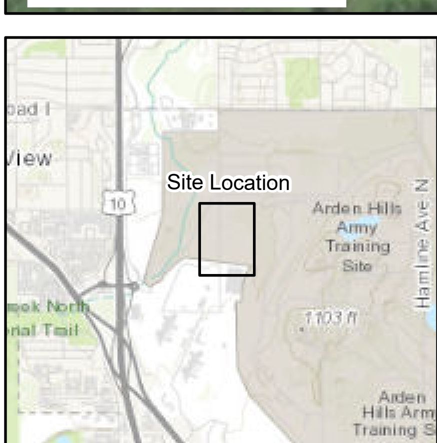
FY 2022 Annual Performance Report











Legend

- Monitoring Well Location
- Sealed Well Location
- Surface Water Sampling Locations
- Annual Monitoring Locations
- Ditch
- Location of Plot for Phytoremediation Demonstration
- Approximate Boundary of Wetland Constructed in 2007
- Cross Section
- 15 µg/L Lead Contour (May 2022)

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure 6-1
FY 2022 Annual Performance Report
Site C Monitoring Plan
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Legend

01U569 Sealed Well Location

01U561 889.38 Monitoring Well Groundwater Elevation

SW-6 Surface Water Sampling Locations

Ditch

Groundwater Elevation Contours (ft amsl)

Inferred Groundwater Elevation Contours

Location of Plot for Phytoremediation Demonstration

Approximate Boundary of Wetland Constructed in 2007

Cross Section

Figure 6-2
Site C, Unit 1, Potentiometric Map
Twin Cities
Army Ammunition Plant
Arden Hills, Minnesota

Date: 2/20/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Legend

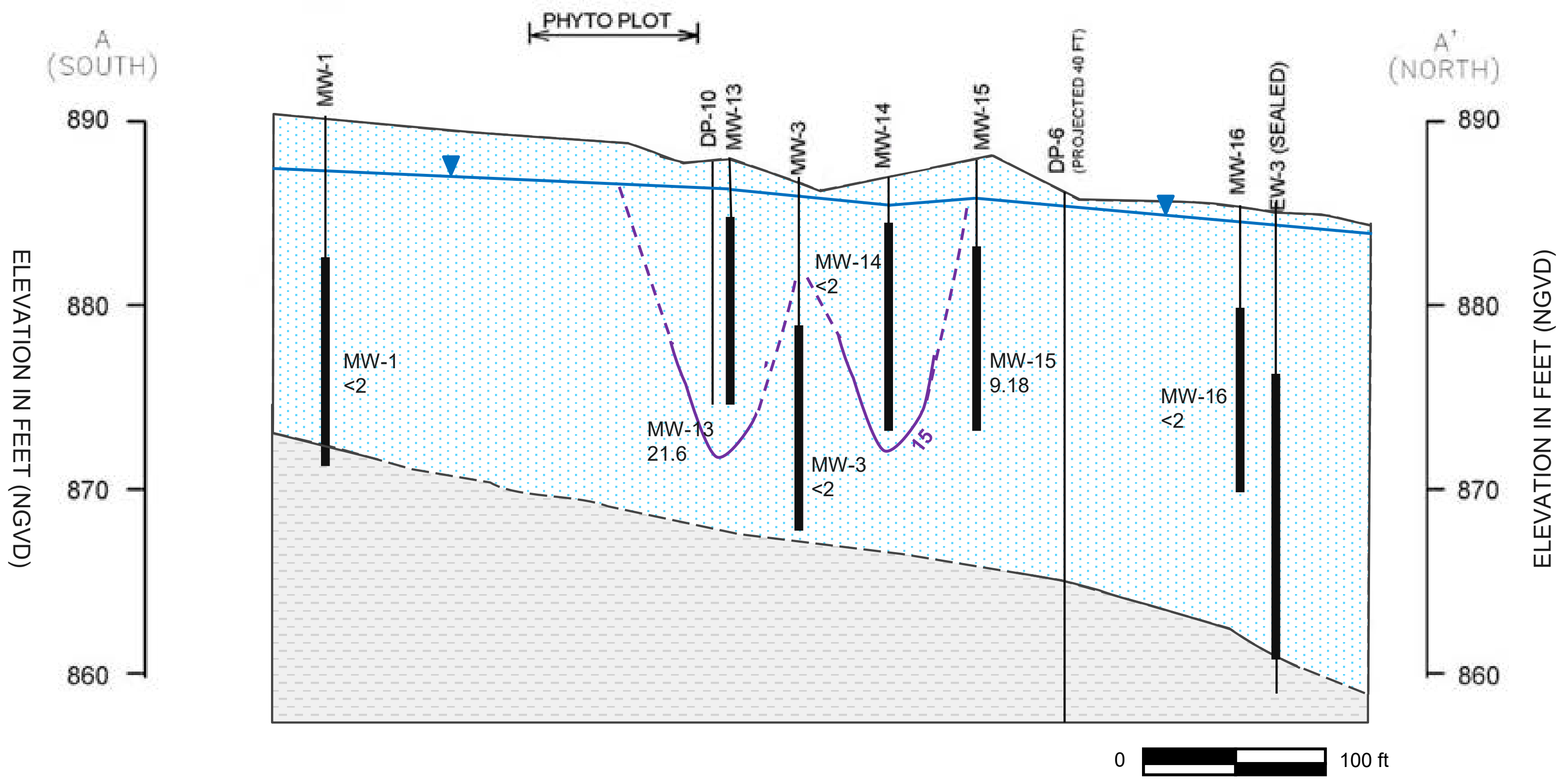
01U573 21.6	Monitoring Well Location
01U569	Sealed Well Location
SW-6	SurfaceWaterSamplingLocations
	Location of Plot for Phytoremediation Demonstration
	Approximate Boundary of Wetland Constructed in 2007
	Exceeds 15 µg/L (Groundwater Cleanup Level) (Values in parentheses were not used for contouring purposes)
	Cross Section
	Ditch

Figure 6-3
Site C, Unit 1,
Lead Results
Twin Cities
Army Ammunition Plant
Arden Hills, Minnesota

Date: 9/12/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

FY 2022 Annual Performance Report
Figure 6-4
Site C Cross Section A-A'

Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

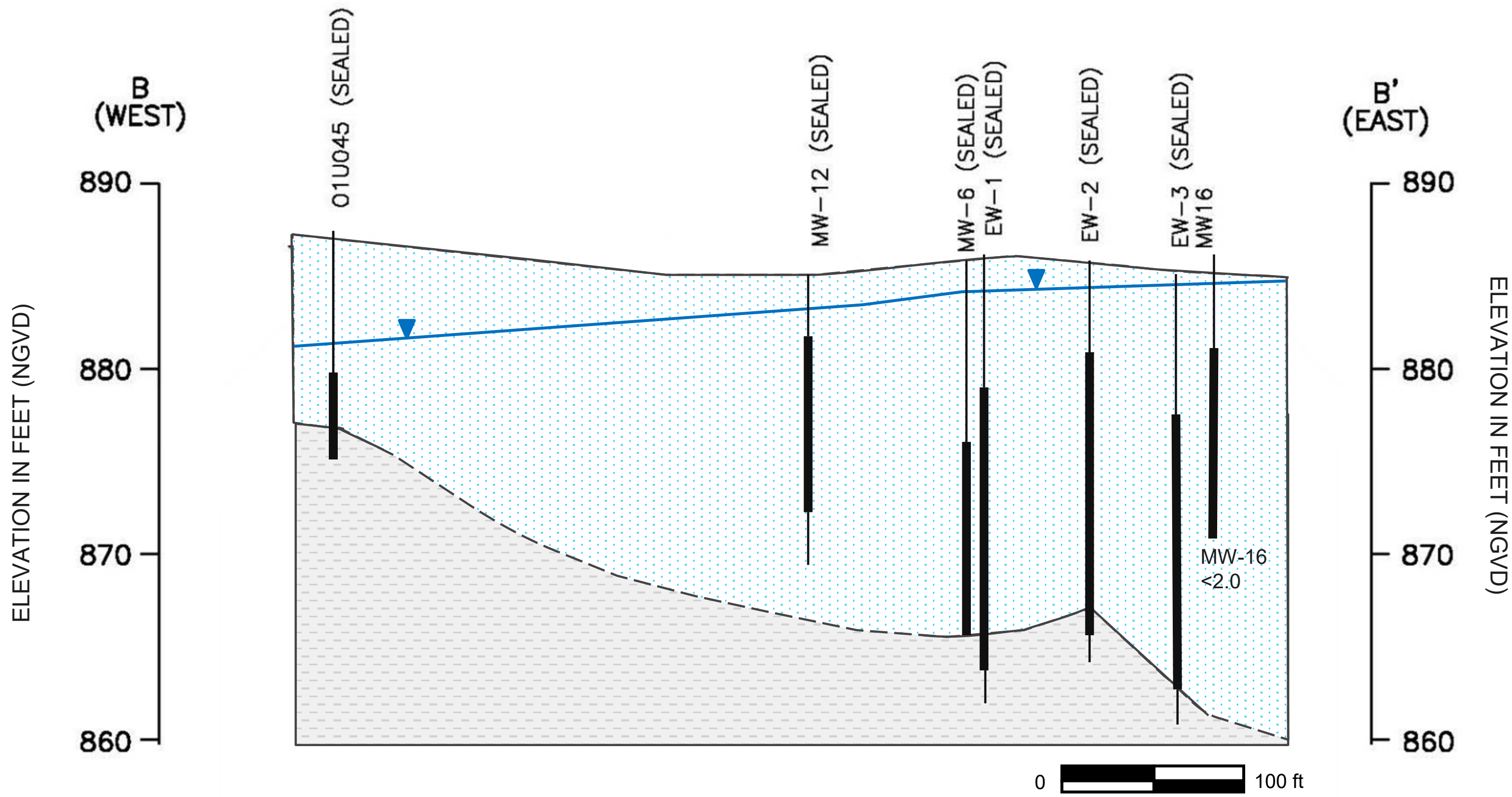


Legend

	Upper Unit 1	—	Geologic Contact (inferred where dashed)	—	15 µg/L Dissolved Lead Concentration Contour (Groundwater Cleanup Level) dashed where inferred
	Upper Unit 2				
—	Water Table	MW-3	Well ID	1.6	Dissolved Lead (µg/L) – May 2022
▌	Screened Interval	µg/L	Micrograms per Liter	NGVD	National Geodetic Vertical Datum

FY 2022 Annual Performance Report
Figure 6-5
Site C Cross Section B-B'

Twin Cities Army Ammunition Plant
Arden Hills, Minnesota



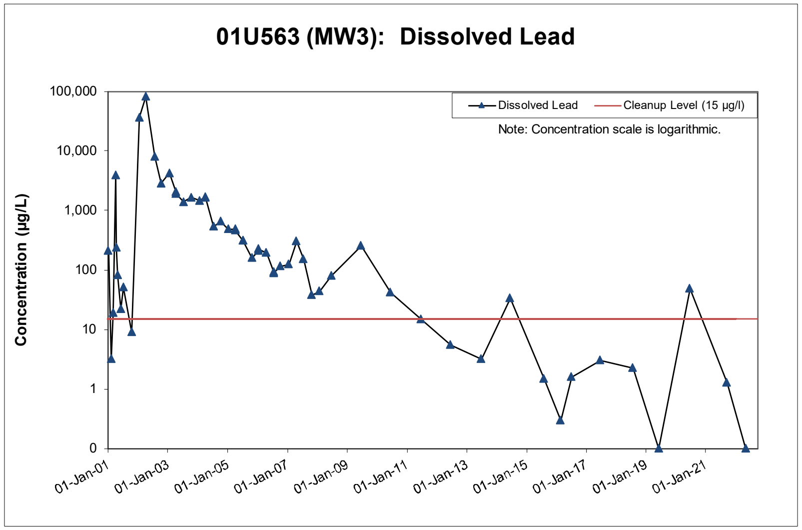
Legend

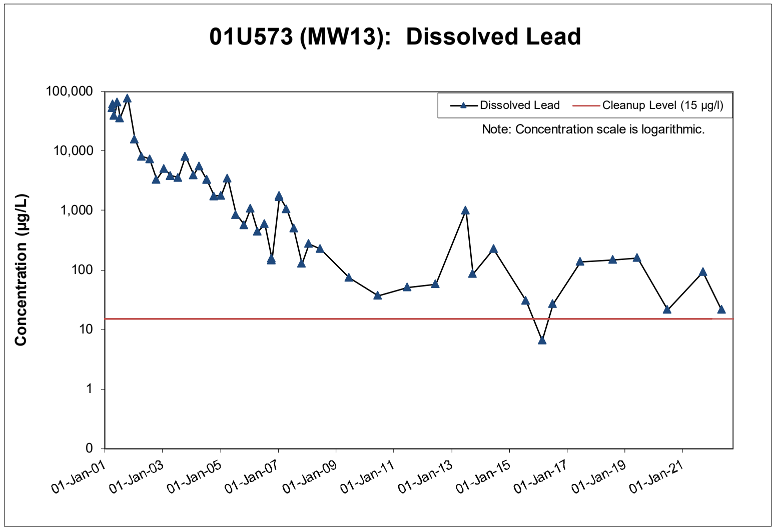
	Upper Unit 1		Geologic Contact (inferred where dashed)	0.30 U	Dissolved Lead (µg/L) – May 2022
	Upper Unit 2			NGVD	National Geodetic Vertical Datum
	Water Table	MW-6	Well ID		
	Screened Interval	µg/L	Micrograms per Liter		

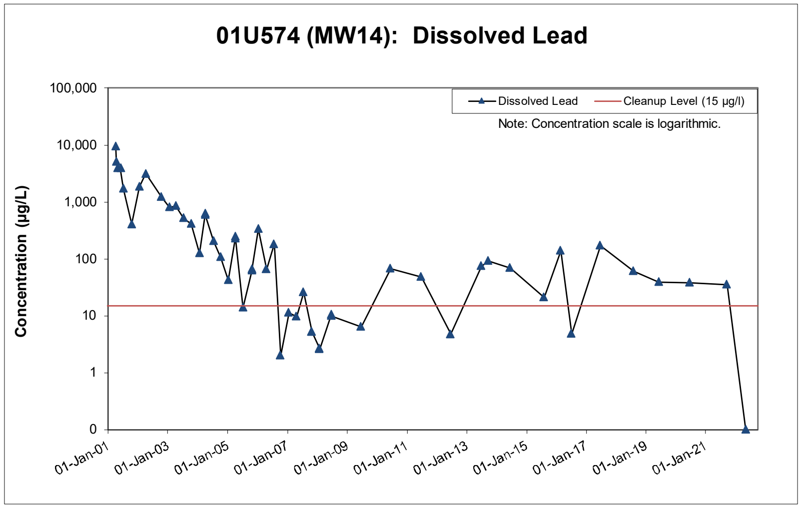
Figure 6-6

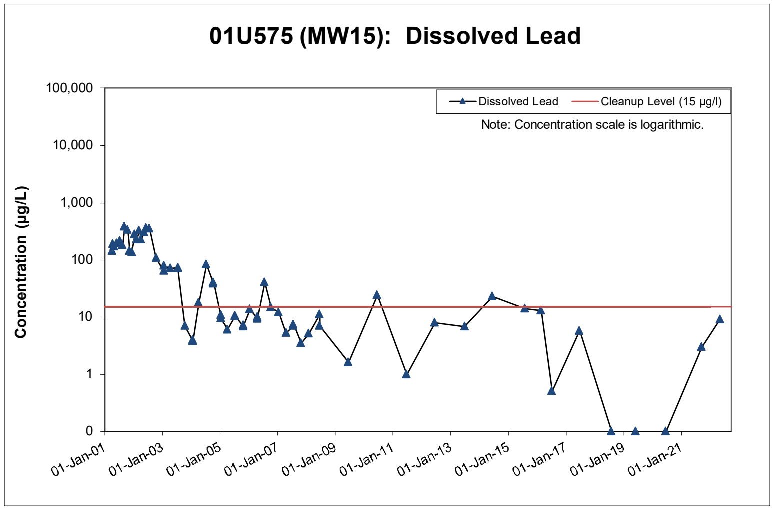
Dissolved Lead

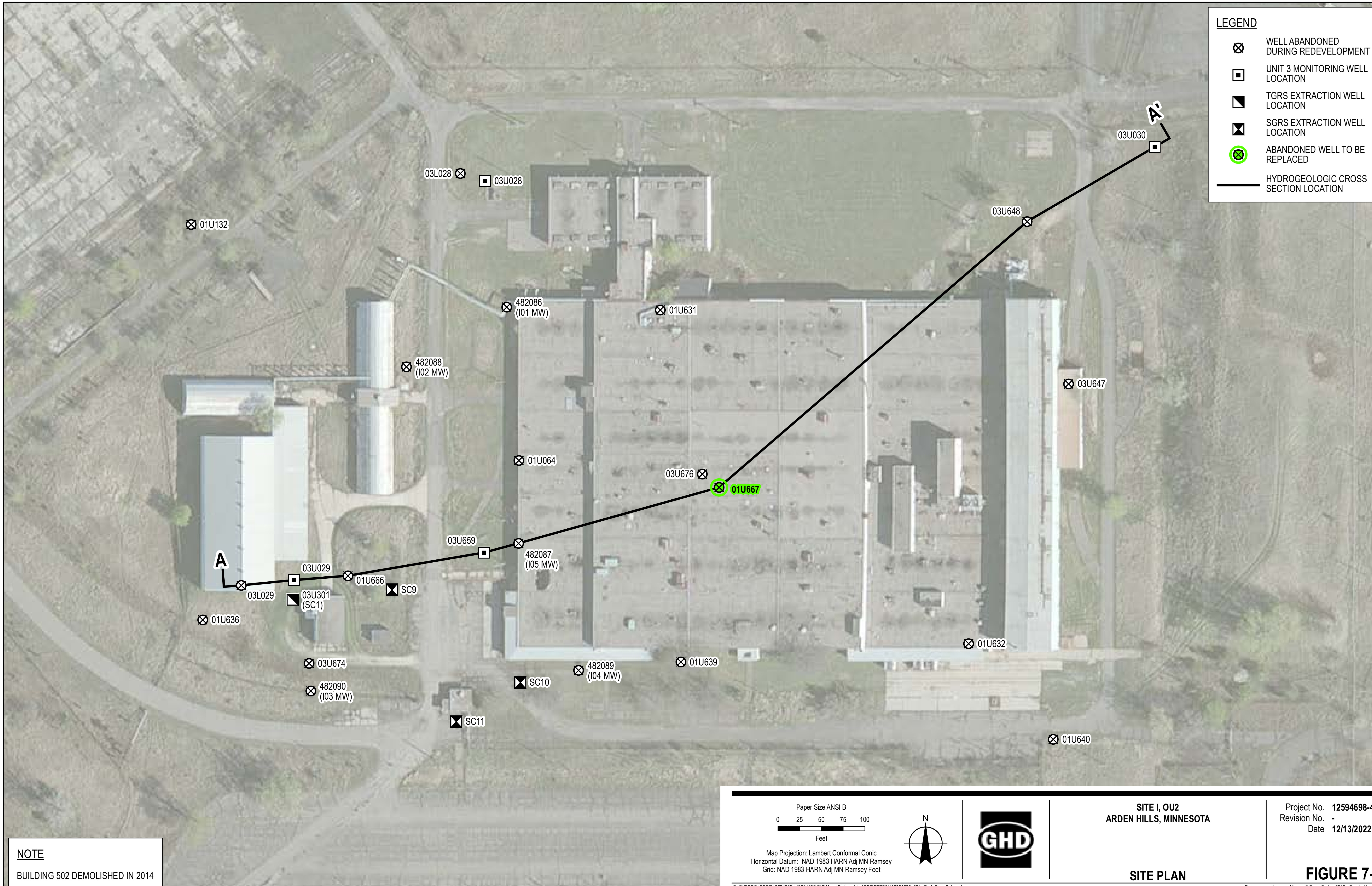
FY 2022 Annual Performance Report











SITE I, OU2
ARDEN HILLS, MINNESOTA

SITE PLAN

Project No. 12594698-43
Revision No. -
Date 12/13/2022

FIGURE 7-1

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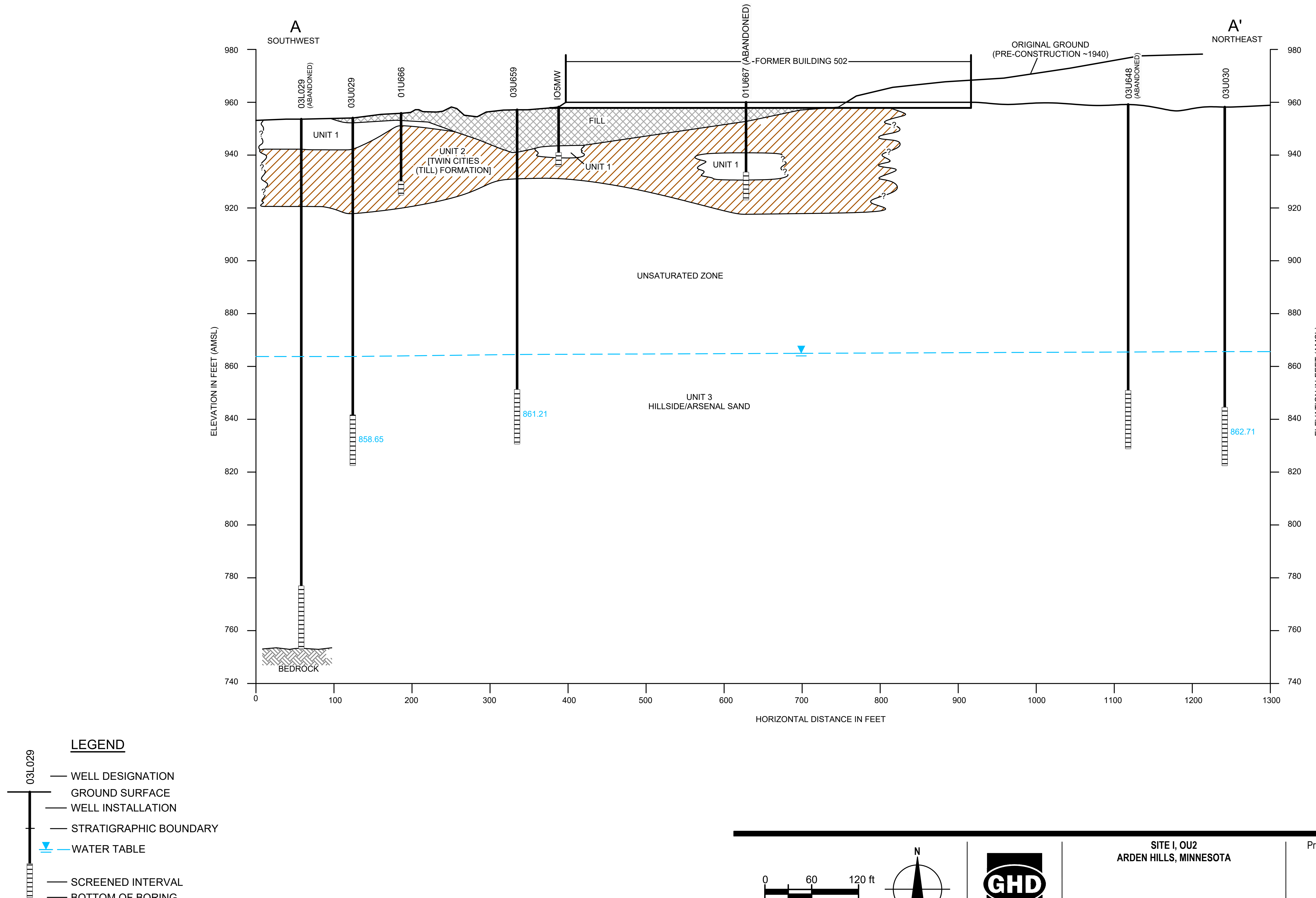

0 60 120 ft

N

GHD

SITE I, OU2
ARDEN HILLS, MINNESOTA

GEOLOGIC CROSS-SECTION A-A'

Project No. 12594698
Date December 2022

FIGURE 7-2

SOURCE: STANTEC, SITE I CROSS SECTION DWG FILE

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D101_WA-001.dwg
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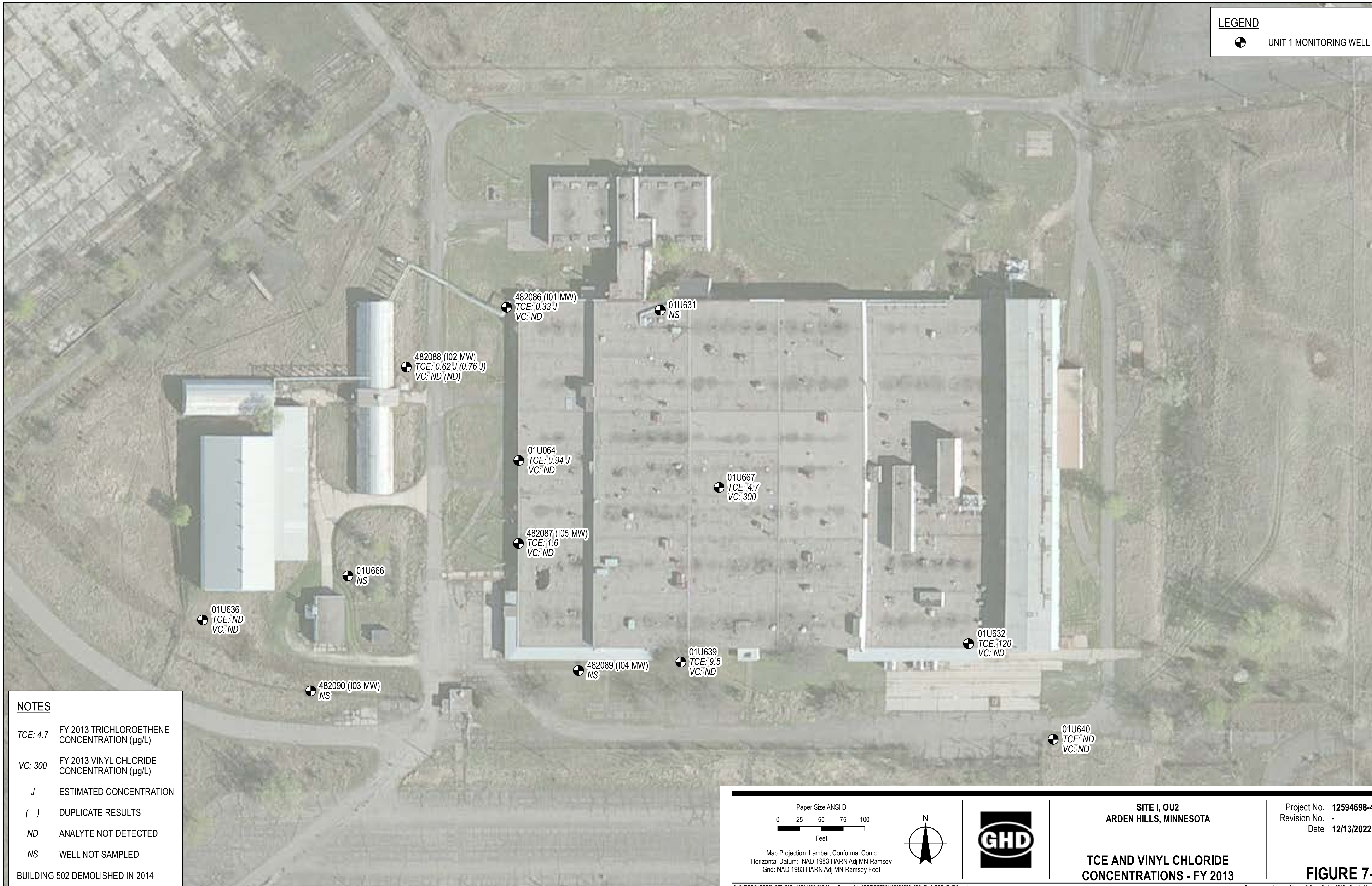

NOTES

TCE: 4.7	FY 2013 TRICHLOROETHENE CONCENTRATION (µg/L)
VC: 300	FY 2013 VINYL CHLORIDE CONCENTRATION (µg/L)
J	ESTIMATED CONCENTRATION
( )	DUPLICATE RESULTS
ND	ANALYTE NOT DETECTED
NS	WELL NOT SAMPLED

BUILDING 502 DEMOLISHED IN 2014

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet

GHD

SITE I, OU2
ARDEN HILLS, MINNESOTA

TCE AND VINYL CHLORIDE CONCENTRATIONS - FY 2013

Project No. **12594698-43**
Revision No. **-**
Date **12/13/2022**

FIGURE 7-3

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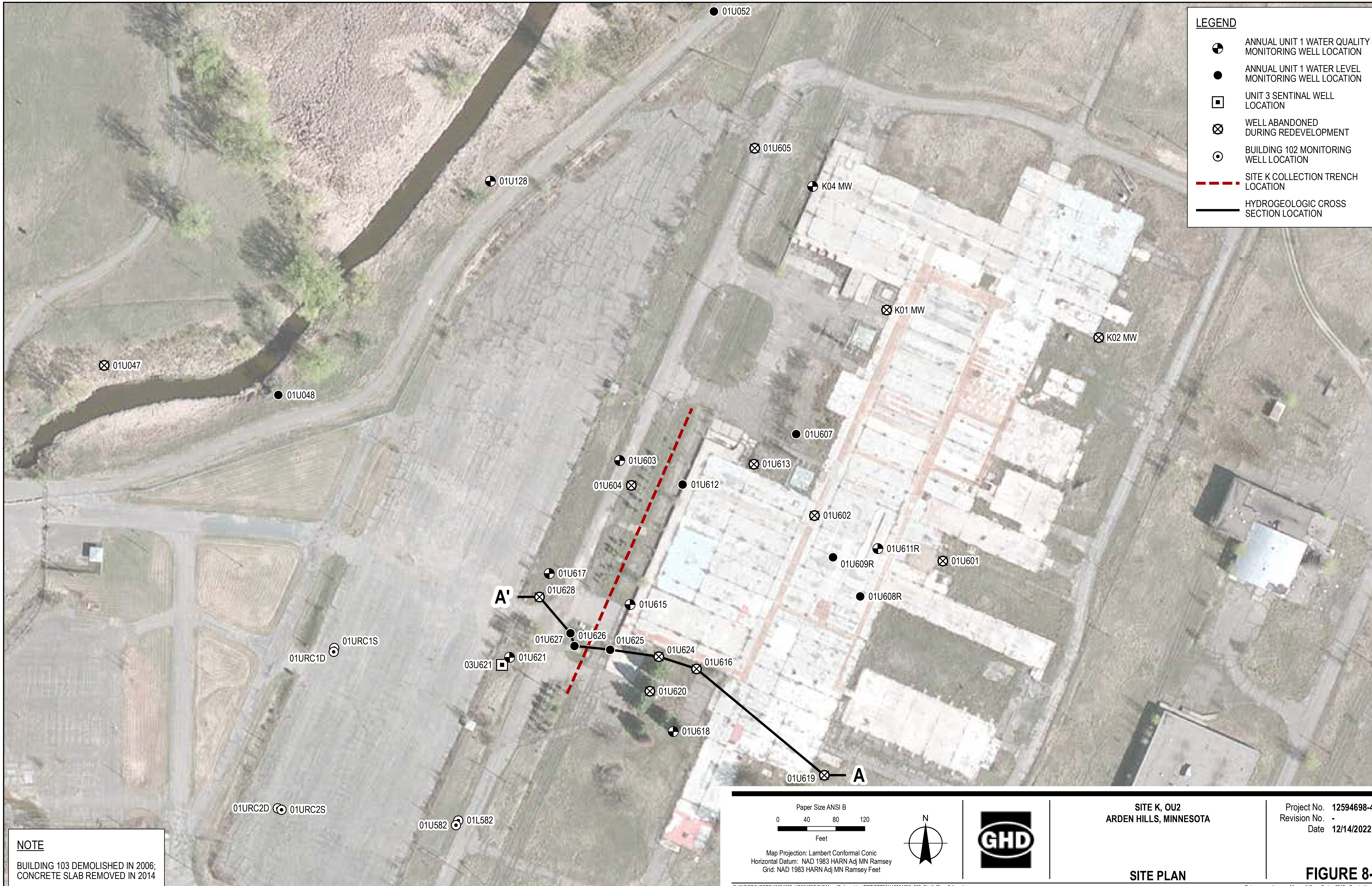

SITE K, OU2
ARDEN HILLS, MINNESOTA

SITE PLAN

FIGURE 8-1

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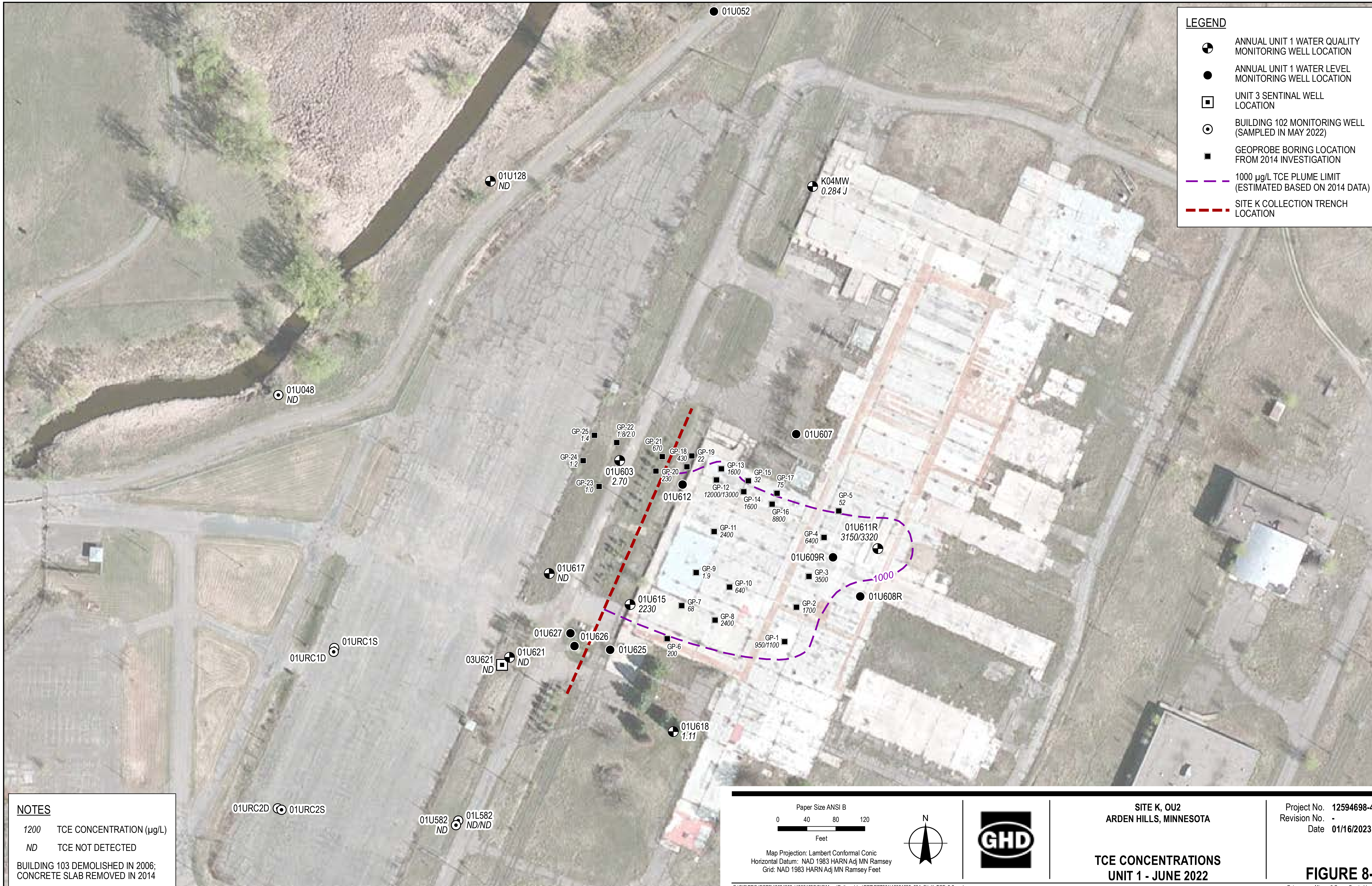

LEGEND

ANNUAL UNIT 1 WATER QUALITY MONITORING WELL LOCATION

ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION

UNIT 3 SENTINAL WELL LOCATION

BUILDING 102 MONITORING WELL (SAMPLED IN MAY 2022)

GEOPROBE BORING LOCATION FROM 2014 INVESTIGATION

1000 µg/L TCE PLUME LIMIT (ESTIMATED BASED ON 2014 DATA)

SITE K COLLECTION TRENCH LOCATION

NOTES

1200 TCE CONCENTRATION (µg/L)

ND TCE NOT DETECTED

BUILDING 103 DEMOLISHED IN 2006; CONCRETE SLAB REMOVED IN 2014

Paper Size ANSI B

0 40 80 120

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet

N

GHD

SITE K, OU2
ARDEN HILLS, MINNESOTA

TCE CONCENTRATIONS
UNIT 1 - JUNE 2022

Project No. 12594698-43
Revision No. -
Date 01/16/2023

FIGURE 8-2

Q:\GIS\PROJECTS\12594000s\12594698\GIS\Maps\Deliverables\RPT\RPT001\12594698_004_SiteK_TCE_8-2.mxd
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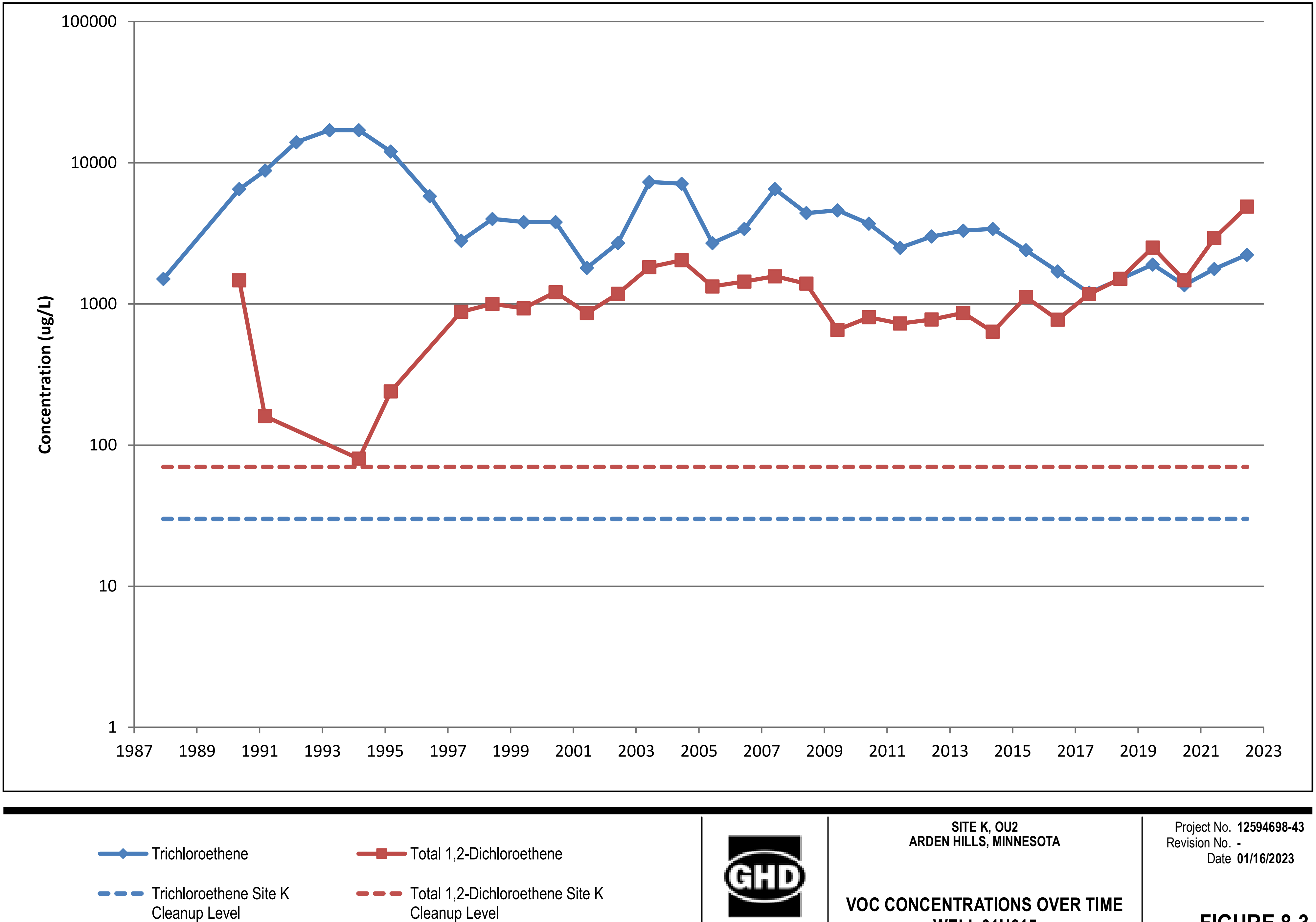

SITE K, OU2
ARDEN HILLS, MINNESOTA

VOC CONCENTRATIONS OVER TIME
WELL 01U615

Project No. 12594698-43
Revision No. -
Date 01/16/2023

FIGURE 8-3

Q:\GIS\PROJECTS\12594000s\12594698\GIS\Maps\Deliverables\RPT\RPT001\12594698_005_01U615_TCE_8-3.mxd
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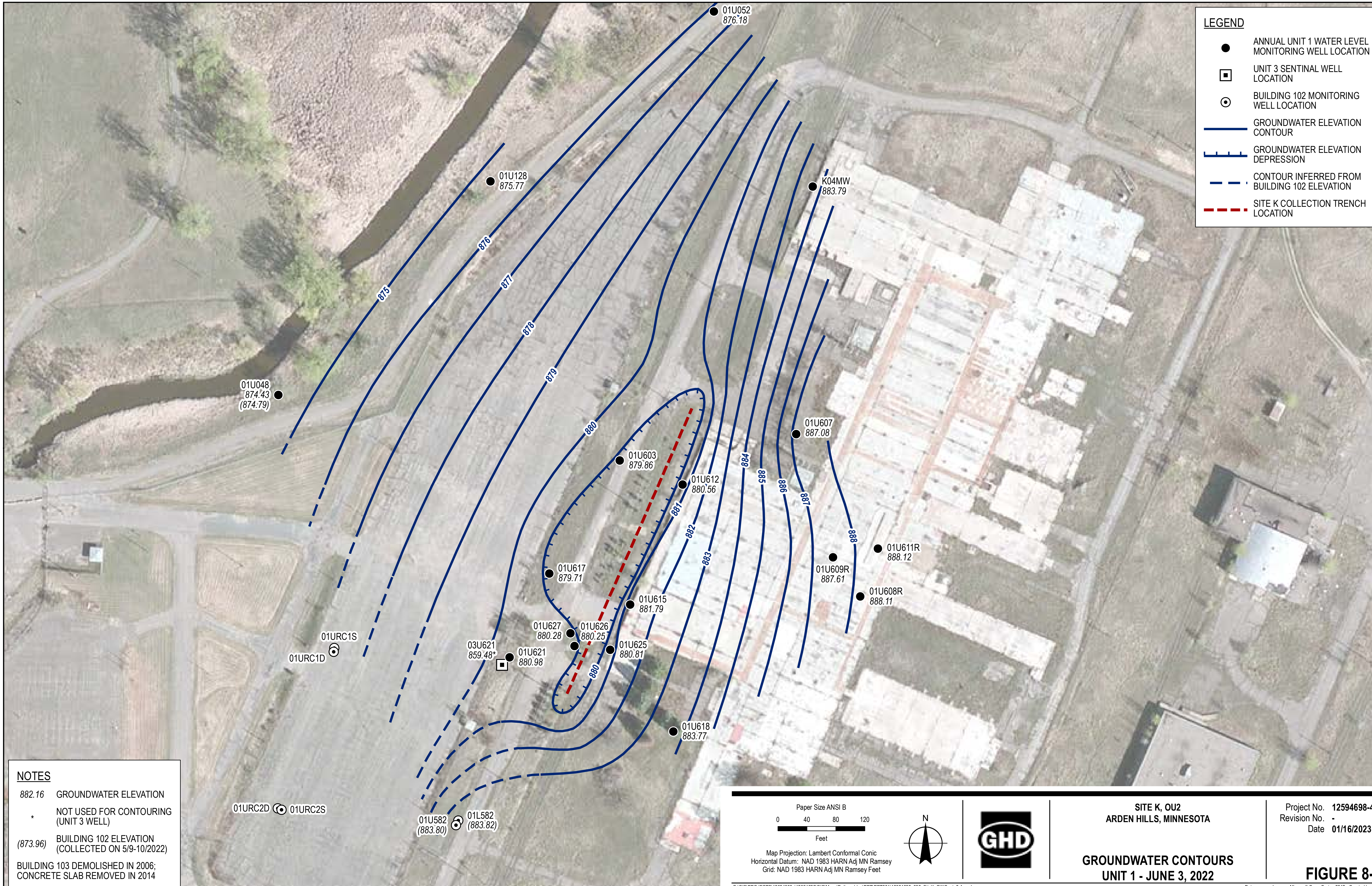

LEGEND

- ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION
- UNIT 3 SENTINAL WELL LOCATION
- BUILDING 102 MONITORING WELL LOCATION
- GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER ELEVATION DEPRESSION
- CONTOUR INFERRED FROM BUILDING 102 ELEVATION
- SITE K COLLECTION TRENCH LOCATION

NOTES

882.16	GROUNDWATER ELEVATION
*	NOT USED FOR CONTOURING (UNIT 3 WELL)
(873.96)	BUILDING 102 ELEVATION (COLLECTED ON 5/9-10/2022)

BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

Paper Size ANSI B

0 40 80 120
Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet

N

GHD

SITE K, OU2
ARDEN HILLS, MINNESOTA

GROUNDWATER CONTOURS
UNIT 1 - JUNE 3, 2022

Project No. 12594698-43
Revision No. -
Date 01/16/2023

FIGURE 8-4

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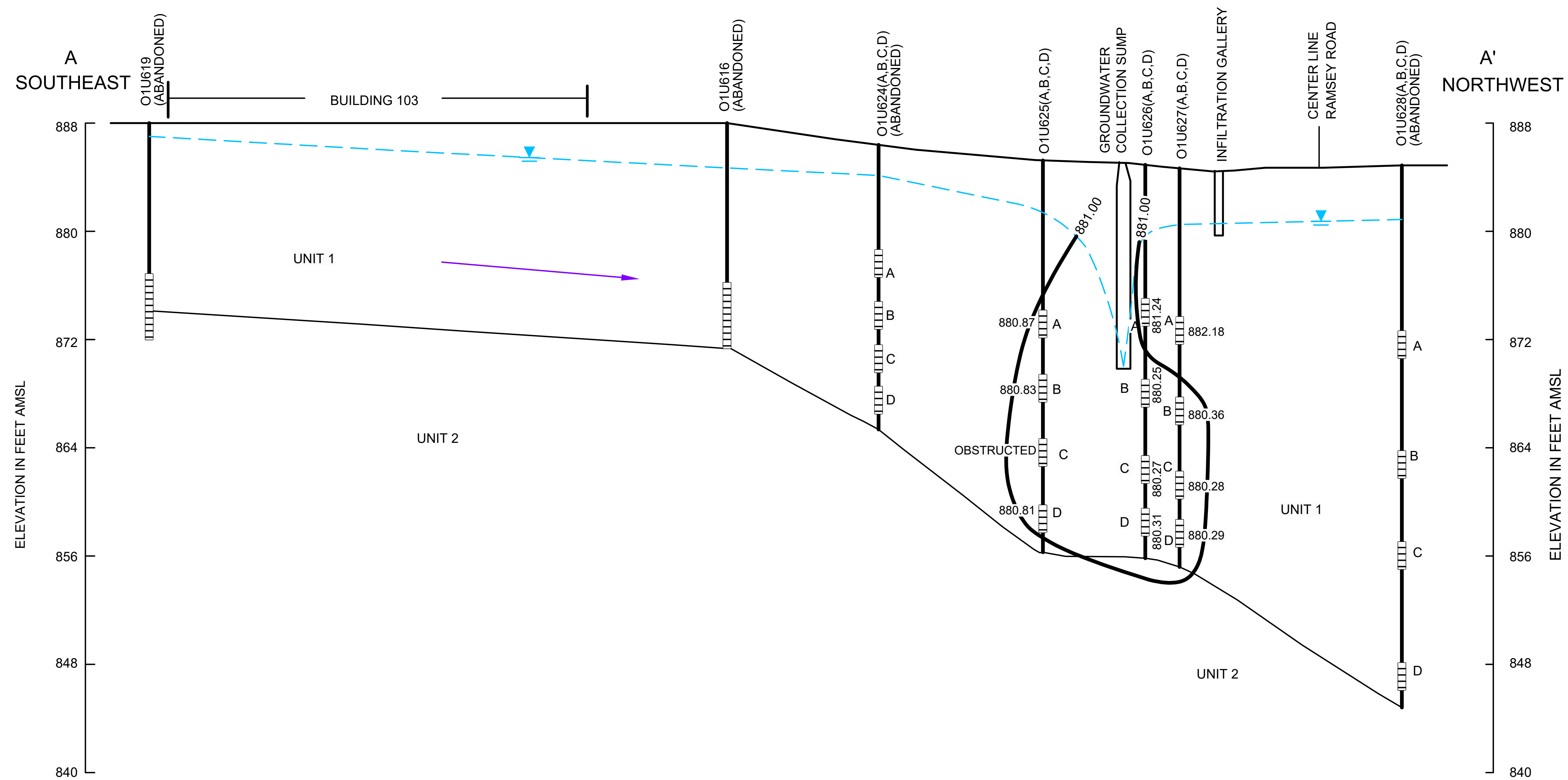

LEGEND

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

HORIZONTAL
1" = 10 ft
0 5 10Ft
0 5 10Ft
1" = 10 ft
VERTICAL

SITE K, OU2
ARDEN HILLS, MINNESOTA

Project No. 12594698
Date January 2023

HYDROGEOLOGIC CROSS-SECTION A-A'
JUNE 3, 2022

FIGURE 8-5

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D102_WA-001.dwg
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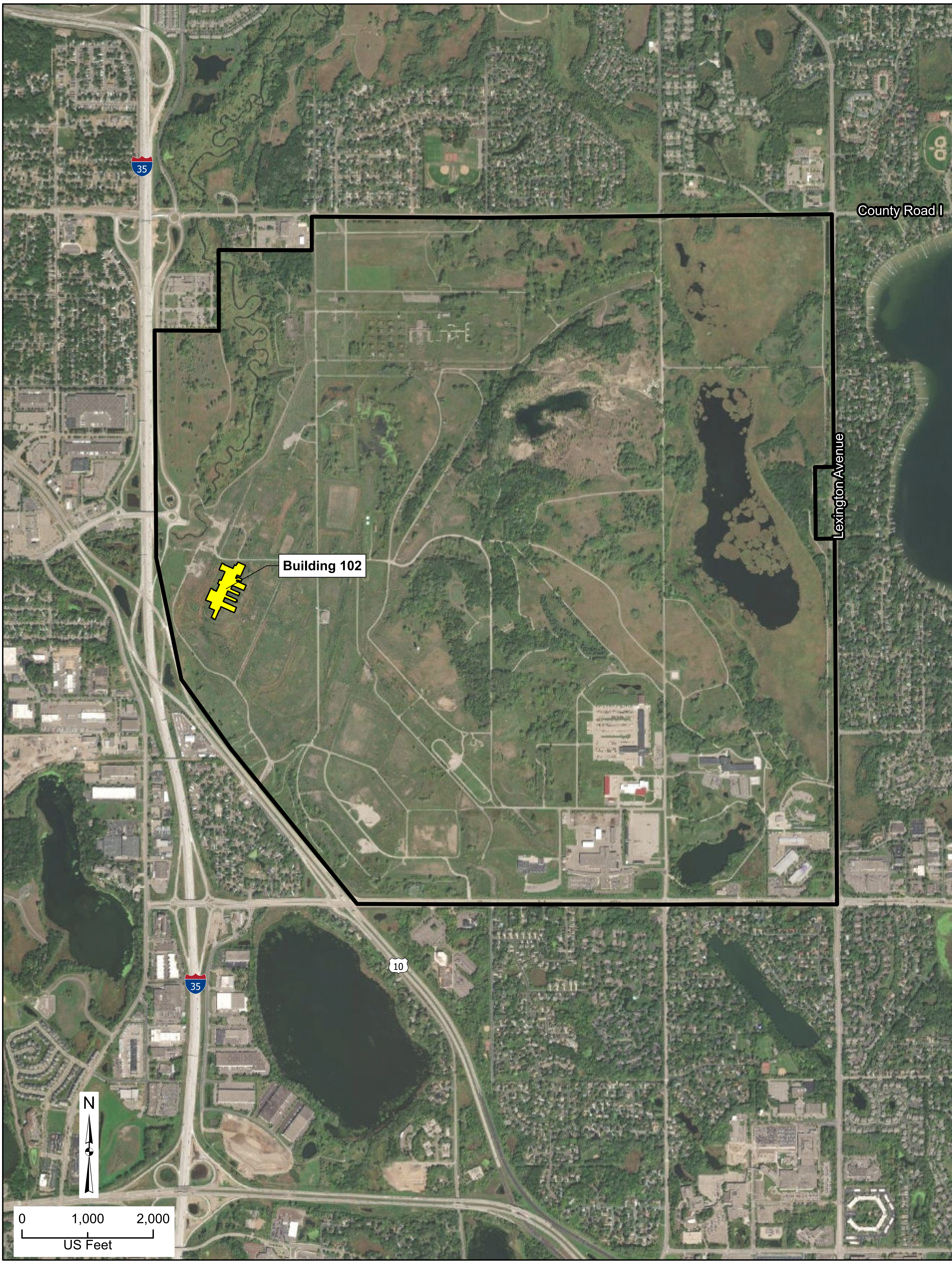
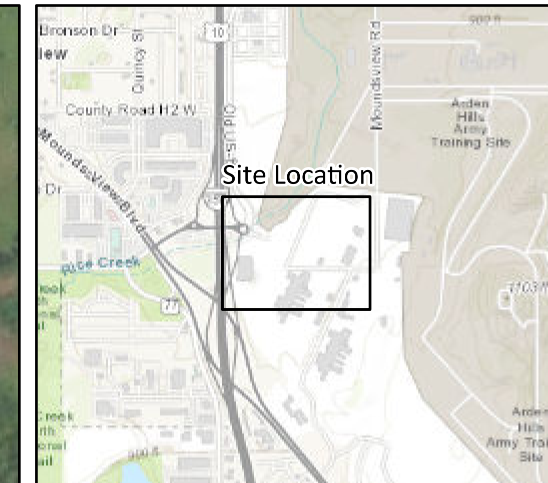


Legend

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.)

Figure 9-1
FY 2022 Annual Performance Report
Location of Building 102
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx



Legend

- 482084 Sealed Well Location
- 01U579 888.65 Monitoring Well Location
- May 2022 Groundwater Elevation Contour (ft amsl)
- Inferred Groundwater Elevation Contour
- Geologic Cross-Section Line
- Building 102

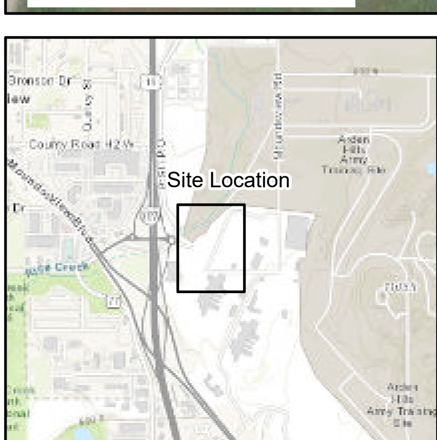
Note: Values in parentheses were not used for contouring.

Map Date: 1/24/2023
Source: ESRI, 2020
Projection: NAD 1983 UTM Zone 15

0 200 400
Feet

Figure 9-2
FY 2022 Annual Performance Report
Building 102, Unit 1,
Potentiometric Map
Twin City Army Ammunition Plant
Arden Hills, Minnesota

Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx\Figure 9-2 - Building 102, Unit 1, Potentiometric Map



Legend

Trichloroethene Concentration Contours (µg/L) - May 2022

01U580 191 Monitoring Well Location

01U578 Sealed Well Location

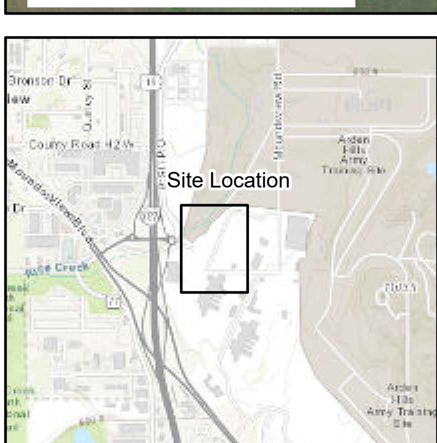
Building 102

Geologic Cross-Section Line

Note: Contour created using "01U" Locations

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure 9-3
FY 2022 Annual Performance Report
Building 102, Unit 1,
Trichloroethene Results
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota



Legend

cis-1,2-Dichloroethene Concentration Contours (µg/L) - May 2022

01U580 166 Monitoring Well Location

01U578 Sealed Well Location

Geologic Cross-Section Line

Building 102

Note: Contour created using "01U" Locations

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure 9-4
FY 2022 Annual Performance Report
Building 102, Unit 1,
***cis*-1,2-Dichloroethene Results**
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Legend

Vinyl Chloride Concentration Contours (µg/L) - May 2022

01U580 22.7 Monitoring Well Location

01U578 Sealed Well Location

Geologic Cross-Section Line

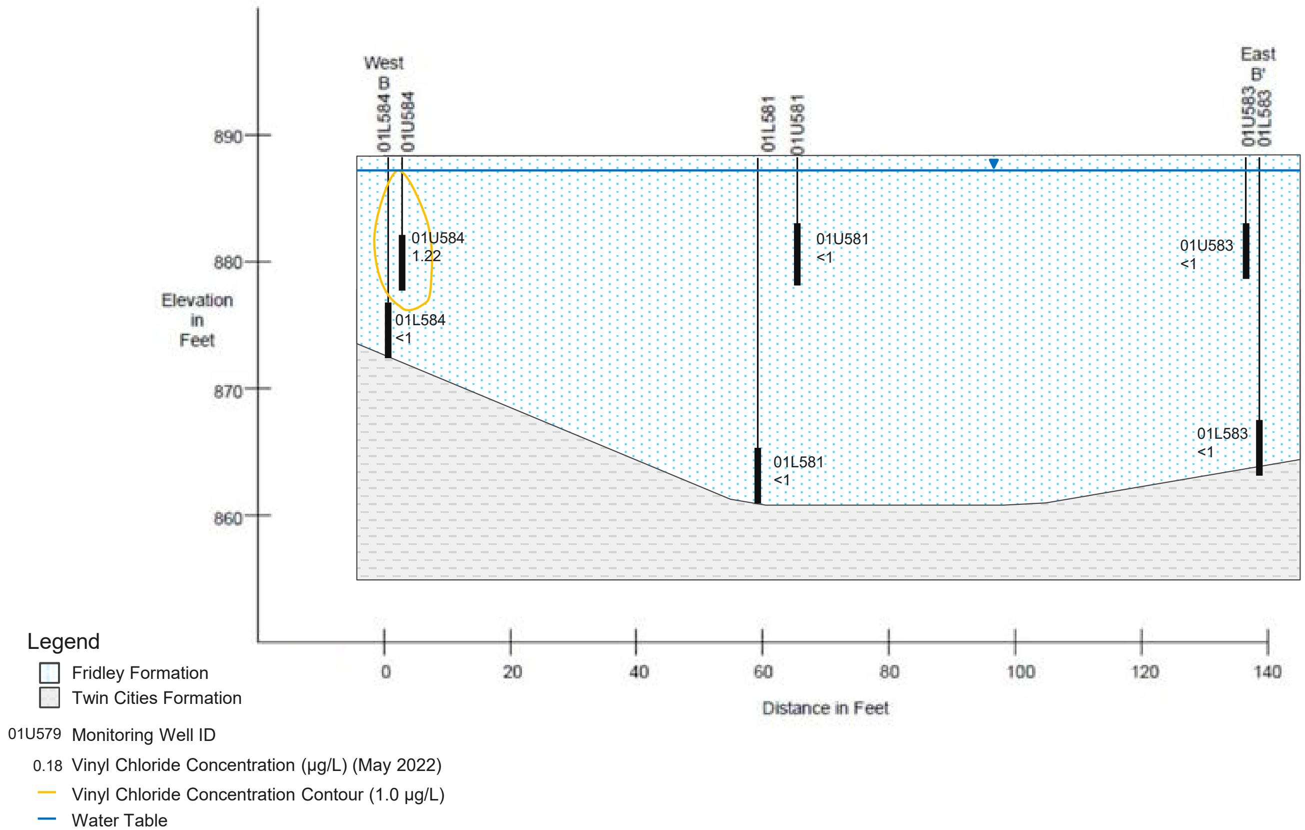
Building 102

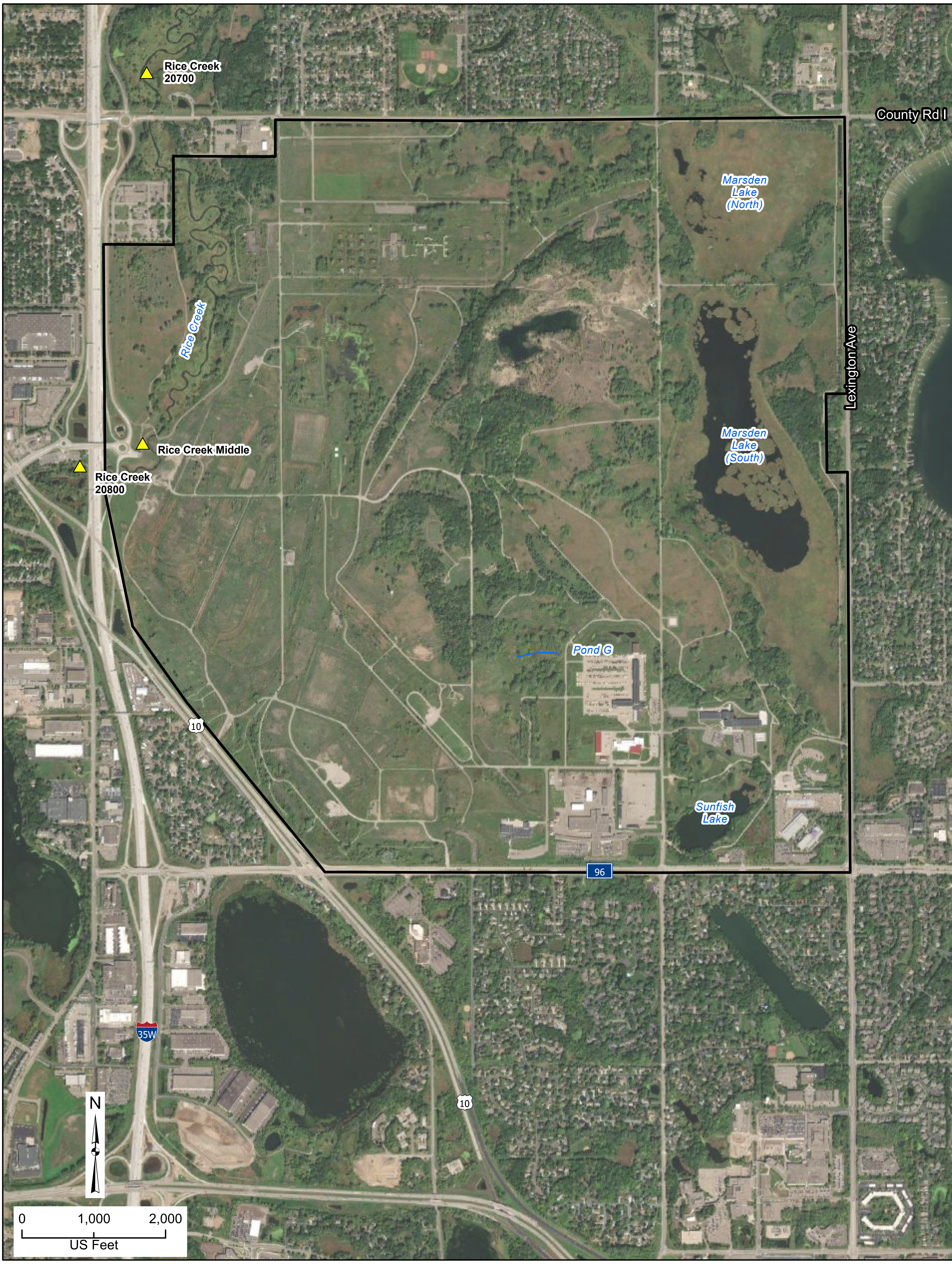
Figure 9-5
FY 2022 Annual Performance Report
Building 102, Unit 1,
Vinyl Chloride Results
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

FY 2022 Annual Performance Report
Figure 9-6
Building 102, Vinyl Chloride Cross Section B-B'

U.S Army - TCAAP
Arden Hills, Minnesota





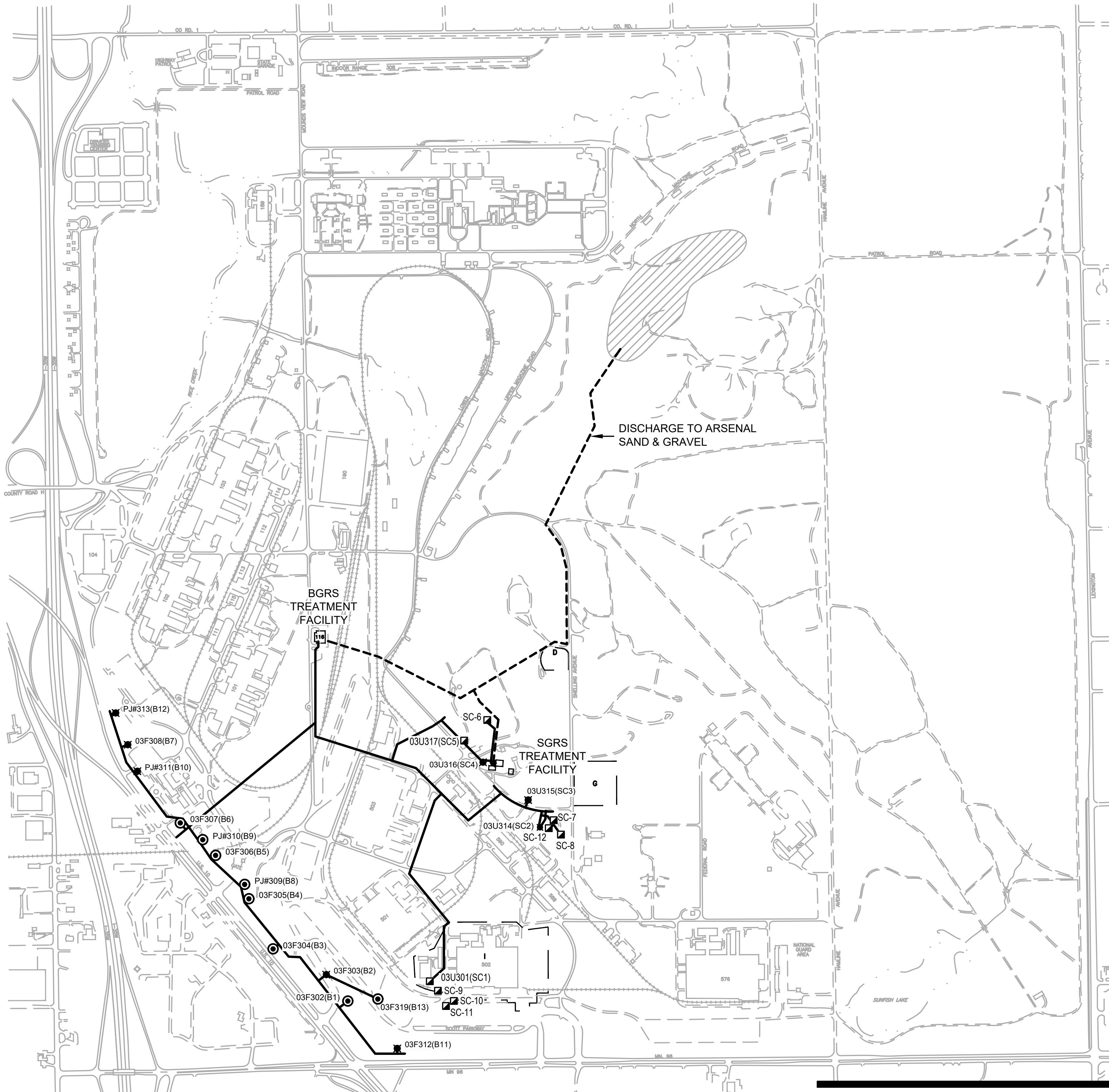
Legend

Rice Creek Sample Location

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.)

Figure 10-1
OU2 Aquatic Sites and Sampling Locations
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx



LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- RAILROAD
- DRAINAGE
- BUILDING
- BUILDING REMOVED
- SOURCE AREA
- TREATMENT FACILITY DISCHARGE LINE
- ACTIVE BGRS EXTRACTION WELL LOCATION
- INACTIVE EXTRACTION WELL LOCATION
- ACTIVE SGRS 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
SC6	03U320
SC7	03U321
SC8	03U322
SC9	03U323
SC10	03U324
SC11	03U325
SC12	03U326

0 600 1200 ft
1" = 1200 ft

N

GHD

OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

TGRS LAYOUT

Project No. 12594698
Date December 2022

FIGURE 11-1

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D111_WA-001.DWG
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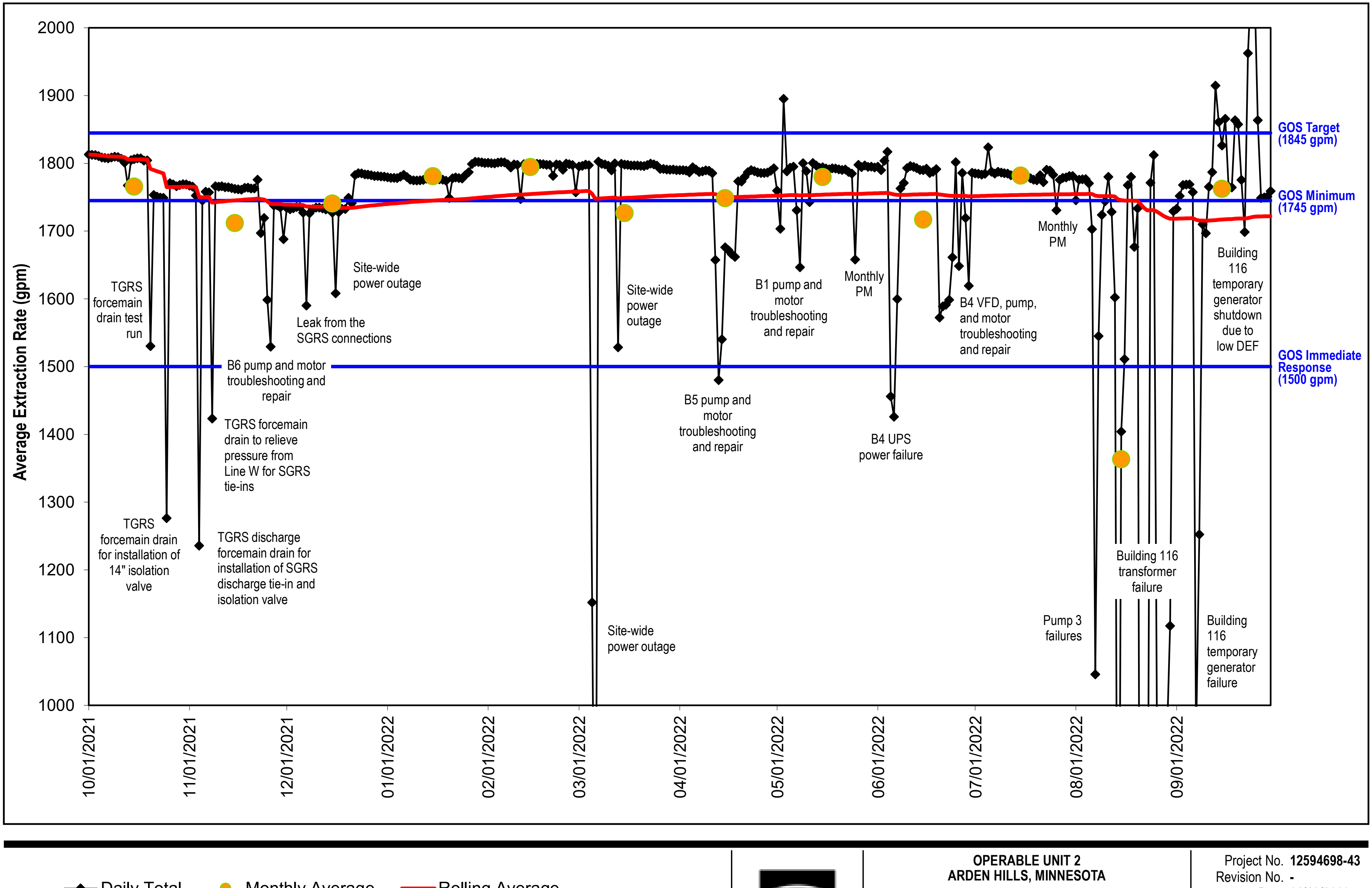

OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

TGRS FY2022 TOTAL DAILY FLOW RATES

Project No. 12594698-43
Revision No. -
Date 01/12/2023

FIGURE 11-2

Q:\GIS\PROJECTS\12594000s\12594698\GIS\Maps\Deliverables\RPT\RPT001\12594698_007_TGRS_Flow_11-2.mxd
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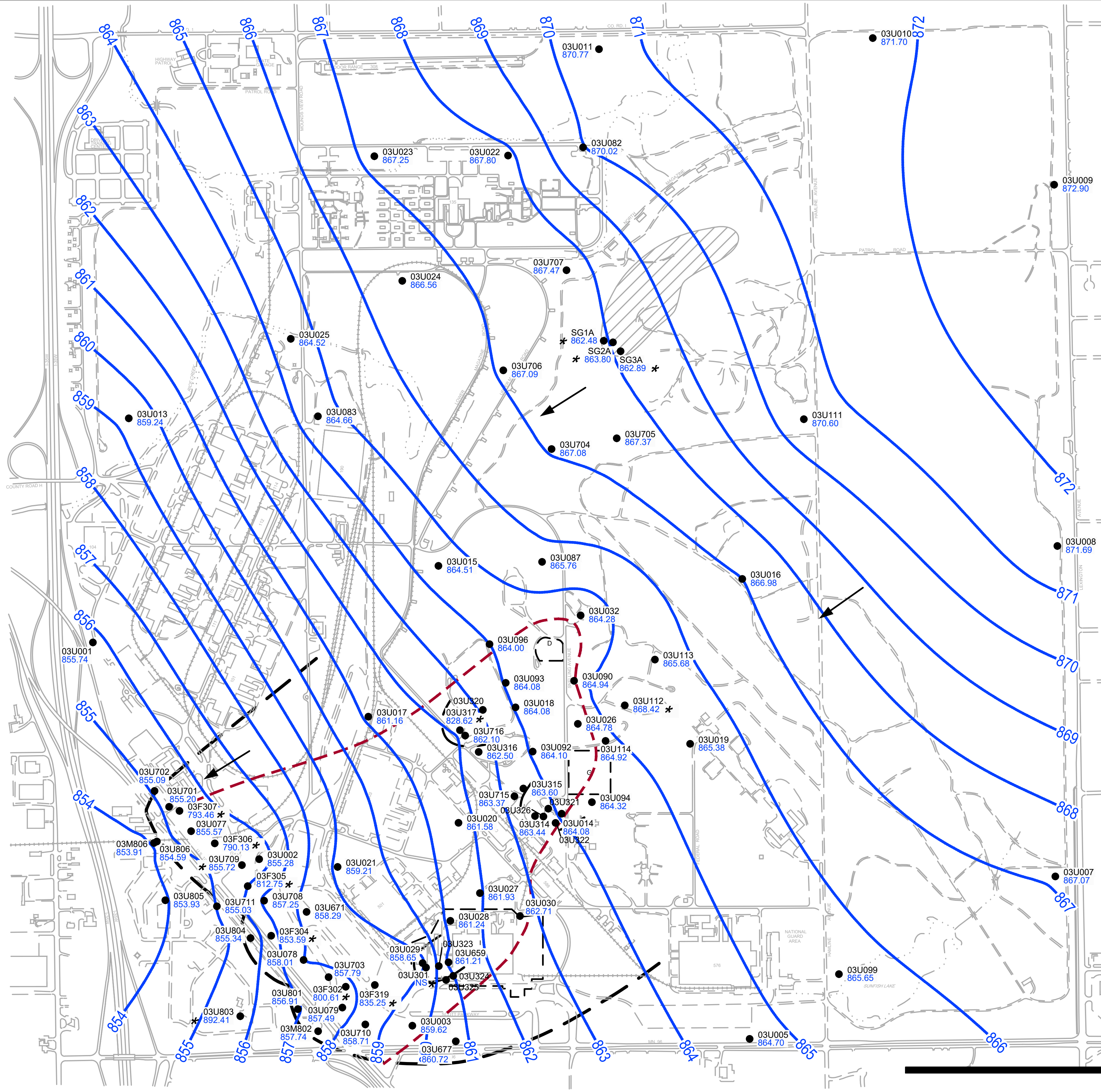

LEGEND

PRIMARY ROAD

SECONDARY ROAD

RAILROAD

DRAINAGE

BUILDING

BUILDING REMOVED

SOURCE AREA

WELL LOCATION

869.15 GROUNDWATER ELEVATION IN FEET AMSL

861 GROUNDWATER CONTOUR

DIRECTION OF GROUNDWATER FLOW

LIMIT OF CAPTURE

NOTE: GROUNDWATER CONTOURS ARE INTERPOLATED FROM THE DATA POINTS SHOWN.

* GROUNDWATER ELEVATION NOT USED IN CONTOURING

ARSENAL SAND AND GRAVEL PIT TREATED WATER DISCHARGE AREA. (APPROXIMATE BOUNDARIES)

5 µg/L TCE PLUME BOUNDARY (FROM 2001)

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
SC6	03U320
SC7	03U321
SC8	03U322
SC9	03U323
SC10	03U324
SC11	03U325
SC12	03U326

0 600 1200 ft

1" = 1200 ft

N

GHD

OPERABLE UNIT 2
HILLS, MINNESOTA

OU2, UPPER UNIT 3,
POTENTIOMETRIC MAP, JUNE 2022

Project No. 12594698
Date September 2023

figure 11-3

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D106_WA-001.DWG
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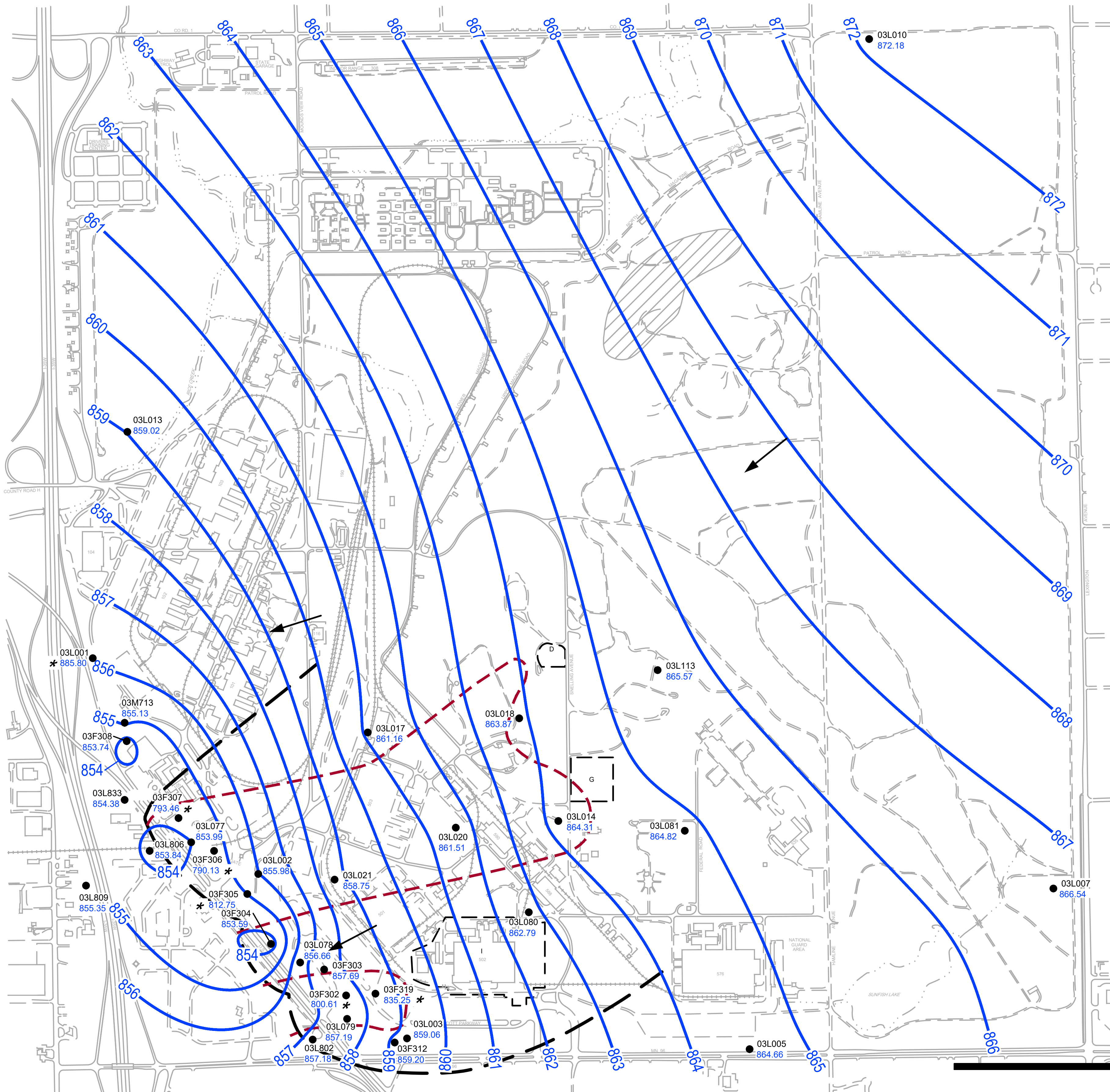

LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- RAILROAD
- DRAINAGE
- BUILDING
- BUILDING REMOVED
- SOURCE AREA
- WELL LOCATION
- 862.46 GROUNDWATER ELEVATION IN FEET AMSL
- 861 GROUNDWATER CONTOUR
- DIRECTION OF GROUNDWATER FLOW
- LIMIT OF CAPTURE
- NOTE: GROUNDWATER CONTOURS ARE INTERPOLATED FROM THE DATA POINTS SHOWN.
- * GROUNDWATER ELEVATION NOT USED IN CONTOURING
- ARSENAL SAND AND GRAVEL PIT TREATED WATER DISCHARGE AREA. (APPROXIMATE BOUNDARIES)
- 5 µg/L TCE PLUME BOUNDARY (FROM 2001)

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
SC6	03U320
SC7	03U321
SC8	03U322
SC9	03U323
SC10	03U324
SC11	03U325
SC12	03U326

0 600 1200 ft
1" = 1200 ft

N

GHD

OPERABLE UNIT 2
HILLS, MINNESOTA

OU2, LOWER UNIT 3,
POTENTIOMETRIC MAP, JUNE 2022

Project No. **12594698**
Date **September 2023**

FIGURE 11-4

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D107_WA-001.DWG
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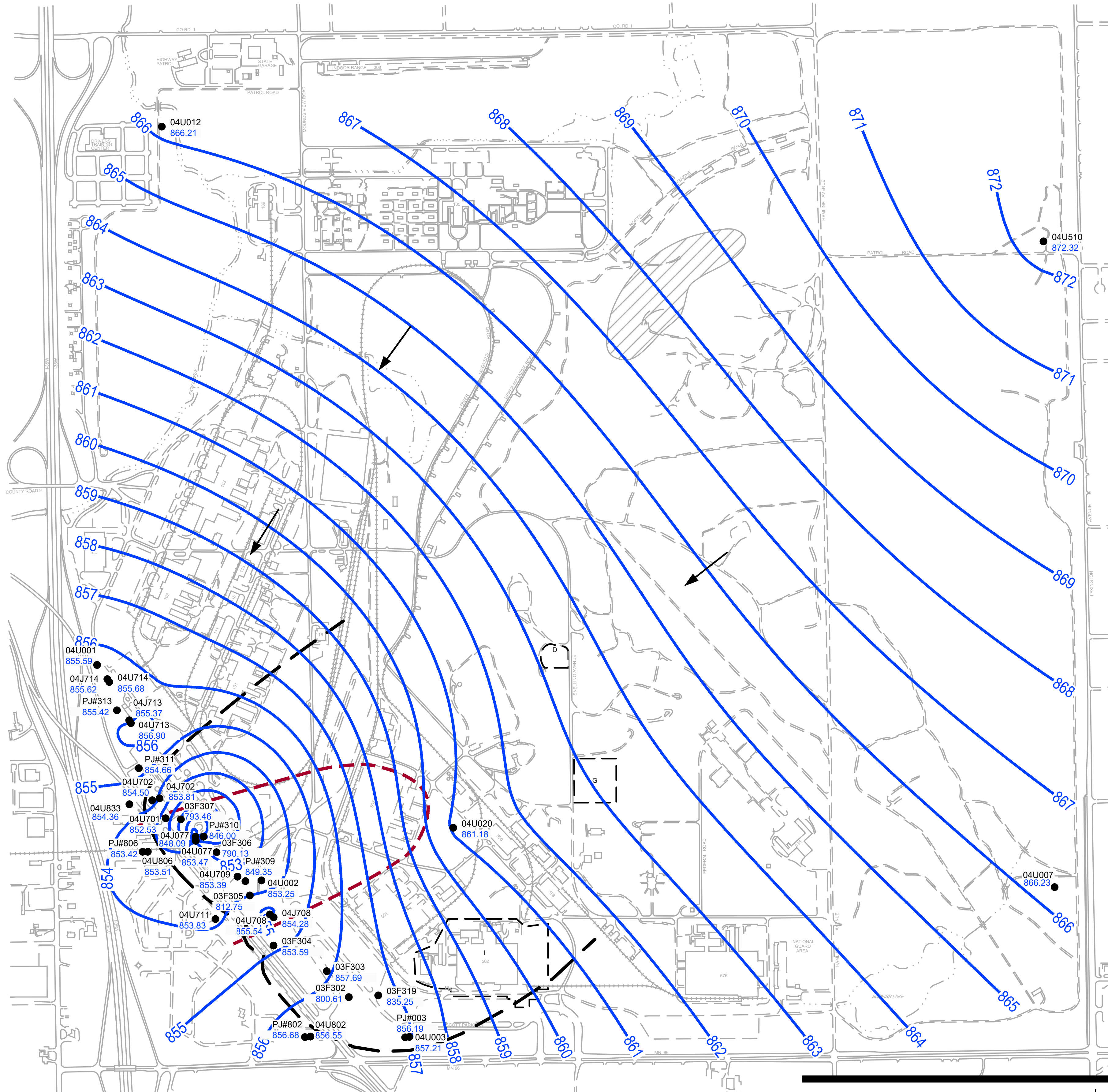

LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- RAILROAD
- DRAINAGE
- BUILDING
- BUILDING REMOVED
- SOURCE AREA
- WELL LOCATION
- 869.67 GROUNDWATER ELEVATION IN FEET AMSL
- 858 GROUNDWATER CONTOUR
- DIRECTION OF GROUNDWATER FLOW
- LIMIT OF CAPTURE
- NOTE: GROUNDWATER CONTOURS ARE INTERPOLATED FROM THE DATA POINTS SHOWN.
- * GROUNDWATER ELEVATION NOT USED IN CONTOURING
- ARSENAL SAND AND GRAVEL PIT TREATED WATER DISCHARGE AREA. (APPROXIMATE BOUNDARIES)
- 5 µg/L TCE PLUME BOUNDARY (FROM 2001)

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
SC6	03U320
SC7	03U321
SC8	03U322
SC9	03U323
SC10	03U324
SC11	03U325
SC12	03U326

0 600 1200 ft
1" = 1200 ft

N

GHD

OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

OU2, UPPER UNIT 4
POTENTIOMETRIC MAP, JUNE 2022

Project No. 12594698
Date September 2023

figure 11-5

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D108_WA-001.DWG
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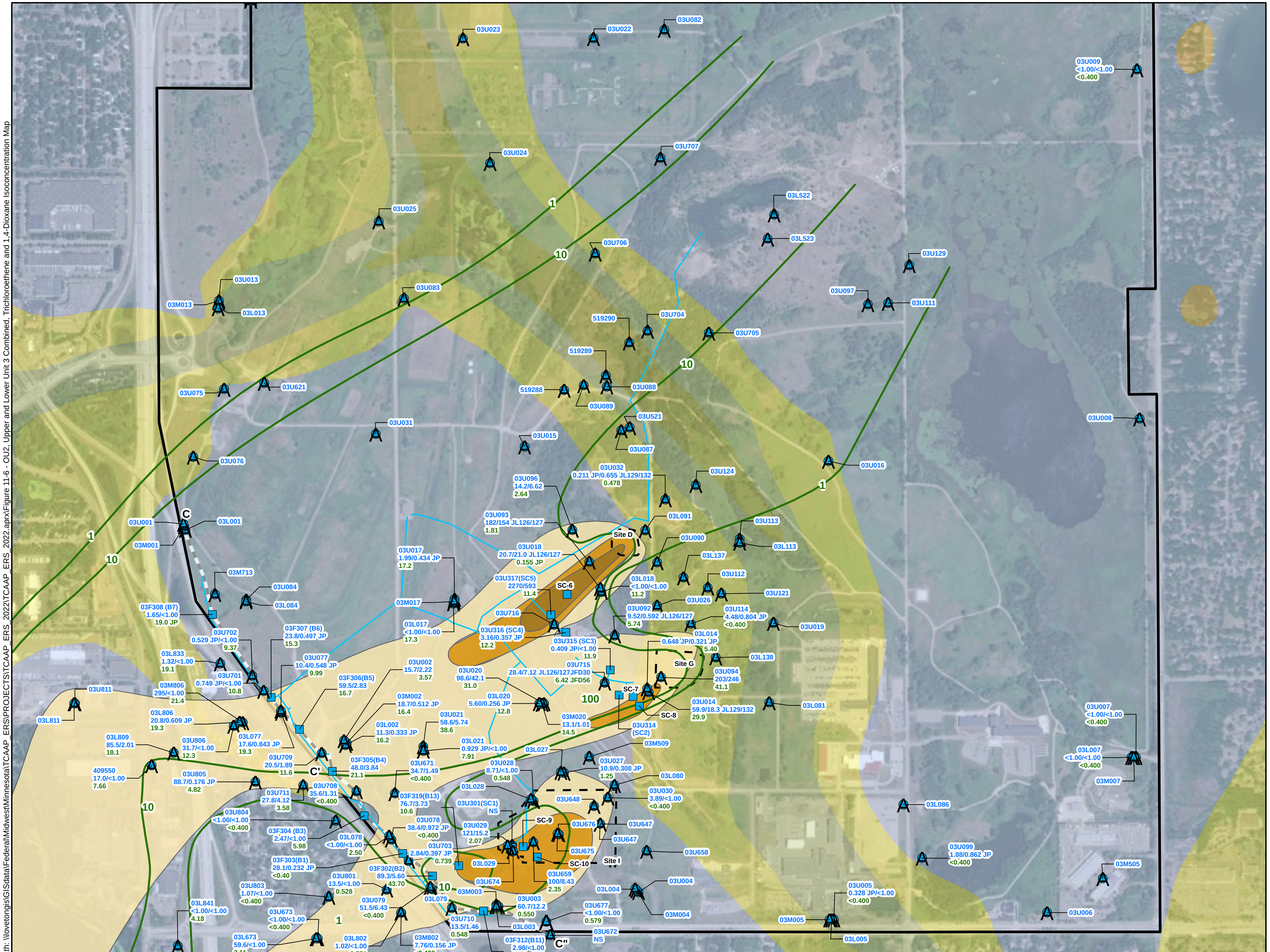
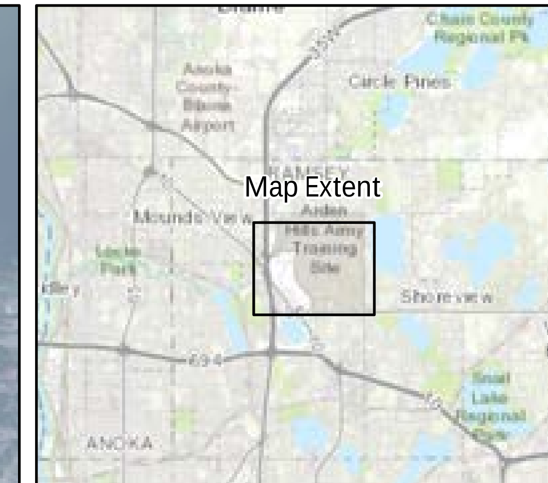




Legend

03U708 Monitoring Well ID

47.7/1.92 Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)

0.40 1,4-Dioxane Concentration (µg/L)

Monitoring Well

Extraction Well

Cross-Section Line

Site Boundary

Extraction Well Piping

2022 1,4 Dioxane Concentration Contour (µg/L)

2022 Trichloroethene Concentrations

5-100 µg/L

100-1,000 µg/L

1,000+ µg/L

Operable Unit 2

Bedrock Geology

St. Peter Sandstone

Prairie du Chien Group

Jordan Sandstone

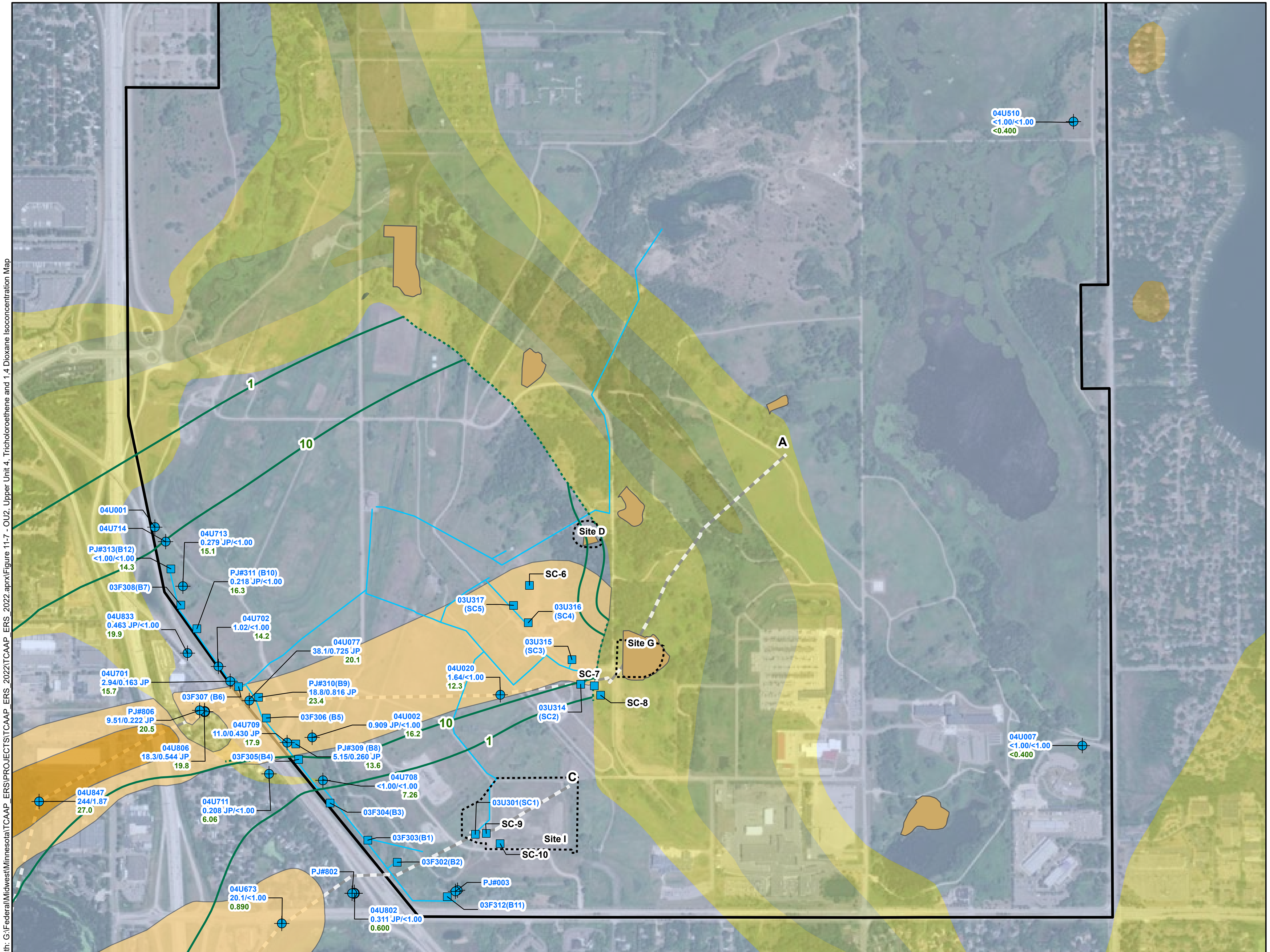
St. Lawrence Formation

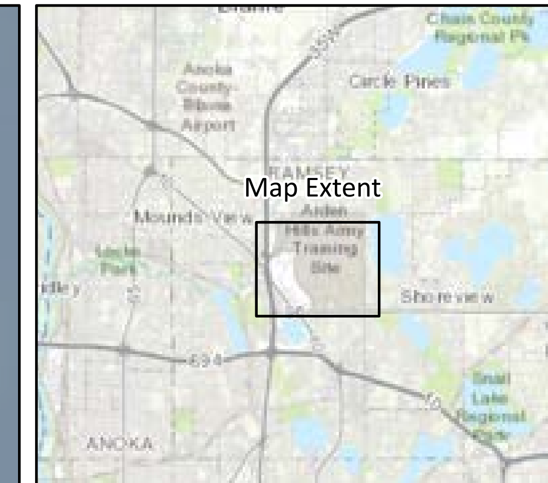
Tunnel City Group

0 500 1,000
US Feet

Figure 11-6
OU2, Upper and Lower Unit 3 Combined
Trichloroethene and 1,4 Dioxane Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\woveton\gis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx\Figure 11-6 - OU2, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map





Legend

PJ#806	Monitoring Well ID
9.51/0.222	Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
20.5	1,4-Dioxane Concentration (µg/L)
	Monitoring Well
	Extraction Well
	Cross-Section Line
	Site Boundary
	Extraction Well Piping
	2022 1,4 Dioxane Concentration Contour (µg/L)
	2022 1,4 Dioxane Concentration Inferred Contour (µg/L)
	Soil Covers

2022 Trichloroethene Concentrations (µg/L)

- 5-100 µg/L
- 100-1,000 µg/L
- Operable Unit 2

Bedrock Geology

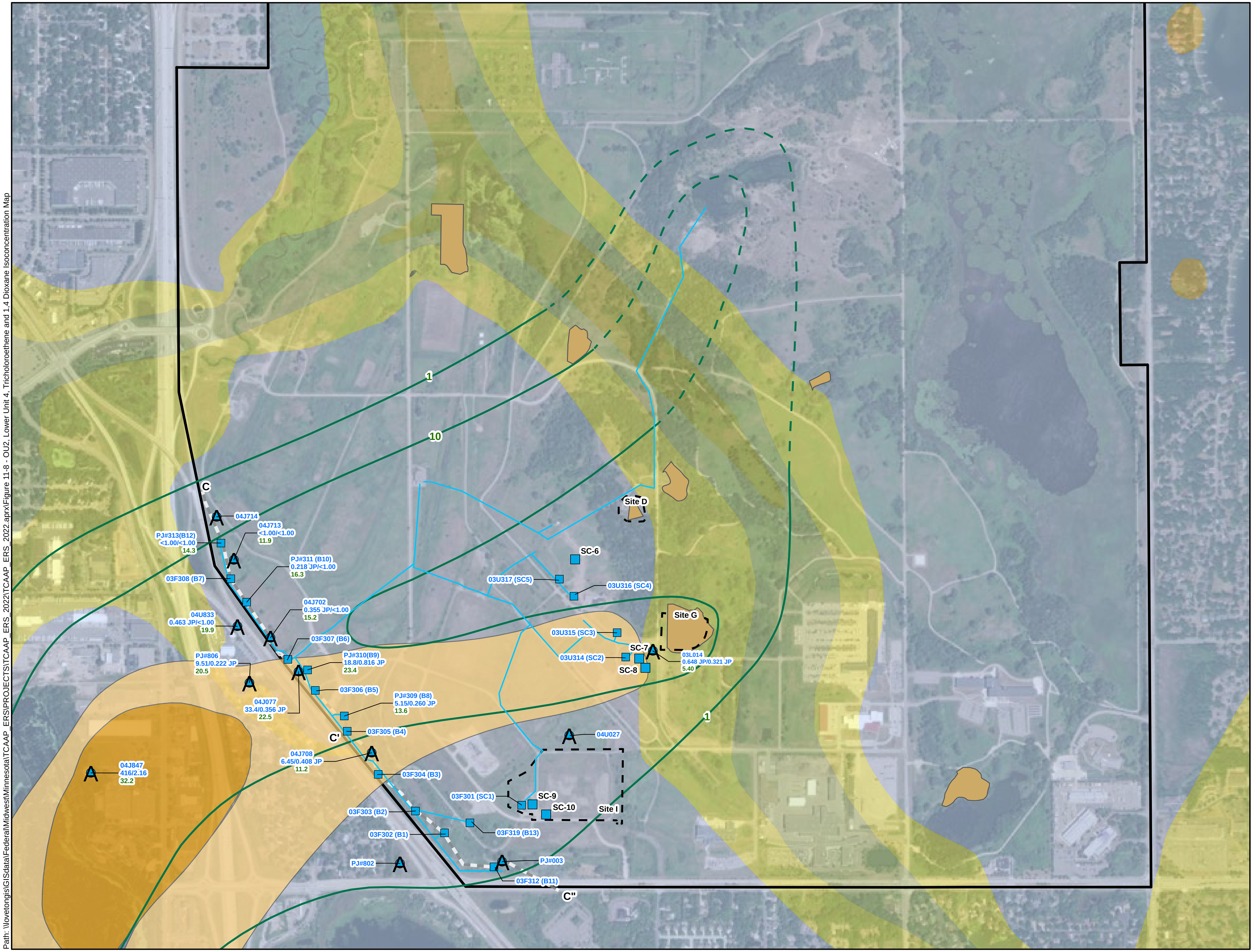
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

0 500 1,000
US Feet

Figure 11-7
OU2, Upper Unit 4
Trichloroethene and 1,4 Dioxane Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx\Figure 11-7 - OU2, Upper Unit 4, Tricholoroethene and 1,4 Dioxane Isoconcentration Map

Path: \\woventogis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx\Figure 11-8 - OU2, Lower Unit 4, Trichloroethene and 1,4 Dioxane Isoconcentration Map



Legend

PJ#806	Monitoring Well ID
9.78/0.173	Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
19.3	1,4-Dioxane Concentration (µg/L)
	Monitoring Well
	Extraction Well
	Cross-Section Line
	Site Boundary
	Extraction Well Piping
	2022 1,4 Dioxane Concentration Contour (µg/L)
	2022 1,4 Dioxane Concentration Inferred Contour (µg/L)
	Soil Covers

2022 Trichloroethene Concentrations (µg/L)

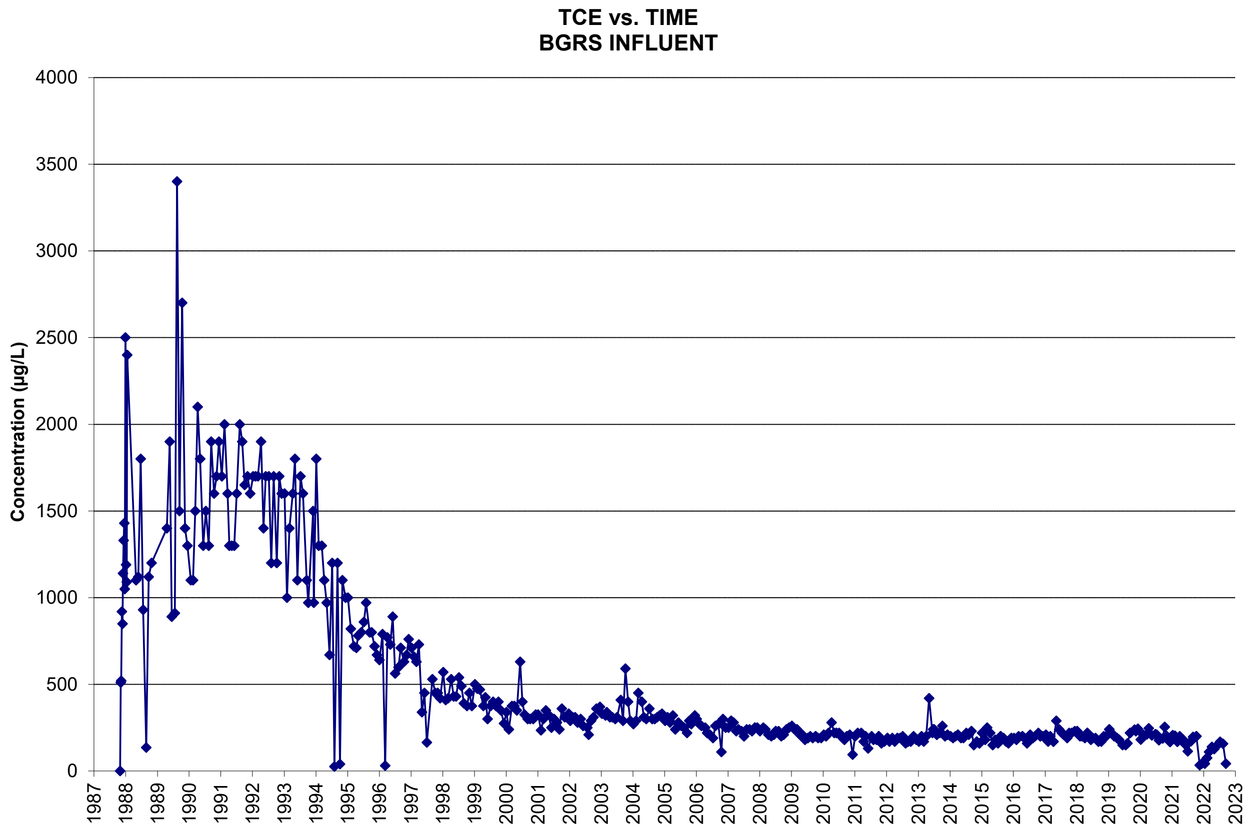
- 100-1,000 µg/L
- 5-100 µg/L
- Operable Unit 2

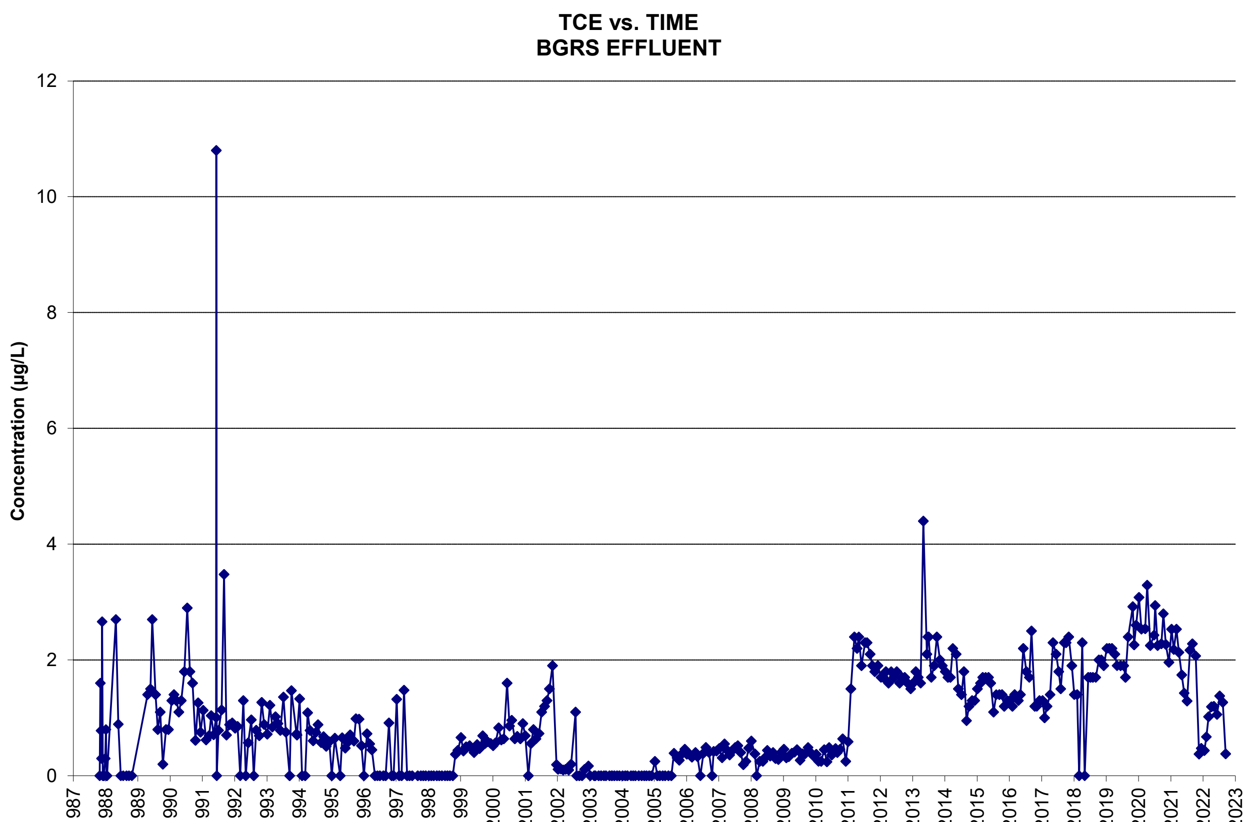
Bedrock Geology

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

0 500 1,000
US Feet

Figure 11-8
OU2, Lower Unit 4
Trichloroethene and 1,4 Dioxane
Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota





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

OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

BGRS (BUILDING 116) TREATMENT SYSTEM PERFORMANCE

Project No. 12594698-43
Revision No. -
Date 01/16/2023

FIGURE 11-9

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Print date: 16 Jan 2023 - 16:56

OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

Project No. 12594698
Date December 2022

GHD

JUNE 2022 GROUNDWATER TRCLE DATA
CROSS SECTION C-C'

figure 11-10

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D109_WA-001.DWG
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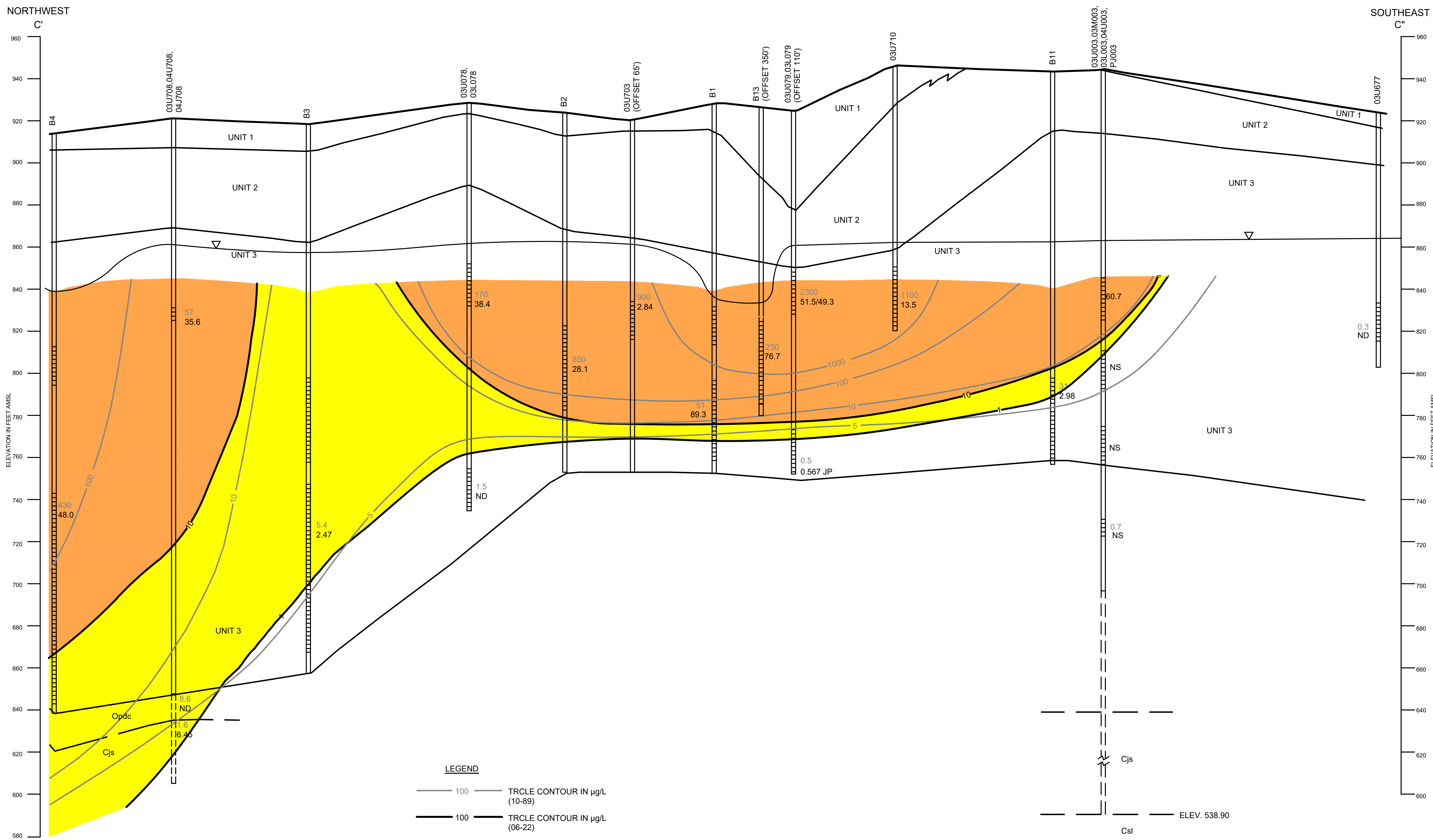

LEGEND

100 TRCLE CONTOUR IN µg/L (10-89)

100 TRCLE CONTOUR IN µg/L (06-22)

2022 TRCLE CONCENTRATION

51.5/49.3 DUPLICATE SAMPLE

SCREENED INTERVAL

OPEN HOLE INTERVAL

VERTICAL SCALE 0 20 SCALE IN FEET

HORIZONTAL SCALE 0 100 SCALE IN FEET

GHD

OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

JUNE 2022 GROUNDWATER TRCLE DATA
CROSS SECTION C'-C"

Project No. 12594698
Date December 2022

figure 11-11

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D110_WA-001.DWG
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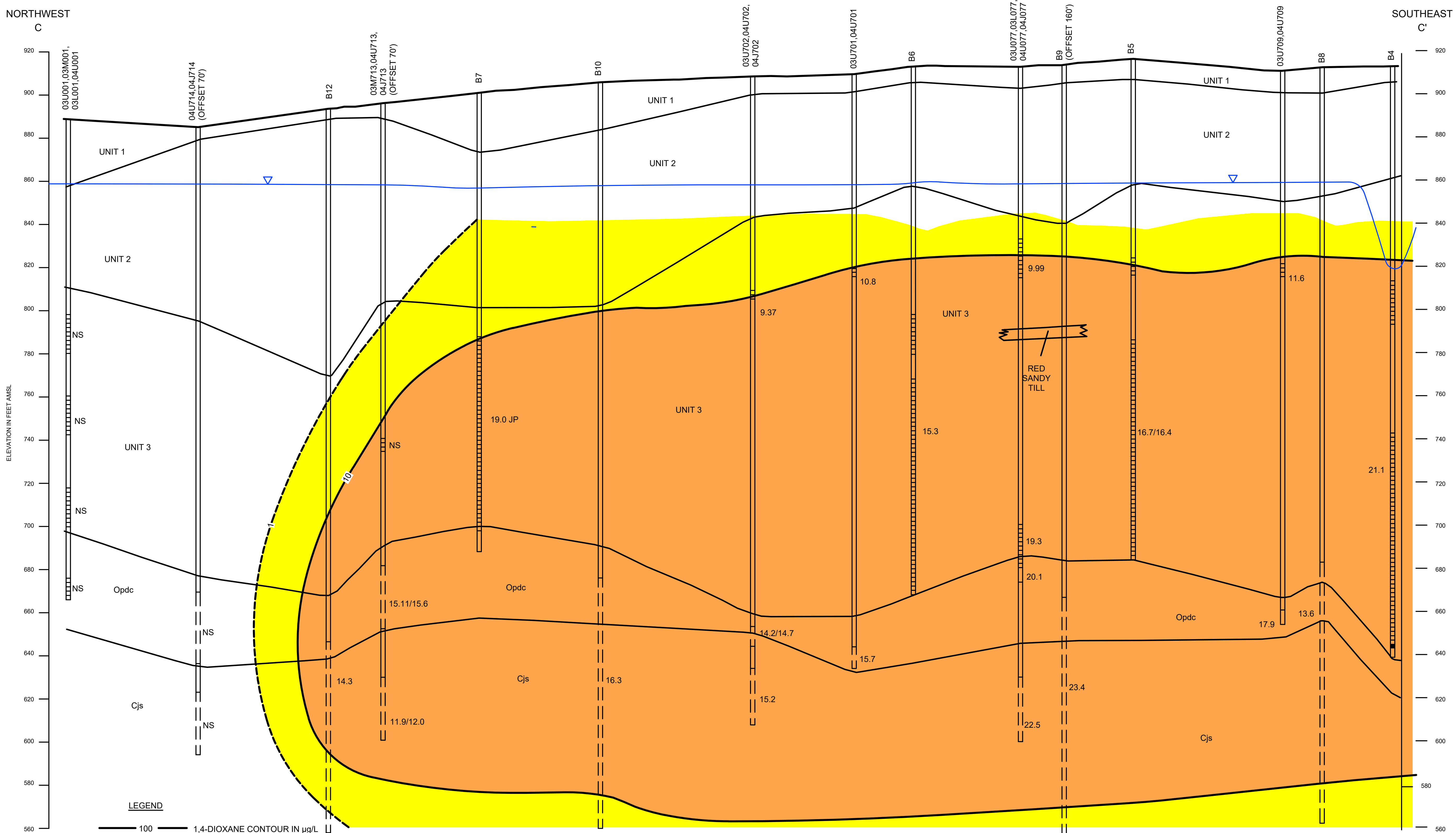

LEGEND

100 — 1,4-DIOXANE CONTOUR IN µg/L (06-22)

2022 1,4-DIOXANE CONCENTRATION

11.9/12.0 DUPLICATE SAMPLE

OPEN HOLE INTERVAL

SCREENED INTERVAL

VERTICAL SCALE
0 20
SCALE IN FEET

HORIZONTAL SCALE
0 100
SCALE IN FEET

OPERABLR UNIT 2
ARDEN HILLS, MINNESOTA

JUNE 2022 GROUNDWATER
1,4-DIOXANE DATA
CROSS SECTION C-C'

Project No. 12594698
Date January 2023

figure 11-12

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D112_WA-001.dwg
Plot Date: 17 January 2023 10:46 AM

OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

JUNE 2022 GROUNDWATER
1,4-DIOXANE DATA
CROSS SECTION C'-C"

Project No. 12594698
Date January 2023

figure 11-13

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D113_WA-001.dwg
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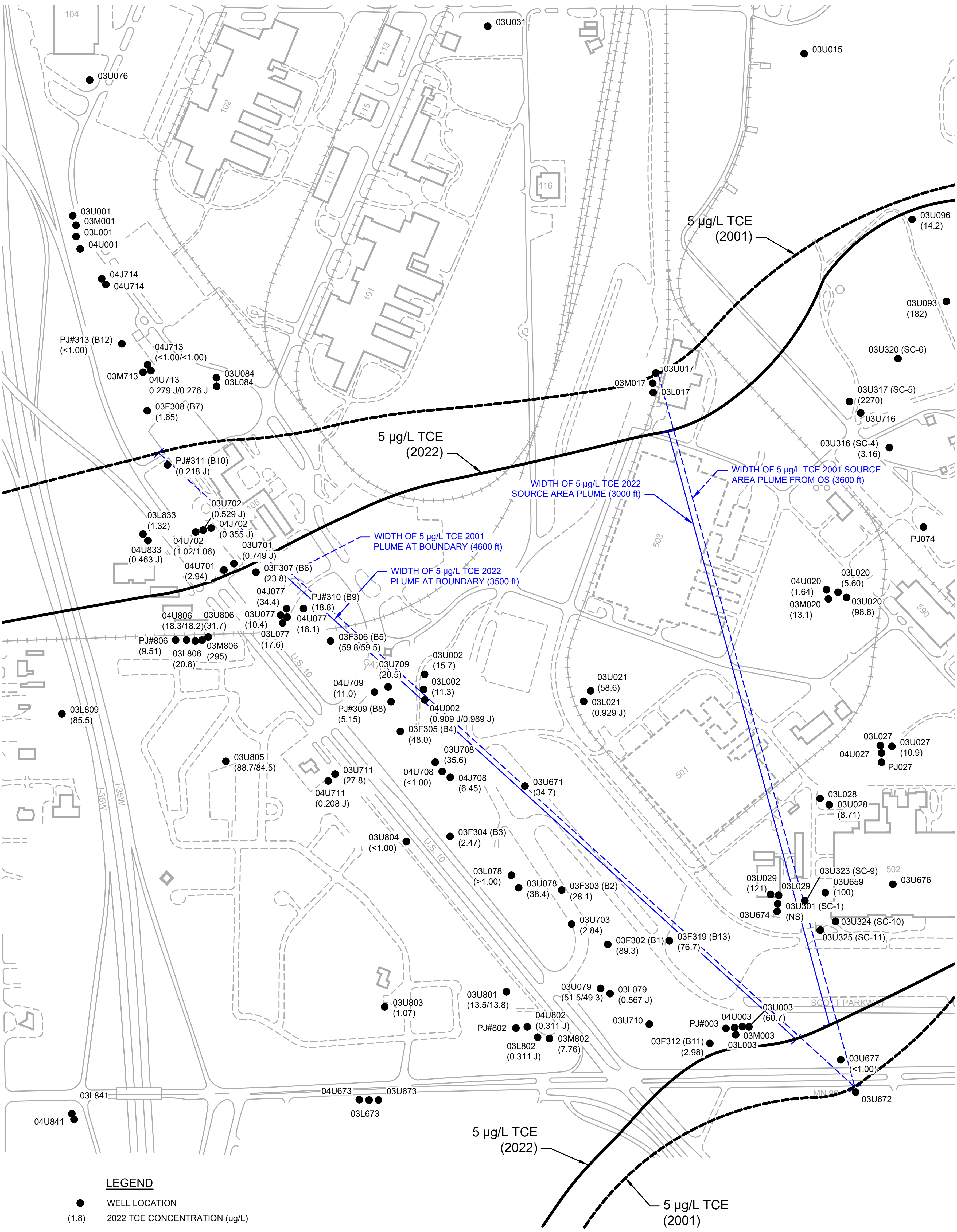

0 250 500 ft

1" = 500 ft

N

TGRS ANNUAL MONITORING DATA - WEST PORTION

TCE CONCENTRATIONS (μg/L) JUNE 2022

Project No. 12594698

Date January 2023

FIGURE 11-14

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D105_WA-001.DWG
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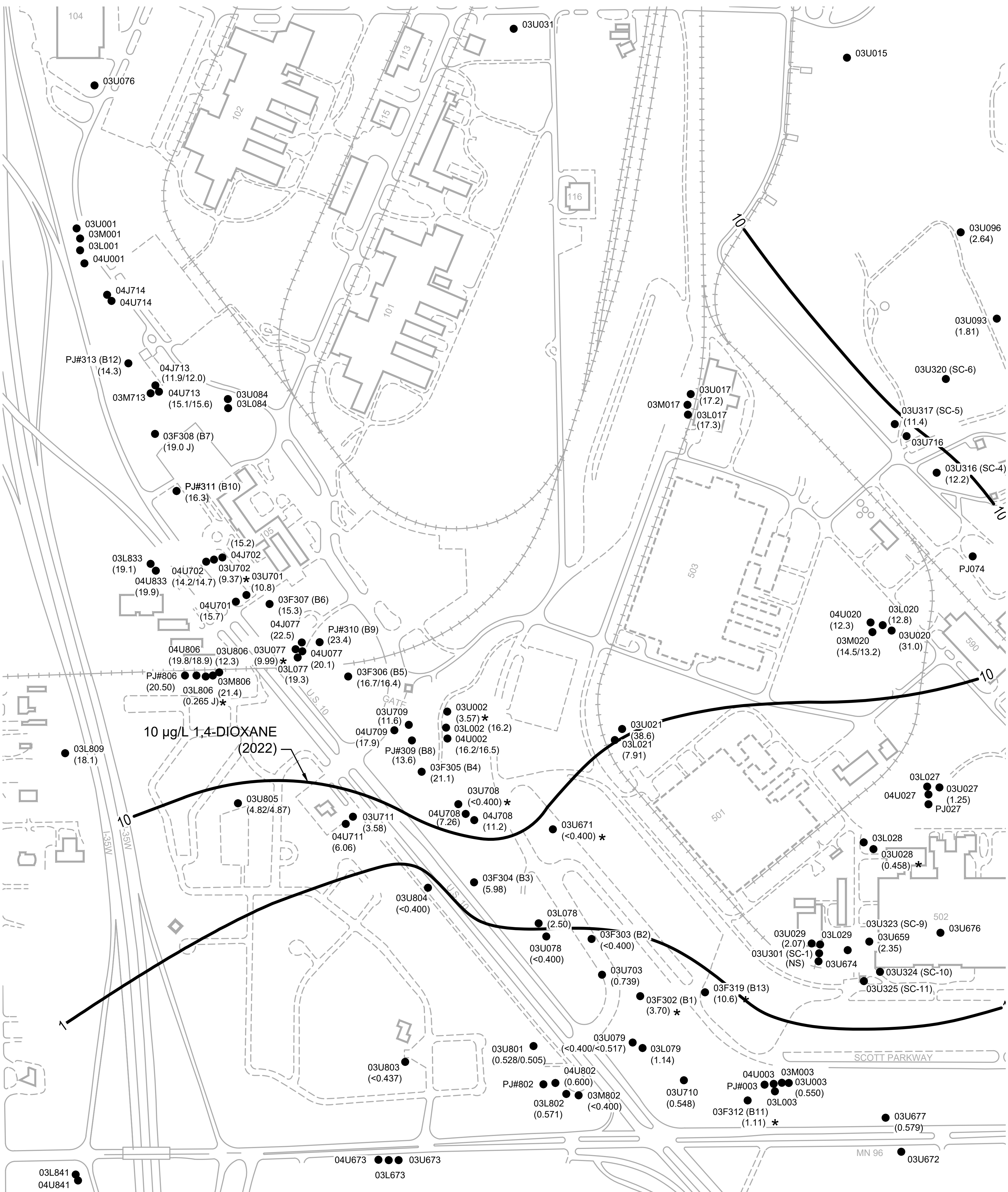


LEGEND

- ● WELL LOCATION
- (3.9) 2022 1,4-DIOXANE CONCENTRATION
- (NS) NOT SAMPLED
- * NOT USED FOR CONTOURING

0 250 500 ft

1" = 500 ft

N

GHD

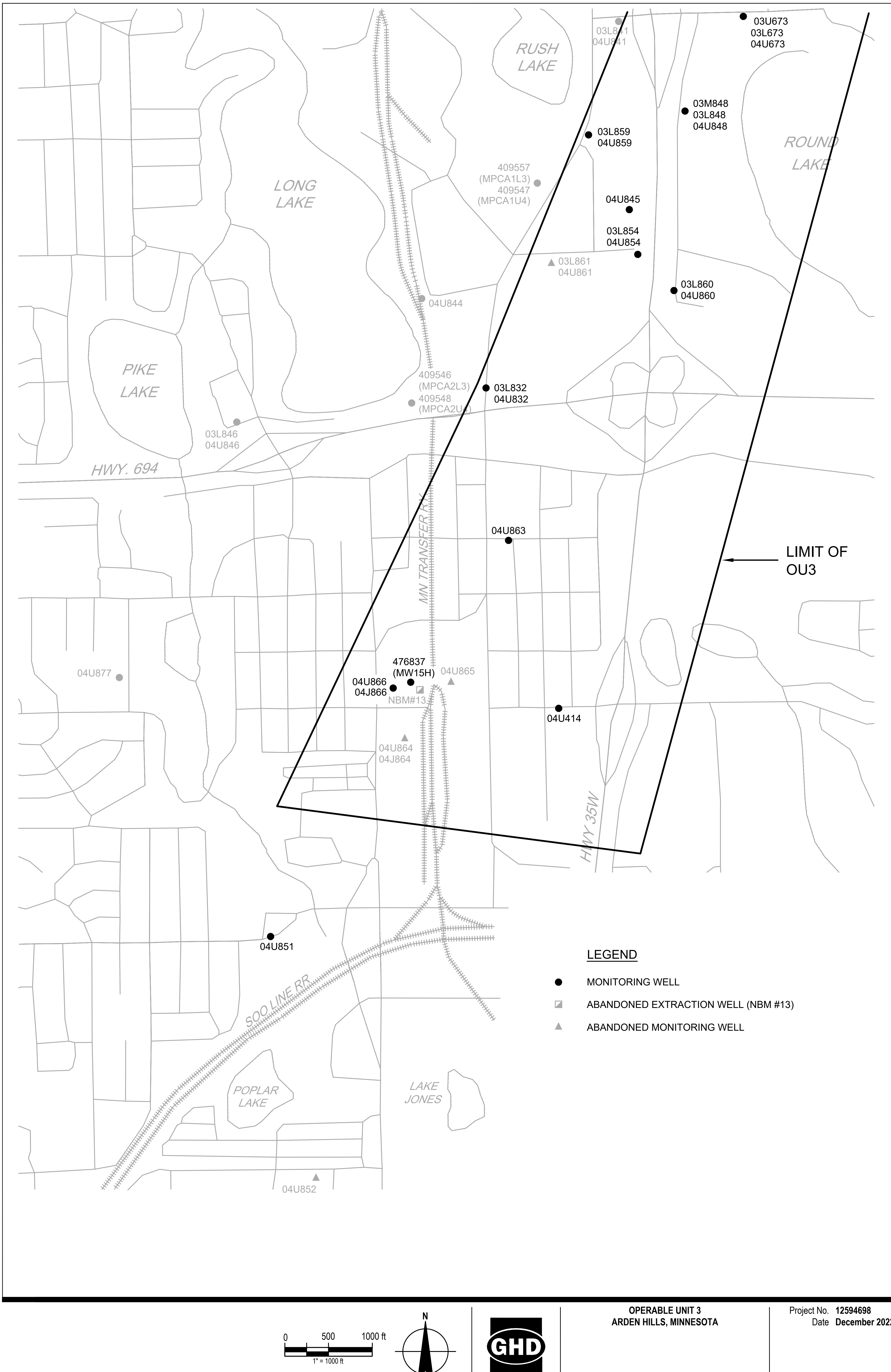
OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

TGRS ANNUAL MONITORING DATA - WEST PORTION - 1,4-DIOXANE CONCENTRATIONS (µg/L) JUNE 2022

Project No. **12594698**
Date **July 2023**

FIGURE 11-15

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D104_WA-001.DWG
Plot Date: 05 July 2023 2:01 PM



OPERABLE UNIT 3
ARDEN HILLS, MINNESOTA

Project No. 12594698
Date December 2022

SITE PLAN

FIGURE 12-1

Filename: N:\US\St Paul\Projects\563\12594698\Digital_Design\ACAD\Figures\RPT001\12594698-GHD-00-00-RPT-EN-D103_WA-001.dwg
Plot Date: 15 December 2022 2:16 PM

Appendix A

FY 2022 – FY 2026 Monitoring Plans

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FY 2022 to 2026 Monitoring Plan for Groundwater Monitoring Wells

Unit Designations:

01U— Upper Fridley Formation	03M— Middle Hillside Formation
SL— St. Lawrence	J— Jordan
01L— Lower Fridley Formation	03L— Lower Hillside Formation
03U— Upper Hillside Formation	UNK— Unknown
SP— St. Peter	PC— Prairie du Chien

Footnotes:

(A) Indicates that the monitoring is the responsibility of Northrop Grumman (formerly 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

- Twin Cities Army Ammunition Plant Groundwater Recovery System (TGRS) Water Quality:
  - O = 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 30 September, if necessary due to temporary inaccessibility.

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Appendix A.1

Groundwater Monitoring Wells

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Appendix A.1
FY 2022 - FY 2026 Monitoring Plan for Groundwater Monitoring Wells

Well Information			Notes	June 22	June 23	June 24	June 25	June 26	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)	---	Q,L(B)	OR	3.b	
03U	03U822			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	None	
03U	03U831			---	---	---	---	---	---	---	Abandoned 2006
03U	409550	PCA 6U3		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	None	
03U	409596	BS118U3		---	---	---	---	---	---	---	Abandoned 2007, may need replacement
03M	03M843			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	None	
03L	03L811			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
03L	03L822			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	None	
03L	03L832			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	None	
03L	03L841			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	None	
03L	03L846			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	None	
03L	03L853			---	---	---	---	---	---	---	
03L	409556	PCA4L3		Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	None	
03L	409557	PCA1L3		Q,L(B)	---	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)	---	Q,L(B)	OR	3.b	
PC	04U834			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	None	
PC	04U836	MW-1		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	04U837	MW-3		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	04U838	MW-5		Q,L(B)	---	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	MPCA recommended annual sampling
PC	04U841			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	04U843			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	3.b	
PC	04U844			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	04U846			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	04U847			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	04U849			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	04U850			Q,L(B)	---	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	
PC	04U872			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	
PC	04U875			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	3.b	
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	MPCA recommended annual sampling
PC	04U880			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	3.b	
PC	04U881			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	None	
PC	04U882			Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	None	
PC	04U883			Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	None	
04U	04U884	New Brighton Pilot Boring 1		---	---	---	---	---	---	---	
PC	191942	BS118U4		---	---	---	---	---	---	---	Abandoned 2007, may need replacement

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Well Information			Notes	June 22	June 23	June 24	June 25	June 26	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
PC	200154	UM Golf Course		Q(B)	---	Q(B)	---	Q(B)	1.a, OR	---	
PC	200814	American Linen		---	---	---	---	---	---	---	
PC	206688	Cloverpond		Q(B)	---	Q(B)	---	Q(B)	1.a, OR	---	
PC	234547	Honeywell Ridgeway		---	---	---	---	---	---	---	
PC	409547	PCA1U4		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	409548	PCA2U4		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	409549	PCA3U4		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
PC	409555	PCA5U4		Q,L(B)	---	Q,L(B)	---	Q,L(B)	1.a, OR	3.b	
PC	512761	Gross Golf Course #2		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
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)	---	Q,L(B)	OR	None	
J	04J835			---	---	---	---	---	---	---	
J	04J836	MW-2		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
J	04J837	MW-4		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
J	04J838	MW-6		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
J	04J839	MW-8		Q,L(B)	---	Q,L(B)	---	Q,L(B)	OR	3.b	
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)	---	Q,L(B)	OR	None	
J	200524	St. Anthony #5		Q(B)	---	Q(B)	---	Q(B)	OR	---	Army gets St. Anthony Data
J	200803	St. Anthony #4		Q(B)	---	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)	---	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)	---	Q,L(B)	OR	None	
UNK	234546	Honeywell Ridgeway		Q(B)	---	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

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Well Information									Purpose For Monitoring[3]		
Unit	Well I.D.	Common Name	Notes	June 22	June 23	June 24	June 25	June 26	Water Quality	Water Level	Comments
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	
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	
01U	01U351	EW-1		---	---	---	---	---	OR	OR	
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	
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	

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Well Information									Purpose For Monitoring[3]		
Unit	Well I.D.	Common Name	Notes	June 22	June 23	June 24	June 25	June 26	Water Quality	Water Level	Comments
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
01U	01U905	Well 1		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	---	---	
01U	01U906	Well 2		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	---	---	
01U	01U907	Well 3		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	---	---	
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
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 FY 14
01U	01U636			---	---	---	---	---	---	---	Abandoned FY 14
01U	01U639			---	---	---	---	---	---	---	Abandoned FY 14
01U	01U640			---	---	---	---	---	---	---	Abandoned FY 14
01U	01U666			---	---	---	---	---	---	---	Abandoned FY 14
01U	01U667			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	OR	Abandoned FY14, replacement pending
01U	482086	I01MW		---	---	---	---	---	---	---	Abandoned FY14
01U	482087	I05MW		---	---	---	---	---	---	---	Abandoned FY14

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Well Information			Notes	June 22	June 23	June 24	June 25	June 26	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
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, replaced FY21
01U	01U609			L(A)	L(A)	L(A)	L(A)	L(A)	---	---	Abandoned FY14, replaced FY21
01U	01U611			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	---	---	Abandoned FY14, replaced FY21
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
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	

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Well Information									Purpose For Monitoring(3)		
Unit	Well I.D.	Common Name	Notes	June 22	June 23	June 24	June 25	June 26	Water Quality	Water Level	Comments
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)	---	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)	---	L(A)	---	1.a	
03U	03U002			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U003			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U004			---	---	---	---	---	---	---	Abandoned FY13
03U	03U005			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U007			Q,L(A)	---	Q,L(A)	---	Q,L(A)	Background	1.a	
03U	03U008			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U009			Q,L(A)	---	Q,L(A)	---	Q,L(A)	Background	1.a	
03U	03U010			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U011			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U012			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U013			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U014			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U015			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U016			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U017			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U018			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U019			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U020			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U021			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U022			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U023			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U024			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U025			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U026			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U027			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	

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Well Information			Notes	June 22	June 23	June 24	June 25	June 26	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
03U	03U028			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U029			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U030			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U031			---	---	---	---	---	---	---	Abandoned FY14
03U	03U032			Q,L(A)	---	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)	---	Q,L(A)	OR	1.a	
03U	03U078			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U079			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U082			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U083			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U084			---	---	---	---	---	---	---	Abandoned FY14
03U	03U087			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U088			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U089			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U090			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U092			Q,L(A)	---	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)	---	Q,L(A)	OR	1.a	
03U	03U096			Q,L(A)	---	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)	---	L(A)	---	1.a	
03U	03U112			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U113			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U114			Q,L(A)	---	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)	---	Q,L(A)	OR	1.a	
03U	03U316	SC4	(5)	Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U317	SC5									See Appendix A.2
03U	03U320	SC6									See Appendix A.2
03U	03U321	SC7									See Appendix A.2
03U	03U322	SC8									See Appendix A.2
03U	03U323	SC9									See Appendix A.2
03U	03U324	SC10									See Appendix A.2
03U	03U325	SC11									See Appendix A.2
03U	03U326	SC12									See Appendix A.2
03U	03U521			---	---	---	---	---	---	---	
03U	03U647			---	---	---	---	---	---	---	Abandoned FY14

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Well Information			Notes	June 22	June 23	June 24	June 25	June 26	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
03U	03U648			---	---	---	---	---	---	---	Abandoned FY14
03U	03U658			---	---	---	---	---	---	---	Abandoned FY13
03U	03U659			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U671			Q,L(A)	---	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)	---	Q,L(A)	OR	1.a	
03U	03U702			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U703			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U704			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U705			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U706			L(A)	---	L(A)	---	L(A)	---	1.a	
03U	03U707			L(A)	---	L(A)	---	L(A)	---	1.a	
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)	---	Q,L(A)	OR	1.a	
03U	03U710			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U711			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U715			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U716			L(A)	---	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)	---	Q,L(A)	OR	1.a	
03U	03U804			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03U	03U805			Q,L(A)	---	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)	---	L(A)	---	1.a	
03M	03M002			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03M	03M003			L(A)	---	L(A)	---	L(A)	---	1.a	
03M	03M004			---	---	---	---	---	---	---	Abandoned FY13
03M	03M005			L(A)	---	L(A)	---	L(A)	---	1.a	
03M	03M007			L(A)	---	L(A)	---	L(A)	---	1.a	
03M	03M010			L(A)	---	L(A)	---	L(A)	---	1.a	
03M	03M012			L(A)	---	L(A)	---	L(A)	---	1.a	
03M	03M013			L(A)	---	L(A)	---	L(A)	---	1.a	
03M	03M017			L(A)	---	L(A)	---	L(A)	---	1.a	
03M	03M020			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03M	03M713			L(A)	---	L(A)	---	L(A)	---	1.a	
03M	03M802			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	1.a	

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Well Information									Purpose For Monitoring(3)		
Unit	Well I.D.	Common Name	Notes	June 22	June 23	June 24	June 25	June 26	Water Quality	Water Level	Comments
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)	---	L(A)	---	1.a	
03L	03L002			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L003			L(A)	---	L(A)	---	L(A)	---	1.a	
03L	03L004			---	---	---	---	---	---	---	Abandoned FY13
03L	03L005			L(A)	---	L(A)	---	L(A)	---	1.a	
03L	03L007			Q,L(A)	---	Q,L(A)	---	Q,L(A)	Background	1.a	
03L	03L010			L(A)	---	L(A)	---	L(A)	---	1.a	
03L	03L012			L(A)	---	L(A)	---	L(A)	---	1.a	
03L	03L013			L(A)	---	L(A)	---	L(A)	---	1.a	
03L	03L014			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L017			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L018			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L020			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L021			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L027			---	---	---	---	---	---	---	Abandoned FY14
03L	03L028			---	---	---	---	---	---	---	Abandoned FY14
03L	03L029			---	---	---	---	---	---	---	Abandoned FY14
03L	03L077			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L078			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L079			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
03L	03L080			L(A)	---	L(A)	---	L(A)	---	1.a	
03L	03L081			L(A)	---	L(A)	---	L(A)	---	1.a	
03L	03L084			---	---	---	---	---	---	---	Abandoned FY14
03L	03L113			L(A)	---	L(A)	---	L(A)	---	1.a	
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)	---	Q,L(A)	OR	1.a	
03L	03L833			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC	04U001			L(A)	---	L(A)	---	L(A)	---	1.a	
PC	04U002			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC	04U003			L(A)	---	L(A)	---	L(A)	---	1.a	
PC	04U007			Q,L(A)	---	Q,L(A)	---	Q,L(A)	Background	1.a	
PC	04U012			L(A)	---	L(A)	---	L(A)	---	1.a	
PC	04U020			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC	04U027			---	---	---	---	---	---	---	Abandoned FY14
PC	04U077			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC	04U510			Q,L(A)	---	Q,L(A)	---	Q,L(A)	Background	1.a	
PC	04U701			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC	04U702			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC	04U708			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC	04U709			Q,L(A)	---	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	

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Well Information			Notes	June 22	June 23	June 24	June 25	June 26	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
PC	04U713			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC	04U714			L(A)	---	L(A)	---	L(A)	---	1.a	
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)	---	Q,L(A)	OR	1.a	
J	04J708			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
J	04J713			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
J	04J714			L(A)	---	L(A)	---	L(A)	---	1.a	
PC/J	PJ#003			L(A)	---	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)	---	Q,L(A)	OR	1.a	
PC/J	PJ#313	B12	(5)	Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	1.a	
PC/J	PJ#802			L(A)	---	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)	---	L(A)	---	---	
Operable Unit 2 - Unit 1 Wells											
01U	01U035			---	---	---	---	---	---	---	
01U	01U043			---	---	---	---	---	---	---	
01U	01U044			---	---	---	---	---	---	---	
01U	01U045			---	---	---	---	---	---	---	
01U	01U046			---	---	---	---	---	---	---	
01U	01U060			---	---	---	---	---	---	---	
01U	01U072			---	---	---	---	---	---	---	
01U	01U085			---	---	---	---	---	---	---	
Operable Unit 3											
03U	03U673			Q,L(A)	---	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)	---	Q,L(A)	OR	2.a	
03L	03L832			L(A)	---	L(A)	---	L(A)	---	2.a	
03L	03L848			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
03L	03L854			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
03L	03L859			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
03L	03L860			L(A)	---	L(A)	---	L(A)	---	2.a	
03L	03L861			---	---	---	---	---	---	---	Abandoned FY06
03L	476837	MW15H		---	---	---	---	---	---	---	
PC	04U414	414U4	(6)	Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
PC	04U673			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
PC	04U832			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	Contingency Action for FY08

FY 2022 - FY 2026 Monitoring Plan for Groundwater Monitoring Wells

Well Information			Notes	June 22	June 23	June 24	June 25	June 26	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
PC	04U845			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	Contingency Action for FY08
PC	04U848			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
PC	04U851		(6)	Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
PC	04U852			---	---	---	---	---	---	---	Abandoned FY09
PC	04U854			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
PC	04U859			Q,L(A)	---	Q,L(A)	---	Q,L(A)	OR	2.a	
PC	04U860			Q,L(A)	---	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)	---	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)	---	Q,L(A)	OR	2.a	
Well Inventory											
(Entries under "Notes" refer to the well inventory category)											
---	200180	Town & Country Golf Course	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	2279 Marshal Ave
---	200522	Windsor Green	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	Silver Lake Rd & Cty Rd E
---	200523	Windsor Green	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	Silver Lake Rd & Cty Rd E
---	234421	BioClean (BioChem)	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	2151 Mustang Dr
---	234544	R&D Systems	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	2201 Kennedy St NE
---	249632	Montzka, Harold	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	2301 N Upland Crest NE
---	433298	Town & Country Golf Course	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	2279 Marshall Ave
---	509052	Shriners Hospital	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	2025 E River Rd
---	537801	Midway Industrial	1b	---	---	Q(B)	Q(B)	---	Well Inventory	---	4759 Old Hwy 8
---	756236	Alcan	1c	---	---	Q(B)	Q(B)	---	Well Inventory	---	150 26th Ave SE
---	UNK057310	Murlowski	2a	---	---	Q(B)	Q(B)	---	Well Inventory	---	1589 26th Avenue NW
---	200176	Waldorf Paper Products	2b	---	---	Q(B)	Q(B)	---	Well Inventory	---	2236 Myrtle Ave
---	249007	Walton, Toni	2b	---	---	Q(B)	Q(B)	---	Well Inventory	---	4453 Old Hwy 10
---	S00002	Midland Hills Country Club	2b	---	---	Q(B)	Q(B)	---	Well Inventory	---	2001 N Fulham St
---	200076	Old Dutch Foods, Inc	2c	---	---	Q(B)	Q(B)	---	Well Inventory	---	2375 Terminal Rd
---	236439	Waldorf Paper Products	2c	---	---	Q(B)	Q(B)	---	Well Inventory	---	2250 Wabash Ave

Notes:
The next major sampling event for Well Inventory will be in June 2024 (conducted every 4 years)
All of the Site I shallow groundwater wells were sealed in FY14.

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Appendix A.2

Remedial Treatment Systems

Appendix A.2
FY 2022 - FY 2026 Monitoring Plan for Remedial Treatment Systems

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 (Active Wells) [3]
Treatment System Influent	Monthly	Pumping Volumes
	Monthly	Water Quality (Active Wells) [3]
Treatment System Effluent	Monthly	Water Quality (Active Wells) [3]

Notes:

(1) Performed by the City of New Brighton using their Sampling and Analysis Plan.

(2) The required analyte list for each specific site is presented in Appendix A-4.

(3) VOC List in Appendix A.4. 1,4-Dioxane samples to be collected and analyzed annually (June) at active extraction wells and Treatment System Effluent

TCAAP = Twin Cities Army Ammunition Plant

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Appendix A.3

Surface Water

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Appendix A.3
FY 2022 - FY 2026 Monitoring Plan for Surface Water

Analysis	Analytical Method	Units	Site K Effluent (Outfall 010)	Site C Surface Water Locations (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			

Notes:

A = Annually in June

gal = Gallons

M = Measurement required once per month

mg/L = Milligram(s) per liter

Q = Analysis required once per quarter

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Appendix A.4

Site Specific Lists of Required Analytes

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Appendix A.4
Site-Specific Lists of Required Analytes

OU1 (DEEP GROUNDWATER) (1)

Analyte	Cleanup Levels
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
1,4 Dioxane (7)	1

SITE A (SHALLOW GROUNDWATER) (2)

Analyte	Cleanup Levels
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 three wells: 01U103, 01U902 and 01U904 (June only)

SITE C (SHALLOW GROUNDWATER) (3)

Analyte	Cleanup Levels
Lead	15

SITE I (SHALLOW GROUNDWATER) (2)

Analyte	Cleanup Levels
1,2-Dichloroethene (*cis* and *trans*)	70
Trichloroethene	30
Vinyl Chloride	0.2

BLDG 102 SHALLOW GROUNDWATER (4)

Analyte	Cleanup Levels
Vinyl Chloride(5)	0.18
cis -1,2-Dichloroethene	70
Trichloroethene	5
1,1-Dichloroethene	6

SITE K (SHALLOW GROUNDWATER) (2)

Analyte	Cleanup Levels
1,2-Dichloroethene (cis and trans)	70
Trichloroethene	30

OU2 (DEEP GROUNDWATER) (2)

Analyte	Cleanup Levels
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
1,4 Dioxane (7)	1

OU3 (DEEP GROUNDWATER) (6)

Analyte	Cleanup Levels
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)

Analytical Methods:
VOCs: SW-846 Method 8260C
Antimony and Lead: SW-846 Method 6020

Note: Cleanup evels (in micrograms per liter [µg/L]) from each Record of Decision are shown above 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 used by the monitoring organization, if so desired. 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 K Unit 3, and TGRS extraction wells.

(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.
(7) Value is the Minnesota Department of Health Health Risk Level. Not an official cleanup level.

OU = Operable Unit
TRGS = Twin Cities Army Ammunition Plant Groundwater Recovery System
VOC = volatile organic compound

Appendix A.5

New Brighton Operating Rates

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Table D-1
Remedial Production Ranges for Normal Operation
(Effective January 2008)

NBCGRS Well	Estimated Physical Capacity Range			Remedial Production Range		Flow Rate Equivalents (24-hr Production Basis)	
	Normal Individual Low (gpm)	Normal Individual High (gpm) (See Note 1)	Peak Combined High (gpm) (See Note 1)	Lower Limit (MGD)	Upper Limit (MGD)	Lower Limit (gpm)	Upper Limit (gpm)
3 (See Note 2)	300	600	400	0.000	0.576	0	400
4 (See Note 2)	500	1,100	900	1.152	1.296	800	900
3 + 4 (See Note 2)	800	n/a	1,300	1.152	1.872	800	1,300
5	400	850	750	0.864	1.080	600	750
6	400	850	750	0.000	1.080	0	750
5 + 6 (See Note 3)	800	1,700	1,500	0.864	2.160	600	1,500
14	500	1,200	1,000	0.000	1.440	0	1,000
15	500	1,200	1,000	1.152	1.440	800	1,000
TOTAL WELL CAPACITY	2,600	n/a	4,800	**3.168**	**6.912**	**2,200**	**4,800**
TREATMENT CAPACITY		3,200	5,000				
NBCGRS SYSTEM LIMIT		3,200	4,800				

NOTES:

1. During peak production periods with all wells running, individual well capacities are limited by interference, high drawdown, and high system head losses
2. While shown individually to illustrate normal operational intent, enforceable target is for combined Well 3 plus Well 4 since the wells are located in close proximity and effectively operate as a single point source. Wells 3 and 4 can be used interchangeably to produce total daily target.
3. While shown individually to illustrate normal operational intent, enforceable target is for combined Well 5 plus Well 6 since the wells are located in close proximity and effectively operate as a single point source. Wells 5 and 6 can be used interchangeably to produce total daily target.

15 FEB 2008
Michael R. Fix
Twin Cities Army Ammunition Plant

2/15/08
Grant M. Wyffels
City of New Brighton

Table D-2
Alternate Remedial Production Ranges for Contingent Events
(Effective January 2008)

Event	Normal Operation			Well 3 and/or 4 Down			Well 5 and/or 6 Down			Well 14 Down			Well 15 Down		
Well / Pair	Priority	Lower Limit (MGD)	Upper Limit (MGD)	Priority	Lower Limit (MGD)	Upper Limit (MGD)	Priority	Lower Limit (MGD)	Upper Limit (MGD)	Priority	Lower Limit (MGD)	Upper Limit (MGD)	Priority	Lower Limit (MGD)	Upper Limit (MGD)
3 + 4	2	1.152	1.872	NA	0.000	0.000	2	1.440	1.872	2	1.152	1.872	1	1.440	1.872
5 + 6	3	0.864	2.160	2	1.728	2.160	NA	0.000	0.000	3	0.864	2.160	2	1.728	2.160
14	4	0.000	1.440	3	1.152	1.440	3	1.152	1.440	NA	0.000	0.000	3	0.720	1.152
15	1	1.152	1.440	1	1.152	1.440	1	1.152	1.440	1	1.152	1.440	NA	0.000	0.000
Total		3.168	6.912		4.032	5.040		3.744	4.752		3.168	5.472		3.888	5.184

Appendix B

Monitoring Well Index

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WELL INDEX FOR NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE

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 regarding work at the New Brighton/Arden Hills Superfund Site (including private wells and off-site monitoring wells sampled by the Army)
- Are owned by the Army
- Are located within the boundaries of Operable Unit (OU)2 (the former Twin Cities Army Ammunition Plant [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), which 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 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 this 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} centimeters per second (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 25-450 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).

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 Northrop Grumman (Formerly Alliant Techsystems/Orbital ATK) 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 landowners. 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 2022 Appendix B Table B-1 shows the most current well index and is sorted by Minnesota unique well number. 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.

To search for detailed records regarding a well, open the appropriate file within the Appendix B Attachment 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
- Sealing records

FY 2022 UPDATE

No new wells 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 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

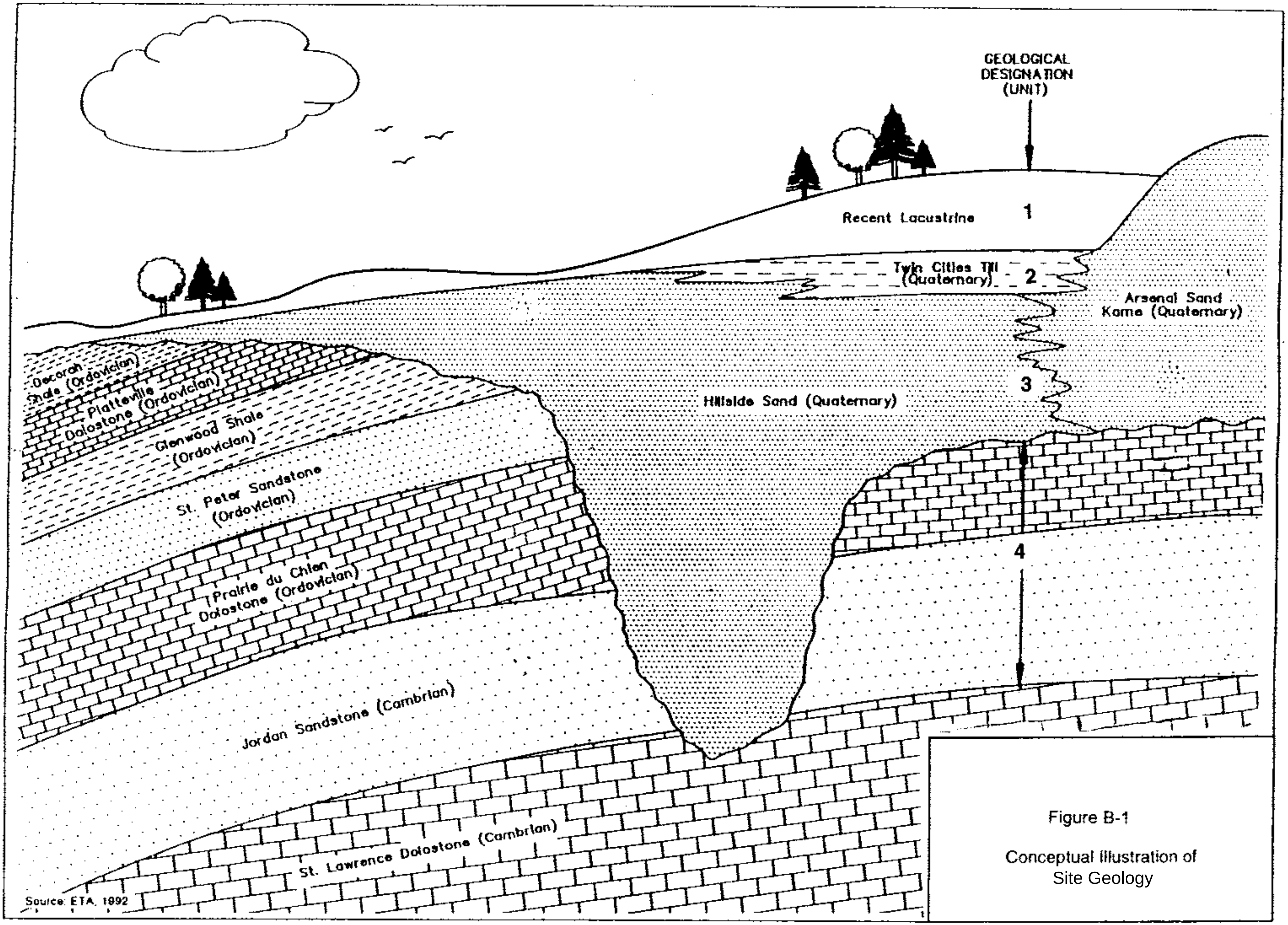
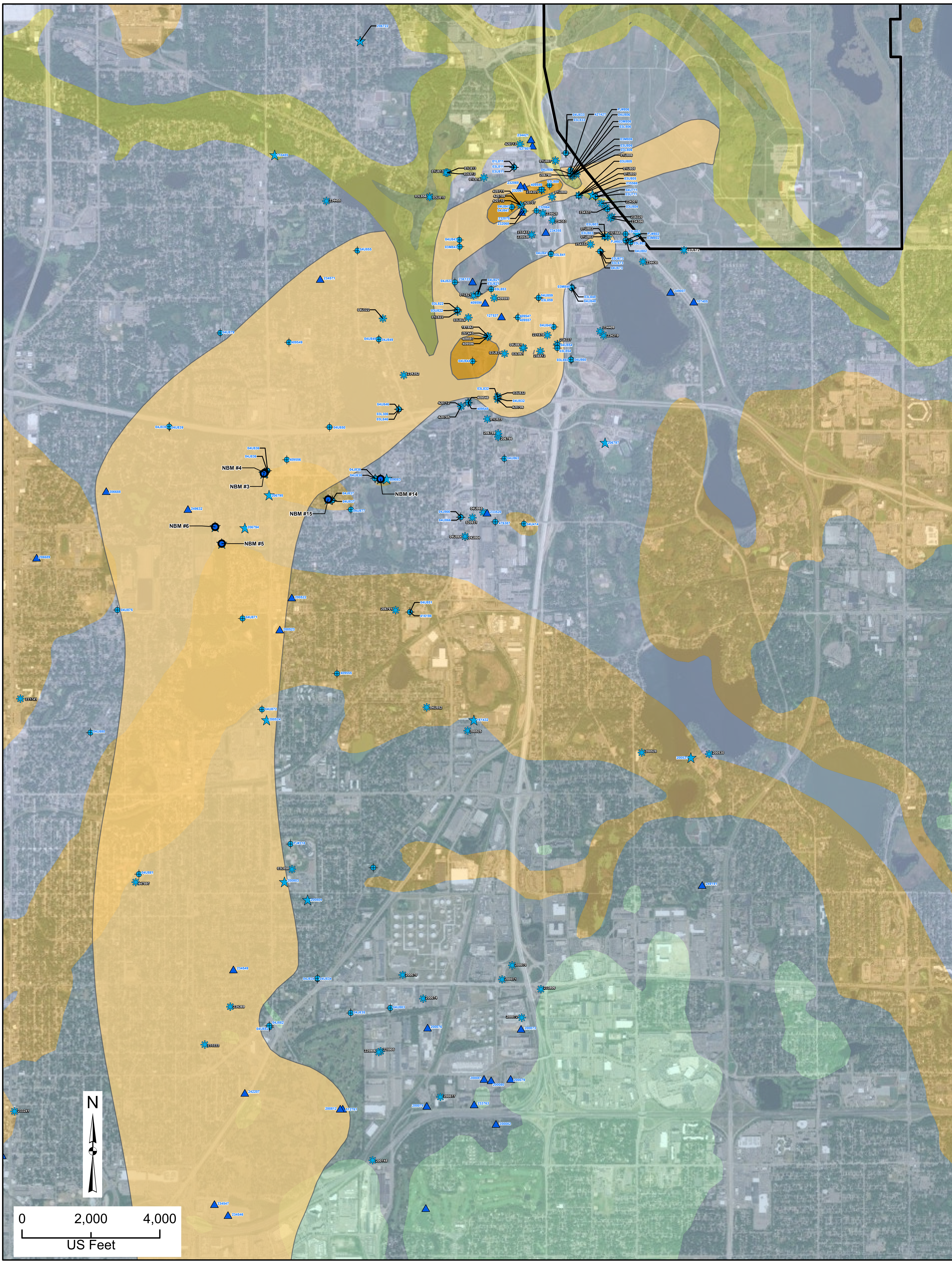
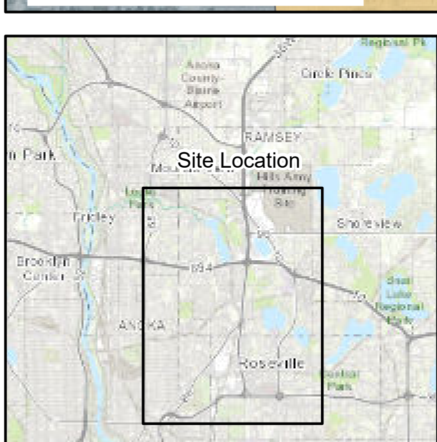


Figure B-1

Conceptual Illustration of Site Geology





Legend

- Monitoring Well
- Private Well
- Public Supply Well
- Sealed Well/Abandoned Well
- New Brighton Municipal Wells
- Operable Unit 2

2022 Trichloroethene Concentrations (μg/L)

- 5-100 μg/L
- 100-1,000 μg/L

Bedrock Geology

- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure B-2
Annual Performance Report
OU1 and OU3 Well Location
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

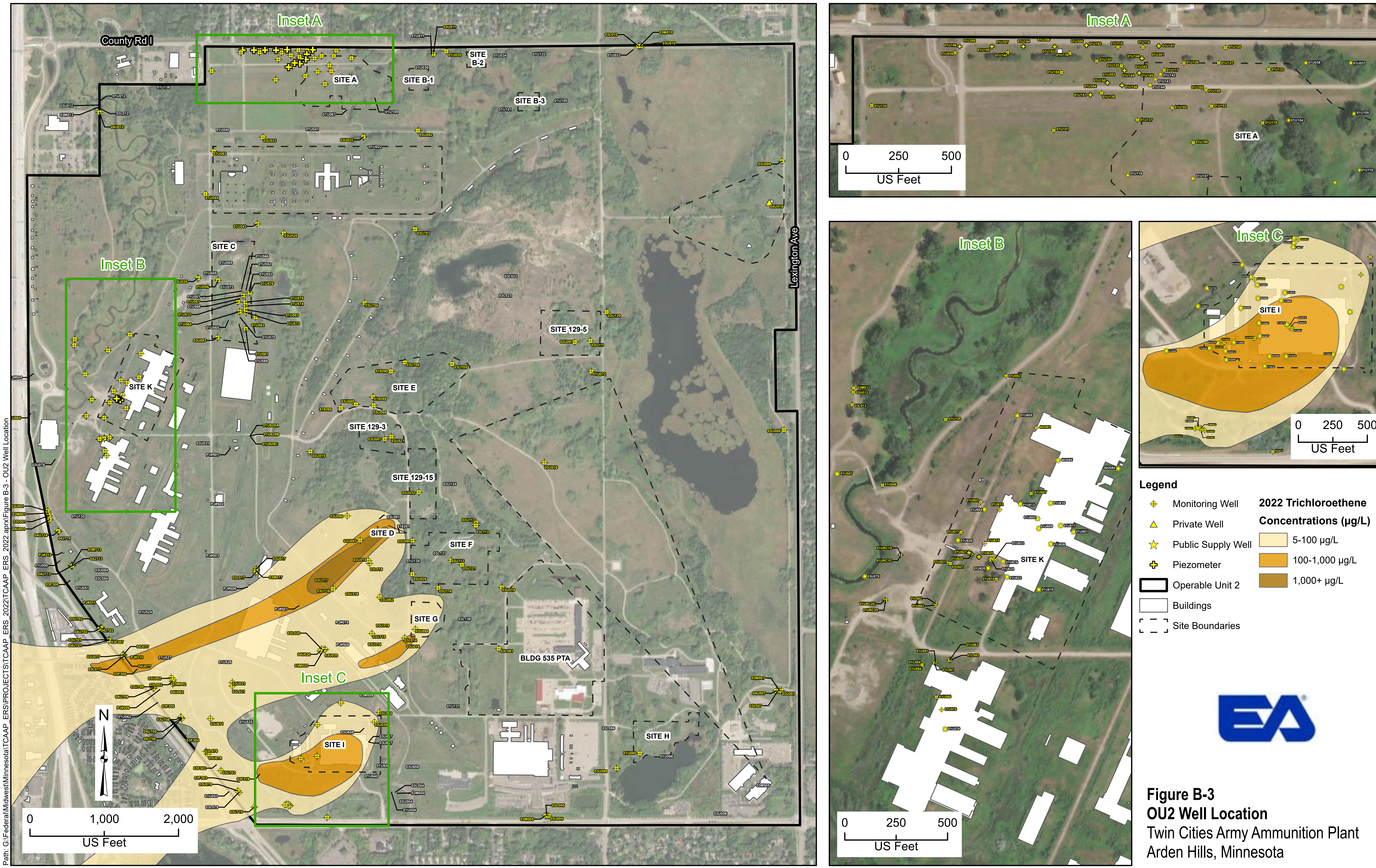


Figure B-3
OU2 Well Location
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Appendix C

Data Collection, Management, and Presentation

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Appendix C.1

Data Collection, Management, and Presentation

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DATA COLLECTION, MANAGEMENT, AND PRESENTATION

INTRODUCTION

A groundwater monitoring program was initiated in January 1984 to obtain water level and water quality data at Operable Unit (OU) 1, OU2 and OU3. Each year has been divided into quarters with each quarter assigned a number. Accordingly, FY 2022was comprised of Quarter 153 (October through December), Quarter 154 (January through March), Quarter 155 (April through June), and Quarter 156 (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” (PIKA-Arcadis JV, Revision 18, 22 June 2020), which covers all sites.

Prior to 1 November 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 1 November 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.

GROUNDWATER LEVELS AND GROUNDWATER QUALITY

Data Collection and Management

Groundwater level and groundwater quality data were collected in accordance with the FY 2022 Annual Monitoring Plan (Appendix A), which established the monitoring responsibilities for both the Army and Northrop Grumman (formerly Orbital ATK). 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 2022 was therefore a minor sampling event. As of FY 2022, sampling only includes 1,4-dioxane analyses at OU1 and OU2 deep groundwater locations after determining it was not a chemical of concern (COC) at the Building 102 Site.

Water level monitoring and water sampling were conducted by JV for the Army and by GHD (formerly Conestoga-Rovers & Associates, Inc.) for Northrop Grumman (formerly Orbital ATK). Laboratory analysis for all sites was performed by Pace Analytical National Center for Testing & Innovation Laboratory, Mt Juliet, Tennessee. 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 COCs. 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 COC. Appendix C.2 presents deviations from the FY 2022 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 and validation was performed by GHD for both EA- and GHD-collected data. Data verification and validation information was compiled into quarterly Data Usability Reports (DURs) that were submitted to the Minnesota Pollution Control Agency (MCPA) and United States Environmental Protection Agency (EPA) for review. If any MPCA/EPA-requested revisions were necessary, a final DUR was resubmitted. The final MPCA/EPA approval letter has not yet been received for the FY 2022 Q4 DUR 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).

Groundwater Elevation Contour Maps

The most extensive water level monitoring events performed during FY 2022 were in May-June (Quarter 155). This data was used to prepare groundwater elevation contour maps for deep groundwater at OU1/OU3 and OU2 (OU3 is shown on the same figure as OU1 in the OU1 section of this report), and for shallow groundwater at Sites A, C, and K and Building 102. 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.

Groundwater Quality Contour Maps and Cross-Sections

The most extensive sampling events performed during FY 2022 were in June (Quarter 155). These 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 Sites A, C, and 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 corresponding 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 COCs 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. A second section lines passes through the source area at Site I and follows the north plume (OU1) south to well 04U852, drawn further east but running roughly parallel with the first section line.

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; however, they 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 COC 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 COC 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 COC 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 COC 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.

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Appendix C.2

Deviations From Monitoring Program

DEVIATIONS FROM MONITORING PROGRAM

DEEP GROUNDWATER VOC SITES

No deviations.

OU1: DEEP GROUNDWATER

No deviations.

OU2: SITE A SHALLOW GROUNDWATER

May 2022:
01U350: Sampled as an alternative to well 01U108, which was sealed in 2020.

OU2: SITE C SHALLOW GROUNDWATER

No deviations.

OU2: SITE C SURFACE WATER

No deviations.

OU2: BUILDING 102 SHALLOW GROUNDWATER

All Wells: Sample VOCs; as per the 2020 QAPP (rev18) update, the project laboratory could not provide reporting limits as low as the Building 102 cleanup level.

OU2: SITE K SHALLOW GROUNDWATER

No deviations.

OU2: SITE I SHALLOW GROUNDWATER

No deviations.

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Appendix C.3

Regulatory Approvals of Data Usability Reports

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Brighton, MI 48116
Telephone: 734-369-3410
Fax: 734-369-3524
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28 June 2022

TECHNICAL MEMORANDUM

TO: Viral Patel (USEPA), Brigitte Hay (MPCA), and Katy Grant (MPCA)

FROM: Arthur Peitsch, EA Project Manager

CC: Linda Albrecht (USAEC), Shawn Horn (GHD), Tom Lineer (U.S. Army), and David Brown (NGIS)

SUBJECT: Final Twin Cities Army Ammunition Plant Data Usability Report #113, Fiscal Year 2022 1st Quarter Monitoring (October – December 2021)

EA Engineering, Science, and Technology, Inc. (EA) is pleased to present this final Data Usability Report (DUR) #113 for the Fiscal Year 2022 1st Quarter Monitoring. This report provides the analytical data summary and data verification for extraction well and treatment system sampling conducted at Operable Unit (OU) 2 Deep Groundwater Site and Site K. A technical memorandum for each site is attached. The data validation/verification confirmed that all data are valid and usable for project purposes.

Technical Memorandum

March 24, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 651 524 6872
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/185	**Ref. No.**	039669-50
Subject	First Quarter DUR FY 2022 Site K Results December 2021		

This memo provides the analytical data summary for the first quarter FY 2022 sampling conducted at Site K. Tables 1 and 2 provide the treatment system sampling results through FY 2022 first quarter. The data verification memo is included as Attachment 1.

Regards

Ruth Mickle

Ruth Mickle
Chemist

Table 1

VOC Concentrations in Site K Treatment System Samples
FY 2022 - Through 1st Quarter

				1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
			MDL	**0.100**	**0.188**	**0.0819**	**0.126**	**0.630**	**0.149**	**0.190**	**0.234**
			RL	**1.00**	**1.00**	**1.00**	**1.00**	**5.00**	**1.00**	**1.00**	**1.00**
			Units	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
Location	**Date**	**Sample ID**									
EFF	12/10/2021	W-211210-EM-101		<1.00	<1.00	<1.00	9.51	--	0.354 JP	0.938 JP	<1.00
EFF	12/10/2021	W-211210-EM-102	FD	<1.00	<1.00	<1.00	10.6	--	0.441 JP	1.13	<1.00
INF	12/10/2021	W-211210-EM-103		<1.00	0.463 JP	<1.00	--	178	<1.00	40.5	1.58

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate

Table 2

Inorganic Water Quality Results in Site K Treatment System Samples
FY 2022 - Through 1st Quarter

Location	Date	Sample ID		Copper	Lead	Mercury	Silver	Zinc	Cyanide (total)	Phosphorus
			MDL	**1.51**	**0.849**	**0.100**	**0.0700**	**3.02**	**1.80**	**35.0**
			RL	**5.00**	**2.00**	**0.200**	**2.00**	**25.0**	**5.00**	**100**
			Units	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
EFF	12/10/2021	W-211210-EM-101		<5.00	<2.00	<0.200	<2.00	<25.0	<5.00	<281 UB64.1

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.

Attachment 1

Data Verification Memo

Technical Memorandum

March 07, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/183	**Ref. No.**	039669-50
Subject	**Data Verification** **TCAAP Site K Sampling** **December 10, 2021** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on December 10, 2021, at the TCAAP Site K in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

The Power of Commitment

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP Site K	
SDG #: L1441669	Sample Collection Date(s):12/10/21
Matrix: Water	Sample Analysis Date(s): 12/15/21-1/14/22
Method: SW 8260D, Inorganics (see item 15)	Date Reviewed:2/11/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	N
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y, see note
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – December 2021

Sample ID	Sample Location
W-211210-EM-101	EFF
W-211210-EM-102	EFF duplicate
W-211210-EM-103	INF
TRIP BLANK	Trip blank

Item	Comment
4	The phosphorus blank yielded a method blank detection (64.1 ug/l). Since the associated sample result was less than five times the blank amount, the associated sample result (W-211210-EM-101) was qualified as nondetect (UB64.1).
15	Metals are analyzed using Method 6020 for Copper, Lead, Silver and Zinc, and Method 7470A (CVAA) for Mercury. Cyanide is analyzed using SM 4500CN E. Total Phosphorus is analyzed using MCAWW Method 365.4.

Table 1

Laboratory Precision and Accuracy Limits
Site K - TCAAP Site
December 2021 Sampling Event

Criteria	Parameter	Pace #L1441669-batch WG1789433, WG1793185 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	99.6-113	70-130	NA
	4-Bromofluorobenzene	92.7-105	77-126	NA
	Toluene-d8	105-113	80-120	NA

Criteria	Parameter	batch WG1789433 Recoveries:	% Recovery Limits	RPD Limit
LCS				
VOC	1,1-Dichloroethane	86.6/99.0 (13.4)	70-126	20
	1,2-Dichloroethane	94.0/101 (6.78)	70-128	20
	1,1-Dichloroethene	85.8/91.4 (6.32)	71-124	20
	cis-1,2-Dichloroethene	93.2/107 (14.0)	73-120	20
	trans-1,2-Dichloroethene	91.8/101 (9.54)	73-120	20
	Trichloroethene	104/97.4 (6.36)	78-124	20
	Vinyl Chloride	87.2/95.6 (9.19)	67-131	20

Criteria	Parameter	batch WG1793185 Recoveries:	% Recovery Limits	RPD Limit
LCS				
VOC	cis-1,2-Dichloroethene	109/103 (4.91)	73-120	20

Criteria	Parameter	batch WG1800124 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Metals	Copper	89.3	80-120	NA
	Lead	94.9	80-120	NA
	Silver	101	80-120	NA
	Zinc	96.9	80-120	NA

Criteria	Parameter	batch WG1792067 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Metals	Mercury	109	80-120	NA

Table 1

Laboratory Precision and Accuracy Limits
Site K - TCAAP Site
December 2021 Sampling Event

Criteria	Parameter	batch WG1790337 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Gen Chem	Cyanide	109	80-120	NA

Criteria	Parameter	batch WG1789564 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Gen Chem	Total Phosphorus	105	80-120	NA

Notes:
RPD - Relative Percent Difference
NA - Not applicable

Table 2

Field Duplicate Summary
Site K - TCAAP Site
SDG ID: L1441669
December 2021 Sampling Event

VOC Parameter	W-211210-EM-101 EFF (ug/l)	W-211210-EM-102 EFF Dup (ug/l)	RPD/ Difference	Difference Limit (+/-RL) or RPD Limit
cis-1,2-Dichloroethene	9.51	10.6	10.8	25
trans-1,2-Dichloroethene	0.354J	0.441J	0.087	1
Trichloroethene	0.938J	1.13	0.192	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds
J - Estimated concentration

Technical Memorandum

March 24, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 612 524 6872
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/11	**Ref. No.**	12563220-32
Subject	First Quarter DUR FY 2022 OU2 Deep Groundwater (TGRS) Results October - December 2021		

This memo provides the analytical data summary for the first quarter FY 2022 sampling conducted at the OU2 Deep Groundwater Site. Tables 1 and 2 provide the treatment system and extraction well sampling results for FY 2022 first quarter. The data validation and verification memos are included as Attachment 1.

Regards,

Ruth Mickle
Chemist

Table 1

VOC Concentrations in TGRS Treatment System Samples
FY 2022 - Through 1st Quarter

				1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
			MDL	**0.149**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**
			RL	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
			Units	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
Location	**Date**	**Sample ID**								
TGRSE	10/08/2021	W-211008-EM-01		0.236 JP	<1.00	<1.00	<1.00	<1.00	<1.00	2.07 JL141 JD25
TGRSE	11/15/2021	W-211115-EM-01		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.376 JP
TGRSE	11/15/2021	W-211115-EM-02	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.360 JP
TGRSE	12/10/2021	W-211210-EM-12		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.476 JP
TGRSE	12/10/2021	W-211210-EM-13	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.460 JP
TGRSI	10/08/2021	W-211008-EM-02		31.4	1.66	2.52	<1.00	2.56	1.20	176 JL141 JD25
TGRSI	10/08/2021	W-211008-EM-03	FD	36.7	1.91	2.97	<1.00	2.85	1.29	201 JL141 JD25
TGRSI	11/15/2021	W-211115-EM-03		1.38	0.899 JP	0.714 JP	<1.00	1.31	0.956 JP	33.4
TGRSI	12/10/2021	W-211210-EM-14		1.97	0.857 JP	0.943 JP	<1.00	1.34	1.35	41.8

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
JD# - Result is qualified as estimated due to outlying RPD from lab control sample analyses.
The following numerical value is the associated RPD from duplicate control samples.
JL# - Result is qualified as estimated due to outlying percent recovery from lab control sample analyses.
The following numerical value is the outlying percent recovery from lab control sample analyses.
< - Not detected at the associated reporting limit.
FD - Field Duplicate

Table 2

VOC Concentrations in TGRS Extraction Well Samples
FY 2022 - Through 1st Quarter

Location	Common Name	Date	Sample ID		1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
				MDL	**0.149**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**
				RL	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
				Units	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
03F302	B1	12/10/2021	W-211210-EM-11		4.81	0.650 JP	0.867 JP	<1.00	4.87	1.96	91.4
03F304	B3	12/10/2021	W-211210-EM-09		<1.00	0.160 JP	0.195 JP	<1.00	0.135 JP	<1.00	2.24
03F305	B4	12/10/2021	W-211210-EM-08		3.07	1.25	1.42	<1.00	1.09	0.558 JP	50.2
03F306	B5	12/10/2021	W-211210-EM-04		2.63	1.55	1.92	<1.00	0.727 JP	4.02	59.3
03F306	B5	12/10/2021	W-211210-EM-05	FD	2.31	1.49	1.76	<1.00	0.745 JP	4.24	62.4
03F307	B6	12/10/2021	W-211210-EM-01		0.478 JP	0.203 JP	0.356 JP	<1.00	0.165 JP	<1.00	21.4
03F319	B13	12/10/2021	W-211210-EM-10		4.91	1.79	1.37	<1.00	9.68	0.452 JP	114
PJ#309	B8	12/10/2021	W-211210-EM-07		0.246 JP	0.195 JP	0.290 JP	<1.00	0.132 JP	<1.00	4.66
PJ#309	B8	12/10/2021	W-211210-EM-06	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
PJ#310	B9	12/10/2021	W-211210-EM-02		0.745 JP	0.849 JP	1.13	<1.00	0.321 JP	<1.00	19.4
PJ#310	B9	12/10/2021	W-211210-EM-03	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Attachment 1

Data Verification Memos

Technical Memorandum

January 04, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/46	**Ref. No.**	11221407-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **October 8, 2021** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on October 8, 2021, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

The Power of Commitment

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1416036	Sample Collection Date(s):10/8/21
Matrix: Water	Sample Analysis Date(s): 10/20/21
Method: SW 8260	Date Reviewed:12/22/21
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	N
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

<u>*Required Attachments:*</u> LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – October 2021

Sample ID	Sample Location
W-211008-EM-01	TGRSE
W-211008-EM-02	TGRSI
W-211008-EM-03	TGRSI duplicate

Item	Comment
6	One trichloorethene recovery was above the upper control limit. Also the relative percent difference for the LCS/LCSD was outside the control limit. The associated trichloroethene detections for samples W-211008-EM-01, -02, -03 were qualified estimated JL141 JD25.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
October 2021 Sampling Event

Criteria	Parameter	Pace #L1416036-batch 1759854 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	92.6-97.4	70-130	NA
	4-Bromofluorobenzene	104-106	77-126	NA
	Toluene-d8	104-105	80-120	NA

Criteria	Parameter	batch 1759854 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	95.4/99.6 (4.31)	70-126	20
	1,2-Dichloroethane	96.0/101 (5.08)	70-128	20
	1,1-Dichloroethene	89.4/93.0 (3.95)	71-124	20
	cis-1,2-Dichloroethene	103/106 (2.48)	73-120	20
	Tetrachloroethene	97.2/101 (4.03)	72-132	20
	1,1,1-Trichloroethane	91.8/99.2 (7.75)	73-124	20
	Trichloroethene	109/141 (25.0)	78-124	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1416036
October 2021 Sampling Event

VOC Parameter	W-211008-EM-02 TGRSI (ug/l)	W-211008-EM-03 TGRSI duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
1,1-Dichloroethane	1.66	1.91	0.25	1
1,1-Dichloroethene	2.52	2.97	0.45	1
cis-1,2-Dichloroethene	2.56	2.85	0.29	1
Tetrachloroethene	1.20	1.29	0.09	1
1,1,1-Trichloroethane	31.4	36.7	15.6	25
Trichloroethene	176	201	13.3	25

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds

Technical Memorandum

January 18, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/47	**Ref. No.**	11221407-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **November 15, 2021** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on November 15, 2021, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

Encl.

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1431682	Sample Collection Date(s):11/15/21
Matrix: Water	Sample Analysis Date(s): 11/22/21
Method: SW 8260	Date Reviewed:1/4/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – November 2021

Sample ID	Sample Location
W-211115-EM-01	TGRSE
W-211115-EM-02	TGRSE duplicate
W-211115-EM-03	TGRSI

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
November 2021 Sampling Event

Criteria	Parameter	Pace #L1431682-batch WG1778116 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	113-116	70-130	NA
	4-Bromofluorobenzene	97.6-101	77-126	NA
	Toluene-d8	101-104	80-120	NA

Criteria	Parameter	batch WG1778116 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	94.6/91.6 (3.22)	70-126	20
	1,2-Dichloroethane	99.4/98.2 (1.21)	70-128	20
	1,1-Dichloroethene	90.8/87.0 (4.27)	71-124	20
	cis-1,2-Dichloroethene	90.0/87.8 (2.47)	73-120	20
	Tetrachloroethene	91.0/82.4 (9.92)	72-132	20
	1,1,1-Trichloroethane	93.0/87.2 (6.44)	73-124	20
	Trichloroethene	113/106 (5.66)	78-124	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1431682
November 2021 Sampling Event

VOC Parameter	W-211115-EM-01 TGRSE (ug/l)	W-211115-EM-01 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	0.376 J	0.360 J	0.016	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds
J - Estimated concentration

Technical Memorandum

January 19, 2022

To	Shawn Horn	**Tel**	612 524-6872
		Email	Ruth.mickle@ghd.com
From	Ruth Mickle/mg/6	**Ref. No.**	12563220
Subject	**Data Validation** **TCAAP TGRS Sampling** **December 10, 2021** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data validation form for samples collected on December 10, 2021, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

ANALYTICAL DATA VALIDATION FORM (VOCs)

SDG NUMBER: L1441667

PROJECT: TCAAP TGRS

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 12/10/21 NO. OF SAMPLES: 15

ANALYSES REQUESTED: Method 8260 (VOCs)

SAMPLE NO. see Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:____

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____ No X

Contractual Violations Yes____ No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.
Yes X____No _____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.
Yes X____No _____

B. Holding Times

1. The required holding times were met for all analyses (Time of sample receipt to time of analysis (VOA) or extraction and from extraction to analysis).
Yes X____No _____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.
Yes X____No _____

2. Samples were received at the required temperature and preservation.
Yes X____No _____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for all compounds for all analyses met the QAPP or method criteria.
Yes X____No_____NA _____

2. The relative standard deviation (RSD) for all compounds in the standard was less than 20%, with an allowance of up to 40% for the poor responders. Per the method, a correlation coefficient "r" of > 0.99 is also acceptable for compounds,
Yes X____No____NA _____

3. The 12 hour system Performance Check was performed as required in SW-846.
Yes X____No____NA _____

B. Continuing Calibration

1. The RRF 50 standard was analyzed for each analysis at the required frequency and the QC criteria were met.
Yes X__No____NA ___

2. The percent difference (%D) limits for all compounds is $\pm$20%, with an allowance of up to 40% for the poor responders per the current validation guidance, were met.
Yes X____No_____NA _____

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The BFB performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met.
Yes X____No_____NA _____

V. INTERNAL STANDARDS

The Internal Standards met the 100% upper and -50% lower limits criteria and the Retention times were within

the required windows.
Yes X No_____NA _____

VI. SURROGATE
Surrogate spikes were analyzed with every sample.
Yes X No _____

And met the recovery limits defined in the QAPP (i.e., Current lab limits).
Yes X No _____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every analysis performed and for every 20 samples or for every matrix whichever is more frequent.
Yes X No _____

B. The MS and MSD percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X No _______
See Table 2

C. The MSD relative percent differences (RPD) were within the QAPP limits.

Yes X No_____NA _____
See Table 2

VIII. LABORATORY CONTROL SAMPLE
A. A Laboratory Control Samples (LCS) was analyzed for every analysis batch or for every 20 samples.
Yes X No _____

The LCS percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X No ____
See Table 2

IX. BLANKS
A. Method Blanks were analyzed at the required frequency and for each matrix and analysis.
Yes X No _____

B. No blank contamination was found in the Method Blank.
Yes______No X

One method blank (batch WG1789308) yielded a low-level tetrachloroethene detection (0.384 ug/l). Since the associated detection (sample W-211210-EM-04) was greater than five times the blank detection, no data qualification was required,

C. If Field/Equipment Rinsate Blanks were identified, no blank contamination was found.

Yes X No_____NA _____

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the RPD or % recovery criteria for the project.

Yes X____No_____NA _____
See Table 3

XI. SYSTEM PERFORMANCE
A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.
Yes X____No_____NA _____
B. The suggested EQL's for the sample matrices in this set were met
Yes X____No_____NA _____

XII. TCL COMPOUNDS
A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.
Yes X____No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compounds in each internal standards quantitation set.
Yes X____No_____NA _____

XIII. TENTATIVELY IDENTIFIED COMPOUNDS
TICs were properly identified and met the library identification criteria.
Yes______No_____NA X___

XIV. OVERALL ASSESSMENT OF THE CASE

The data are usable for project purposes without qualification.

Table 1

Sample Identification Numbers
TGRS - TCAAP Site
SDG ID: L1441667
December 2021 Sampling Event

Sample ID	Sample Location
W-211210-EM-01	B6 (03F307)
W-211210-EM-02	B9 (PJ#310)
W-211210-EM-03	B9 (PJ#310) field blank
W-211210-EM-04	B5 (03F306)
W-211210-EM-05	B5 (03F306) duplicate
W-211210-EM-06	B8 (PJ#309) field blank
W-211210-EM-07	B8 (PJ#309)
W-211210-EM-08	B4 (03F305)
W-211210-EM-09	B3 (03F304)
W-211210-EM-10	B13 (03F319)
W-211210-EM-11	B1 (03F302)
W-211210-EM-12	Treatment System Effluent
W-211210-EM-13	Treatment System Effluent duplicate
W-211210-EM-14	Treatment System Influent
TRIP BLANK	Trip Blank

Table 2

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
SDG ID: L1441667
December 2021 Sampling Event

Criteria	Parameter	Pace #L1441667 batch WG1789308 & WG1789433 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	110-130	70-130	NA
	4-Bromofluorobenzene	90.3-97.9	77-126	NA
	Toluene-d8	94.6-116	80-120	NA

Criteria	Parameter	W-211210-EM-01 Recoveries (RPD):	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	94.9/95.5 (0.604)	25-158	27
	1,2-Dichloroethane	121/119 (2.17)	29-151	27
	1,1-Dichloroethene	104/102 (1.64)	11-160	29
	cis-1,2-Dichloroethene	86.5/86.1 (0.446)	10-160	27
	Tetrachloroethene	104/108 (3.39)	10-160	27
	1,1,1-Trichloroethane	122/123 (0.910)	23-160	28
	Trichloroethene	108/92.0 (3.03)	10-160	25

Criteria	Parameter	batch WG1789308 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	86.6/92.8(6.91)	70-126	20
	1,2-Dichloroethane	116/119(2.04)	70-128	20
	1,1-Dichloroethene	90.0/98.8(9.32)	71-124	20
	cis-1,2-Dichloroethene	81.0/86.6(6.68)	73-120	20
	Tetrachloroethene	118/117(1.53)	72-132	20
	1,1,1-Trichloroethane	109/113(3.41)	73-124	20
	Trichloroethene	102/105(2.70)	78-124	20

Criteria	Parameter	batch WG1789433 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	86.6/99.0(13.4)	70-126	20
	1,2-Dichloroethane	94.0/101(6.78)	70-128	20
	1,1-Dichloroethene	85.8/91.4(6.32)	71-124	20
	cis-1,2-Dichloroethene	93.2/107(14.0)	73-120	20

Table 2

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
SDG ID: L1441667
December 2021 Sampling Event

Tetrachloroethene	100/106(5.63)	72-132	20
1,1,1-Trichloroethane	101/112(10.3)	73-124	20
Trichloroethene	104/97.4(6.36)	78-124	20

Note:
NA - Not Applicable

Table 3

Field Duplicate Summary
TGRS - TCAAP Site
SDG ID: L1441667
December 2021 Sampling Event

	W-211210-EM-04 B5 (03F306) (ug/l)	W-211210-EM-05 B5 (03F306) duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
1,1-Dichloroethane	1.55	1.49	0.06	1
1,1-Dichloroethene	1.92	1.76	0.16	1
cis-1,2-Dichloroethene	0.727 J	0.745 J	0.018	1
Tetrachloroethene	4.02	4.24	0.22	1
1,1,1-Trichloroethane	2.63	2.31	0.32	1
Trichloroethene	59.3	62.4	5.1	25

	W-211210-EM-12 Treatment System Effluent (ug/l)	W-211210-EM-13 Treatment System Effluent duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
Trichloroethene	0.476 J	0.460 J	0.016	1

Notes:
RL - Reporting limit
RPD - Relative Percent Difference
J - Estimated concentration

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21 September 2022

TECHNICAL MEMORANDUM

TO: Viral Patel (USEPA), Brigitte Hay (MPCA), and Katy Grant (MPCA)

FROM: Arthur Peitsch, EA Project Manager

CC: Linda Albrecht (USAEC), Shawn Horn (GHD), Tom Lineer (U.S. Army), and David Brown (NGIS)

SUBJECT: Final Twin Cities Army Ammunition Plant Data Usability Report #114, Fiscal Year 2022 2nd Quarter Monitoring (January – March 2022)

EA Engineering, Science, and Technology, Inc. (EA) is pleased to present this final Data Usability Report (DUR) #114 for the Fiscal Year 2022 2nd Quarter Monitoring. This report provides the analytical data summary and data verification for extraction well and treatment system sampling conducted at Operable Unit (OU) 2 Deep Groundwater Site and Site K. A technical memorandum for each site is attached. The data validation/verification confirmed that all data are valid and usable for project purposes.

Technical Memorandum

May 13, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 612 524 6872
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/19	**Ref. No.**	12563220-32
Subject	Second Quarter DUR FY 2022 OU2 Deep Groundwater (TGRS) Results January - March 2022		

This memo provides the analytical data summary for the second quarter FY 2022 sampling conducted at the OU2 Deep Groundwater Site. Tables 1 and 2 provide the treatment system and extraction well sampling results for FY 2022 second quarter. The data verification memos are included as Attachment 1.

Regards,

Ruth Mickle
Chemist

Table 1

VOC Concentrations in TGRS Treatment System Samples
FY 2022 - Through 2nd Quarter

				1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
			MDL	0.149	0.100	0.188	0.0819	0.126	0.300	0.190
			RL	1.00	1.00	1.00	1.00	1.00	1.00	1.00
			Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Location	Date	Sample ID								
TGRSE	10/08/2021	W-211008-EM-01		0.236 JP	<1.00	<1.00	<1.00	<1.00	<1.00	2.07 JL141 JD25
TGRSE	11/15/2021	W-211115-EM-01		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.376 JP
TGRSE	11/15/2021	W-211115-EM-02	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.360 JP
TGRSE	12/10/2021	W-211210-EM-12		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.476 JP
TGRSE	12/10/2021	W-211210-EM-13	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.460 JP
TGRSE	01/14/2022	W-220114-EM-01		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.364 JP
TGRSE	01/14/2022	W-220114-EM-02	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.435 JP
TGRSE	02/07/2022	W-220207-EM-01		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.673 JP
TGRSE	03/04/2022	W-220304-EM-01		0.157 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.02
TGRSE	03/04/2022	W-220304-EM-02	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.01
TGRSI	10/08/2021	W-211008-EM-02		31.4	1.66	2.52	<1.00	2.56	1.20	176 JL141 JD25
TGRSI	10/08/2021	W-211008-EM-03	FD	36.7	1.91	2.97	<1.00	2.85	1.29	201 JL141 JD25
TGRSI	11/15/2021	W-211115-EM-03		1.38	0.899 JP	0.714 JP	<1.00	1.31	0.956 JP	33.4
TGRSI	12/10/2021	W-211210-EM-14		1.97	0.857 JP	0.943 JP	<1.00	1.34	1.35	41.8
TGRSI	01/14/2022	W-220114-EM-03		2.07	0.756 JP	1.18	<1.00	1.26	0.812 JP	42.1
TGRSI	02/07/2022	W-220207-EM-02		9.56	2.05	1.93	<1.00	1.29	1.06	74.2
TGRSI	02/07/2022	W-220207-EM-03	FD	9.71	2.01	1.73	<1.00	1.31	1.04	75.1
TGRSI	03/04/2022	W-220304-EM-03		23.5	1.97	2.11	<1.00	1.44	1.24 JD21.3	110

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
JD# - Result is qualified as estimated due to outlying RPD from lab control sample analyses.
The following numerical value is the associated RPD from duplicate control samples.
JL# - Result is qualified as estimated due to outlying percent recovery from lab control sample analyses.
The following numerical value is the outlying percent recovery from lab control sample analyses.
< - Not detected at the associated reporting limit.
FD - Field Duplicate

Table 2

VOC Concentrations in TGRS Extraction Well Samples
FY 2022 - Through 2nd Quarter

Location	Common Name	Date	Sample ID		1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
				MDL	0.149	0.100	0.188	0.0819	0.126	0.300	0.190
				RL	1.00	1.00	1.00	1.00	1.00	1.00	1.00
				Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
03F302	B1	12/10/2021	W-211210-EM-11		4.81	0.650 JP	0.867 JP	<1.00	4.87	1.96	91.4
03F304	B3	12/10/2021	W-211210-EM-09		<1.00	0.160 JP	0.195 JP	<1.00	0.135 JP	<1.00	2.24
03F305	B4	12/10/2021	W-211210-EM-08		3.07	1.25	1.42	<1.00	1.09	0.558 JP	50.2
03F306	B5	12/10/2021	W-211210-EM-04		2.63	1.55	1.92	<1.00	0.727 JP	4.02	59.3
03F306	B5	12/10/2021	W-211210-EM-05	FD	2.31	1.49	1.76	<1.00	0.745 JP	4.24	62.4
03F307	B6	12/10/2021	W-211210-EM-01		0.478 JP	0.203 JP	0.356 JP	<1.00	0.165 JP	<1.00	21.4
03F319	B13	12/10/2021	W-211210-EM-10		4.91	1.79	1.37	<1.00	9.68	0.452 JP	114
PJ#309	B8	12/10/2021	W-211210-EM-07		0.246 JP	0.195 JP	0.290 JP	<1.00	0.132 JP	<1.00	4.66
PJ#309	B8	12/10/2021	W-211210-EM-06	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
PJ#310	B9	12/10/2021	W-211210-EM-02		0.745 JP	0.849 JP	1.13	<1.00	0.321 JP	<1.00	19.4
PJ#310	B9	12/10/2021	W-211210-EM-03	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Attachment 1

Data Verification Memos

Technical Memorandum

April 12, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/13	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **January 14, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on January 14, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
January 2022 Sampling Event

Criteria	Parameter	Pace #L1451949-batch WG1803624 & WG1805576 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	87.8-100	70-130	NA
	4-Bromofluorobenzene	94.6-97.4	77-126	NA
	Toluene-d8	96.9-106	80-120	NA

Criteria	Parameter	batch WG1803624 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	88.8/91.0 (2.45)	70-126	20
	1,2-Dichloroethane	98.0/101 (3.41)	70-128	20
	1,1-Dichloroethene	121/117 (2.86)	71-124	20
	cis-1,2-Dichloroethene	101/110 (8.17)	73-120	20
	Tetrachloroethene	126/124 (1.12)	72-132	20
	1,1,1-Trichloroethane	114/116 (1.74)	73-124	20
	Trichloroethene	118/117 (1.19)	78-124	20

Criteria	Parameter	batch WG1805576 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethene	98.2/101 (2.41)	71-124	20
	Trichloroethene	98.6/101 (2.80)	78-124	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1451949
January 2022 Sampling Event

VOC Parameter	W-220114-EM-01 TGRSE (ug/l)	W-220114-EM-02 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	0.364 J	0.435 J	0.071	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds
J - Estimated concentration

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1451949	Sample Collection Date(s):1/14/22
Matrix: Water	Sample Analysis Date(s): 1/18-20/22
Method: SW 8260	Date Reviewed:4/12/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – January 2022

Sample ID	Sample Location
W-220114-EM-01	TGRSE
W-220114-EM-02	TGRSE duplicate
W-220114-EM-03	TGRSI

Technical Memorandum

April 13, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/14	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **February 7, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on February 7, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

The Power of Commitment

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
February 2022 Sampling Event

Criteria	Parameter	Pace #L1458600-batch WG1814923 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	105-110	70-130	NA
	4-Bromofluorobenzene	96.7-99.0	77-126	NA
	Toluene-d8	98.0-103	80-120	NA

Criteria	Parameter	batch WG1814923 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	108/111 (3.10)	70-126	20
	1,2-Dichloroethane	103/108 (4.93)	70-128	20
	1,1-Dichloroethene	103/108 (4.72)	71-124	20
	cis-1,2-Dichloroethene	101/105 (3.88)	73-120	20
	Tetrachloroethene	104/103 (0.970)	72-132	20
	1,1,1-Trichloroethane	103/107 (3.62)	73-124	20
	Trichloroethene	106/112 (5.69)	78-124	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1458600
February 2022 Sampling Event

VOC Parameter	W-220207-EM-02 TGRSI (ug/l)	W-220207-EM-03 TGRSI duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
1,1-Dichloroethane	2.05	2.01	0.040	1
1,1-Dichloroethene	1.93	1.73	0.20	1
cis-1,2-Dichloroethene	1.29	1.31	0.020	1
Tetrachloroethene	1.06	1.04	0.020	1
1,1,1-Trichloroethane	9.56	9.71	1.6	25
Trichloroethene	74.2	75.1	1.2	25

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1458600	Sample Collection Date(s):2/7/22
Matrix: Water	Sample Analysis Date(s): 2/8/22
Method: SW 8260	Date Reviewed:4/12/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – February 2022

Sample ID	Sample Location
W-220207-EM-01	TGRSE
W-220207-EM-02	TGRSI
W-220207-EM-03	TGRSI duplicate

Technical Memorandum

May 10, 2022

To	Shawn Horn, GHD	Tel	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/15	Ref. No.	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **March 4, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on March 4, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

→ **The Power of Commitment**

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
March 2022 Sampling Event

Criteria	**Parameter**	**Pace #L1468827-batch WG1829388 Recovery range:**	**% Recovery Limits**	**RPD Limits**
Surrogate				
VOC	1,2-Dichloroethane-d4	106-109	70-130	NA
	4-Bromofluorobenzene	95.4-102	77-126	NA
	Toluene-d8	104-107	80-120	NA

Criteria	**Parameter**	**batch WG1829388 Recoveries:**	**% Recovery Limits**	**RPD Limits**
LCS/LCSD				
VOC	1,1-Dichloroethane	112/97.4 (14.1)	70-126	20
	1,2-Dichloroethane	106/97.4 (8.27)	70-128	20
	1,1-Dichloroethene	106/88.6 (18.1)	71-124	20
	cis-1,2-Dichloroethene	109/99.2 (9.60)	73-120	20
	Tetrachloroethene	**110/89.0 (21.3)**	72-132	20
	1,1,1-Trichloroethane	111/96.4 (14.4)	73-124	20
	Trichloroethene	109/96.4 (12.5)	78-124	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1468827
March 2022 Sampling Event

VOC Parameter	W-220304-EM-01 TGRSE (ug/l)	W-220304-EM-02 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
1,1,1-Trichloroethane	0.157J	1.00U	0.843	1
Trichloroethene	1.02	1.01	0.010	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds
J - Estimated concentration
U - Non-detect at the reporting limit

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1468827	Sample Collection Date(s):3/4/22
Matrix: Water	Sample Analysis Date(s): 3/9/22
Method: SW 8260	Date Reviewed:4/13/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	NA
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – March 2022

Sample ID	Sample Location
W-220304-EM-01	TGRSE
W-220304-EM-02	TGRSE duplicate
W-220304-EM-03	TGRSI

Item	Comment
5	A trip blank was inadvertently not submitted for analyses. There does not appear to be any evidence of contamination based on method blank data or the results comparison to historical data.
6	The tetrachloroethene RPD was outside the control limit for batch WG1829388. The associated detected tetrachloroethene result for sample W-220304-EM-03 was qualified estimated (JD 21.3).

Technical Memorandum

May 13, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 612 524 6872
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/189	**Ref. No.**	039669-50
Subject	Second Quarter DUR FY 2022 Site K Results March 2022		

This memo provides the analytical data summary for the second quarter FY 2022 sampling conducted at Site K. Tables 1 and 2 provide the treatment system sampling results through FY 2022 second quarter. The data verification memo is included as Attachment 1.

Regards,

Ruth Mickle
Chemist

Table 1

VOC Concentrations in Site K Treatment System Samples
FY 2022 - Through 2nd Quarter

Location	Date	Sample ID		1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
			MDL	**0.100**	**0.188**	**0.0819**	**0.126**	**1.26**	**0.630**	**0.149**	**0.190**	**0.234**
			RL	**1.00**	**1.00**	**1.00**	**1.00**	**10.0**	**5.00**	**1.00**	**1.00**	**1.00**
			Units	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
EFF	12/10/2021	W-211210-EM-101		<1.00	<1.00	<1.00	9.51	--	--	0.354 JP	0.938 JP	<1.00
EFF	12/10/2021	W-211210-EM-102	FD	<1.00	<1.00	<1.00	10.6	--	--	0.441 JP	1.13	<1.00
EFF	03/04/2022	W-220304-EM-101		<1.00	<1.00	<1.00	10.7	--	--	0.556 JP	1.51	<1.00
INF	12/10/2021	W-211210-EM-103		<1.00	0.463 JP	<1.00	--	--	178	<1.00	40.5	1.58
INF	03/04/2022	W-220304-EM-102		<1.00	0.633 JP	<1.00	--	219	--	29.6	61.4	2.48
INF	03/04/2022	W-220304-EM-103	FD	<1.00	0.607 JP	<1.00	--	222	--	28.0	64.1	2.57

MDL - Method Detection Limit
RL - Reporting Limit
< - Not detected at the associated reporting limit.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
FD - Field Duplicate

Table 2

Inorganic Water Quality Results in Site K Treatment System Samples
FY 2022 - Through 2nd Quarter

Location	Date	Sample ID		Copper	Lead	Mercury	Silver	Zinc	Cyanide (total)	Phosphorus	Phosphorus
			MDL	1.51	0.849	0.100	0.0700	3.02	1.80	35.0	35.0
			RL	5.00	2.00	0.200	2.00	25.0	5.00	100	281
			Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
EFF	12/10/2021	W-211210-EM-101		<5.00	<2.00	<0.200	<2.00	<25.0	<5.00	--	<281 UB64.1
EFF	03/04/2022	W-220304-EM-101		<5.00	<2.00	<0.200	<2.00	<25.0	<5.00	242	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.

Attachment 1

Data Verification Memo

Technical Memorandum

April 18, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/187	**Ref. No.**	039669-50
Subject	**Data Verification** **TCAAP Site K Sampling** **March 4, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on March 4, 2022, at the TCAAP Site K in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Table 1

Laboratory Precision and Accuracy Limits
Site K - TCAAP Site
March 2022 Sampling Event

Criteria	Parameter	Pace #L1468829-batch WG1829390, WG1830986 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	94.9-107	70-130	NA
	4-Bromofluorobenzene	97.4-103	77-126	NA
	Toluene-d8	103-110	80-120	NA

Criteria	Parameter	batch WG1829390 Recoveries:	% Recovery Limits	RPD Limit
LCS				
VOC	1,1-Dichloroethane	108/104 (3.77)	70-126	20
	1,2-Dichloroethane	105/102 (2.70)	70-128	20
	1,1-Dichloroethene	116/98.6 (16.2)	71-124	20
	cis-1,2-Dichloroethene	109/102 (6.66)	73-120	20
	trans-1,2-Dichloroethene	110/107 (2.58)	73-120	20
	Trichloroethene	113/108 (4.90)	78-124	20
	Vinyl Chloride	108/98.6 (9.47)	67-131	20

Criteria	Parameter	batch WG1830986 Recoveries:	% Recovery Limits	RPD Limit
LCS				
VOC	cis-1,2-Dichloroethene	85.0/90.6 (6.38)	73-120	20

Criteria	Parameter	batch WG1829397 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Metals	Copper	83.7	80-120	NA
	Lead	99.9	80-120	NA
	Silver	96.6	80-120	NA
	Zinc	97.2	80-120	NA

Table 1

Laboratory Precision and Accuracy Limits
Site K - TCAAP Site
March 2022 Sampling Event

Criteria	Parameter	batch WG1829446 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Metals	Mercury	99.2	80-120	NA

Criteria	Parameter	batch WG1829013 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Gen Chem	Cyanide	89.2	80-120	NA

Criteria	Parameter	W-220304-EM-101 Recoveries:	% Recovery Limits	RPD Limit
MS/MSD				
Gen Chem	Cyanide	81.0/101 (22.0)	75-125	20

Criteria	Parameter	batch WG1832784 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Gen Chem	Total Phosphorus	103	80-120	NA

Notes:
RPD - Relative Percent Difference
NA - Not applicable

Table 2

Field Duplicate Summary
Site K - TCAAP Site
SDG ID: L1468829
March 2022 Sampling Event

VOC Parameter	W-220304-EM-102 INF (ug/l)	W-220304-EM-103 INF Dup (ug/l)	RPD/ Difference	Difference Limit (+/-RL) or RPD Limit
1,1-Dichloroethene	0.633J	0.607J	0.026	1
cis-1,2-Dichloroethene	219	222	1.4	25
trans-1,2-Dichloroethene	29.6	28.0	5.6	25
Trichloroethene	61.4	64.1	4.3	25
Vinyl Chloride	2.48	2.57	0.090	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds
J - Estimated concentration

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP Site K	
SDG #: L1468829	Sample Collection Date(s):3/4/22
Matrix: Water	Sample Analysis Date(s): 3/9/22-3/16/22
Method: SW 8260D, Inorganics (see item 15)	Date Reviewed:4/15/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	N
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	NA
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	Y
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	N
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	Y
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y, see note
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

<u>*Required Attachments:*</u> LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – March 2022

Sample ID	**Sample Location**
W-220304-EM-101	EFF
W-220304-EM-102	INF
W-220304-EM-103	INF duplicate

Item	Comment
5	A trip blank was inadvertently not submitted for analyses. There does not appear to be any evidence of contamination based on method blank data or the results comparison to historical data.
8	The cyanide RPD result was outside the control limit. Since the associated sample result was non-detect, no data qualification was required.
15	Metals are analyzed using Method 6020 for Copper, Lead, Silver and Zinc, and Method 7470A (CVAA) for Mercury. Cyanide is analyzed using SM 4500CN E. Total Phosphorus is analyzed using MCAWW Method 365.4.

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11 January 2023

TECHNICAL MEMORANDUM

TO: Viral Patel (USEPA), Brigitte Hay (MPCA), and Katy Grant (MPCA)

FROM: Arthur Peitsch, EA Project Manager

CC: Linda Albrecht (USAEC), Shawn Horn (GHD), Tom Lineer (U.S. Army), and David Brown (NGIS)

SUBJECT: Final Twin Cities Army Ammunition Plant Data Usability Report #115, Fiscal Year 2022 3rd Quarter Monitoring (April – June 2022)

EA Engineering, Science, and Technology, Inc. (EA) is pleased to present this final Data Usability Report (DUR) #115 for the Fiscal Year 2022 3rd Quarter Monitoring. This report provides the analytical data summary and data verification for extraction well and treatment system sampling conducted at Operable Unit (OU) 1, OU2 Deep Groundwater Site, OU3, Building 102, Site A, Site C, and Site K. A technical memorandum for each site is attached. The data validation/verification confirmed that all data are valid and usable for project purposes.

Technical Memorandum

August 23, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 612 524 6872
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/14	**Ref. No.**	12561153
Subject	Third Quarter DUR FY 2022 OU1, Building 102, Site A and Site C Annual Results May 2022		

This memo provides the analytical data summary for the third quarter FY 2022 annual sampling conducted at the OU1, Building 102, Site A and Site C. Tables 1 through 6 provide the monitoring well sampling results from FY 2022 third quarter. The data validation and verification memos are included as Attachment 1.

Regards,

Ruth Mickle
Chemist

Table 1

VOC Concentrations in Building 102 Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	1,1-Dichloroethene	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	Trichloroethene	Trichloroethene	Vinyl chloride
				MDL	0.188	0.126	1.26	0.190	1.90	0.234
				RL	1.00	1.00	10.0	1.00	10.0	1.00
					ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Bldg 102	01L581	05/11/2022	BLDG102-220511-RA-11		<1.00	3.89	--	4.73	--	<1.00
Bldg 102	01U581	05/11/2022	BLDG102-220511-RA-09	FB	<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01L582	05/09/2022	BLDG102-220509-RA-01		<1.00	12.6	--	<1.00	--	<1.00
Bldg 102	01L582	05/09/2022	BLDG102-220509-RA-02	FD	<1.00	12.6	--	<1.00	--	<1.00
Bldg 102	01L583	05/11/2022	BLDG102-220511-RA-07		<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01L583	05/11/2022	BLDG102-220511-RA-08	FD	<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01L584	05/11/2022	BLDG102-220511-RA-13		<1.00	7.46	--	8.02	--	<1.00
Bldg 102	01U048	05/10/2022	BLDG102-220510-RA-04	FB	<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01U048	05/10/2022	BLDG102-220510-RA-05		<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01U579	05/11/2022	BLDG102-220511-RA-15		<1.00	4.79	--	0.456 JP	--	<1.00
Bldg 102	01U580	05/11/2022	BLDG102-220511-RA-14		1.21	--	166	--	191	22.7
Bldg 102	01U581	05/11/2022	BLDG102-220511-RA-10		<1.00	30.9	--	6.99	--	<1.00
Bldg 102	01U582	05/10/2022	BLDG102-220510-RA-03		<1.00	0.160 JP	--	<1.00	--	<1.00
Bldg 102	01U583	05/11/2022	BLDG102-220511-RA-06		<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01U584	05/11/2022	BLDG102-220511-RA-12		<1.00	9.66	--	2.02	--	1.22

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 2

VOC Concentrations in Site OU1 Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	Trichloroethene
				MDL	0.149	0.158	0.100	0.188	0.126	0.190
				RL	1.00	1.00	1.00	1.00	1.00	1.00
					ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
OU1	03L832	05/17/2022	OU1-220517-RA-53		<1.00	<1.00	0.136 JP	<1.00	0.238 JP	2.51
OU1	03L822	05/16/2022	OU1-220516-RA-10		<1.00	<1.00	2.36	2.81	5.31	91.6
OU1	03L841	05/16/2022	OU1-220516-RA-13		<1.00	<1.00	0.212 JP	0.228 JP	0.525 JP	<1.00
OU1	03L846	05/17/2022	OU1-220517-RA-49		<1.00	<1.00	10.5	7.31	25.6	0.656 JP
OU1	03M843	05/17/2022	OU1-220517-RA-50		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	03U821	05/17/2022	OU1-220517-RA-47		<1.00	<1.00	0.457 JP	0.323 JP	0.619 JP	6.65
OU1	03U821	05/17/2022	OU1-220517-RA-48	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	03U822	05/16/2022	OU1-220516-RA-11		<1.00	<1.00	1.65	1.69	34.0	6.77
OU1	04J822	05/16/2022	OU1-220516-RA-09		<1.00	<1.00	0.666 JP	0.370 JP	0.663 JP	0.914 JP
OU1	04J834	05/16/2022	OU1-220516-RA-19		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04J834	05/16/2022	OU1-220516-RA-22	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04J836	05/17/2022	OU1-220517-RA-28		<1.00	<1.00	0.159 JP	<1.00	<1.00	1.67
OU1	04J837	05/16/2022	OU1-220516-RA-16		<1.00	<1.00	0.272 JP	<1.00	0.367 JP	1.22
OU1	04J838	05/17/2022	OU1-220517-RA-44		0.884 JP	<1.00	2.26	3.32	2.22	45.2
OU1	04J839	05/17/2022	OU1-220517-RA-30		<1.00	<1.00	0.122 JP	0.231 JP	<1.00	2.86
OU1	04J839	05/17/2022	OU1-220517-RA-31	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04J849	05/17/2022	OU1-220517-RA-58		1.55	<1.00	1.12	2.11	<1.00	4.13
OU1	04J882	05/16/2022	OU1-220516-RA-36		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04J882	05/16/2022	OU1-220516-RA-37		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U821	05/17/2022	OU1-220517-RA-45		<1.00	<1.00	0.999 JP	0.912 JP	9.04	1.54
OU1	04U821	05/17/2022	OU1-220517-RA-46	FD	<1.00	<1.00	0.934 JP	0.860 JP	8.13	1.37
OU1	04U834	05/16/2022	OU1-220516-RA-20		<1.00	<1.00	0.122 JP	<1.00	<1.00	1.19
OU1	04U834	05/16/2022	OU1-220516-RA-21	FD	<1.00	<1.00	0.123 JP	<1.00	<1.00	0.919 JP
OU1	04U836	05/17/2022	OU1-220517-RA-29		<1.00	<1.00	2.15	2.13	12.4	8.90
OU1	04U837	05/16/2022	OU1-220516-RA-15		<1.00	<1.00	1.52	<1.00	0.165 JP	0.523 JP
OU1	04U838	05/17/2022	OU1-220517-RA-43		<1.00	<1.00	<1.00	<1.00	<1.00	0.306 JP
OU1	04U839	05/17/2022	OU1-220517-RA-32		0.550 JP	<1.00	1.89	1.36	0.442 JP	23.8
OU1	04U839	05/17/2022	OU1-220517-RA-33	FD	0.505 JP	<1.00	1.89	0.880 JP	0.427 JP	22.8
OU1	04U841	05/16/2022	OU1-220516-RA-14		0.243 JP	<1.00	0.758 JP	0.851 JP	0.241 JP	5.02
OU1	04U843	05/17/2022	OU1-220517-RA-51		2.46	<1.00	3.99	5.86	0.679 JP	43.5
OU1	04U844	05/17/2022	OU1-220517-RA-55		4.84	0.188 JP	11.1	12.6	4.52	141
OU1	04U844	05/17/2022	OU1-220517-RA-56	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U846	05/17/2022	OU1-220517-RA-52		<1.00	<1.00	12.8	10.2	28.0	20.6
OU1	04U849	05/17/2022	OU1-220517-RA-57		1.19	<1.00	3.50	4.14	0.568 JP	39.3
OU1	04U850	05/17/2022	OU1-220517-RA-34		0.334 JP	<1.00	3.71	3.93	10.6 JFD56.3	33.5
OU1	04U850	05/17/2022	OU1-220517-RA-35	FD	0.299 JP	<1.00	2.86	2.94	5.94 JFD56.3	28.7
OU1	04U855	05/17/2022	OU1-220517-RA-59		0.152 JP	<1.00	0.576 JP	0.774 JP	0.163 JP	9.19
OU1	04U871	05/16/2022	OU1-220516-RA-27		2.83	<1.00	3.17	5.08	0.958 JP	76.7
OU1	04U872	05/16/2022	OU1-220516-RA-25		0.204 JP	<1.00	0.675 JP	0.480 JP	1.50	7.32
OU1	04U875	05/12/2022	OU1-220512-RA-02		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U875	05/12/2022	OU1-220512-RA-03	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U877	05/17/2022	OU1-220517-RA-39		<1.00	<1.00	1.90	<1.00	0.174 JP	0.358 JP
OU1	04U879	05/17/2022	OU1-220517-RA-42		<1.00	<1.00	0.188 JP	<1.00	<1.00	1.19
OU1	04U880	05/16/2022	OU1-220516-RA-24		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U881	05/16/2022	OU1-220516-RA-23		0.212 JP	<1.00	1.35	<1.00	0.269 JP	7.39
OU1	04U882	05/16/2022	OU1-220516-RA-17		<1.00	<1.00	0.439 JP	0.402 JP	0.155 JP	4.31
OU1	04U883	05/16/2022	OU1-220516-RA-18		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	200154	05/12/2022	OU1-220512-RA-01		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	234546	05/20/2022	OU1-220520-RA-62		<1.00	<1.00	0.415 JP	0.376 JP	<1.00	5.06
OU1	409547	05/16/2022	OU1-220516-RA-08		0.924 JP	<1.00	6.42	6.51	1.54	2.85
OU1	409557	05/20/2022	OU1-220520-RA-60		1.67	0.184 JP	7.28	11.1	3.87	61.1
OU1	409548	05/16/2022	OU1-220516-RA-12		<1.00	<1.00	0.287 JP	<1.00	0.994 JP	0.369 JP
OU1	409549	05/17/2022	OU1-220517-RA-40		0.810 JP	<1.00	2.99	3.07	0.590 JP	23.8
OU1	409549	05/17/2022	OU1-220517-RA-41	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	409550	05/17/2022	OU1-220517-RA-54		<1.00	<1.00	0.535 JP	0.339 JP	1.93	17.0
OU1	409555	05/16/2022	OU1-220516-RA-26		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	409556	05/17/2022	OU1-220517-RA-38		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	512761	05/20/2022	OU1-220520-RA-63		0.380 JP	<1.00	0.382 JP	0.779 JP	<1.00	10.1
OU1	PJ#318	05/12/2022	OU1-220512-RA-04		<1.00	<1.00	<1.00	<1.00	<1.00	0.403 JP
OU1	PJ#318	05/12/2022	OU1-220512-RA-05	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank
JFD# - Result is qualified as estimated due to outlying field duplicate RPD result. The following numerical value is the associated RPD value.

Table 3

1,4-Dioxane Concentrations in Site OU1 Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	1,4-Dioxane	1,4-Dioxane	1,4-Dioxane
				MDL	0.0447	0.0469	0.0496
				RL	0.400	0.420	0.444
					ug/L	ug/L	ug/L
OU1	03L832	05/17/2022	OU1-220517-RA-53		0.475	--	--
OU1	03L822	05/16/2022	OU1-220516-RA-10		18.5	--	--
OU1	03L841	05/16/2022	OU1-220516-RA-13		4.18	--	--
OU1	03L846	05/17/2022	OU1-220517-RA-49		17.7	--	--
OU1	03M843	05/17/2022	OU1-220517-RA-50		13.7	--	--
OU1	03U821	05/17/2022	OU1-220517-RA-47		13.1	--	--
OU1	03U821	05/17/2022	OU1-220517-RA-48	FB	<0.400	--	--
OU1	03U822	05/16/2022	OU1-220516-RA-11		9.58	--	--
OU1	04J822	05/16/2022	OU1-220516-RA-09		<0.400	--	--
OU1	04J834	05/16/2022	OU1-220516-RA-19		<0.400	--	--
OU1	04J834	05/16/2022	OU1-220516-RA-22	FB	3.13	--	--
OU1	04J836	05/17/2022	OU1-220517-RA-28		1.29	--	--
OU1	04J837	05/16/2022	OU1-220516-RA-16		1.16	--	--
OU1	04J838	05/17/2022	OU1-220517-RA-44		4.39	--	--
OU1	04J839	05/17/2022	OU1-220517-RA-30		0.532	--	--
OU1	04J839	05/17/2022	OU1-220517-RA-31	FB	<0.400	--	--
OU1	04J849	05/17/2022	OU1-220517-RA-58		0.705	--	--
OU1	04J882	05/16/2022	OU1-220516-RA-36		<0.400	--	--
OU1	04J882	05/16/2022	OU1-220516-RA-37		<0.400	--	--
OU1	04U821	05/17/2022	OU1-220517-RA-45		15.1	--	--
OU1	04U821	05/17/2022	OU1-220517-RA-46	FD	13.5	--	--
OU1	04U834	05/16/2022	OU1-220516-RA-20		1.23	--	--
OU1	04U834	05/16/2022	OU1-220516-RA-21	FD	0.554	--	--
OU1	04U836	05/17/2022	OU1-220517-RA-29		5.72	--	--
OU1	04U837	05/16/2022	OU1-220516-RA-15		--	--	2.55
OU1	04U838	05/17/2022	OU1-220517-RA-43		0.701	--	--
OU1	04U839	05/17/2022	OU1-220517-RA-32		5.31	--	--
OU1	04U839	05/17/2022	OU1-220517-RA-33	FD	5.05	--	--
OU1	04U841	05/16/2022	OU1-220516-RA-14		4.78	--	--
OU1	04U843	05/17/2022	OU1-220517-RA-51		19.0	--	--
OU1	04U844	05/17/2022	OU1-220517-RA-55		11.8	--	--
OU1	04U844	05/17/2022	OU1-220517-RA-56	FB	<0.400	--	--
OU1	04U846	05/17/2022	OU1-220517-RA-52		--	--	16.5
OU1	04U849	05/17/2022	OU1-220517-RA-57		4.17	--	--
OU1	04U850	05/17/2022	OU1-220517-RA-34		8.51	--	--
OU1	04U850	05/17/2022	OU1-220517-RA-35	FD	7.34	--	--
OU1	04U855	05/17/2022	OU1-220517-RA-59		--	2.49	--
OU1	04U871	05/16/2022	OU1-220516-RA-27		7.10	--	--
OU1	04U872	05/16/2022	OU1-220516-RA-25		1.99	--	--
OU1	04U875	05/12/2022	OU1-220512-RA-02		<0.400	--	--
OU1	04U875	05/12/2022	OU1-220512-RA-03	FD	0.204 JP	--	--
OU1	04U877	05/17/2022	OU1-220517-RA-39		2.37	--	--
OU1	04U879	05/17/2022	OU1-220517-RA-42		1.76	--	--
OU1	04U880	05/16/2022	OU1-220516-RA-24		<0.400	--	--
OU1	04U881	05/16/2022	OU1-220516-RA-23		2.01	--	--
OU1	04U882	05/16/2022	OU1-220516-RA-17		1.81	--	--
OU1	04U883	05/16/2022	OU1-220516-RA-18		0.374 JP	--	--
OU1	200154	05/12/2022	OU1-220512-RA-01		0.193 JP	--	--
OU1	234546	05/20/2022	OU1-220520-RA-62		0.762	--	--
OU1	409547	05/16/2022	OU1-220516-RA-08		6.37	--	--
OU1	409557	05/20/2022	OU1-220520-RA-60		3.84	--	--
OU1	409548	05/16/2022	OU1-220516-RA-12		3.25	--	--
OU1	409549	05/17/2022	OU1-220517-RA-40		9.70	--	--
OU1	409549	05/17/2022	OU1-220517-RA-41	FB	<0.400	--	--
OU1	409550	05/17/2022	OU1-220517-RA-54		7.66	--	--
OU1	409555	05/16/2022	OU1-220516-RA-26		0.432	--	--
OU1	409556	05/17/2022	OU1-220517-RA-38		<0.400	--	--
OU1	512761	05/20/2022	OU1-220520-RA-63		0.394 JP	--	--
OU1	PJ#318	05/12/2022	OU1-220512-RA-04		0.304 JP	--	--
OU1	PJ#318	05/12/2022	OU1-220512-RA-05	FB	<0.400	--	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 4

Dissolved Lead Concentrations in Site C Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	Lead (dissolved)
				MDL	0.849
				RL	2.00
					ug/L
Site C	01U046	05/09/2022	SITEC-220509-RA-15		<2.00
Site C	01U561	05/09/2022	SITEC-220509-RA-09		<2.00
Site C	01U561	05/09/2022	SITEC-220509-RA-10	FD	<2.00
Site C	01U562	05/09/2022	SITEC-220509-RA-08		<2.00
Site C	01U563	05/09/2022	SITEC-220509-RA-06		<2.00
Site C	01U564	05/09/2022	SITEC-220509-RA-12		<2.00
Site C	01U564	05/09/2022	SITEC-220509-RA-11	FB	<2.00
Site C	01U567	05/09/2022	SITEC-220509-RA-01		<2.00
Site C	01U567	05/09/2022	SITEC-220509-RA-02	FD	<2.00
Site C	01U571	05/09/2022	SITEC-220509-RA-13		<2.00
Site C	01U573	05/09/2022	SITEC-220509-RA-07		21.6
Site C	01U574	05/09/2022	SITEC-220509-RA-05		<2.00
Site C	01U574	05/09/2022	SITEC-220509-RA-04	FB	<2.00
Site C	01U575	05/09/2022	SITEC-220509-RA-03		9.18
Site C	01U576	05/09/2022	SITEC-220509-RA-14		<2.00
Site C	NE Wetland	05/09/2022	SITEC-220509-RA-17A		<2.00
Site C	NE Wetland	05/10/2022	SITEC-220510-RA-17B		<2.00
Site C	NE Wetland	05/11/2022	SITEC-220511-RA-17C		<2.00
Site C	SW-5	05/09/2022	SITEC-220509-RA-16A		<2.00
Site C	SW-5	05/10/2022	SITEC-220510-RA-16B		<2.00
Site C	SW-5	05/11/2022	SITEC-220511-RA-16C		<2.00
Site C	SW-6	05/09/2022	SITEC-220509-RA-18A		<2.00
Site C	SW-6	05/10/2022	SITEC-220510-RA-18B		<2.00
Site C	SW-6	05/11/2022	SITEC-220511-RA-18C		<2.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 5

VOC Concentrations in Site A Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	1,1-Dichloroethene	1,2-Dichloroethane	Benzene	Chloroform (Trichloromethane)	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
				MDL	**0.188**	**0.0819**	**0.0941**	**0.111**	**0.126**	**2.52**	**0.300**	**0.190**
				RL	**1.00**	**1.00**	**1.00**	**5.00**	**1.00**	**20.0**	**1.00**	**1.00**
					ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
Site A	01U108	05/12/2022	SITEA-220512-RA-26		<1.00	<1.00	<1.00	<5.00	<1.00	--	0.856 JP	<1.00
Site A	01U039	05/12/2022	SITEA-220512-RA-10		<1.00	<1.00	<1.00	<5.00	0.480 JP	--	<1.00	<1.00
Site A	01U039	05/12/2022	SITEA-220512-RA-11	FB	<1.00	<1.00	<1.00	0.821 JP	<1.00	--	<1.00	<1.00
Site A	01U102	05/12/2022	SITEA-220512-RA-29		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U103	05/12/2022	SITEA-220512-RA-27		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U115	05/12/2022	SITEA-220512-RA-19		<1.00	<1.00	<1.00	<5.00	4.50	--	<1.00	1.08
Site A	01U116	05/12/2022	SITEA-220512-RA-30		<1.00	<1.00	<1.00	<5.00	0.793 JP	--	<1.00	0.656 JP
Site A	01U117	05/12/2022	SITEA-220512-RA-24		<1.00	<1.00	<1.00	<5.00	45.3	--	1.95	0.380 JP
Site A	01U126	05/12/2022	SITEA-220512-RA-25		<1.00	<1.00	<1.00	<5.00	0.406 JP	--	7.01	0.737 JP
Site A	01U126	05/12/2022	SITEA-220512-RA-28	FB	<1.00	<1.00	<1.00	0.748 JP	<1.00	--	<1.00	<1.00
Site A	01U138	05/12/2022	SITEA-220512-RA-31		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U139	05/12/2022	SITEA-220512-RA-17		0.696 JP	<1.00	7.36	0.130 JP	--	653	<1.00	0.288 JP
Site A	01U140	05/12/2022	SITEA-220512-RA-15		<1.00	<1.00	0.230 JP	<5.00	3.29	--	<1.00	0.253 JP
Site A	01U157	05/12/2022	SITEA-220512-RA-20		<1.00	<1.00	0.490 JP	<5.00	44.3	--	<1.00	0.658 JP
Site A	01U158	05/12/2022	SITEA-220512-RA-32		<1.00	<1.00	0.517 JP	<5.00	53.0	--	<1.00	0.819 JP
Site A	01U352	05/12/2022	SITEA-220512-RA-22		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U352	05/12/2022	SITEA-220512-RA-23	FD	<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U353	05/12/2022	SITEA-220512-RA-21		<1.00	<1.00	2.15	<5.00	81.0	--	<1.00	<1.00
Site A	01U355	05/12/2022	SITEA-220512-RA-18		<1.00	<1.00	<1.00	<5.00	12.8	--	<1.00	<1.00
Site A	01U356	05/12/2022	SITEA-220512-RA-16		<1.00	<1.00	<1.00	<5.00	20.1	--	<1.00	<1.00
Site A	01U357	05/12/2022	SITEA-220512-RA-14		<1.00	<1.00	0.219 JP	<5.00	3.24	--	<1.00	<1.00
Site A	01U358	05/12/2022	SITEA-220512-RA-12		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U358	05/12/2022	SITEA-220512-RA-13	FD	<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U901	05/11/2022	SITEA-220511-RA-01		<1.00	<1.00	<1.00	<5.00	0.176 JP	--	<1.00	<1.00
Site A	01U902	05/11/2022	SITEA-220511-RA-03		<1.00	<1.00	1.52	<5.00	99.8	--	<1.00	<1.00
Site A	01U902	05/11/2022	SITEA-220511-RA-04	FD	<1.00	<1.00	1.51	<5.00	103	--	<1.00	<1.00
Site A	01U903	05/11/2022	SITEA-220511-RA-06		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U903	05/11/2022	SITEA-220511-RA-05	FB	<1.00	<1.00	<1.00	0.623 JP	0.149 JP	--	<1.00	<1.00
Site A	01U904	05/11/2022	SITEA-220511-RA-02		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U905	05/12/2022	SITEA-220512-RA-07		<1.00	<1.00	<1.00	<5.00	0.131 JP	--	<1.00	<1.00
Site A	01U906	05/11/2022	SITEA-220511-RA-08		<1.00	<1.00	<1.00	<5.00	0.242 JP	--	<1.00	<1.00
Site A	01U907	05/12/2022	SITEA-220512-RA-09		<1.00	<1.00	<1.00	<5.00	0.141 JP	--	<1.00	<1.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 6

Dissolved Antimony Concentraions in Site A Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	Antimony (dissolved)
				MDL	1.03
				RL	4.00
					ug/L
Site A	01U103	05/12/2022	SITEA-220512-RA-27		2.18 JP
Site A	01U902	05/11/2022	SITEA-220511-RA-03		<4.00
Site A	01U902	05/11/2022	SITEA-220511-RA-04	FD	<4.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate

Attachment 1

Data Validation/Verification Memos

Technical Memorandum

July 20, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/7	**Ref. No.**	12561153
Subject	**Data Validation** **VOC Analysis** **Building 102 Well Sampling** **May 9-11, 2022** **TCAAP Site** **St. Paul, Minnesota**		

The following are data validation forms for samples collected on May 9-11, 2022, at TCAAP Building 102 Site in St. Paul, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

Table 1

Sample Identification Numbers
Building 102 Site
SDG ID: L1493339
May 2022 Sampling Event

Sample ID	Sample Location
BLDG102-220509-RA-01	01L582
BLDG102-220509-RA-02	01L582 Field Duplicaate
BLDG102-220510-RA-03	01U582
BLDG102-220510-RA-04	01U048 Field Blank
BLDG102-220510-RA-05	01U048
BLDG102-220511-RA-06	01U583
BLDG102-220511-RA-07	01L583
BLDG102-220511-RA-08	01L583 Field Duplicate
BLDG102-220511-RA-09	01U581 Field Blank
BLDG102-220511-RA-10	01U581
BLDG102-220511-RA-11	01L581
BLDG102-220511-RA-12	01U584
BLDG102-220511-RA-13	01L584
BLDG102-220511-RA-14	01U580
BLDG102-220511-RA-15	01U579
Trip Blank	Trip Blank

Table 2

Laboratory Precision and Accuracy Limits
TCAAP - Building 102 Site
SDG ID: L1493339
May 2022 Sampling Event

Criteria	Parameter	Pace #L1493339 batch WG1865320, WG 1865739 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	97.8-121	70-130	NA
	4-Bromofluorobenzene	94.3-110	77-126	NA
	Toluene-d8	97.7-115	80-120	NA

Criteria	Parameter	batch WG1865320 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethene	99.4/83.6 (17.3)	71-124	20
	cis-1,2-Dichloroethene	102/90.4 (11.7)	73-120	20
	Trichloroethene	92.8/87.8(5.54)	78-124	20
	Vinyl Chloride	93.0/85.0 (8.99)	67-131	20

Criteria	Parameter	batch WG1865739 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethene	92.4/98.2 (6.09)	71-124	20
	cis-1,2-Dichloroethene	106/111 (4.23)	73-120	20
	Trichloroethene	95.4/104(8.24)	78-124	20
	Vinyl Chloride	83.4/93.2 (11.1)	67-131	20

Criteria	Parameter	BLDG102-210916-RA-06 Recoveries (RPD):	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethene	95.4103 (7.85)	11-160	29
	cis-1,2-Dichloroethene	101/114 (11.9)	10-160	27
	Trichloroethene	104/113 (8.50)	10-160	25
	Vinyl Chloride	80.8/87.0 (7.39)	10-160	27

Note:
NA - Not Applicable

Table 3

Field Duplicate Summary
TCAAP - Building 102 Site
SDG ID: L1493339
May 2022 Sampling Event

	Bldg102-220509-RA-01 01L582 (ug/l)	Bldg102-220509-RA-02 01L582 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
cis-1,2-Dichloroethene	12.6	12.6	0	25

	BLDG102-220511-RA-07 01L583 (ug/l)	BLDG102-220511-RA-08 01L583 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
		All Non-detect		

Notes:
RL - Reporting limit
RPD - Relative Percent Difference

ANALYTICAL DATA VALIDATION FORM (VOCs)

SDG NUMBER: L1493339

PROJECT: Building 102 TCAAP

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 5/9/22-5/11/22 NO. OF SAMPLES: 15

ANALYSES REQUESTED: Method 8260 (VOCs)

SAMPLE NO. see Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____No X

Contractual Violations Yes____No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.

Yes X No ____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.

Yes X No ____

B. Holding Times

1. The required holding times were met for all analyses (Time of sample receipt to time of analysis (VOA) or extraction and from extraction to analysis).

Yes X No ____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.

Yes X No ____

2. Samples were received at the required temperature and preservation.

Yes X No ____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for all compounds for all analyses met the QAPP or method criteria.

Yes X No____ NA ____

2. The relative standard deviation (RSD) for all compounds in the standard was less than 20%, with an allowance of up to 40% for the poor responders. Per the method, a correlation coefficient "r" of > 0.99 is also acceptable for compounds,

Yes X No____ NA ____

3. The 12 hour system Performance Check was performed as required in SW-846.

Yes X No____ NA ____

B. Continuing Calibration

1. The RRF 50 standard was analyzed for each analysis at the required frequency and the QC criteria were met.

Yes X No____ NA ___

2. The percent difference (%D) limits for all compounds is ±20%, with an allowance of up to 40% for the poor responders per the current validation guidance, were met.

Yes X No____ NA ____

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The BFB performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met.

Yes X No____ NA ____

V. INTERNAL STANDARDS

The Internal Standards met the 100% upper and -50% lower limits criteria and the Retention times were within the required windows.

Yes X No____ NA ____

VI. SURROGATE

Surrogate spikes were analyzed with every sample.

Yes X No ____

And met the recovery limits defined in the QAPP (i.e., Current lab limits).
Yes X No _____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE

A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every analysis performed and for every 20 samples or for every matrix whichever is more frequent.
Yes X No _____

B. The MS and MSD percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X No _____
See Table 2

C. The MSD relative percent differences (RPD) were within the QAPP limits.

Yes X No_____NA _____
See Table 2

VIII. LABORATORY CONTROL SAMPLE

A. A Laboratory Control Samples (LCS) was analyzed for every analysis batch or for every 20 samples.
Yes X No _____
The LCS percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X No ____
See Table 2

IX. BLANKS

A. Method Blanks were analyzed at the required frequency and for each matrix and analysis.
Yes X No _____

B. No blank contamination was found in the Method Blank.
Yes X No _____

C. If Equipment Rinsate Blanks were identified, no blank contamination was found.
Yes X No_____NA _____

X. FIELD QC

If Field duplicates or Performance Check Compounds were identified, they met the RPD or % recovery criteria for the project.
Yes X No_____NA _____
See Table 3

XI. SYSTEM PERFORMANCE

A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.
Yes X No_____NA _____
B. The suggested EQL's for the sample matrices in this set were met
Yes X No_____NA _____

XII. TCL COMPOUNDS

A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.
Yes X No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compounds in each internal standards quantitation set.
Yes X No_____NA _____

XIII. TENTATIVELY IDENTIFIED COMPOUNDS

TICs were properly identified and met the library identification criteria.
Yes______No_____NA X___

XIV. OVERALL ASSESSMENT OF THE CASE

The data are usable for project purposes without qualification.

Technical Memorandum

July 20, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/8	**Ref. No.**	12561153
Subject	**Data Validation Metals Analysis Site C Well Sampling May 9-11, 2022 TCAAP Site C St. Paul, Minnesota**		

The following are data validation forms for samples collected on May 9-11, 2022, at TCAAP Site C in St. Paul, Minnesota.

Regards

Ruth Mickle
Chemist

Table 1

Sample Identification Numbers
TCAAP Site C
SDG ID: L1493942
May 2022 Sampling Event

Sample ID	Sample Location
SITEC-220509-RA-01	01U567
SITEC-220509-RA-02	01U567 Field Duplicate
SITEC-220509-RA-03	01U575
SITEC-220509-RA-04	01U574 Field Blank
SITEC-220509-RA-05	01U574
SITEC-220509-RA-06	01U563
SITEC-220509-RA-07	01U573
SITEC-220509-RA-08	01U562
SITEC-220509-RA-09	01U561
SITEC-220509-RA-10	01U561 Field Duplicate
SITEC-220509-RA-11	01U564 Field Blank
SITEC-220509-RA-12	01U564
SITE C-220509-RA-13	01U571
SITEC-220509-RA-14	01U576
SITEC-220509-RA-15	01U046
SITEC-220509-RA-16A	SW-5
SITEC-220509-RA-17A	NEWETLAND
SITEC-220509-RA-18A	SW-6
SITEC-220510-RA-16B	SW-5
SITEC-220510-RA-17B	NEWETLAND
SITEC-220510-RA-18B	SW-6
SITEC-220511-RA-16C	SW-5
SITEC-220511-RA-17C	NEWETLAND
SITEC-220511-RA-18C	SW-6

Table 2

Laboratory Precision and Accuracy Limits
TCAAP Site C
SDG ID: L1493942
May 2022 Sampling Event

Criteria	Parameter	batch WG1865525 Recoveries:	% Recovery Limits	RPD Limits
LCS				
Metals	Lead	100	80-120	20

Criteria	Parameter	batch WG1866309 Recoveries:	% Recovery Limits	RPD Limits
LCS				
Metals	Lead	96.9	80-120	20

Criteria	Parameter	SITE C-220509-RA-13 Recoveries:	% Recovery Limits	RPD Limit
MS/MSD				
Metals	Lead	99.6/97.8 (1.84)	75-125	20

Table 3

Field Duplicate Summary
TCAAP Site C
SDG ID: L1493942
May 2022 Sampling Event

Metals parameter	SITEC-220509-RA-01 01U567 (ug/l)	SITEC-220509-RA-02 01U567 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
Lead (dissolved)	All non-detect			

Metals parameter	SITEC-220509-RA-09 01U561 (ug/l)	SITEC-220509-RA-10 01U561 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
Lead (dissolved)	All non-detect			

Notes:
RL - Reporting limit
RPD - Relative Percent Difference

ANALYTICAL DATA VALIDATION FORM (INORGANICS)

SDG: L1493942

PROJECT: TCAAP Site C

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE : 5/9/22-5/11/22 NO. OF SAMPLES: 24

ANALYSES REQUESTED: Method 6020 (Lead)

SAMPLE NO. see Table 1

REVIEWER: Ruth Mickle

QA REVIEWER: Ruth Mickle INITIALS/DATE:

Telephone Logs included Yes____ No X

Contractual Violations Yes____ No X

Comments:

I. DELIVERABLES
All deliverables were present as specified in the Scope of Work and QAPP.
Yes_X__No_____

II. CALIBRATIONS
A. All initial instrument calibrations were performed as defined in the method standard operating procedure (SOP). All correlation coefficients of the multi point curve (at least the minimum # standards used) were > 0.995.
Yes_X__ No____ NA____

B. The initial calibration verification (ICV) and continuing calibration verification (CCV) standards were analyzed at the required frequency.
Yes_X__No_____

The ICV and CCV standard percent recovery results were within the required control limits (90 – 110% metals, exc Hg; Hg 80-120%) or per method SOP (e.g., Cn, general chemistry parameters).
Yes_X__No_____

C. ICP/MS Tune and Calibrations

1. The tuning solution was analyzed at the required frequency throughout the analyses. The results of all instrument performance checks were within the method acceptance criteria, indicating that proper optimization of the instrumentation was achieved.

Yes_X__No_____

D. Internal Standardization
1. The appropriate # of internal standards were present in all standards and blanks, as applicable to limited list of metals.
Yes_X__No_____
2. The intensity of each internal standard was within the 60 - 125% control limits.
Yes_X__No_____

III. LOW LEVEL (CRI/CRDL) STANDARDS

A. Low Level (CRI/CRDL) standards were analyzed.
Yes X No___ NA___

IV. LABORATORY BLANKS

Note: the highest blank associated with any particular analyte is used for the qualification process and is the value entered after the "B" blank descriptor.

A. The initial calibration blanks (ICB) and continuing calibration blanks (CCB) were analyzed at the required frequency.
Yes X No___ NA___

And the ICB and CCB results were within the required control limits criteria (Appendix H-inorganics).
Yes X No___ NA___

B. Preparation blanks were prepared and analyzed at the required frequency.
Yes X No____

And Preparation blanks were within the required control limits criteria (Appendix H-inorganics).
Yes X No____

V. ICP INTERFERENCE CHECK SAMPLE

A. The Interference check sample (ICS) was analyzed as required in the method.
Yes_X___ No____ NA____

And the ICS percent recovery results were reported for all required ICS analytes and were within required control limits of 80% to 120%.
Yes_X___ No____ NA____

VI. INTERELEMENT CORRECTION FACTORS

A. The Interelement Correction Factors are included and complete for all possible interferent analytes.
Yes____ No____ NA_X___

VII. SPIKE SAMPLE RECOVERY

A. A matrix (pre-digestion) spike sample was analyzed for each digestion group and/or matrix or as required in the method.
Yes_X___No_____

And the Matrix spike percent recoveries were within the required control limits of 75 – 125%. (20% RPD)
Yes_X___No_____

B. A Post-digest spike was analyzed if required.
Yes____ No____ NA_X___

C. The MS/MSD samples were client samples
Yes_X__No_____

VIII. LAB DUPLICATES
A. Matrix (pre-digestion) duplicate samples were analyzed at the required frequency, where applicable.
Yes____No_____NA_X__

And the Matrix duplicate relative percent differences (RPD) were within the required control limits (Water 20%) or the RL limits were met if the duplicate values are < 5 x RL. If either one of the duplicate results are < 5 X RL, the RPD is not used. The QC limit used is the difference between the original and the duplicate results where a difference of ± the RL for water is acceptable.
Yes____No_____NA_X__

IX. LABORATORY CONTROL SAMPLE

X. A. Laboratory control samples (LCS) were analyzed at the required frequency.
Yes_X__No_____

And LCS recoveries were within the required control limits of 80 to 120%.
Yes_X__No_____

XI. SERIAL DILUTION
A. Serial Dilutions have been analyzed at the required frequency if the analyte concentrations are greater than 50 x IDL.
Yes_X__ No____ NA____

And the percent difference criteria of ± 10 % have been met.
Yes____ No____ NA_X___

Sample result was nondetect for dilution parameter.

XII. INSTRUMENT DETECTION LIMITS & REPORTING LIMTS
A. The Instrument Detection Limits have met the Quarterly reporting requirements.
Yes_X__ No____ NA____

And all sample results have met the required reporting limits (RL).
Yes_X__ No____ NA____

XIII. PREPARATION AND ANALYSIS LOGS

A. All samples were prepared within the required holding times (time of sample receipt to preparation/distillation).
Yes_X__No_____

B. All samples were analyzed within the method recommended holding times (time of sample collection to date of analysis).
Yes_X__No_____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.
Yes_X__No_____

2. Samples were received at the required temperature and preservation.
Yes_X__No_____

XIV. FIELD QC

A.Field QC samples (duplicates, blanks) were identified in a sample key.

Yes_X__ No____ NA____

B. Field duplicates were within a guidance limit of < 25% RPD limit for water. If values are < 5 x RL, the water limit is ± RL. Final determination will be made by the project manager.
Yes_X__ No____ NA____

C. Field blanks (including equipment rinsates) are contained and identified in the package.
Yes_X__ No____ NA____

And the reported results are less than the RL
Yes_X__ No____ NA____

XV. GENERAL COMMENTS

The data are usable for project purposes without qualification.

Technical Memorandum

July 20, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/9	**Ref. No.**	12561153
Subject	**Data Validation** **VOC and Metals Analysis** **Site A Well Sampling** **May 11-12, 2022** **TCAAP Site A** **St. Paul, Minnesota**		

The following are data validation forms for samples collected on May 11-12, 2022, at TCAAP Site A in St. Paul, Minnesota.

Regards,

Ruth Mickle
Chemist

The Power of Commitment

Table 1

Sample Identification Numbers
TCAAP Site A
SDG ID: L1494552
May 2022 Sampling Event

Sample ID	Sample Location
SITEA-220511-RA-01	01U901
SITEA-220511-RA-02	01U904
SITEA-220511-RA-03	01U902
SITEA-220511-RA-04	01U902 Field Duplicate
SITEA-220511-RA-05	01U903 Field Blank
SITEA-220511-RA-06	01U903
SITEA-220512-RA-07	01U905
SITEA-220511-RA-08	01U906
SITEA-220512-RA-09	01U907
SITEA-220512-RA-10	01U039
SITEA-220512-RA-11	01U039 Field Blank
SITEA-220512-RA-12	01U358
SITEA-220512-RA-13	01U358 Field Duplicate
SITEA-220512-RA-14	01U357
SITEA-220512-RA-15	01U140
SITEA-220512-RA-16	01U356
SITEA-220512-RA-17	01U139
SITEA-220512-RA-18	01U355
SITEA-220512-RA-19	01U115
SITEA-220512-RA-20	01U157
SITEA-220512-RA-21	01U353
SITEA-220512-RA-29	01U102
SITEA-220512-RA-22	01U352
SITEA-220512-RA-23	01U352 Field Duplicate
SITEA-220512-RA-24	01U117
SITEA-220512-RA-25	01U126
SITEA-220512-RA-26	01U108
SITEA-220512-RA-27	01U103
SITEA-220512-RA-28	01U126 Field Blank
SITEA-220512-RA-30	01U116
SITEA-220512-RA-31	01U138
SITEA-220512-RA-32	01U158
TRIP BLANK	Trip Blank

Table 2

Laboratory Precision and Accuracy Limits
TCAAP Site A
SDG ID: L1494552
May 2022 Sampling Event

Criteria	Parameter	Pace #L1494552-batch WG1867408, WG1867409,WG1868180, WG1869196	% Recovery Limits	RPD Limits
		Recovery range:		
Surrogate				
VOC	1,2-Dichloroethane-d4	95.3-129	70-130	NA
	4-Bromofluorobenzene	100-110	77-126	NA
	Toluene-d8	98.5-108	80-120	NA

Criteria	Parameter	batch WG1867408 Recoveries:	% Recovery Limits	RPD Limit
LCS				
VOC	Benzene	89.8/90.0 (0.222)	70-123	20
	Chloroform	102/99.2 (2.39)	73-120	20
	1,2-Dichloroethane	96.2/97.8 (1.65)	70-128	20
	1,1-Dichloroethene	92.2/96.4 (4.45)	71-124	20
	cis-1,2-Dichloroethene	97.2/103 (5.60)	73-120	20
	Tetrachloroethene	104/105 (1.15)	72-132	20
	Trichloroethene	100/102 (1.78)	78-124	20

Criteria	Parameter	batch WG1867409 Recoveries:	% Recovery Limits	RPD Limit
LCS				
VOC	Benzene	107/102 (4.79)	70-123	20
	Chloroform	121/116 (3.88)	73-120	20
	1,2-Dichloroethane	129/126 (2.20)	70-128	20
	1,1-Dichloroethene	107/100 (6.19)	71-124	20
	cis-1,2-Dichloroethene	114/109 (4.49)	73-120	20
	Tetrachloroethene	111/105 (5.56)	72-132	20
	Trichloroethene	116/111 (4.23)	78-124	20

Table 2

Laboratory Precision and Accuracy Limits
TCAAP Site A
SDG ID: L1494552
May 2022 Sampling Event

Criteria	Parameter	batch WG1868180 Recoveries:	% Recovery Limits	
LCS				
VOC	Benzene	90.4/92.0 (1.75)	70-123	20
	Chloroform	106/105 (0.568)	73-120	20
	1,2-Dichloroethane	106/105 (1.52)	70-128	20
	1,1-Dichloroethene	97.6/102 (4.41)	71-124	20
	cis-1,2-Dichloroethene	105/98.8 (6.27)	73-120	20
	Tetrachloroethene	102/99.4 (2.19)	72-132	20
	Trichloroethene	106/105 (0.948)	78-124	20

Criteria	Parameter	batch WG1869196 Recoveries:	% Recovery Limits	RPD Limit
LCS				
LCS				
VOC	Benzene	90.4/92.0 (1.75)	70-123	20
	Chloroform	106/105 (0.568)	73-120	20
	1,2-Dichloroethane	106/105 (1.52)	70-128	20
	1,1-Dichloroethene	97.6/102 (4.41)	71-124	20
	cis-1,2-Dichloroethene	105/98.8 (6.27)	73-120	20
	Tetrachloroethene	102/99.4 (2.19)	72-132	20
	Trichloroethene	106/105 (0.948)	78-124	20

Criteria	Parameter	SITEA-220511-RA-01 Recoveries:	% Recovery Limits	RPD Limit
MS/MSD				
VOC	Benzene	112/108 (4.01)	17-158	27
	Chloroform	125/117 (7.27)	29-154	28
	1,2-Dichloroethane	122/118 (3.67)	29-151	27
	1,1-Dichloroethene	126/119 (6.05)	11-160	29
	cis-1,2-Dichloroethene	121/118 (2.60)	10-160	27
	Tetrachloroethene	118/121 (2.18)	10-160	27
	Trichloroethene	126/121 (4.54)	10-160	25

Table 2

Laboratory Precision and Accuracy Limits
TCAAP Site A
SDG ID: L1494552
May 2022 Sampling Event

Criteria	Parameter	SITEA-220512-RA-21 Recoveries:	% Recovery Limits	RPD Limit
MS/MSD				
VOC	Benzene	125/133 (4.64)	17-158	27
	Chloroform	147/159 (8.24)	29-154	28
	1,2-Dichloroethane	164/168 (2.65)	29-151	27
	1,1-Dichloroethene	127/140 (10.1)	11-160	29
	cis-1,2-Dichloroethene	0/144 (10.3)	10-160	27
	Tetrachloroethene	137/135 (1.32)	10-160	27
	Trichloroethene	136/143 (5.31)	10-160	25

Criteria	Parameter	batch WG1868177 Recoveries:	% Recovery Limits	RPD Limits
LCS				
Metals	Antimony	91.3	80-120	20

Table 3

Field Duplicate Summary
TCAAP Site A
SDG ID: L1494552
May 2022 Sampling Event

VOC parameters	SITEA-220511-RA-03 01U902 (ug/l)	SITEA-220511-RA-04 01U902 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
Benzene	1.52	1.51	0.01	1
cis-1,2-Dichloroethene	99.8	103	3.2	25
Metals parameters				
Antimony (dissolved)	All Non-detect			

VOC parameters	SITEA-220512-RA-12 01U358 (ug/l)	SITEA-220512-RA-13 01U358 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
	All Non-detect			

VOC parameters	SITEA-220512-RA-22 01U352	SITEA-220512-RA-23 01U352 Field Duplicate	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
	All Non-detect			

Notes:
RL - Reporting limit
RPD - Relative Percent Difference

ANALYTICAL DATA VALIDATION FORM (INORGANICS)

SDG: L1494552

PROJECT: TCAAP Site A

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE: 5/11/22-5/12/22 NO. OF SAMPLES: 3

ANALYSES REQUESTED: Method 6020 (Antimony)

SAMPLE NO. see Table 1

REVIEWER: Ruth Mickle

QA REVIEWER: Ruth Mickle INITIALS/DATE:

Telephone Logs included Yes____ No X

Contractual Violations Yes____ No X

Comments:

I. DELIVERABLES

All deliverables were present as specified in the Scope of Work and QAPP.

Yes X No_____

II. CALIBRATIONS

A. All initial instrument calibrations were performed as defined in the method standard operating procedure (SOP). All correlation coefficients of the multi point curve (at least the minimum # standards used) were > 0.995.

Yes X No____ NA____

B. The initial calibration verification (ICV) and continuing calibration verification (CCV) standards were analyzed at the required frequency.

Yes X No_____

The ICV and CCV standard percent recovery results were within the required control limits (90 – 110% metals, exc Hg; Hg 80-120%) or per method SOP (e.g., Cn, general chemistry parameters).

Yes X No_____

C. ICP/MS Tune and Calibrations

1. The tuning solution was analyzed at the required frequency throughout the analyses. The results of all instrument performance checks were within the method acceptance criteria, indicating that proper optimization of the instrumentation was achieved.

Yes X No_____

D. Internal Standardization

1. The appropriate # of internal standards were present in all standards and blanks, as applicable to limited list of metals.

Yes X No_____

2. The intensity of each internal standard was within the 60 - 125% control limits.

Yes X No_____

III. LOW LEVEL (CRI/CRDL) STANDARDS
A. Low Level (CRI/CRDL) standards were analyzed.
Yes_X__ No____ NA____

IV. LABORATORY BLANKS
Note: the highest blank associated with any particular analyte is used for the qualification process and is the value entered after the "B" blank descriptor.
A. The initial calibration blanks (ICB) and continuing calibration blanks (CCB) were analyzed at the required frequency.
Yes_X__ No____ NA____

And the ICB and CCB results were within the required control limits criteria (Appendix H-inorganics).
Yes_X__ No____ NA____

B. Preparation blanks were prepared and analyzed at the required frequency.
Yes_X__No_____

And Preparation blanks were within the required control limits criteria (Appendix H-inorganics).
Yes_X__No_____

V. ICP INTERFERENCE CHECK SAMPLE
A. The Interference check sample (ICS) was analyzed as required in the method.
Yes_X__ No____ NA____

And the ICS percent recovery results were reported for all required ICS analytes and were within required control limits of 80% to 120%.
Yes_X__ No____ NA____

VI. INTERELEMENT CORRECTION FACTORS
A. The Interelement Correction Factors are included and complete for all possible interferent analytes.
Yes____ No____ NA_X__

VII. SPIKE SAMPLE RECOVERY
A. A matrix (pre-digestion) spike sample was analyzed for each digestion group and/or matrix or as required in the method.
Yes_X__No_____

And the Matrix spike percent recoveries were within the required control limits of 75 – 125%. (20% RPD)
Yes_X__No_____non-project

B. A Post-digest spike was analyzed if required.
Yes____ No____ NA_X__

C. The MS/MSD samples were client samples
Yes____No X

VIII. LAB DUPLICATES
A. Matrix (pre-digestion) duplicate samples were analyzed at the required frequency, where applicable.
Yes____No_____NA_X__

And the Matrix duplicate relative percent differences (RPD) were within the required control limits (Water 20%) or the RL limits were met if the duplicate values are < 5 x RL. If either one of the duplicate results are < 5 X RL, the RPD is not used. The QC limit used is the difference between the original and the duplicate results where a difference of ± the RL for water is acceptable.
Yes____No_____NA_X__

IX. LABORATORY CONTROL SAMPLE
A. Laboratory control samples (LCS) were analyzed at the required frequency.
Yes_X__No_____

And LCS recoveries were within the required control limits of 80 to 120%.
Yes_X__No_____

X. SERIAL DILUTION
A. Serial Dilutions have been analyzed at the required frequency if the analyte concentrations are greater than 50 x IDL.
Yes_X__ No____ NA____

And the percent difference criteria of ± 10 % have been met.
Yes_X__ No____ NA____

XI. INSTRUMENT DETECTION LIMITS & REPORTING LIMTS
A. The Instrument Detection Limits have met the Quarterly reporting requirements.
Yes_X__ No____ NA____

And all sample results have met the required reporting limits (RL).
Yes_X__ No____ NA____

XII. PREPARATION AND ANALYSIS LOGS

A. All samples were prepared within the required holding times (time of sample receipt to preparation/distillation).

Yes X No_____

B. All samples were analyzed within the method recommended holding times (time of sample collection to date of analysis).

Yes X No_____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.

Yes X No_____

2. Samples were received at the required temperature and preservation.

Yes X No_____

XIII. FIELD QC

A. Field QC samples (duplicates, blanks) were identified in a sample key.

Yes X No____ NA____

B. Field duplicates were within a guidance limit of < 25% RPD limit for water. If values are < 5 x RL, the water limit is ± RL. Final determination will be made by the project manager.

Yes X No____ NA____

C. Field blanks (including equipment rinsates) are contained and identified in the package.

Yes____ No____ NA X

And the reported results are less than the RL

Yes____ No___ NA X

XIV. GENERAL COMMENTS

The data are usable for project purposes without qualification.

ANALYTICAL DATA VALIDATION FORM (VOCs)

SDG NUMBER: L1494552

PROJECT: TCAAP Site A

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 5/11/22-5/11/22 NO. OF SAMPLES: 33

ANALYSES REQUESTED: Method 8260 (VOCs)

SAMPLE NO. see Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:__________

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____No X

Contractual Violations Yes____No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.

Yes X No ____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.

Yes X No ____

B. Holding Times

1. The required holding times were met for all analyses (Time of sample receipt to time of analysis (VOA) or extraction and from extraction to analysis).

Yes X No ____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.

Yes X No ____

2. Samples were received at the required temperature and preservation.

Yes X No ____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for all compounds for all analyses met the QAPP or method criteria.

Yes X No____ NA ____

2. The relative standard deviation (RSD) for all compounds in the standard was less than 20%, with an allowance of up to 40% for the poor responders. Per the method, a correlation coefficient “r” of > 0.99 is also acceptable for compounds,

Yes X No____ NA ____

3. The 12 hour system Performance Check was performed as required in SW-846.

Yes X No____ NA ____

B. Continuing Calibration

1. The RRF 50 standard was analyzed for each analysis at the required frequency and the QC criteria were met.

Yes X No____ NA ___

2. The percent difference (%D) limits for all compounds is $\pm$20%, with an allowance of up to 40% for the poor responders per the current validation guidance, were met.

Yes X No____ NA ____

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The BFB performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met.

Yes X No____ NA ____

V. INTERNAL STANDARDS

The Internal Standards met the 100% upper and -50% lower limits criteria and the Retention times were within the required windows.

Yes X No____ NA ____

VI. SURROGATE

Surrogate spikes were analyzed with every sample.

Yes X No ____

And met the recovery limits defined in the QAPP (i.e., Current lab limits).
Yes X ___ No _____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every analysis performed and for every 20 samples or for every matrix whichever is more frequent.
Yes X ___ No _____

B. The MS and MSD percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes ______ No X
See Table 2
Sample SITEA-220512-RA-21 yielded high biased recoveries for chloroform and 1,2-dichloroethane. Since the associated sample results were non-detect, no data qualification was required. One cis- 1,2-dichloroethene was outside of control limits. Since the sample concentration was much greater than the spike concentration, no qualification was required.

C. The MSD relative percent differences (RPD) were within the QAPP limits.

Yes X ___ No _____ NA _____
See Table 2

VIII. LABORATORY CONTROL SAMPLE
A. A Laboratory Control Samples (LCS) was analyzed for every analysis batch or for every 20 samples.
Yes X ___ No _____
The LCS percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes ___ No ____ X
See Table 2
Chloroform and 1,2-dichloroethane recoveries were above the upper control limit for LCS batch 1867409. Since the associated sample results were non-detect, no data qualification was required.

IX. BLANKS
A. Method Blanks were analyzed at the required frequency and for each matrix and analysis.
Yes X ___ No _____

B. No blank contamination was found in the Method Blank.
Yes X ___ No _____

C. If Equipment Rinsate Blanks were identified, no blank contamination was found.
Yes ______ No X NA _______
There were several low-level VOC detections in field blanks. Since the associated data were non-detect, no qualification was necessary.

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the RPD or % recovery criteria for the project.
Yes X ___ No _____ NA _____
See Table 3

XI. SYSTEM PERFORMANCE
A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.
Yes X ___ No _____ NA _____
B. The suggested EQL's for the sample matrices in this set were met
Yes X ___ No _____ NA _____

XII. TCL COMPOUNDS
A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.

Yes X____No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compounds in each internal standards quantitation set.
Yes X____No_____NA _____

XIII. TENTATIVELY IDENTIFIED COMPOUNDS
TICs were properly identified and met the library identification criteria.
Yes______No_____NA X___

XIV. OVERALL ASSESSMENT OF THE CASE
The data are usable for project purposes without qualification.

Technical Memorandum

July 20, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/10	**Ref. No.**	12561153
Subject	**Data Validation** **VOC and 1,4-Dioxane Analysis** **TCAAP OU1 Well Sampling** **May 17, 2022** **TCAAP OU1 Site** **St. Paul, Minnesota**		

The following are data validation forms for samples collected on May 17, 2022, at TCAAP OU1 Site in St. Paul, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Sample Identification Numbers
OU1 - TCAAP Site
SDG ID: L1496137
May 2022 Sampling Event

Sample ID	Sample Location
OU1-220517-RA-28	04J836
OU1-220517-RA-29	04U836
OU1-220517-RA-30	04J839
OU1-220517-RA-31	04J839 Field Blank
OU1-220517-RA-32	04U839
OU1-220517-RA-33	04U839 Field Duplicate
OU1-220517-RA-34	04U850
OU1-220517-RA-35	04U850 Field Duplicate
OU1-220517-RA-38	409556
OU1-220517-RA-39	04U877
OU1-220517-RA-40	409549
OU1-220517-RA-41	409549 Field Blank
OU1-220517-RA-42	04U879
OU1-220517-RA-43	04U838
OU1-220517-RA-44	04J838
OU1-220517-RA-45	04U821
OU1-220517-RA-46	04U821 Field Duplicate
OU1-220517-RA-47	03U821
OU1-220517-RA-48	03U821 Field Blank
OU1-220517-RA-49	03L846
OU1-220517-RA-50	03M843
OU1-220517-RA-51	04U843
OU1-220517-RA-52	04U846
OU1-220517-RA-53	03L832
OU1-220517-RA-54	409550
OU1-220517-RA-55	04U844
OU1-220517-RA-56	04U844 Field Blank
OU1-220517-RA-57	04U849
OU1-220517-RA-58	04J849
OU1-220517-RA-59	04U855

Table 2

Laboratory Precision and Accuracy Limits
OU1 - TCAAP Site
SDG ID: L1496137
May 2022 Sampling Event

Criteria	Parameter	Pace #L1496137 batch WG1868051, WG1868583 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	94.4-100	70-130	NA
	4-Bromofluorobenzene	86.5-94.8	77-126	NA
	Toluene-d8	101-108	80-120	NA

Criteria	Parameter	batch WG1868051 Recoveries:	% Recovery Limits	
LCS				
VOC	1,1-Dichloroethane	98.0/95.2 (2.90)	70-126	20
	1,1-Dichloroethene	100/99.8 (0.997)	71-124	20
	cis-1,2-Dichloroethene	93.8/95.8 (2.11)	73-120	20
	1,1,1-Trichloroethane	95.2/95.2 (0)	73-124	20
	1,1,2-Trichloroethane	98.2/99.4 (1.21)	80-120	20
	Trichloroethene	97.8/94.0 (3.96)	78-124	20

Criteria	Parameter	batch WG1868583 Recoveries:	% Recovery Limits	
LCS				
VOC	1,1-Dichloroethane	99.2/101 (1.80)	70-126	20
	1,1-Dichloroethene	102/94.4 (8.13)	71-124	20
	cis-1,2-Dichloroethene	97.2/95.6 (1.66)	73-120	20
	1,1,1-Trichloroethane	96.8/96.8 (0)	73-124	20
	1,1,2-Trichloroethane	101/105 (3.69)	80-120	20
	Trichloroethene	94.2/98.8 (4.77)	78-124	20

Criteria	Parameter	OU1-220517-RA-50 Recoveries (RPD):	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	87.8/110 (22.4)	25-158	27
	1,1-Dichloroethene	86.4/112 (25.8)	11-160	29
	cis-1,2-Dichloroethene	83.2/104 (21.8)	10-160	27
	1,1,1-Trichloroethane	82.0/111 (30.4)	23-160	28
	1,1,2-Trichloroethane	97.4/106 (8.08)	35-147	27
	Trichloroethene	77.8/97.8 (22.8)	10-160	25

Table 2

Laboratory Precision and Accuracy Limits
OU1 - TCAAP Site
SDG ID: L1496137
May 2022 Sampling Event

Criteria	Parameter	Pace #L1496137 batch WG1867325, WG1867688, WG1867712 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	36.2-75.0	10-120	NA

Criteria	Parameter	batch WG1867325 Recoveries (RPD):	% Recovery Limits	RPD Limits
LCS				
VOC	1,4-Dioxane	113	73-146	NA

Criteria	Parameter	batch WG1867688 Recoveries (RPD):	% Recovery Limits	RPD Limits
LCS				
VOC	1,4-Dioxane	111	73-146	NA

Criteria	Parameter	batch WG1867712 Recoveries (RPD):	% Recovery Limits	RPD Limits
LCS				
VOC	1,4-Dioxane	93.8	73-146	NA

Criteria	Parameter	OU1-220517-RA-50 Recoveries (RPD):	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,4-Dioxane	97.6/93.0 (3.68)	38-160	21

Note:
NA - Not Applicable

Table 3

Field Duplicate Summary
OU1 - TCAAP Site
SDG ID: L1496137
May 2022 Sampling Event

	OU1-220517-RA-32 04U839 (ug/l)	OU1-220517-RA-33 04U839 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
1,1,1-Trichloroethane	0.550 J	0.505 J	0.045	1
1,1-Dichloroethane	1.89	1.89	0	1
1,1-Dichloroethene	1.36	0.880 J	0.480	1
cis-1,2-Dichloroethene	0.442 J	0.427 J	0.015	1
Trichloroethene	23.8	22.8	4.3	25
				Difference Limit (+/-2 RL) or RPD Limit
SVOC parameter				
1,4-Dioxane	5.31	5.05	5.0	25

	OU1-220517-RA-34 04U850 (ug/l)	OU1-220517-RA-35 04U850 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
1,1,1-Trichloroethane	0.334 J	0.299 J	0.035	1
1,1-Dichloroethane	3.71	2.86	0.85	1
1,1-Dichloroethene	3.93	2.94	0.99	1
cis-1,2-Dichloroethene	10.6	5.94	56.3	25
Trichloroethene	33.5	28.7	15.4	25
				Difference Limit (+/-2 RL) or RPD Limit
SVOC parameter				
1,4-Dioxane	8.51	7.34	14.8	25

	OU1-220517-RA-45 04U821 (ug/l)	OU1-220517-RA-46 04U821 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
1,1-Dichloroethane	0.999 J	0.934 J	0.065	1
1,1-Dichloroethene	0.912 J	0.860 J	0.052	1
cis-1,2-Dichloroethene	9.04	8.13	10.6	25
Trichloroethene	1.54	1.37	0.17	1
				Difference Limit (+/-2 RL) or RPD Limit
SVOC parameter				
1,4-Dioxane	15.1	13.5	11.2	25

Notes:
J - Estimated concentration
RL - Reporting limit
RPD - Relative Percent Difference

ANALYTICAL DATA VALIDATION FORM (1,4-Dioxane)

SDG NUMBER: L1496137

PROJECT: TCAAP OU1

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 5/17/22 NO. OF SAMPLES: 30

ANALYSES REQUESTED: Method 8270 SIM (1,4-dioxane)

SAMPLE NO. Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____ No X

Contractual Violations Yes____ No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.
Yes X____No _____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.
Yes X____No _____

B. Holding Times

1. The required holding times were met for all analyses. Time elapsed from sample collection to extraction (7 days) and from extraction to analysis (40 days) were within criteria.
Yes X_____No_____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all entries were complete, signatures were present and cross outs were clean and initialed.
Yes X____No _____

2. Samples were received at the required temperature (samples cooled to < 6 ^{o}C upon collection)
Yes X____No _____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for 1,4-dioxane met the method criteria. A minimum of five point calibration was used. An isotope dilution procedure was performed.
Yes X____No_____NA _____

2. The relative standard deviation (RSD) was less than or equal to 20%. Alternatively, a coefficient of determination ("r2") of > or equal to 0.99 is acceptable for 1,4-dioxane.
Yes_X____No_____NA _____

B. Continuing Calibration

1. The continuing calibration standard was analyzed at the required frequency and the QC criteria were met. The continuing calibration verification (CCV) was analyzed before sample analysis; after every 12 hours of analysis.
Yes X__No____NA ___

The percent difference (%D) limits of ±20% was met for the CCV.
Yes X__No____NA ___

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The DFTPP performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met per the Method specifications.
Yes X____No_____NA _____

V. INTERNAL STANDARDS

The Internal Standards met the -50 to +100% criteria compared to the daily CCV and the Retention times were within the required windows (+/- 0.06 RRT) for samples.
Yes X____No_____NA _____

VI. SURROGATE
Surrogate spikes were analyzed with every sample.
Yes X____No _____

Surrogates met the limits established in the QAPP (i.e., Current lab limits).
Yes X____No _____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every batch or for every 20 samples.
Yes X____No _____

B. The MS and MSD percent recoveries were within the current limits established in the QAPP (i.e., Current lab limits).
Yes X____No _____
See Table 2

C. The MSD relative percent differences (RPDs) were within the current limits established in the QAPP (i.e., Current lab limits).
Yes X____No _____

VIII. LABORATORY CONTROL SAMPLE
A. Laboratory Control Samples (LCS) was analyzed for every batch or every 20 samples.
Yes X____No _____

B. The LCS percent recoveries (and RPD limits, if LCS duplicate) were within the limits established in the QAPP (i.e., Current lab limits).
Yes X__No ____
See Table 2

IX. BLANKS
A. Method Blanks were analyzed at the required frequency for the analysis.
Yes X___No _____

B. No blank contamination was found in the Method Blank.
Yes X___No _____

C. If Equipment/Field Blanks were identified, no blank contamination was found.
Yes X___No_____NA _____

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the <25% RPD, or ± 2 x RL for either result < 5 x RL, criteria for the project.
Yes X___No_____NA _____

XI. SYSTEM PERFORMANCE
A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.
Yes X___No_____NA _____

B. The suggested EQL's for the sample matrices in this set were met.
Yes X No_____NA _____

XII. COMPOUND IDENTIFICATION & QUANTITATION
A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.
Yes X No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compound in one internal standards quantitation set.
Yes X No_____NA _____

XIII. OVERALL ASSESSMENT OF THE CASE
The data are usable for project purposes without qualification.

ANALYTICAL DATA VALIDATION FORM (VOCs)

SDG NUMBER: L1496137

PROJECT: TCAAP Site OU1

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 5/17/22 NO. OF SAMPLES: 30

ANALYSES REQUESTED: Method 8260 (VOCs)

SAMPLE NO. see Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____No X

Contractual Violations Yes____No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.
Yes X____ No ____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.
Yes X____ No ____

B. Holding Times

1. The required holding times were met for all analyses (Time of sample receipt to time of analysis (VOA) or extraction and from extraction to analysis).
Yes X____ No ____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.
Yes X____ No ____

2. Samples were received at the required temperature and preservation.
Yes X____ No ____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for all compounds for all analyses met the QAPP or method criteria.
Yes X____ No____ NA ____

2. The relative standard deviation (RSD) for all compounds in the standard was less than 20%, with an allowance of up to 40% for the poor responders. Per the method, a correlation coefficient "r" of > 0.99 is also acceptable for compounds,
Yes_X____ No____ NA ____

3. The 12 hour system Performance Check was performed as required in SW-846.
Yes_X____ No____ NA ____

B. Continuing Calibration

1. The RRF 50 standard was analyzed for each analysis at the required frequency and the QC criteria were met.
Yes X__ No____ NA ___

2. The percent difference (%D) limits for all compounds is ±20%, with an allowance of up to 40% for the poor responders per the current validation guidance, were met.
Yes X____ No____ NA ____

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The BFB performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met.
Yes X____ No____ NA ____

V. INTERNAL STANDARDS

The Internal Standards met the 100% upper and -50% lower limits criteria and the Retention times were within

the required windows.
Yes X____No_____NA _____

VI. SURROGATE
Surrogate spikes were analyzed with every sample.
Yes X____No _____

And met the recovery limits defined in the QAPP (i.e., Current lab limits).
Yes X____No _____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every analysis performed and for every 20 samples or for every matrix whichever is more frequent.
Yes X____No _____

B. The MS and MSD percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X____No _____
See Table 2

C. The MSD relative percent differences (RPD) were within the QAPP limits.

Yes______No X___NA _____
See Table 2
The 1,1,1-trichloroethane RPD result from MS/MSD analyses for sample OU1-220517-RA-50 was outside the control limit. Since the associated detection for sample OU1-220517-RA-50 was non-detect, no qualification was necessary.

VIII. LABORATORY CONTROL SAMPLE
A. A Laboratory Control Samples (LCS) was analyzed for every analysis batch or for every 20 samples.
Yes X____No _____

The LCS percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X__No ____
See Table 2

IX. BLANKS
A. Method Blanks were analyzed at the required frequency and for each matrix and analysis.
Yes X____No _____

B. No blank contamination was found in the Method Blank.
Yes X____No _____

C. If Equipment Rinsate Blanks were identified, no blank contamination was found.
Yes X____No_____NA _____

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the RPD or % recovery criteria for the project.
Yes______No X___NA _____
See Table 3
The cis-1,2-dichloroethene RPD result (56.3) exceeded the control limit (RPD=25) for samples OU1-220517-RA-34 and OU1-

220517-RA-35. As a result, the associated cis-1,2-dichloroethene data for these samples were qualified as estimated (JFD 56.3).

XI. SYSTEM PERFORMANCE

A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.

Yes X____No_____NA _____

B. The suggested EQL's for the sample matrices in this set were met

Yes X____No_____NA _____

XII. TCL COMPOUNDS

A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.

Yes X____No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compounds in each internal standards quantitation set.

Yes X____No_____NA _____

XIII. TENTATIVELY IDENTIFIED COMPOUNDS

TICs were properly identified and met the library identification criteria.

Yes______No_____NA X___

XIV. OVERALL ASSESSMENT OF THE CASE

The data are usable for project purposes with the qualifications noted.

GHD Digital

Technical Memorandum

July 20, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/11	**Ref. No.**	12561153
Subject	**Data Verification** **OU1 Sampling** **May 12, 2022** **TCAAP Site** **St. Paul, Minnesota**		

The following is a data verification form for samples collected on May 12, 2022, at the TCAAP OU1 Site in St. Paul, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1494603
May 2022 Sampling Event

Criteria	Parameter	batch WG1867409 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	117-131	70-130	NA
	4-Bromofluorobenzene	98.0-111	77-126	NA
	Toluene-d8	99.7-104	80-120	NA

Criteria	Parameter	batch WG1867409 Recoveries:	% Recovery Limits	RPD Limits
LCS				
VOC	1,1-Dichloroethane	112/107 (5.30)	70-126	20
	1,1-Dichloroethene	107/100 (6.19)	71-124	20
	cis-1,2-Dichloroethene	114/109 (4.49)	73-120	20
	1,1,1-Trichloroethane	132/124 (6.55)	73-124	20
	1,1,2-Trichloroethane	101/97.0 (3.84)	80-120	20
	Trichloroethene	116/111 (4.23)	78-124	20

Criteria	Parameter	OU1-220512-RA-01 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	135/140 (3.78)	25-158	27
	1,1-Dichloroethene	131/130 (0.613)	11-160	29
	cis-1,2-Dichloroethene	134/141 (5.24)	10-160	27
	1,1,1-Trichloroethane	168/169 (0.474)	23-160	28
	1,1,2-Trichloroethane	123/131 (6.28)	35-147	27
	Trichloroethene	129/134 (3.80)	10-160	25

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1494603
May 2022 Sampling Event

Criteria	Parameter	batch WG1865845 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	40.9-48.9	10-120	NA

Criteria	Parameter	batch WG1865845 Recoveries (RPD):	% Recovery Limits	RPD Limits
LCS				
VOC	1,4-Dioxane	107	73-146	NA

Criteria	Parameter	OU1-220512-RA-01 Recoveries (RPD):	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,4-Dioxane	105/106 (0.989)	73-146	21

Note:
NA - Not Applicable

Table 2

Field Duplicate Summary
TCAAP Site OU1
SDG ID: L1494603
May 2022 Sampling Event

VOC parameters	OU1-220512-RA-02 04U875 (ug/l)	OU1-220512-RA-03 04U875 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
	All non-detect			

SVOC parameter				Difference Limit (+/-2 RL) or RPD Limit
1,4-Dioxane	0.400 U	0.204 J	0.196	0.8

Notes:
J - Estimated concentration
U - Non-detect
RL - Reporting limit
RPD - Relative Percent Difference

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP OU1	
SDG #: L1494603	Sample Collection Date(s):5/12/22
Matrix: Water	Sample Analysis Date(s): 5/22/22-5/24/22
Method: VOC SW8260, SW 8270	Date Reviewed:7/19/22-7/20/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	N
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	N
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	Y
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	N
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	Y
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – May 2022

Sample ID	Sample Location
OU1-220512-RA-01	200154
OU1-220512-RA-02	04U875
OU1-220512-RA-03	04U875 Field Duplicate
OU1-220512-RA-04	PJ#318
OU1-220512-RA-05	PJ#318 Field Bank
TRIP BLANK	Trip Blank

Item	Comment
6	The LCS batch WG1867409 for 1,1,1-trichloroethane yielded one high biased recovery(132%). However, since the associated sample data were non-detect, no data qualification was required.
7	The MS/MSD recoveries from sample OU1-220512-RA-01 for 1,1,1-trichloroethane yielded high biased recoveries (168 and 169%). However, since the associated sample data were non-detect, no data qualification was required.
11	Sample OU1-220512-RA-02 yielded one high biased surrogate recovery (1,2-Dichloroethane-d4).Since the associated sample data were all non-detect, no data qualification was required.

Technical Memorandum

July 20, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/12	**Ref. No.**	12561153
Subject	**Data Verification** **OU1 Sampling** **May 16, 2022** **TCAAP Site** **St. Paul, Minnesota**		

The following is a data verification form for samples collected on May 16, 2022, at the TCAAP OU1 Site in St. Paul, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1495160
May 2022 Sampling Event

Criteria	Parameter	batch WG1867719, WG1867821, WG1868986 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	93.1-106	70-130	NA
	4-Bromofluorobenzene	89.3-108	77-126	NA
	Toluene-d8	102-112	80-120	NA

Criteria	Parameter	batch WG1867719 Recoveries:	% Recovery Limits	RPD Limits
LCS				
VOC	1,1-Dichloroethane	99.4/98.8 (0.605)	70-126	20
	1,1-Dichloroethene	102/110 (8.11)	71-124	20
	cis-1,2-Dichloroethene	104/101 (3.13)	73-120	20
	1,1,1-Trichloroethane	103/101 (1.37)	73-124	20
	1,1,2-Trichloroethane	94.6/101 (6.54)	80-120	20
	Trichloroethene	96.8/98.4 (1.64)	78-124	20

Criteria	Parameter	OU1-220516-RA-24 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	91.8/106 (14.5)	25-158	27
	1,1-Dichloroethene	88.8/106 (17.3)	11-160	29
	cis-1,2-Dichloroethene	90.0/96.6 (7.07)	10-160	27
	1,1,1-Trichloroethane	92.8/112 (18.4)	23-160	28
	1,1,2-Trichloroethane	93.0/99.4 (6.65)	35-147	27
	Trichloroethene	78.2/98.0 (22.5)	10-160	25

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1495160
May 2022 Sampling Event

Criteria	Parameter	batch WG1867821 Recoveries:	% Recovery Limits	RPD Limits
LCS				
VOC	1,1-Dichloroethane	96.2/93.6 (2.74)	70-126	20
	1,1-Dichloroethene	98.6/97.0 (1.64)	71-124	20
	cis-1,2-Dichloroethene	93.0/91.6 (1.52)	73-120	20
	1,1,1-Trichloroethane	93.4/92.6 (0.860)	73-124	20
	1,1,2-Trichloroethane	98.8/99.6 (0.806)	80-120	20
	Trichloroethene	96.2/93.8 (2.53)	78-124	20

Criteria	Parameter	batch WG1868986 Recoveries:	% Recovery Limits	RPD Limits
LCS				
VOC	1,1-Dichloroethane	104/110 (5.81)	70-126	20
	1,1-Dichloroethene	104/107 (2.85)	71-124	20
	cis-1,2-Dichloroethene	107/112 (5.12)	73-120	20
	1,1,1-Trichloroethane	104/109 (5.07)	73-124	20
	1,1,2-Trichloroethane	106/108 (1.87)	80-120	20
	Trichloroethene	104/108 (3.39)	78-124	20

Criteria	Parameter	batch WG1866494, WG1867325 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	25.3-88.8	10-120	NA

Criteria	Parameter	batch WG1866494 Recoveries (RPD):	% Recovery Limits	RPD Limits

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1495160
May 2022 Sampling Event

LCS				
VOC	1,4-Dioxane	101	73-146	NA
		batch WG1867325	**% Recovery**	**RPD**
Criteria	**Parameter**	**Recoveries (RPD):**	**Limits**	**Limits**
LCS				
VOC	1,4-Dioxane	113	73-146	NA
		OU1-220516-RA-24	**% Recovery**	**RPD**
Criteria	**Parameter**	**Recoveries (RPD):**	**Limits**	**Limits**
MS/MSD				
VOC	1,4-Dioxane	113/116 (2.49)	73-146	21

Note:
NA - Not Applicable

Table 2

Field Duplicate Summary
TCAAP Site OU1
SDG ID: L1495160
May 2022 Sampling Event

VOC parameters	OU1-220516-RA-20 04U834 (ug/l)	OU1-220516-RA-21 04U834 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
1,1-Dichloroethane	0.122 J	0.123 J	0.0010	1
Trichloroethene	1.23	0.919 J	0.31	1
SVOC parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	1.23	0.554	0.68	0.8

Notes:
RL - Reporting limit
RPD - Relative Percent Difference
J - Estimated concentration

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP OU1	
SDG #: L1495160	Sample Collection Date(s):5/16/22
Matrix: Water	Sample Analysis Date(s): 5/21/22-5/25/22
Method: VOC SW8260, SW 8270	Date Reviewed:7/19/22-7/20/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	Y
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	Y
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	N
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – May 2022

Sample ID	Sample Location
OU1-220516-RA-07	409557
OU1-220516-RA-08	409547
OU1-220516-RA-09	04J822
OU1-220516-RA-10	03L822
OU1-220516-RA-11	03U822
OU1220516-RA-13	03L841
OU1220516-RA-14	04U841
OU1-220516-RA-15	04U837
OU1-220516-RA-16	04J837
OU1-220516-RA-17	04U882
OU1-220516-RA-18	04U883
OU1-220516-RA-19	04J834
OU1-220516-RA-20	04U834
OU1-220516-RA-21	04U834 Field Duplicate
OU1-220516-RA-22	04J834 Field Blank
OU1-220516-RA-23	04U881
OU1-220516-RA-24	04U880
OU1-220516-RA-25	04U872

OU1-220516-RA-26	409555
OU1-220516-RA-27	04U871
OU1-220516-RA-36	04J882
OU1-220516-RA-37	04J882
TRIP BLANK	Trip Blank

Item	Comment
13	The field blank yielded a low level 1,4-dioxane detection. However, since the associated sample result was non-detect, no data qualification was required.

Technical Memorandum

July 20, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/13	**Ref. No.**	12561153
Subject	**Data Verification** **OU1 Sampling** **May 20, 2022** **TCAAP Site** **St. Paul, Minnesota**		

The following is a data verification form for samples collected on May 20, 2022, at the TCAAP OU1 Site in St. Paul, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1496631
May 2022 Sampling Event

Criteria	Parameter	batch WG1869957 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	90.3-92.6	70-130	NA
	4-Bromofluorobenzene	99.7-102	77-126	NA
	Toluene-d8	112-115	80-120	NA

Criteria	Parameter	batch WG1869957 Recoveries:	% Recovery Limits	
LCS				
VOC	1,1-Dichloroethane	102/9.2 (3.17)	70-126	20
	1,1-Dichloroethene	115/117 (1.55)	71-124	20
	cis-1,2-Dichloroethene	102/101 (1.57)	73-120	20
	1,1,1-Trichloroethane	106/103 (3.25)	73-124	20
	1,1,2-Trichloroethane	107/106 (1.31)	80-120	20
	Trichloroethene	109/108 (1.29)	78-124	20

Criteria	Parameter	batch WG1868770 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	23.8-74.5	10-120	NA

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1496631
May 2022 Sampling Event

Criteria	Parameter	batch WG1868770 Recoveries (RPD):	% Recovery Limits	RPD Limits
LCS				
VOC	1,4-Dioxane	103/102 (0.585)	73-146	20

Note:

NA - Not Applicable

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP OU1	
SDG #: L1496631	Sample Collection Date(s):5/20/22
Matrix: Water	Sample Analysis Date(s): 5/26/22-5/27/22
Method: VOC SW8260, SW 8270	Date Reviewed:7/16/22-7/18/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	NA
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – May 2022

Sample ID	Sample Location
OU1-220520-RA-60	409547
OU1-220520-RA-62	234546
OU1-220520-RA-63	512761

Technical Memorandum

August 23, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 651 639 0913
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/39	**Ref. No.**	12563220
Subject	Third Quarter DUR FY 2022 OU2 Deep Groundwater (TGRS) Results April - June 2022		

This memo provides the analytical data summary for the third quarter FY 2022 sampling conducted at the OU2 Deep Groundwater Site. Tables 1 through 6 provide the treatment system, monitoring well and extraction well sampling results for FY 2022 third quarter. The data verification memos are included as Attachment 1.

Ruth Mickle
Chemist

+1 612 524-6872
ruth.mickle@ghd.com

Table 1

VOC Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 3rd Quarter

Location	Date	Sample ID		1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Trichloroethene	Trichloroethene
			MDL	**0.149**	**1.49**	**2.98**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**	**1.90**	**3.80**
			RL	**1.00**	**10.0**	**20.0**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**10.0**	**20.0**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
03L002	W-220610-EM-49	06/10/2022		0.333 JP	--	--	0.373 JP	0.664 JP	<1.00	0.193 JP	<1.00	11.3	--	--
03L002	W-220610-EM-50	06/10/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L007	W-220608-EM-30	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L014	W-220621-EM-110	06/21/2022		0.321 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.648 JP	--	--
03L017	W-220616-EM-85	06/16/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L018	W-220622-EM-118	06/22/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L020	W-220615-EM-78	06/15/2022		0.256 JP	--	--	0.120 JP	<1.00	<1.00	<1.00	<1.00	5.60	--	--
03L021	W-220615-EM-81	06/15/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.929 JP	--	--
03L077	W-220610-EM-55	06/10/2022		0.843 JP	--	--	0.120 JP	0.629 JP	<1.00	0.149 JP	<1.00	17.6	--	--
03L078	W-220609-EM-40	06/09/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L079	W-220609-EM-37	06/09/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.567 JP	--	--
03L079	W-220609-EM-38	06/09/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L802	W-220608-EM-27	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.02	--	--
03L802	W-220608-EM-26	06/08/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L806	W-220607-EM-18	06/07/2022		0.609 JP	--	--	0.154 JP	0.293 JP	<1.00	0.219 JP	<1.00	20.8	--	--
03L806	W-220607-EM-19	06/07/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L809	W-220606-EM-04	06/06/2022		2.01	--	--	0.636 JP	1.17	<1.00	0.720 JP	<1.00	85.5	--	--
03L833	W-220607-EM-20	06/07/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.32	--	--
03M002	W-220610-EM-51	06/10/2022		0.512 JP	--	--	1.02	1.12	<1.00	0.469 JP	<1.00	18.7	--	--
03M020	W-220615-EM-74	06/15/2022		1.01	--	--	0.278 JP	<1.00	<1.00	<1.00	<1.00	13.1	--	--
03M020	W-220615-EM-75	06/15/2022	FD	0.874 JP	--	--	0.277 JP	<1.00	<1.00	<1.00	<1.00	12.9	--	--
03M802	W-220608-EM-28	06/08/2022		0.156 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	7.76	--	--
03M806	W-220607-EM-11	06/07/2022		--	<10.0	--	26.0	23.1	0.430 JP	7.53	<1.00	--	295	--
03U002	W-220610-EM-52	06/10/2022		2.22	--	--	0.173 JP	0.603 JP	<1.00	0.698 JP	<1.00	15.7	--	--
03U003	W-220608-EM-34	06/08/2022		12.2	--	--	1.08	2.38	<1.00	3.74	<1.00	60.7	--	--
03U005	W-220615-EM-83	06/15/2022		<1.00	--	--	<1.00	<1.00	<1.00	0.322 JP	<1.00	0.328 JP	--	--
03U007	W-220608-EM-32	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U009	W-220616-EM-89	06/16/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U009	W-220616-EM-90	06/16/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U014	W-220621-EM-112	06/21/2022		18.3 JL129/132	--	--	1.99	1.25	<1.00	1.17	<1.00	59.9	--	--
03U014	W-220621-EM-111	06/21/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U017	W-220616-EM-84	06/16/2022		0.434 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.99	--	--
03U018	W-220622-EM-117	06/22/2022		21.0 JL126/127	--	--	0.139 JP	1.98	<1.00	8.27	<1.00	20.7	--	--
03U020	W-220615-EM-76	06/15/2022		42.1	--	--	4.16	5.93	<1.00	5.40	<1.00	98.6	--	--
03U020	W-220615-EM-77	06/15/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U021	W-220615-EM-82	06/15/2022		5.74	--	--	2.40	2.00	<1.00	3.26	<1.00	58.6	--	--
03U027	W-220614-EM-71	06/14/2022		0.308 JP	--	--	<1.00	0.238 JP	<1.00	0.984 JP	<1.00	10.9	--	--
03U028	W-220614-EM-72	06/14/2022		<1.00	--	--	<1.00	<1.00	<1.00	0.275 JP	<1.00	8.71	--	--
03U029	W-220615-EM-80	06/15/2022		15.2	--	--	1.16	2.88	<1.00	16.2	<1.00	121	--	--
03U030	W-220614-EM-70	06/14/2022		<1.00	--	--	<1.00	<1.00	<1.00	0.158 JP	<1.00	3.89	--	--
03U032	W-220621-EM-107	06/21/2022		0.655 JL129/132	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.211 JP	--	--
03U032	W-220621-EM-108	06/21/2022	FD	0.644 JL129/132	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--

Table 1

VOC Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 3rd Quarter

				1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Trichloroethene	Trichloroethene
			MDL	**0.149**	**1.49**	**2.98**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**	**1.90**	**3.80**
			RL	**1.00**	**10.0**	**20.0**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**10.0**	**20.0**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
03U077	W-220610-EM-57	06/10/2022		0.548 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	10.4	--	--
03U078	W-220609-EM-41	06/09/2022		0.972 JP	--	--	<1.00	0.711 JP	<1.00	1.04	10.2	38.4	--	--
03U079	W-220609-EM-35	06/09/2022		6.43	--	--	0.378 JP	1.64	<1.00	1.74	<1.00	51.5	--	--
03U079	W-220609-EM-36	06/09/2022	FD	5.86	--	--	0.360 JP	1.80	<1.00	1.59	<1.00	49.3	--	--
03U092	W-220622-EM-115	06/22/2022		0.592 JL126/127	--	--	<1.00	<1.00	<1.00	0.963 JP	<1.00	9.52	--	--
03U092	W-220622-EM-116	06/22/2022	EB	<1.00	--	--	<1.00	<1.00	<1.00	0.132 JP	<1.00	<1.00	--	--
03U093	W-220622-EM-119	06/22/2022		154 JL126/127	--	--	1.43	9.89	<1.00	13.5	<1.00	182	--	--
03U094	W-220621-EM-109	06/21/2022		--	--	246	6.97	12.9	<1.00	8.73	0.312 JP	--	--	203
03U096	W-220622-EM-120	06/22/2022		6.62	--	--	0.459 JP	1.11	<1.00	<1.00	<1.00	14.2	--	--
03U099	W-220616-EM-86	06/16/2022		0.862 JP	--	--	<1.00	<1.00	<1.00	0.211 JP	<1.00	1.88	--	--
03U114	W-220616-EM-91	06/16/2022		0.804 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	4.48	--	--
03U659	W-220614-EM-73	06/14/2022		8.43	--	--	0.728 JP	1.57	<1.00	8.02	<1.00	100	--	--
03U671	W-220609-EM-43	06/09/2022		1.49	--	--	<1.00	0.673 JP	<1.00	0.645 JP	11.6	34.7	--	--
03U677	W-220608-EM-33	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U701	W-220613-EM-59	06/13/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.749 JP	--	--
03U702	W-220613-EM-61	06/13/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.529 JP	--	--
03U703	W-220609-EM-39	06/09/2022		0.397 JP	--	--	<1.00	<1.00	<1.00	<1.00	2.22	2.84	--	--
03U708	W-220609-EM-46	06/09/2022		1.31	--	--	<1.00	0.387 JP	<1.00	1.88	16.1	35.6	--	--
03U709	W-220610-EM-53	06/10/2022		1.89	--	--	0.407 JP	0.599 JP	<1.00	0.979 JP	<1.00	20.5	--	--
03U710	W-220609-EM-42	06/09/2022		1.46	--	--	<1.00	0.218 JP	<1.00	0.445 JP	<1.00	13.5	--	--
03U711	W-220607-EM-22	06/07/2022		4.12	--	--	0.729 JP	1.30	<1.00	0.561 JP	0.684 JP	27.8	--	--
03U715	W-220622-EM-113	06/22/2022		7.12 JL126/127JFD30	--	--	0.593 JP	0.920 JP	<1.00	0.398 JP	<1.00	28.4	--	--
03U715	W-220622-EM-114	06/22/2022	FD	5.25 JL126/127JFD30	--	--	0.485 JP	0.549 JP	<1.00	0.648 JP	<1.00	22.4	--	--
03U801	W-220608-EM-24	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	0.248 JP	<1.00	13.5	--	--
03U801	W-220608-EM-25	06/08/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	0.254 JP	<1.00	13.8	--	--
03U803	W-220606-EM-05	06/06/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.07	--	--
03U804	W-220606-EM-09	06/06/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U804	W-220606-EM-08	06/06/2022	EB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U805	W-220606-EM-06	06/06/2022		0.176 JP	--	--	8.50	9.45	<1.00	5.25	2.26	88.7	--	--
03U805	W-220606-EM-07	06/06/2022	FD	0.182 JP	--	--	8.36	8.87	<1.00	5.37	2.22	84.5	--	--
03U806	W-220607-EM-10	06/07/2022		<1.00	--	--	0.517 JP	0.438 JP	<1.00	0.269 JP	0.609 JP	31.7	--	--
04J077	W-220610-EM-58	06/10/2022		0.356 JP	--	--	0.916 JP	1.02	<1.00	0.420 JP	<1.00	34.4	--	--
04J702	W-220613-EM-65	06/13/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.355 JP	--	--
04J702	W-220613-EM-64	06/13/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04J708	W-220609-EM-44	06/09/2022		0.408 JP	--	--	0.710 JP	0.579 JP	<1.00	0.175 JP	<1.00	6.45	--	--
04J713	W-220614-EM-66	06/14/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04J713	W-220614-EM-67	06/14/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U002	W-220610-EM-47	06/10/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.909 JP	--	--
04U002	W-220610-EM-48	06/10/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.989 JP	--	--
04U007	W-220608-EM-31	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U020	W-220615-EM-79	06/15/2022		<1.00	--	--	0.119 JP	<1.00	<1.00	<1.00	<1.00	1.64	--	--
04U077	W-220610-EM-56	06/10/2022		0.725 JP	--	--	0.198 JP	0.665 JP	<1.00	0.254 JP	<1.00	18.1	--	--
04U510	W-220616-EM-87	06/16/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--

Table 1

VOC Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 3rd Quarter

				1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Trichloroethene	Trichloroethene
			MDL	0.149	1.49	2.98	0.100	0.188	0.0819	0.126	0.300	0.190	1.90	3.80
			RL	1.00	10.0	20.0	1.00	1.00	1.00	1.00	1.00	1.00	10.0	20.0
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
04U510	W-220616-EM-88	06/16/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U701	W-220613-EM-60	06/13/2022		0.163 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	2.94	--	--
04U702	W-220613-EM-62	06/13/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.02	--	--
04U702	W-220613-EM-63	06/13/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.06	--	--
04U708	W-220609-EM-45	06/09/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U709	W-220610-EM-54	06/10/2022		0.430 JP	--	--	0.324 JP	0.740 JP	<1.00	0.184 JP	<1.00	11.0	--	--
04U711	W-220607-EM-23	06/07/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.208 JP	--	--
04U713	W-220614-EM-69	06/14/2022	EB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U802	W-220608-EM-29	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.311 JP	--	--
04U806	W-220607-EM-16	06/07/2022		0.544 JP	--	--	0.180 JP	0.309 JP	<1.00	0.288 JP	<1.00	18.3	--	--
04U806	W-220607-EM-17	06/07/2022	FD	0.511 JP	--	--	0.191 JP	0.286 JP	<1.00	0.273 JP	<1.00	18.2	--	--
04U833	W-220607-EM-21	06/07/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.463 JP	--	--
PJ#806	W-220607-EM-12	06/07/2022		0.222 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	9.51	--	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JFD# - Result is qualified as estimated due to outlying field duplicate RPD result. The following numerical value is the associated RPD value.
JL# - Result is qualified as estimated due to outlying percent recovery from lab control sample analyses.
The following numerical value is the associated percent recovery.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FB - Field Blank
EB - Equipment Blank
FD - Field Duplicate

Table 2

VOC Concentrations in TGRS Extraction Well Samples
FY 2022 - Throuhg 3rd Quarter

					1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Trichloroethene
				MDL	**0.149**	**14.9**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**	**19.0**
				RL	**1.00**	**100**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**100**
					ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
Location	**Common Name**	**Date**	**Sample ID**										
03F302	B1	W-211210-EM-11	12/10/2021		4.81	--	0.650 JP	0.867 JP	<1.00	4.87	1.96	91.4	--
03F302	B1	W-220617-EM-98	06/17/2022		5.60	--	0.830 JP	1.30	<1.00	6.00	1.57	89.3	--
03F303	B2	W-220617-EM-96	06/17/2022		0.232 JP	--	0.172 JP	0.927 JP	0.416 JP	2.13	0.984 JP	28.1	--
03F304	B3	W-211210-EM-09	12/10/2021		<1.00	--	0.160 JP	0.195 JP	<1.00	0.135 JP	<1.00	2.24	--
03F304	B3	W-220617-EM-99	06/17/2022		<1.00	--	0.193 JP	0.265 JP	<1.00	0.180 JP	<1.00	2.47	--
03F305	B4	W-211210-EM-08	12/10/2021		3.07	--	1.25	1.42	<1.00	1.09	0.558 JP	50.2	--
03F305	B4	W-220617-EM-100	06/17/2022		3.84	--	1.62	1.85	<1.00	1.33	0.473 JP	48.0	--
03F306	B5	W-211210-EM-04	12/10/2021		2.63	--	1.55	1.92	<1.00	0.727 JP	4.02	59.3	--
03F306	B5	W-211210-EM-05	12/10/2021	FD	2.31	--	1.49	1.76	<1.00	0.745 JP	4.24	62.4	--
03F306	B5	W-220617-EM-102	06/17/2022		2.83	--	1.93	2.36	<1.00	0.892 JP	3.75	59.8	--
03F306	B5	W-220617-EM-103	06/17/2022	FD	2.71	--	1.91	2.14	<1.00	0.947 JP	3.34	59.5	--
03F307	B6	W-211210-EM-01	12/10/2021		0.478 JP	--	0.203 JP	0.356 JP	<1.00	0.165 JP	<1.00	21.4	--
03F307	B6	W-220617-EM-105	06/17/2022		0.497 JP	--	0.258 JP	0.420 JP	<1.00	0.227 JP	<1.00	23.8	--
03F307	B6	W-220617-EM-104	06/17/2022	FB	<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--
03F308	B7	W-220617-EM-93	06/17/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.65	--
PJ#309	B8	W-211210-EM-07	12/10/2021		0.246 JP	--	0.195 JP	0.290 JP	<1.00	0.132 JP	<1.00	4.66	--
PJ#309	B8	W-211210-EM-06	12/10/2021	FB	<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--
PJ#309	B8	W-220617-EM-101	06/17/2022		0.260 JP	--	0.240 JP	0.319 JP	<1.00	<1.00	<1.00	5.15	--
PJ#310	B9	W-211210-EM-02	12/10/2021		0.745 JP	--	0.849 JP	1.13	<1.00	0.321 JP	<1.00	19.4	--
PJ#310	B9	W-211210-EM-03	12/10/2021	FB	<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--
PJ#310	B9	W-220617-EM-106	06/17/2022		0.816 JP	--	0.986 JP	1.21	<1.00	0.419 JP	<1.00	18.8	--
PJ#311	B10	W-220617-EM-94	06/17/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.218 JP	--
03F312	B11	W-220617-EM-95	06/17/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	2.98	--
PJ#313	B12	W-220617-EM-92	06/17/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--
03F319	B13	W-211210-EM-10	12/10/2021		4.91	--	1.79	1.37	<1.00	9.68	0.452 JP	114	--
03F319	B13	W-220617-EM-97	06/17/2022		3.73	--	1.84	1.12	<1.00	8.07	<1.00	76.7	--
03U315	SC3	W-220603-RC-02	06/03/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.409 JP	--
03U316	SC4	W-220603-RC-01	06/03/2022		0.357 JP	--	<1.00	<1.00	<1.00	<1.00	<1.00	3.16	--
03U317	SC5	W-220603-RC-03	06/03/2022		--	593	19.5	42.3	1.46	7.32	5.14	--	2270

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 3

VOC Concentrations in TGRS Treatment System Samples
FY 2022 - Through 3rd Quarter

				1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
			MDL	0.149	0.100	0.188	0.0819	0.126	0.300	0.190
			RL	1.00	1.00	1.00	1.00	1.00	1.00	1.00
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Location	Date	Sample ID								
TGRSE	W-211008-EM-01	10/08/2021		0.236 JP	<1.00	<1.00	<1.00	<1.00	<1.00	2.07 JL141JD25
TGRSE	W-211115-EM-01	11/15/2021		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.376 JP
TGRSE	W-211115-EM-02	11/15/2021	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.360 JP
TGRSE	W-211210-EM-12	12/10/2021		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.476 JP
TGRSE	W-211210-EM-13	12/10/2021	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.460 JP
TGRSE	W-220114-EM-01	01/14/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.364 JP
TGRSE	W-220114-EM-02	01/14/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.435 JP
TGRSE	W-220207-EM-01	02/07/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.673 JP
TGRSE	W-220304-EM-01	03/04/2022		0.157 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.02
TGRSE	W-220304-EM-02	03/04/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.01
TGRSE	W220406-EM-01	04/06/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.19
TGRSE	W220406-EM-02	04/06/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.19
TGRSE	W-220502-EM-01	05/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.16
TGRSE	W-220502-EM-02	05/02/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.20
TGRSE	W-220606-EM-13	06/06/2022		0.150 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.06
TGRSI	W-211008-EM-02	10/08/2021		31.4	1.66	2.52	<1.00	2.56	1.20	176 JL141JD25
TGRSI	W-211008-EM-03	10/08/2021	FD	36.7	1.91	2.97	<1.00	2.85	1.29	201 JL141JD25
TGRSI	W-211115-EM-03	11/15/2021		1.38	0.899 JP	0.714 JP	<1.00	1.31	0.956 JP	33.4
TGRSI	W-211210-EM-14	12/10/2021		1.97	0.857 JP	0.943 JP	<1.00	1.34	1.35	41.8
TGRSI	W-220114-EM-03	01/14/2022		2.07	0.756 JP	1.18	<1.00	1.26	0.812 JP	42.1
TGRSI	W-220207-EM-02	02/07/2022		9.56	2.05	1.93	<1.00	1.29	1.06	74.2
TGRSI	W-220207-EM-03	02/07/2022	FD	9.71	2.01	1.73	<1.00	1.31	1.04	75.1
TGRSI	W-220304-EM-03	03/04/2022		23.5	1.97	2.11	<1.00	1.44	1.24 JD21.3	110
TGRSI	W220406-EM-03	04/06/2022		26.5	1.79	2.38	<1.00	1.39	1.42 JC24.1	139
TGRSI	W-220502-EM-03	05/02/2022		27.7	1.79	2.54	<1.00	1.01	1.01	127
TGRSI	W-220606-EM-14	06/06/2022		36.7	1.58	3.56	<1.00	1.50	1.16	148
TGRSI	W-220606-EM-15	06/06/2022	FD	35.0	1.52	3.85	<1.00	1.59	1.17	146

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JC# - Result is qualified as estimated due to outlying continuing calibration result. The following numerical value is the associated % D value.
JD# - Result is qualified as estimated due to outlying relative percent difference from matrix spike analyses.
The following numerical value is the associated relative percent difference.
JL# - Result is qualified as estimated due to outlying percent recovery from lab control sample analyses.
The following numerical value is the associated percent recovery.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate

Table 4

1,4-Dioxane Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 3rd Quarter

				1,4-Dioxane	1,4-Dioxane	1,4-Dioxane
			MDL	0.0447	0.0447	0.0447
			RL	0.400	0.437	0.517
				ug/L	ug/L	ug/L
Location	Date	Sample ID				
03L002	W-220610-EM-49	06/10/2022		16.2	--	--
03L002	W-220610-EM-50	06/10/2022	FB	<0.400	--	--
03L007	W-220608-EM-30	06/08/2022		<0.400 UB0.0968	--	--
03L014	W-220621-EM-110	06/21/2022		5.40	--	--
03L017	W-220616-EM-85	06/16/2022		17.3	--	--
03L018	W-220622-EM-118	06/22/2022		11.2	--	--
03L020	W-220615-EM-78	06/15/2022		12.8	--	--
03L021	W-220615-EM-81	06/15/2022		7.91	--	--
03L077	W-220610-EM-55	06/10/2022		19.3	--	--
03L078	W-220609-EM-40	06/09/2022		2.50	--	--
03L079	W-220609-EM-37	06/09/2022		1.14	--	--
03L079	W-220609-EM-38	06/09/2022	FB	0.0848 JP	--	--
03L802	W-220608-EM-27	06/08/2022		0.571	--	--
03L802	W-220608-EM-26	06/08/2022	FB	0.0968 JP	--	--
03L806	W-220607-EM-18	06/07/2022		19.3	--	--
03L806	W-220607-EM-19	06/07/2022	FB	0.265 JP	--	--
03L809	W-220606-EM-04	06/06/2022		18.1	--	--
03L833	W-220607-EM-20	06/07/2022		19.1	--	--
03M002	W-220610-EM-51	06/10/2022		16.4	--	--
03M020	W-220615-EM-74	06/15/2022		14.5	--	--
03M020	W-220615-EM-75	06/15/2022	FD	13.2	--	--
03M802	W-220608-EM-28	06/08/2022		<0.400 UB0.0968	--	--
03M806	W-220607-EM-11	06/07/2022		21.4	--	--
03U002	W-220610-EM-52	06/10/2022		3.57	--	--
03U003	W-220608-EM-34	06/08/2022		0.550	--	--
03U005	W-220615-EM-83	06/15/2022		<0.400 UB0.0776	--	--
03U007	W-220608-EM-32	06/08/2022		<0.400 UB0.0968	--	--
03U009	W-220616-EM-89	06/16/2022		<0.400 UB0.130	--	--
03U009	W-220616-EM-90	06/16/2022	FB	0.130 JP	--	--
03U014	W-220621-EM-112	06/21/2022		29.9	--	--
03U014	W-220621-EM-111	06/21/2022	FB	<0.400	--	--
03U017	W-220616-EM-84	06/16/2022		17.2	--	--
03U018	W-220622-EM-117	06/22/2022		<0.400 UB0.0505	--	--
03U020	W-220615-EM-76	06/15/2022		31.0	--	--
03U020	W-220615-EM-77	06/15/2022	FB	0.106 JP	--	--
03U021	W-220615-EM-82	06/15/2022		38.6	--	--
03U027	W-220614-EM-71	06/14/2022		1.25	--	--
03U028	W-220614-EM-72	06/14/2022		0.458	--	--
03U029	W-220615-EM-80	06/15/2022		2.07	--	--
03U030	W-220614-EM-70	06/14/2022		<0.400 UB0.0776	--	--
03U032	W-220621-EM-107	06/21/2022		0.478	--	--
03U032	W-220621-EM-108	06/21/2022	FD	0.660	--	--
03U077	W-220610-EM-57	06/10/2022		9.99	--	--
03U078	W-220609-EM-41	06/09/2022		<0.400 UB0.101	--	--
03U079	W-220609-EM-35	06/09/2022		<0.400 UB0.101	--	--
03U079	W-220609-EM-36	06/09/2022	FD	--	--	<0.517 UB0.101
03U092	W-220622-EM-115	06/22/2022		5.74	--	--
03U092	W-220622-EM-116	06/22/2022	EB	0.0505 JP	--	--
03U093	W-220622-EM-119	06/22/2022		1.81	--	--
03U094	W-220621-EM-109	06/21/2022		41.1	--	--
03U096	W-220622-EM-120	06/22/2022		2.64	--	--
03U099	W-220616-EM-86	06/16/2022		<0.400 UB0.130	--	--
03U114	W-220616-EM-91	06/16/2022		<0.400 UB0.130	--	--
03U659	W-220614-EM-73	06/14/2022		2.35	--	--
03U671	W-220609-EM-43	06/09/2022		<0.400 UB0.101	--	--
03U677	W-220608-EM-33	06/08/2022		0.579	--	--
03U701	W-220613-EM-59	06/13/2022		10.8	--	--
03U702	W-220613-EM-61	06/13/2022		9.37	--	--
03U703	W-220609-EM-39	06/09/2022		0.739	--	--
03U708	W-220609-EM-46	06/09/2022		<0.400 UB0.101	--	--

Table 4

1,4-Dioxane Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 3rd Quarter

				1,4-Dioxane	1,4-Dioxane	1,4-Dioxane
			MDL	**0.0447**	**0.0447**	**0.0447**
			RL	**0.400**	**0.437**	**0.517**
				ug/L	**ug/L**	**ug/L**
03U709	W-220610-EM-53	06/10/2022		11.6	--	--
03U710	W-220609-EM-42	06/09/2022		0.548	--	--
03U711	W-220607-EM-22	06/07/2022		3.58	--	--
03U715	W-220622-EM-113	06/22/2022		6.42 JFD56	--	--
03U715	W-220622-EM-114	06/22/2022	FD	3.60 JFD56	--	--
03U801	W-220608-EM-24	06/08/2022		0.528	--	--
03U801	W-220608-EM-25	06/08/2022	FD	0.505	--	--
03U803	W-220606-EM-05	06/06/2022		--	<0.437 UB0.122	--
03U804	W-220606-EM-09	06/06/2022		<0.400 UB0.122	--	--
03U804	W-220606-EM-08	06/06/2022	EB	0.137 JP	--	--
03U805	W-220606-EM-06	06/06/2022		4.82	--	--
03U805	W-220606-EM-07	06/06/2022	FD	4.87	--	--
03U806	W-220607-EM-10	06/07/2022		12.3	--	--
04J077	W-220610-EM-58	06/10/2022		22.5	--	--
04J702	W-220613-EM-65	06/13/2022		15.2	--	--
04J702	W-220613-EM-64	06/13/2022	FB	<0.400	--	--
04J708	W-220609-EM-44	06/09/2022		11.2	--	--
04J713	W-220614-EM-66	06/14/2022		11.9	--	--
04J713	W-220614-EM-67	06/14/2022	FD	12.0	--	--
04U002	W-220610-EM-47	06/10/2022		16.2	--	--
04U002	W-220610-EM-48	06/10/2022	FD	16.5	--	--
04U007	W-220608-EM-31	06/08/2022		<0.400 UB0.0968	--	--
04U020	W-220615-EM-79	06/15/2022		12.3	--	--
04U077	W-220610-EM-56	06/10/2022		20.1	--	--
04U510	W-220616-EM-87	06/16/2022		<0.400 UB0.130	--	--
04U510	W-220616-EM-88	06/16/2022	FD	<0.400 UB0.130	--	--
04U701	W-220613-EM-60	06/13/2022		15.7	--	--
04U702	W-220613-EM-62	06/13/2022		14.2	--	--
04U702	W-220613-EM-63	06/13/2022	FD	14.7	--	--
04U708	W-220609-EM-45	06/09/2022		7.26	--	--
04U709	W-220610-EM-54	06/10/2022		17.9	--	--
04U711	W-220607-EM-23	06/07/2022		6.06	--	--
04U713	W-220614-EM-69	06/14/2022	EB	0.0976 JP	--	--
04U802	W-220608-EM-29	06/08/2022		0.600	--	--
04U806	W-220607-EM-16	06/07/2022		19.8	--	--
04U806	W-220607-EM-17	06/07/2022	FD	18.9	--	--
04U833	W-220607-EM-21	06/07/2022		19.9	--	--
PJ#806	W-220607-EM-12	06/07/2022		20.5	--	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JFD# - Result is qualified as estimated due to outlying field duplicate RPD result. The following numerical value is the associated RPD value.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.
< - Not detected at the associated reporting limit.
EB - Equipment Blank
FD - Field Duplicate
FB - Field Blank

Table 5

1,4-Dioxane Concentrations in TGRS Extraction Well Samples
FY 2022 - Through 3rd Quarter

					1,4-Dioxane
				MDL	**0.0447**
				RL	**0.400**
					ug/L
Location	**Common Name**	**Date**	**Sample ID**		
B1-03F302	B1	W-220617-EM-98	06/17/2022		3.70
B2-03F303	B2	W-220617-EM-96	06/17/2022		<0.400 UB0.0857
B3-03F304	B3	W-220617-EM-99	06/17/2022		5.98
B4-03F305	B4	W-220617-EM-100	06/17/2022		21.1
B5-03F306	B5	W-220617-EM-102	06/17/2022		16.7
B5-03F306	B5	W-220617-EM-103	06/17/2022	FD	16.4
B6-03F307	B6	W-220617-EM-105	06/17/2022		15.3
B6-03F307	B6	W-220617-EM-104	06/17/2022	FB	0.204 JP
B7-03F308	B7	W-220617-EM-93	06/17/2022		19.0 JP
B8-PJ#309	B8	W-220617-EM-101	06/17/2022		13.6
B9-PJ#310	B9	W-220617-EM-106	06/17/2022		23.4
B10-PJ#311	B10	W-220617-EM-94	06/17/2022		16.3
B11-03F312	B11	W-220617-EM-95	06/17/2022		1.11
B12-PJ#313	B12	W-220617-EM-92	06/17/2022		14.3
B13-03F319	B13	W-220617-EM-97	06/17/2022		10.6
SC3-03U315	SC3	W-220603-RC-02	06/03/2022		11.9
SC4-03U316	SC4	W-220603-RC-01	06/03/2022		12.2
SC5-03U317	SC5	W-220603-RC-03	06/03/2022		11.4

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 6

1,4-Dioxane Concentrations in TGRS Treatment System Samples
FY 2022 - Through 3rd Quarter

				1,4-Dioxane
			MDL	**0.0447**
			RL	**0.400**
				ug/L
Location	**Date**	**Sample ID**		
TGRSE	W-220606-EM-13	06/06/2022		10.9
TGRSI	W-220606-EM-14	06/06/2022		10.0
TGRSI	W-220606-EM-15	06/06/2022	FD	9.82

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
FD - Field Duplicate

Attachment 1

Data Validation/Verification Memos

Technical Memorandum

May 17, 2022

To	Shawn Horn, GHD		
From	Ruth Mickle/kg/20	**Tel**	+1 612 524-6872
Subject	Data Verification TCAAP TGRS Sampling April 6, 2022 TCAAP Site, Arden Hills, Minnesota	**Project no.**	12563220-32

The following is a data verification form for samples collected on April 6, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1479882	Sample Collection Date(s):4/6/22
Matrix: Water	Sample Analysis Date(s): 4/9/22
Method: SW 8260	Date Reviewed:5/13/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	N
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

<u>*Required Attachments:*</u> LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – April 2022

Sample ID	Sample Location
W-220406-EM-01	TGRSE
W-220406-EM-02	TGRSE duplicate
W-220406-EM-03	TGRSI

Item	Comment
3	As noted in the report, the tetrachloroethene %D in the continuing calibration sample was outside the control limit. The associated detected tetrachloroethene result for sample W-220406-EM-03 was qualified estimated (JC 24.1).

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
April 2022 Sampling Event

Criteria	Parameter	Pace #L1479882-batch WG1845668 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	88.9-98.9	70-130	NA
	4-Bromofluorobenzene	102-104	77-126	NA
	Toluene-d8	99.7-102	80-120	NA

Criteria	Parameter	batch WG1845668 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	100/103 (2.56)	70-126	20
	1,2-Dichloroethane	102/104 (1.74)	70-128	20
	1,1-Dichloroethene	115/115 (0.173)	71-124	20
	cis-1,2-Dichloroethene	103/106 (3.06)	73-120	20
	Tetrachloroethene	124/123 (0.647)	72-132	20
	1,1,1-Trichloroethane	109/111 (1.82)	73-124	20
	Trichloroethene	117/118 (1.36)	78-124	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1479882
April 2022 Sampling Event

VOC Parameter	W-220406-EM-01 TGRSE (ug/l)	W-220406-EM-02 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	1.19	1.19	0	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds

GHD Digital

Technical Memorandum

May 16, 2022

To	Shawn Horn, GHD		
From	Ruth Mickle/kg/21	**Tel**	+1 612 524-6872
Subject	Data Verification TCAAP TGRS Sampling May 2022 TCAAP Site, Arden Hills, Minnesota	**Project no.**	12563220-32

The following is a data verification form for samples collected on May 2, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

Encl.

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1490592	Sample Collection Date(s):5/2/22
Matrix: Water	Sample Analysis Date(s): 5/7/22-5/9/22
Method: SW 8260	Date Reviewed:5/16/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – May 2022

Sample ID	Sample Location
W-220502-EM-01	TGRSE
W-220502-EM-02	TGRSE duplicate
W-220502-EM-03	TGRSI

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
May 2022 Sampling Event

Criteria	Parameter	Pace #L1490592-batch WG1860251 & batch WG1860900 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	88.1-96.6	70-130	NA
	4-Bromofluorobenzene	103-107	77-126	NA
	Toluene-d8	105-111	80-120	NA

Criteria	Parameter	batch WG1860251 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	99.8/96.6 (3.26)	70-126	20
	1,2-Dichloroethane	99.6/93.2 (6.64)	70-128	20
	1,1-Dichloroethene	109/104 (4.31)	71-124	20
	cis-1,2-Dichloroethene	105/100 (4.49)	73-120	20
	Tetrachloroethene	97.4/97.6 (0.205)	72-132	20
	1,1,1-Trichloroethane	102/95.6 (6.87)	73-124	20
	Trichloroethene	102/101 (1.38)	78-124	20

Criteria	Parameter	batch WG1860900 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	cis-1,2-Dichloroethene	119/119 (0.505)	73-120	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1490592
May 2022 Sampling Event

VOC Parameter	W-220502-EM-01 TGRSE (ug/l)	W-220502-EM-02 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	1.16	1.2	0.04	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds

Technical Memorandum

August 01, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/27	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 3, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 3, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1502553-batch WG1880811, batch WG1881595 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	95.8-109	70-130	NA
	4-Bromofluorobenzene	97.2-103	77-126	NA
	Toluene-d8	105-107	80-120	NA

Criteria	Parameter	batch WG1880811 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	104/101 (2.54)	70-126	20
	1,2-Dichloroethane	104/104 (0)	70-128	20
	1,1-Dichloroethene	111/109 (1.63)	71-124	20
	cis-1,2-Dichloroethene	108/109 (1.29)	73-120	20
	Tetrachloroethene	106/96.6 (9.28)	72-132	20
	1,1,1-Trichloroethane	115/120 (4.24)	73-124	20
	Trichloroethene	111/110 (0.362)	78-124	20

Criteria	Parameter	batch WG1881595 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1,1-Trichloroethane	96.6/101 (4.26)	73-124	20
	Trichloroethene	93.4/98.6 (5.42)	78-124	20

Criteria	Parameter	Pace #L1502553 batch WG1876984 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	63.4-64.8	10-120	NA

Criteria	Parameter	batch WG1876984 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	117	73-146	NA

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1502553	Sample Collection Date(s):6/3/22
Matrix: Water	Sample Analysis Date(s): 6/14/22-6/18/22
Method: SW 8260, SW 8270SIM	Date Reviewed:7/26/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	N
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	NA
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	**Sample Location**
W-220603-RC-01	SC4-03U316
W-220603-RC-02	SC3-03U315
W-220603-RC-03	SC5-03U317
TRIP BLANK	Trip Blank

Item	Comment
4	One SVOC method blank yielded a low-level 1,4-dioxane detection (0.112 ug/l). Since associated sample results were greater than 5x the blank concentration, no data qualification was required.

Technical Memorandum

August 01, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/28	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 7-8, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 7-8, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1503670-batch WG1881855, WG1882148, WG1882372 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	97.1-112	70-130	NA
	4-Bromofluorobenzene	96.3-104	77-126	NA
	Toluene-d8	100-111	80-120	NA

Criteria	Parameter	batch WG1882148 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	95.4/94.8 (0.631)	70-126	20
	1,2-Dichloroethane	103/101 (2.15)	70-128	20
	1,1-Dichloroethene	94.6/93.6 (1.06)	71-124	20
	cis-1,2-Dichloroethene	96.2/100 (3.87)	73-120	20
	Tetrachloroethene	88.4/92.0 (3.99)	72-132	20
	1,1,1-Trichloroethane	108/109 (0.368)	73-124	20
	Trichloroethene	91.2/94.2 (3.24)	78-124	20

Criteria	Parameter	batch WG1881855 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	102/106 (3.83)	70-126	20
	1,2-Dichloroethane	103/103 (0)	70-128	20
	1,1-Dichloroethene	114/116 (1.56)	71-124	20
	cis-1,2-Dichloroethene	109/114 (4.12)	73-120	20
	Tetrachloroethene	104/107 (3.22)	72-132	20
	1,1,1-Trichloroethane	122/124 (1.30)	73-124	20
	Trichloroethene	100/109 (8.58)	78-124	20

Criteria	Parameter	batch WG1882372 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1,1-Trichloroethane	95.8/95.4 (0.418)	73-124	20

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

	Trichloroethene	115/111 (3.19)	78-124	20

Criteria	Parameter	Pace #L1503670 WG1878259, WG1878673 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	44.5-84.2	10-120	NA

Criteria	Parameter	WG1878259 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	138/141 (2.43)	73-146	20

Criteria	Parameter	WG1878673 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	95/104 (8.85)	73-146	20

Notes:

RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1503670
June 2022 Sampling Event

VOC Parameter	W-220607-EM-16 04U806 (ug/l)	W-220607-EM-17 04U806 Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
1,1,1-Trichloroethane	0.544 J	0.511 J	0.033	1
1,1-Dichloroethane	0.180 J	0.191 J	0.011	1
1,1-Dichloroethene	0.309 J	0.286 J	0.023	1
cis-1,2-Dichloroethene	0.288 J	0.273 J	0.015	1
Trichloroethene	18.3	18.2	0.55	25
SVOC Parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	19.8	18.9	4.6	25

VOC Parameter	W-220608-EM-24 03U801 (ug/l)	W-220608-EM-25 03U801 Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
cis-1,2-Dichloroethene	0.248 J	0.254 J	0.006	1
Trichloroethene	13.5	13.8	2.2	25

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1503670
June 2022 Sampling Event

SVOC Parameter				Difference Limit (+/-2 RL) or RPD Limit
1,4-Dioxane	0.528	0.505	0.023	0.8

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds
J - Estimated concentration

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1503670	Sample Collection Date(s):6/7/22-6/8/22
Matrix: Water	Sample Analysis Date(s): 6/15/22-6/21/22
Method: SW 8260, SW 8270SIM	Date Reviewed:7/26/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	NA
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse/field Blanks free of detections?	---	---	---	N
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220607-EM-10	03U806
W-220607-EM-11	03M806
W-220607-EM-12	PJ#806
W-220607-EM-16	04U806
W-220607-EM-17	04U806 Field Duplicate
W-220607-EM-18	03L806
W-220607-EM-19	03L806 Field Blank
W-220607-EM-20	03L833
W-220607-EM-21	04U833
W-220607-EM-22	03U711
W-220607-EM-23	04U711
W-220608-EM-24	03U801
W-220608-EM-26	03L802 Field Blank
W-220608-EM-25	03U801 Field Duplicate
W-220608-EM-27	03L802
W-220608-EM-28	03M802
W-220608-EM-29	04U802

W-220608-EM-30	03L007
W-220608-EM-31	04U007
W-220608-EM-32	03U007
W-220608-EM-33	03U677
W-220608-EM-34	03U003

Item	Comment
13	The SVOC field blanks (W-220607-EM-19 and W-220608-EM-26) yielded low-level 1,4-dioxane detections (0.265 ug/l and 0.0968 ug/l, respectively). Most of the associated sample detections were greater than 5x the blank concentration and no data qualification was required. The 1,4-dioxane detections for samples W-220608-EM-28,-30,-31 and -32 were qualified non-detect (UB0.0968).

GHD Digital

Technical Memorandum

August 01, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/29	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 9-10, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 9-10, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1504686-batch WG1882440, WG1882969	% Recovery Limits	RPD Limits
		Recovery range:		
Surrogate				
VOC	1,2-Dichloroethane-d4	85.4-98.4	70-130	NA
	4-Bromofluorobenzene	94.7-111	77-126	NA
	Toluene-d8	99.3-107	80-120	NA

Criteria	Parameter	batch WG1882440 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	94.0/90.8 (3.46)	70-126	20
	1,2-Dichloroethane	96.6/94.6 (2.09)	70-128	20
	1,1-Dichloroethene	112/101 (10.1)	71-124	20
	cis-1,2-Dichloroethene	111/97.4 (13.2)	73-120	20
	Tetrachloroethene	86.4/88.8 (2.74)	72-132	20
	1,1,1-Trichloroethane	99.8/92.8 (7.27)	73-124	20
	Trichloroethene	106/95.4 (10.3)	78-124	20

Criteria	Parameter	W-220609-EM-39 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	105/99.0 (5.88)	25-158	27
	1,2-Dichloroethane	101/98.0 (2.82)	29-151	27
	1,1-Dichloroethene	118/110 (7.38)	11-160	29
	cis-1,2-Dichloroethene	113/103 (9.08)	10-160	27
	Tetrachloroethene	105/96.8 (5.51)	10-160	27
	1,1,1-Trichloroethane	112/108 (3.23)	23-160	28
	Trichloroethene	106/88.6 (11.4)	10-160	25

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	batch WG1882969 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	91.2/84.4 (7.74)	70-126	20
	1,2-Dichloroethane	85.0/81.2 (4.57)	70-128	20
	1,1-Dichloroethene	101/95.4 (5.90)	71-124	20
	cis-1,2-Dichloroethene	103/94.4 (8.32)	73-120	20
	Tetrachloroethene	95.2/98.2 (3.10)	72-132	20
	1,1,1-Trichloroethane	96.4/88.2 (8.88)	73-124	20
	Trichloroethene	97.6/94.2 (3.55)	78-124	20

Criteria	Parameter	Pace #L1504686-batch WG1879544, WG1879829 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	25.1-83.3	10-120	NA

Criteria	Parameter	WG1879544 Recoveries:	% Recovery Limits	RPD Limits
LCS				
SVOC	1,4-Dioxane	121	73-146	NA

Criteria	Parameter	W-220609-EM-39 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
SVOC	1,4-Dioxane	127/125 (1.55)	38-160	21

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	WG1879829 Recoveries:	% Recovery Limits	RPD Limits
LCS				
SVOC	1,4-Dioxane	119	73-146	NA

Notes:

RPD	- Relative Percent Difference
NA	- Not applicable
VOC	- Volatile Organic Compounds
SVOC	- Semi-Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1504686
June 2022 Sampling Event

VOC Parameter	W-220609-EM-35 03U079 (ug/l)	W-220609-EM-36 03U079 Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
1,1,1-Trichloroethane	6.43	5.86	9.3	25
1,1-Dichloroethane	0.378 J	0.360 J	0.018	1
1,1-Dichloroethene	1.64	1.80	0.16	1
cis-1,2-Dichloroethene	1.74	1.59	0.15	1
Trichloroethene	51.5	49.3	4.4	25
SVOC Parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	0.340 J	0.517	0.18	0.8

VOC Parameter	W-220610-EM-47 04U002 (ug/l)	W-220610-EM-48 04U002 Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	0.909 J	0.989 J	0.080	1

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1504686
June 2022 Sampling Event

SVOC Parameter				Difference Limit (+/-2 RL) or RPD Limit
1,4-Dioxane	16.2	16.5	1.8	25

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds
J - Estimated concentration

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1504686	Sample Collection Date(s):6/9/22-6/10/22
Matrix: Water	Sample Analysis Date(s): 6/16/22-6/21/22
Method: SW 8260, SW 8270SIM	Date Reviewed:7/27/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	N
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	Y
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	Y
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse/field Blanks free of detections?	---	---	---	N
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220609-EM-35	03U079
W-220609-EM-36	03U079 Field Duplicate
W-220609-EM-37	03L079
W-220609-EM-38	03L079 Field Blank
W-220609-EM-39	03U703
W-220609-EM-40	03L078
W-220609-EM-41	03U078
W-220609-EM-42	03U710
W-220609-EM-43	03U671
W-220609-EM-44	04J708
W-220609-EM-45	04U708
W-220609-EM-46	03U708
TRIP BLANK-1	Trip Blank
W-220610-EM-47	04U002
W-220610-EM-48	04U002 Field Duplicate
W-220610-EM-49	03L002
W-220610-EM-50	03L002 Field Blank

W-220610-EM-51	03M002
W-220610-EM-52	03U002
W-220610-EM-53	03U709
W-220610-EM-54	04U709
W-220610-EM-55	03L077
W-220610-EM-56	04U077
W-220610-EM-57	03U077
W-220610-EM-58	04J077
TRIP BLANK-2	Trip Blank
TRIP BLANK-3	Trip Blank

Item	Comment
4	Two SVOC method blanks (batch WG1879544 and WG1879829) yielded a low-level 1,4-dioxane detection (0.101 and 0.104, respectively). The 1,4-dioxane results for several samples (W-220609-EM-35, -36,-41,-43,-46) were qualified non-detect (UB0.101). Several associated sample detections were greater than 5x the blank concentration and data qualification was not required.
13	The SVOC field blank (W-220609-EM-38) yielded a low-level 1,4-dioxane detection (0.0848 ug/l). Since the 1,4-dioxane results were previously qualified based on method blank results, no qualification was required based on field blank data.

Technical Memorandum

August 01, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/30	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 13, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 13, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle

Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1505627-batch WG1883862, WG1884684 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	91.4-96.9	70-130	NA
	4-Bromofluorobenzene	99.4-103	77-126	NA
	Toluene-d8	94.1-103	80-120	NA

Criteria	Parameter	batch WG1883862 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	97.8/92.2 (5.89)	70-126	20
	1,2-Dichloroethane	93.4/90.4 (3.26)	70-128	20
	1,1-Dichloroethene	113/112 (0.532)	71-124	20
	cis-1,2-Dichloroethene	108/100 (7.48)	73-120	20
	Tetrachloroethene	98.4/95.2 (3.31)	72-132	20
	1,1,1-Trichloroethane	102/101 (0.987)	73-124	20
	Trichloroethene	94.2/97.0 (2.93)	78-124	20

Criteria	Parameter	batch WG1884684 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	115/110 (4.28)	70-126	20
	1,2-Dichloroethane	108/110 (1.84)	70-128	20
	1,1-Dichloroethene	113/108 (4.34)	71-124	20
	cis-1,2-Dichloroethene	110/108 (1.66)	73-120	20
	Tetrachloroethene	94.6/90.0 (4.98)	72-132	20
	1,1,1-Trichloroethane	111/111 (0.181)	73-124	20
	Trichloroethene	103/101 (1.96)	78-124	20

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	W-220613-EM-59 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	135/136 (1.03)	25-158	27
	1,2-Dichloroethane	126/126 (0.477)	29-151	27
	1,1-Dichloroethene	131/137 (4.19)	11-160	29
	cis-1,2-Dichloroethene	130/127 (2.34)	10-160	27
	Tetrachloroethene	114/111 (2.67)	10-160	27
	1,1,1-Trichloroethane	147/147 (0.408)	23-160	28
	Trichloroethene	115/118 (1.98)	10-160	25

Criteria	Parameter	Pace #L1505627-batch WG1881156 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	25.2-43.7	10-120	NA

Criteria	Parameter	WG1881156 Recoveries:	% Recovery Limits	RPD Limits
LCS				
SVOC	1,4-Dioxane	96.2	73-146	NA

Criteria	Parameter	W-220613-EM-59 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
SVOC	1,4-Dioxane	96.7/101 (3.58)	38-160	21

Notes:

RPD	- Relative Percent Difference
NA	- Not applicable
VOC	- Volatile Organic Compounds
SVOC	- Semi-Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1505627
June 2022 Sampling Event

VOC Parameter	W-220613-EM-62 04U702 (ug/l)	W-220613-EM-63 04U702 Field Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	1.02	1.06	0.04	1
SVOC Parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	14.2	14.7	3.50	25

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1505627	Sample Collection Date(s):6/13/22
Matrix: Water	Sample Analysis Date(s): 6/18/22-6/24/22
Method: SW 8260, SW 8270SIM	Date Reviewed:7/28/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	N
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	Y
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	Y
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse/field Blanks free of detections?	---	---	---	Y
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220613-EM-59	03U701
W-220613-EM-60	04U701
W-220613-EM-61	03U702
W-220613-EM-62	04U702
W-220613-EM-63	04U702 Field Duplicate
W-220613-EM-64	04J702 Field Blank
W-220613-EM-65	04J702
TRIP BLANK	Trip Blank

Item	Comment
4	One SVOC method blank yielded a low-level 1,4-dioxane detection (0.0868 ug/l). Since associated sample results were greater than 5x the blank concentration, no data qualification was required.

Technical Memorandum

August 01, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/31	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 6, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 6, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1502561-batch WG1881422 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	93.3-99.8	70-130	NA
	4-Bromofluorobenzene	94.3-102	77-126	NA
	Toluene-d8	102-105	80-120	NA

Criteria	Parameter	batch WG1881422 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	96.6/95.0 (1.67)	70-126	20
	1,2-Dichloroethane	95.6/93.6 (2.11)	70-128	20
	1,1-Dichloroethene	113/112 (1.07)	71-124	20
	cis-1,2-Dichloroethene	105/106 (1.32)	73-120	20
	Tetrachloroethene	90.6/95.8 (5.58)	72-132	20
	1,1,1-Trichloroethane	96.6/101 (4.26)	73-124	20
	Trichloroethene	93.4/98.6 (5.42)	78-124	20

Criteria	Parameter	W-220606-EM-09 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	95.6/111 (15.1)	25-158	27
	1,2-Dichloroethane	92.6/108 (15.0)	29-151	27
	1,1-Dichloroethene	116/120 (2.71)	11-160	29
	cis-1,2-Dichloroethene	104/114 (8.81)	10-160	27
	Tetrachloroethene	94.4/85.2 (10.2)	10-160	27
	1,1,1-Trichloroethane	105/114 (8.25)	23-160	28
	Trichloroethene	92.8/100 (7.47)	10-160	25

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1502561 WG1876989 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	48-6-73.2	10-120	NA

Criteria	Parameter	Recoveries:	% Recovery Limits	RPD Limits
LCS				
SVOC	1,4-Dioxane	104	73-146	NA

Criteria	Parameter	W-220606-EM-09 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
SVOC	1,4-Dioxane	107/105 (1.97)	38-160	21

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1502561
June 2022 Sampling Event

VOC Parameter	W-220606-EM-06 03U805 (ug/l)	W-220606-EM-07 03U805 Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
1,1,1-Trichloroethane	0.176 J	0.182 J	0.006	1
1,1-Dichloroethane	8.50	8.36	1.7	25
1,1-Dichloroethene	9.45	8.87	6.3	25
cis-1,2-Dichloroethene	5.25	5.37	2.3	25
Tetrachloroethene	2.26	2.22	1.8	1
Trichloroethene	88.7	84.5	4.8	25
SVOC Parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	4.82	4.87	1	25

VOC Parameter	W-220606-EM-14 TGRS Influent (ug/l)	W-220606-EM-15 TGRS Influent Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
1,1,1-Trichloroethane	36.7	35.0	4.7	25
1,1-Dichloroethane	1.58	1.52	0.06	1
1,1-Dichloroethene	3.56	3.85	0.29	1
cis-1,2-Dichloroethene	1.50	1.59	0.09	1
Tetrachloroethene	1.16	1.17	0.01	1
Trichloroethene	148	146	1.4	25

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1502561
June 2022 Sampling Event

SVOC Parameter				Difference Limit (+/-2 RL) or RPD Limit
1,4-Dioxane	10.0	9.82	1.8	25

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds
J - Estimated concentration

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1502561	Sample Collection Date(s):6/6/22
Matrix: Water	Sample Analysis Date(s): 6/16/22-6/18/22
Method: SW 8260, SW 8270SIM	Date Reviewed:7/26/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	N
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	Y
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	Y
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	N
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220606-EM-04	03L809
W-220606-EM-05	03U803
W-220606-EM-06	03U805
W-220606-EM-07	03U805 Field Duplicate
W-220606-EM-08	03U804 Rinse Blank
W-220606-EM-09	03U804
TRIP BLANK	Trip Blank
W-220606-EM-13	TGRS Effluent
W-220606-EM-14	TGRS Influent
W-220606-EM-15	TGRS Influent Field Duplicate

Item	Comment
4	The SVOC method blank for batch WG1876984 yielded a low-level 1,4-dioxane detection (0.122 ug/l). The associated sample detections from samples W-220606-EM-05 and W-220606-EM-09 were qualified non-detect (UB0.122). Additional samples

	from the batch yielded 1,4-dioxane detections that were greater than 5x the blank concentration. No data qualification was required in that case.
13	The SVOC rinse blank (W-220606-EM-08) yielded a low-level 1,4-dioxane detection (0.137 ug/l). Since the associated sample detections were previously qualified based on method blank results or were much greater than 5x the blank concentration, no data qualification was required based on rinse blank results.

GHD Digital

Technical Memorandum

August 09, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/32	**Ref. No.**	12563220-32
Subject	**Data Validation VOC and 1,4-Dioxane Analysis TGRS Well Sampling June 14-15, 2022 TCAAP Site Arden Hills, Minnesota**		

The following are data validation forms for samples collected on June 14-15, 2022, at TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Sample Identification Numbers
TGRS - TCAAP Site
SDG ID: L1506264
June 2022 Sampling Event

Sample ID	Sample Location
W-220614-EM-66	04J713
W-220614-EM-67	04J713 Field Duplicate
W-220614-EM-69	04U713 Rinse Blank
W-220614-EM-70	03U030
W-220614-EM-71	03U027
W-220614-EM-72	03U028
W-220614-EM-73	03U659
W-220615-EM-74	03M020
W-220615-EM-75	03M020 Field Duplicate
W-220615-EM-76	03U020
W-220615-EM-77	03U020 Field Blank
W-220615-EM-78	03L020
W-220615-EM-79	04U020
W-220615-EM-80	03U029
W-220615-EM-81	03L021
W-220615-EM-82	03U021
W-220615-EM-83	03U005
TRIP BLANK	Trip Blank
TRIP BLANK	Trip Blank

Table 2

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
SDG ID: L1506264
June 2022 Sampling Event

Criteria	Parameter	Pace #L1506264 batch WG1884128 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	90.9-97.1	70-130	NA
	4-Bromofluorobenzene	94.5-103	77-126	NA
	Toluene-d8	101-108	80-120	NA

Criteria	Parameter	batch WG1884128 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	83.0/84.8 (2.15)	70-126	20
	1,2-Dichloroethane	84.6/87.8 (3.71)	70-128	20
	1,1-Dichloroethene	91.4/97.0 (5.94)	71-124	20
	cis-1,2-Dichloroethene	92.2/92.6 (0.433)	73-120	20
	Tetrachloroethene	91.2/82.8 (9.66)	72-132	20
	1,1,1-Trichloroethane	83.2/88.8 (6.51)	73-124	20
	Trichloroethene	81.8/87.0 (6.16)	78-124	20

Criteria	Parameter	Pace #L1506264 batch WG1881922 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	51.2-83.7	10-120	NA

Criteria	Parameter	Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	116/117 (0.514)	73-146	20

Note:
NA - Not Applicable

Table 3

Field Duplicate Summary
TGRS - TCAAP Site
SDG ID: L1506264
June 2022 Sampling Event

	W-220614-EM-66 04J713 (ug/l)	W-220614-EM-67 04J713 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
		All Non-detect		
SVOC parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	11.9	12.0	0.84	25

	W-220615-EM-74 03M020 (ug/l)	W-220615-EM-75 03M020 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
1,1-Dichloroethane	0.278 J	0.277 J	0.0010	1
1,1,1-Trichloroethane	1.01	0.874 J	0.14	1
Trichloroethene	13.1	12.9	1.5	25
SVOC parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	14.5	13.2	9.4	25

Notes:
J - Estimated concenration
RL - Reporting limit
RPD - Relative Percent Difference

ANALYTICAL DATA VALIDATION FORM (1,4-Dioxane)

SDG NUMBER: L1506264

PROJECT: TCAAP TGRS

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 6/14/22-6/15/22 NO. OF SAMPLES: 17

ANALYSES REQUESTED: Method 8270 SIM (1,4-dioxane)

SAMPLE NO. Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____No X

Contractual Violations Yes____No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.

Yes X No ____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.

Yes X No ____

B. Holding Times

1. The required holding times were met for all analyses. Time elapsed from sample collection to extraction (7 days) and from extraction to analysis (40 days) were within criteria.

Yes X No____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all entries were complete, signatures were present and cross outs were clean and initialed.

Yes X No ____

2. Samples were received at the required temperature (samples cooled to < 6 ^{o}C upon collection)

Yes X No ____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for 1,4-dioxane met the method criteria. A minimum of five point calibration was used. An isotope dilution procedure was performed.

Yes X No____ NA ____

2. The relative standard deviation (RSD) was less than or equal to 20%. Alternatively, a coefficient of determination ("r2") of > or equal to 0.99 is acceptable for 1,4-dioxane.

Yes X No____ NA ____

B. Continuing Calibration

1. The continuing calibration standard was analyzed at the required frequency and the QC criteria were met. The continuing calibration verification (CCV) was analyzed before sample analysis; after every 12 hours of analysis.

Yes X No____ NA ___

The percent difference (%D) limits of $\pm$20% was met for the CCV.

Yes X No____ NA ___

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The DFTPP performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met per the Method specifications.

Yes X No____ NA ____

V. INTERNAL STANDARDS

The Internal Standards met the -50 to +100% criteria compared to the daily CCV and the Retention times were within the required windows (+/- 0.06 RRT) for samples.

Yes X No____ NA ____

VI. SURROGATE

Surrogate spikes were analyzed with every sample.
Yes X____No _____

Surrogates met the limits established in the QAPP (i.e., Current lab limits).
Yes X____No _____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE

A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every batch or for every 20 samples.
Yes______No _____NA_X__
Non-project sample

B. The MS and MSD percent recoveries were within the current limits established in the QAPP (i.e., Current lab limits).
Yes______No _____NA_X__
Non-project sample

C. The MSD relative percent differences (RPDs) were within the current limits established in the QAPP (i.e., Current lab limits).
Yes______No X___NA_X__
Non-project sample

VIII. LABORATORY CONTROL SAMPLE

A. Laboratory Control Samples (LCS) was analyzed for every batch or every 20 samples.
Yes X____No _____

B. The LCS percent recoveries (and RPD limits, if LCS duplicate) were within the limits established in the QAPP (i.e., Current lab limits).
Yes X__No ____
See Table 2

IX. BLANKS

A. Method Blanks were analyzed at the required frequency for the analysis.
Yes X___No _____

B. No blank contamination was found in the Method Blank.
Yes ____No X___
The method blank yielded a low-level detection (0.0776 ug/l). Most associated detections were greater than 5x the blank concentration and did not require qualification. The associated 1,4-dioxane detections for samples W-220614-EM-70 and W-220615-EM-83 were qualified non-detect (UB0.0776).

C. If Equipment/Field Blanks were identified, no blank contamination was found.
Yes_____No X___NA _____
The rinse blank (W-220614-EM-69) and field blank (W-220615-EM-77) yielded low-level detections (0.0976 ug/l and 0.106 ug/l, respectively). However, since the associated detections were greater than 5x the blank concentration or previously qualified based on the method blank detection, no qualification was required based on rinse/field blanks.

FIELD QC

If Field duplicates or Performance Check Compounds were identified, they met the <25% RPD, or $\pm$ 2 x RL for either result < 5 x RL, criteria for the project.
Yes X___No_____NA _____

See Table 3.

SYSTEM PERFORMANCE

A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.

Yes X No_____NA _____

B. The suggested EQL's for the sample matrices in this set were met.

Yes X No_____NA _____

X. COMPOUND IDENTIFICATION & QUANTITATION

A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.

Yes X No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compound in one internal standards quantitation set.

Yes X No_____NA _____

XI. OVERALL ASSESSMENT OF THE CASE

The data are usable for project purposes with the qualifications noted.

ANALYTICAL DATA VALIDATION FORM (VOCs)

SDG NUMBER: L1506264

PROJECT: TCAAP TGRS

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 6/14/2-6/15/222 NO. OF SAMPLES: 19

ANALYSES REQUESTED: Method 8260 (VOCs)

SAMPLE NO. see Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____No X

Contractual Violations Yes____No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.
Yes X No ____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.
Yes X No ____

B. Holding Times

1. The required holding times were met for all analyses (Time of sample receipt to time of analysis (VOA) or extraction and from extraction to analysis).
Yes X No ____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.
Yes X No ____

2. Samples were received at the required temperature and preservation.
Yes X No ____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for all compounds for all analyses met the QAPP or method criteria.
Yes X No____NA ____

2. The relative standard deviation (RSD) for all compounds in the standard was less than 20%, with an allowance of up to 40% for the poor responders. Per the method, a correlation coefficient "r" of > 0.99 is also acceptable for compounds,
Yes X No____NA ____

3. The 12 hour system Performance Check was performed as required in SW-846.
Yes X No____NA ____

B. Continuing Calibration

1. The RRF 50 standard was analyzed for each analysis at the required frequency and the QC criteria were met.
Yes X No____NA ___

2. The percent difference (%D) limits for all compounds is $\pm$20%, with an allowance of up to 40% for the poor responders per the current validation guidance, were met.
Yes X No____NA ____

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The BFB performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met.
Yes X No____NA ____

V. INTERNAL STANDARDS

The Internal Standards met the 100% upper and -50% lower limits criteria and the Retention times were within

the required windows.
Yes X____No_____NA _____

VI. SURROGATE
Surrogate spikes were analyzed with every sample.
Yes X____No _____

And met the recovery limits defined in the QAPP (i.e., Current lab limits).
Yes X____No _____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every analysis performed and for every 20 samples or for every matrix whichever is more frequent.
Yes______No __NA_X_
Non-project sample

B. The MS and MSD percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X____No _____NA_X_

C. The MSD relative percent differences (RPD) were within the QAPP limits.

Yes X____No_____NA X___

VIII. LABORATORY CONTROL SAMPLE
A. A Laboratory Control Samples (LCS) was analyzed for every analysis batch or for every 20 samples.
Yes X____No _____

The LCS percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X__No ____
See Table 2

IX. BLANKS
A. Method Blanks were analyzed at the required frequency and for each matrix and analysis.
Yes X____No _____

B. No blank contamination was found in the Method Blank.
Yes X____No _____

C. If Equipment Rinsate Blanks were identified, no blank contamination was found.
Yes X____No_____NA _____

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the RPD or % recovery criteria for the project.
Yes X____No_____NA _____
See Table 3

XI. SYSTEM PERFORMANCE
A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.
Yes X____No_____NA _____

B. The suggested EQL's for the sample matrices in this set were met
Yes X No_____NA _____

XII. TCL COMPOUNDS
A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.
Yes X No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compounds in each internal standards quantitation set.
Yes X No_____NA _____

XIII. TENTATIVELY IDENTIFIED COMPOUNDS
TICs were properly identified and met the library identification criteria.
Yes______No_____NA X___

XIV. OVERALL ASSESSMENT OF THE CASE

The data are usable for project purposes without qualification.

Technical Memorandum

August 09, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/33	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 16, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 16, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1506775-batch WG1886141 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	105-121	70-130	NA
	4-Bromofluorobenzene	97.4-104	77-126	NA
	Toluene-d8	98.3-106	80-120	NA

Criteria	Parameter	batch WG1886141 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	98.0/101 (3.21)	70-126	20
	1,2-Dichloroethane	99.8/97.4 (2.43)	70-128	20
	1,1-Dichloroethene	109/114 (3.95)	71-124	20
	cis-1,2-Dichloroethene	96.2/107 (10.3)	73-120	20
	Tetrachloroethene	92.6/90.0 (2.85)	72-132	20
	1,1,1-Trichloroethane	111/124 (10.9)	73-124	20
	Trichloroethene	91.0/94.0 (3.24)	78-124	20

Criteria	Parameter	batch WG1886424 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	119/120 (0.502)	70-126	20
	1,2-Dichloroethane	113/112 (0.892)	70-128	20
	1,1-Dichloroethene	118/112 (5.05)	71-124	20
	cis-1,2-Dichloroethene	115/109 (4.83)	73-120	20
	Tetrachloroethene	105/106 (1.32)	72-132	20
	1,1,1-Trichloroethane	119/115 (3.24)	73-124	20
	Trichloroethene	115/121 (5.10)	78-124	20

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1506775-batch WG1882955 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	23.5-61.9	10-120	NA

Criteria	Parameter	WG1882955 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	122/122 (0)	73-146	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1506775
June 2022 Sampling Event

VOC Parameter	W-220616-EM-87 04U510 (ug/l)	W-220616-EM-88 04U510 Field Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
	All Non-detect			

SVOC Parameter				Difference Limit (+/-2 RL) or RPD Limit
1,4-Dioxane	All Non-detect			

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1506775	Sample Collection Date(s):6/16/22
Matrix: Water	Sample Analysis Date(s): 6/24/22-6/28/22
Method: SW 8260, SW 8270SIM	Date Reviewed:8/3/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse/field Blanks free of detections?	---	---	---	N
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220616-EM-84	03U017
W-220616-EM-85	03L017
W-220616-EM-86	03U099
W-220616-EM-87	04U510
W-220616-EM-88	04U510 Field Duplicate
W-220616-EM-89	03U009
W-220616-EM-90	03U009 Field Blank
W-220616-EM-91	03U114
TRIP BLANK	Trip Blank

Item	Comment
13	The SVOC field blank yielded a low-level 1,4-dioxane detection (0.130 ug/l). The 1,4-dioxane results for samples W-220616-EM-86,-87,-88,-89,-91 were qualified as non-detect (UB0.130). The remaining associated sample results were greater than 5x the blank concentration and no data qualification was required.

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1506775
June 2022 Sampling Event

VOC Parameter	W-220616-EM-87 04U510 (ug/l)	W-220616-EM-88 04U510 Field Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
	All Non-detect			

SVOC Parameter				Difference Limit (+/-2 RL) or RPD Limit
1,4-Dioxane	All Non-detect			

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds

Technical Memorandum

August 09, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/34	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 17, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 17, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1506772-batch WG1886141 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	115-123	70-130	NA
	4-Bromofluorobenzene	99.6-108	77-126	NA
	Toluene-d8	98.3-104	80-120	NA

Criteria	Parameter	batch WG1886141 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	98.0/101 (3.21)	70-126	20
	1,2-Dichloroethane	99.8/97.4 (2.43)	70-128	20
	1,1-Dichloroethene	109/114 (3.95)	71-124	20
	cis-1,2-Dichloroethene	96.2/107 (10.3)	73-120	20
	Tetrachloroethene	92.6/90.0 (2.85)	72-132	20
	1,1,1-Trichloroethane	111/124 (10.9)	73-124	20
	Trichloroethene	91.0/94.0 (3.24)	78-124	20

Criteria	Parameter	W-220617-EM-93 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	116/117 (0.343)	25-158	27
	1,2-Dichloroethane	111/115 (3.19)	29-151	27
	1,1-Dichloroethene	124/120 (3.77)	11-160	29
	cis-1,2-Dichloroethene	119/116 (3.23)	10-160	27
	Tetrachloroethene	102/99.2 (3.17)	10-160	27
	1,1,1-Trichloroethane	141/149 (5.38)	23-160	28
	Trichloroethene	107/103 (3.18)	10-160	25

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1506772-batch WG1882955 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	32.1-60.8	10-120	NA

Criteria	Parameter	WG1882955 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	122/122 (0)	73-146	20

Criteria	Parameter	WG1884345 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	120	73-146	NA

Criteria	Parameter	W-220617-EM-93 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
SVOC	1,4-Dioxane	99.6/136 (23.1)	38-160	21

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1506772
June 2022 Sampling Event

VOC Parameter	W-220617-EM-102 B5-03F306 (ug/l)	W-220617-EM-103 B5-03F306 Field Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
1,1,1-Trichloroethane	2.83	2.71	0.12	1
1,1-Dichloroethane	1.93	1.91	0.02	1
1,1-Dichloroethene	2.36	2.14	0.22	1
cis-1,2-Dichloroethene	0.892 J	0.947 J	0.055	1
Tetrachloroethene	3.75	3.34	0.41	1
Trichloroethene	59.8	59.5	0.50	25
SVOC Parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	16.7	16.4	0.18	25

Notes:
J - Estimated concentration
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1506772	Sample Collection Date(s):6/17/22
Matrix: Water	Sample Analysis Date(s): 6/24/22-6/28/22
Method: SW 8260, SW 8270SIM	Date Reviewed:8/2/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	N
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	Y
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	Y
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse/field Blanks free of detections?	---	---	---	N
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

<u>*Required Attachments:*</u> LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220617-EM-92	B12 (PJ#313)
W-220617-EM-93	B7 (03F308)
W-220617-EM-94	B10 (PJ#311)
W-220617-EM-95	B11 (03F312)
W-220617-EM-96	B2 (03F303)
W-220617-EM-97	B13 (03F319)
W-220617-EM-98	B1 (03F302)
W-220617-EM-99	B3 (03F304)
W-220617-EM-100	B4 (03F305)
W-220617-EM-101	B8 (PJ#309)
W-220617-EM-102	B5 (03F306)
W-220617-EM-103	B5 (03F306) Field Duplicate
W-220617-EM-104	B6 (03F307) Field Blank
W-220617-EM-105	B6 (03F307)
W-220617-EM-106	B9 (PJ#310)
Trip Blank	Trip Blank
Trip Blank	Trip Blank

Item	Comment
4	One SVOC method blank yielded a low-level 1,4-dioxane detection (0.0857 ug/l). With one exception, the associated sample results were greater than 5x the blank concentration and no data qualification was required. The 1,4-dioxane result for sample W-220617-EM-96 was qualified as non-detect (UB0.0857).
13	The field blank (W-220617-EM-104) yielded a low-level 1,4-dioxane detection (0.204 ug/l). Since the associated sample results were greater than 5x the blank concentration or previously qualified, no data qualification was required.

GHD Digital

Technical Memorandum

August 09, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/35	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 22, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 22, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1508057-batch WG1887817 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	108-122	70-130	NA
	4-Bromofluorobenzene	98.1-112	77-126	NA
	Toluene-d8	94.7-107	80-120	NA

Criteria	Parameter	batch WG1887817 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	106/109 (2.61)	70-126	20
	1,2-Dichloroethane	106/109 (3.17)	70-128	20
	1,1-Dichloroethene	111/113 (1.25)	71-124	20
	cis-1,2-Dichloroethene	106/111 (4.97)	73-120	20
	Tetrachloroethene	100/98.8 (1.41)	72-132	20
	1,1,1-Trichloroethane	129/132 (2.15)	73-124	20
	Trichloroethene	99.0/103 (3.16)	78-124	20

Criteria	Parameter	batch WG1889281 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD	1,1,1-Trichloroethane	108/120 (10.7)	73-124	20
VOC	Trichloroethene	98.0/104 (6.13)	78-124	20

Criteria	Parameter	Pace #L1508057-batch WG1886179 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	32.4-53.8	10-120	NA

Criteria	Parameter	WG1886179 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	126/124 (1.76)	73-146	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1508057
June 2022 Sampling Event

VOC Parameter	W-220621-EM-107 03U032 (ug/l)	W-220621-EM-108 03U032 Field Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
1,1,1-Trichloroethane	0.655 J	0.644 J	0.12	1
Trichloroethene	0.211 J	1.00 U	0.79	1
SVOC Parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	0.478	0.660	0.18	0.8

Notes:

J	- Estimated concentration
RL	- Reporting Limit
RPD	- Relative Percent Difference
SVOC	- Semi-Volatile Organic Compounds
VOC	- Volatile Organic Compounds

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1508057	Sample Collection Date(s):6/21/22
Matrix: Water	Sample Analysis Date(s): 6/30/22 &7/3/22
Method: SW 8260, SW 8270SIM	Date Reviewed:8/8/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	N
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse/field Blanks free of detections?	---	---	---	Y
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220621-EM-107	03U032
W-220621-EM-108	03U032 Field Duplicate
W-220621-EM-109	03U094
W-220621-EM-110	03L014
W-220621-EM-111	03U014 Field Blank
W-220621-EM-112	03U014
TRIP BLANK	Trip Blank

Item	Comment
6	The LCS/LCSD spike recoveries for 1,1,1-trichloroethane from batch WG1887817 were above the upper control limit. The associated sample detections were qualified estimated (JL129/132) for samples: W-220621-EM-107, -108 and -112.

Technical Memorandum

August 09, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/36	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **June 22, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 22, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1508730-batch WG1888498 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	90.2-117	70-130	NA
	4-Bromofluorobenzene	90.8-106	77-126	NA
	Toluene-d8	101-105	80-120	NA

Criteria	Parameter	batch WG1888498 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	101/109 (7.25)	70-126	20
	1,2-Dichloroethane	107/107 (0.187)	70-128	20
	1,1-Dichloroethene	107/117 (8.91)	71-124	20
	cis-1,2-Dichloroethene	105/113 (7.34)	73-120	20
	Tetrachloroethene	90.6/99.2 (9.06)	72-132	20
	1,1,1-Trichloroethane	126/127 (0.316)	73-124	20
	Trichloroethene	105/109 (4.30)	78-124	20

Criteria	Parameter	batch WG1888857 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD	cis-1,2-Dichloroethene	108/118 (8.82)	73-120	20
VOC				

Criteria	Parameter	batch WG1889036 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	98.2/98.0 (0.204)	70-126	20
	1,2-Dichloroethane	85.4/84.2 (1.42)	70-128	20
	1,1-Dichloroethene	97.6/96.0 (1.65)	71-124	20
	cis-1,2-Dichloroethene	104/102 (1.93)	73-120	20
	Tetrachloroethene	109/107 (2.41)	72-132	20
	1,1,1-Trichloroethane	96.0/93.0 (3.17)	73-124	20
	Trichloroethene	108/111 (3.28)	78-124	20

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
June 2022 Sampling Event

Criteria	Parameter	Pace #L1508730-batch WG1886179 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	7.53-53.4	10-120	NA

Criteria	Parameter	WG1886179 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	126/124 (1.76)	73-146	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds
SVOC - Semi-Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1508730
June 2022 Sampling Event

VOC Parameter	W-220622-EM-113 03U715 (ug/l)	W-220622-EM-114 03U715 Field Duplicate (ug/l)	Difference/ RPD	Difference Limit (+/-RL) or RPD Limit
1,1,1-Trichloroethane	7.12	5.25	30	25
1,1-Dichloroethane	0.593 J	0.485 J	0.11	1
1,1-Dichloroethene	0.920 J	0.549 J	0.37	1
cis-1,2-Dichloroethene	0.398 J	0.648 J	0.25	1
Trichloroethene	28.4	22.4	24	25
SVOC Parameter				**Difference Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	6.42	3.60	56	25

Notes:
J - Estimated concentration
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1508730	Sample Collection Date(s):6/22/22
Matrix: Water	Sample Analysis Date(s): 6/30/22-7/2/22
Method: SW 8260, SW 8270SIM	Date Reviewed:8/8/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	N
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	N
13	Rinse/field Blanks free of detections?	---	---	---	N
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?[1]
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220622-EM-113	03U715
W-220622-EM-114	03U715 Field Duplicate
W-220622-EM-115	03U092
W-220622-EM-116	03U092 Rinse Blank
W-220622-EM-117	03U018
W-220622-EM-118	03L018
W-220622-EM-119	03U093
W-220622-EM-120	03U096
TRIP BLANK	Trip Blank

Item	Comment
6	The LCS/LCSD spike recoveries for 1,1,1-trichloroethane from batch WG1888498 were above the upper control limit. The associated sample detections were qualified estimated (JL126/127) for samples: W-220622-EM-113, -114, -115, -117 and -119.
12	The 1,1,1-trichloroethane and 1,4-dioxane results for duplicate samples W-220622-EM-113 and W-220622-EM-114 were outside field duplicate criteria. The 1,1,1-trichloroethane and 1,4-dioxane results were qualified JFD30 and JFD56, respectively, for both samples.
13	The SVOC rinse blank yielded a low-level 1,4-dioxane detection. The associated 1,4-dioxane result for sample W-220622-EM-117 was qualified as non-detect (UB0.0505). The remaining associated sample results were greater than 5x the blank concentration and no data qualification was required.

Technical Memorandum

August 22, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 651 639 0913
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/4	**Ref. No.**	003877
Subject	Third Quarter DUR FY 2022 Site OU3 Results June 2022		

This memo provides the analytical data summary for the third quarter FY 2022 sampling conducted at Site OU3. Tables 1 and 2 provide the sampling results through FY 2022 third quarter. The data validation memo is included as Attachment 1.

Ruth Mickle
Chemist

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ruth.mickle@ghd.com

Table 1

VOC Concentrations in OU3 Monitoring Well Samples
FY 2022 - Through 3rd Quarter

				1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	Trichloroethene
			MDL	**0.149**	**0.158**	**0.100**	**0.188**	**0.126**	**0.190**
			RL	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
Location	**Date**	**Sample ID**							
03L673	W-220603-EM-22	06/03/2022		<1.00	<1.00	0.410 JP	0.373 JP	5.70	59.6
03L848	W-220603-EM-17	06/03/2022		<1.00	<1.00	<1.00	<1.00	1.99	0.463 JP
03L848	W-220603-EM-16	06/03/2022	EB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
03L854	W-220602-EM-09	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
03L859	W-220603-EM-12	06/03/2022		0.654 JP	<1.00	2.42	4.72	0.986 JP	4.33
03M848	W-220603-EM-19	06/03/2022		<1.00	<1.00	0.235 JP	0.441 JP	7.10	77.8
03U673	W-220603-EM-20	06/03/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04J866	W-220602-EM-05	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04U414	W-220602-EM-06	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04U673	W-220603-EM-21	06/03/2022		<1.00	<1.00	<1.00	<1.00	1.20	20.1
04U832	W-220602-EM-08	06/02/2022		<1.00	<1.00	0.781 JP	0.735 JP	1.05	14.7
04U845	W-220602-EM-11	06/02/2022		<1.00	<1.00	<1.00	<1.00	0.343 JP	7.07
04U848	W-220603-EM-18	06/03/2022		<1.00	<1.00	<1.00	<1.00	<1.00	2.89
04U851	W-220602-EM-01	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04U851	W-220602-EM-02	06/02/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04U854	W-220602-EM-10	06/02/2022		<1.00	<1.00	<1.00	<1.00	0.223 JP	5.97
04U859	W-220603-EM-13	06/03/2022		0.930 JP	<1.00	1.52	1.66	0.681 JP	14.3
04U860	W-220603-EM-14	06/03/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04U860	W-220603-EM-15	06/03/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04U863	W-220602-EM-07	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04U866	W-220602-EM-04	06/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
04U866	W-220602-EM-03	06/02/2022	EB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
EB - Equipment Blank
FD - Field Duplicate

Table 2

1,4-Dioxane Concentrations in OU3 Montoring Well Samples
FY 2022 - Through 3rd Quarter

				1,4-Dioxane
			MDL	**0.0447**
			RL	**0.400**
				ug/L
Location	**Date**	**Sample ID**		
03L673	W-220603-EM-22	06/03/2022		2.11
03L848	W-220603-EM-17	06/03/2022		0.854
03L848	W-220603-EM-16	06/03/2022	EB	<0.400 UB0.112
03L854	W-220602-EM-09	06/02/2022		0.141 JP
03L859	W-220603-EM-12	06/03/2022		3.50
03M848	W-220603-EM-19	06/03/2022		0.778
03U673	W-220603-EM-20	06/03/2022		<0.400 UB0.112
04J866	W-220602-EM-05	06/02/2022		<0.400
04U414	W-220602-EM-06	06/02/2022		<0.400
04U673	W-220603-EM-21	06/03/2022		0.890
04U832	W-220602-EM-08	06/02/2022		1.35
04U845	W-220602-EM-11	06/02/2022		0.666
04U848	W-220603-EM-18	06/03/2022		0.745
04U851	W-220602-EM-01	06/02/2022		<0.400
04U851	W-220602-EM-02	06/02/2022	FD	0.119 JP
04U854	W-220602-EM-10	06/02/2022		0.713
04U859	W-220603-EM-13	06/03/2022		4.36
04U860	W-220603-EM-14	06/03/2022		<0.400 UB0.112
04U860	W-220603-EM-15	06/03/2022	FD	<0.400 UB0.112
04U863	W-220602-EM-07	06/02/2022		0.136 JP
04U866	W-220602-EM-04	06/02/2022		0.158 JP
04U866	W-220602-EM-03	06/02/2022	EB	<0.400

Notes:
MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.
< - Not detected at the associated reporting limit.
EB - Equipment Blank
FD - Field Duplicate

Attachment 1

Data Validation Memo

Technical Memorandum

July 21, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/3	**Ref. No.**	003877
Subject	**Data Validation** **VOC and 1,4-Dioxane Analysis** **OU3 Monitoring Well Sampling** **June 2-3, 2022** **TCAAP Site** **Arden Hills, Minnesota**		

The following are data validation forms for samples collected on June 2-3, 2022, at TCAAP Site OU3 in Arden Hills, Minnesota.

Regards

Ruth Mickle
Chemist

Table 1

Sample Identification Numbers
OU3 - TCAAP Site
SDG ID: L1502544
June 2022 Sampling Event

Sample ID	Sample Location
W-220602-EM-01	04U851
W-220602-EM-02	04U851 Field Duplicate
W-220602-EM-03	04U866 Rinse Blank
W-220602-EM-04	04U866
W-220602-EM-05	04J866
W-220602-EM-06	04U414
W-220602-EM-07	04U863
W-220602-EM-08	04U832
W-220602-EM-09	03L854
W-220602-EM-10	04U854
W-220602-EM-11	04U845
W-220603-EM-12	03L859
W-220603-EM-13	04U859
W-220603-EM-14	04U860
W-220603-EM-15	04U860 Field Duplicate
W-220603-EM-16	03L848 Rinse Blank
W-220603-EM-17	03L848
W-220603-EM-18	04U848
W-220603-EM-19	03M848
W-220603-EM-20	03U673
W-220603-EM-21	04U673
W-220603-EM-22	03L673
TRIP BLANK	Trip Blank

Table 2

Laboratory Precision and Accuracy Limits
OU3 - TCAAP Site
SDG ID: L1502544
June 2022 Sampling Event

Criteria	Parameter	batch WG1880129 & WG1880136 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	97.4-113	70-130	NA
	4-Bromofluorobenzene	90.9-103	77-126	NA
	Toluene-d8	96.7-107	80-120	NA

Criteria	Parameter	batch WG1880129 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	101/101 (0.199)	70-126	20
	1,1-Dichloroethene	108/111 (2.56)	71-124	20
	cis-1,2-Dichloroethene	109/102 (6.44)	73-120	20
	1,1,1-Trichloroethane	125/121 (2.60)	73-124	20
	1,1,2-Trichloroethane	109/108 (0.739)	80-120	20
	Trichloroethene	108/101 (6.88)	78-124	20

Criteria	Parameter	batch WG1880136 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	103/104 (0.970)	70-126	20
	1,1-Dichloroethene	99.2/98.8 (0.404)	71-124	20
	cis-1,2-Dichloroethene	102/102 (0.784)	73-120	20
	1,1,1-Trichloroethane	102/106 (3.84)	73-124	20
	1,1,2-Trichloroethane	106/103 (2.68)	80-120	20
	Trichloroethene	108/110 (1.83)	78-124	20

Criteria	Parameter	batch WG1880811 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	104/101 (2.54)	70-126	20
	1,1-Dichloroethene	111/109 (1.63)	71-124	20
	cis-1,2-Dichloroethene	108/109 (1.29)	73-120	20
	1,1,1-Trichloroethane	115/120 (4.24)	73-124	20
	1,1,2-Trichloroethane	106/99.8 (6.21)	80-120	20
	Trichloroethene	111/110 (0.362)	78-124	20

Criteria	Parameter	W-220603-EM-21 Recoveries (RPD):	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	123/116 (6.02)	25-158	27
	1,1-Dichloroethene	137/123 (11.1)	11-160	29
	cis-1,2-Dichloroethene	117/117 (0.283)	10-160	27
	1,1,1-Trichloroethane	146/134 (8.30)	23-160	28
	1,1,2-Trichloroethane	121/118 (2.84)	35-147	27
	Trichloroethene	126/76.0 (9.56)	10-160	25

Criteria	Parameter	batch WG1876373, batch WG1876984 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	44.2-71.4	10-120	NA

Table 2

Laboratory Precision and Accuracy Limits
OU3 - TCAAP Site
SDG ID: L1502544
June 2022 Sampling Event

Criteria	Parameter	batch WG1876373 Recoveries:	% Recovery Limits	RPD Limits
LCS				
SVOC	1,4-Dioxane	96.6/96.0 (0.623)	73-146	20

Criteria	Parameter	batch WG1876984 Recoveries:	% Recovery Limits	RPD Limits
LCS				
SVOC	1,4-Dioxane	117	73-146	NA

Criteria	Parameter	W-220603-EM-21 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
SVOC	1,4-Dioxane	111/114 (2.11)	38-160	21

Note:
NA - Not Applicable

Table 3

Field Duplicate Summary
OU3 - TCAAP Site
SDG ID: L1502544
June 2022 Sampling Event

	W-220602-EM-01 04U851 (ug/l)	W-220602-EM-02 04U851 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
	All Non-detect			
SVOC parameter				**Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	0.400 U	0.119 J	0.28	0.8

	W-220603-EM-14 04U860 (ug/l)	W-220603-EM-15 04U860 Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
	All Non-detect			
SVOC parameter				**Limit (+/-2 RL) or RPD Limit**
1,4-Dioxane	0.400 U	0.400 U	0	0.8

Notes:
J - Estimated concentration
U - Non-detect
RL - Reporting limit
RPD - Relative Percent Difference

ANALYTICAL DATA VALIDATION FORM (1,4-Dioxane)

SDG NUMBER L1502544

PROJECT: 003877

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 6/02/22-6/03/22 NO. OF SAMPLES: 22

ANALYSES REQUESTED: Method 8270 SIM (1,4-dioxane)

SAMPLE NO. Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____No X

Contractual Violations Yes____No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.
Yes X No ____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.
Yes X No ____

B. Holding Times

1. The required holding times were met for all analyses. Time elapsed from sample collection to extraction (7 days) and from extraction to analysis (40 days) were within criteria.
Yes X No____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all entries were complete, signatures were present and cross outs were clean and initialed.
Yes X No ____

2. Samples were received at the required temperature (samples cooled to < 6 °C upon collection)
Yes X No ____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for 1,4-dioxane met the method criteria. A minimum of five point calibration was used. An isotope dilution procedure was performed.
Yes X No____ NA ____

2. The relative standard deviation (RSD) was less than or equal to 20%. Alternatively, a coefficient of determination ("r2") of > or equal to 0.99 is acceptable for 1,4-dioxane.
Yes X No____ NA ____

B. Continuing Calibration

1. The continuing calibration standard was analyzed at the required frequency and the QC criteria were met. The continuing calibration verification (CCV) was analyzed before sample analysis; after every 12 hours of analysis.
Yes X No____ NA ___

The percent difference (%D) limits of ±20% was met for the CCV.
Yes X No____ NA ___

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The DFTPP performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met per the Method specifications.
Yes X No____ NA ____

V. INTERNAL STANDARDS

The Internal Standards met the -50 to +100% criteria compared to the daily CCV and the Retention times were within the required windows (+/- 0.06 RRT) for samples.
Yes X No____ NA ____

VI. SURROGATE
Surrogate spikes were analyzed with every sample.
Yes X No ____

Surrogates met the limits established in the QAPP (i.e., Current lab limits).
Yes X No ____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every batch or for every 20 samples.
Yes X No ___NA___
See Table 2

B. The MS and MSD percent recoveries were within the current limits established in the QAPP (i.e., Current lab limits).
Yes X No ____ NA__

C. The MSD relative percent differences (RPDs) were within the current limits established in the QAPP (i.e., Current lab limits).
Yes X No ____ NA__

VIII. LABORATORY CONTROL SAMPLE
A. Laboratory Control Samples (LCS) was analyzed for every batch or every 20 samples.
Yes X No ____

B. The LCS percent recoveries (and RPD limits, if LCS duplicate) were within the limits established in the QAPP (i.e., Current lab limits).
Yes X No ____
See Table 2

IX. BLANKS
A. Method Blanks were analyzed at the required frequency for the analysis.
Yes X No ____

B. No blank contamination was found in the Method Blank.
Yes ____ No X

The method blank for batch WG1876984 yielded a low-level 1,4-dioxane detection (0.112 ug/l). The associated 1,4-dioxane results for samples -14,15,16 and 20 were qualified non-detect (UB 0.112). Several other detections from the batch remained unqualified since the detections were greater than 5x the blank concentration.

C. If Equipment/Field Blanks were identified, no blank contamination was found.
Yes X No____ NA ____

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the <25% RPD, or ± 2 x RL for either result < 5 x RL, criteria for the project.
Yes X No____ NA ____
See Table 3

XI. SYSTEM PERFORMANCE
A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and

analytical systems.
Yes X No_____NA _____

B. The suggested EQL's for the sample matrices in this set were met.
Yes X No_____NA _____

XII. COMPOUND IDENTIFICATION & QUANTITATION
A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.
Yes X No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compound in one internal standards quantitation set.
Yes X No_____NA _____

XIII. OVERALL ASSESSMENT OF THE CASE
The data are usable for project purposes with the qualifications noted.

ANALYTICAL DATA VALIDATION FORM (VOCs)

SDG NUMBER L1502544

PROJECT: TCAAP OU3

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 6/02/22-6/03/22 NO. OF SAMPLES: 23

ANALYSES REQUESTED: Method 8260 (VOCs)

SAMPLE NO. see Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes___ No X

Contractual Violations Yes___ No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.
Yes X____No _____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.
Yes_X___No _____

B. Holding Times

1. The required holding times were met for all analyses (Time of sample receipt to time of analysis (VOA) or extraction and from extraction to analysis).
Yes X____No _____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.
Yes X____No _____

2. Samples were received at the required temperature and preservation.
Yes X____No _____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for all compounds for all analyses met the QAPP or method criteria.
Yes X____No_____NA _____

2. The relative standard deviation (RSD) for all compounds in the standard was less than 20%, with an allowance of up to 40% for the poor responders. Per the method, a correlation coefficient "r" of > 0.99 is also acceptable for compounds,
Yes_X____No_____NA _____

3. The 12 hour system Performance Check was performed as required in SW-846.
Yes_X____No_____NA _____

B. Continuing Calibration

1. The RRF 50 standard was analyzed for each analysis at the required frequency and the QC criteria were met.
Yes X___No___NA ___

2. The percent difference (%D) limits for all compounds is ±20%, with an allowance of up to 40% for the poor responders per the current validation guidance, were met.
Yes X____No_____NA _____

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The BFB performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met.
Yes X____No_____NA _____

V. INTERNAL STANDARDS

The Internal Standards met the 100% upper and -50% lower limits criteria and the Retention times were within

the required windows.
Yes X No NA

VI. SURROGATE
Surrogate spikes were analyzed with every sample.
Yes X No

And met the recovery limits defined in the QAPP (i.e., Current lab limits).
Yes X No
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every analysis performed and for every 20 samples or for every matrix whichever is more frequent.
Yes X No
See Table 2

B. The MS and MSD percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X No NA

C. The MSD relative percent differences (RPD) were within the QAPP limits.

Yes X No NA

VIII. LABORATORY CONTROL SAMPLE
A. A Laboratory Control Samples (LCS) was analyzed for every analysis batch or for every 20 samples. Yes X No

The LCS percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes No X
See Table 2
One LCS recovery for 1,1,1-trichloroethane in batch WG1880129 was above the upper control limit. Since the associated sample data were non-detect, no data qualification was required.

IX. BLANKS
A. Method Blanks were analyzed at the required frequency and for each matrix and analysis.
Yes X No

B. No blank contamination was found in the Method Blank.
Yes X No

C. If Equipment Rinsate Blanks were identified, no blank contamination was found.
Yes X No NA

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the RPD or % recovery criteria for the project.
Yes X No NA
See Table 3

XI. SYSTEM PERFORMANCE

A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.

Yes X No____ NA ____

B. The suggested EQL's for the sample matrices in this set were met

Yes X No____ NA ____

XII. TCL COMPOUNDS

A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.

Yes X No____ NA ____

B. Quantitation was checked to determine the accuracy of calculations for representative compounds in each internal standards quantitation set.

Yes X No____ NA ____

XIII. TENTATIVELY IDENTIFIED COMPOUNDS

TICs were properly identified and met the library identification criteria.

Yes____ No____ NA X

XIV. OVERALL ASSESSMENT OF THE CASE

The data are usable for project purposes without qualification.

Technical Memorandum

August 22, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 651 639 0913
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/	**Ref. No.**	039669-50
Subject	Third Quarter DUR FY 2022 Site K Results June 2022		

This memo provides the analytical data summary for the third quarter FY 2022 sampling conducted at Site K. Tables 1 through 4 provide the treatment system and monitoring well sampling results through FY 2022 third quarter. The data validation/verification memos are included as Attachment 1.

Ruth Mickle

Ruth Mickle
Chemist

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grant.anderson@ghd.com

Table 1

VOC Concentrations in Site K Monitoring Well Samples
FY 2022 - Through Third Quarter

Location	Date	Sample ID		1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Trichloroethene	Trichloroethene	Vinyl chloride
			MDL	**0.100**	**0.188**	**0.0819**	**0.126**	**12.6**	**6.30**	**0.149**	**0.190**	**19.0**	**9.50**	**0.234**
			RL	**1.00**	**1.00**	**1.00**	**1.00**	**100**	**50.0**	**1.00**	**1.00**	**100**	**50.0**	**1.00**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
01U128	06/20/2022	W-220620-EM-01		<1.00	<1.00	<1.00	<1.00	--	--	0.209 JPJD62.9	<1.00	--	--	<1.00
01U603	06/20/2022	W-220620-EM-03		<1.00	<1.00	<1.00	3.92	--	--	0.483 JP	2.70	--	--	<1.00
01U611R	06/20/2022	W-220620-EM-04		<1.00	4.09	<1.00	--	--	395	143	--	--	3150	8.27 JC27
01U611R	06/20/2022	W-220620-EM-05	FD	<1.00	4.21	<1.00	--	--	419	143	--	--	3320	8.64 JC27
01U615	06/21/2022	W-220620-EM-08		<1.00	12.5	<1.00	--	4710	--	176	--	2230	--	77.9
01U617	06/20/2022	W-220620-EM-06		<1.00	<1.00	<1.00	1.84	--	--	0.222 JP	<1.00	--	--	<1.00
01U618	06/20/2022	W-220620-EM-09		<1.00	<1.00	<1.00	1.01	--	--	0.307 JP	1.11	--	--	<1.00
01U618	06/20/2022	W-220620-EM-07	FB	<1.00	<1.00	<1.00	<1.00	--	--	<1.00	<1.00	--	--	<1.00
01U621	06/20/2022	W-220620-EM-10		<1.00	<1.00	<1.00	<1.00	--	--	<1.00	<1.00	--	--	<1.00
03U621	06/20/2022	W-220620-EM-11		<1.00	<1.00	<1.00	<1.00	--	--	<1.00	<1.00	--	--	<1.00
482083	06/20/2022	W-220620-EM-02		<1.00	<1.00	<1.00	<1.00	--	--	<1.00	0.284 JP	--	--	<1.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JC# - Result is qualified as estimated due to outlying continuing calibration result. The following numerical value is the associated % D value.
JD# - Result is qualified as estimated due to outlying relative percent difference from matrix spike analyses.
The following numerical value is the associated relative percent difference.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 2

VOC Concentrations in Site K Treatment System Samples
FY 2022 - Through 3rd Quarter

Location	Date	Sample ID		1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
			MDL	0.100	0.188	0.0819	0.126	0.630	1.26	0.149	0.190	0.234
			RL	1.00	1.00	1.00	1.00	5.00	10.0	1.00	1.00	1.00
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
EFF	12/10/2021	W-211210-EM-101		<1.00	<1.00	<1.00	9.51	--	--	0.354 JP	0.938 JP	<1.00
EFF	12/10/2021	W-211210-EM-102	FD	<1.00	<1.00	<1.00	10.6	--	--	0.441 JP	1.13	<1.00
INF	12/10/2021	W-211210-EM-103		<1.00	0.463 JP	<1.00	--	178	--	<1.00	40.5	1.58
EFF	03/04/2022	W-220304-EM-101		<1.00	<1.00	<1.00	10.7	--	--	0.556 JP	1.51	<1.00
INF	03/04/2022	W-220304-EM-102		<1.00	0.633 JP	<1.00	--	--	219	29.6	61.4	2.48
INF	03/04/2022	W-220304-EM-103	FD	<1.00	0.607 JP	<1.00	--	--	222	28.0	64.1	2.57
EFF	06/06/2022	W-220606-EM-101		<1.00	<1.00	<1.00	6.35	--	--	0.317 JP	0.881 JP	<1.00
EFF	06/06/2022	W-220606-EM-102	FD	<1.00	<1.00	<1.00	6.31	--	--	0.296 JP	0.701 JP	<1.00
INF	06/06/2022	W-220606-EM-103		<1.00	0.296 JP	<1.00	151	--	--	16.5	25.0	1.76

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate

Table 3

1,4-Dioxane Concentrations in Site K Samples
FY 2020 - Through 3rd Quarter

				1,4-Dioxane
			MDL	0.0447
			RL	0.400
				ug/L
Location	Date	Sample ID		
03U621	06/20/2022	W-220620-EM-11		11.9

Notes:

MDL - Method Detection Limit
RL - Reporting Limit

Table 4

Inorganic Water Quality Results in Site K Treatment System Samples
FY 2022 - Through 3rd Quarter

Location	Date	Sample ID		Copper	Copper	Lead	Lead	Mercury	Silver	Silver	Zinc	Zinc	Cyanide (total)	Phosphorus	Phosphorus
			MDL	**1.51**	**3.68**	**0.849**	**2.99**	**0.100**	**0.0700**	**1.54**	**3.02**	**6.52**	**1.80**	**35.0**	**35.0**
			RL	**5.00**	**10.0**	**2.00**	**6.00**	**0.200**	**2.00**	**5.00**	**25.0**	**50.0**	**5.00**	**100**	**281**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
EFF	12/10/2021	W-211210-EM-101		<5.00	--	<2.00	--	<0.200	<2.00	--	<25.0	--	<5.00	--	<281 UB64.1
EFF	03/04/2022	W-220304-EM-101		<5.00	--	<2.00	--	<0.200	<2.00	--	<25.0	--	<5.00	242	--
EFF	06/06/2022	W-220606-EM-101		--	<10.0	--	<6.00	<0.200	--	<5.00	--	<50.0	<5.00	103	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.
< - Not detected at the associated reporting limit.

Attachment 1

Data Validation/Verification Memos

Technical Memorandum

July 22, 2022

To	Shawn Horn, GHD	Tel	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/192	Ref. No.	039669-50
Subject	**Data Verification** **Site K Sampling** **June 6, 2022** **TCAAP Site** **Arden Hills, Minnesota**		

The following is a data verification form for samples collected on June 6, 2022, at the TCAAP Site K in Arden Hills, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

Table 1

Laboratory Precision and Accuracy Limits
Site K - TCAAP
SDG ID: L1502571
June 2022 Sampling Event

Criteria	Parameter	Pace #L1502571 batch WG1881422	% Recovery Limits	RPD Limits
		Recovery range:		
Surrogate				
VOC	1,2-Dichloroethane-d4	94.9-98.3	70-130	NA
	4-Bromofluorobenzene	97.6-105	77-126	NA
	Toluene-d8	101-106	80-120	NA

Criteria	Parameter	batch WG1881422 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	96.6/95.0 (1.67)	70-126	20
	1,2-Dichloroethane	95.6/93.6 (2.11)	70-128	20
	1,1-Dichloroethene	113/112 (1.07)	71-124	20
	cis-1,2-Dichloroethene	105/106 (1.32)	73-120	20
	trans-1,2-Dichloroethene	111/108 (2.93)	73-120	20
	Trichloroethene	93.4/98.6 (5.42)	78-124	20
	Vinyl Chloride	98.0/99.0 (1.02)	67-131	20

Table 1

Laboratory Precision and Accuracy Limits
Site K - TCAAP
SDG ID: L1502571
June 2022 Sampling Event

Criteria	Parameter	batch WG1882547 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Metals	Copper	99.4	80-120	NA
	Lead	93.6	80-120	NA
	Silver	93.2	80-120	NA
	Zinc	92.4	80-120	NA

Criteria	Parameter	batch WG1879650 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Metals	Mercury	102	80-120	NA

Criteria	Parameter	batch WG1878035 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Gen Chem	Cyanide	107	80-120	NA

Criteria	Parameter	batch WG1889176 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Gen Chem	Total Phosphorus	105	80-120	NA

Note:
NA - Not Applicable

Table 2

Field Duplicate Summary
TGRS - TCAAP Site
SDG ID: L1502571
June 2022 Sampling Event

	W-220606-EM-101 Effluent (ug/l)	W-220606-EM-102 Effluent Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameter				
cis-1,2-Dichloroethene	6.35	6.31	0.63	25
trans-1,2-Dichloroethene	0.317 J	0.296 J	0.021	1
Trichhloroethene	0.881 J	0.701 J	0.18	1

Notes:
RL - Reporting limit
RPD - Relative Percent Difference
J - Estimated concentration

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP Site K	
SDG #: L1502571	Sample Collection Date(s):6/6/22
Matrix: Water	Sample Analysis Date(s): 6/17/22-7/2/22
Method: VOC, Metals, Inorganics (see item 15)	Date Reviewed:7/21/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	---	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y, see note
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
18	Is data usable for the intended purpose?				Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – June 2022

Sample ID	Sample Location
W-220606-EM-101	Effluent
W-220606-EM-102	Effluent Duplicate
W-220606-EM-103	Influent
TRIP BLANK	Trip Blank
TRIP BLANK	Trip Blank

Item	Comment
15	Metals are analyzed using Method 6010B for Copper, Lead, Silver and Zinc, and Method 7470A (CVAA) for Mercury. Cyanide is analyzed using SM 4500CN E. Total Phosphorus is analyzed using MCAWW Method 365.4. VOCs were analyzed using SW 8260D.

Technical Memorandum

July 25, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/193	**Ref. No.**	039669-50
Subject	**Data Validation** **VOC & 1,4-Dioxane Analysis** **Site K Sampling** **June 20, 2022** **TCAAP Site** **Arden Hills, Minnesota**		

The following are data validation forms for samples collected on June 20, 2022, at the TCAAP Site K in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Sample Identification Numbers
Site K - TCAAP
SDG ID: L1508063
June 2022 Sampling Event

Sample ID	Sample Location
W-220620-EM-01	01U128
W-220620-EM-02	482083
W-220620-EM-03	01U603
W-220620-EM-04	01U611R
W-220620-EM-05	01U611R Field Duplicate
W-220620-EM-06	01U617
W-220620-EM-07	01U618 Field Blank
W-220620-EM-08	01U615
W-220620-EM-09	01U618
W-220620-EM-10	01U621
W-220620-EM-11	03U621
Trip Blank	Trip Blank

Table 2

Laboratory Precision and Accuracy Limits
Site K - TCAAP
SDG ID: L1508063
June 2022 Sampling Event

Criteria	Parameter	Pace #L1508063 batch WG1887817,WG1888498, WG1888857, WG1889281 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	110-125	70-130	NA
	4-Bromofluorobenzene	97.6-111	77-126	NA
	Toluene-d8	95.9-106	80-120	NA

Criteria	Parameter	batch WG1887817 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	106/109 (2.61)	70-126	20
	1,2-Dichloroethane	106/109 (3.17)	70-128	20
	1,1-Dichloroethene	111/113 (1.25)	71-124	20
	cis-1,2-Dichloroethene	106/111 (4.97)	73-120	20
	trans-1,2-Dichloroethene	107/112 (4.57)	73-120	20
	Trichloroethene	99.8/103 (3.16)	78-124	20
	Vinyl Chloride	73.0/87.2 (17.7)	67-131	20

Criteria	Parameter	W-220620-EM-01 Recoveries:	% Recovery Limits	RPD Limits
MS/MSD				
VOC	1,1-Dichloroethane	63/121 (63.3)	25-158	27
	1,2-Dichloroethane	78.6/124 (44.5)	29-151	27
	1,1-Dichloroethene	58.0/122 (71.4)	11-160	29
	cis-1,2-Dichloroethene	70.4/125 (55.7)	10-160	27
	trans-1,2-Dichloroethene	64.2/127 (62.9)	17-153	27
	Trichloroethene	67.4/115 (52.0)	10-160	25
	Vinyl Chloride	46.8/94.0 (67.0)	10-160	27

Table 2

Laboratory Precision and Accuracy Limits
Site K - TCAAP
SDG ID: L1508063
June 2022 Sampling Event

Criteria	Parameter	batch WG1888498 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	101/109 (7.25)	70-126	20
	1,2-Dichloroethane	107/107 (0.187)	70-128	20
	1,1-Dichloroethene	107/117 (8.91)	71-124	20
	cis-1,2-Dichloroethene	105/113 (7.34)	73-120	20
	trans-1,2-Dichloroethene	108/114 (5.60)	73-120	20
	Trichloroethene	105/109 (4.30)	78-124	20
	Vinyl Chloride	82.8/84.4 (1.91)	67-131	20

Criteria	Parameter	batch WG1888857 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	108/115 (6.27)	70-126	20
	1,2-Dichloroethane	111/114 (2.67)	70-128	20
	1,1-Dichloroethene	106/117 (10.4)	71-124	20
	cis-1,2-Dichloroethene	108/118 (8.82)	73-120	20
	trans-1,2-Dichloroethene	108/117 (8.71)	73-120	20
	Trichloroethene	95.4/114 (17.4)	78-124	20
	Vinyl Chloride	76.8/91.6 (17.6)	67-131	20

Criteria	Parameter	batch WG1889281 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	cis-1,2-Dichloroethene	99.2/105 (6.06)	73-120	20
	Trichloroethene	98.0/104 (6.13)	78-124	20

Criteria	Parameter	batch WG1885740 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	49.2	10-120	NA

Table 2

Laboratory Precision and Accuracy Limits
Site K - TCAAP
SDG ID: L1508063
June 2022 Sampling Event

Criteria	Parameter	batch WG1885740 Recoveries:	% Recovery Limits	RPD Limits
LCS				
SVOC	1,4-Dioxane	108/109 (0.554)	73-146	20

Note:
NA - Not Applicable

Table 3

Field Duplicate Summary
TGRS - TCAAP Site
SDG ID: L1508063
June 2022 Sampling Event

	W-220620-EM-04 01U611R (ug/l)	W-220620-EM-05 01U611R Field Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameters				
1,1-Dichloroethene	4.09	4.21	0.12	1
cis-1,2-Dichloroethene	395	419	5.9	25
trans-1,2-Dichloroethene	143	143	0	25
Trichloroethene	3150	3320	5.3	25
Vinyl chloride	8.27	8.64	4.4	25

Notes:
RL - Reporting limit
RPD - Relative Percent Difference

ANALYTICAL DATA VALIDATION FORM (VOCs)

SDG NUMBER: L1508063

PROJECT: TCAAP Site K

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 6/20/22 NO. OF SAMPLES: 12

ANALYSES REQUESTED: Method 8260 (VOCs)

SAMPLE NO. see Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE:______

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____No X

Contractual Violations Yes____No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.
Yes X No ____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.
Yes X No ____

B. Holding Times

1. The required holding times were met for all analyses (Time of sample receipt to time of analysis (VOA) or extraction and from extraction to analysis).
Yes X No ____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all fields were complete, signatures were present and cross outs were clean and initialed.
Yes X No ____

2. Samples were received at the required temperature and preservation.
Yes X No ____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for all compounds for all analyses met the QAPP or method criteria.
Yes X No____ NA ____

2. The relative standard deviation (RSD) for all compounds in the standard was less than 20%, with an allowance of up to 40% for the poor responders. Per the method, a correlation coefficient "r" of > 0.99 is also acceptable for compounds,
Yes X No____ NA ____

3. The 12 hour system Performance Check was performed as required in SW-846.
Yes X No____ NA ____

B. Continuing Calibration

1. The RRF 50 standard was analyzed for each analysis at the required frequency and the QC criteria were met.
Yes X No____ NA ___

2. The percent difference (%D) limits for all compounds is $\pm$20%, with an allowance of up to 40% for the poor responders per the current validation guidance, were met.
Yes____ No X NA ____

The vinyl chloride % D was outside the limit for one continuing calibration sample (0630_03). The associated detections were qualified estimated (JC27) for samples W-220620-EM-04 and W-220620-EM-05.

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The BFB performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met.
Yes X No____ NA ____

V. INTERNAL STANDARDS
The Internal Standards met the 100% upper and -50% lower limits criteria and the Retention times were within the required windows.
Yes X No____NA ____

VI. SURROGATE
Surrogate spikes were analyzed with every sample.
Yes X No ____

And met the recovery limits defined in the QAPP (i.e., Current lab limits).
Yes X No X
See Table 2.

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every analysis performed and for every 20 samples or for every matrix whichever is more frequent.
Yes X No ____
Non-project sample

B. The MS and MSD percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X No ____ NA___

C. The MSD relative percent differences (RPD) were within the QAPP limits.

Yes_____No X NA ____

Sample W-220620-EM-01 yielded all VOC RPDs outside control limits. Except for trans-1,2-dichloroethene, the associated sample data were non-detect. The associated trans-1,2-dichloroethene detection for sample W-220620-EM-01 was qualified estimated (JD62.9).

VIII. LABORATORY CONTROL SAMPLE
A. A Laboratory Control Samples (LCS) was analyzed for every analysis batch or for every 20 samples.
Yes X No ____

The LCS percent recoveries were within the limits defined in the QAPP (i.e., Current lab limits).
Yes X No ____
See Table 2

IX. BLANKS
A. Method Blanks were analyzed at the required frequency and for each matrix and analysis.
Yes X No ____

B. No blank contamination was found in the Method Blank.
Yes X No ____

C. If Equipment Rinsate Blanks were identified, no blank contamination was found.
Yes X No____NA ____

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the RPD or % recovery criteria for the project.

Yes X____No_____NA _____
See Table 3

XI. SYSTEM PERFORMANCE
A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.
Yes X____No_____NA _____
B. The suggested EQL's for the sample matrices in this set were met
Yes X____No_____NA _____

XII. TCL COMPOUNDS
A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.
Yes X____No_____NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compounds in each internal standards quantitation set.
Yes X____No_____NA _____

XIII. TENTATIVELY IDENTIFIED COMPOUNDS
TICs were properly identified and met the library identification criteria.
Yes______No_____NA X___

XIV. OVERALL ASSESSMENT OF THE CASE

The data are usable for project purposes with the qualifications noted.

ANALYTICAL DATA VALIDATION FORM (1,4-Dioxane)

SDG NUMBER: L1508063

PROJECT: TCAAP Site K

LABORATORY: Pace, TN

SAMPLE MATRIX: Water

SAMPLING DATE(S): 6/20/22 NO. OF SAMPLES: 1

ANALYSES REQUESTED: Method 8270 SIM (1,4-dioxane)

SAMPLE NO. Table 1

DATA REVIEWER: Ruth Mickle INITIALS/DATE: ____

QA REVIEWER: Ruth Mickle

Telephone Logs included Yes____ No X

Contractual Violations Yes____ No X

Comments:

I. DELIVERABLES

A. All deliverables were present as specified in the Scope of Work and QAPP.
Yes X No ____

II. ANALYTICAL REPORT FORMS

A. The Analytical Report or Data Sheets are present and complete for all requested analyses.
Yes X No ____

B. Holding Times

1. The required holding times were met for all analyses. Time elapsed from sample collection to extraction (7 days) and from extraction to analysis (40 days) were within criteria.
Yes X No ____

C. Chains of Custody (COC)

1. Chains of Custody (COC) were reviewed and all entries were complete, signatures were present and cross outs were clean and initialed.
Yes X No ____

2. Samples were received at the required temperature (samples cooled to < 6 °C upon collection)
Yes X No ____

III. INSTRUMENT CALIBRATION - GC/MS

A. Initial Calibration

1. The Relative Response Factors (RRF) and average RRF for 1,4-dioxane met the method criteria. A minimum of five point calibration was used. An isotope dilution procedure was performed.
Yes X No ____ NA ____

2. The relative standard deviation (RSD) was less than or equal to 20%. Alternatively, a coefficient of determination ("r2") of > or equal to 0.99 is acceptable for 1,4-dioxane.
Yes X No ____ NA ____

B. Continuing Calibration

1. The continuing calibration standard was analyzed at the required frequency and the QC criteria were met. The continuing calibration verification (CCV) was analyzed before sample analysis; after every 12 hours of analysis.
Yes X No ____ NA ___

The percent difference (%D) limits of $\pm$20% was met for the CCV.
Yes X No ____ NA ___

IV. GC/MS INSTRUMENT PERFORMANCE CHECK

The DFTPP performance check was injected once at the beginning of each 12-hour period and relative abundance criteria for the ions were met per the Method specifications.
Yes X No ____ NA ____

V. INTERNAL STANDARDS

The Internal Standards met the -50 to +100% criteria compared to the daily CCV and the Retention times were within the required windows (+/- 0.06 RRT) for samples.
Yes X No ____ NA ____

VI. SURROGATE
Surrogate spikes were analyzed with every sample.
Yes X No _____

Surrogates met the limits established in the QAPP (i.e., Current lab limits).
Yes X No _____
See Table 2

VII. MATRIX SPIKE/MATRIX SPIKE DUPLICATE
A. Matrix spike (MS) and matrix spike duplicates (MSD) were analyzed for every batch or for every 20 samples.
Yes______No _____NA_X___

B. The MS and MSD percent recoveries were within the current limits established in the QAPP (i.e., Current lab limits).
Yes______No _____NA_X___

C. The MSD relative percent differences (RPDs) were within the current limits established in the QAPP (i.e., Current lab limits).
Yes______No _____NA_X___

VIII. LABORATORY CONTROL SAMPLE
A. Laboratory Control Samples (LCS) was analyzed for every batch or every 20 samples.
Yes X No _____

B. The LCS percent recoveries (and RPD limits, if LCS duplicate) were within the limits established in the QAPP (i.e., Current lab limits).
Yes X No ____
See Table 2

IX. BLANKS
A. Method Blanks were analyzed at the required frequency for the analysis.
Yes X No _____

B. No blank contamination was found in the Method Blank.
Yes X No _____

C. If Equipment/Field Blanks were identified, no blank contamination was found.
Yes_____No_____NA X

X. FIELD QC
If Field duplicates or Performance Check Compounds were identified, they met the <25% RPD, or $\pm$ 2 x RL for either result < 5 x RL, criteria for the project.
Yes X No_____NA X

XI. SYSTEM PERFORMANCE
A. The RICs, chromatograms, tunes and general system performance were acceptable for all instruments and analytical systems.

Yes X___ No_____ NA _____

B. The suggested EQL's for the sample matrices in this set were met.
Yes X___ No_____ NA _____

XII. COMPOUND IDENTIFICATION & QUANTITATION
A. The identification is accurate and all retention times, library spectra and reconstructed ion chromatograms (RIC) were evaluated for all detected compounds.
Yes X___ No_____ NA _____

B. Quantitation was checked to determine the accuracy of calculations for representative compound in one internal standards quantitation set.
Yes X___ No_____ NA _____

XIII. OVERALL ASSESSMENT OF THE CASE
The data are usable for project purposes without qualification.

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Brighton, MI 48116
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11 January 2023

TECHNICAL MEMORANDUM

TO: Viral Patel (USEPA), Brigitte Hay (MPCA), and Katy Grant (MPCA)

FROM: Arthur Peitsch, EA Project Manager

CC: Linda Albrecht (USAEC), Shawn Horn (GHD), Tom Lineer (U.S. Army), and David Brown (NGIS)

SUBJECT: Draft Final Twin Cities Army Ammunition Plant Data Usability Report #116, Fiscal Year 2022 4th Quarter Monitoring (July – September 2022)

EA Engineering, Science, and Technology, Inc. (EA) is pleased to present this draft final Data Usability Report (DUR) #116 for the Fiscal Year 2022 4th Quarter Monitoring. This report provides the analytical data summary and data verification for extraction well and treatment system sampling conducted at Operable Unit (OU) 1, OU2 Deep Groundwater Site, Building 102, Site A, Site C, and Site K. A technical memorandum for each site is attached. The data validation/verification confirmed that all data are valid and usable for project purposes.

Technical Memorandum

December 23, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 612-524-6872
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/201	**Ref. No.**	039669-50
Subject	Fourth Quarter DUR FY 2022 Site K Results September 2022		

This memo provides the analytical data summary for the fourth quarter FY 2022 sampling conducted at Site K. Tables 1 through 4 provide the treatment system and monitoring well sampling results through FY 2022 fourth quarter. The data verification memo is included as Attachment 1.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

Table 1

VOC Concentrations in Site K Monitoring Well Samples
FY 2022 - Through 4th Quarter

Location	Date	Sample ID		1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Trichloroethene	Trichloroethene	Vinyl chloride
			MDL	**0.100**	**0.188**	**0.0819**	**0.126**	**12.6**	**6.30**	**0.149**	**0.190**	**19.0**	**9.50**	**0.234**
			RL	**1.00**	**1.00**	**1.00**	**1.00**	**100**	**50.0**	**1.00**	**1.00**	**100**	**50.0**	**1.00**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
01U128	06/20/2022	W-220620-EM-01		<1.00	<1.00	<1.00	<1.00	--	--	0.209 JPJD62.9	<1.00	--	--	<1.00
01U603	06/20/2022	W-220620-EM-03		<1.00	<1.00	<1.00	3.92	--	--	0.483 JP	2.70	--	--	<1.00
01U611R	06/20/2022	W-220620-EM-04		<1.00	4.09	<1.00	--	--	395	143	--	--	3150	8.27 JC27
01U611R	06/20/2022	W-220620-EM-05	FD	<1.00	4.21	<1.00	--	--	419	143	--	--	3320	8.64 JC27
01U615	06/21/2022	W-220620-EM-08		<1.00	12.5	<1.00	--	4710	--	176	--	2230	--	77.9
01U617	06/20/2022	W-220620-EM-06		<1.00	<1.00	<1.00	1.84	--	--	0.222 JP	<1.00	--	--	<1.00
01U618	06/20/2022	W-220620-EM-09		<1.00	<1.00	<1.00	1.01	--	--	0.307 JP	1.11	--	--	<1.00
01U618	06/20/2022	W-220620-EM-07	FB	<1.00	<1.00	<1.00	<1.00	--	--	<1.00	<1.00	--	--	<1.00
01U621	06/20/2022	W-220620-EM-10		<1.00	<1.00	<1.00	<1.00	--	--	<1.00	<1.00	--	--	<1.00
03U621	06/20/2022	W-220620-EM-11		<1.00	<1.00	<1.00	<1.00	--	--	<1.00	<1.00	--	--	<1.00
482083	06/20/2022	W-220620-EM-02		<1.00	<1.00	<1.00	<1.00	--	--	<1.00	0.284 JP	--	--	<1.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JC# - Result is qualified as estimated due to outlying continuing calibration result. The following numerical value is the associated % D value.
JD# - Result is qualified as estimated due to outlying relative percent difference from matrix spike analyses.
The following numerical value is the associated relative percent difference.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 2

VOC Concentrations in Site K Treatment System Samples
FY 2022 - Through 4th Quarter

Location	Date	Sample ID		1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
			MDL	**0.100**	**0.188**	**0.0819**	**0.126**	**0.630**	**1.26**	**0.149**	**0.190**	**0.234**
			RL	**1.00**	**1.00**	**1.00**	**1.00**	**5.00**	**10.0**	**1.00**	**1.00**	**1.00**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
EFF	12/10/2021	W-211210-EM-101		<1.00	<1.00	<1.00	9.51	--	--	0.354 JP	0.938 JP	<1.00
EFF	12/10/2021	W-211210-EM-102	FD	<1.00	<1.00	<1.00	10.6	--	--	0.441 JP	1.13	<1.00
INF	12/10/2021	W-211210-EM-103		<1.00	0.463 JP	<1.00	--	178	--	<1.00	40.5	1.58
EFF	03/04/2022	W-220304-EM-101		<1.00	<1.00	<1.00	10.7	--	--	0.556 JP	1.51	<1.00
INF	03/04/2022	W-220304-EM-102		<1.00	0.633 JP	<1.00	--	--	219	29.6	61.4	2.48
INF	03/04/2022	W-220304-EM-103	FD	<1.00	0.607 JP	<1.00	--	--	222	28.0	64.1	2.57
EFF	06/06/2022	W-220606-EM-101		<1.00	<1.00	<1.00	6.35	--	--	0.317 JP	0.881 JP	<1.00
EFF	06/06/2022	W-220606-EM-102	FD	<1.00	<1.00	<1.00	6.31	--	--	0.296 JP	0.701 JP	<1.00
INF	06/06/2022	W-220606-EM-103		<1.00	0.296 JP	<1.00	151	--	--	16.5	25.0	1.76
EFF	09/07/2022	W-220907-EM-101		<1.00	<1.00	<1.00	4.56	--	--	0.188 JP	0.237 JP	<1.00
EFF	09/07/2022	W-220907-EM-103	FD	<1.00	<1.00	<1.00	4.69	--	--	<1.00	0.289 JP	<1.00
INF	09/07/2022	W-220907-EM-102		<1.00	0.214 JPJL129	<1.00	164	--	--	17.2	19.3	1.49

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JL# - Result is qualified as estimated due to outlying percent recovery from lab control sample analyses. The following numerical value is the associated percent recovery.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate

Table 3

1,4-Dioxane Concentrations in Site K Samples
FY 2020 - Through 4th Quarter

				1,4-Dioxane
			MDL	0.0447
			RL	0.400
				ug/L
Location	Date	Sample ID		
03U621	06/20/2022	W-220620-EM-11		11.9

Notes:

MDL - Method Detection Limit
RL - Reporting Limit

Table 4

Inorganic Water Quality Results in Site K Treatment System Samples
FY 2022 - Through 4th Quarter

Location	Date	Sample ID		Copper	Copper	Lead	Lead	Mercury	Silver	Silver	Zinc	Zinc	Cyanide (total)	Phosphorus	Phosphorus
			MDL	1.51	3.68	0.849	2.99	0.100	0.0700	1.54	3.02	6.52	1.80	35.0	35.0
			RL	5.00	10.0	2.00	6.00	0.200	2.00	5.00	25.0	50.0	5.00	100	281
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
EFF	12/10/2021	W-211210-EM-101		<5.00	--	<2.00	--	<0.200	<2.00	--	<25.0	--	<5.00	--	<281 UB64.1
EFF	03/04/2022	W-220304-EM-101		<5.00	--	<2.00	--	<0.200	<2.00	--	<25.0	--	<5.00	242	--
EFF	06/06/2022	W-220606-EM-101		--	<10.0	--	<6.00	<0.200	--	<5.00	--	<50.0	<5.00	103	--
EFF	09/07/2022	W-220907-EM-101		1.97 JP	--	<2.00	--	<0.200	<2.00	--	3.92 JP	--	<5.00	250	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.
< - Not detected at the associated reporting limit.

Attachment 1

Data Verification Memo

GHD Digital

Technical Memorandum

October 18, 2022

To	Shawn Horn, GHD	**Contact No.**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/kg/198	**Project No.**	039669-50
Subject	Data Verification Site K Sampling September 7, 2022 TCAAP Site Arden Hills, Minnesota		

The following is a data verification form for samples collected on September 7, 2022, at the TCAAP Site K in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

→ The Power of Commitment

Table 1

Laboratory Precision and Accuracy Limits
Site K - TCAAP
SDG ID: L1533741
September 2022 Sampling Event

Criteria	Parameter	Pace #L1533741 batch WG1924432	% Recovery Limits	RPD Limits
		Recovery range:		
Surrogate				
VOC	1,2-Dichloroethane-d4	117-123	70-130	NA
	4-Bromofluorobenzene	112-122	77-126	NA
	Toluene-d8	110-120	80-120	NA

Criteria	Parameter	batch WG1924432 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	113/121 (7.18)	70-126	20
	1,2-Dichloroethane	105/111 (5.19)	70-128	20
	1,1-Dichloroethene	119/129 (7.42)	71-124	20
	cis-1,2-Dichloroethene	111/116 (4.59)	73-120	20
	trans-1,2-Dichloroethene	114/117 (2.42)	73-120	20
	Trichloroethene	107/120 (10.7)	78-124	20
	Vinyl Chloride	112/107 (4.76)	67-131	20

Criteria	Parameter	batch WG1924487 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Metals	Copper	96.0	80-120	NA
	Lead	99.7	80-120	NA
	Silver	96.7	80-120	NA
	Zinc	96.4	80-120	NA

Criteria	Parameter	batch WG1924733 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Metals	Mercury	98.0	80-120	NA

Criteria	Parameter	batch WG1925486 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Gen Chem	Cyanide	98.0	80-120	NA

Table 1

Laboratory Precision and Accuracy Limits
Site K - TCAAP
SDG ID: L1533741
September 2022 Sampling Event

Criteria	Parameter	batch WG1925486 Recoveries:	% Recovery Limits	RPD Limit
MS/MSD				
Gen Chem	Cyanide	101/98.6 (2.40)	75-125	20

Criteria	Parameter	batch WG1929824 Recoveries:	% Recovery Limits	RPD Limit
LCS				
Gen Chem	Total Phosphorus	98.1	80-120	NA

Note:
NA - Not Applicable

Table 2

Field Duplicate Summary
TGRS - TCAAP Site
SDG ID: L1533741
September 2022 Sampling Event

	W-220907-EM-101 Effluent (ug/l)	W-220907-EM-103 Effluent Duplicate (ug/l)	RPD/Difference	Difference Limit (+/-RL) or RPD Limit
VOC parameter				
cis-1,2-Dichloroethene	4.56	4.69	0.13	1
trans-1,2-Dichloroethene	0.188 J	1.00 U	0.812	1
Trichhloroethene	0.237 J	0.289 J	0.052	1

Notes:

RL - Reporting limit
RPD - Relative Percent Difference
J - Estimated concentration
U - Non-detect

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP Site K	
SDG #: L1533741	Sample Collection Date(s):9/7/22
Matrix: Water	Sample Analysis Date(s): 9/11/22-9/21/22
Method: VOC, Metals, Inorganics (see item 15)	Date Reviewed:10/17/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	VOC-14 days	ICP-180 days, Hg-28 days	Cn-14 days,Total P-28 days	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	N
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	Y
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	Y
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y

15	All req'd analyses performed?	---	---	---	Y, see note
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – September 2022

Sample ID	**Sample Location**
W-220907-EM-101	Effluent
W-220907-EM-102	Influent
W-220907-EM-103	Effluent Duplicate
TRIP BLANK	Trip Blank

Item	Comment
6	One LCS spike recovery for 1,1-diichloroethene from batch WG1924432 was above the upper control limit. The associated sample detection was qualified estimated (JL129) for sample: W-220907-EM-102.
15	Metals are analyzed using Method 6020 for Copper, Lead, Silver and Zinc, and Method 7470A (CVAA) for Mercury. Cyanide is analyzed using SM 4500CN E. Total Phosphorus is analyzed using MCAWW Method 365.4. VOCs were analyzed using SW 8260D.

Technical Memorandum

December 23, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 612 524 6872
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/16	**Ref. No.**	12561153
Subject	Fourth Quarter DUR FY 2022 OU1, Building 102, Site A and Site C Annual Results September 2022		

This memo provides the analytical data summary through the fourth quarter FY 2022 sampling conducted at the OU1, Building 102, Site A and Site C. Tables 1 through 6 provide the monitoring well sampling results from FY 2022 through fourth quarter. The fourth quarter data verification memo is included as Attachment 1.

Regards,

Ruth Mickle
Chemist

Table 1

VOC Concentrations in Building 102 Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	1,1-Dichloroethene	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	Trichloroethene	Trichloroethene	Vinyl chloride
				MDL	0.188	0.126	1.26	0.190	1.90	0.234
				RL	1.00	1.00	10.0	1.00	10.0	1.00
					ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Bldg 102	01L581	05/11/2022	BLDG102-220511-RA-11		<1.00	3.89	--	4.73	--	<1.00
Bldg 102	01U581	05/11/2022	BLDG102-220511-RA-09	FB	<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01L582	05/09/2022	BLDG102-220509-RA-01		<1.00	12.6	--	<1.00	--	<1.00
Bldg 102	01L582	05/09/2022	BLDG102-220509-RA-02	FD	<1.00	12.6	--	<1.00	--	<1.00
Bldg 102	01L583	05/11/2022	BLDG102-220511-RA-07		<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01L583	05/11/2022	BLDG102-220511-RA-08	FD	<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01L584	05/11/2022	BLDG102-220511-RA-13		<1.00	7.46	--	8.02	--	<1.00
Bldg 102	01U048	05/10/2022	BLDG102-220510-RA-04	FB	<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01U048	05/10/2022	BLDG102-220510-RA-05		<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01U579	05/11/2022	BLDG102-220511-RA-15		<1.00	4.79	--	0.456 JP	--	<1.00
Bldg 102	01U580	05/11/2022	BLDG102-220511-RA-14		1.21	--	166	--	191	22.7
Bldg 102	01U581	05/11/2022	BLDG102-220511-RA-10		<1.00	30.9	--	6.99	--	<1.00
Bldg 102	01U582	05/10/2022	BLDG102-220510-RA-03		<1.00	0.160 JP	--	<1.00	--	<1.00
Bldg 102	01U583	05/11/2022	BLDG102-220511-RA-06		<1.00	<1.00	--	<1.00	--	<1.00
Bldg 102	01U584	05/11/2022	BLDG102-220511-RA-12		<1.00	9.66	--	2.02	--	1.22

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 2

VOC Concentrations in Site OU1 Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	Trichloroethene
				MDL	0.149	0.158	0.100	0.188	0.126	0.190
				RL	1.00	1.00	1.00	1.00	1.00	1.00
					ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
OU1	03L832	05/17/2022	OU1-220517-RA-53		<1.00	<1.00	0.136 JP	<1.00	0.238 JP	2.51
OU1	03L822	05/16/2022	OU1-220516-RA-10		<1.00	<1.00	2.36	2.81	5.31	91.6
OU1	03L841	05/16/2022	OU1-220516-RA-13		<1.00	<1.00	0.212 JP	0.228 JP	0.525 JP	<1.00
OU1	03L846	05/17/2022	OU1-220517-RA-49		<1.00	<1.00	10.5	7.31	25.6	0.656 JP
OU1	03M843	05/17/2022	OU1-220517-RA-50		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	03U821	05/17/2022	OU1-220517-RA-47		<1.00	<1.00	0.457 JP	0.323 JP	0.619 JP	6.65
OU1	03U821	05/17/2022	OU1-220517-RA-48	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	03U822	05/16/2022	OU1-220516-RA-11		<1.00	<1.00	1.65	1.69	34.0	6.77
OU1	04J822	05/16/2022	OU1-220516-RA-09		<1.00	<1.00	0.666 JP	0.370 JP	0.663 JP	0.914 JP
OU1	04J834	05/16/2022	OU1-220516-RA-19		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04J834	05/16/2022	OU1-220516-RA-22	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04J836	05/17/2022	OU1-220517-RA-28		<1.00	<1.00	0.159 JP	<1.00	<1.00	1.67
OU1	04J837	05/16/2022	OU1-220516-RA-16		<1.00	<1.00	0.272 JP	<1.00	0.367 JP	1.22
OU1	04J838	05/17/2022	OU1-220517-RA-44		0.884 JP	<1.00	2.26	3.32	2.22	45.2
OU1	04J839	05/17/2022	OU1-220517-RA-30		<1.00	<1.00	0.122 JP	0.231 JP	<1.00	2.86
OU1	04J839	05/17/2022	OU1-220517-RA-31	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04J847	09/22/2022	OU1-220922-RA-02		2.16	<1.00	9.51	8.47	3.07	416
OU1	04J849	05/17/2022	OU1-220517-RA-58		1.55	<1.00	1.12	2.11	<1.00	4.13
OU1	04J882	05/16/2022	OU1-220516-RA-36		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04J882	05/16/2022	OU1-220516-RA-37		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U821	05/17/2022	OU1-220517-RA-45		<1.00	<1.00	0.999 JP	0.912 JP	9.04	1.54
OU1	04U821	05/17/2022	OU1-220517-RA-46	FD	<1.00	<1.00	0.934 JP	0.860 JP	8.13	1.37
OU1	04U834	05/16/2022	OU1-220516-RA-20		<1.00	<1.00	0.122 JP	<1.00	<1.00	1.19
OU1	04U834	05/16/2022	OU1-220516-RA-21	FD	<1.00	<1.00	0.123 JP	<1.00	<1.00	0.919 JP
OU1	04U836	05/17/2022	OU1-220517-RA-29		<1.00	<1.00	2.15	2.13	12.4	8.90
OU1	04U837	05/16/2022	OU1-220516-RA-15		<1.00	<1.00	1.52	<1.00	0.165 JP	0.523 JP
OU1	04U838	05/17/2022	OU1-220517-RA-43		<1.00	<1.00	<1.00	<1.00	<1.00	0.306 JP
OU1	04U839	05/17/2022	OU1-220517-RA-32		0.550 JP	<1.00	1.89	1.36	0.442 JP	23.8
OU1	04U839	05/17/2022	OU1-220517-RA-33	FD	0.505 JP	<1.00	1.89	0.880 JP	0.427 JP	22.8
OU1	04U841	05/16/2022	OU1-220516-RA-14		0.243 JP	<1.00	0.758 JP	0.851 JP	0.241 JP	5.02
OU1	04U843	05/17/2022	OU1-220517-RA-51		2.46	<1.00	3.99	5.86	0.679 JP	43.5
OU1	04U844	05/17/2022	OU1-220517-RA-55		4.84	0.188 JP	11.1	12.6	4.52	141
OU1	04U844	05/17/2022	OU1-220517-RA-56	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U846	05/17/2022	OU1-220517-RA-52		<1.00	<1.00	12.8	10.2	28.0	20.6
OU1	04U847	09/22/2022	OU1-220922-RA-01		1.87	<1.00	10.3	10.7	2.49	244
OU1	04U849	05/17/2022	OU1-220517-RA-57		1.19	<1.00	3.50	4.14	0.568 JP	39.3
OU1	04U850	05/17/2022	OU1-220517-RA-34		0.334 JP	<1.00	3.71	3.93	10.6 JFD56.3	33.5
OU1	04U850	05/17/2022	OU1-220517-RA-35	FD	0.299 JP	<1.00	2.86	2.94	5.94 JFD56.3	28.7
OU1	04U855	05/17/2022	OU1-220517-RA-59		0.152 JP	<1.00	0.576 JP	0.774 JP	0.163 JP	9.19
OU1	04U871	05/16/2022	OU1-220516-RA-27		2.83	<1.00	3.17	5.08	0.958 JP	76.7
OU1	04U872	05/16/2022	OU1-220516-RA-25		0.204 JP	<1.00	0.675 JP	0.480 JP	1.50	7.32
OU1	04U875	05/12/2022	OU1-220512-RA-02		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U875	05/12/2022	OU1-220512-RA-03	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U877	05/17/2022	OU1-220517-RA-39		<1.00	<1.00	1.90	<1.00	0.174 JP	0.358 JP
OU1	04U879	05/17/2022	OU1-220517-RA-42		<1.00	<1.00	0.188 JP	<1.00	<1.00	1.19
OU1	04U880	05/16/2022	OU1-220516-RA-24		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	04U881	05/16/2022	OU1-220516-RA-23		0.212 JP	<1.00	1.35	<1.00	0.269 JP	7.39
OU1	04U882	05/16/2022	OU1-220516-RA-17		<1.00	<1.00	0.439 JP	0.402 JP	0.155 JP	4.31
OU1	04U883	05/16/2022	OU1-220516-RA-18		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	200154	05/12/2022	OU1-220512-RA-01		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	234546	05/20/2022	OU1-220520-RA-62		<1.00	<1.00	0.415 JP	0.376 JP	<1.00	5.06
OU1	409547	05/16/2022	OU1-220516-RA-08		0.924 JP	<1.00	6.42	6.51	1.54	2.85
OU1	409557	05/20/2022	OU1-220520-RA-60		1.67	0.184 JP	7.28	11.1	3.87	61.1
OU1	409548	05/16/2022	OU1-220516-RA-12		<1.00	<1.00	0.287 JP	<1.00	0.994 JP	0.369 JP
OU1	409549	05/17/2022	OU1-220517-RA-40		0.810 JP	<1.00	2.99	3.07	0.590 JP	23.8
OU1	409549	05/17/2022	OU1-220517-RA-41	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	409550	05/17/2022	OU1-220517-RA-54		<1.00	<1.00	0.535 JP	0.339 JP	1.93	17.0
OU1	409555	05/16/2022	OU1-220516-RA-26		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	409556	05/17/2022	OU1-220517-RA-38		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
OU1	512761	05/20/2022	OU1-220520-RA-63		0.380 JP	<1.00	0.382 JP	0.779 JP	<1.00	10.1
OU1	PJ#318	05/12/2022	OU1-220512-RA-04		<1.00	<1.00	<1.00	<1.00	<1.00	0.403 JP
OU1	PJ#318	05/12/2022	OU1-220512-RA-05	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank
JFD# - Result is qualified as estimated due to outlying field duplicate RPD result. The following numerical value is the associated RPD value.

Table 3

1,4-Dioxane Concentrations in Site OU1 Well Samples
2022 Annual Sampling Event

					1,4-Dioxane	1,4-Dioxane	1,4-Dioxane
				MDL	**0.0447**	**0.0469**	**0.0496**
				RL	**0.400**	**0.420**	**0.444**
					ug/L	**ug/L**	**ug/L**
Site	**Location**	**Date**	**Sample ID**	**Sample Type**			
OU1	03L832	05/17/2022	OU1-220517-RA-53		0.475	--	--
OU1	03L822	05/16/2022	OU1-220516-RA-10		18.5	--	--
OU1	03L841	05/16/2022	OU1-220516-RA-13		4.18	--	--
OU1	03L846	05/17/2022	OU1-220517-RA-49		17.7	--	--
OU1	03M843	05/17/2022	OU1-220517-RA-50		13.7	--	--
OU1	03U821	05/17/2022	OU1-220517-RA-47		13.1	--	--
OU1	03U821	05/17/2022	OU1-220517-RA-48	FB	<0.400	--	--
OU1	03U822	05/16/2022	OU1-220516-RA-11		9.58	--	--
OU1	04J822	05/16/2022	OU1-220516-RA-09		<0.400	--	--
OU1	04J834	05/16/2022	OU1-220516-RA-19		<0.400	--	--
OU1	04J834	05/16/2022	OU1-220516-RA-22	FB	3.13	--	--
OU1	04J836	05/17/2022	OU1-220517-RA-28		1.29	--	--
OU1	04J837	05/16/2022	OU1-220516-RA-16		1.16	--	--
OU1	04J838	05/17/2022	OU1-220517-RA-44		4.39	--	--
OU1	04J839	05/17/2022	OU1-220517-RA-30		0.532	--	--
OU1	04J839	05/17/2022	OU1-220517-RA-31	FB	<0.400	--	--
OU1	04J847	09/22/2022	OU1-220922-RA-02		32.2	--	--
OU1	04J849	05/17/2022	OU1-220517-RA-58		0.705	--	--
OU1	04J882	05/16/2022	OU1-220516-RA-36		<0.400	--	--
OU1	04J882	05/16/2022	OU1-220516-RA-37		<0.400	--	--
OU1	04U821	05/17/2022	OU1-220517-RA-45		15.1	--	--
OU1	04U821	05/17/2022	OU1-220517-RA-46	FD	13.5	--	--
OU1	04U834	05/16/2022	OU1-220516-RA-20		1.23	--	--
OU1	04U834	05/16/2022	OU1-220516-RA-21	FD	0.554	--	--
OU1	04U836	05/17/2022	OU1-220517-RA-29		5.72	--	--
OU1	04U837	05/16/2022	OU1-220516-RA-15		--	--	2.55
OU1	04U838	05/17/2022	OU1-220517-RA-43		0.701	--	--
OU1	04U839	05/17/2022	OU1-220517-RA-32		5.31	--	--
OU1	04U839	05/17/2022	OU1-220517-RA-33	FD	5.05	--	--
OU1	04U841	05/16/2022	OU1-220516-RA-14		4.78	--	--
OU1	04U843	05/17/2022	OU1-220517-RA-51		19.0	--	--
OU1	04U844	05/17/2022	OU1-220517-RA-55		11.8	--	--
OU1	04U844	05/17/2022	OU1-220517-RA-56	FB	<0.400	--	--
OU1	04U846	05/17/2022	OU1-220517-RA-52		--	--	16.5
OU1	04U847	09/22/2022	OU1-220922-RA-01		27.0	--	--
OU1	04U849	05/17/2022	OU1-220517-RA-57		4.17	--	--
OU1	04U850	05/17/2022	OU1-220517-RA-34		8.51	--	--
OU1	04U850	05/17/2022	OU1-220517-RA-35	FD	7.34	--	--
OU1	04U855	05/17/2022	OU1-220517-RA-59		--	2.49	--
OU1	04U871	05/16/2022	OU1-220516-RA-27		7.10	--	--
OU1	04U872	05/16/2022	OU1-220516-RA-25		1.99	--	--
OU1	04U875	05/12/2022	OU1-220512-RA-02		<0.400	--	--
OU1	04U875	05/12/2022	OU1-220512-RA-03	FD	0.204 JP	--	--
OU1	04U877	05/17/2022	OU1-220517-RA-39		2.37	--	--
OU1	04U879	05/17/2022	OU1-220517-RA-42		1.76	--	--
OU1	04U880	05/16/2022	OU1-220516-RA-24		<0.400	--	--
OU1	04U881	05/16/2022	OU1-220516-RA-23		2.01	--	--
OU1	04U882	05/16/2022	OU1-220516-RA-17		1.81	--	--
OU1	04U883	05/16/2022	OU1-220516-RA-18		0.374 JP	--	--
OU1	200154	05/12/2022	OU1-220512-RA-01		0.193 JP	--	--
OU1	234546	05/20/2022	OU1-220520-RA-62		0.762	--	--
OU1	409547	05/16/2022	OU1-220516-RA-08		6.37	--	--
OU1	409557	05/20/2022	OU1-220520-RA-60		3.84	--	--
OU1	409548	05/16/2022	OU1-220516-RA-12		3.25	--	--
OU1	409549	05/17/2022	OU1-220517-RA-40		9.70	--	--
OU1	409549	05/17/2022	OU1-220517-RA-41	FB	<0.400	--	--
OU1	409550	05/17/2022	OU1-220517-RA-54		7.66	--	--
OU1	409555	05/16/2022	OU1-220516-RA-26		0.432	--	--
OU1	409556	05/17/2022	OU1-220517-RA-38		<0.400	--	--
OU1	512761	05/20/2022	OU1-220520-RA-63		0.394 JP	--	--
OU1	PJ#318	05/12/2022	OU1-220512-RA-04		0.304 JP	--	--
OU1	PJ#318	05/12/2022	OU1-220512-RA-05	FB	<0.400	--	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 4

Dissolved Lead Concentrations in Site C Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	Lead (dissolved)
				MDL	0.849
				RL	2.00
					ug/L
Site C	01U046	05/09/2022	SITEC-220509-RA-15		<2.00
Site C	01U561	05/09/2022	SITEC-220509-RA-09		<2.00
Site C	01U561	05/09/2022	SITEC-220509-RA-10	FD	<2.00
Site C	01U562	05/09/2022	SITEC-220509-RA-08		<2.00
Site C	01U563	05/09/2022	SITEC-220509-RA-06		<2.00
Site C	01U564	05/09/2022	SITEC-220509-RA-12		<2.00
Site C	01U564	05/09/2022	SITEC-220509-RA-11	FB	<2.00
Site C	01U567	05/09/2022	SITEC-220509-RA-01		<2.00
Site C	01U567	05/09/2022	SITEC-220509-RA-02	FD	<2.00
Site C	01U571	05/09/2022	SITEC-220509-RA-13		<2.00
Site C	01U573	05/09/2022	SITEC-220509-RA-07		21.6
Site C	01U574	05/09/2022	SITEC-220509-RA-05		<2.00
Site C	01U574	05/09/2022	SITEC-220509-RA-04	FB	<2.00
Site C	01U575	05/09/2022	SITEC-220509-RA-03		9.18
Site C	01U576	05/09/2022	SITEC-220509-RA-14		<2.00
Site C	NE Wetland	05/09/2022	SITEC-220509-RA-17A		<2.00
Site C	NE Wetland	05/10/2022	SITEC-220510-RA-17B		<2.00
Site C	NE Wetland	05/11/2022	SITEC-220511-RA-17C		<2.00
Site C	SW-5	05/09/2022	SITEC-220509-RA-16A		<2.00
Site C	SW-5	05/10/2022	SITEC-220510-RA-16B		<2.00
Site C	SW-5	05/11/2022	SITEC-220511-RA-16C		<2.00
Site C	SW-6	05/09/2022	SITEC-220509-RA-18A		<2.00
Site C	SW-6	05/10/2022	SITEC-220510-RA-18B		<2.00
Site C	SW-6	05/11/2022	SITEC-220511-RA-18C		<2.00

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 5

VOC Concentrations in Site A Well Samples
2022 Annual Sampling Event

Site	Location	Date	Sample ID	Sample Type	1,1-Dichloroethene	1,2-Dichloroethane	Benzene	Chloroform (Trichloromethane)	cis-1,2-Dichloroethene	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
				MDL	0.188	0.0819	0.0941	0.111	0.126	2.52	0.300	0.190
				RL	1.00	1.00	1.00	5.00	1.00	20.0	1.00	1.00
					ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Site A	01U108	05/12/2022	SITEA-220512-RA-26		<1.00	<1.00	<1.00	<5.00	<1.00	--	0.856 JP	<1.00
Site A	01U039	05/12/2022	SITEA-220512-RA-10		<1.00	<1.00	<1.00	<5.00	0.480 JP	--	<1.00	<1.00
Site A	01U039	05/12/2022	SITEA-220512-RA-11	FB	<1.00	<1.00	<1.00	0.821 JP	<1.00	--	<1.00	<1.00
Site A	01U102	05/12/2022	SITEA-220512-RA-29		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U103	05/12/2022	SITEA-220512-RA-27		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U115	05/12/2022	SITEA-220512-RA-19		<1.00	<1.00	<1.00	<5.00	4.50	--	<1.00	1.08
Site A	01U116	05/12/2022	SITEA-220512-RA-30		<1.00	<1.00	<1.00	<5.00	0.793 JP	--	<1.00	0.656 JP
Site A	01U117	05/12/2022	SITEA-220512-RA-24		<1.00	<1.00	<1.00	<5.00	45.3	--	1.95	0.380 JP
Site A	01U126	05/12/2022	SITEA-220512-RA-25		<1.00	<1.00	<1.00	<5.00	0.406 JP	--	7.01	0.737 JP
Site A	01U126	05/12/2022	SITEA-220512-RA-28	FB	<1.00	<1.00	<1.00	0.748 JP	<1.00	--	<1.00	<1.00
Site A	01U138	05/12/2022	SITEA-220512-RA-31		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U139	05/12/2022	SITEA-220512-RA-17		0.696 JP	<1.00	7.36	0.130 JP	--	653	<1.00	0.288 JP
Site A	01U140	05/12/2022	SITEA-220512-RA-15		<1.00	<1.00	0.230 JP	<5.00	3.29	--	<1.00	0.253 JP
Site A	01U157	05/12/2022	SITEA-220512-RA-20		<1.00	<1.00	0.490 JP	<5.00	44.3	--	<1.00	0.658 JP
Site A	01U158	05/12/2022	SITEA-220512-RA-32		<1.00	<1.00	0.517 JP	<5.00	53.0	--	<1.00	0.819 JP
Site A	01U352	05/12/2022	SITEA-220512-RA-22		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U352	05/12/2022	SITEA-220512-RA-23	FD	<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U353	05/12/2022	SITEA-220512-RA-21		<1.00	<1.00	2.15	<5.00	81.0	--	<1.00	<1.00
Site A	01U355	05/12/2022	SITEA-220512-RA-18		<1.00	<1.00	<1.00	<5.00	12.8	--	<1.00	<1.00
Site A	01U356	05/12/2022	SITEA-220512-RA-16		<1.00	<1.00	<1.00	<5.00	20.1	--	<1.00	<1.00
Site A	01U357	05/12/2022	SITEA-220512-RA-14		<1.00	<1.00	0.219 JP	<5.00	3.24	--	<1.00	<1.00
Site A	01U358	05/12/2022	SITEA-220512-RA-12		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U358	05/12/2022	SITEA-220512-RA-13	FD	<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U901	05/11/2022	SITEA-220511-RA-01		<1.00	<1.00	<1.00	<5.00	0.176 JP	--	<1.00	<1.00
Site A	01U902	05/11/2022	SITEA-220511-RA-03		<1.00	<1.00	1.52	<5.00	99.8	--	<1.00	<1.00
Site A	01U902	05/11/2022	SITEA-220511-RA-04	FD	<1.00	<1.00	1.51	<5.00	103	--	<1.00	<1.00
Site A	01U903	05/11/2022	SITEA-220511-RA-06		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U903	05/11/2022	SITEA-220511-RA-05	FB	<1.00	<1.00	<1.00	0.623 JP	0.149 JP	--	<1.00	<1.00
Site A	01U904	05/11/2022	SITEA-220511-RA-02		<1.00	<1.00	<1.00	<5.00	<1.00	--	<1.00	<1.00
Site A	01U905	05/12/2022	SITEA-220512-RA-07		<1.00	<1.00	<1.00	<5.00	0.131 JP	--	<1.00	<1.00
Site A	01U906	05/11/2022	SITEA-220511-RA-08		<1.00	<1.00	<1.00	<5.00	0.242 JP	--	<1.00	<1.00
Site A	01U907	05/12/2022	SITEA-220512-RA-09		<1.00	<1.00	<1.00	<5.00	0.141 JP	--	<1.00	<1.00

Notes:
- MDL - Method Detection Limit
- RL - Reporting Limit
- JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
- < - Not detected at the associated reporting limit.
- FD - Field Duplicate
- FB - Field Blank

Table 6

Dissolved Antimony Concentraions in Site A Well Samples
2022 Annual Sampling Event

					Antimony (dissolved)
				MDL	1.03
				RL	4.00
					ug/L
Site	Location	Date	Sample ID	Sample Type	
Site A	01U103	05/12/2022	SITEA-220512-RA-27		2.18 JP
Site A	01U902	05/11/2022	SITEA-220511-RA-03		<4.00
Site A	01U902	05/11/2022	SITEA-220511-RA-04	FD	<4.00

Notes:
- MDL - Method Detection Limit
- RL - Reporting Limit
- JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
- < - Not detected at the associated reporting limit.
- FD - Field Duplicate

Attachment 1

Data Verification Memo

Technical Memorandum

October 19, 2022

To	Shawn Horn, GHD	**Tel**	+1 651 639 0913
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/mg/15	**Ref. No.**	12561153
Subject	Data Verification OU1 Sampling September 22, 2022 TCAAP Site St. Paul, Minnesota		

The following is a data verification form for samples collected on September 22, 2022, at the TCAAP OU1 Site in St. Paul, Minnesota.

Regards,

Ruth Mickle

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1539082
September 2022 Sampling Event

Criteria	Parameter	batch WG1935118, WG1937562 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	86.5-139	70-130	NA
	4-Bromofluorobenzene	102-110	77-126	NA
	Toluene-d8	91.4-105	80-120	NA

Criteria	Parameter	batch WG1935118 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	101/99.2 (2.19)	70-126	20
	1,1-Dichloroethene	94.6/97.4 (2.92)	71-124	20
	cis-1,2-Dichloroethene	101/100 (0.398)	73-120	20
	1,1,1-Trichloroethane	105/108 (3.01)	73-124	20
	1,1,2-Trichloroethane	94.4/98.2 (3.95)	80-120	20
	Trichloroethene	105/103 (1.15)	78-124	20

Criteria	Parameter	batch WG1937562 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	Trichloroethene	116/103 (12.2)	78-124	20

Table 1

Laboratory Precision and Accuracy Limits
TCAAP Site OU1
SDG ID: L1539082
September 2022 Sampling Event

Criteria	Parameter	batch WG1933179 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	58.0-60.2	10-120	NA

Criteria	Parameter	batch WG1933179 Recoveries (RPD):	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	120/122 (1.81)	73-146	20

Note:
NA - Not Applicable

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP OU1	
SDG #: L1539082	Sample Collection Date(s):9/22/22
Matrix: Water	Sample Analysis Date(s): 9/30/22-10/6/22
Method: VOC SW8260, SW 8270	Date Reviewed:10/18/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	VOC-14 days, SVOC-7/40 days	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	N
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	NA
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – September 2022

Sample ID	**Sample Location**
OU1-220922-RA-01	04U847
OU1-220922-RA-02	04J847
TRIP BLANK	Trip Blank

Item	Comment
11	One surrogate spike recovery in the trip blank was above the upper control limit. Since the associated sample is a non-detect field QC blank, no data qualification was required.

Technical Memorandum

December 23, 2022

To	Arthur Peitsch, EAEST	**Tel**	+1 612-524-6872
Copy to	Shawn Horn, GHD	**Email**	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/50	**Ref. No.**	12563220
Subject	Fourth Quarter DUR FY 2022 OU2 Deep Groundwater (TGRS) Results July - September 2022		

This memo provides the analytical data summary for the fourth quarter FY 2022 sampling conducted at the OU2 Deep Groundwater Site. Tables 1 through 6 provide the treatment system, monitoring well and extraction well sampling results for FY 2022 fourth quarter. The data verification memos are included as Attachment 1.

Regards,

Ruth Mickle
Chemist

Table 1

VOC Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 4th Quarter

				1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Trichloroethene	Trichloroethene
			MDL	**0.149**	**1.49**	**2.98**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**	**1.90**	**3.80**
			RL	**1.00**	**10.0**	**20.0**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**10.0**	**20.0**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
Location	**Sample ID**	**Date**												
03L002	W-220610-EM-49	06/10/2022		0.333 JP	--	--	0.373 JP	0.664 JP	<1.00	0.193 JP	<1.00	11.3	--	--
03L002	W-220610-EM-50	06/10/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L007	W-220608-EM-30	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L014	W-220621-EM-110	06/21/2022		0.321 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.648 JP	--	--
03L017	W-220616-EM-85	06/16/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L018	W-220622-EM-118	06/22/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L020	W-220615-EM-78	06/15/2022		0.256 JP	--	--	0.120 JP	<1.00	<1.00	<1.00	<1.00	5.60	--	--
03L021	W-220615-EM-81	06/15/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.929 JP	--	--
03L077	W-220610-EM-55	06/10/2022		0.843 JP	--	--	0.120 JP	0.629 JP	<1.00	0.149 JP	<1.00	17.6	--	--
03L078	W-220609-EM-40	06/09/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L079	W-220609-EM-37	06/09/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.567 JP	--	--
03L079	W-220609-EM-38	06/09/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L802	W-220608-EM-27	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.02	--	--
03L802	W-220608-EM-26	06/08/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L806	W-220607-EM-18	06/07/2022		0.609 JP	--	--	0.154 JP	0.293 JP	<1.00	0.219 JP	<1.00	20.8	--	--
03L806	W-220607-EM-19	06/07/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03L809	W-220606-EM-04	06/06/2022		2.01	--	--	0.636 JP	1.17	<1.00	0.720 JP	<1.00	85.5	--	--
03L833	W-220607-EM-20	06/07/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.32	--	--
03M002	W-220610-EM-51	06/10/2022		0.512 JP	--	--	1.02	1.12	<1.00	0.469 JP	<1.00	18.7	--	--
03M020	W-220615-EM-74	06/15/2022		1.01	--	--	0.278 JP	<1.00	<1.00	<1.00	<1.00	13.1	--	--
03M020	W-220615-EM-75	06/15/2022	FD	0.874 JP	--	--	0.277 JP	<1.00	<1.00	<1.00	<1.00	12.9	--	--
03M802	W-220608-EM-28	06/08/2022		0.156 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	7.76	--	--
03M806	W-220607-EM-11	06/07/2022		--	<10.0	--	26.0	23.1	0.430 JP	7.53	<1.00	--	295	--
03U002	W-220610-EM-52	06/10/2022		2.22	--	--	0.173 JP	0.603 JP	<1.00	0.698 JP	<1.00	15.7	--	--
03U003	W-220608-EM-34	06/08/2022		12.2	--	--	1.08	2.38	<1.00	3.74	<1.00	60.7	--	--
03U005	W-220615-EM-83	06/15/2022		<1.00	--	--	<1.00	<1.00	<1.00	0.322 JP	<1.00	0.328 JP	--	--
03U007	W-220608-EM-32	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U009	W-220616-EM-89	06/16/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U009	W-220616-EM-90	06/16/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U014	W-220621-EM-112	06/21/2022		18.3 JL129/132	--	--	1.99	1.25	<1.00	1.17	<1.00	59.9	--	--
03U014	W-220621-EM-111	06/21/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U017	W-220616-EM-84	06/16/2022		0.434 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.99	--	--
03U018	W-220622-EM-117	06/22/2022		21.0 JL126/127	--	--	0.139 JP	1.98	<1.00	8.27	<1.00	20.7	--	--
03U020	W-220615-EM-76	06/15/2022		42.1	--	--	4.16	5.93	<1.00	5.40	<1.00	98.6	--	--
03U020	W-220615-EM-77	06/15/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U021	W-220615-EM-82	06/15/2022		5.74	--	--	2.40	2.00	<1.00	3.26	<1.00	58.6	--	--
03U027	W-220614-EM-71	06/14/2022		0.308 JP	--	--	<1.00	0.238 JP	<1.00	0.984 JP	<1.00	10.9	--	--

Table 1

VOC Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 4th Quarter

				1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Trichloroethene	Trichloroethene
			MDL	**0.149**	**1.49**	**2.98**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**	**1.90**	**3.80**
			RL	**1.00**	**10.0**	**20.0**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**10.0**	**20.0**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
03U028	W-220614-EM-72	06/14/2022		<1.00	--	--	<1.00	<1.00	<1.00	0.275 JP	<1.00	8.71	--	--
03U029	W-220615-EM-80	06/15/2022		15.2	--	--	1.16	2.88	<1.00	16.2	<1.00	121	--	--
03U030	W-220614-EM-70	06/14/2022		<1.00	--	--	<1.00	<1.00	<1.00	0.158 JP	<1.00	3.89	--	--
03U032	W-220621-EM-107	06/21/2022		0.655 JL129/132	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.211 JP	--	--
03U032	W-220621-EM-108	06/21/2022	FD	0.644 JL129/132	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U077	W-220610-EM-57	06/10/2022		0.548 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	10.4	--	--
03U078	W-220609-EM-41	06/09/2022		0.972 JP	--	--	<1.00	0.711 JP	<1.00	1.04	10.2	38.4	--	--
03U079	W-220609-EM-35	06/09/2022		6.43	--	--	0.378 JP	1.64	<1.00	1.74	<1.00	51.5	--	--
03U079	W-220609-EM-36	06/09/2022	FD	5.86	--	--	0.360 JP	1.80	<1.00	1.59	<1.00	49.3	--	--
03U092	W-220622-EM-115	06/22/2022		0.592 JL126/127	--	--	<1.00	<1.00	<1.00	0.963 JP	<1.00	9.52	--	--
03U092	W-220622-EM-116	06/22/2022	EB	<1.00	--	--	<1.00	<1.00	<1.00	0.132 JP	<1.00	<1.00	--	--
03U093	W-220622-EM-119	06/22/2022		154 JL126/127	--	--	1.43	9.89	<1.00	13.5	<1.00	182	--	--
03U094	W-220621-EM-109	06/21/2022		--	--	246	6.97	12.9	<1.00	8.73	0.312 JP	--	--	203
03U096	W-220622-EM-120	06/22/2022		6.62	--	--	0.459 JP	1.11	<1.00	<1.00	<1.00	14.2	--	--
03U099	W-220616-EM-86	06/16/2022		0.862 JP	--	--	<1.00	<1.00	<1.00	0.211 JP	<1.00	1.88	--	--
03U114	W-220616-EM-91	06/16/2022		0.804 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	4.48	--	--
03U659	W-220614-EM-73	06/14/2022		8.43	--	--	0.728 JP	1.57	<1.00	8.02	<1.00	100	--	--
03U671	W-220609-EM-43	06/09/2022		1.49	--	--	<1.00	0.673 JP	<1.00	0.645 JP	11.6	34.7	--	--
03U677	W-220608-EM-33	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U701	W-220613-EM-59	06/13/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.749 JP	--	--
03U702	W-220613-EM-61	06/13/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.529 JP	--	--
03U703	W-220609-EM-39	06/09/2022		0.397 JP	--	--	<1.00	<1.00	<1.00	<1.00	2.22	2.84	--	--
03U708	W-220609-EM-46	06/09/2022		1.31	--	--	<1.00	0.387 JP	<1.00	1.88	16.1	35.6	--	--
03U709	W-220610-EM-53	06/10/2022		1.89	--	--	0.407 JP	0.599 JP	<1.00	0.979 JP	<1.00	20.5	--	--
03U710	W-220609-EM-42	06/09/2022		1.46	--	--	<1.00	0.218 JP	<1.00	0.445 JP	<1.00	13.5	--	--
03U711	W-220607-EM-22	06/07/2022		4.12	--	--	0.729 JP	1.30	<1.00	0.561 JP	0.684 JP	27.8	--	--
03U715	W-220622-EM-113	06/22/2022		7.12 JL126/127JFD30	--	--	0.593 JP	0.920 JP	<1.00	0.398 JP	<1.00	28.4	--	--
03U715	W-220622-EM-114	06/22/2022	FD	5.25 JL126/127JFD30	--	--	0.485 JP	0.549 JP	<1.00	0.648 JP	<1.00	22.4	--	--
03U801	W-220608-EM-24	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	0.248 JP	<1.00	13.5	--	--
03U801	W-220608-EM-25	06/08/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	0.254 JP	<1.00	13.8	--	--
03U803	W-220606-EM-05	06/06/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.07	--	--
03U804	W-220606-EM-09	06/06/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U804	W-220606-EM-08	06/06/2022	EB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
03U805	W-220606-EM-06	06/06/2022		0.176 JP	--	--	8.50	9.45	<1.00	5.25	2.26	88.7	--	--
03U805	W-220606-EM-07	06/06/2022	FD	0.182 JP	--	--	8.36	8.87	<1.00	5.37	2.22	84.5	--	--
03U806	W-220607-EM-10	06/07/2022		<1.00	--	--	0.517 JP	0.438 JP	<1.00	0.269 JP	0.609 JP	31.7	--	--
04J077	W-220610-EM-58	06/10/2022		0.356 JP	--	--	0.916 JP	1.02	<1.00	0.420 JP	<1.00	34.4	--	--
04J702	W-220613-EM-65	06/13/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.355 JP	--	--

Table 1

VOC Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 4th Quarter

				1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Trichloroethene	Trichloroethene
			MDL	**0.149**	**1.49**	**2.98**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**	**1.90**	**3.80**
			RL	**1.00**	**10.0**	**20.0**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**10.0**	**20.0**
				ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
04J702	W-220613-EM-64	06/13/2022	FB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04J708	W-220609-EM-44	06/09/2022		0.408 JP	--	--	0.710 JP	0.579 JP	<1.00	0.175 JP	<1.00	6.45	--	--
04J713	W-220614-EM-66	06/14/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04J713	W-220614-EM-67	06/14/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U713	W-220907-EM-01	09/07/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.279 JP	--	--
04U713	W-220907-EM-02	09/07/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.276 JP	--	--
04U002	W-220610-EM-47	06/10/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.909 JP	--	--
04U002	W-220610-EM-48	06/10/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.989 JP	--	--
04U007	W-220608-EM-31	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U020	W-220615-EM-79	06/15/2022		<1.00	--	--	0.119 JP	<1.00	<1.00	<1.00	<1.00	1.64	--	--
04U077	W-220610-EM-56	06/10/2022		0.725 JP	--	--	0.198 JP	0.665 JP	<1.00	0.254 JP	<1.00	18.1	--	--
04U510	W-220616-EM-87	06/16/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U510	W-220616-EM-88	06/16/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U701	W-220613-EM-60	06/13/2022		0.163 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	2.94	--	--
04U702	W-220613-EM-62	06/13/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.02	--	--
04U702	W-220613-EM-63	06/13/2022	FD	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.06	--	--
04U708	W-220609-EM-45	06/09/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U709	W-220610-EM-54	06/10/2022		0.430 JP	--	--	0.324 JP	0.740 JP	<1.00	0.184 JP	<1.00	11.0	--	--
04U711	W-220607-EM-23	06/07/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.208 JP	--	--
04U713	W-220614-EM-69	06/14/2022	EB	<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--	--
04U802	W-220608-EM-29	06/08/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.311 JP	--	--
04U806	W-220607-EM-16	06/07/2022		0.544 JP	--	--	0.180 JP	0.309 JP	<1.00	0.288 JP	<1.00	18.3	--	--
04U806	W-220607-EM-17	06/07/2022	FD	0.511 JP	--	--	0.191 JP	0.286 JP	<1.00	0.273 JP	<1.00	18.2	--	--
04U833	W-220607-EM-21	06/07/2022		<1.00	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.463 JP	--	--
PJ#806	W-220607-EM-12	06/07/2022		0.222 JP	--	--	<1.00	<1.00	<1.00	<1.00	<1.00	9.51	--	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JFD# - Result is qualified as estimated due to outlying field duplicate RPD result. The following numerical value is the associated RPD value.
JL# - Result is qualified as estimated due to outlying percent recovery from lab control sample analyses.
The following numerical value is the associated percent recovery.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FB - Field Blank
EB - Equipment Blank
FD - Field Duplicate

Table 2

VOC Concentrations in TGRS Extraction Well Samples
FY 2022 - Through 4th Quarter

Location	Common Name	Sample ID	Date		1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Trichloroethene
				MDL	**0.149**	**14.9**	**0.100**	**0.188**	**0.0819**	**0.126**	**0.300**	**0.190**	**19.0**
				RL	**1.00**	**100**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**100**
					ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
03F302	B1	W-211210-EM-11	12/10/2021		4.81	--	0.650 JP	0.867 JP	<1.00	4.87	1.96	91.4	--
03F302	B1	W-220617-EM-98	06/17/2022		5.60	--	0.830 JP	1.30	<1.00	6.00	1.57	89.3	--
03F303	B2	W-220617-EM-96	06/17/2022		0.232 JP	--	0.172 JP	0.927 JP	0.416 JP	2.13	0.984 JP	28.1	--
03F304	B3	W-211210-EM-09	12/10/2021		<1.00	--	0.160 JP	0.195 JP	<1.00	0.135 JP	<1.00	2.24	--
03F304	B3	W-220617-EM-99	06/17/2022		<1.00	--	0.193 JP	0.265 JP	<1.00	0.180 JP	<1.00	2.47	--
03F305	B4	W-211210-EM-08	12/10/2021		3.07	--	1.25	1.42	<1.00	1.09	0.558 JP	50.2	--
03F305	B4	W-220617-EM-100	06/17/2022		3.84	--	1.62	1.85	<1.00	1.33	0.473 JP	48.0	--
03F306	B5	W-211210-EM-04	12/10/2021		2.63	--	1.55	1.92	<1.00	0.727 JP	4.02	59.3	--
03F306	B5	W-211210-EM-05	12/10/2021	FD	2.31	--	1.49	1.76	<1.00	0.745 JP	4.24	62.4	--
03F306	B5	W-220617-EM-102	06/17/2022		2.83	--	1.93	2.36	<1.00	0.892 JP	3.75	59.8	--
03F306	B5	W-220617-EM-103	06/17/2022	FD	2.71	--	1.91	2.14	<1.00	0.947 JP	3.34	59.5	--
03F307	B6	W-211210-EM-01	12/10/2021		0.478 JP	--	0.203 JP	0.356 JP	<1.00	0.165 JP	<1.00	21.4	--
03F307	B6	W-220617-EM-105	06/17/2022		0.497 JP	--	0.258 JP	0.420 JP	<1.00	0.227 JP	<1.00	23.8	--
03F307	B6	W-220617-EM-104	06/17/2022	FB	<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--
03F308	B7	W-220617-EM-93	06/17/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	1.65	--
PJ#309	B8	W-211210-EM-07	12/10/2021		0.246 JP	--	0.195 JP	0.290 JP	<1.00	0.132 JP	<1.00	4.66	--
PJ#309	B8	W-211210-EM-06	12/10/2021	FB	<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--
PJ#309	B8	W-220617-EM-101	06/17/2022		0.260 JP	--	0.240 JP	0.319 JP	<1.00	<1.00	<1.00	5.15	--
PJ#310	B9	W-211210-EM-02	12/10/2021		0.745 JP	--	0.849 JP	1.13	<1.00	0.321 JP	<1.00	19.4	--
PJ#310	B9	W-211210-EM-03	12/10/2021	FB	<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--
PJ#310	B9	W-220617-EM-106	06/17/2022		0.816 JP	--	0.986 JP	1.21	<1.00	0.419 JP	<1.00	18.8	--
PJ#311	B10	W-220617-EM-94	06/17/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.218 JP	--
03F312	B11	W-220617-EM-95	06/17/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	2.98	--
PJ#313	B12	W-220617-EM-92	06/17/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	--
03F319	B13	W-211210-EM-10	12/10/2021		4.91	--	1.79	1.37	<1.00	9.68	0.452 JP	114	--
03F319	B13	W-220617-EM-97	06/17/2022		3.73	--	1.84	1.12	<1.00	8.07	<1.00	76.7	--
03U315	SC3	W-220603-RC-02	06/03/2022		<1.00	--	<1.00	<1.00	<1.00	<1.00	<1.00	0.409 JP	--
03U316	SC4	W-220603-RC-01	06/03/2022		0.357 JP	--	<1.00	<1.00	<1.00	<1.00	<1.00	3.16	--
03U317	SC5	W-220603-RC-03	06/03/2022		--	593	19.5	42.3	1.46	7.32	5.14	--	2270

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 3

VOC Concentrations in TGRS Treatment System Samples
FY 2022 - Through 4th Quarter

				1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
			MDL	0.149	0.100	0.188	0.0819	0.126	0.300	0.190
			RL	1.00	1.00	1.00	1.00	1.00	1.00	1.00
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Location	Sample ID	Date								
TGRSE	W-211008-EM-01	10/08/2021		0.236 JP	<1.00	<1.00	<1.00	<1.00	<1.00	2.07 JL141JD25
TGRSE	W-211115-EM-01	11/15/2021		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.376 JP
TGRSE	W-211115-EM-02	11/15/2021	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.360 JP
TGRSE	W-211210-EM-12	12/10/2021		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.476 JP
TGRSE	W-211210-EM-13	12/10/2021	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.460 JP
TGRSE	W-220114-EM-01	01/14/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.364 JP
TGRSE	W-220114-EM-02	01/14/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.435 JP
TGRSE	W-220207-EM-01	02/07/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.673 JP
TGRSE	W-220304-EM-01	03/04/2022		0.157 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.02
TGRSE	W-220304-EM-02	03/04/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.01
TGRSE	W220406-EM-01	04/06/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.19
TGRSE	W220406-EM-02	04/06/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.19
TGRSE	W-220502-EM-01	05/02/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.16
TGRSE	W-220502-EM-02	05/02/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.20
TGRSE	W-220606-EM-13	06/06/2022		0.150 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.06
TGRSE	W-220708-EM-01	07/08/2022		0.162 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.38
TGRSE	W-220708-EM-02	07/08/2022	FD	0.175 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.36
TGRSE	W-220811-EM-01	08/11/2022		0.170 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.27
TGRSE	W-220811-EM-02	08/11/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.23
TGRSE	W-220912-EM-01	09/12/2022		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.335 JP
TGRSE	W-220912-EM-02	09/12/2022	FD	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.378 JP
TGRSI	W-211008-EM-02	10/08/2021		31.4	1.66	2.52	<1.00	2.56	1.20	176 JL141JD25
TGRSI	W-211008-EM-03	10/08/2021	FD	36.7	1.91	2.97	<1.00	2.85	1.29	201 JL141JD25
TGRSI	W-211115-EM-03	11/15/2021		1.38	0.899 JP	0.714 JP	<1.00	1.31	0.956 JP	33.4
TGRSI	W-211210-EM-14	12/10/2021		1.97	0.857 JP	0.943 JP	<1.00	1.34	1.35	41.8
TGRSI	W-220114-EM-03	01/14/2022		2.07	0.756 JP	1.18	<1.00	1.26	0.812 JP	42.1
TGRSI	W-220207-EM-02	02/07/2022		9.56	2.05	1.93	<1.00	1.29	1.06	74.2
TGRSI	W-220207-EM-03	02/07/2022	FD	9.71	2.01	1.73	<1.00	1.31	1.04	75.1
TGRSI	W-220304-EM-03	03/04/2022		23.5	1.97	2.11	<1.00	1.44	1.24 JD21.3	110
TGRSI	W220406-EM-03	04/06/2022		26.5	1.79	2.38	<1.00	1.39	1.42 JC24.1	139
TGRSI	W-220502-EM-03	05/02/2022		27.7	1.79	2.54	<1.00	1.01	1.01	127
TGRSI	W-220606-EM-14	06/06/2022		36.7	1.58	3.56	<1.00	1.50	1.16	148
TGRSI	W-220606-EM-15	06/06/2022	FD	35.0	1.52	3.85	<1.00	1.59	1.17	146
TGRSI	W-220708-EM-03	07/08/2022		34.6	1.76	2.75	<1.00	1.56	1.33	169
TGRSI	W-220811-EM-03	08/11/2022		35.6	1.82	2.83	0.118 JP	1.71	1.12	157
TGRSI	W-220912-EM-03	09/12/2022		1.93	0.999 JP	1.10	<1.00	1.43	2.14	42.4

Table 3

VOC Concentrations in TGRS Treatment System Samples
FY 2022 - Through 4th Quarter

				1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
			MDL	0.149	0.100	0.188	0.0819	0.126	0.300	0.190
			RL	1.00	1.00	1.00	1.00	1.00	1.00	1.00
				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JC# - Result is qualified as estimated due to outlying continuing calibration result. The following numerical value is the associated % D value.
JD# - Result is qualified as estimated due to outlying relative percent difference from matrix spike analyses.
The following numerical value is the associated relative percent difference.
JL# - Result is qualified as estimated due to outlying percent recovery from lab control sample analyses.
The following numerical value is the associated percent recovery.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
< - Not detected at the associated reporting limit.
FD - Field Duplicate

Table 4

1,4-Dioxane Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 4th Quarter

				1,4-Dioxane	1,4-Dioxane	1,4-Dioxane
			MDL	**0.0447**	**0.0447**	**0.0447**
			RL	**0.400**	**0.437**	**0.517**
				ug/L	**ug/L**	**ug/L**
Location	**Sample ID**	**Date**				
03L002	W-220610-EM-49	06/10/2022		16.2	--	--
03L002	W-220610-EM-50	06/10/2022	FB	<0.400	--	--
03L007	W-220608-EM-30	06/08/2022		<0.400 UB0.0968	--	--
03L014	W-220621-EM-110	06/21/2022		5.40	--	--
03L017	W-220616-EM-85	06/16/2022		17.3	--	--
03L018	W-220622-EM-118	06/22/2022		11.2	--	--
03L020	W-220615-EM-78	06/15/2022		12.8	--	--
03L021	W-220615-EM-81	06/15/2022		7.91	--	--
03L077	W-220610-EM-55	06/10/2022		19.3	--	--
03L078	W-220609-EM-40	06/09/2022		2.50	--	--
03L079	W-220609-EM-37	06/09/2022		1.14	--	--
03L079	W-220609-EM-38	06/09/2022	FB	0.0848 JP	--	--
03L802	W-220608-EM-27	06/08/2022		0.571	--	--
03L802	W-220608-EM-26	06/08/2022	FB	0.0968 JP	--	--
03L806	W-220607-EM-18	06/07/2022		19.3	--	--
03L806	W-220607-EM-19	06/07/2022	FB	0.265 JP	--	--
03L809	W-220606-EM-04	06/06/2022		18.1	--	--
03L833	W-220607-EM-20	06/07/2022		19.1	--	--
03M002	W-220610-EM-51	06/10/2022		16.4	--	--
03M020	W-220615-EM-74	06/15/2022		14.5	--	--
03M020	W-220615-EM-75	06/15/2022	FD	13.2	--	--
03M802	W-220608-EM-28	06/08/2022		<0.400 UB0.0968	--	--
03M806	W-220607-EM-11	06/07/2022		21.4	--	--
03U002	W-220610-EM-52	06/10/2022		3.57	--	--
03U003	W-220608-EM-34	06/08/2022		0.550	--	--
03U005	W-220615-EM-83	06/15/2022		<0.400 UB0.0776	--	--
03U007	W-220608-EM-32	06/08/2022		<0.400 UB0.0968	--	--
03U009	W-220616-EM-89	06/16/2022		<0.400 UB0.130	--	--
03U009	W-220616-EM-90	06/16/2022	FB	0.130 JP	--	--
03U014	W-220621-EM-112	06/21/2022		29.9	--	--
03U014	W-220621-EM-111	06/21/2022	FB	<0.400	--	--
03U017	W-220616-EM-84	06/16/2022		17.2	--	--
03U018	W-220622-EM-117	06/22/2022		0.155 JP	--	--
03U020	W-220615-EM-76	06/15/2022		31.0	--	--
03U020	W-220615-EM-77	06/15/2022	FB	0.106 JP	--	--
03U021	W-220615-EM-82	06/15/2022		38.6	--	--
03U027	W-220614-EM-71	06/14/2022		1.25	--	--
03U028	W-220614-EM-72	06/14/2022		0.458	--	--
03U029	W-220615-EM-80	06/15/2022		2.07	--	--
03U030	W-220614-EM-70	06/14/2022		<0.400 UB0.0776	--	--
03U032	W-220621-EM-107	06/21/2022		0.478	--	--
03U032	W-220621-EM-108	06/21/2022	FD	0.660	--	--
03U077	W-220610-EM-57	06/10/2022		9.99	--	--
03U078	W-220609-EM-41	06/09/2022		<0.400 UB0.101	--	--
03U079	W-220609-EM-35	06/09/2022		<0.400 UB0.101	--	--
03U079	W-220609-EM-36	06/09/2022	FD	--	--	<0.517 UB0.101
03U092	W-220622-EM-115	06/22/2022		5.74	--	--
03U092	W-220622-EM-116	06/22/2022	EB	0.0505 JP	--	--
03U093	W-220622-EM-119	06/22/2022		1.81	--	--
03U094	W-220621-EM-109	06/21/2022		41.1	--	--
03U096	W-220622-EM-120	06/22/2022		2.64	--	--
03U099	W-220616-EM-86	06/16/2022		<0.400 UB0.130	--	--
03U114	W-220616-EM-91	06/16/2022		<0.400 UB0.130	--	--
03U659	W-220614-EM-73	06/14/2022		2.35	--	--
03U671	W-220609-EM-43	06/09/2022		<0.400 UB0.101	--	--
03U677	W-220608-EM-33	06/08/2022		0.579	--	--

Table 4

1,4-Dioxane Concentrations in TGRS Monitoring Well Samples
FY 2022 - Through 4th Quarter

				1,4-Dioxane	1,4-Dioxane	1,4-Dioxane
			MDL	**0.0447**	**0.0447**	**0.0447**
			RL	**0.400**	**0.437**	**0.517**
				ug/L	**ug/L**	**ug/L**
03U701	W-220613-EM-59	06/13/2022		10.8	--	--
03U702	W-220613-EM-61	06/13/2022		9.37	--	--
03U703	W-220609-EM-39	06/09/2022		0.739	--	--
03U708	W-220609-EM-46	06/09/2022		<0.400 UB0.101	--	--
03U709	W-220610-EM-53	06/10/2022		11.6	--	--
03U710	W-220609-EM-42	06/09/2022		0.548	--	--
03U711	W-220607-EM-22	06/07/2022		3.58	--	--
03U715	W-220622-EM-113	06/22/2022		6.42 JFD56	--	--
03U715	W-220622-EM-114	06/22/2022	FD	3.60 JFD56	--	--
03U801	W-220608-EM-24	06/08/2022		0.528	--	--
03U801	W-220608-EM-25	06/08/2022	FD	0.505	--	--
03U803	W-220606-EM-05	06/06/2022		--	<0.437 UB0.122	--
03U804	W-220606-EM-09	06/06/2022		<0.400 UB0.122	--	--
03U804	W-220606-EM-08	06/06/2022	EB	0.137 JP	--	--
03U805	W-220606-EM-06	06/06/2022		4.82	--	--
03U805	W-220606-EM-07	06/06/2022	FD	4.87	--	--
03U806	W-220607-EM-10	06/07/2022		12.3	--	--
04J077	W-220610-EM-58	06/10/2022		22.5	--	--
04J702	W-220613-EM-65	06/13/2022		15.2	--	--
04J702	W-220613-EM-64	06/13/2022	FB	<0.400	--	--
04J708	W-220609-EM-44	06/09/2022		11.2	--	--
04J713	W-220614-EM-66	06/14/2022		11.9	--	--
04J713	W-220614-EM-67	06/14/2022	FD	12.0	--	--
04U713	W-220907-EM-01	09/07/2022		15.1	--	--
04U713	W-220907-EM-02	09/07/2022	FD	15.6	--	--
04U002	W-220610-EM-47	06/10/2022		16.2	--	--
04U002	W-220610-EM-48	06/10/2022	FD	16.5	--	--
04U007	W-220608-EM-31	06/08/2022		<0.400 UB0.0968	--	--
04U020	W-220615-EM-79	06/15/2022		12.3	--	--
04U077	W-220610-EM-56	06/10/2022		20.1	--	--
04U510	W-220616-EM-87	06/16/2022		<0.400 UB0.130	--	--
04U510	W-220616-EM-88	06/16/2022	FD	<0.400 UB0.130	--	--
04U701	W-220613-EM-60	06/13/2022		15.7	--	--
04U702	W-220613-EM-62	06/13/2022		14.2	--	--
04U702	W-220613-EM-63	06/13/2022	FD	14.7	--	--
04U708	W-220609-EM-45	06/09/2022		7.26	--	--
04U709	W-220610-EM-54	06/10/2022		17.9	--	--
04U711	W-220607-EM-23	06/07/2022		6.06	--	--
04U713	W-220614-EM-69	06/14/2022		0.0976 JP	--	--
04U802	W-220608-EM-29	06/08/2022		0.600	--	--
04U806	W-220607-EM-16	06/07/2022		19.8	--	--
04U806	W-220607-EM-17	06/07/2022	FD	18.9	--	--
04U833	W-220607-EM-21	06/07/2022		19.9	--	--
PJ#806	W-220607-EM-12	06/07/2022		20.5	--	--

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JFD# - Result is qualified as estimated due to outlying field duplicate RPD result. The following numerical value is the associated RPD value.
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.
< - Not detected at the associated reporting limit.
EB - Equipment Blank
FD - Field Duplicate
FB - Field Blank

Table 5

1,4-Dioxane Concentrations in TGRS Extraction Well Samples
FY 2022 - Through 4th Quarter

					1,4-Dioxane
				MDL	0.0447
				RL	0.400
					ug/L
Location	**Common Name**	**Sample ID**	**Date**		
B1-03F302	B1	W-220617-EM-98	06/17/2022		3.70
B2-03F303	B2	W-220617-EM-96	06/17/2022		<0.400 UB0.0857
B3-03F304	B3	W-220617-EM-99	06/17/2022		5.98
B4-03F305	B4	W-220617-EM-100	06/17/2022		21.1
B5-03F306	B5	W-220617-EM-102	06/17/2022		16.7
B5-03F306	B5	W-220617-EM-103	06/17/2022	FD	16.4
B6-03F307	B6	W-220617-EM-105	06/17/2022		15.3
B6-03F307	B6	W-220617-EM-104	06/17/2022	FB	0.204 JP
B7-03F308	B7	W-220617-EM-93	06/17/2022		19.0 JP
B8-PJ#309	B8	W-220617-EM-101	06/17/2022		13.6
B9-PJ#310	B9	W-220617-EM-106	06/17/2022		23.4
B10-PJ#311	B10	W-220617-EM-94	06/17/2022		16.3
B11-03F312	B11	W-220617-EM-95	06/17/2022		1.11
B12-PJ#313	B12	W-220617-EM-92	06/17/2022		14.3
B13-03F319	B13	W-220617-EM-97	06/17/2022		10.6
SC3-03U315	SC3	W-220603-RC-02	06/03/2022		11.9
SC4-03U316	SC4	W-220603-RC-01	06/03/2022		12.2
SC5-03U317	SC5	W-220603-RC-03	06/03/2022		11.4

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
JP - Value is estimated; result is less than the reporting limit but greater than the method detection limit.
UB# - Result is qualified as non-detect based on a associated blank detection. The following numerical value is the blank concentration.
< - Not detected at the associated reporting limit.
FD - Field Duplicate
FB - Field Blank

Table 6

1,4-Dioxane Concentrations in TGRS Treatment System Samples
FY 2022 - Through 4th Quarter

				1,4-Dioxane
			MDL	0.0447
			RL	0.400
				ug/L
Location	Sample ID	Date		
TGRSE	W-220606-EM-13	06/06/2022		10.9
TGRSI	W-220606-EM-14	06/06/2022		10.0
TGRSI	W-220606-EM-15	06/06/2022	FD	9.82

Notes:

MDL - Method Detection Limit
RL - Reporting Limit
FD - Field Duplicate

Attachment 1

Data Verification Memos

Technical Memorandum

September 26, 2022

To	Shawn Horn, GHD	**Contact No.**	+1 612 524-6872
		Email	ruth.mickle@ghd.com
From	Ruth Mickle/kg/42	**Project No.**	12563220-32
Subject	Data Verification TCAAP TGRS Sampling July 8, 2022 TCAAP Site, Arden Hills, Minnesota		

The following is a data verification form for samples collected on July 8, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1513424	Sample Collection Date(s):7/8/22
Matrix: Water	Sample Analysis Date(s): 7/15/22
Method: SW 8260	Date Reviewed:9/22/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	14 day-VOC	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – July 2022

Sample ID	Sample Location
W-220708-EM-01	TGRSE
W-220708-EM-02	TGRSE duplicate
W-220708-EM-03	TGRSI

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
July 2022 Sampling Event

Criteria	Parameter	Pace #L1513424-batch WG1895528	% Recovery Limits	RPD Limits
		Recovery range:		
Surrogate				
VOC	1,2-Dichloroethane-d4	99.9-108	70-130	NA
	4-Bromofluorobenzene	102-112	77-126	NA
	Toluene-d8	114-118	80-120	NA

Criteria	Parameter	batch WG1895528 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	108/110 (1.47)	70-126	20
	1,2-Dichloroethane	105/110 (4.46)	70-128	20
	1,1-Dichloroethene	113/112 (0.712)	71-124	20
	cis-1,2-Dichloroethene	113/116 (2.97)	73-120	20
	Tetrachloroethene	115/116 (0.691)	72-132	20
	1,1,1-Trichloroethane	112/112 (0.178)	73-124	20
	Trichloroethene	119/123 (3.80)	78-124	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1513424
July 2022 Sampling Event

VOC Parameter	W-220708-EM-01 TGRSE (ug/l)	W-220708-EM-02 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	1.38	1.36	0.02	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1513424
July 2022 Sampling Event

VOC Parameter	W-220708-EM-01 TGRSE (ug/l)	W-220708-EM-02 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	1.38	1.36	0.02	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds

GHD Digital

Technical Memorandum

September 26, 2022

To	Shawn Horn, GHD	**Contact No.**	+1 612 524-6872
		Email	Ruth.mickle@ghd.com
From	Ruth Mickle/kg/43	**Project No.**	12563220-32
Subject	Data Verification TCAAP TGRS Sampling August 11, 2022 TCAAP Site, Arden Hills Minnesota		

The following is a data verification form for samples collected on August 11, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1525051	Sample Collection Date(s):8/11/22
Matrix: Water	Sample Analysis Date(s): 8/19/22
Method: SW 8260	Date Reviewed:9/23/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	14 day-VOC	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – August 2022

Sample ID	**Sample Location**
W-220811-EM-01	TGRSE
W-220811-EM-02	TGRSE duplicate
W-220811-EM-03	TGRSI

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
August 2022 Sampling Event

Criteria	Parameter	Pace #L1525051-batch WG1913285	% Recovery Limits	RPD Limits
		Recovery range:		
Surrogate				
VOC	1,2-Dichloroethane-d4	110-112	70-130	NA
	4-Bromofluorobenzene	99.2-101	77-126	NA
	Toluene-d8	98.3-99.8	80-120	NA
Criteria	**Parameter**	**batch WG WG1913285 Recoveries:**	**% Recovery Limits**	**RPD Limits**
LCS/LCSD				
VOC	1,1-Dichloroethane	112/110 (1.26)	70-126	20
	1,2-Dichloroethane	115/114 (1.57)	70-128	20
	1,1-Dichloroethene	114/113 (0.881)	71-124	20
	cis-1,2-Dichloroethene	107/105 (1.89)	73-120	20
	Tetrachloroethene	103/99.0 (3.96)	72-132	20
	1,1,1-Trichloroethane	120/122 (1.32)	73-124	20
	Trichloroethene	115/114 (1.57)	78-124	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1525051
August 2022 Sampling Event

VOC Parameter	W-220811-EM-01 TGRSE (ug/l)	W-220811-EM-02 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethane	0.170 J	1.0U	0.83	1
Trichloroethene	1.27	1.23	0.04	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds
J - Estimated result
U - Non-detect result

GHD Digital

Technical Memorandum

September 27, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/44	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS - Well 04U713 Sampling** **September 7, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on September 7, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
September 2022 Sampling Event

Criteria	Parameter	Pace #L1533743-batch WG1924432	% Recovery Limits	RPD Limits
		Recovery range:		
Surrogate				
VOC	1,2-Dichloroethane-d4	113-115	70-130	NA
	4-Bromofluorobenzene	111-117	77-126	NA
	Toluene-d8	119-121	80-120	NA

Criteria	Parameter	batch WG WG1924432 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	113/121 (7.18)	70-126	20
	1,2-Dichloroethane	105/111 (5.19)	70-128	20
	1,1-Dichloroethene	119/129 (7.42)	71-124	20
	cis-1,2-Dichloroethene	111/116 (4.59)	73-120	20
	Tetrachloroethene	109/104 (4.49)	72-132	20
	1,1,1-Trichloroethane	116/121 (4.73)	73-124	20
	Trichloroethene	107/120 (10.7)	78-124	20

Criteria	Parameter	Pace #L1533743-batch WG1924618 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
SVOC	Nitrobenzene-d5	79.7-80.2	10-120	NA

Criteria	Parameter	WG1924618 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
SVOC	1,4-Dioxane	113/116 (2.62)	73-146	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1533743
September 2022 Sampling Event

VOC Parameter	W-220907-EM-01 04U713 (ug/l)	W-220907-EM-02 04U713 duplicate (ug/l)	RPD/ Difference	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	0.279 J	0.276 J	0.003	1
SVOC Parameter				
1,4-Dioxane	15.1	15.6	3.3	25

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
SVOC - Semi-Volatile Organic Compounds
VOC - Volatile Organic Compounds
J - Estimated result

ANALYTICAL DATAVERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1533743	Sample Collection Date(s): 9/7/22
Matrix: Water	Sample Analysis Date(s): 9/11/22 & 9/12/22
Method: SW 8260 & 8270	Date Reviewed: 9/26/22
Laboratory: Pace, TN	Reviewed By: Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	14 day-VOC; 7/40 day SVOC	---	---	Y
3	Calibration met method req’ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	N
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req’d samples collected?	---	---	---	Y
15	All req’d analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

Required Attachments: LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – September 2022

Sample ID	**Sample Location**
W-220907-EM-01	04U713
W-220907-EM-02	04U713 duplicate

Item	Comment
6	One of two LCS/LCSD spike recoveries for 1,1-dichloroethene from batch WG1924432 was above the upper control limit. Since the associated sample results were non-detect, no data qualification was necessary.

Technical Memorandum

September 28, 2022

To	Shawn Horn, GHD	**Tel**	612-524-6872
		Email	Ruth.Mickle@ghd.com
From	Ruth Mickle/lg/45	**Ref. No.**	12563220-32
Subject	**Data Verification** **TCAAP TGRS Sampling** **September 12, 2022** **TCAAP Site, Arden Hills, Minnesota**		

The following is a data verification form for samples collected on September 12, 2022, at the TCAAP TGRS Site in Arden Hills, Minnesota.

Regards,

Ruth Mickle
Chemist

Encl.

Table 1

Laboratory Precision and Accuracy Limits
TGRS - TCAAP Site
September 2022 Sampling Event

Criteria	Parameter	Pace #L1535270-batch WG1927328, batch WG1929263,WG1929397 Recovery range:	% Recovery Limits	RPD Limits
Surrogate				
VOC	1,2-Dichloroethane-d4	91.3-110	70-130	NA
	4-Bromofluorobenzene	90.6-95.5	77-126	NA
	Toluene-d8	110-115	80-120	NA

Criteria	Parameter	batch WG WG1927328 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	98.4/96.0 (2.47)	70-126	20
	1,2-Dichloroethane	93.6/91.6 (2.16)	70-128	20
	1,1-Dichloroethene	94.6/86.2 (9.29)	71-124	20
	cis-1,2-Dichloroethene	98.0/94.8 (3.32)	73-120	20
	Tetrachloroethene	100/99.6 (0.401)	72-132	20
	1,1,1-Trichloroethane	94.6/96.0 (0.416)	73-124	20
	Trichloroethene	102/102 (0.0)	78-124	20

Criteria	Parameter	batch WG1929263 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	1,1-Dichloroethane	95.2/98.2 (3.10)	70-126	20
	1,2-Dichloroethane	93.4/98.8 (5.62)	70-128	20
	1,1-Dichloroethene	84.0/89.6 (6.45)	71-124	20
	cis-1,2-Dichloroethene	92.8/97.6 (5.04)	73-120	20
	Tetrachloroethene	96.0/96.6 (0.623)	72-132	20
	1,1,1-Trichloroethane	89.6/95.2 (6.06)	73-124	20
	Trichloroethene	90.8/97.8 (7.42)	78-124	20

Criteria	Parameter	batch WG1929397 Recoveries:	% Recovery Limits	RPD Limits
LCS/LCSD				
VOC	Tetrachloroethene	110/113 (2.87)	72-132	20

Notes:
RPD - Relative Percent Difference
NA - Not applicable
VOC - Volatile Organic Compounds

Table 2

Field Duplicate Summary
TGRS-TCAAP Site
SDG ID: L1535270
Sepetmber 2022 Sampling Event

VOC Parameter	W-220912-EM-01 TGRSE (ug/l)	W-220912-EM-02 TGRSE duplicate (ug/l)	RPD/ Difference RPD	Difference Limit (+/-RL) or RPD Limit
Trichloroethene	0.335 J	0.378 J	0.043	1

Notes:
RL - Reporting Limit
RPD - Relative Percent Difference
VOC - Volatile Organic Compounds
J - Estimated result

ANALYTICAL DATA VERIFICATION FORM

Site/Event: TCAAP TGRS	
SDG #: L1535270	Sample Collection Date(s): 9/12/22
Matrix: Water	Sample Analysis Date(s): 9/16/22-9/21/22
Method: SW 8260	Date Reviewed: 9/27/22
Laboratory: Pace, TN	Reviewed By:Ruth Mickle

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
1	Samples properly preserved?	---	---	---	Y
2	Holding Time(2)	14 day-VOC	---	---	Y
3	Calibration met method req'ts?	---	---	---	Y
4	Method Blank free of detections?	---	---	---	Y
5	Trip Blank free of detections?	---	(Not Applicable)	(Not Applicable)	Y
6	Laboratory Control Spike (LCS)	Current Lab limits	80 to 120%	80 to 120%	Y
7	MS/MSD Recoveries(3)	Current Lab limits	75 to 125%	75 to 125%	NA
8	MS/MSD Precision(3)	Current Lab Limits	< 20% RPD	< 20% RPD	NA
9	Lab Duplicate Precision(3)	(Not Applicable)	< 20% RPD(4)	< 20% RPD(4)	NA
10	Serial Dilution(3)	(Not Applicable)	< 10% D	(Not Applicable)	NA
11	Surrogate Recovery	Current Lab limits	(Not Applicable)	(Not Applicable)	Y
12	Field Duplicate Precision	< 25% RPD(4)	< 25% RPD(4)	< 25% RPD(4)	Y
13	Rinse Blanks free of detections?	---	---	---	NA
14	All req'd samples collected?	---	---	---	Y
15	All req'd analyses performed?	---	---	---	Y

Item No.	Parameter/Question	Control Limits for Organics	Control Limits for Metals (6020/7470)	Control Limits for General Chemistry	Control Limits Met (yes/no)?(1)
16	All req'd analytes reported?	---	---	---	Y
17	All req'd reporting limits met?	---	---	---	Y
18	Is data usable for the intended purpose?	---	---	---	Y

(1) If the control limits were not met for any parameters, list the item number(s) below and provide additional explanation.
(2) List the applicable holding time under the control limits column.
(3) Applicable only if performed on an environmental sample from this Site.
(4) If the sample and/or duplicate result is < 5 x RL, then the control limit is +/- RL. (+/- 2 RL for 1,4-dioxane).

<u>*Required Attachments:*</u> LCS, MS/MSD, and Surrogate Recovery results; field duplicate results table (RPDs); and data tables with sample results and any data qualifiers applied.

Cross Reference – September 2022

Sample ID	**Sample Location**
W-220912-EM-01	TGRSE
W-220912-EM-02	TGRSE duplicate
W-220912-EM-03	TGRSI

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Appendix D

Comprehensive Groundwater Quality and Groundwater Level Database

Appendix D.1

Comprehensive Groundwater Quality And Groundwater Level Databases

COMPREHENSIVE GROUNDWATER QUALITY AND GROUNDWATER LEVEL DATABASES

The historical groundwater databases are located on this CD in a folder named Appendix D.1.

This folder contains four Microsoft Excel files:

Compelev_FY22 Groundwater elevations

Comporwq_FY22 Groundwater quality: organic data

Compinwq_FY22 Groundwater quality: inorganic data (excluding Site C)

Site C wq_FY22 Groundwater quality: inorganic data (Site C only)

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Appendix D.2

Operable Unit 1 Statistical Analysis

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Appendix D.2.1

Well Group And Statistical Evaluation Criteria Tables

STATISTICAL EVALUATIONS – WELL GROUPS

GROUP 1 – DOWNGRADIENT OF TGRS

03U806	04U806	03L802	03U801
03M806	PJ#806	04U802	03U711
03L806	03M802	PJ#802[1]	04U711

GROUP 2 – AREAL EXTENT OF PLUME

03U805	409557	04U841	04U875
03U672 abandoned	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 [2] – 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
04U027 abandoned	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 abandoned	409597 abandoned	03U831 abandoned

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	---

(1) PJ#802 will not be monitored or used for evaluation unless 04U802 shows tricholoroethylene TCE concentrations greater than 1 part per billion.

(2) Group 3 is analyzed as a rectangular area taken from the Group 5 contouring.

Appendix D.2.2

Groups 1, 2, 3, 5, and 6 Mann-Kendall Evaluations

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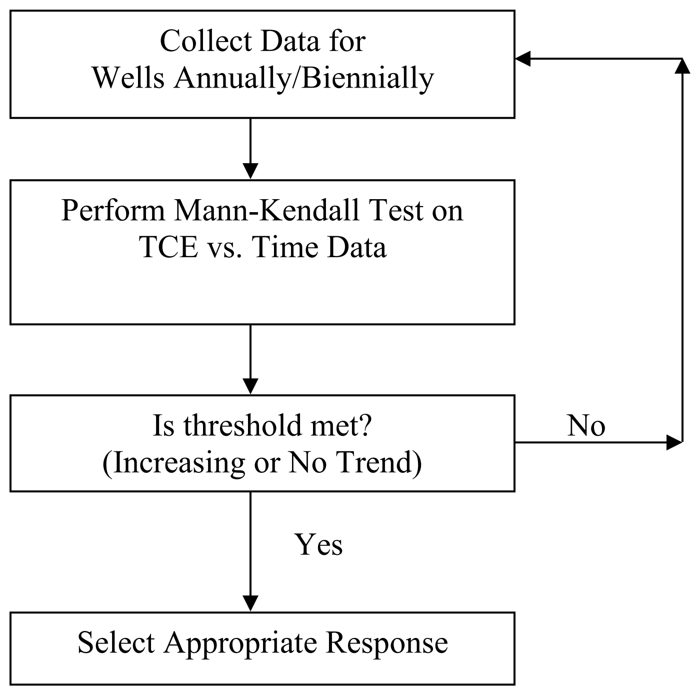
EVALUATION PROCESS



Appendix D.2.3

Group 6 New Brighton Municipal Well Regression Analysis

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RESPONSES TO THRESHOLD INDICATORS

Factors to Consider

- Contaminant concentrations
- Location (vertical and horizontal)
- Surrounding data
- Risks to human health or the environment
- Need for urgency in response

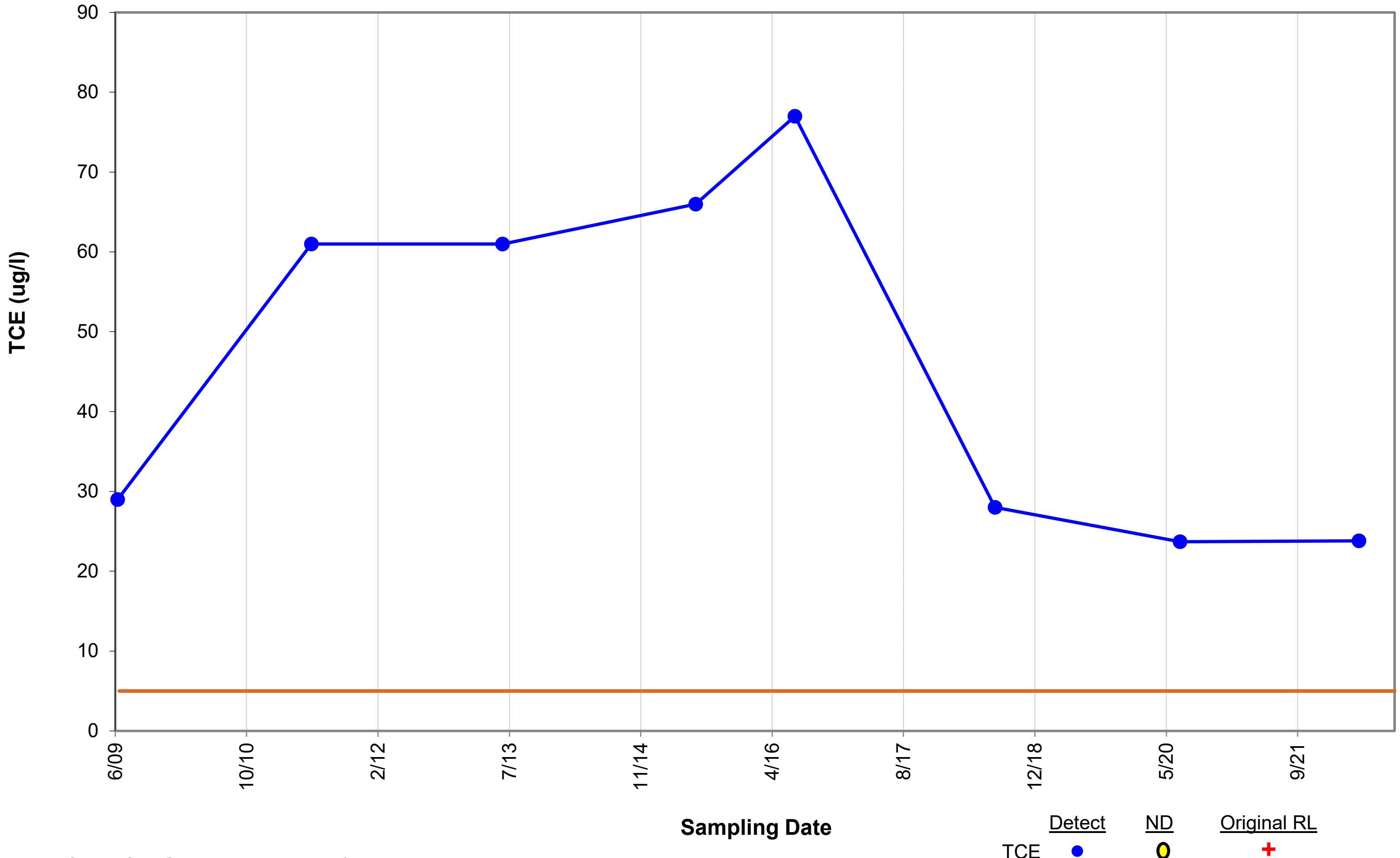
Possible Evaluation Responses

- 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.



TCAAP Site Standard Value 5 ug/l

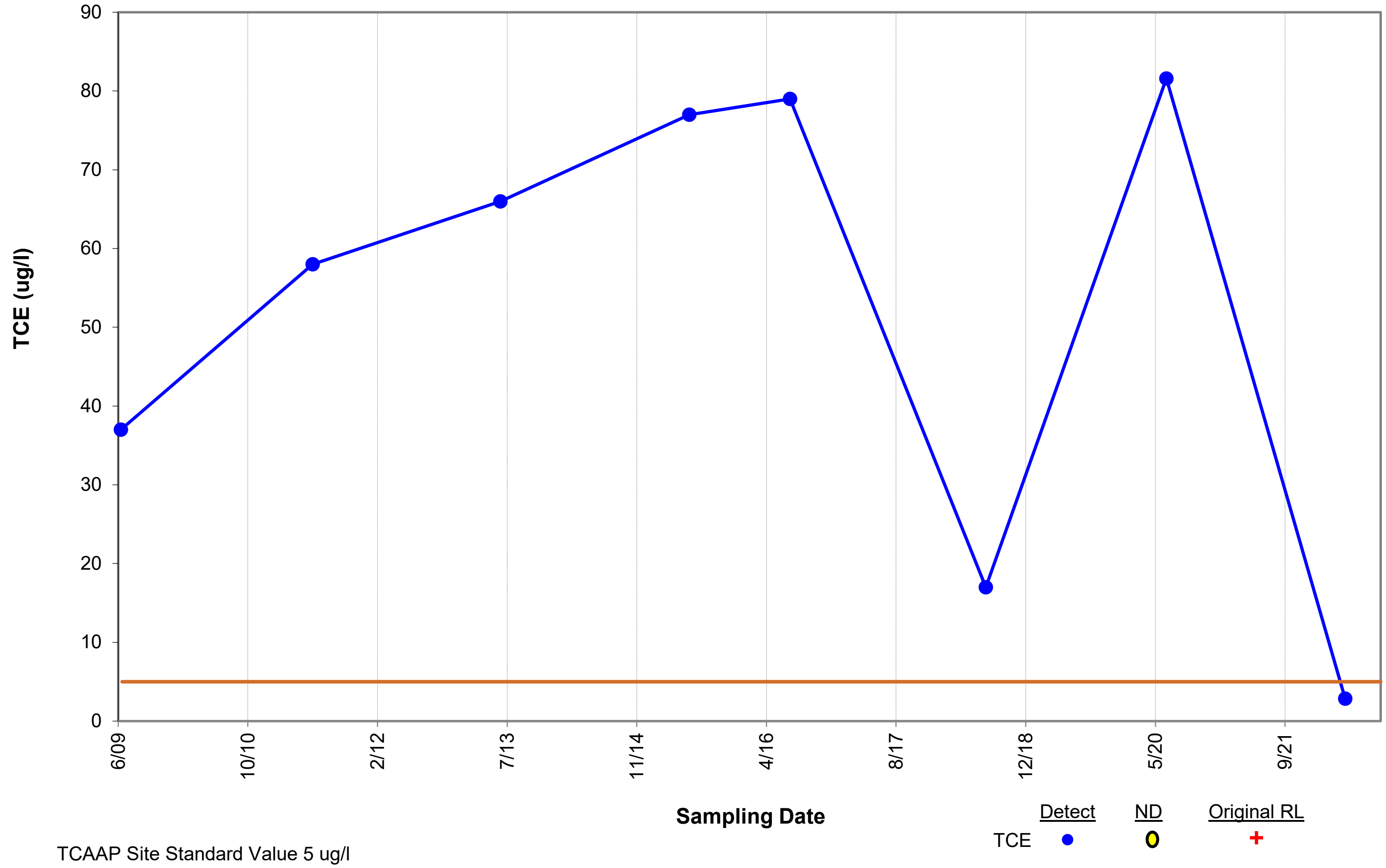
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/17/2022

S =	-7
two-tailed p-value =	0.4675
Trend =	None

Concentration vs. Time Plot – TCE in Well 409549
Twin Cities Army Ammunition Plant

Figure D-2-1



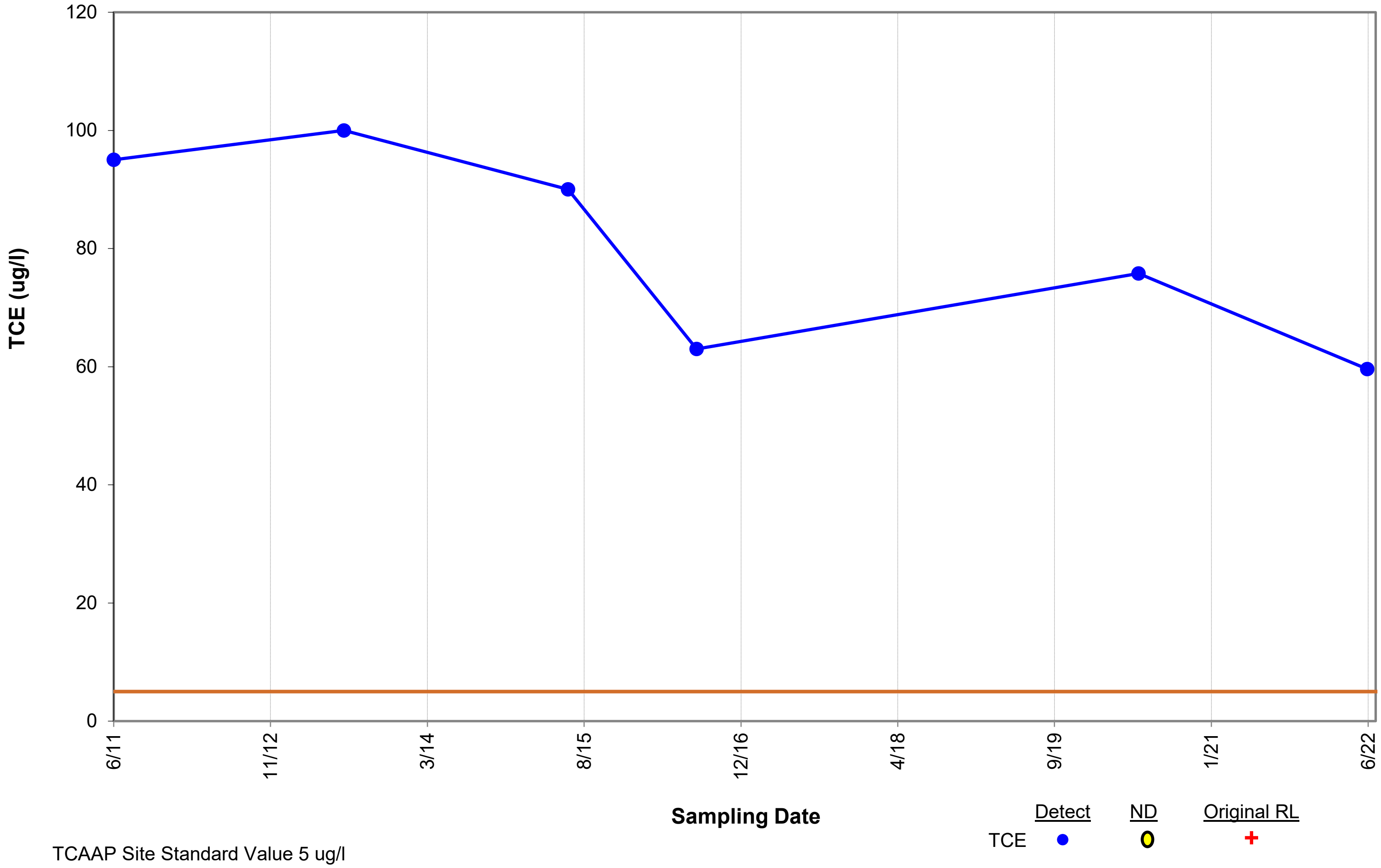
Mann-Kendall Test Result: **No Significant Trend**

S =	4
two-tailed p-value =	0.7195
Trend =	None

Sampling Date: 5/16/2022

Concentration vs. Time Plot – TCE in Well 409557
Twin Cities Army Ammunition Plant

Figure D-2-2

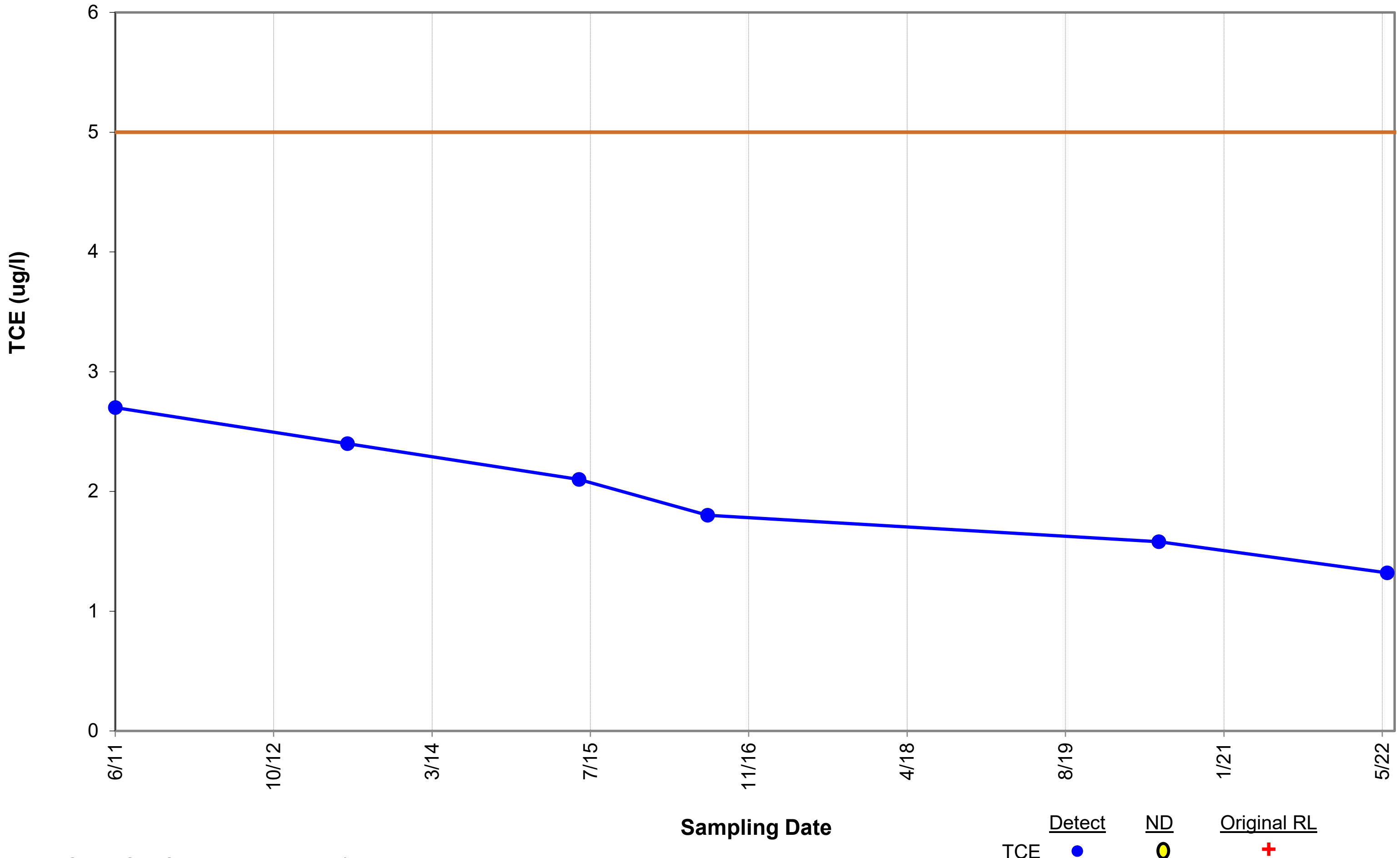


Mann-Kendall Test Result: **Probably Decreasing** **Sampling Date:** 6/3/2022

S =	-11
two-tailed p-value =	0.0556
Trend =	Decreasing

Concentration vs. Time Plot – TCE in Well 03L673
Twin Cities Army Ammunition Plant

Figure D-2-3



TCAAP Site Standard Value 5 ug/l

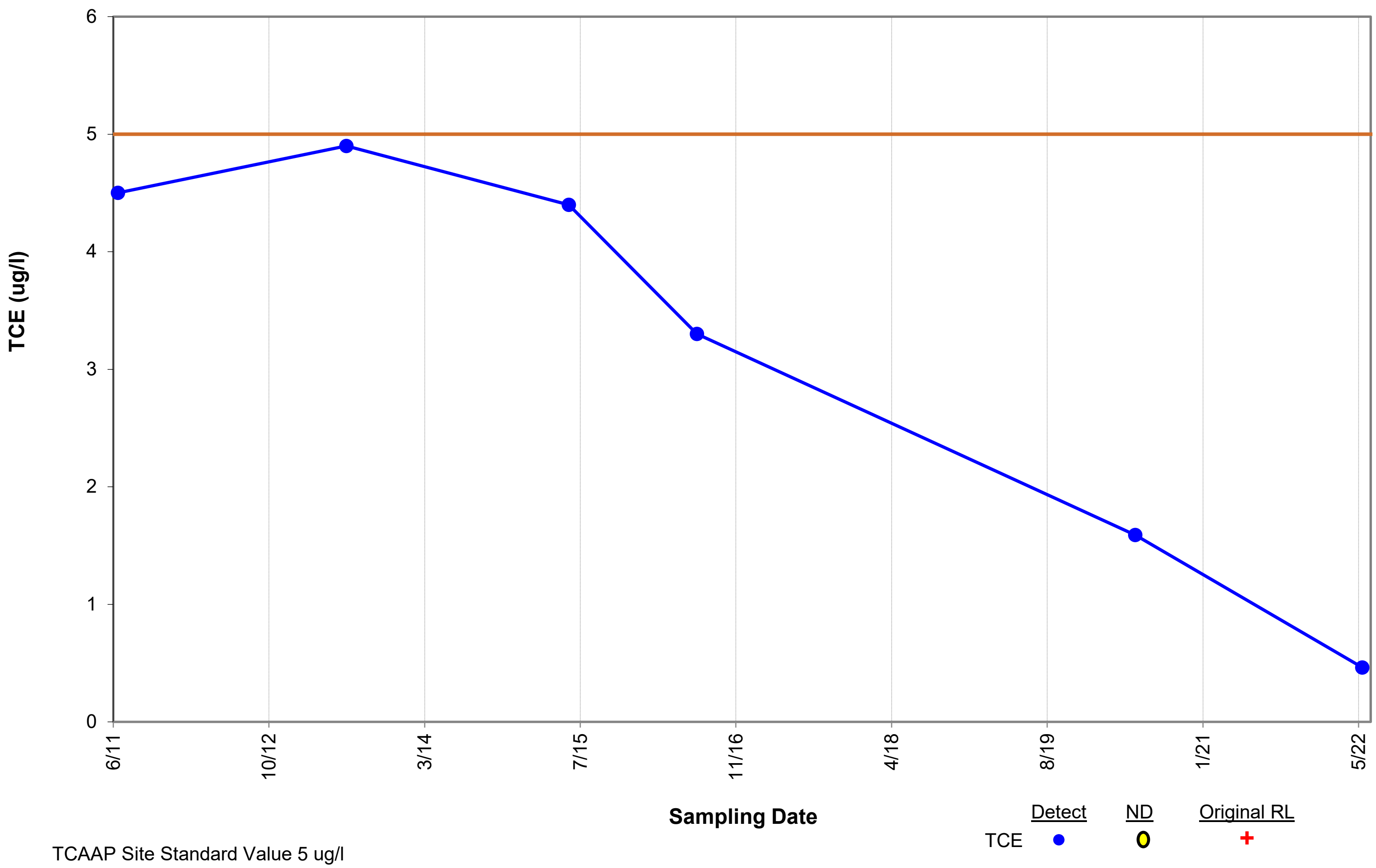
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 6/7/2022

S =	-5
two-tailed p-value =	0.4694
Trend =	None

Concentration vs. Time Plot – TCE in Well 03L833
Twin Cities Army Ammunition Plant

Figure D-2-4



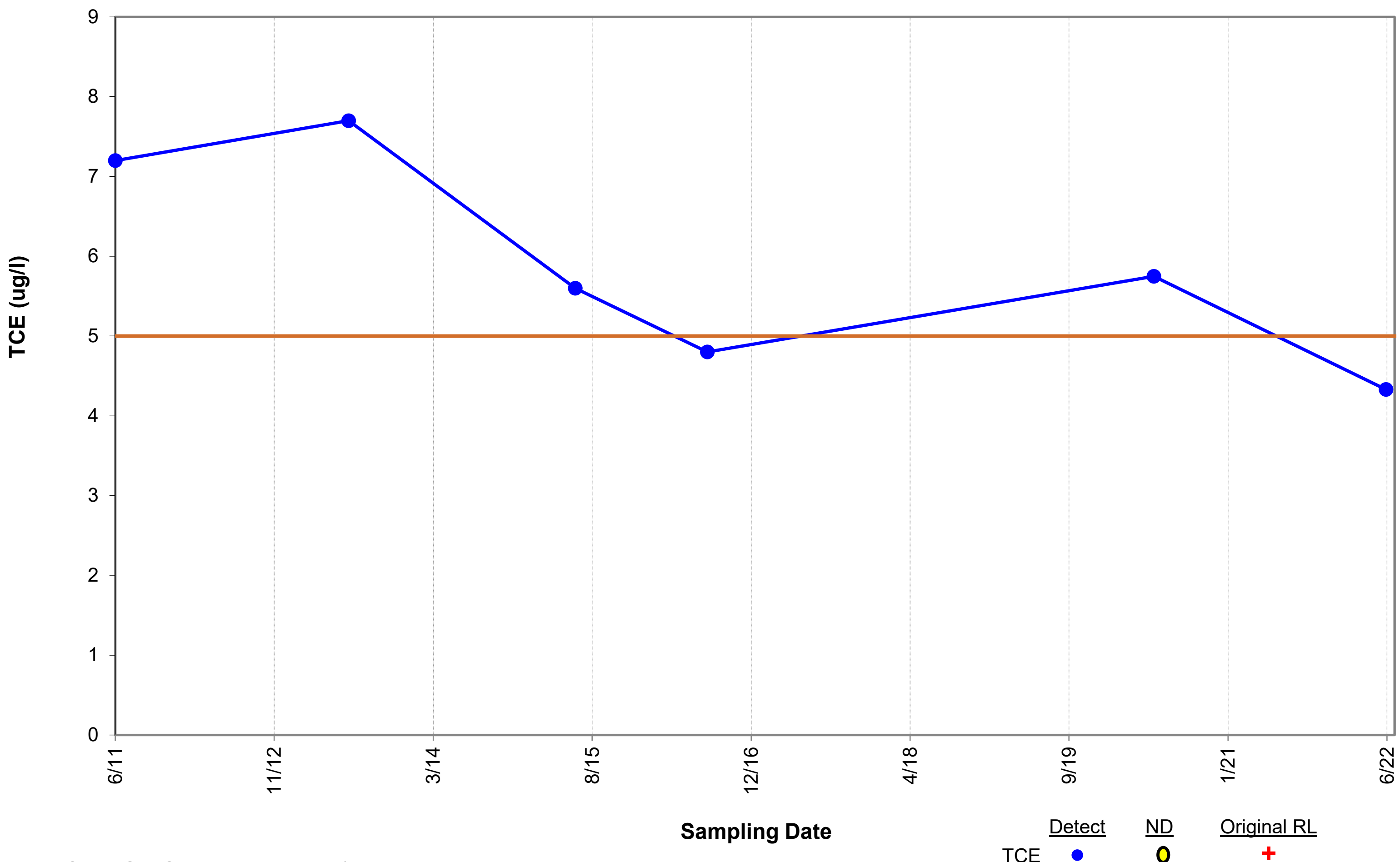
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 6/3/2022

S =	-5
two-tailed p-value =	0.4694
Trend =	None

Concentration vs. Time Plot – TCE in Well 03L848
Twin Cities Army Ammunition Plant

Figure D-2-5



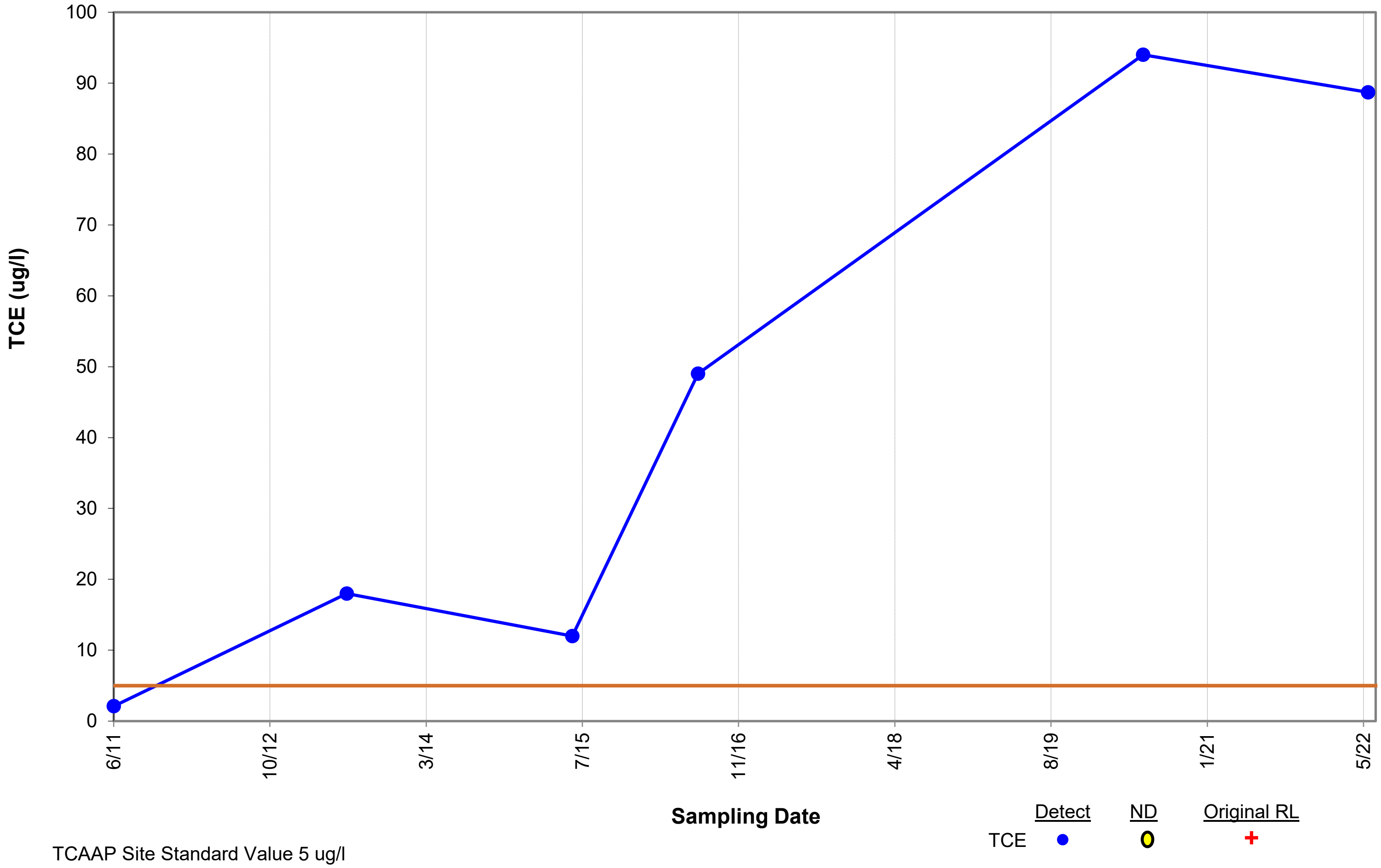
TCAAP Site Standard Value 5 ug/l

Mann-Kendall Test Result: **No Significant Trend** **Sampling Date:** 6/3/2022

S =	-9
two-tailed p-value =	0.1361
Trend =	None

Concentration vs. Time Plot – TCE in Well 03L859
Twin Cities Army Ammunition Plant

Figure D-2-6



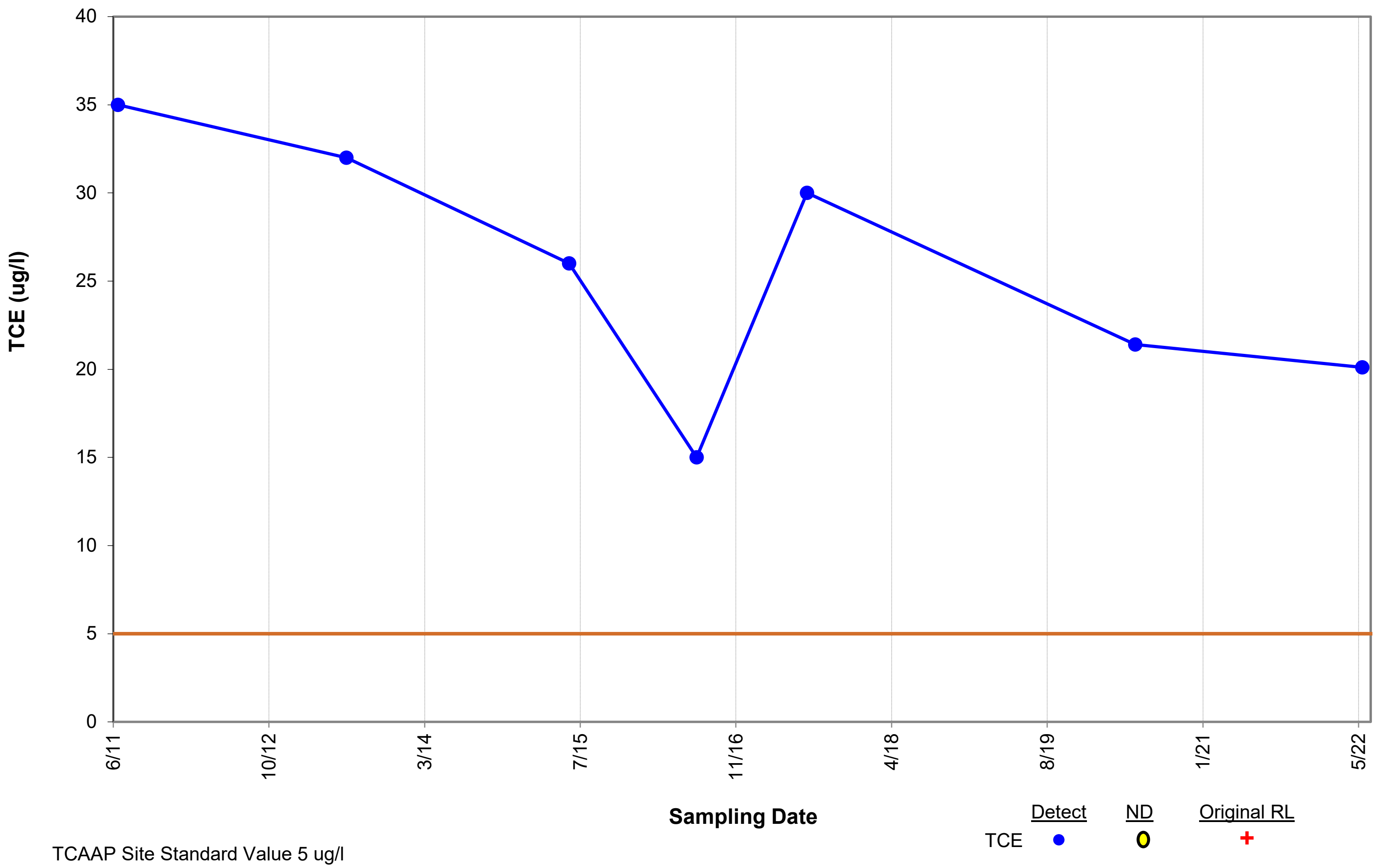
Mann-Kendall Test Result: **Probably Increasing**

Sampling Date: 6/6/2022

S =	11
two-tailed p-value =	0.0556
Trend =	Increasing

Concentration vs. Time Plot – TCE in Well 03U805
Twin Cities Army Ammunition Plant

Figure D-2-7



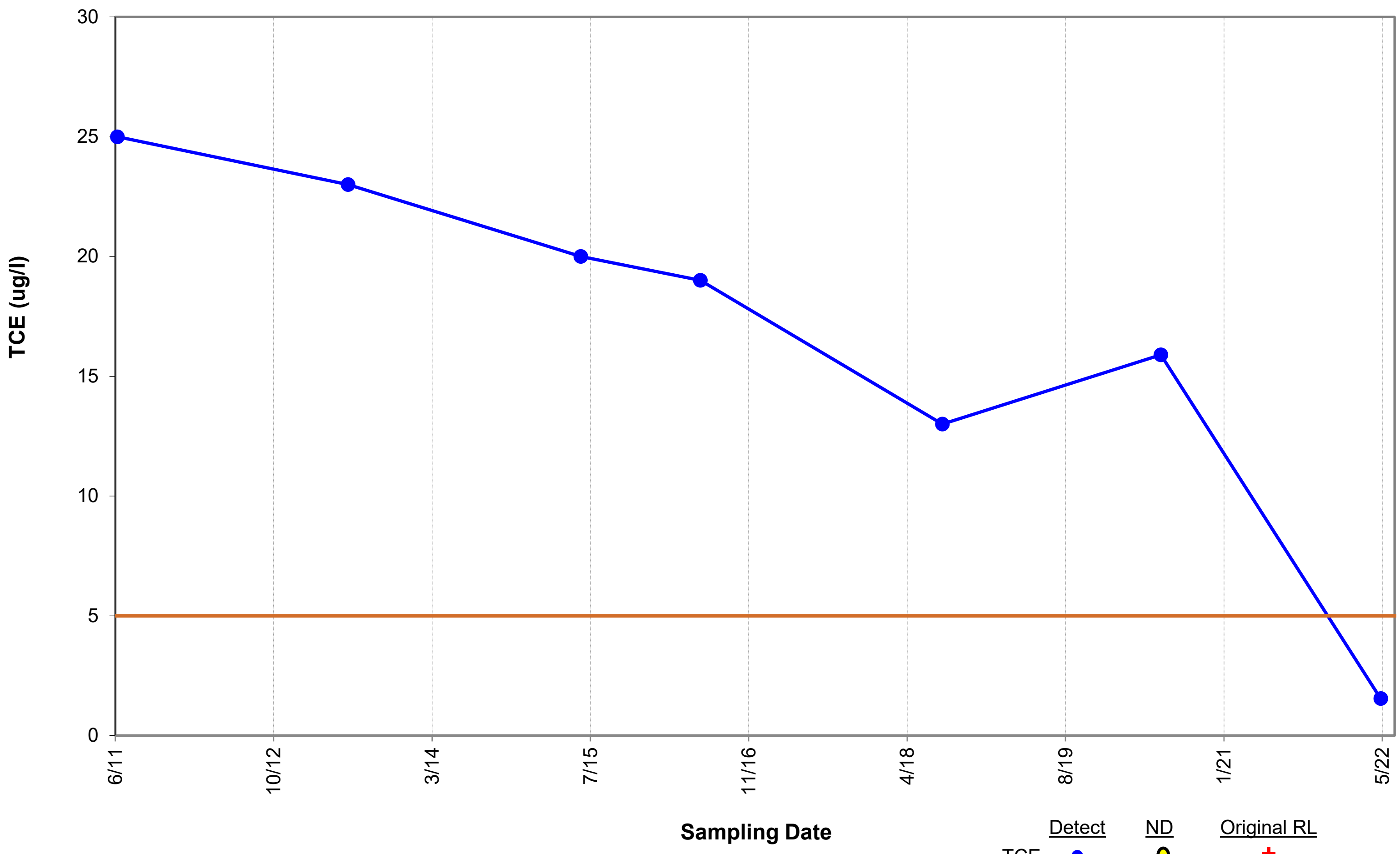
Mann-Kendall Test Result: **Decreasing**

Sampling Date: 6/3/2022

S =	-15
two-tailed p-value =	0.0302
Trend =	Decreasing

Concentration vs. Time Plot – TCE in Well 04U673
Twin Cities Army Ammunition Plant

Figure D-2-8



TCAAP Site Standard Value 5 ug/l

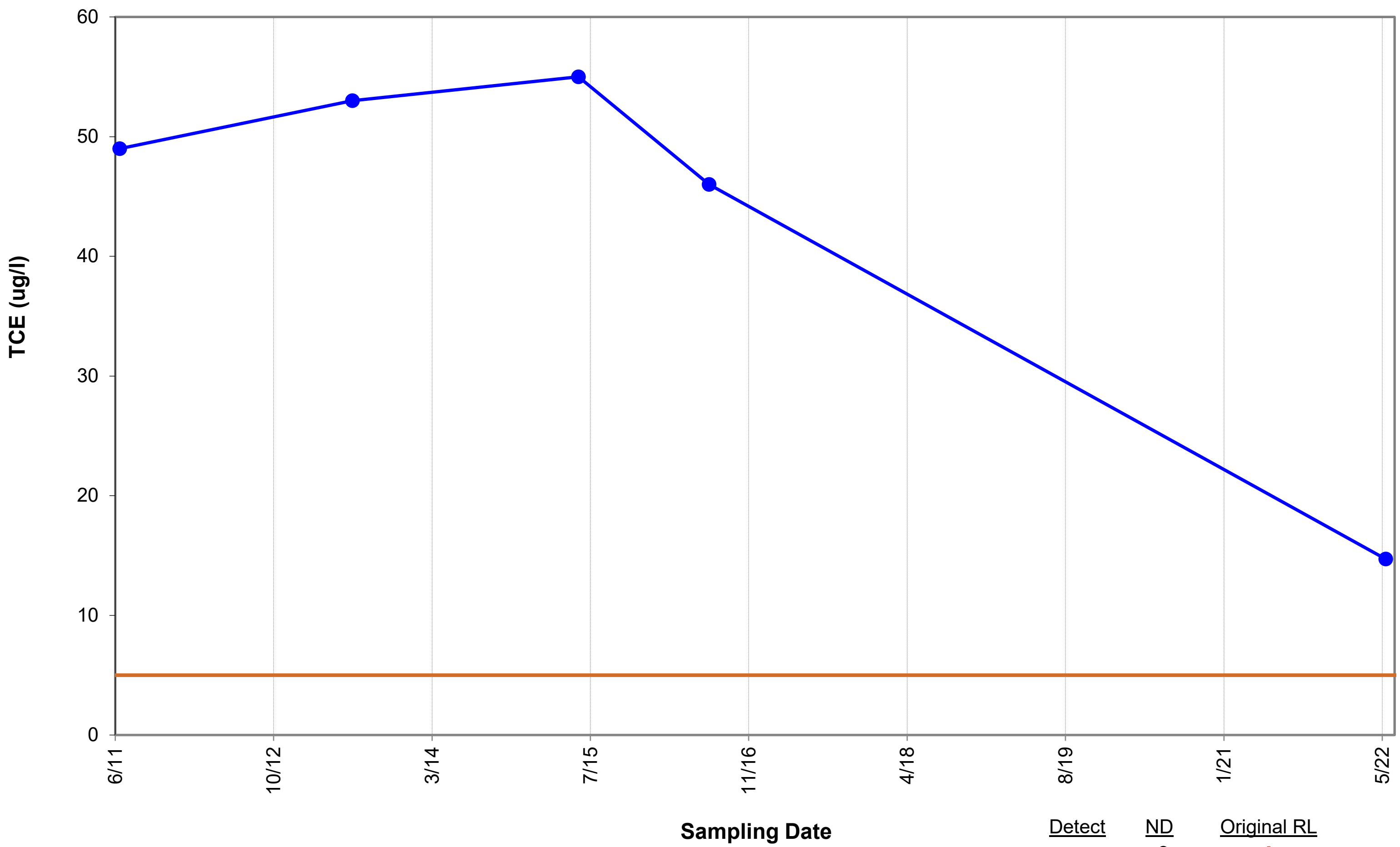
Mann-Kendall Test Result: **Decreasing**

S =	-19
two-tailed p-value =	0.0200
Trend =	Decreasing

Sampling Date: 5/17/2022

Concentration vs. Time Plot – TCE in Well 04U821
Twin Cities Army Ammunition Plant

Figure D-2-9



TCAAP Site Standard Value 5 ug/l

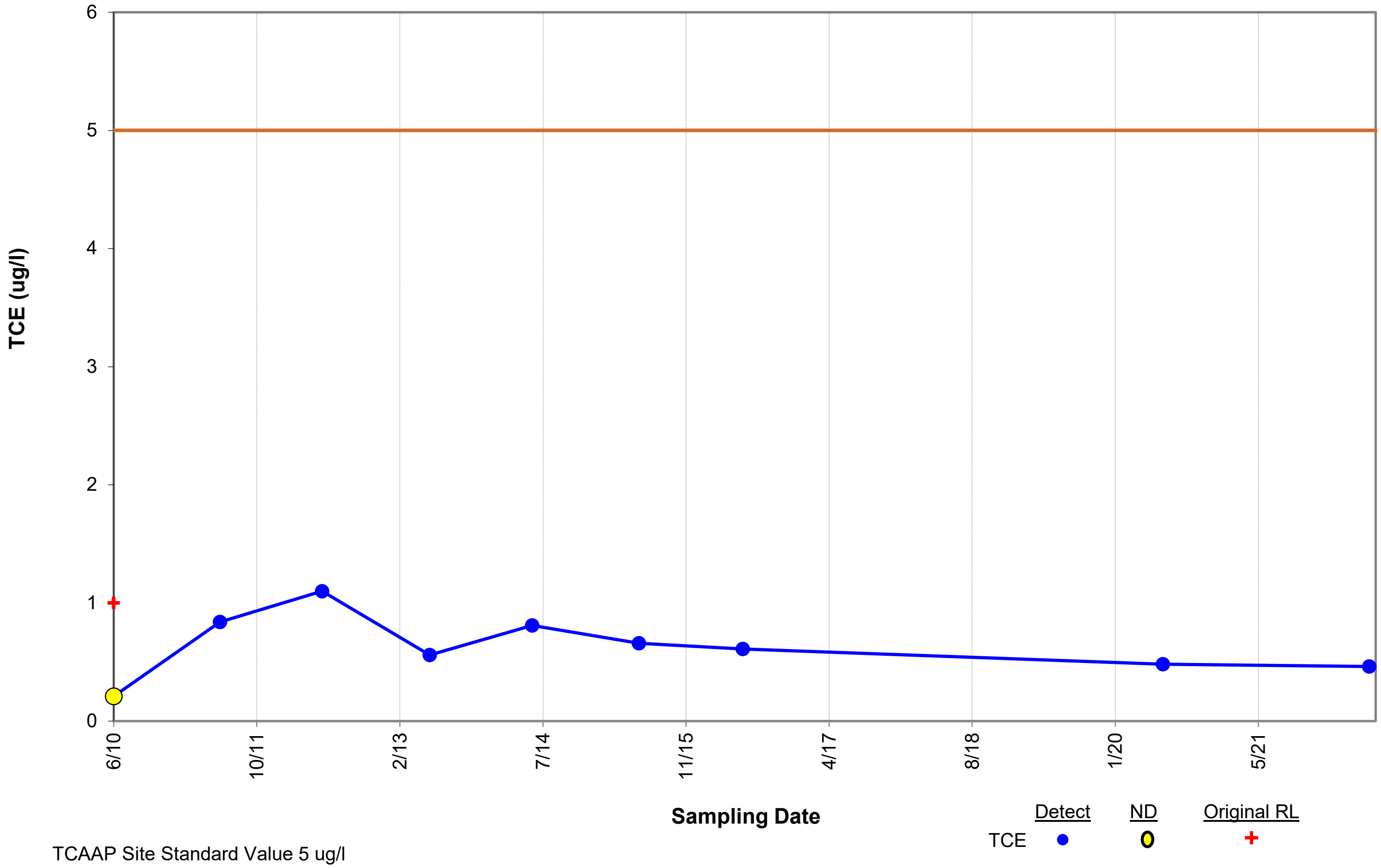
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 6/2/2022

S =	3
two-tailed p-value =	0.6333
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U832
Twin Cities Army Ammunition Plant

Figure D-2-10

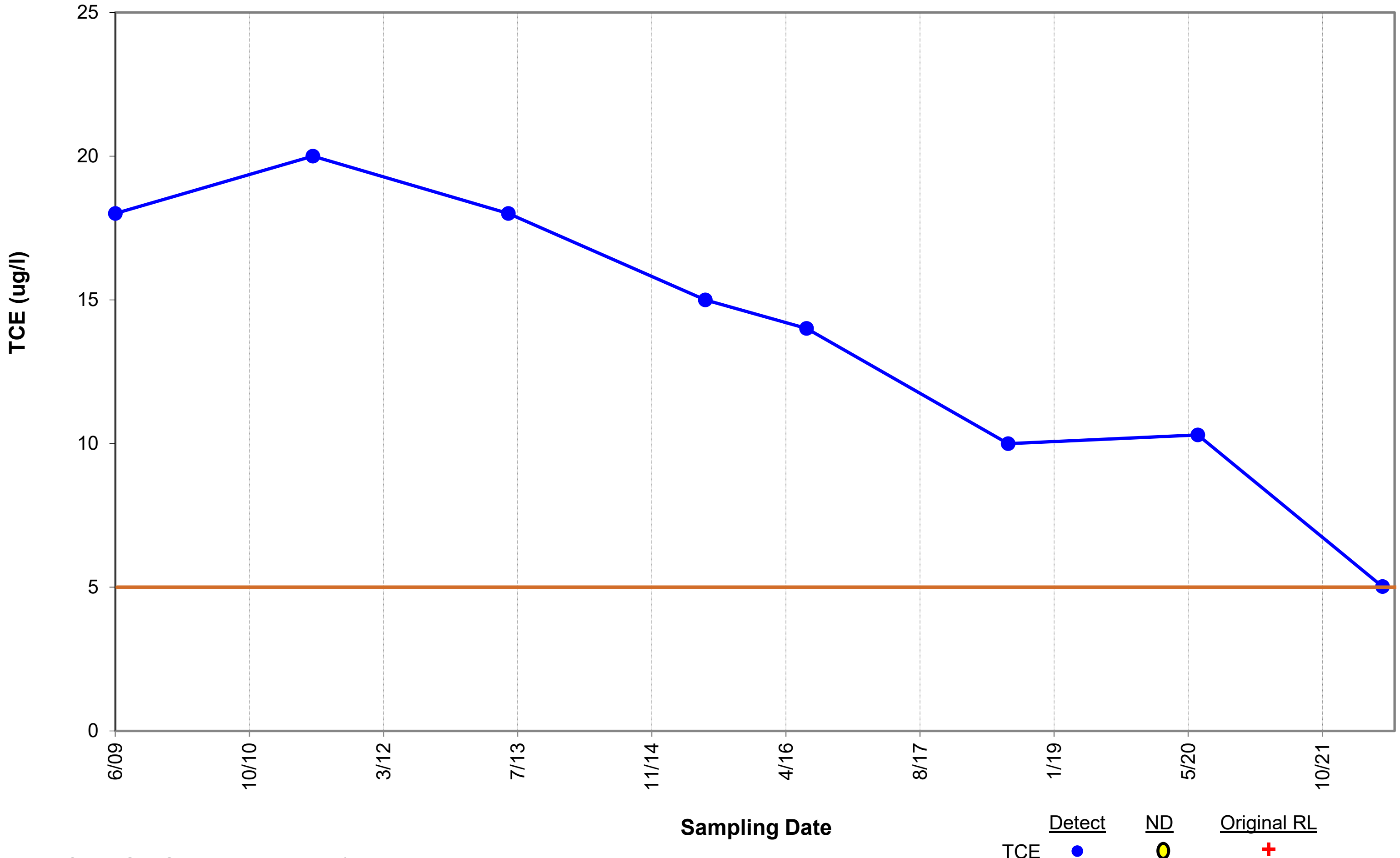


Mann-Kendall Test Result: No Significant Trend **Sampling Date:** 6/7/2022

S =	-14
two-tailed p-value =	0.1802
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U833
Twin Cities Army Ammunition Plant

Figure D-2-11



TCAAP Site Standard Value 5 ug/l

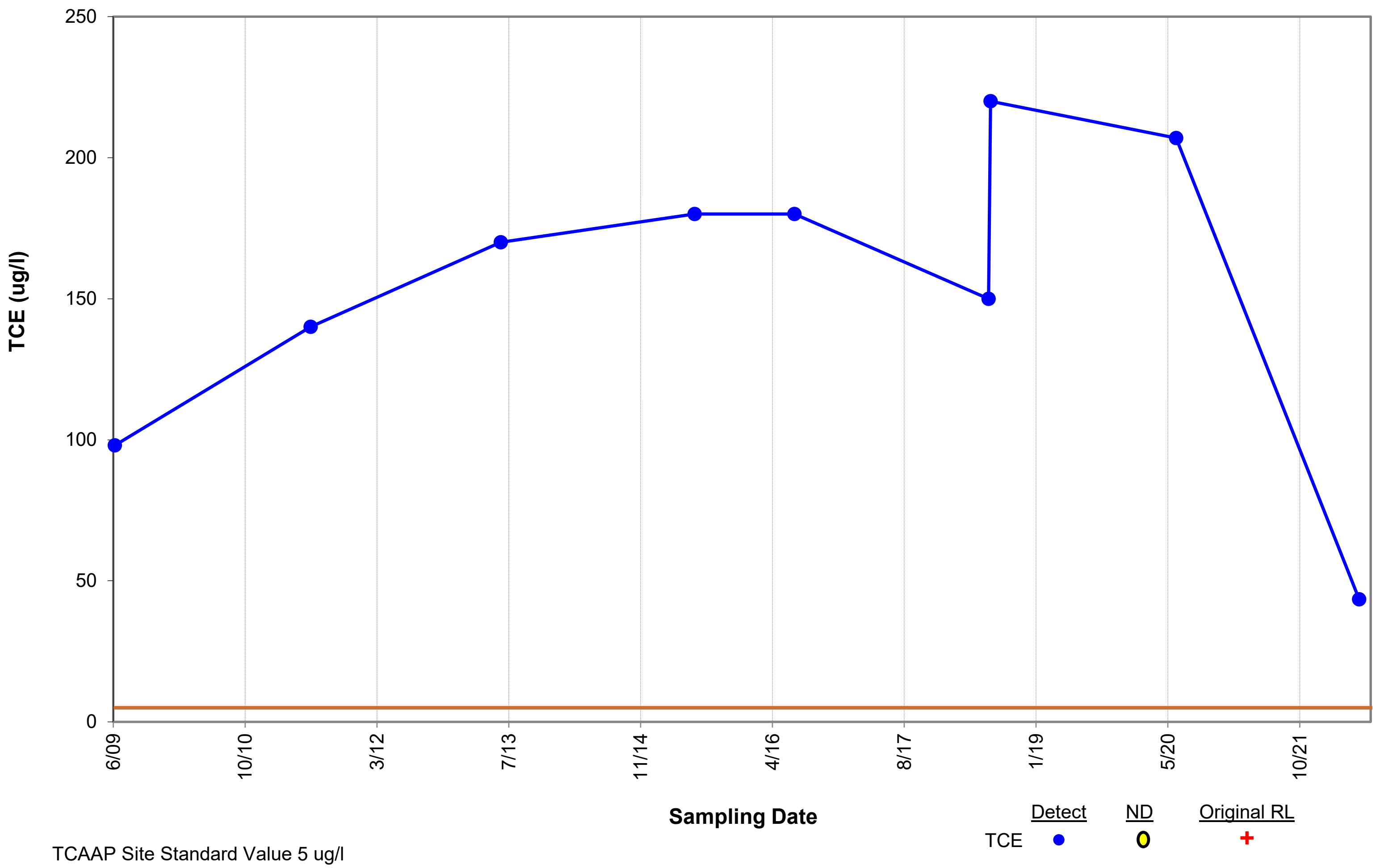
Mann-Kendall Test Result: **Decreasing**

S =	-23
two-tailed p-value =	0.0028
Trend =	Decreasing

Sampling Date: 5/16/2022

Concentration vs. Time Plot – TCE in Well 04U841
Twin Cities Army Ammunition Plant

Figure D-2-12



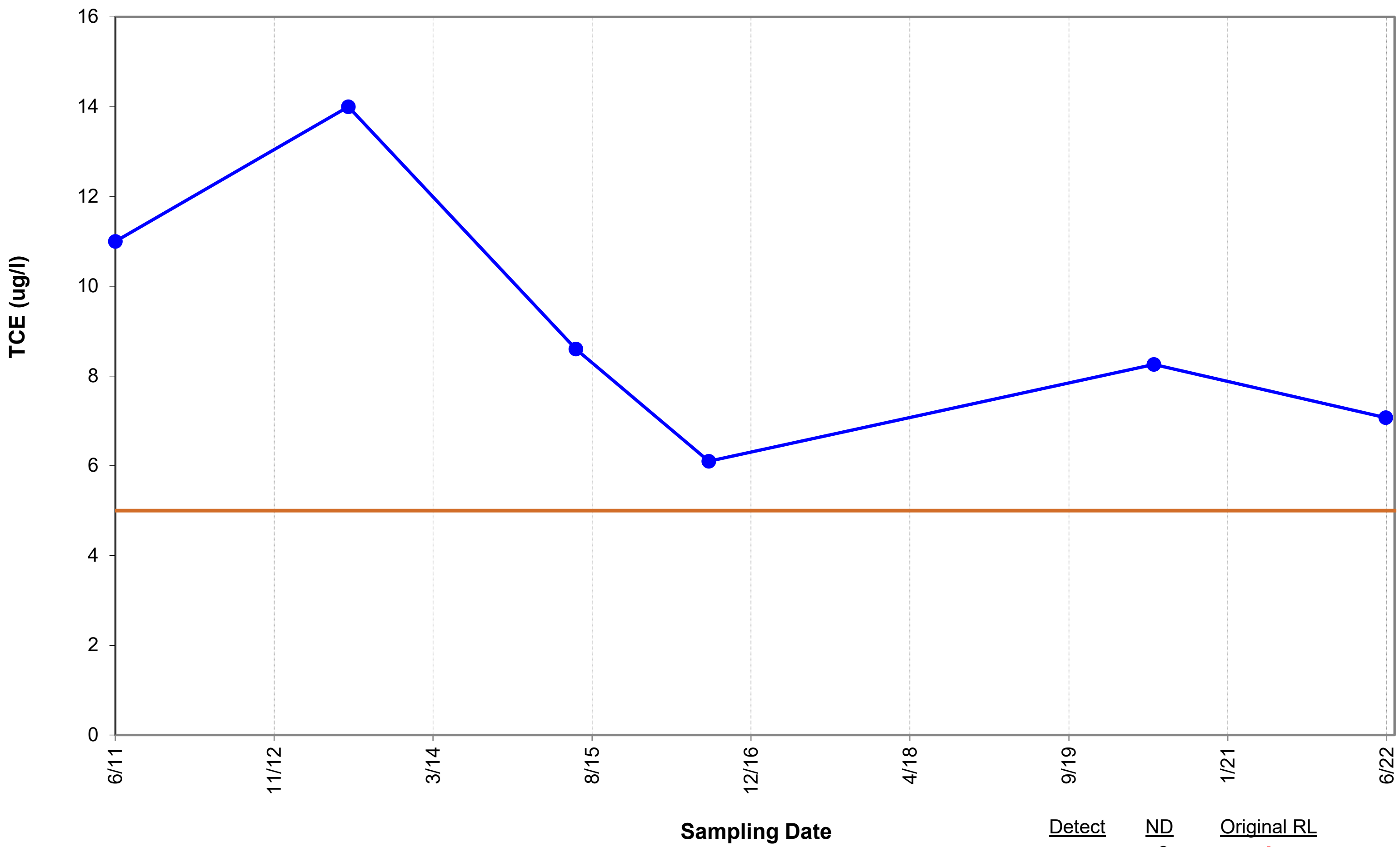
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/17/2022

S =	15
two-tailed p-value =	0.1454
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U843
Twin Cities Army Ammunition Plant

Figure D-2-13



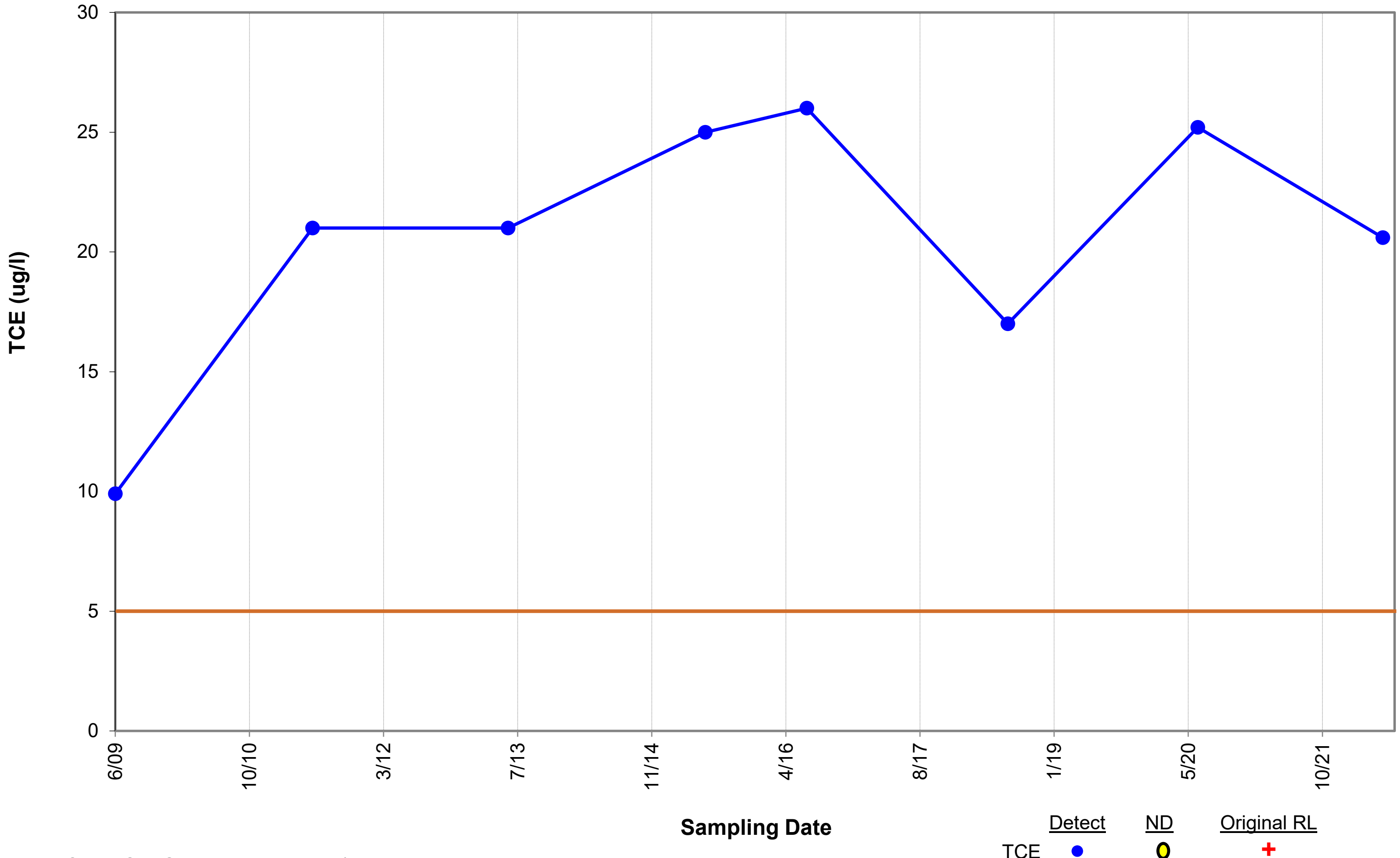
TCAAP Site Standard Value 5 ug/l

Mann-Kendall Test Result: No Significant Trend **Sampling Date:** 6/2/2022

S =	-3
two-tailed p-value =	0.7194
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U845
Twin Cities Army Ammunition Plant

Figure D-2-14



TCAAP Site Standard Value 5 ug/l

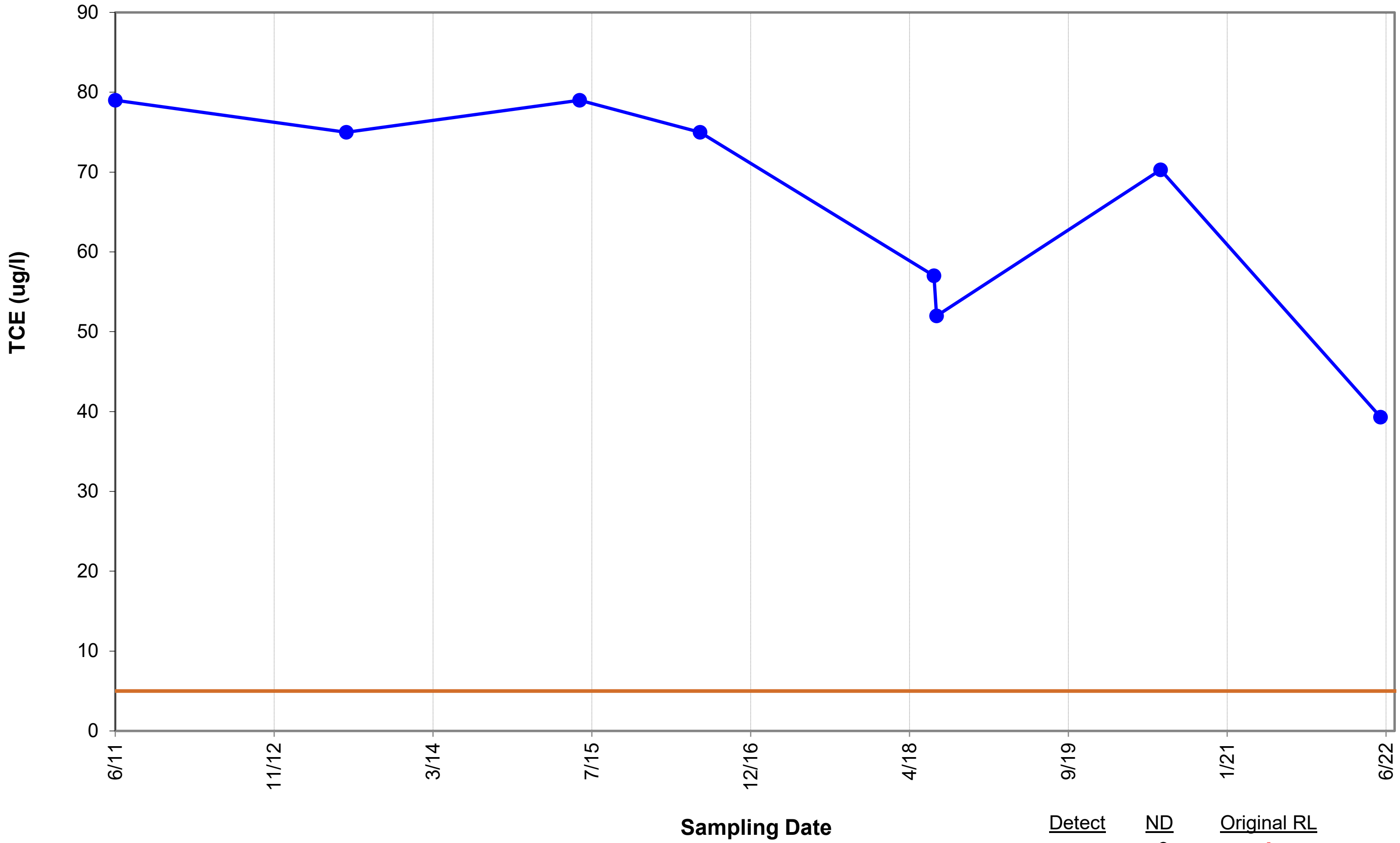
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/17/2022

S =	7
two-tailed p-value =	0.4675
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U846
Twin Cities Army Ammunition Plant

Figure D-2-15



TCAAP Site Standard Value 5 ug/l

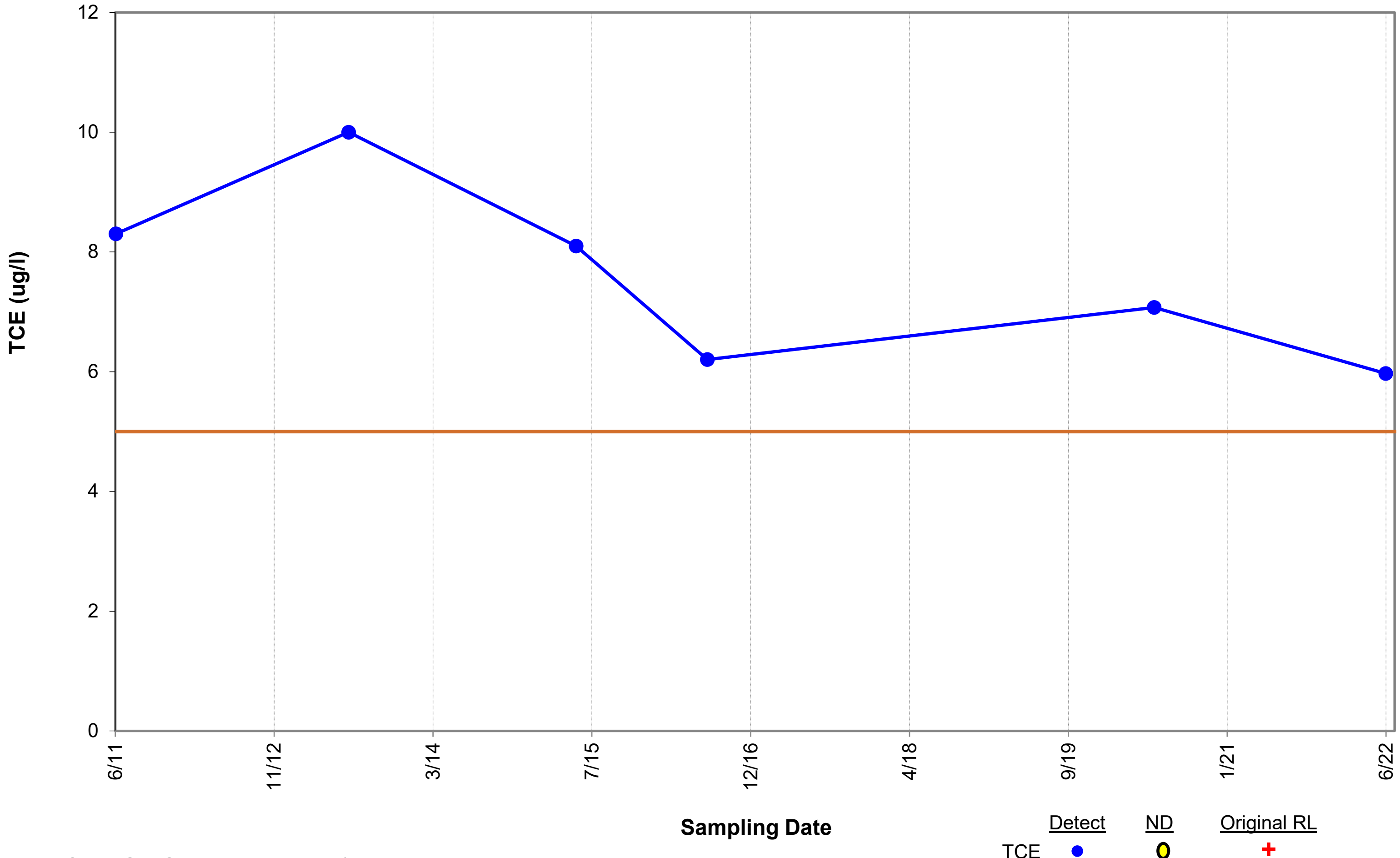
Mann-Kendall Test Result: No Significant Trend

Sampling Date: 5/17/2022

S =	-10
two-tailed p-value =	0.2681
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U849
Twin Cities Army Ammunition Plant

Figure D-2-16



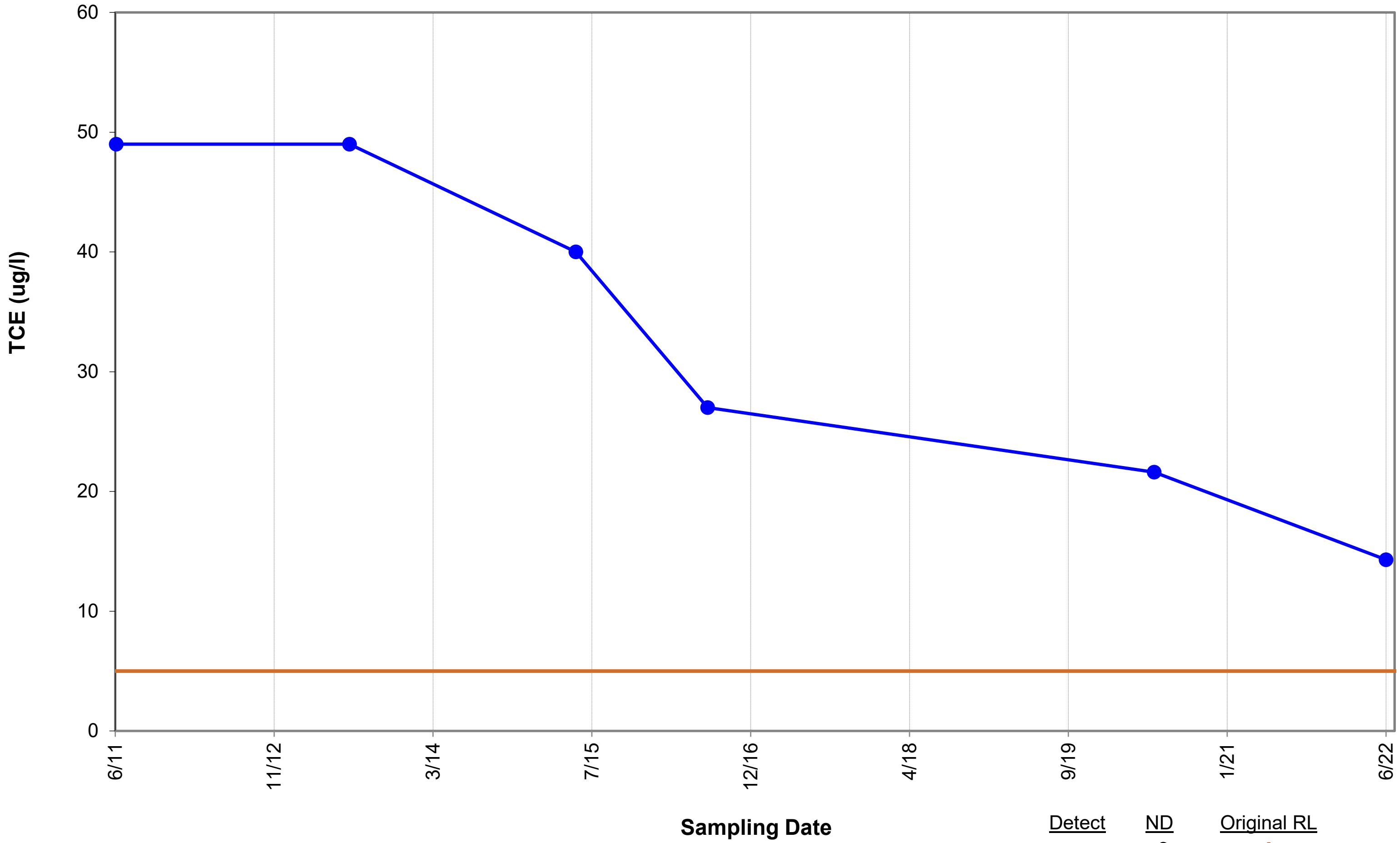
TCAAP Site Standard Value 5 ug/l

Mann-Kendall Test Result: **No Significant Trend** **Sampling Date:** 6/2/2022

S =	-9
two-tailed p-value =	0.1361
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U854
Twin Cities Army Ammunition Plant

Figure D-2-17



TCAAP Site Standard Value 5 ug/l

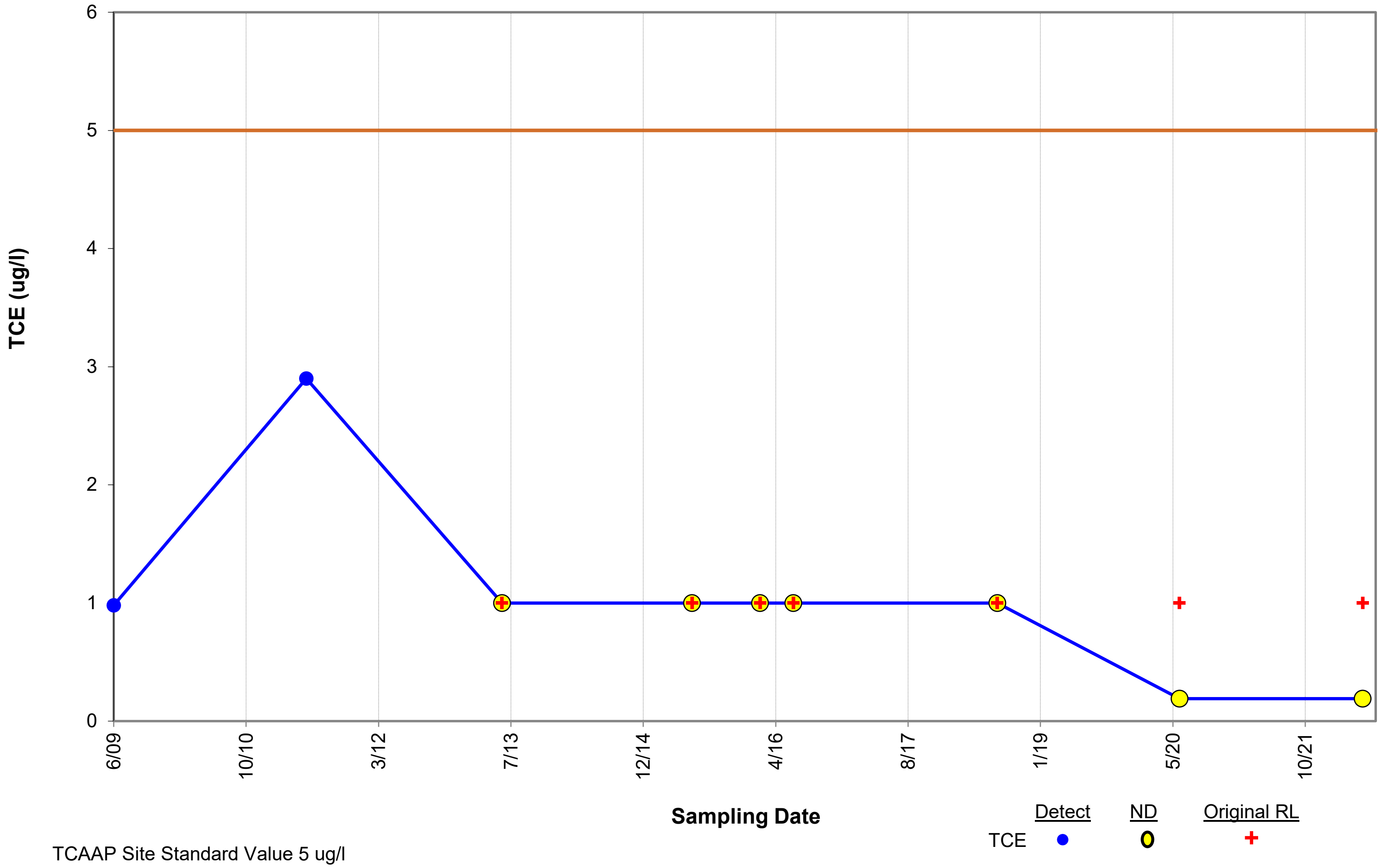
Mann-Kendall Test Result: **Decreasing**

Sampling Date: 6/3/2022

S =	-14
two-tailed p-value =	0.0056
Trend =	Decreasing

Concentration vs. Time Plot – TCE in Well 04U859
Twin Cities Army Ammunition Plant

Figure D-2-18



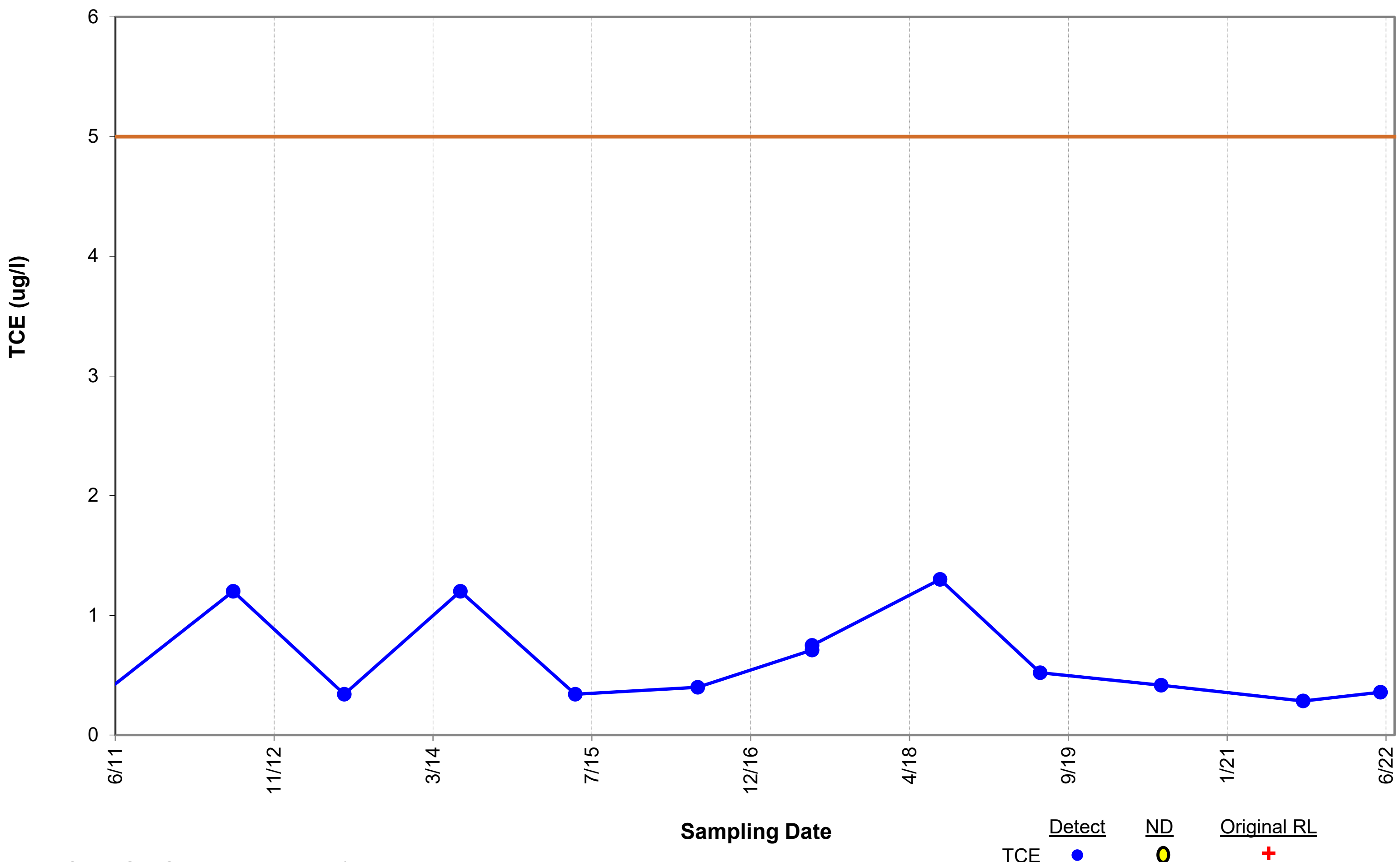
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/12/2022

S =	-11
two-tailed p-value =	0.1071
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U875
Twin Cities Army Ammunition Plant

Figure D-2-19



TCAAP Site Standard Value 5 ug/l

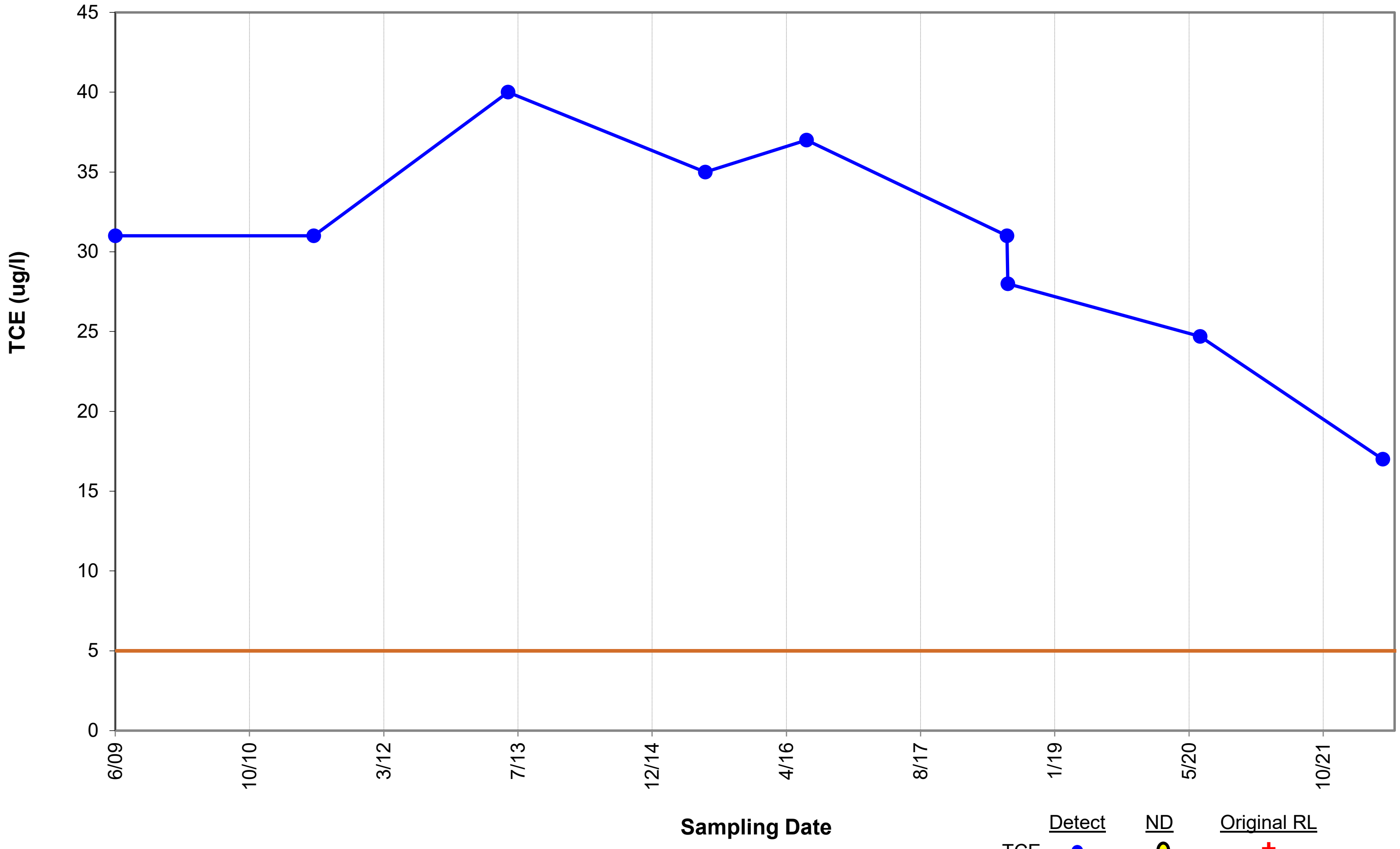
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/17/2022

S =	-3
two-tailed p-value =	0.9044
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U877
Twin Cities Army Ammunition Plant

Figure D-2-20



TCAAP Site Standard Value 5 ug/l

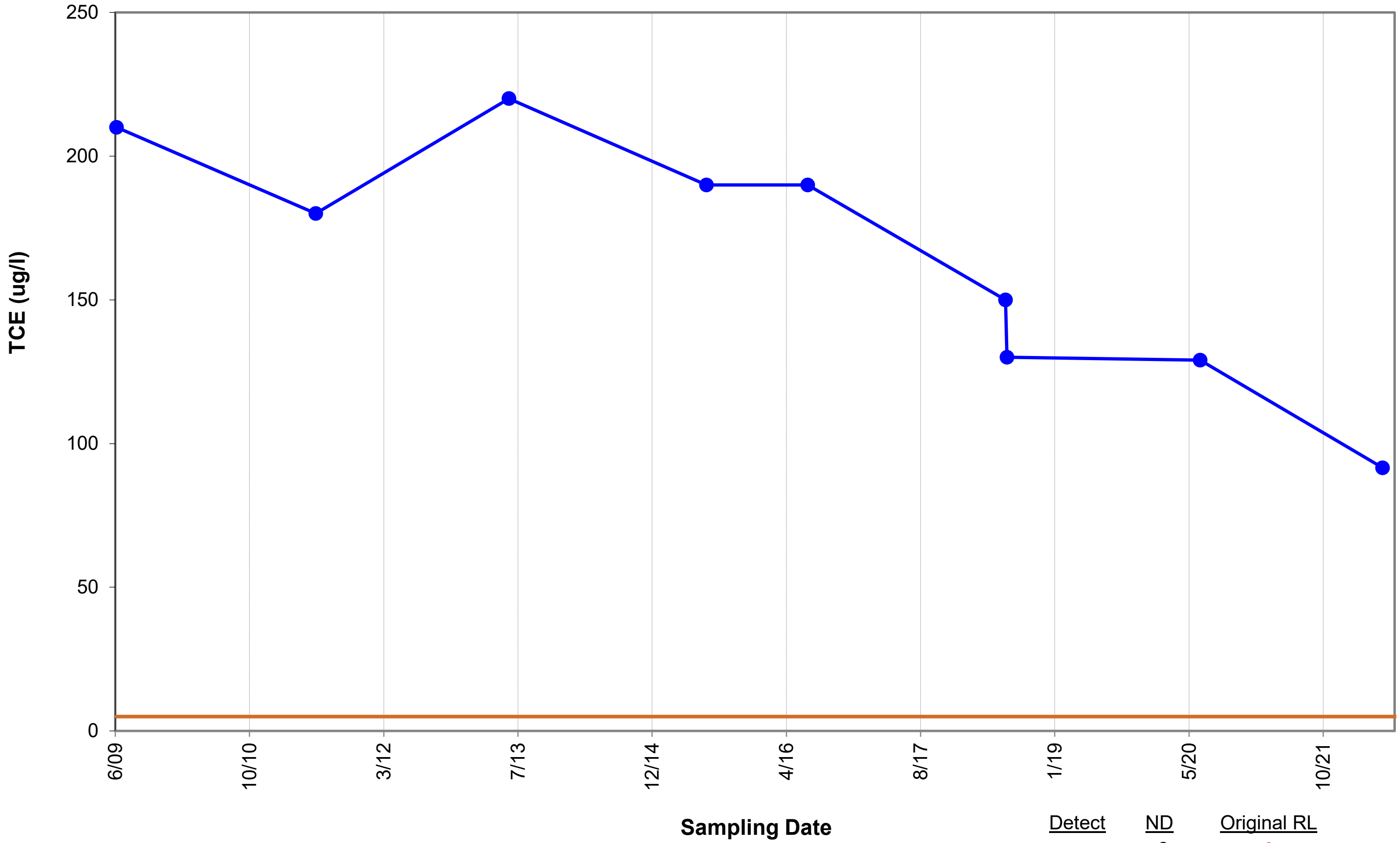
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/17/2022

S =	-13
two-tailed p-value =	0.1376
Trend =	None

Concentration vs. Time Plot – TCE in Well 409550
Twin Cities Army Ammunition Plant

Figure D-2-21



TCAAP Site Standard Value 5 ug/l

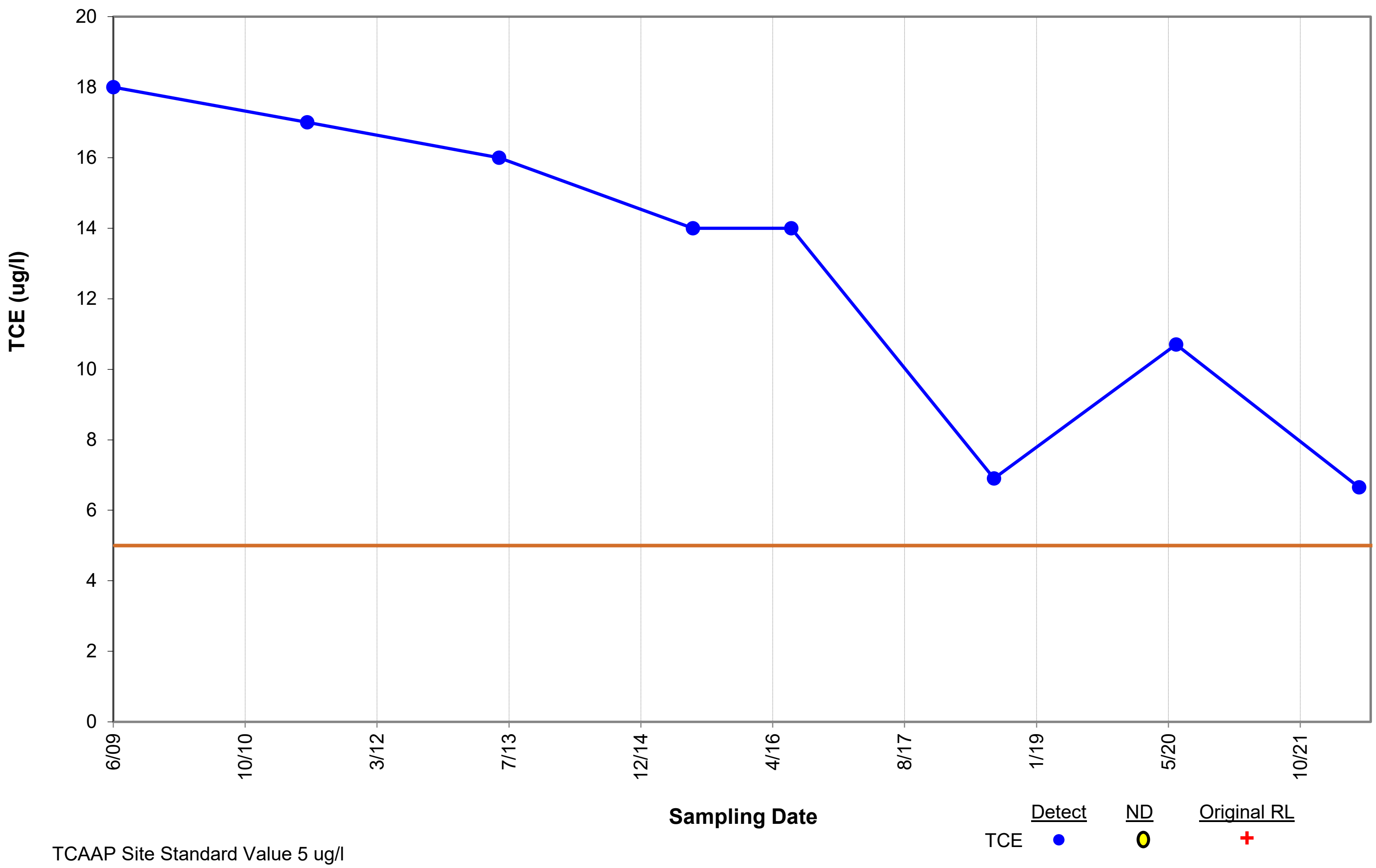
Mann-Kendall Test Result: Decreasing

S =	-19
two-tailed p-value =	0.0200
Trend =	Decreasing

Sampling Date: 5/16/2022

Concentration vs. Time Plot – TCE in Well 03L822
Twin Cities Army Ammunition Plant

Figure D-2-22



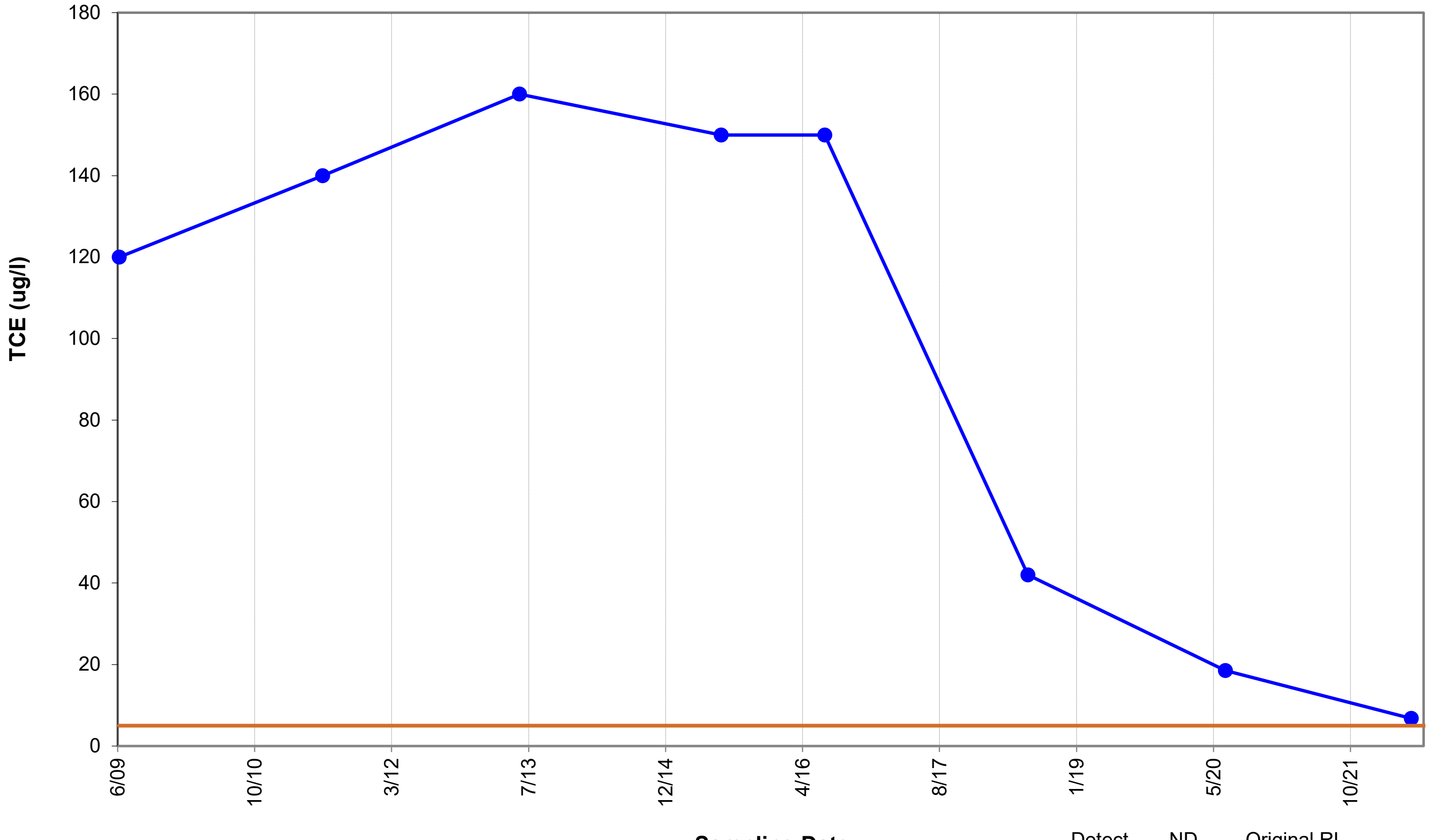
Mann-Kendall Test Result: **Decreasing**

S =	-25
two-tailed p-value =	0.0007
Trend =	Decreasing

Sampling Date: 5/17/2022

Concentration vs. Time Plot – TCE in Well 03U821
Twin Cities Army Ammunition Plant

Figure D-2-23



TCAAP Site Standard Value 5 ug/l

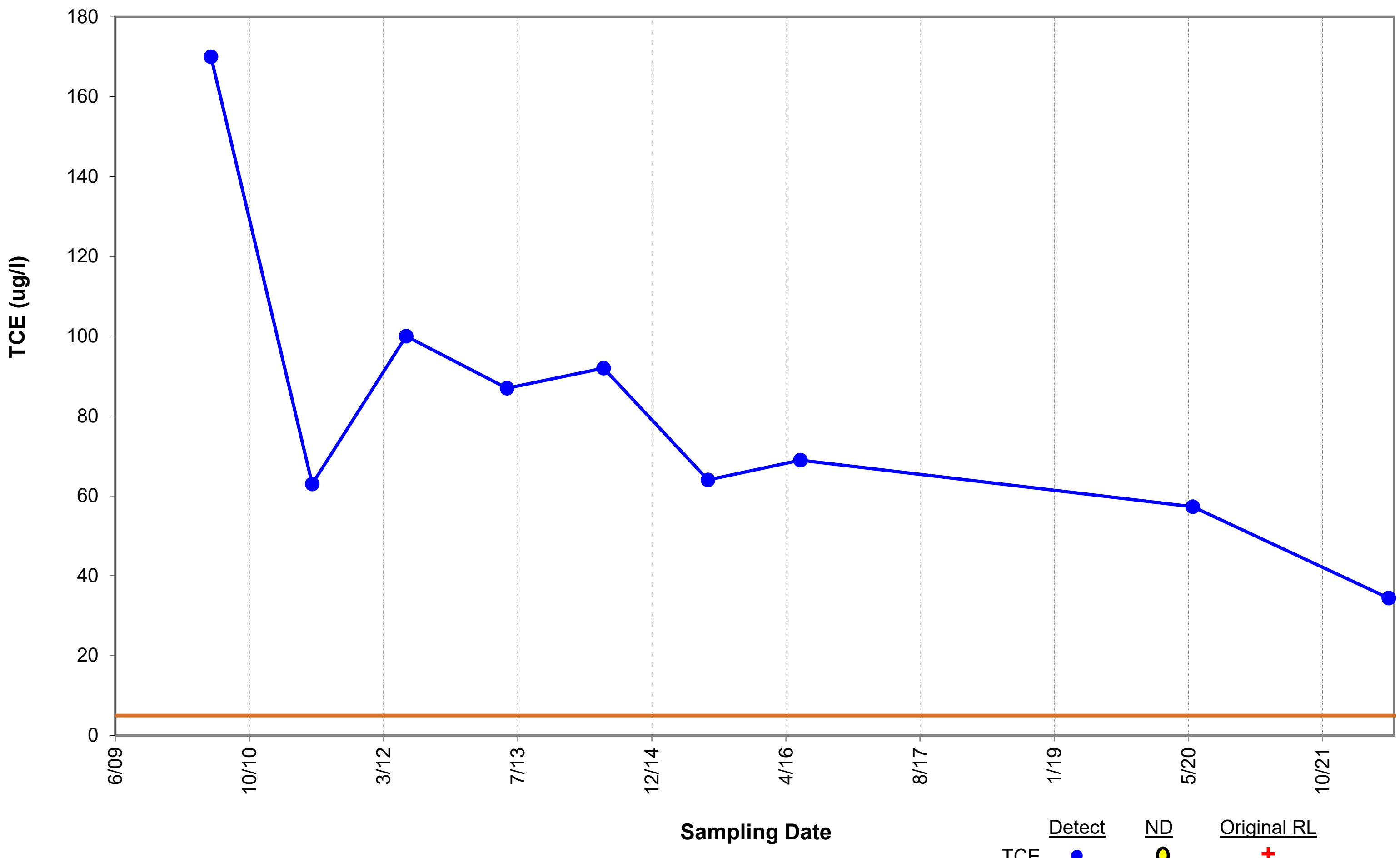
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/16/2022

S =	-13
two-tailed p-value =	0.1376
Trend =	None

Concentration vs. Time Plot – TCE in Well 03U822
Twin Cities Army Ammunition Plant

Figure D-2-24



TCAAP Site Standard Value 5 ug/l

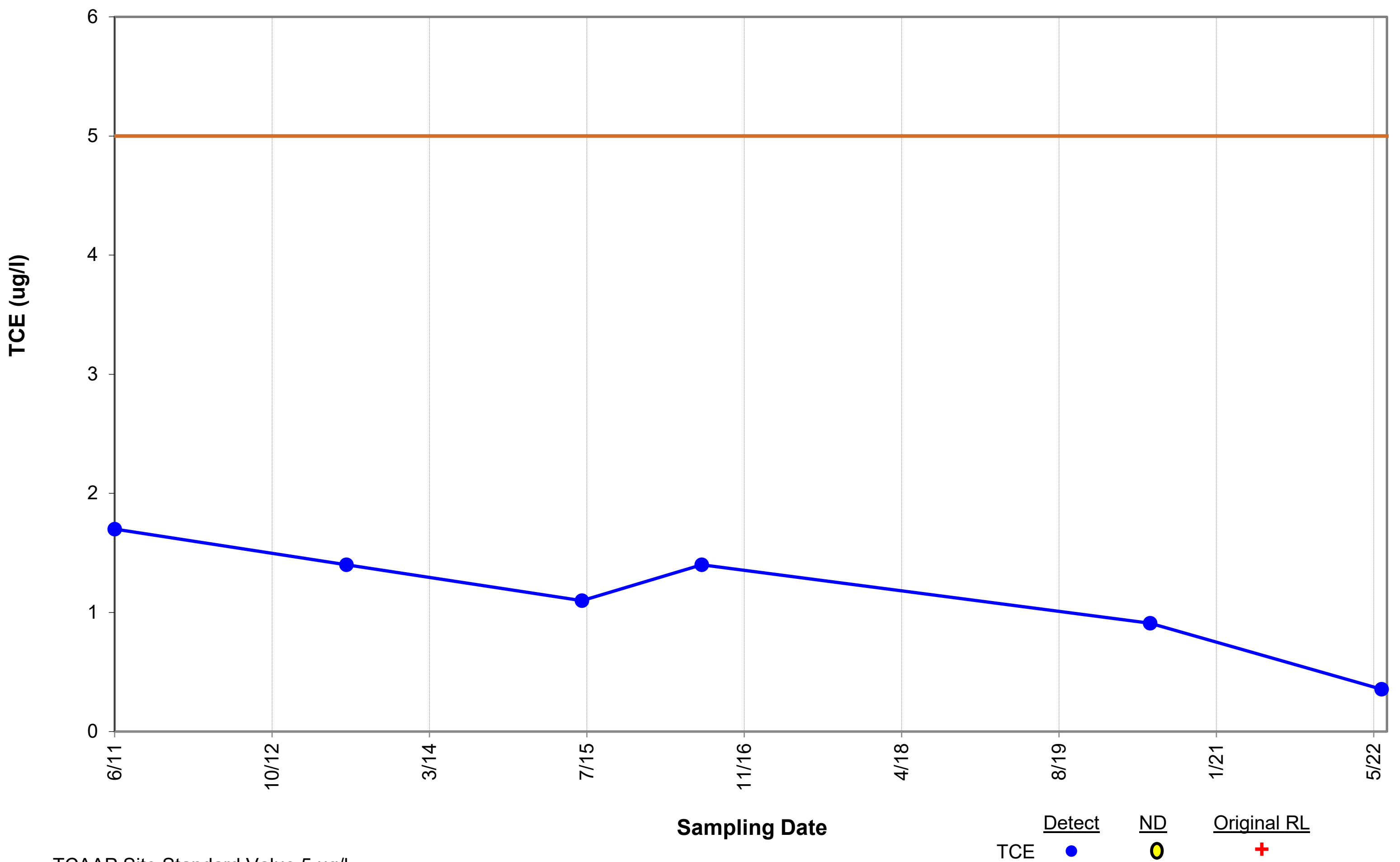
Mann-Kendall Test Result: **Decreasing**

S =	-22
two-tailed p-value =	0.0247
Trend =	Decreasing

Sampling Date: 6/10/2022

Concentration vs. Time Plot – TCE in Well 04J077
Twin Cities Army Ammunition Plant

Figure D-2-25



TCAAP Site Standard Value 5 ug/l

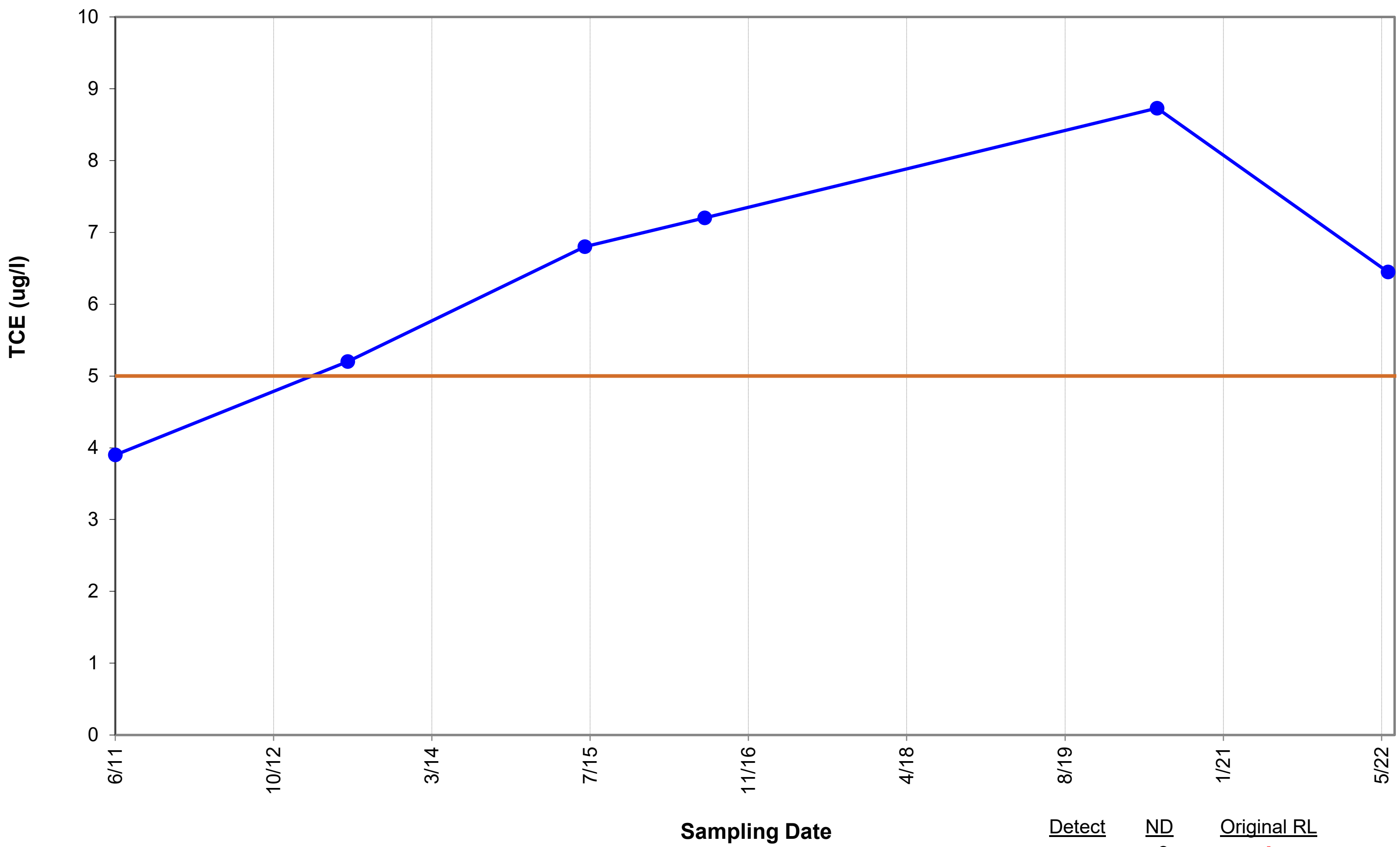
Mann-Kendall Test Result: Decreasing

S =	-12
two-tailed p-value =	0.0278
Trend =	Decreasing

Sampling Date: 6/13/2022

Concentration vs. Time Plot – TCE in Well 04J702
Twin Cities Army Ammunition Plant

Figure D-2-26



TCAAP Site Standard Value 5 ug/l

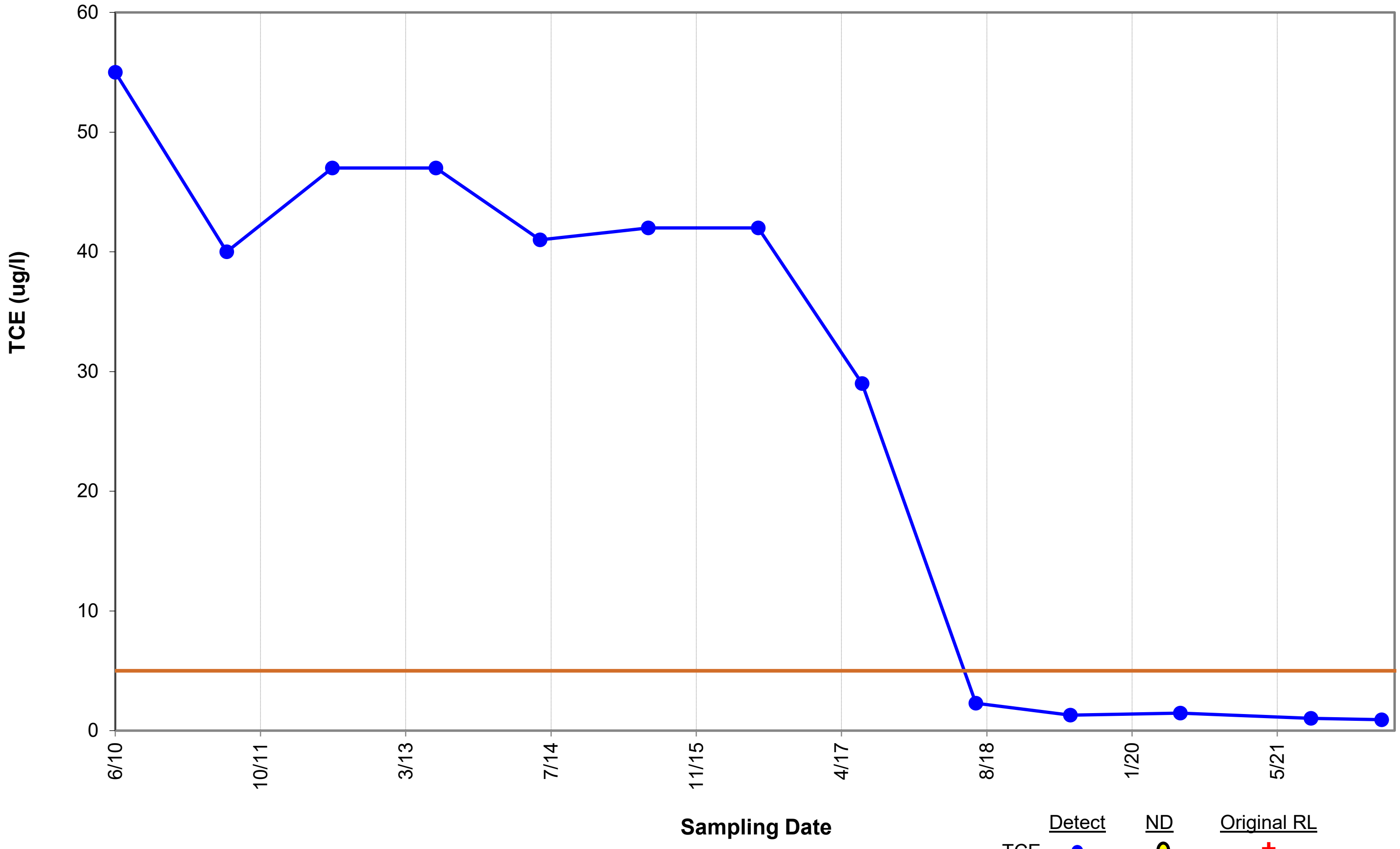
Mann-Kendall Test Result: **Increasing**

S =	15
two-tailed p-value =	0.0028
Trend =	Increasing

Sampling Date: 6/9/2022

Concentration vs. Time Plot – TCE in Well 04J708
Twin Cities Army Ammunition Plant

Figure D-2-27



TCAAP Site Standard Value 5 ug/l

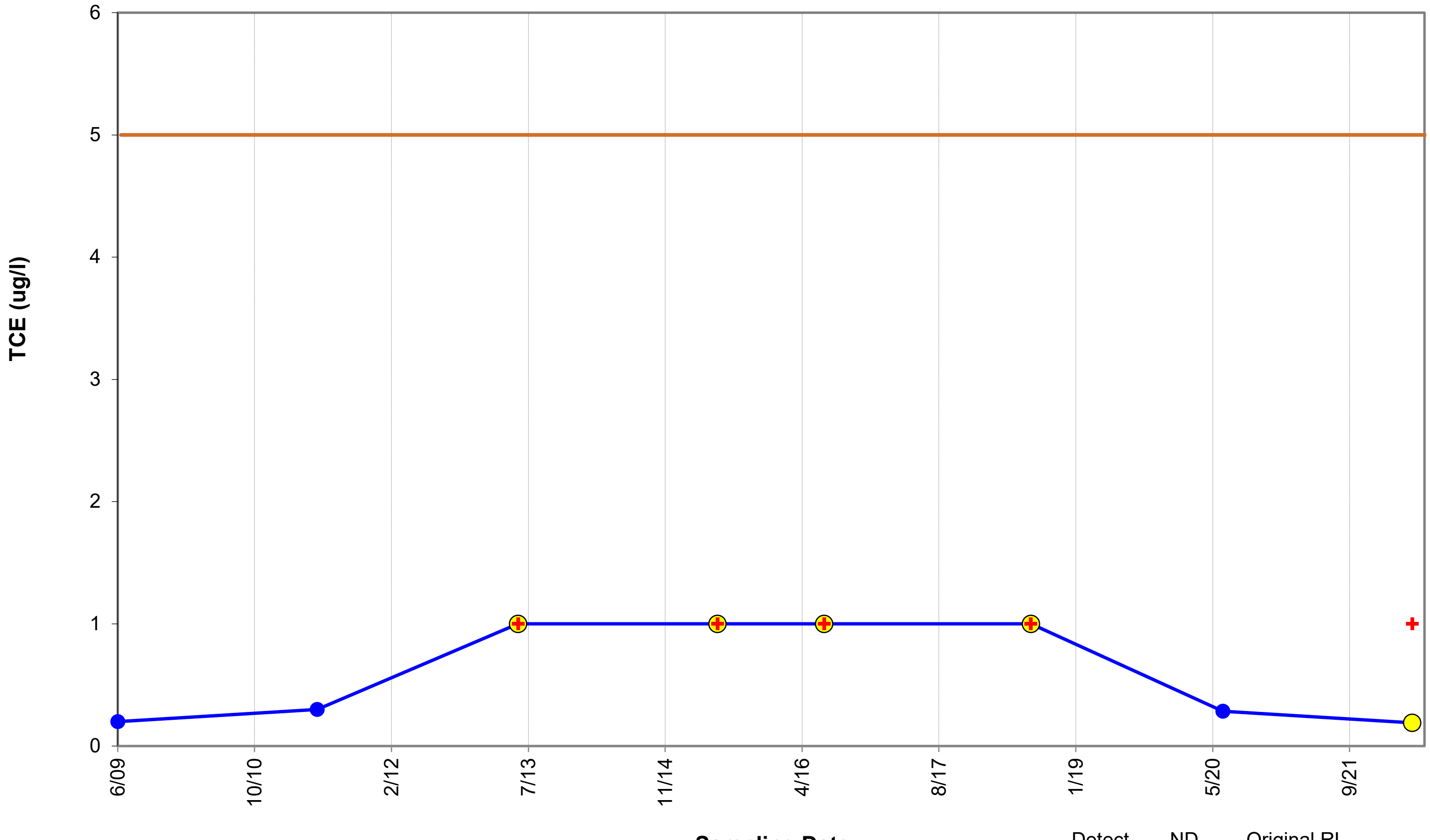
Mann-Kendall Test Result: **Decreasing**

S =	-60
two-tailed p-value =	0.0001
Trend =	Decreasing

Sampling Date: 5/16/2022

Concentration vs. Time Plot – TCE in Well 04J822
Twin Cities Army Ammunition Plant

Figure D-2-28



TCAAP Site Standard Value 5 ug/l

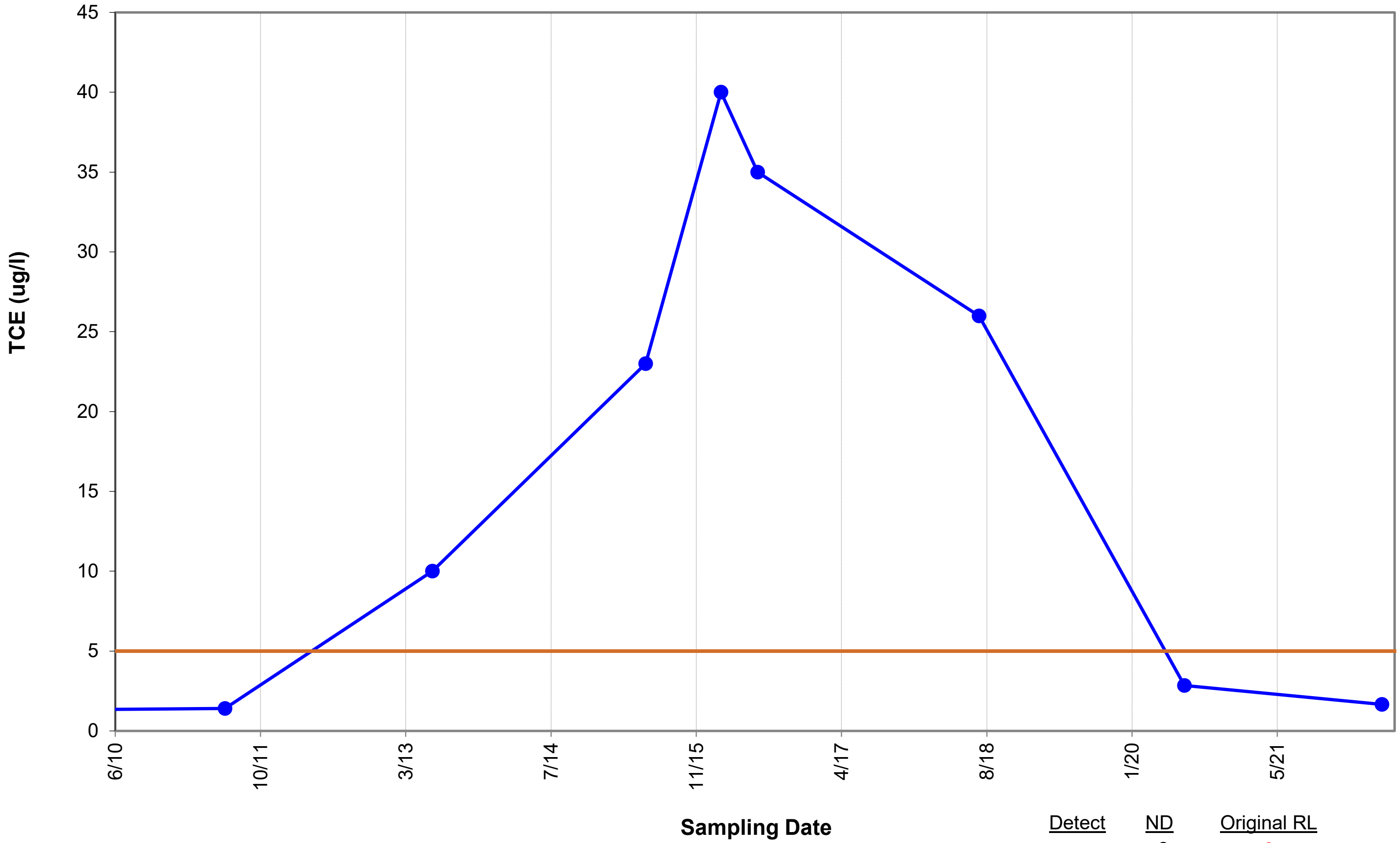
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/16/2022

S =	-6
two-tailed p-value =	0.4940
Trend =	None

Concentration vs. Time Plot – TCE in Well 04J834
Twin Cities Army Ammunition Plant

Figure D-2-29



TCAAP Site Standard Value 5 ug/l

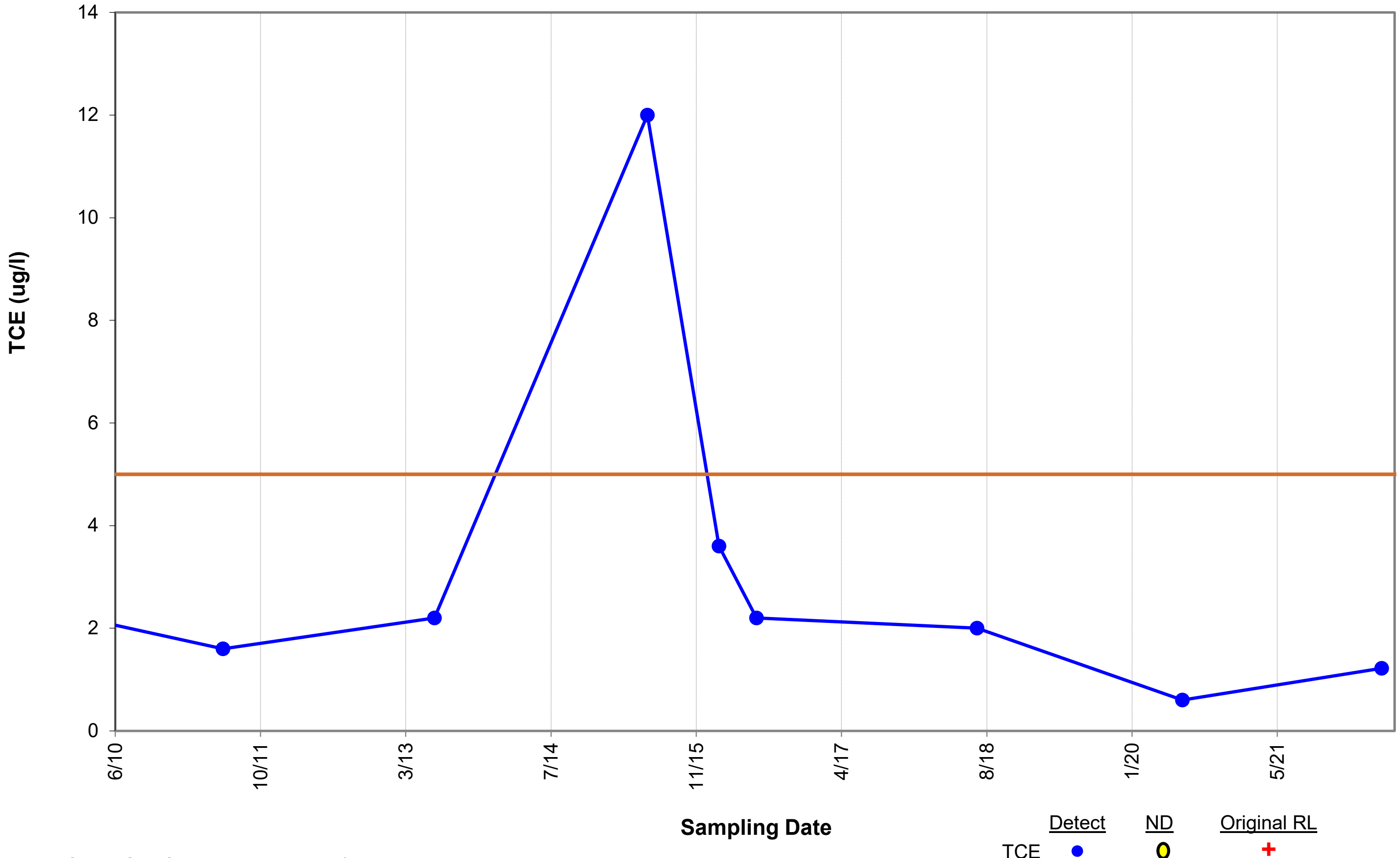
Mann-Kendall Test Result: **No Significant Trend**

S =	8
two-tailed p-value =	0.3988
Trend =	None

Sampling Date: 5/17/2022

Concentration vs. Time Plot – TCE in Well 04J836
Twin Cities Army Ammunition Plant

Figure D-2-30



TCAAP Site Standard Value 5 ug/l

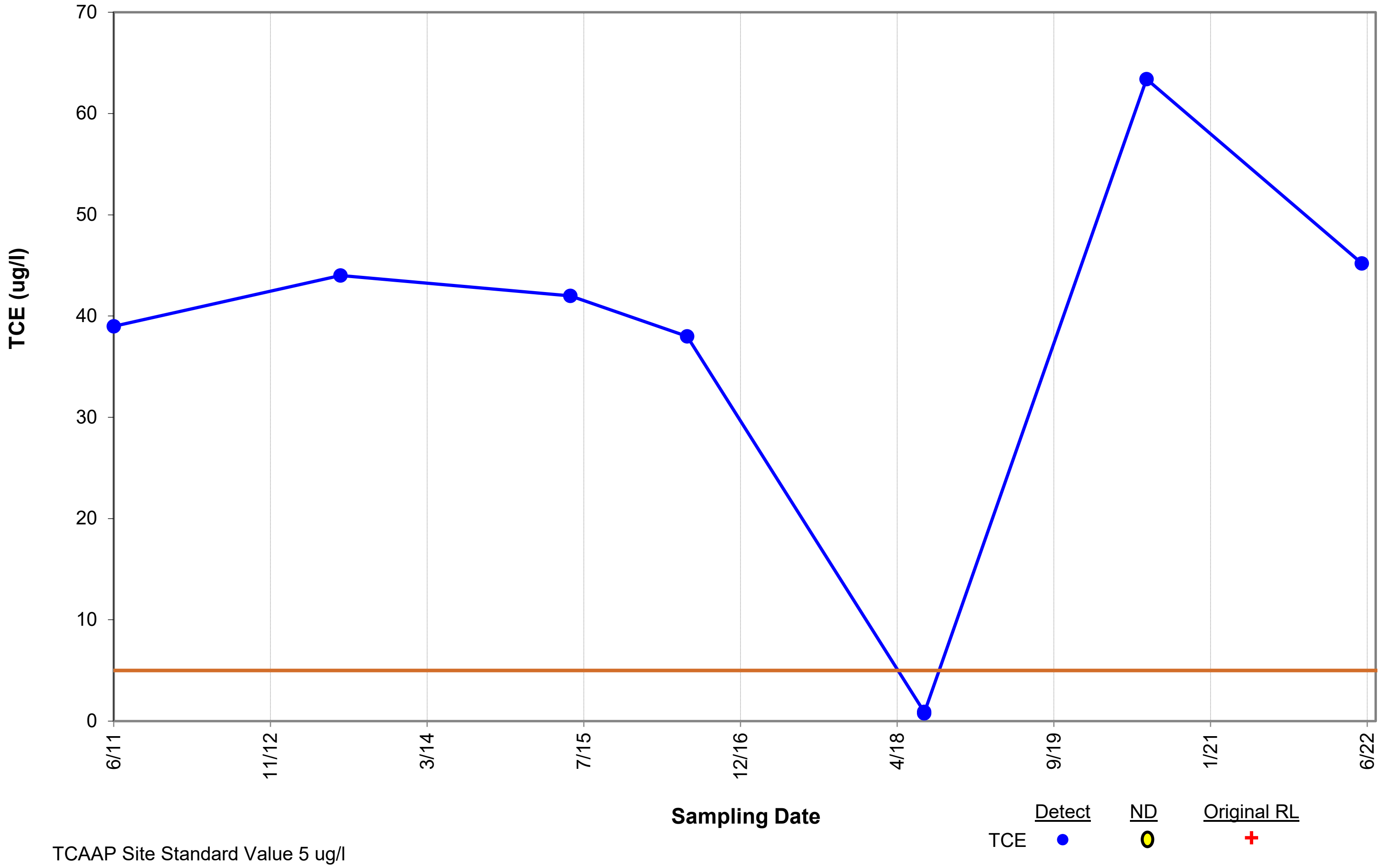
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/16/2022

S =	-10
two-tailed p-value =	0.2751
Trend =	None

Concentration vs. Time Plot – TCE in Well 04J837
Twin Cities Army Ammunition Plant

Figure D-2-31



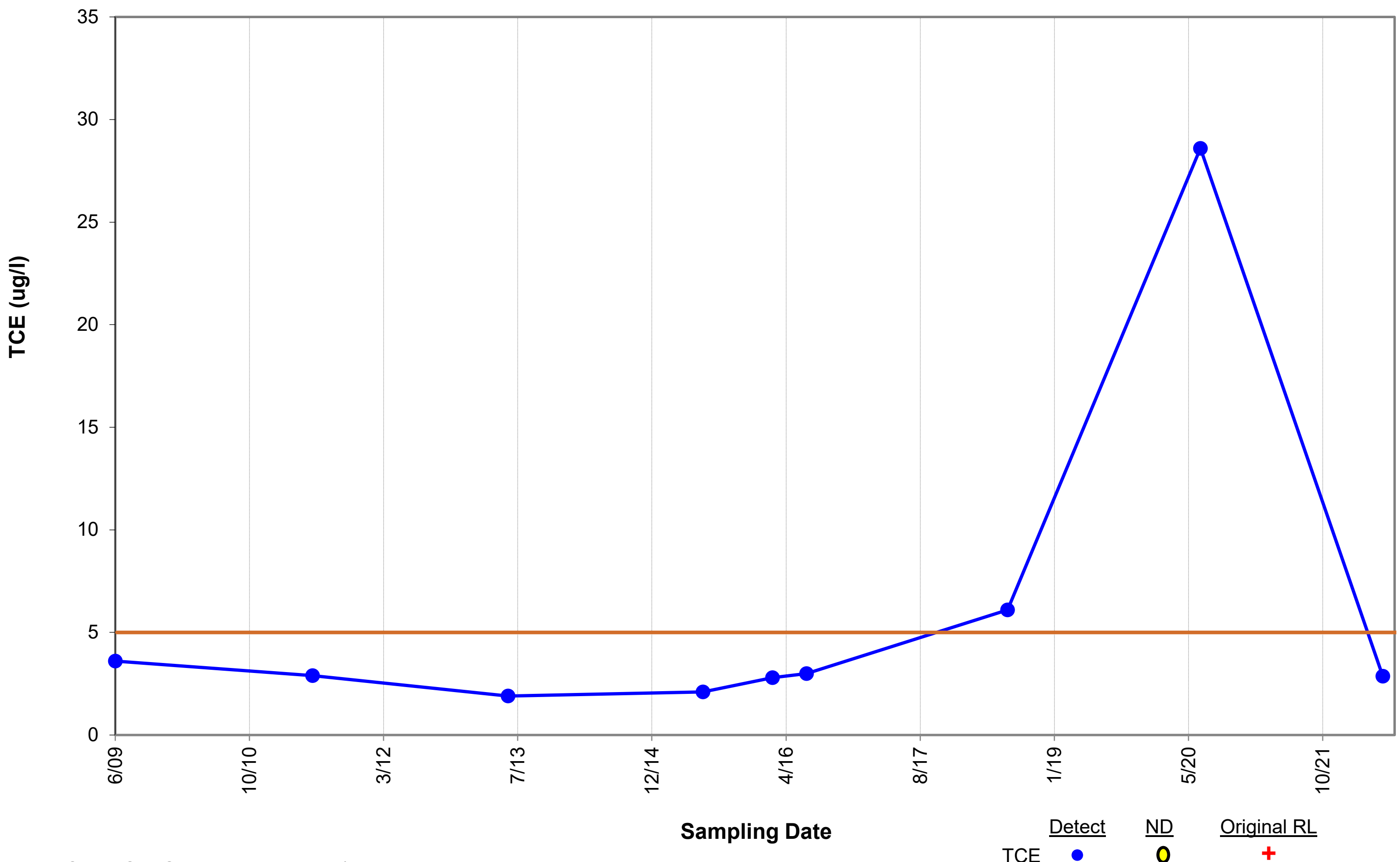
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/17/2022

S =	8
two-tailed p-value =	0.3988
Trend =	None

Concentration vs. Time Plot – TCE in Well 04J838
Twin Cities Army Ammunition Plant

Figure D-2-32



TCAAP Site Standard Value 5 ug/l

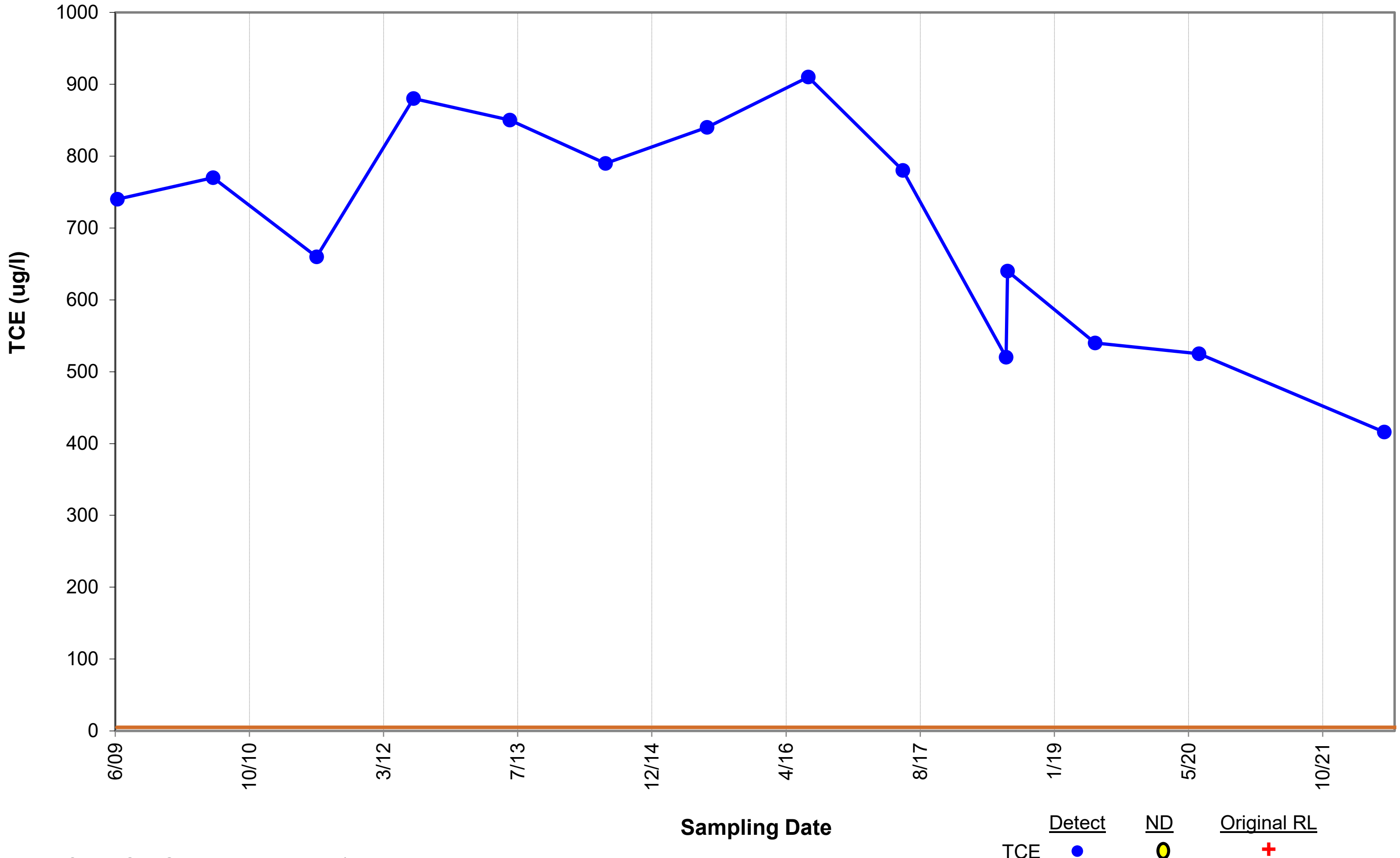
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/17/2022

S =	5
two-tailed p-value =	0.6294
Trend =	None

Concentration vs. Time Plot – TCE in Well 04J839
Twin Cities Army Ammunition Plant

Figure D-2-33



TCAAP Site Standard Value 5 ug/l

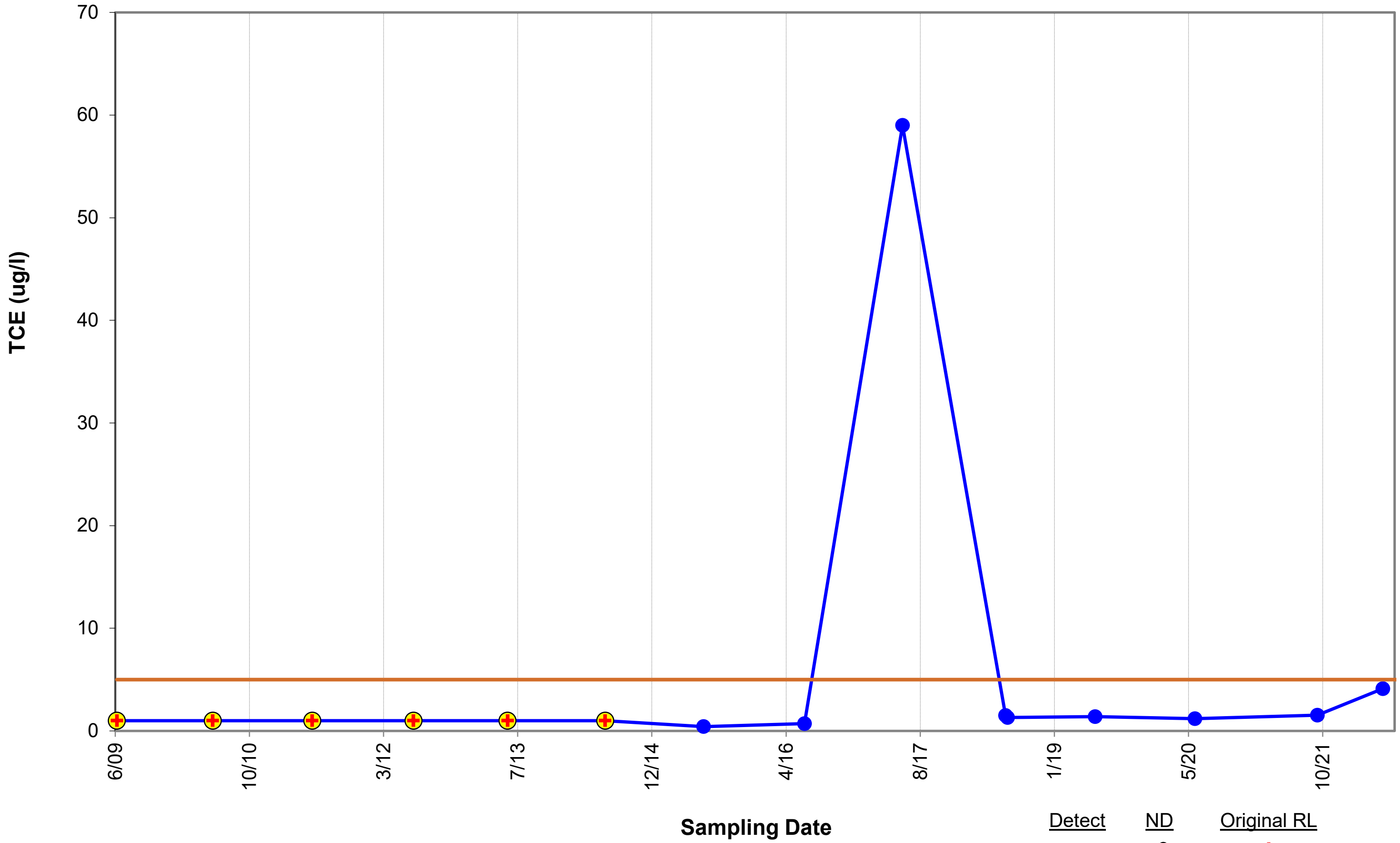
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/22/2022

S =	-22
two-tailed p-value =	0.1526
Trend =	None

Concentration vs. Time Plot – TCE in Well 04J847
Twin Cities Army Ammunition Plant

Figure D-2-34



TCAAP Site Standard Value 5 ug/l

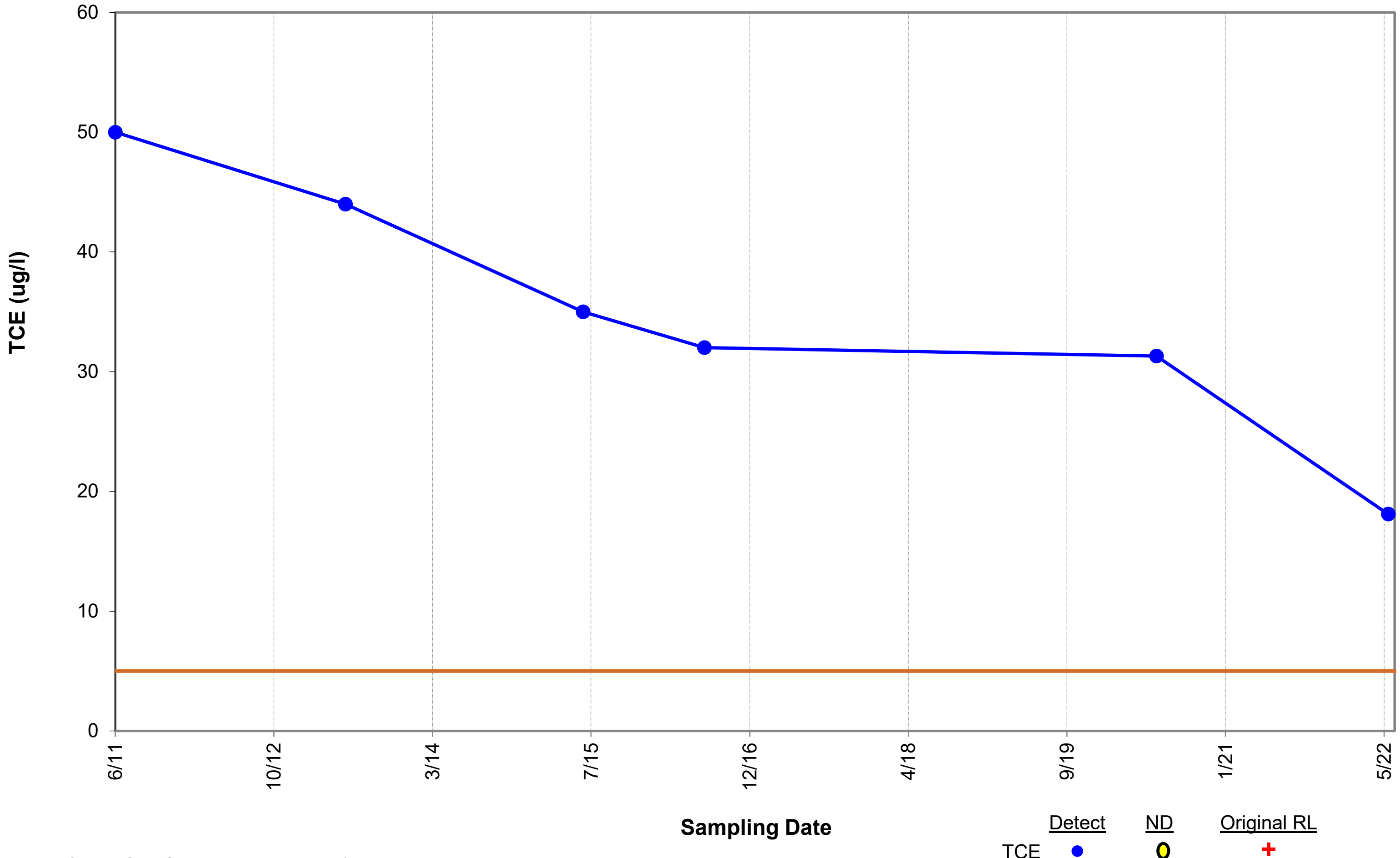
Mann-Kendall Test Result: **Increasing**

S =	50
two-tailed p-value =	0.0005
Trend =	Increasing

Sampling Date: 5/17/2022

Concentration vs. Time Plot – TCE in Well 04J849
Twin Cities Army Ammunition Plant

Figure D-2-35



TCAAP Site Standard Value 5 ug/l

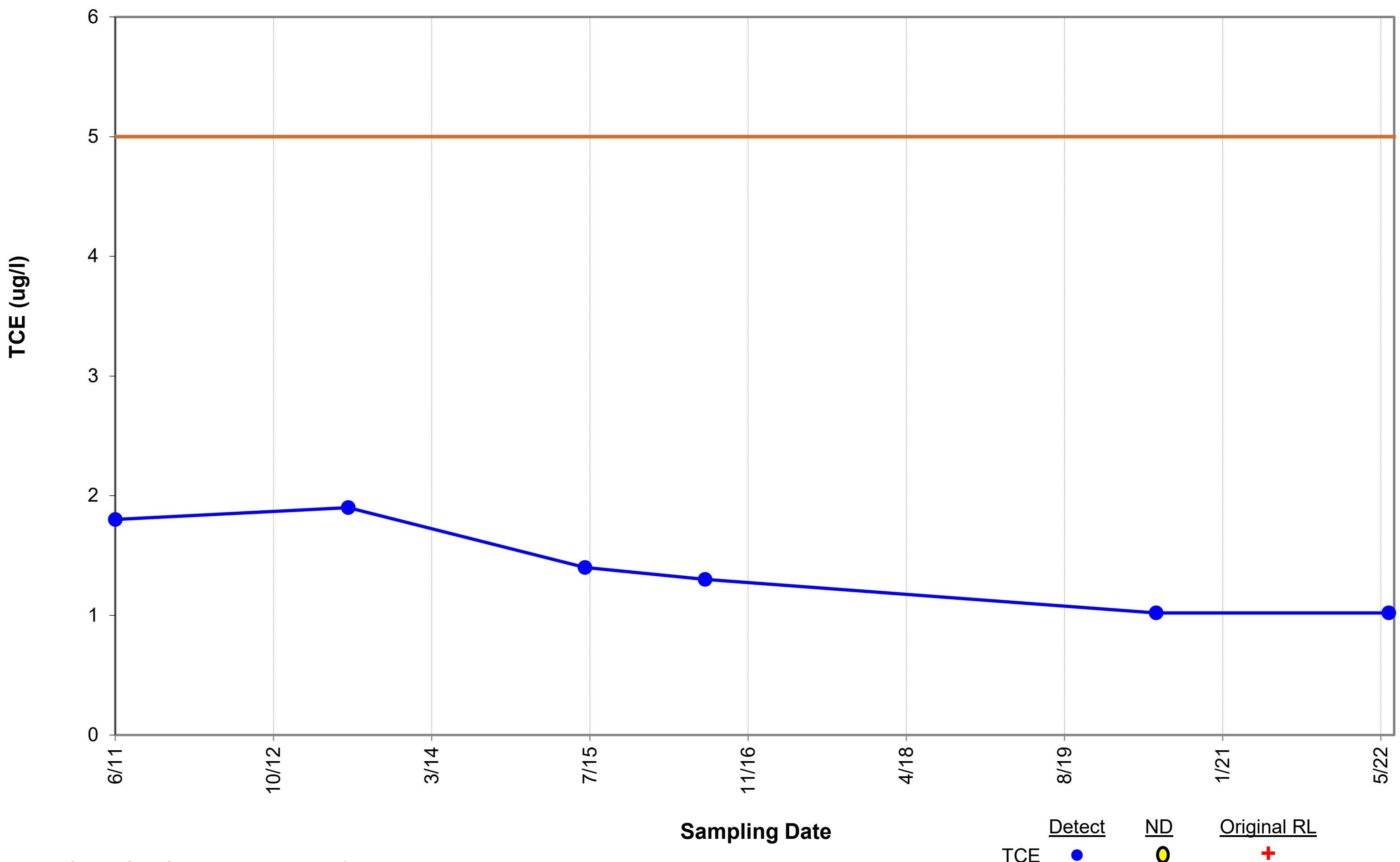
Mann-Kendall Test Result: **Decreasing**

S =	-15
two-tailed p-value =	0.0028
Trend =	Decreasing

Sampling Date: 6/10/2022

Concentration vs. Time Plot – TCE in Well 04U077
Twin Cities Army Ammunition Plant

Figure D-2-36



TCAAP Site Standard Value 5 ug/l

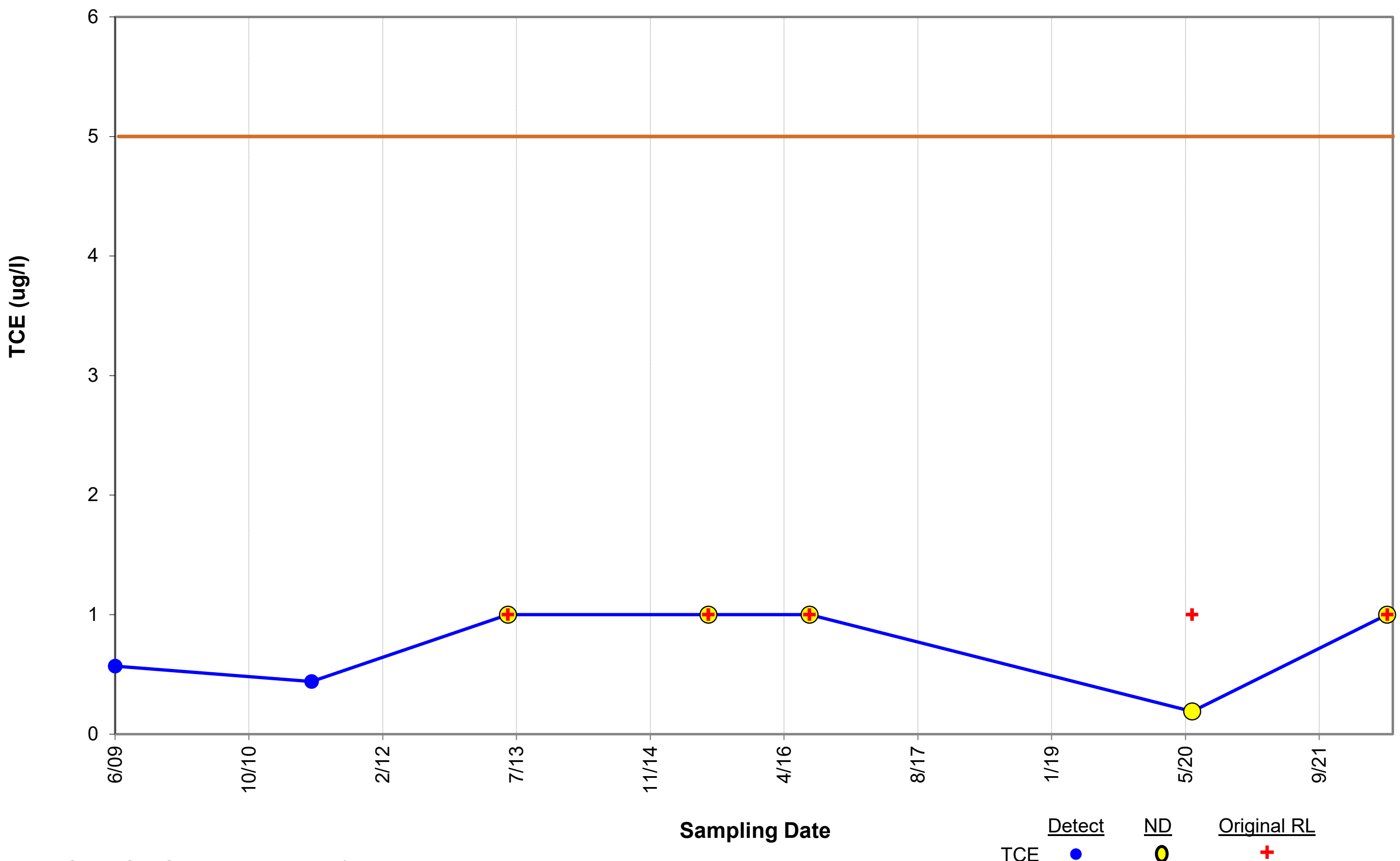
Mann-Kendall Test Result: **Decreasing**

S =	-13
two-tailed p-value =	0.0167
Trend =	Decreasing

Sampling Date: 6/13/2022

Concentration vs. Time Plot – TCE in Well 04U702
Twin Cities Army Ammunition Plant

Figure D-2-37



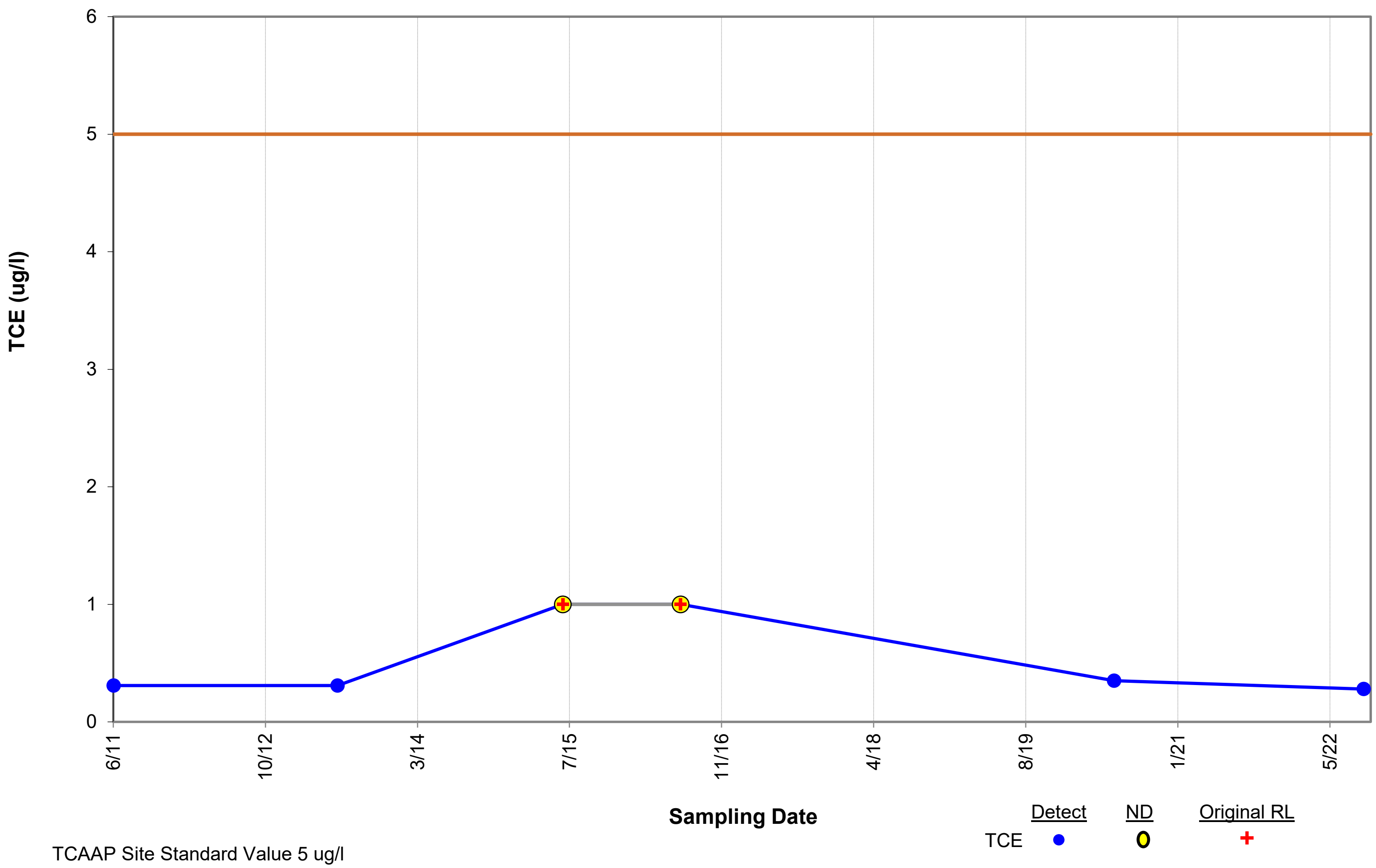
TCAAP Site Standard Value 5 ug/l

Mann-Kendall Test Result: **Probably Decreasing** **Sampling Date:** 6/9/2022

S =	-9
two-tailed p-value =	0.0067
Trend =	Decreasing

Concentration vs. Time Plot – TCE in Well 04U708
Twin Cities Army Ammunition Plant

Figure D-2-38



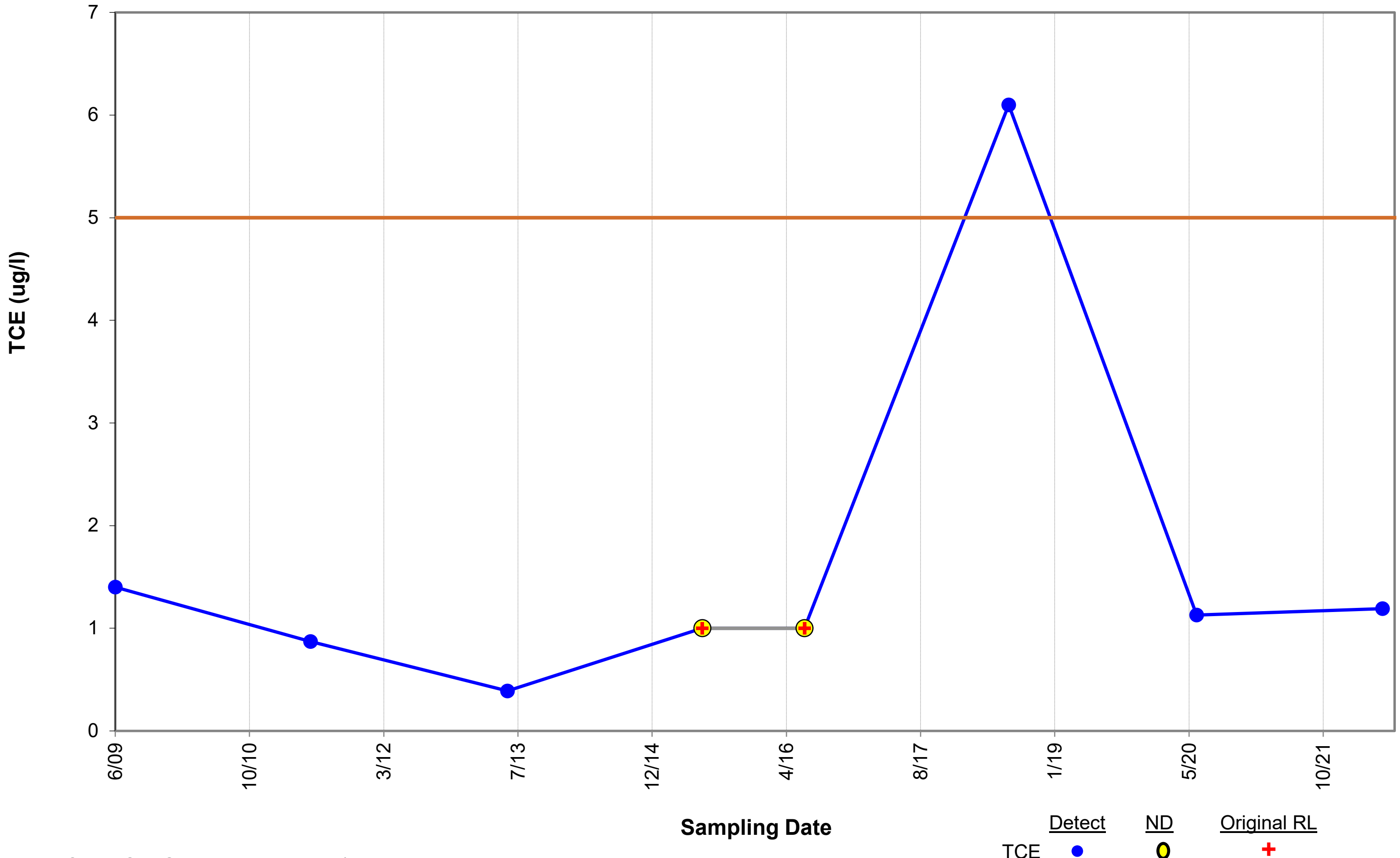
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 9/7/2022

S =	-5
two-tailed p-value =	0.4556
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U713
Twin Cities Army Ammunition Plant

Figure D-2-39



TCAAP Site Standard Value 5 ug/l

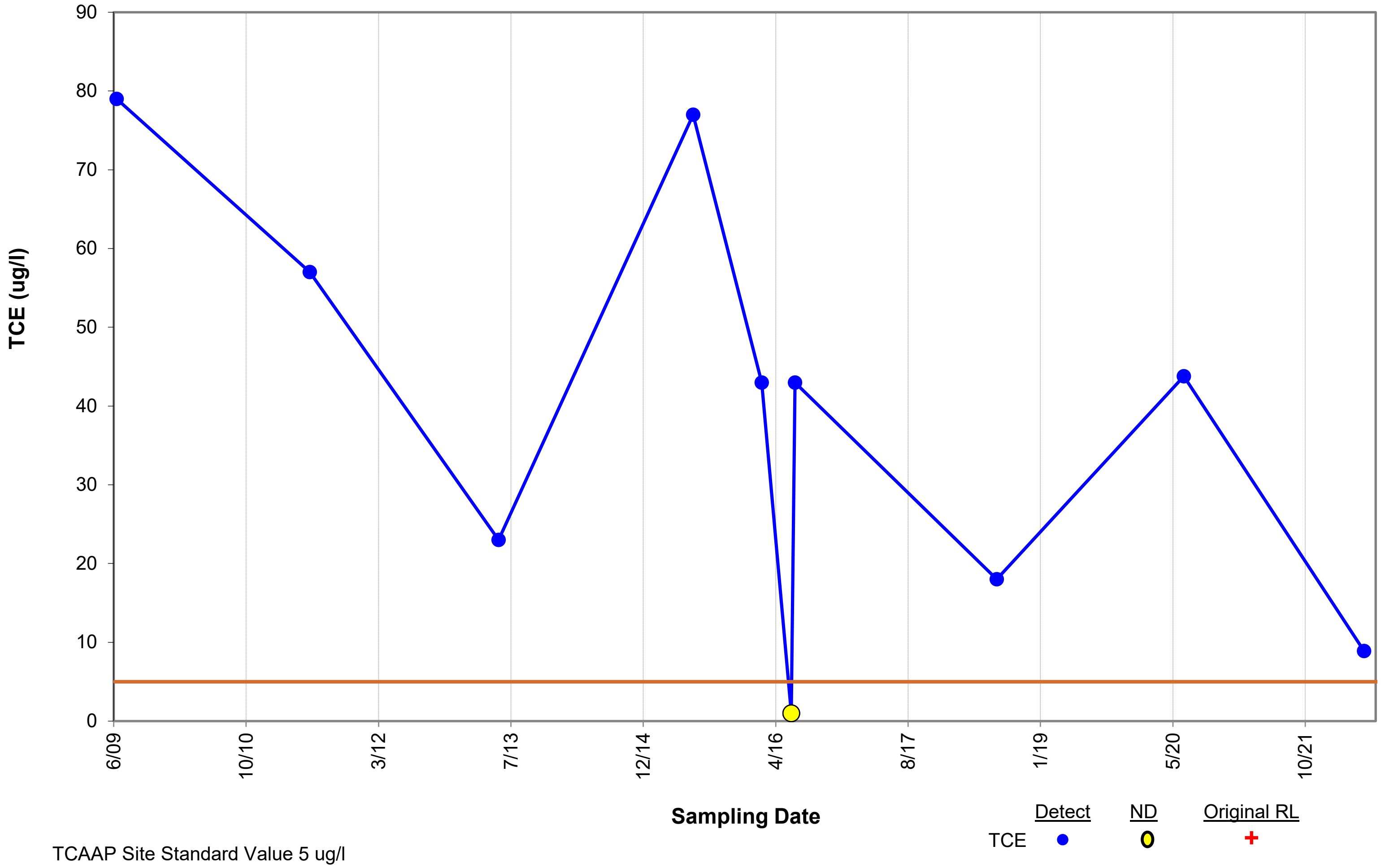
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/16/2022

S =	1
two-tailed p-value =	1.0000
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U834
Twin Cities Army Ammunition Plant

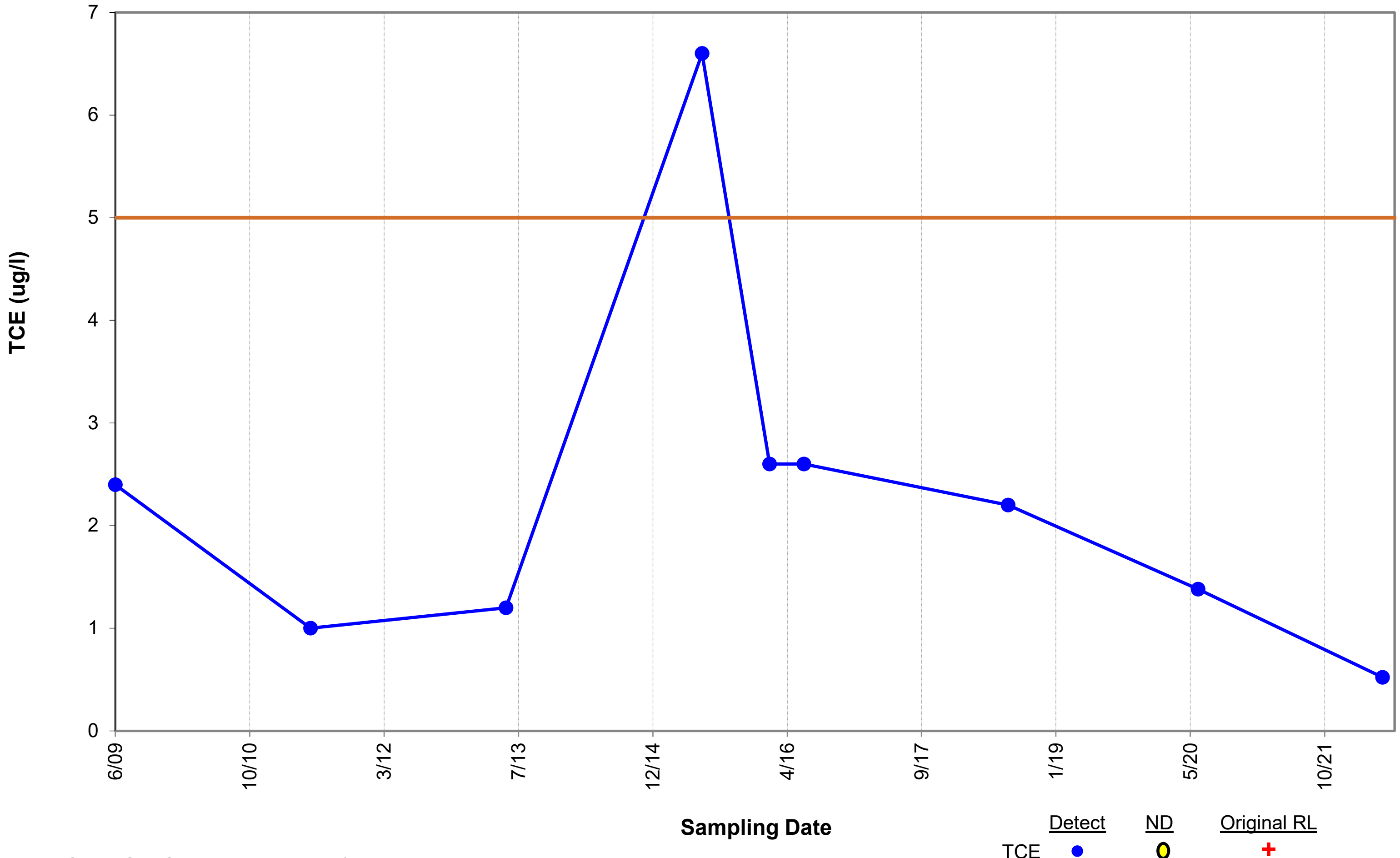
Figure D-2-40



Mann-Kendall Test Result:	**Probably Decreasing**	**Sampling Date:**	5/17/2022
S =	-16		
two-tailed p-value =	0.0610		
Trend =	Decreasing		

Concentration vs. Time Plot – TCE in Well 04U836
Twin Cities Army Ammunition Plant

Figure D-2-41



TCAAP Site Standard Value 5 ug/l

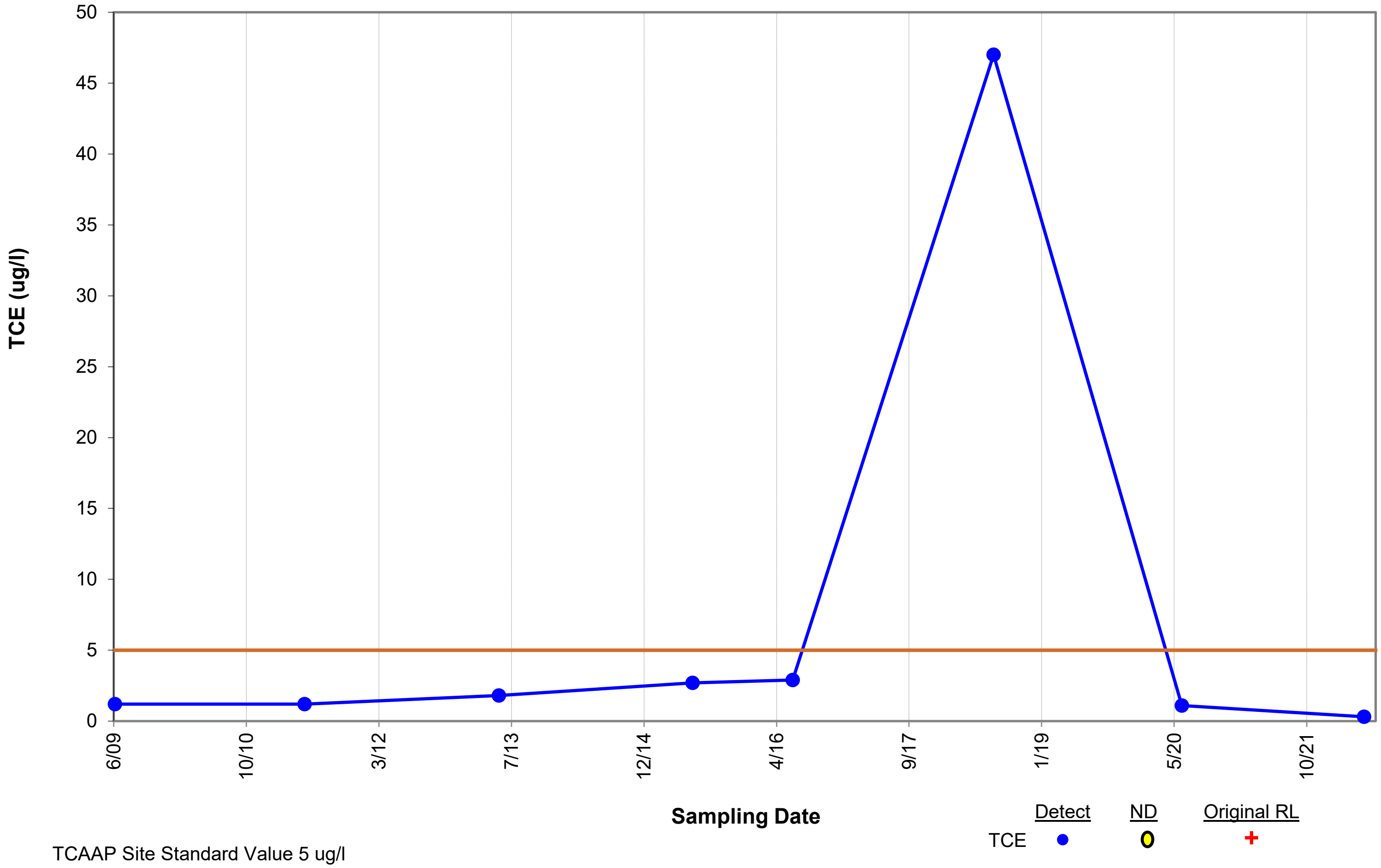
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/16/2022

S =	-6
two-tailed p-value =	0.5484
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U837
Twin Cities Army Ammunition Plant

Figure D-2-42



TCAAP Site Standard Value 5 ug/l

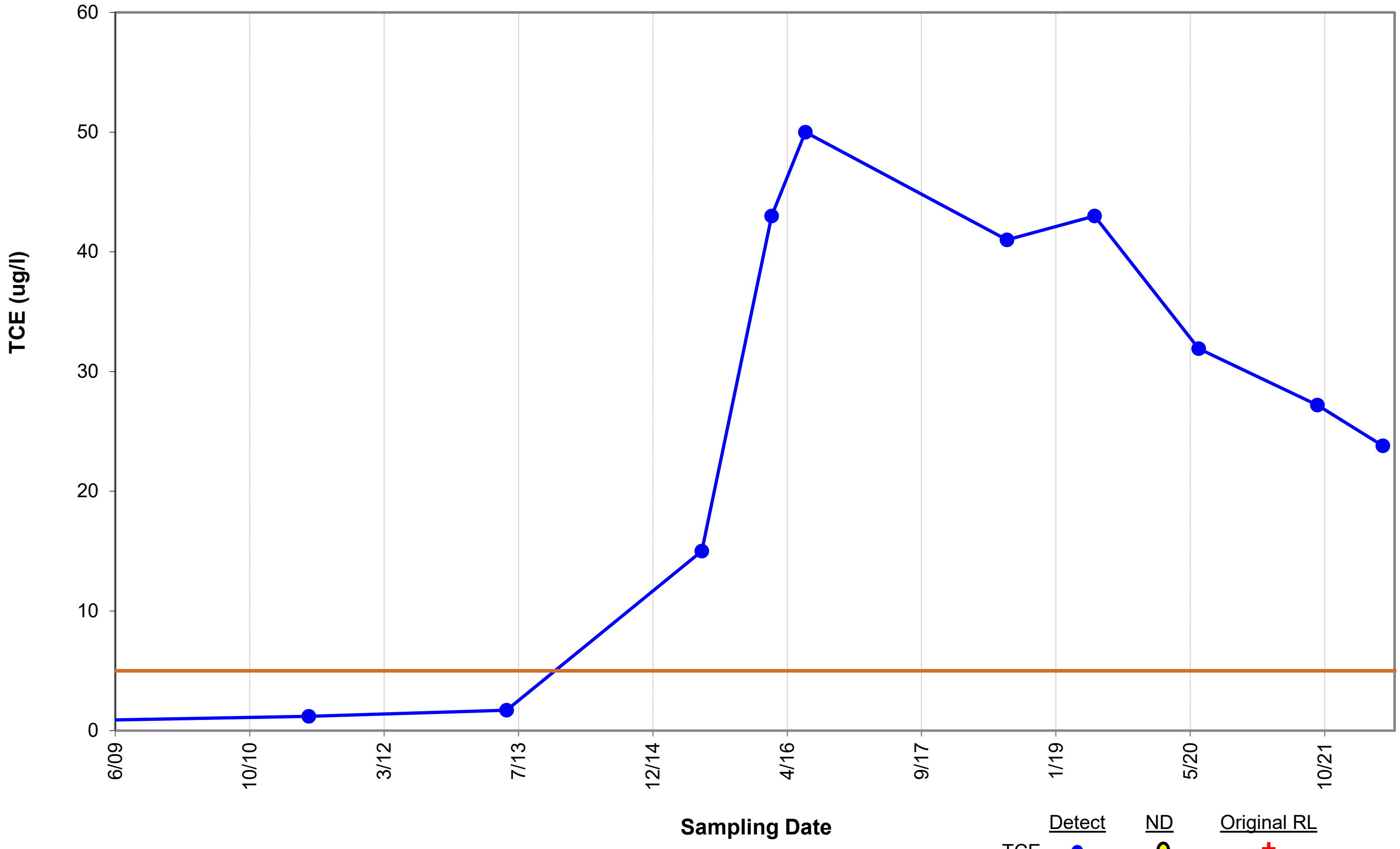
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 5/17/2022

S =	1
two-tailed p-value =	1.0000
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U838
Twin Cities Army Ammunition Plant

Figure D-2-43



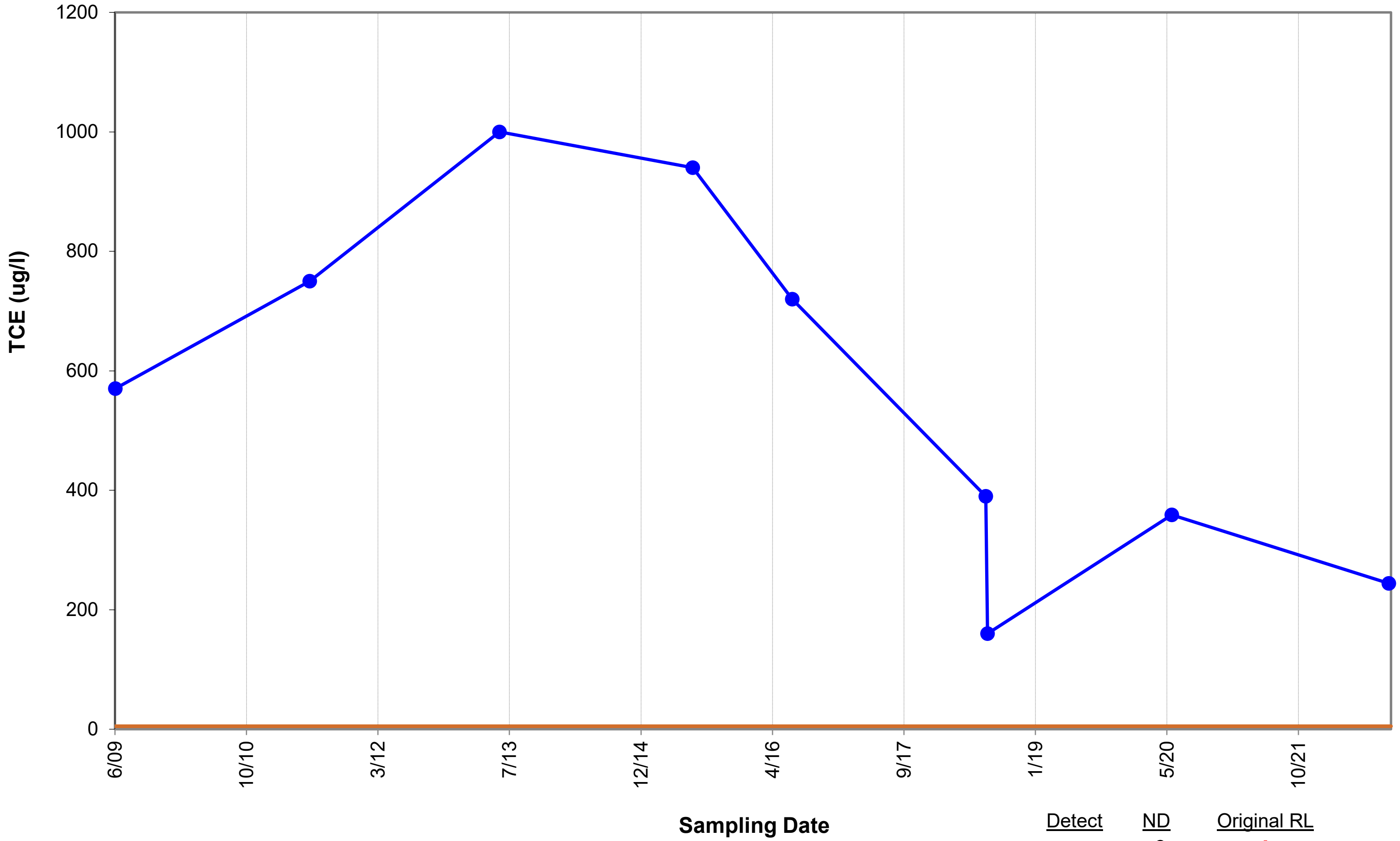
TCAAP Site Standard Value 5 ug/l

Mann-Kendall Test Result: **Probably Increasing** **Sampling Date:** 5/17/2022

S =	18
two-tailed p-value =	0.0752
Trend =	Increasing

Concentration vs. Time Plot – TCE in Well 04U839
Twin Cities Army Ammunition Plant

Figure D-2-44



TCAAP Site Standard Value 5 ug/l

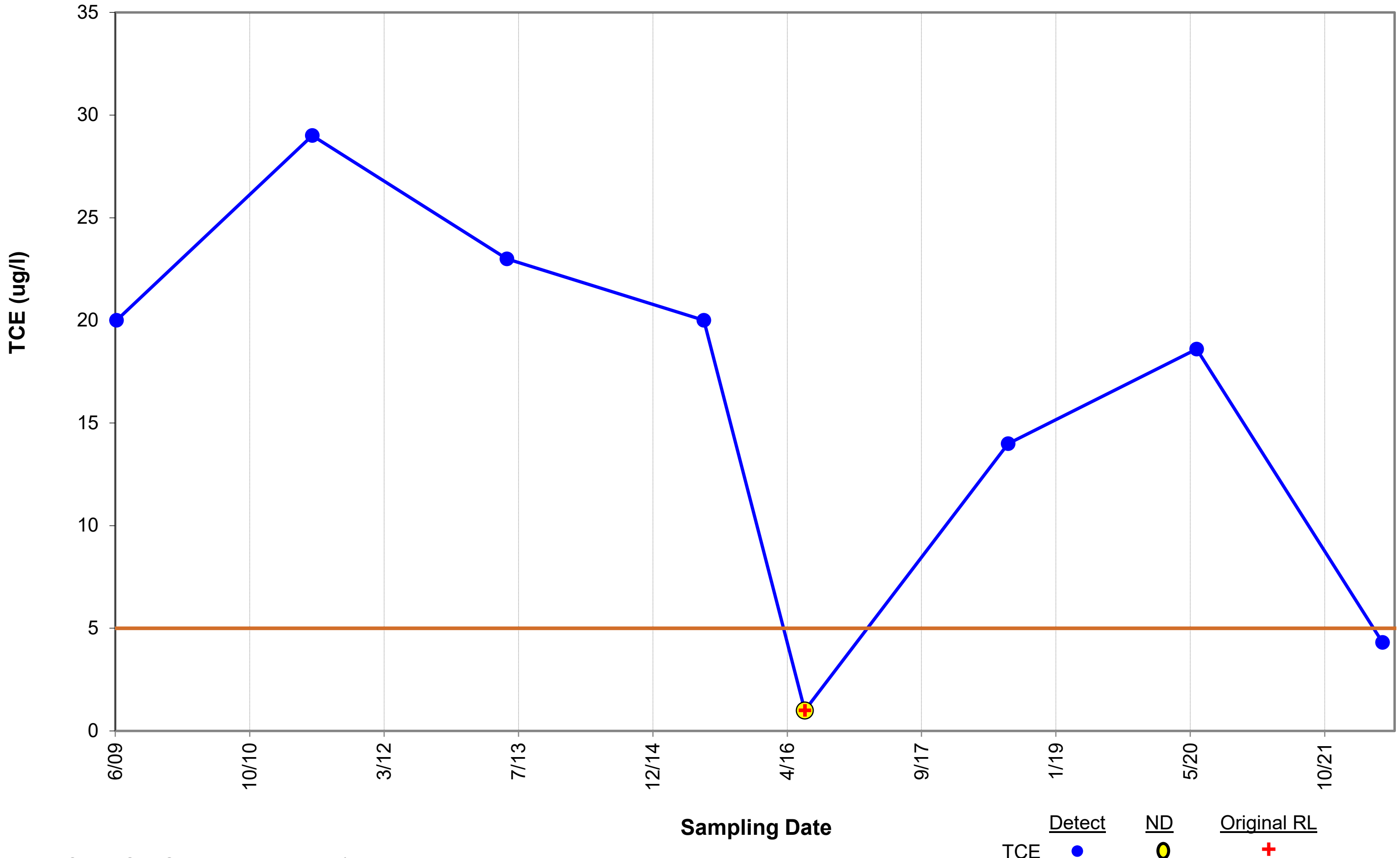
Mann-Kendall Test Result: **No Significant Trend**

Sampling Date: 9/22/2022

S =	-12
two-tailed p-value =	0.1789
Trend =	None

Concentration vs. Time Plot – TCE in Well 04U847
Twin Cities Army Ammunition Plant

Figure D-2-45



TCAAP Site Standard Value 5 ug/l

Mann-Kendall Test Result: **Probably Decreasing**

Sampling Date: 5/16/2022

S =	-15
two-tailed p-value =	0.0798
Trend =	Decreasing

Concentration vs. Time Plot – TCE in Well 04U882
Twin Cities Army Ammunition Plant

Figure D-2-46

Table D-2-1 Mann-Kendall Decision Matrix

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

Table D-2-2 Response Thresholds By Group

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

Notes:

A Response Threshold is the test result(s) that triggers further response. See text for additional explanation of response process.

AWC = Area-weighted concentration

TCE = Trichchloroethylene

TGRS = Twin Cities Army Ammunition Plant Groundwater Recovery System

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Appendix E

Well Survey

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FY 2022 ANNUAL PERFORMANCE REPORT

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 5 micrograms per liter (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 Operable Unit (OU)2.

The "area of concern" for the Unit 3 and Unit 4 aquifers is created by adding a quarter mile buffer area outside the 5 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 Well and Boring Records)
- Sealed Wells (generated through drillers submitting Well Sealing Records)
- 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 reclassified as Category 1a, 1b, 1c, 2a, 2b, or 2c are targeted for sampling in that fiscal year.

"Major" well inventory sampling events occur every 4 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 1 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 2022 UPDATE

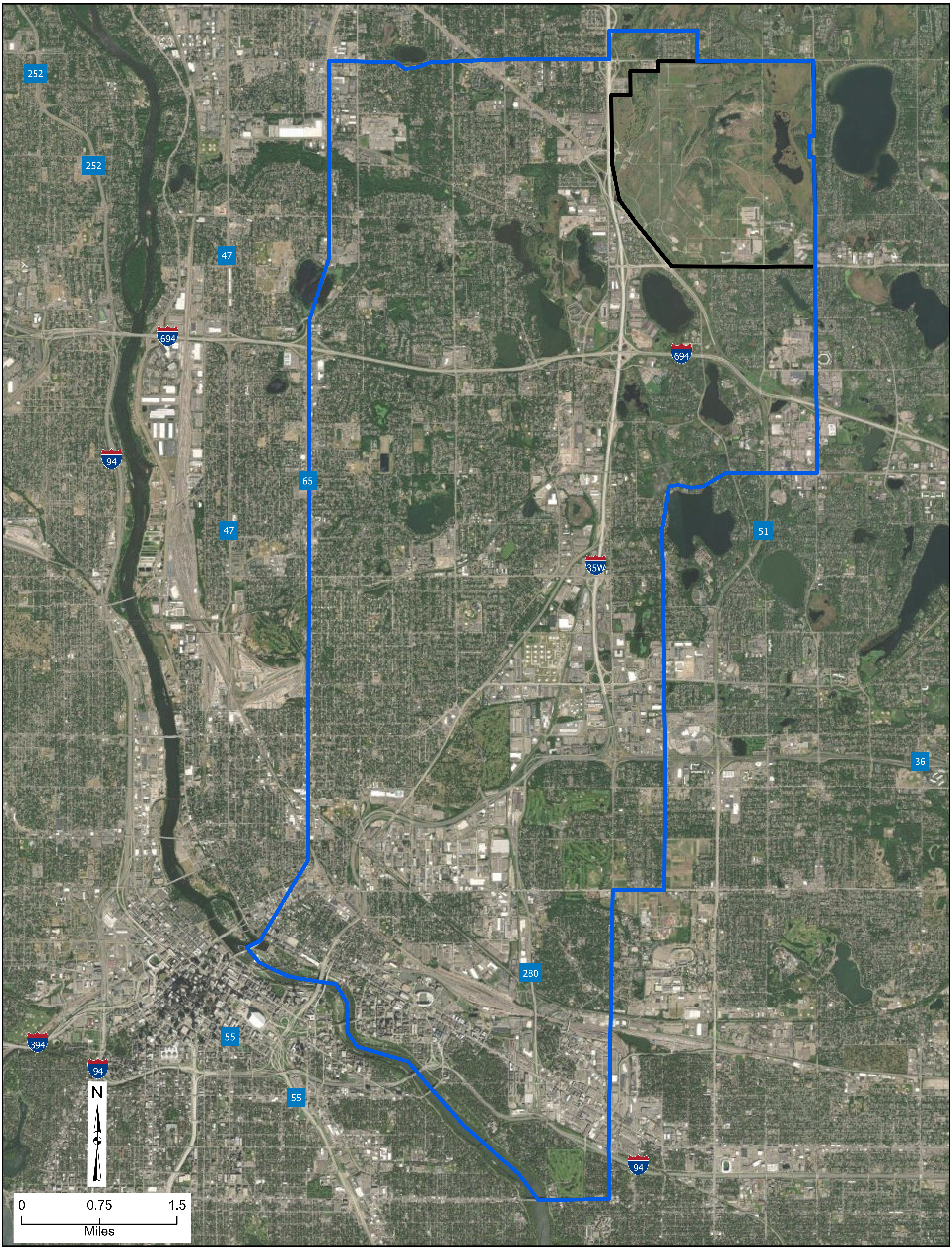
The updated MDH database was provided to EA on 23 January 2023. MDH generates the database from specific Township, Range, and Section data. This comprehensive database was screened to extract the lists of wells that were constructed, disclosed, or sealed between 1 October 2021 and 30 September 2022. Due to the later sampling date for FY 2022, further investigative efforts have not yet commenced for these wells. When initiated, investigation will primarily focus 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. One well was identified within the study area, classified as an environmental well, and placed into Category 6.

Disclosed wells that were identified as being in use, inactive, sealed, or of unknown status and that were determined to be located within the study area, are identified in Table E-3. Disclosed wells that are potentially located within the area of concern and that the MDH identified as having a change in status from active or inactive to sealed will be further investigated for confirmation of their sealed status. There were 29 wells disclosed during FY22 that are located within the study area. Of the 29 wells disclosed, 23 were categorized as 7a (documented as sealed). Six wells were noted in the query as "Not In Use" or of unknown status and were categorized as 4b (unknown location potentially within the study area), pending further investigation.

Sealed wells were found by reviewing the MDH sealed well list. The 25 wells identified as sealed are shown in Table E-4. Wells identified as sealed in the MDH database updates were assigned to Category 7a.

FY 2022 was not a "major" well inventory sampling event, which occur every 4 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 2024.



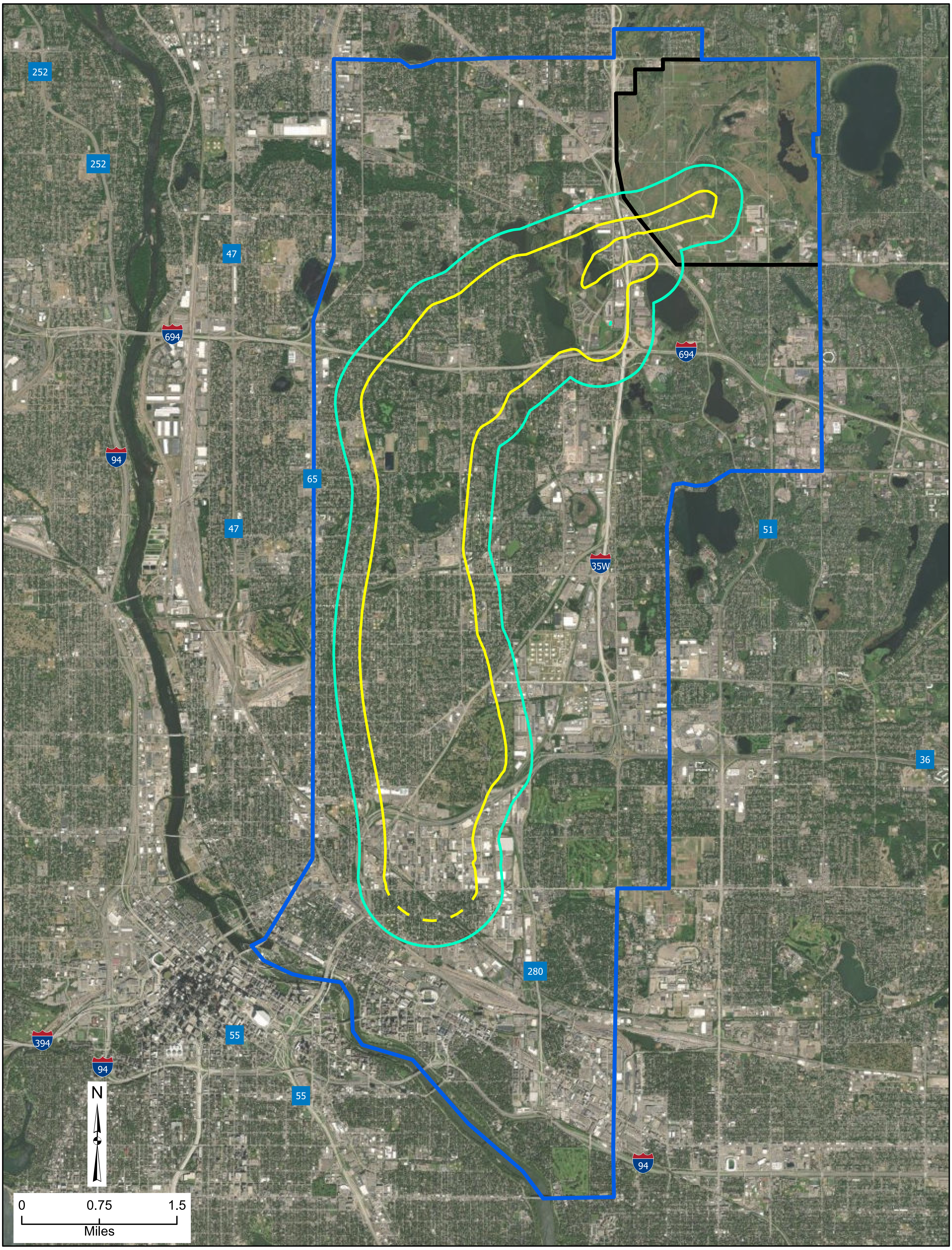
Legend

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.)

Well Inventory Study Area and MDH Special Well Construction Area

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure E-1
Annual Performance Report
Well Inventory Study Area
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

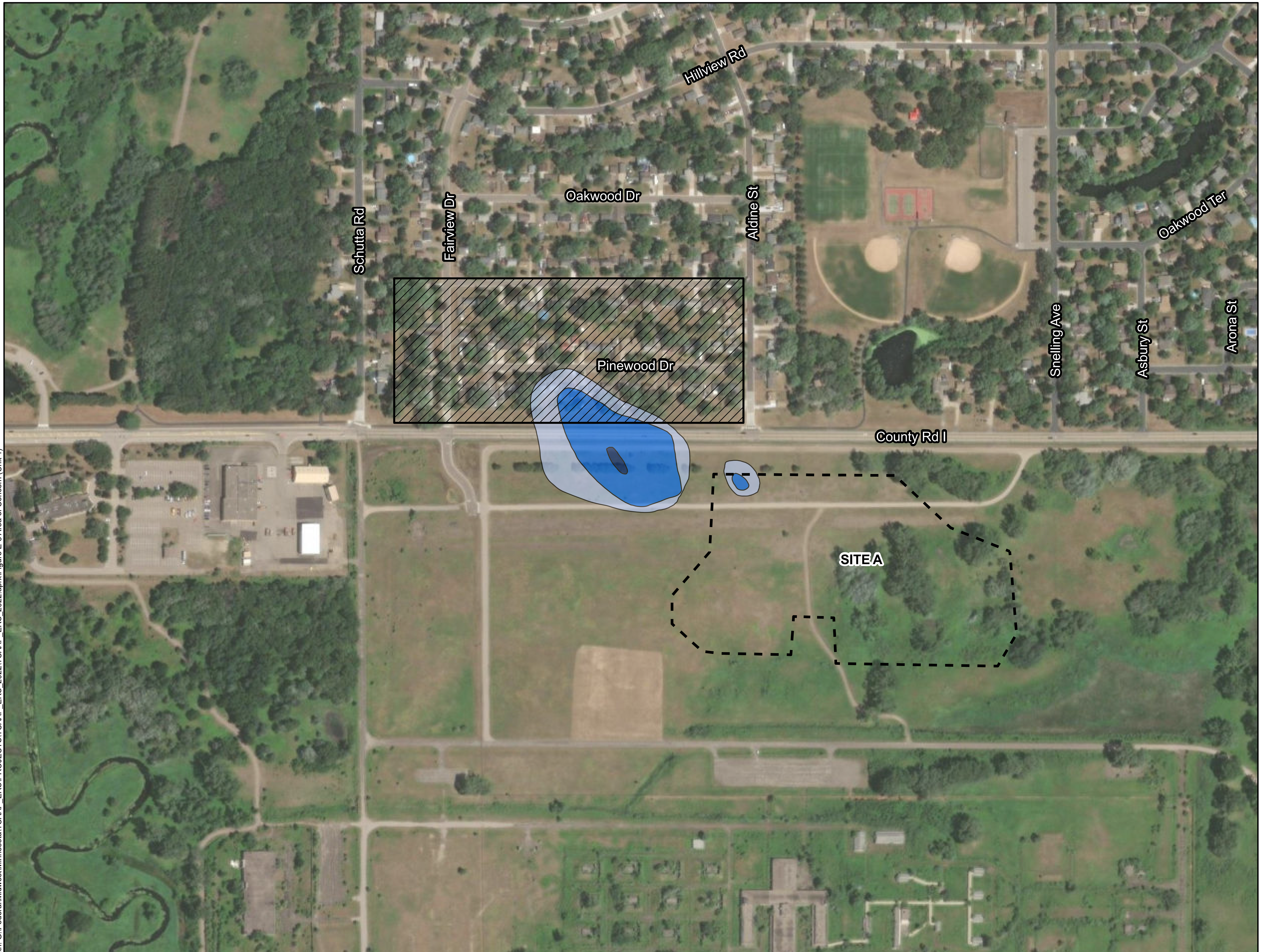


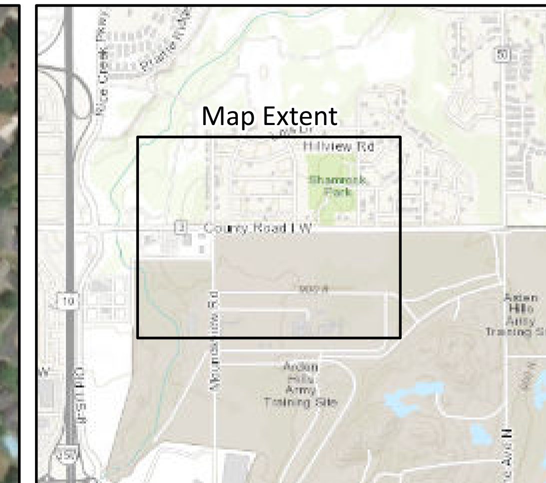
Legend

- 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.)
- Well Inventory Study Area and MDH Special Well Construction Area
- 2022 (0.4 µg/L)
- 2022 Inferred (0.4 µg/L)
- Area of Concern (1/4 mile Buffer)

Date: 1/26/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure E-2
FY 2022 Annual Performance Report
Areas of Concern (Upper Unit 4)
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota





Legend

Unit 1 Aquifer Area of Concern

OU2 On-site Boundaries

cis-1,2-Dichloroethene Concentrations

1-10 μg/L

10-100 μg/L

> 100 μg/L

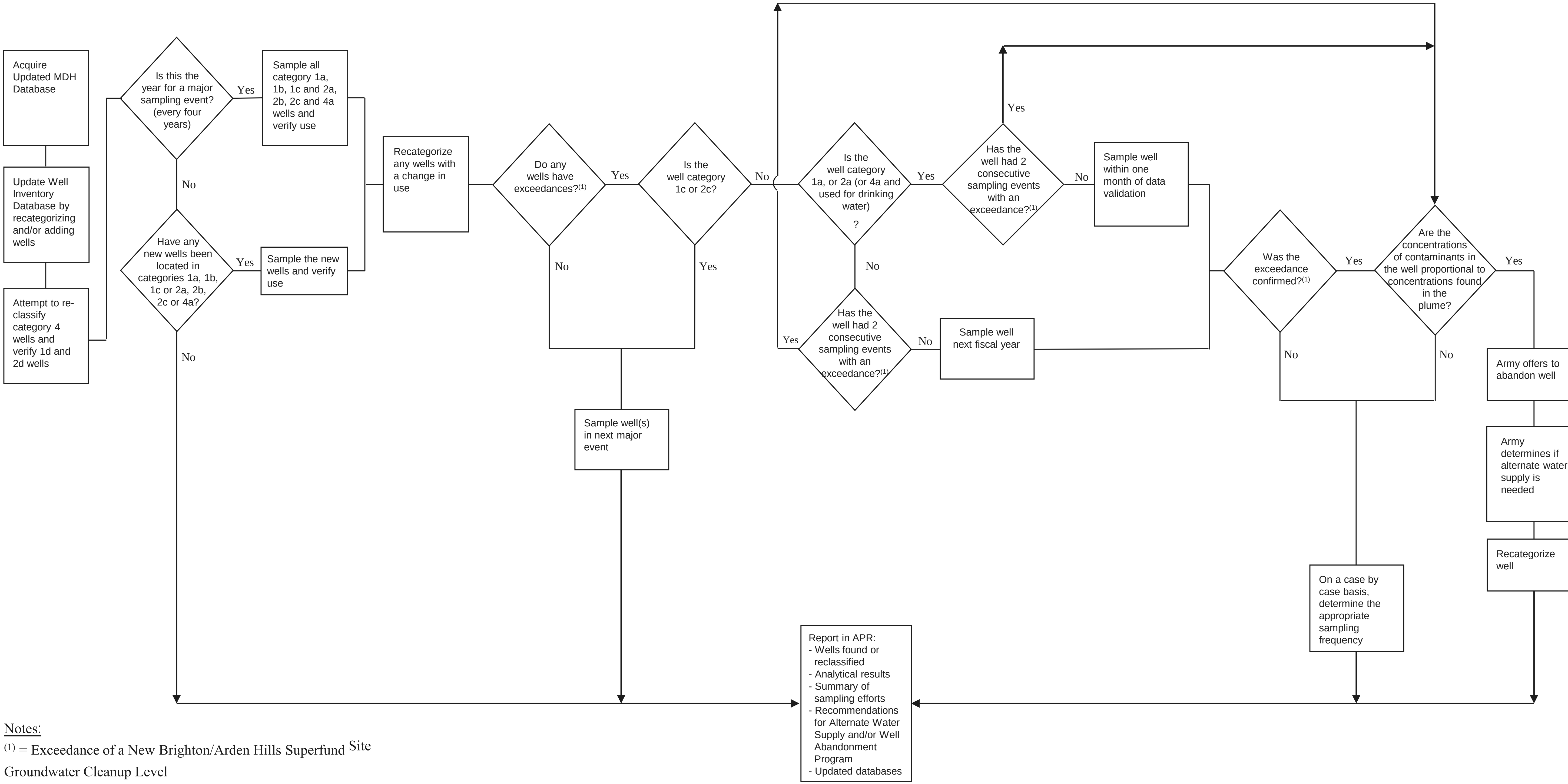
Map Date: 1/24/2023
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 250 500
US Feet

Figure E-3
Annual Performance Report
Area of Concern (Unit 1)
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

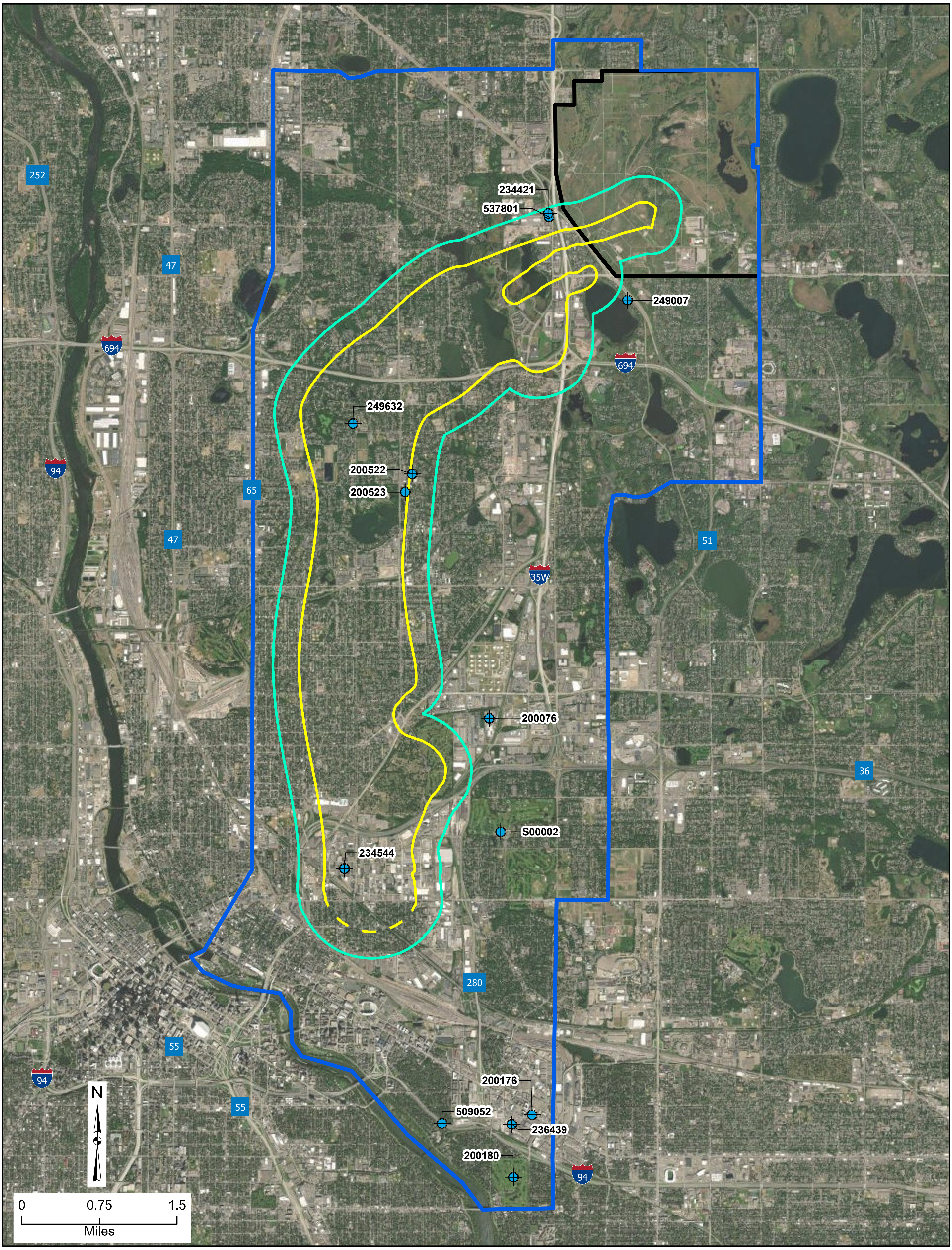
Figure E-4
Annual Requirements for Maintaining Well Inventory Database

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.



Legend

- Well Location
- 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.)
- Well Inventory Study Area and MDH Special Well Construction Area
- Upper Unit 4 1 μg/L TCE Plume (FY 2022)
- Inferred Upper Unit 4 1 μg/L TCE Plume (FY 2022)
- Area of Concern (1/4 mile Buffer)

Date: 1/24/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_2022\TCAAP_ERS_2022.aprx

Figure E-5
Annual Performance Report
FY 2021 Well Inventory Sampling Locations
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Table E-1 Well Inventory Category Descriptions

Category	Subcategory	Explanation
1		Water supply wells screened in an aquifer of concern, inside the area of concern. 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 or inside the buffer lines but outside the area of concern, 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
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 Minnesota Department of Health Constructed Wells FY22

Unique Number	Category	Last Name or Business Name	Street	City	Use	Depth (feet)	Date Drilled
773089	6	US Army	N/A	N/A	Environmental Well	9	12/8/2021

Notes:

MDH = Minnesota Department of Health

N/A = not applicable

Table E-3 Minnesota Department of Health Disclosed Wells FY22

Unique Number	Category	Last Name or Business Name	Street	City	Status	Date Completed	Depth	Date Drilled
280615	4b	Michel Sales Co.	45 Maryland Avenue E	St. Paul	Unknown	12/28/2021	N/A	N/A
280616	4b	Michel Sales Co.	45 Maryland Avenue E	St. Paul	Unknown	12/28/2021	N/A	N/A
280617	4b	Michel Sales Co.	45 Maryland Avenue E	St. Paul	Unknown	12/28/2021	N/A	N/A
548481	7a	Khan	2968 Old Highway 8	Roseville	Sealed	6/16/2022	N/A	N/A
629854	7a	Shepperd	2211 St. Croix Street	Roseville	Sealed	9/14/2022	N/A	N/A
656372	7a	Hanson	4223 Hamline Avenue N	Arden Hills	Sealed	8/11/2022	N/A	N/A
658676	7a	Drake	1749 Roselawn Avenue W	Roseville	Sealed	8/9/2022	N/A	N/A
3086418	7a	Johnson	3308 New Brighton Road	Arden Hills	Sealed	2/21/2022	N/A	N/A
3381312	7a	Anderson	2043 Thom Drive	Arden Hills	Sealed	3/10/2022	N/A	N/A
3582648	7a	Diedrich	2545 Herschel Street	Roseville	Sealed	2/21/2022	N/A	N/A
3653017	4b	Kenzie Multifamily, LLC	2401 Lowry Avenue NE	St. Anthony	Not In Use	6/16/2022	N/A	N/A
3760698	7a	Anderson	1748 Lake Valentine Road	Arden Hills	Sealed	3/11/2022	N/A	N/A
3857869	7a	Heppner	2221 Seventh Street NW	New Brighton	Sealed	6/15/2022	N/A	N/A
3905807	7a	Kuenzli	1481 17th Street NW	New Brighton	Sealed	11/3/2021	N/A	N/A
3915765	7a	Palmer	1916 Glen Paul Avenue	Arden Hills	Sealed	12/23/2021	N/A	N/A
3919395	4b	Barlow	7425 Bacon Drive NE	Fridley	Not In Use	1/22/2022	N/A	N/A
3920197	7a	Bartzen	642 11th Street NW	New Brighton	Sealed	1/27/2022	N/A	N/A
3921808	4b	Vickerman	4740 Second Street NE	Fridley	Not In Use	2/9/2022	N/A	N/A
3930897	7a	Hemken	4444 Snelling Avenue N	Arden Hills	Sealed	4/8/2022	N/A	N/A
3932296	7a	Olson	1617 Ridgewood Lane S	Roseville	Sealed	9/13/2022	N/A	N/A
3934241	7a	Jenkins	1833 Draper Drive	Roseville	Sealed	5/31/2022	N/A	N/A
3936563	7a	Ledray	6040 Fifth Street NE	Fridley	Sealed	6/30/2022	N/A	N/A
3943444	7a	Cohen	1686 Ridgewood Lane S	Roseville	Sealed	6/21/2022	N/A	N/A
3943849	7a	Douvier	3041 Wheeler Street N	Roseville	Sealed	6/10/2022	N/A	N/A
3944811	7a	Meeds	2551 Fry Street	Roseville	Sealed	7/15/2022	N/A	N/A
3947181	7a	Yuanqing	6449 Pierce Street NE	Fridley	Sealed	8/1/2022	N/A	N/A
3951091	7a	Scherman	5060 Long Lake Road	Mounds View	Sealed	9/26/2022	N/A	N/A
3951235	7a	Christiansen	1891 Lake Lane	Arden Hills	Sealed	8/29/2022	N/A	N/A
3951309	7a	Kammeyer	3006 16th Street NW	New Brighton	Sealed	8/5/2022	N/A	N/A

Table E-4 Minnesota Department of Health Sealed Wells FY22

Unique Number	Category	Last Name or Business Name	Street	City	Use	Date Sealed
0000206761	7a	City of New Brighton	1975 Silver Lake Road	New Brighton	Water Supply	11/17/2021
0000447908	7a	N/A	2576 Doswell Avenue	St. Paul	Monitoring	6/21/2022
0000447909	7a	Metro Metals	2576 Doswell Avenue	St. Paul	Monitoring	6/21/2022
0000447910	7a	Metro Metals	2576 Doswell Avenue St. Paul 55108	St. Paul	Monitoring	6/21/2022
0000447912	7a	Metro Metals	2576 Doswell Avenue	St. Paul	Monitoring	6/21/2022
0000447913	7a	Metro Metals	2576 Doswell Avenue	St. Paul	Monitoring	6/21/2022
0000850987	7a	The Flats at Malcolm Yards, LLC	495 Malcolm Avenue SE	Minneapolis	Monitoring	4/11/2022
0000867641	7a	Twin City Die Cast	1070 33Rd Avenue SE	Minneapolis	WMTB	9/14/2022
H000348421	7a	N/A	2420 County Road C W	Roseville	Env. Boring	10/12/2021
H000377095	7a	Bartzen	642 11th Street NW	New Brighton	Water Supply	11/30/2021
H000383447	7a	N/A	2299 Palmer Drive	New Brighton	Other	11/2/2021
H000386343	7a	Doherty	2110 Rosewood Lane S	Roseville	Water Supply	11/4/2021
H000389284	7a	Capp Industries	Vandalia Street	St. Paul	Other	10/8/2021
H000389286	7a	Capp Industries	Vandalia Street	St. Paul	Other	10/8/2021
H000389287	7a	Capp Industries	Vandalia Street	St. Paul	Other	10/8/2021
H000389288	7a	Capp Industries	Vandalia Street	St. Paul	Other	10/8/2021
H000389289	7a	Capp Industries	Vandalia Street	St. Paul	WMEW	10/8/2021
H000389290	7a	Capp Industries	Vandalia Street	St. Paul	WMEW	10/8/2021
H000389291	7a	Capp Industries	Vandalia Street	St. Paul	WMEW	10/8/2021
H000389292	7a	N/A	Vandalia Street	St. Paul	WMEW	10/8/2021
H000389293	7a	N/A	Vandalia Street	St. Paul	WMEW	10/8/2021
H000389451	7a	FM Trucking Co., Inc.	175 Old Highway 8 SW	New Brighton	WMTB	10/27/2021
H000389549	7a	PPL	3430 University Avenue SE	Minneapolis	WMTB	12/2/2021
H000390564	7a	JRW Property, LLC	2100 Old Highway 8 NW	New Brighton	WMTB	11/10/2021
H000392189	7a	Professional Ground Maintenance	2395 County Road B W	Roseville	Water Supply	12/8/2021

Appendix F

Annual Site Inspection Checklist for Land Use Controls

ANNUAL SITE INSPECTION CHECKLIST FOR LAND USE CONTROLS

Operable Unit 2, New Brighton/Arden Hills Superfund Site

Date: 06/14/2022 Inspected by: Linda Albrecht, Mary Lee, and Ryan Aamot

Period Covered: From prior annual inspection (7/22/2021) 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	129-15	Outdoor Firing Range
Property owner:	BRAC	N.G.	Reserve	R.C.	N.G.	BRAC	N.G.	N.G.	N.G.	N.G.	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	Yes	N/A	N/A	N/A	No	No	No	No	No	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	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	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	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	Yes	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	No	N/A	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

Site(s) D, E, G, H, 129-15, and OFR had small woody trees in and around the soil cap that were removed (ex: russian olive, siberian elm, etc.)
A new treament building (SGRS) is being built on OU2, located between Site D and Site G (outside soil caps).
The rip-rap runoff located on the eastern portion of site 129-15 had woody tree growth in the rip-rap that was noted in the 2021 inspection but was removed in June 2022. A few large tree remain.
R.C. installed a cedar post landscaping fence on Site C. Some of the fencing is installed inside of the posted limits.
Site C has numerous small woody trees and a few large trees growing in and around the soil cap. These trees were not removed.

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 deficiencies and completed or planned actions to address such deficiencies are described in the attached Explanation of Deficiency(ies).

Ryan Aamot, GHD

Description of Deficiency(ies) attached? ☒ **Yes, above** ☐ No (none were identified)

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Appendix G

Site K and TGRS Operational Data

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Appendix G.1

Inspection and Maintenance Activities, Fiscal Year 2021, Site K, OU2

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Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2022
Site K, OU2
Arden Hills, Minnesota

October 2021

10/1/2021 System down, cycling normally.
Down time: None.

10/15/2021 System down, cycling normally.
Down time: None.

10/18/2021 USGS on site and using effluent water for injection well pumping.
Down time: None.

10/20/2021 Normal preventative maintenance was conducted.
Down time: 1 hour.

10/29/2021 System down, cycling normally.
Down time: None.

November 2021

11/5/2021 Treatment system down, cycling normally.
Down time: None.

11/10/2021 Treatment system down, cycling normally.
Down time: None.

11/12/2021 Treatment system down, cycling normally.
Down time: None.

11/15/2021 Completed monthly preventative maintenance. Treatment system down, cycling normally.

Down time: 1 hour.

11/17/2021 Treatment system down, cycling normally.
Down time: None.

11/19/2021 Treatment system down, cycling normally.
Down time: None.

11/22/2021 Treatment system down, cycling normally.
Down time: None.

11/24/2021 Treatment system down, cycling normally.
Down time: None.

11/26/2021 No inspection completed due to Thanksgiving holiday weekend.
Down time: None.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2022
Site K, OU2
Arden Hills, Minnesota

December 2021

12/3/2021 Treatment system down, cycling normally.
Down time: None.

12/6/2021 Treatment system down, cycling normally.
Down time: None.

12/8/2021 Treatment system down, cycling normally.
Down time: None.

12/10/2021 Treatment system down, cycling normally.
Down time: None.

12/13/2021 Treatment system down, cycling normally.
Down time: None.

12/17/2021 Completed monthly preventative maintenance. Treatment system down, cycling normally.

Down time: 1 hour.

12/20/2021 Treatment system down, cycling normally.
Down time: None.

12/22/2021 Treatment system down, cycling normally.
Down time: None.

12/24/2021 Treatment system down, cycling normally.
Down time: None.

12/31/2021 Treatment system down, cycling normally.
Down time: None.

January 2022

1/12/2022 System down, cycling normally.
Down time: None.

1/14/2022 System down, cycling normally.
Down time: None.

1/17/2022 System down, cycling normally.
Down time: None.

1/17/2022 System down, cycling normally.
Down time: None.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2022
Site K, OU2
Arden Hills, Minnesota

January 2022

1/19/2022	System down, cycling normally. Down time: None.
1/20/2022	Completed normal monthly preventative maintenance. Down time: 1 hour.
1/21/2022	System down, cycling normally. Down time: None.
1/28/2022	System down, cycling normally. Down time: None.
1/31/2022	System down, cycling normally. Down time: None.

February 2022

2/4/2022	System down, cycling normally. Down time: None.
2/7/2022	System down, cycling normally. Down time: None.
2/9/2022	System down, cycling normally. Down time: None.
2/11/2022	Conducted normal monthly preventative maintenance. Down time: 1 hour.
2/14/2022	System down, cycling normally. Down time: None.
2/16/2022	System down, cycling normally. Down time: None.
2/18/2022	System down, cycling normally. Down time: None.
2/21/2022	System down, cycling normally. Down time: None.
2/23/2022	System down, cycling normally. Down time: None.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2022
Site K, OU2
Arden Hills, Minnesota

February 2022

2/25/2022	System down, cycling normally. Down time: None.

March 2022

3/2/2022	System off, cycling normally. Down time: None.
3/4/2022	System off, cycling normally. Switched treatment system to HAND at 13:30 to complete quarterly sampling, switched treatment system to AUTO once sampling was completed (14:10). Down time: None.
3/9/2022	Normal preventative maintenance was completed. New heater part arrived, working with Preferred Electric to install it. Down time: 1 hour.
3/11/2022	System off, cycling normally. Down time: None.
3/14/2022	Preferred Electric on site to repair heater. System shut down at 8:17. New thermostat installed in heater. System set back to Auto at 8:52. Down time: 0.5 hours.

April 2022

4/12/2022	Completed normal monthly preventative maintenance and annual electrical inspection with Preferred Electric. Down time: 1.0 hour
4/15/2022	Adjusted sump valve, 3” to 9”. Waited 10-15 minutes to stabilize. Down time: None.
4/18/2022	Exercised influent valve and increased flow rate to 11.0 gpm. Down time: None.
4/25/2022	Exercised influent valve and increased flow rate to 10.5 gpm. Down time: None.

May 2022

5/2/2022	Exercised influent valve to increase flow rate from 9.4 gpm. Influent piping sprung a leak. The flow rate was lowered to 8.8 gpm to slow the leak. Shutdown system at 1822 to remove failed pipe fitting. Found 2 pieces that will work temporarily. Need a 2x1.5 SCH80 pvc reducer bushing. Had to use a galvanized 2x1.5 to get system running. Installed pipe section. System on at 1845, set to 10.5 gpm, 21 psi. Adjusted outlet valve just a bit. No leaks observed. 1900 off site. May have a very small leak develope, didn't want to crack the galvanized pipe into the pvc. Will get part needed and complete repair soon. Down time: 0.5 hours.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2022
Site K, OU2
Arden Hills, Minnesota

May 2022

5/10/2022	Completed normal monthly preventative maintenance. Down time. 1 hour.
5/23/2022	Flow rate at 8.6, exercised influent valve. Could only get flow rate to 9.5 gpm max. Shut down system for 15 minutes. Restarted system and saw flow rate jump to 11.9 gpm, then fall immediately down to 10.2 gpm. Exercised influent valve. No flow improvement. Need to check spray nozzle for blockage. Down time: None.
5/24/2022	Flow rate at 10.0 gpm, opened influent valve completely and no change in flow. Determined that the spray nozzle must be blocked. Shut down treatment system at 1325. Removed top of tower to acess the nozzle. Found a small rubber like disc partially blocking nozzle. Removed from nozzle and cleaned obstruction. Reinstalled top of tower. Installed the four flange bolts to the inlet pipe only. Restarted pump to test, observed a 12.9 gpm and 21 psi. Opened the drain valve and cleaned the nozzle. Restarted pump to test again, observed 13.5 gpm and 21 psi. Started system pump to Hand for test, observed 14.1 gpm at 22 psi. Installed nozzle at top of the tower and the remainder of the flange bolts. Switched system to Auto and observed a max flow of 13.4 gpm at 25 psi. Set flow to 11 gpm and 20 psi. Observed normal operation. Will look into adding a possible strainer at the influent to avoid future blockage. Down time: 1.5 hours.
5/31/2022	Exercised influent valve to increase flow rate from 9.4 gpm to 11.1 gpm. Down time: None.

June 2022

6/6/2022	Completed Quarterly Sampling then exercised influent valve to get flow rate up to 10.1 gpm from 9.5 gpm. Need to check spray nozzle again, flow rate would not increase very much. Down time: None.
6/13/2022	Exercised influent valve to increase flow rate from 8.9 gpm to target flow rate. Saw minimal change in flow rate. Shut down system and restarted. Observed initial flow rate of 11.0, dropped slightly then increased to 12 gpm. Exercised influent valve some more. Set flow rate to 10.5 gpm. Down time: None.
6/16/2022	Completed normal monthly preventative maintenance. Upon arrival to site flow rate was at 9.9 gpm, the flow rate was increased to 11.1 gpm after preventative maintenance was completed. Down time: 1 hour.
6/20/2022	Increased flow rate from 9.7 gpm to 11.3 gpm. Down time: None.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2022
Site K, OU2
Arden Hills, Minnesota

June 2022

6/27/2022 Upon arrival system down due to high water level alarm. Drained sump to 3 inches using effluent valve, originally at 15 inches. Restarted system. System started normally, flow rate at 12.8 gpm. Lowered to 10.9 gpm.
Down time: 1 hour.

6/29/2022 Upon arrival to site it was discovered that water was bleeding out of the air release valve causing water to pool up on the floor and outside the building. The valve was closed for the night until repairs could be made.
Down time: None.

6/30/2022 Cleaned out air release valve and treatment system building.
Down time: None.

July 2022

7/1/2022 System down, cycling normally.
Down time: None.

7/6/2022 System down, cycling normally.
Down time: None.

7/11/2022 System down, cycling normally.
Down time: None.

7/18/2022 Exercised influent valve to increase flow rate from 10.0 gpm to 10.9 gpm.
Down time: None.

7/20/2022 GHD was notified by USGS that the power pole near the treatment system was swaying a lot. GHD reached out to Xcel to look into the issue with the power pole. Xcel found that the bottom of the pole was at least partially broken and needs to be replaced.
Down time: None.

7/20/2022 System down on arrival for air stripper high/high water level alarm. Restarted system. Shut down due to high water level alarm multiple times, adjusted flow and system stabilized around 6" sump level.
Down time: 48 hours.

7/22/2022 Completed monthly preventative maintenance.
Down time: 1 hour.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2022
Site K, OU2
Arden Hills, Minnesota

July 2022

7/22/2022 Xcel on site to complete the repair to the swaying power pole. Xcel originally planned to replace the pole without cutting the power; however after observing the swaying pole, Xcel determined that it would take quite a bit more time to deal with the live wires than expected. Xcel determined that power must be cut to complete the repair. To do this they require a switch plan, which they do not have. Xcel checked which lines are energized, dug the new hole and filled it with sand, and staged the new 50 ft pole near the location. Xcel will obtain a switch plan and reschedule the work.

Down time: None.

7/27/2022 System down, cycling normally.
Down time: None.

7/28/2022 Arrived on site at 8:00 for Xcel repair or swaying power pole, received call from Xcel saying a crew is on their way. Went to Site K to shut down. At 8:20 switch pump and air stripper to OFF. Waited for blower and pump to stop. Confirmed flow rate of 0.0 gpm. Flipped Mains off in both breaker panels. Confirm power off by checking lights. Waited for Xcel to arrive. Xcel arrived on site around 9, gave them the go ahead to cut power. Asked them to let me know when the power was restored so that the treatment system can be restarted. Left site. Got word from Xcel that they were reenergizing the power lines and the system can be restarted. Headed out to site. Arrived at Site K, flipped breakers back on then switched the pump and air stripper blower to AUTO at 14:46. Observed normal operation of treatment system with flow rate of 12.0 gpm.

Down time: 6.5

7/29/2022 Sump water level low, below glass. Opened valve on arrival and waited 20 min. Sump water level stabilized at 5”.
Down time: None.

August 2022

8/1/2022 System off, cycling normally.
Down time: None.

8/10/2022 System off, cycling normally.
Down time: None.

8/12/2022 Air stripper sump high high water level upon arrival. Cleared alarm, open effluent valve slightly. Waited 10 min for the sump to stabilize. Sump stabilized at 7 in. Restarted system and observed normal operation.

Down time: 30.5 hours.

8/17/2022 System off, cycling normally.
Down time: None.

8/19/2022 System off, cycling normally.
Down time: None.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2022
Site K, OU2
Arden Hills, Minnesota

August 2022

8/25/2022	Completed normal preventative maintenance. Down time: 1 hour.
8/29/2022	System off, cycling normally. Down time: None.

September 2022

9/2/2022	System down, cycling normally. Down time: None.
9/5/2022	Exercised influent valve, adjusted flow to 10.3 gpm. Observed normal operation. Down time: None.
9/9/2022	System down, cycling normally. Down time: None.
9/12/2022	System down, cycling normally. Down time: None.
9/16/2022	Treatment system down upon arrival due to high high water level alarm. Closed effluent valve slightly. Reset system. Water level stabilized at 9” after 15 minutes and observed normal operation. Down time: 20.5 hours.
9/21/2022	Shutdown treatment system at 7:45 AM. Removed air stripper packing material and replaced with new packing material. Back flushed and cleaned air stripper discharge pipe and water lines. Restarted treatment system at 2:30 PM. Observed normal operation. Down time: 7.0 hours.
9/26/2022	System down, cycling normally. Down time: None.
9/29/2022	Normal monthly preventative maintenance was conducted. Down time: 1.0 hour.

Appendix G.2

Inspection and Maintenance Activities, Fiscal Year 2021, Site K, OU2

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Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

October 2021

10/7/2021 SC1 Pumphouse. Received an SC1 Failed to Start Pump alarm at 8:30 AM. Remote connection showed SC1 was down. Acknowledged alarm. When arrived on site observed that there was no power to the SC1 pumphouse and that the flow meter was not moving. Attempted to turn on SC1 at the control panel in the treatment building, received a second Failed to Start Pump alarm. Acknowledged alarm. Contacted the Arcadis site personnel overseeing the SGRS construction work to ask about any site work occurring near the SC1 pumphouse. Arcadis verified that the power to the SC1 pumphouse had been shut down for construction work occurring near the SC1 pumphouse. The power was restored to the pumphouse and SC1 was restarted at 2:00 PM. Observed normal operation.

Down time: 3.5 hours.

10/12/2021 SC1 Pumphouse. SC1 was shut down at 7:17 AM for SGRS construction work near SC1. Disabled AC Power Fail, UPS Power Fail, Pump Failed to Start, and Communication Failure alarms for SC1. Received a call from Arcadis site personnel overseeing the SGRS construction work notifying us that during excavation on the west side of the SC1 pumphouse a 3" HDPE pipe had been broken. Reviewed site plans and determined that the broken pipe was the SC1 pumphouse discharge line to the forcemain. GHD arrived on site at 11:00 AM to meet with Arcadis and the contractor. The 3" HDPE pipe was pinched with an excavator bucket. Reviewed the damage to the pipe and the site plans with Arcadis and the contractor. Confirmed that the broken pipe was the SC1 discharge line and began troubleshooting ideas to repair the line. It was determined that since the line was pressured, to make the repair the discharge line would need to be isolated or the entire TGRS forcemain would need to be drained. Attempts to locate the isolation valve for SC1 was made. The valve was not found. The construction crew proposed pinching the discharge line on the forcemain side to make the repair. This repair plan was approved by GHD and Arcadis. SC5 was shut down at 3:45 PM to reduce the level of the contaminates in the water in the event that another leak would occur. The damaged section of pipe was cut and removed. The new section was defaced and then heated to fuse the old section with the new section. Once the repair was completed , SC1 was turned on at 5:00 PM and no leaks were observed. All the previously disabled alarms for SC1 were enabled. SC5 was turned on at 5:05 PM. Normal operation of SC1 and SC5 were observed. The leaked water in the excavation was pumped out into a 275-gallon tote for later disposal.
Down time: SC1 for 4.5 hours and SC5 for 1.5 hours.

10/13/2021 Treatment System and Well Field. Completed half of the routine monthly preventative maintenance.
Down time: None

10/15/2021 SC1 Pumphouse. SC1 was shut down at 9:30 AM for SGRS work near the SC1 pumphouse. SC1 was remotely turned back on at 3:17 PM. Normal operation was observed.

Down time: 1.5 hour.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

October 2021

10/18/2021	SC1 Pumphouse. SC1 was shut down at 7:48 AM for SGRS work near the SC1 pumphouse. Power was shut off to the pumphouse at 8:15 AM. After work was complete the power was restored to the SC1 pumphouse at 12:16 PM and SC1 was turned back on at 12:30 PM. Upon arrival back to the SC1 pumphouse, a leak from the connection of the influent pipe and the well was discovered. Arcadis was notified and SC1 was shut down at 12:47 PM. The influent pipe appeared to have moved downward due to the removal of dirt around it. The pipe was stabilized using wooden stakes. SC1 was turned back on at 1:09 PM. Normal operation was observed of the pump. The flow meter was not moving. Down time: 5.0 hours.
10/19/2021	SC1 Pumphouse. SC1 was shut down at 7:20 AM to clean the flow meter. Flow meter removed and cleaned. Reinstalled flow meter and started SC1 at 7:55 AM. Observed normal operation. Down time: 1.5 hours.
10/20/2021	Treatment System and Well Field. Arrived on site at 11:00 AM to go over details of the TGRS forcemain drain. Shut down SC1 and SC5 at 11:45 AM. Went to SC4 pumphouse, noticed that the well had been repiped to pull water from the well instead of sending water into the forcemain. Went to the SC3 pumphouse, attempted to turn on SC3 but had an electrical short in the control panel. Determined since neither SC3 or SC4 was operational, SC1 and SC5 would remain shut down until all SGRS work and Line W capping was complete. Shut down TGRS and disarmed autodialer at 12:52 PM. Closed influent valve for the treatment system and the SC4/SC5 shut-off valve. Closed the main boundary line valve near B6 and opened the B12 boundary line valve. Went to B12 and observed water draining from the drain chamber, it appears that the valve was left partially open. Opened the B12 drain chamber valve completely and observed draining until no additional water was overflowing from the drain chamber or the valve box. Draining was completed at 3:53 PM. The manway to the drain chamber and the valve were closed. Closed the B12 boundary line valve and opened the main boundary line valve. Opened the influent valve for the treatment system and restarted the TGRS treatment system with boundary wells in Auto. The system was completely operational at 4:30 PM. The auto-dialer was re-armed. The flow rate for B8 was increased from 140 gpm to 205 gpm. Down time: B1, B4, B5, B6, and B9 for 4.0 hours, B13 for 2.0 hours, SC1 for 16.0 hours, and SC5 11.0 hours.
10/21/2021-present	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. Down time: SC1 and SC5 for 264 hours. (ending 10/31/2021)
10/21/2021	Treatment System and Well Field. Completed the remainder of the routine monthly preventative maintenance. Down time: None

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

October 2021

10/25/2021 Treatment System and Well Field. Arrived on site at 6:30 AM. Shut down TGRS and disarmed autodialer at 6:40 AM. Closed influent valve for the treatment system. Closed the main boundary line valve near B6 and opened the B12 drain chamber valve and manway. Opened the B12 boundary line valve. Went to B12 and observed water draining from the drain chamber. Observed draining until no additional water was overflowing from the drain chamber or the valve box. Draining was completed at 10:10 AM. Left B12 at 10:15 AM to observe the installation of the isolation valve. Once the new section was installed the isolation valve was closed. The manway to the drain chamber and the valve were closed at 1:35 PM. Closed the B12 boundary line valve and opened the main boundary line valve. Opened the influent valve for the treatment system and restarted the TGRS treatment system at 2:03 PM. No leaks observed from the new section of pipe or isolation valve. The system was completely operational and the auto-dialer was re-armed at 2:17 PM. Observed normal operation of the treatment system and wells.

Down time: B1, B4, B5, B6, B8, and B9 for 7.5 hours, B3 for 3.5 hours, B13 for 1.5 hours, SC1 and SC5 24.0 hours.

November 2021

10/21/2021-present SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping.

Down time: SC1 for 980.5 hours and SC5 for 984 hours. (ending 11/30/2021)

11/3-4/2021 Treatment System. Excavation and decommissioning of the east side of Line W by placing caps on the water line in two locations. Site 1 is located on the south portion of Line W east of the tie-in to SC1 and Site 2 is located on the north portion of Line W east of valve 1365 (the connection to SC2 and SC3). SC4 and SC1 were turned on after the capping was completed to test the caps. No leaks were observed from the newly installed caps. A leak was observed from the pitless adapter at SC1. SC1 was shut off and the leak stopped after adjusting the influent pipe from the SC1 well. A pressure of 90 psi was observed from piping within the SC1 pumphouse. The influent and effluent ball valves were closed to relieve pressure from the influent line until Line W can be drained.

Down time: None.

11/4/2021 Treatment System and Well Field. Arrived on-site at 7:00 AM, disarmed autodialer and shut down TGRS treatment system. Once treatment system completely off, opened the Rice Creek Discharge valve. Observed draining from the Rice Creek discharge culvert. Alerted Arcadis that draining of the discharge line had begun. Observed draining from discharge culvert for ~2 hours. Notified Arcadis that they could begin work on the SGRS discharge line tie-in. At 2:40 PM, after being notified by Arcadis that the SGRS tie-in was complete, the Rice Creek Discharge valve was closed, the TGRS treatment system was re-started, and the autodialer was re-armed. No leaks were observed from the new SGRS discharge line tie-in and normal operation observed from TGRS treatment system.

Down time: B1, B4, B5, B6, and B9 for 7.5 hours, B13 for 2.0 hours, B3 for 2.5 hours, and B8 for 8.5 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

November 2021

11/8/2021 Treatment System and Well Field. Arrived on-site at 10:00 AM, disarmed autodialer and shut down TGRS Treatment system. Open B12 drain chamber valve and removed manway cover to B12 drain chamber. Closed the main boundary line valve and opened the B12 boundary line valve. Observed water draining from the B12 drain chamber and valve box. Opened new isolation valve with Arcadis. At 3:03 PM, GHD began pumping water out of the B12 drain chamber to winterize the B12 boundary line. Opened the isolation gate valves in the B10, B7, and B12 pumphouses. Once water was pumped down, the B12 boundary line valve was closed and the main boundary line valve was opened. New isolation valve was closed and the TGRS treatment system was restarted at 3:39 PM. The B12 drain chamber manway was closed and the B12 drain chamber valve was left open for winter. The autodialer was re-armed and normal operation of the TGRS treatment system and valve was observed.

Down time: B1, B4, B5, B6, B8, and B9 for 5.0 hours.

11/18/2021 SC1 Pumphouse. GHD and Thein on-site at 8:50 AM. Reviewed problem and SC1 influent pipe pitless adapter. Determined that the compression fitting to the influent pipe is loose and was causing the leak. Removed the compression fitting and a short section of the influent pipe. Installed a new barbed fitting to the new section of influent pipe and a new fitting to the nipple of the pitless adapter. The new section of pipe connected to the existing section of the influent pipe. The area under the influent pipe was backfilled to provide support.

Down time: None.

11/22/2021 B6 Pumphouse. During the daily inspection, a vibration was felt on the floor of the B6 pumphouse around the well. Field technician was notified and will assess the problem tomorrow.

Down time: None.

11/23/2021 B6 Pumphouse. Field technician determined that operation of B6 was not normal and there may be an issue with the connection between the pump and motor. B6 was shut down and the flow rates of the following wells were increased to maintain the minimum total flow rate of the TGRS treatment system: B3 to 234 gpm, B4 to 405 gpm, and B9 to 300 gpm. Received two alarm emails, VFD Faulted and Pump Failed to Start, for B4 at 6:20 PM. Alarms were acknowledged and B4 was restarted. Normal operation was observed and the flow rate was lowered to 395 gpm.

Down time: B4 for 2.0 hours and B6 for 12.0 hours.

11/24-29/2021 B6 Pumphouse. B6 shut down awaiting replacement of the pump and motor.
Down time: 144 hours.

11/25-26/2021 B4 Pumphouse. During TGRS remote monitoring on 11/26, B4 alarms for VFD Fault and Pump Failed to Start were discovered. No alarm emails were sent out. B4 shut down at 1:00 PM on 11/25. Alarms were acknowledged and the well restarted at 11:00 AM on 11/26. Flow rate was lowered to 390 gpm.

Down time: 22 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

November 2021

11/30/2021	B6 Pumphouse. GHD and Thein on site at 10:00 AM. Power was shut down to the B6 pump and the riser pipes, pump, and motor were removed from the B6 well. Five of the six riser pipes were in good condition, the closest riser pipe to the pump and motor had significant build-up on the outside and was replaced. There were no evident issues with the pump or motor removed from the well. The new pump and motor were connected and placed into the well with the riser pipes. Once the pump, well, and riser pipe were in place, power was restored to the pump and B6 was turned on at 3:03 PM with an initial flow rate of 215 gpm, at this flow rate Thein observed a water level of ~116-117 feet, which would only give ~10 feet of clearance above the well. Thein thought that the vibration felt before could be due to cavitation of the well. The flow rate for B6 was dropped to 170 gpm where a water level of 103.7 feet was observed. Normal well operation was observed. A transducer was installed in the water level pipe in B6 at 120 feet. The transducer needs to be wired and calibrated. Down time: 19 hours.

December 2021

10/21/2021-present	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. Down time: SC1 for 1,724.5 hours and SC5 for 1,728 hours. (ending 12/31/2021)
12/7/2021	Treatment System and Well Field. Began receiving various alarm emails at 7:40 from treatment system and pumphouses. Treatment system and well field down due to a possible power outage. GHD arrived on site and assessed the power at Building 116 and pumphouses B8 and B6. Power was normal at all three locations. Autodialer was found to be blinking upon arrival and was disabled temporally. All alarms were acknowledged and cleared. Treatment system and well field restarted at 9:40. Autodialer was enabled and normal. Observed normal operation. Determined that alarms and treatment system shut down was caused by brief power outage. Down time: 2.0 hours at B1, B4, B5, B6, B8, and B9.
12/7/2021	Treatment System. Attempted to install new SIM card into Juniper modem for PLC. Unable to get IP address set up for new SIM card. Re-installed previous SIM card and set date to install new SIM card another day. Observed normal operation. Down time: None.
12/7/2021	SC5 Pumphouse. Arcadis notified GHD that pressure caps were installed on all SGRS connections and ready to restart SC5 that morning. GHD opened the new isolation valve at 3:05 PM while Arcadis observed pressure caps. SC5 was turned on at the control panel at 3:30 PM. Arcadis notified GHD that the pressure caps did not hold at the new SGRS Building pressure cap and to shut down SC5. SC5 was shut down at 3:39 PM by turning off the disconnect breaker in the SC5 pumphouse (and later on the control panel in Building 116). The new isolation valve was closed at 4:01 PM. Leak also discovered at Site G SGRS connections by Arcadis. Water from leak was left to infiltrate into the ground and all appropriate parties were notified of the spill. SC5 and new isolation valve will be off and closed, respectively, until further notice. Down time: 23.9 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

December 2021

12/8/2021 GHD was notified that during excavation work for the new SGRS treatment system an underground live electrical wire was hit. GHD arrived on site at 2:30 PM to observe the damage and discuss repair plans. GHD met with Arcadis, Bradbury (SGRS excavation contractor), GPRS (electrical utility locate contractor), and ACE Electrical (electrical evaluation and repairs) to discuss incident and repair plan. Broken buried electrical line and intact data line were observed in trench east of SC3 pumphouse. GHD observed new flags placed by GPRS west and east of SC3 pumphouse in proposed path of continued excavation. GHD viewed SC2 and SC3 pumphouse interior and exterior - no obvious visible damage/disconnection apparent. ACE Electrical confirmed that 2 of 3 fuses in SC2 pumphouse building were blown - ACE replaced all and left the remaining fuse in building as a spare. GHD opened up all water lines in SC2 pumphouse to prevent freeze damage while power to building is off. GHD reviewed available historical plan sets with Arcadis and did not identify documentation of a buried electrical line between SC2 and SC3. Power to SC3 is provided by an overhead power line.

Down time: None.

12/9/2021 GHD on site at 7:25 to oversee underground electrical wire repair. GHD met with Arcadis, SGRS contractor, and electrician and discussed the repair plan. Electrician began repair to underground wire by connecting a new section of cable to the existing underground wire. Electrician found that the wires within the nearby fuse box were labeled, which allows the electrician to confirm that SC2 pump will run in the correct direction. Power was restored to the line at 10:30. Electrician confirmed that power to the control panel and heater were working correctly. Pump disconnect breaker was left in the off position. The new wire will run in the same location as the previous underground wire was with 3 inches of sand below and 6 inches of sand above the wires. Observed normal electrical operation.

Down time: None.

12/14/2021 SC5 Pumphouse. SC5 disconnect breaker was turned back on to restore power to SC5 pumphouse. Observed normal operation.
Down time: None.

12/16/2021 Treatment System and Well Field. GHD received a call from Time Communication at 2:24 and received multiple alarm emails. Remotely connected to the treatment system and it showed power issues at the site, treatment system down. Lost remote connection and unable to reconnect at 3:02. GHD traveled to site and checked power at Building 116 and various pumphouses, power appeared to be on and operating normally. All alarms were acknowledged on and control panel. Restarted treatment system at 4:15, observed normal operation.

Down time: 2.0 hours at B1, B4, B5, B6, B8, and B9.

12/20/2021 B4 Pumphouse. During the site inspection a small leak in the piping going to the pressure gauge was found in B4 pumphouse. Ball valve going to the pressure gauge piping was shut to temporarily stop the leak until repairs could occur the next day.
Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

December 2021

12/20/2021	Data logger stopped working for unknown reason and did not record treatment system data for December 20th, 2021. Meter readings were estimated. Down time: None.
12/20/2021	B8 Pumphouse. Flow rate was increased to 205 gpm from 140 gpm to maintain the minimum total flow rate for the treatment system since the current well flow rates were not maintaining a 1,745 gpm total flow rate. Down time: None.
12/21/2021	B4 Pumphouse. The leak was coming from the side of the ball valve body. No spare ball valves in that size were on site, two spare ball valves and some additional brass pipe were purchased for the repair. B4 was shut down for repair at 10:45. Ball valve was replaced and B4 was restarted at 10:55. No leaks observed. Normal operation observed. Down time: 10 minutes.

January 2022

10/21/2021-present	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. SC5 was restarted on 1/26/2022, see further notes below. Down time: SC1 for 103 days and SC5 for 97.5 days. (ending 1/31/2022)
1/18/2022	Pumphouse B13. During the Quarterly Preventative Maintenance, found that the operating solenoid valve was not energized during normal operation at B13 pumphouse. Further troubleshooting required another person onsite to help with verifying correct wiring/tracing and troubleshooting ECV operation. Down time: None.
1/18/2022	Treatment System and Well Field. Normal monthly prevenative maintenance was started. Down time: None.
1/20/2022	Pumphouse B13. Troubleshooting and testing ECV operation with second person at pumphouse B13. Operating solenoid valve was not energized during normal operation. Found that the wire to the operating solenoid valve was not landed on the terminal strip. Preformed a remote stop of the pump and powered down the controls (PLC, UPS). Ensured that the wire was dead and landed the wire onto the terminal strip. Powered up the controls and remotely started the pump. The solenoid valve is operating/energizing correctly now. Normal operation of solenoid valve observed. Down time: None.
1/20/2022	Treatment System and Well Field. Normal monthly prevenative maintenance was completed. Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

January 2022

1/24/2022 Pumphouse B13. Found that the Electric Check Valve (ECV) was not operating correctly on 1-18-2022. Troubleshooting with controls engineer reviewing the electrical drawings. Wiring at both pumphouse B13 and B3 were checked. It was determined that the microswitch was wired Normally Open when it should be wired to Normally Closed. Remotely stopped the pump and powered down the PLC and UPS in pumphouse B13. The cover of the microswitch was removed to get the wiring. Verified the wires were dead, switched wire 4061 to the Norma;ly Closed terminal. Powered up the controls and started the pump remotely. Remotely stopped the pump. Observed normal operation. Further cleaning of the ECV is needed.

Down time: None.

1/24/2022 GHD arrived on site at to assist Arcadis with pressure test for SGRS connections at Site I, Site G, and SGRS Building. GHD met with Arcadis at the new 14" isolation valve to showe them the location of the valve and how to open and close it. Arcadis checked and confirmed that the forcemain isolation valves in pumphouses SC2, SC3, and SC4 were closed. Opened the 14" isolation valve at 9:45. After 2 hours, GHD checked with Arcadis and confirmed no leaks had occured at any of the SGRS connections and that no further observation of the isolation valve was needed. GHD returned to Building 116 and left T-handle in isolation valve for Arcadis's use.

Down time: None.

1/25/2022 Pumphouse SC5. The flow rate set point was lowered to 40 gpm while the well was still off. B8's flow rate was lowered to 175 gpm to account for SC5 restart. Arcadis notified that the 14" isolation valve was opened at 8:10. At 8:24 SC5 was started with a flow set point of 40 gpm. SC5 flow rate was not increasing beyond 0.9 gpm after serval minutes of operation. Went to the SC5 pumphouse to troubleshot. No obvious issues, called field tech to assist. Confirmed normal operation with pump and motor. Tried replacing analog card with spare, no change in operation. Switched control panel in pumphouse to Local control (vs. PLC control) and manually set motor speed to 41 Hz. Observed flow of 45.2 gpm on flow meter and PLC control screen. Manually lowered flow to ~40 gpm to complete pressure test. Will continue to troubleshoot once pressure test for SGRS connections is completed. After 4 hours of SC5 operating at 40 gpm and no leaks at the SGRS connections, manually increased motor speed to 52.85 Hz and flow rate of 79.5 gpm. After over 2 hours of SC5 operating at 80 gpm and no leaks at the SGRS connections, SC5 was shut down from the PLC control panel. Attempted to restart SC5 from the PLC control panel and observed same operation as seen previously. Will need to set SC5 flow rate from pumphouse until further troubleshooting can be completed. Shut down SC5 at 4:23.

Down time: 19.5 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

January 2022

1/26/2022	SC5 Pumphouse. Contacted Arcadis and confirmed no leaks at the SGRS connections overnight. Restarted SC5 from the PLC control panel, observed green status, 4 gpm, and 30 Hz. Went to the SC5 pumphouse, observed 0.00 gpm on the pumphouse flow meter. Switched SC5 to Local control from PLC control, immediately the motor speed jumped to 52.85 Hz and a flow rate of ~80 gpm on the flow meter. Manually set motor speed to 49.65 Hz and a flow rate of 69.94 gpm on pumphouse meter. System ok light on. Lowered flow rate to 70 gpm due to a low water level above pump was observed, waiting for confirmation on readings. Returned to Building 116 and lowered B8 flow rate to 140 gpm to account for SC5 flow. Observed normal SC5 operation on the PLC control screen. Down time: 12.0 hours.
1/27/2022	SC5 Pumphouse. Troubleshooting the communication issue observed at SC5 on January 25th. Confirmed that all the VFD parameters on the SC5 control panel in the pumphouse looked normal. Confirmed that the VFD was communicating with the PLC normally. Switched the control of SC5 from Local control to PLC control. The motor speed began to increase to the desired speed (slowly), did not operate as seen previously. Increased flow setpoint to 80 gpm on the PLC control panel, motor ramped up to 80 gpm in ~ 1 min. Checked water level above pump and determined that the transmitter in the pump is located 20 feet above, no low water level issue. Normal operation observed. Down time: 1.5 hours.

February 2022

10/21/2021-present	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 131 days (ending 2/28/2022)
2/7/2022	Pumphouses B6. Troubleshooting installation of B6 transducer for water level measurements. B6 was shut down and reviewed transducer wiring connections. Noticed that the wires from the transducer to the pumphouse control panel were not wired to the correct landing. Moved wires 5011 and 5021 from the 5111 and 5121 slots to the 5011 and 5021 slots. This was confirmed by reviewing and comparing to the B5 pumphouse wiring in control panel, where a transducer was already installed. Still not able to see any water level readings on the TGRS control panel. Began checking power to connections and was seeing no power in the wires from the transducer, re-landed the 5011 and 5021 wires and found power running from the transducer connection to the input wiring. Still not seeing any water level readings on the TGRS control panel, possible programming issue. Will need to review transducer install procedure and programming with controls engineer. Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

February 2022

2/11/2022 Treatment System and Well Field. Normal monthly preventative maintenance was conducted.

Down time: None.

2/11/2022 Pumphouse B6. Explained transducer installation issues with controls engineer. Determined that calibration information needed to be entered into the PLC program. Controls engineer entered the proper calibration information provided by the manufacturer into the program. Observed water level reading on TGRS control panel. Will confirm water level reading shown on TGRS control panel with field reading.

Down time: None.

2/15/2022 Pumphouse B6. Confirmed water level reading shown on TGRS control panel for B6 extraction well matches the water level measured in the field.

Down time: None.

2/21/2022 Treatment System. During site inspection, noticed that the pressure gauges for the treatment system effluent, wet well pump 3, and wet well pump 4 were fluctuating and there was a slight gurgling/humming noise. Reached out and discussed issue and possible troubleshooting steps with field tech once off site. Returned to site to troubleshoot. Issue was still occurring. Ran sink faucet in treatment system room connected to effluent water and noticed possible air bubbles disrupting the water flow. Shut down B4 and Pump 3. Pump 3 was taking a while to shut down. Noticed that the valve wasn't closing (micro switch stick wasn't moving and back pressure pilot was stuck inside). Drained the back pressure pilot using ball valve at base. As this was occurring, the valve began to close and the pump shut down. Observed no pressure fluctuating while Pump 3 was down. Restarted B4 and Pump 3. B4 started normally. Pump 3 attempted to start, received two alarms (Failed to Start and Valve Failed to Stay Open). Acknowledged alarms. Received alarm that Wet Well 1 Level was too high, this shut down the entire treatment system and well field. Restarted treatment system and waited until Pump 3 started. Observed normal pressure from treatment system effluent, Pump 3, and Pump 4 (no fluctuating). Appeared some air bubbles got into Pump 3 or forcemain. Observed normal operation.

Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

February 2022

2/24/2022 Treatment System. Arrived onsite and could hear the same noise from 2/21/22 (a slight gurgling/humming) while entering the building. Found that ECV #3 was not closing when directed, causing the wet well level to drop below the pump inlet resulting in Pump 3 cavitating. Troubleshooting revealed 2 issues with wet well Pump 3: (1) The inline filter was blanked out from sediment fouling and was not allowing water to get to the top of the ECV forcing it to close. The filter was replaced. Since Pump 3 was barely operating before Pump 4 was replaced with a smaller pump/motor, a considerable amount of sediment built up in time over on the side of the wet well where Pump 3 sits. Now that Pump 3 is running much more, this sediment is now being sucked into the pump and filter. The fouled filters have placed in an area to dry completely. The filters were inspected, it appears that the filters are mostly blanking out on the surface and not penetrating the media too much itself, creating a layer that water cannot pass through. The used filters were cleaned off and will attempt to use them again. The filters will be swapped out every 2 weeks instead of monthly and will be monitored for any changing conditions. (2) The 3-way solenoid valve (SV) that operates the back pressure sustaining pilot was sticking in the open position when the coil power is off. During normal pump operation, once the pump is started the 3-way SV is energized which in turn opens the pilot which creates a “slow leak” off the top of the valve and allows it to open. When the pump is directed to stop/close, the 3-way is deenergized which closes the pilot, stops the “leak” and the valve is forced closed using the pump pressure. The valve stem then closes “in” releasing the micro switch which stops power to the motor. So the 3-way SV was stuck open, keeping the pilot open, keeping the valve open and motor running. The 3-way SV was replaced with a cleaned/refurbish one from stock.

Down time: None.

2/28/2022 Treatment System. Noticed recently that ECV #4 was closing very slowly, if not at all when directed. Did some troubleshooting to identify the problem. Determined that the valve was getting insufficient water pressure to close. Shut down the TGRS system at 1510 and disabled the autodialer. Noticed that B13 was not turning off, will troubleshoot this issue later. Opened the electrical disconnect for Pump 4 and closed the isolation valve between ECV 4 and the discharge force main. Vented all pressure from the valve control piping and removed a section of piping from the inlet side of the valve that provides high pressure for valve closing. The pipe that was tapped into the valve body was very fouled, cleaned out the pipe. Didn’t want to remove this pipe due to the rusty condition where it is tapped into the valve body. Also replaced the ¼ inch globe valve with a ball valve to make it much easier to inspect and clean without having to remove. Inspected and verified proper operation of the check valve on this section. Next, removed a section of control piping that included the ECV opening speed angle valve. Valve was very fouled and operation was suspect. Replaced this angle valve with a new one from stock. After the replacement work was completed, the isolation valve was slowly opened. Checked and tightened any connections for leaks, all good. Closed the power disconnect to Pump 4. Pressed the System Start at 1550, well field came up normally and enabled autodialer. Observed normal valve operation.

Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

March 2022

10/21/2021-present	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 162 days (ending 3/31/2022)
3/5/2022	Treatment System. Various alarm emails began at 13:28 and an autodialer call was received at 14:24. Traveled to site, arrived on site at 14:50. Found power issues at B5 meter, phases A and B flashing. Opened the disconnects for the VFD panel and the main in the pumphouse. Call to Xcel Energy dispatch and Power Out Line. Powered down all the other pumphouses (B9, B6, B3, B4, B13, B1, SC5). Found meter at B7 and SC4 flashing. Power issues at Building 116. Opened the disconnects for wet well pumps 3 and 4 at the motor control center. Powered down the PLC/control panel and autodialer. Opened the disconnect for the shop heater and the treatment center heaters, opened the local disconnects for the wet well pumps 3 and 4 and blowers 3 and 4. No call from Xcel as of 16:40. Left site. Received call from Xcel at 17:30, went back to site. Met with Xcel at 18:25, discussed power issue. Xcel tried a fuse in one of the switches and it blew. Unable to locate the problem. No obvious issues. Will resume troubleshooting tomorrow, left treatment system off. Down time: B1, B4, B5, B6, B8, B9, and SC5 for 8.5 hours, and B3 and B13 for 9.5 hours.
3/6/2022	Treatment System. Reached out to Xcel to get a ETA for repair, Xcel was already in site. Received call from Xcel, they have isolated the issue to a pole along Pillsbury Ave, west of Building 116. Xcel said there is a "tracking" (electrical short) occurring at the top of the pole. A different crew has to come to the site for this type of repair. Xcel called it in and requested for it to be expedited. Xcel gave GHD contact information to the foreman and request they call with an ETA when they will began the repair. Received call that a crew is heading to site. At 13:45 GHD and Xcel arrived on site. Xcel was able to energize the lines and issues seems to be resolved. Closed all the open disconnects in the pumphouses and in Building 116. Powered up the PLC. Many alarms began appearing, clearing/acknowledging alarms. First attempted to start the system, did not start. Returned to a few pumphouses and turned on the UPSs. Tried to start the system again, Blowers 3 and 4 failed. Both overloads were tripped at the motor control center up front, reset. Started system again, blowers started and well field began to come up. Went to SC5 and closed both disconnects. System fully up and operational at 16:20. Reset autodialer. Xcel explained that the carry-over jumpers needed to be replaced. The jumpers and pins were replaced. These have a porcelain isolator and both were older and cracked. The third carry over jumper was in good condition. System operating normally. Down time: B1, B4, B5, B6, B8, B9, and SC5 for 18.0 hours, and B3 and B13 for 9.5 hours.
3/9/2022	Treatment System. Normal Monthly Preventative maintenance was started. Down time: None.
3/10/2022	Treatment System. Normal Monthly Preventative maintenance was completed. Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

March 2022

3/10/2022	Pumphouses B3 and B13. ECV maintenance for B3 and B13 pumphouses. Down time: B3 and B13 for 1 hour.
3/13/2022	Treatment System. Alarm emails began at 7:16, autodialer call at 7:48, called Xcel Energy power outage line and the White Bear Lake dispatch line. GHD on site at 8:50, found the electric meter at B5 was completely off, began to follow power outage restart steps. Xcel Energy on site at 9:00, found that a vehicle hit a ground wire at the first power pole on site from Sherer Brothers Lumber resulting in the wire snaping from the ground and tripping open two fusible links. Xcel restored power to the site at 10:20. GHD began powering up the UPSs at the pumphouses and powered up Building 116. Cleared and acknowledged the alarms. Started the treatment system at 11:10. Treatment system and well field operating normally. GHD notified Xcel that the system was on and operating normally. Down time: B1, B4, B5, B6, B8, B9, and SC5 for 4.0 hours, B13 for 1.5 hour, and B3 for 2.0 hours.

April 2022

10/21/2021-present	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 192 days (ending 4/30/2022)
4/4/2022	B5 Pumphouse. B5 UPS Power Fail alarm, extraction well still running. Alarm acknowledged. Went to B5 pumphouse, extraction well running normally. System okay light was off. UPS had no indicator lights on. Remotely stopped B5, cycled power to the controls and powered on the UPS. Restarted B5 and observed normal operation at 1725. System okay light back on. Down time: None.
4/11-12/2022	Treatment System and Well Field. Normal Monthly Preventative maintenance was completed. Down time: B1 for 1.5 hours, B4, B6, B8, B9, and SC5 for 2.0 hours.
4/13/2022	B5 Pumphouse. B5 VFD Fault and Pump Failed to Start alarms at 21:46 on 4/12/2022, no alarm emails sent. Alarms acknowledged and well restarted. B5 VFD Fault, Pump Failed to Start, and Low-Low Flow alarms again ~15 minutes after restart. Alarms acknowledged and well restarted. Will continue to monitor well status. Down time: 24 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

April 2022

4/14/2022	B5 Pumphouse. Noticed during remote monitoring that B5 was down due to alarms for VFD Fault and Pump Failed to Start, no alarm emails were sent out. GHD arrived on site at 15:30, B5 System ok light on, no faults currently listed on the VFD Display. All power going into the VFD is normal. Cycled through VFD fault history, dates and times are not set correctly. Faults listed are undervoltage, IO time-out, ground fault, and overvoltage. Started well remotely and the VFD immediately recorded an overvoltage fault. Attempted to start well at pumphouse (local), also got an immediate overvoltage fault. Possible issue with VFD or pump/motor. Need to coordinate with an electrician to come to site to test pump windings to determine if pump/motor needs replacement. Left B5 off over night awaiting further troubleshooting and increased flow rate of other boundary wells (B4, B8, B9) to maintain minimum flow rate. Down time: 24 hours.
4/15/2022	B5 Pumphouse. GHD and Preferred Electric on site at 9:55. B5 still off and no faults shown on VFD. Electrician unlanded power leads to pump and restored power. The control panel was put in Local control and started VFD, the VFD ramped up to 60 Hz with no issue or faults. VFD appears to be operating normally. Put multimeter to pump leads and got continuity to ground from every leg, which indicates a possible issue with the motor. Electrician left site to get additional equipment for further troubleshooting. GHD found a spare pump and motor that would fit the well if a replacement was needed. Electrician returned to site and checked megger lines, no readings were shown indicating very low resistance short to ground. These results determined that the motor has dead shorted, pump and motor will need to be replaced. GHD and Preferred off site at 11:45. GHD coordinated with Thein well to replace pump and motor as soon as possible. B5 will remain off until replacement. Down time: 24 hours.
4/16-17/2022	B5 Pumphouse. B5 off awaiting pump and motor replacement. B4, B8, and B9 flow rates increased to maintain minimum flow rate. Down time: 48 hours.
4/18/2022	B5 Pumphouse. GHD and Thein on site at 11:00 for B5 pump and motor replacement. Thein removed riser pipes and pump/motor from extraction well. Thein determined that both the pump and motor were damaged. Thein replaced the B5 pump and motor. B5 was restarted at 17:25. Observed normal operation. B4 and B9 flow rates decreased to normal operation. Down time: 18.5 hours
4/18/2022	SC5 Pumphouse. GHD on-site to shut down SC5 for SGRS work. GHD contacted SGRS contractor to notify them that SC5 is getting shut down. Lower SC5 flow rate to 10 gpm, then shut down SC5 at 9:30 from Building 116. Confirmed SC5 off at pumphouse. Went to SC4 pumphouse and followed procedure to start the well. SC4 started at 9:57. Let SC4 to run for at least 4 hours to dilute the forcemain water for safer SGRS work. Returned to SC4 pumphouse and shut down SC4 at 14:17. Closed the 14" isolation valve to the east side of the forcemain. Notified SGRS contractor and Arcadis that SC5 was shut down and the isolation valve was closed and they are set to go for their work on the SC5 SGRS connection. Down time: 13.5 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

April 2022

4/19-20/2022	SC5 Pumphouse. SC5 off during SGRS work to SC5 SGRS connection. B8 flow rate increased to maintain minimum flow rate. Down time: 48 hours.
4/21/2022	SC5 Pumphouse. SGRS contractor notified GHD that the SC5 SGRS connection work was complete in the afternoon of Wednesday, April 20th. GHD arrived on site to restart SC5 at 7:00. Notified SGRS contractor that GHD is ready to restart SC5. SGRS contractor watching SC5 connection and two other representatives watching Site G and Site I connections. Opened 14" isolation valve at 7:13 and notified SGRS contractor. After one hour of isolation valve being open, confirmed with SGRS contractor that there were no leaks or issues with the connections. Went to SC5 pumphouse and opened the isolation valve to the forcemain. Started SC5 with a flow rate of 10 gpm at 8:17, then increased flow rate to 40 gpm. SGRS contractor notified GHD that there is a small leak and to shut down SC5 temporarily. SC5 off at 8:23. SGRS contractor notified GHD that leak had been repaired and to restart SC5. Restarted SC5 at 8:27 at 10 gpm. Increased flow to 40 gpm. Lower B8 flow rate to 180 gpm. After 30 minutes, increased SC5 flow rate to 60 gpm and decreased B8 flow rate to 140 gpm. After 30 minutes, confirmed no leaks or issues with SGRS connections then increased SC5 flow rate to 80 gpm. After 1 hour of operation at 80 gpm, checked Site I SGRS connections, no leaks observed. Notified SGRS contractor of no leaks at Site I and that GHD is leaving site. Observed normal operation at SC5. Down time: 10.0 hours.

May 2022

10/21/2021 - present	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 223 days (ending 5/31/2022)
5/2/2022	B1 Pumphouse. Upon arrival to site, discovered B1 alarms for Pump Failed to Start and VFD Faulted the previous day (5/1/2022) resulting in 4.7 hours of downtime. Alarms were acknowledged and alarms immediately went off again. Went to B1 pumphouse, extraction well off, System Okay light not on. Observed F004 VFD fault (undervoltage) on VFD unit. Acknowledged alarms, restarted well. Instant VFD fault, Fault F013 (ground connection). Spoke with field tech about issue. Shut down B1 and acknowledged alarms. Determined that electric connections needed to be checked, may be a motor issue. Electrician heading to site. Preferred Electric on site at 12:45, and determined the motor has shorted due to inconsistent voltage readings from lead cable. Reviewing other wire connections and VFD, VFD is operating normally. Determined the issue is either with the motor and/or lead cable. Need to replace motor and pump. Began to reach out to vendor to set up pump and motor replacement. Left extraction well B1 off until replacement pump and motor have been installed. The flow rates of B5, B8, and B9 were increased to maintain the minimal operation flow rate. Down time: 24 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

May 2022

5/4/2022	B1 Pumphouse. GHD arrived on site to oversee the replacement of the pump and motor for the B1 extraction well. Collected static water level and checked what changes were needed to install the transducer into the well. Disabled Building entry and VFD fault alarms for B1. Thein Well arrived on site at 9:15, discussed issue with well and plan for the day. Thein removed the riser pipes and water level pipe, then removed the pump and motor. Thein confirmed that motor had shorted and needs replacement. Thein installed a new motor and pump, and lowered it back into the well. The lead cable and riser pipes were reused. Once the pump and motor were fully installed, the flow rate of B5, B8, and B9 were lowered to normal operating flow rates. The water level pipe was lowered 2 ft to allow for the installation of the transducer. Restarted B1 at 12:48 to auto, shut down well immediately, as motor is running backwards. Thein rewired the motor and B1 was restarted. Observed normal operation of B1. Enabled the disabled alarms. Down time: 37.5 hours.
5/8/2022	B4 Pumphouse. B4 VFD Fault and Pump Failed to Start alarms at 18:11 on 5/7/2022 (4.8 hours down time). Alarms were found and acknowledged. B4 was restarted and normal operation was observed. Down time: 10.4 hours.
5/10/2022	B6 Pumphouse. While conducting preventative maintenance at the B6 pumphouse, there was a noise coming from the well that sounded like cavitation, the pressure gage was fluctuating as well. At the main control panel, the water level was showing 120.3' and -0.3 above the pump. Flow showing 165.3 with the set point at 170 gpm. Reduced the flow set point to 160 gpm, no change in the water level. Reduced the flow further to 150 gpm and the water level came up to 118.3'. The well is no longer making noise and the pressure is steady. Flow was reduced at around 1355. Increased the flow at B8 from 140 gpm to 160 gpm to help with the reduced flow at B6. Possible acid cleaning needed at the well. Down time: None.
5/10/2022	Treatment System and Well Field. Began normal Monthly Preventative maintenance. Down time: None.
5/11/2022	B4 Pumphouse. B4 VFD Fault alarm at 14:00, alarm was acknowledged. B4 was restarted and normal operation was observed. Down time: 3.5 hours.
5/20/2022	B5 Pumphouse. High temperature were observed in the B5 pumphouse in the prior week, and the vent fan appeared to not be working. The B5 pumphouse vent fan was replaced. Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

May 2022

5/24/2022 B1 Pumphouse. Heard leak or cavitation in the B1 well, pressure needle is bouncing around. Determined that the water falling from the screen may be causing the abnormal water level reading. Got new water level tape and got a reading of 128 feet. Set tape at 125 feet and stopped pump remotely. Water level hit 125 feet probe instantly. Set point to 75% manually, switched to hand. Pump on 75%, 30 Hz, 0 gpm. Bumped up to 100%, Hz still at 30 Hz. Switched control from PLC to local. Ramped up the motor to 60 Hz. Hz instantly dropped down to 56 Hz, flow rate at 205 gpm (97/98 psi). To PLC, Hz at 30 and 0 gpm. Motor speed would not change with the change in set point. Switched control panel to local control, speed ramped up to 56 Hz and 217 gpm (max amp setting in controller 589 VDC?). Flow rate down to 206 gpm, controller HIM Reference 60 Hz. VDC lower at 56 Hz than at 30 Hz. Need control engineer input. Back to PLC control. Spoke with controls engineer, possible an issue with the VFD settings (limiting factor).

Down time: None.

5/25/2022 Treatment System and Well Field. Completed normal Monthly Preventative maintenance.

Down time: B1 for 1.5 hours; B3, B4, B5, B6, B9, and SC5 for 2.0 hours.

June 2022

10/21/2021 - present SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation.

Down time: SC1 for 253 days (ending 6/30/2022)

6/3/2022 SC2, SC3, and SC4 Pumphouses: Completed pump, piping, and electrical maintenance on the pumphouses to collect a groundwater sample for the Annual Sampling Event.

Down time: None.

6/4-5/2022 B4 Pumphouse. Received an alarm email for UPS Power Failure at 10:41 PM on 6/4/2022. Alarm email was not seen until remote monitoring the next morning. B4 appeared to be operating normally via the remote monitoring viewing connection. Attempted to acknowledge alarm, alarm would not shut off. Updated project team on B4 status.

Down time: 24.0 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

June 2022

6/6/2022	B4 Pumphouse. Arrived on site, B4 UPS Power Failure alarm still on. B4 appeared to be running still. Upon arriving to the B4 pumphouse, it was discovered that B4 was off, the flow meter was off, the System OK light and any other light in the control panel were off, no lights on the UPS Power unit inside control panel, and could not hear the motor running down the well. B4 was shut down on the main control panel by switching it to the OFF position. The green status did not change when flipped to OFF. The control panel in the pumphouse, showed 0.00 Hz and FAULTED, Fault Code 4037. The fault was cleared and control of the pump was switched to Local on the pumphouse control panel. Set the reference to 57.0 Hz, and started the motor. The speed instantly jumped to 57 Hz, could hear the pump and motor starting down the well, normal pressure on the pressure gauge, and could hear water moving through the pipes. The flow meter was still off and the main control panel status is unchanged. The UPS still has no lights on. Flipped the pumphouse control panel to PLC, and the motor automatically goes to 0 Hz. Reached out to project team for troubleshooting assistance and restarted B4 in Local mode. Down time: 24.0 hours.
6/6/2022	SC5 Pumphouse. Notified SGRS crew that GHD was ready to shut down SC5, and that we would be running SC4 in preparation for Site I and Site G manifold work. Shut down SC5 on main control panel at 13:29. Confirmed that SC5 was off at pumphouse. Arrived at the SC4 pumphouse and realized that the hose and piping has changed since the last start up due to Annual Sampling Event, unable to run SC4 from well into forcemain. Went to SC3, power already cut to SC3 pumphouse for new electrical connections to the SGRS. Spoke with Project Manager and Project Director about the situation, Project Manager and Project Director approved plan to leave isolation valve open overnight and close the next morning. Updated SGRS crew on the new plan and increased B8 to 205 gpm to account for SC5 being down. Down time: 9.5 hours.
6/7/2022	B4 Pumphouse. Returned to B4 pumphouse first thing in the morning, found that the well had faulted again. Tested the power to the outlet that the UPS is plugged into with a phone charger, no power. Flipped the CB-301 breaker, instantly got power to the control cabinet and flow meter, and the system ok light flipped on. I switched the well to PLC control on the pumphouse control panel and observed normal operation for around 10 minutes, then received another UPS Power Failure alarm. Shut down the well and acknowledged the alarm. Moved the plug-in that was in the UPS outlet to the outlet that was just tested. B4 was restarted and normal operation was observed. It was determined that the UPS unit has failed or the UPS battery unit needs to be replaced. Will order replacement unit. Down time: 11.0 hours.
6/7/2022	SC5 Pumphouse. Arrived on site, packed T-handle into work truck and headed to the isolation valve. Closed isolation valve and confirmed everything is operating normally at the main control panel in Building 116. Notified the SGRS crew that the isolation valve is closed and they are set to begin their work. They notified me that they would complete the depressurizing of the lines today so they can begin their work first thing on Wednesday morning. Down time: 24.0 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

June 2022

6/8/2022 SC5 Pumphouse: Received a call from the SGRS crew at 13:00 that they have completed the work to the manifolds at Site I and Site G. We decided it would be best to start the restart process first thing the next morning since the SGRS crew would be leaving site at 15:00 and we would only have two hours on crew onsite in the event of a leak or issue.

Down time: 24.0 hours.

6/9/2022 SC5 Pumphouse. Arrived on site and observed normal operation of the TGRS. Opened isolation valve at 7:30 and notified SGRS crew that it was open (will leave isolation valve open without SC5 operating for 4 hours). Left the isolation valve with the T-handle in it (went to complete Annual Sampling). SGRS contractor to site by isolation valve in case of issue or leak. Confirmed no leaks or issues at Site I or Site G with SGRS crew, started SC5 at 40 gpm at 11:45. Decreased B8 to 160 gpm. Confirmed no leaks or issues at Site I or Site G with SGRS crew, increased SC5 to 80 gpm at 12:50. After tightening some bolts on one connection, no additional leaks or issues at Site I or Site G. SC5 operating normally. Picked up T-handle from isolation valve and returned it to Building 116. TGRS operating normally.

Down time: 13.5 hours.

6/12/2022 B3 Pumphouse. B3 Communication Failure alarm email at 19:20. Remotely connected to the treatment system and acknowledged the alarm. B3 is "Green" on the TGRS screen. 224 gpm. Pulled up the B3 screen. Pump is green, but 0 gpm. No Alarms. To Alarm Page 5, B3 No Alarms box is lit green. Communications Failure alarm is red. Disabled/Enabled the alarm, now normal. The system appears to be operating normally.

Down time: None.

6/13/2022 B7, B10, and B12 Pumphouses. Began pump, piping, and electrical maintenance on the pumphouses determine what needs to be done to collect a groundwater sample for the Annual Sampling Event. Determined B10 and B12 will operate, B7 needs to be inspected by an electrician. before sampling can occur.

Down time: None.

6/16/2022 B7, B10, and B12 Pumphouses. Meet electrician on site to troubleshoot B7. Was able to make a temporary fix to the control panel to run B7 to collect the sample. Completed other pump and piping maintenance to collect a groundwater sample for the Annual Sampling Event.

Down time: None.

6/17/2022 B4 Pumphouse. The new UPS was installed in the B4 pumphouse control cabinet today. It was discovered that the back of the panel where the original UPS was mounted was somewhat hot to the touch. This may be part of the reason the previous UPS failed. After ensuring that the unit will fit without interference of the inner panel door, it was decided to place the UPS on top of the mounting bracket on the floor of the cabinet. Had to rewire the power cord to the PLC temporarily so it could reach the back of the UPS. The pump was down for approximately 10 minutes for the installation. After the work was completed, all alarms were acknowledged and started B4 at 14:55. Observed normal operation.

Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

June 2022

6/19/2022 B3 Pumphouse. B3 Communication Failure was found during the remote monitoring. Acknowledged alarm and attempted to reset the pump remotely with no response. Will head to site later to troubleshoot, by cycling the power to the controls/wireless modem and check connections. Checked B3's status before heading to site, acknowledged Communication Failure alarm and was able to restart B3 remotely at 13:40. Will continue to monitor.

Down time: None.

6/20/2022 B4 Pumphouse. B4 VFD Fault and Pump Failed to Start alarm emails around 4:00. GHD onsite at 7:13, Fault Code 12 (overcurrent). Cycled VFD disconnect. Acknowledged alarms and reset B4 to Auto. VFD Faulted immediately. Shut down B4. Disconnected pump leads in cabinet and acknowledged alarms. Seeing normal output reading, may need to troubleshoot VFD. Had to leave site for another project, contacted project team. Met with controls engineer to continue to troubleshoot. Disabled Building entry alarm for B4. Checked voltage reading on lead cable, motor rated for 77 volts. Shut off power to VFD. Got VFD fault, acknowledged. Reconnected leads, and restarted VFD. Everything going into VFD looks good. Flipped B4 to Hand at 12:13, heard VFD start, but 0 Hz and 0 gpm. Main control panel showed green and 3.9 gpm, no flow or Hz observed at pumphouse. Switch B4 off, switched to Local tried to start and faulted right away. Low low flow alarm, acknowledged alarm. VFD faulted immediately when trying to start in Local. Same resistance on windings, motor not shorted. Disconnected pump and started VFD, started up normally (went right to 54 Hz). Something is causing the motor to run harder than it needs to. A little unbalanced on what it is sending out per leg. Voltage, putting out what it is supposed to be. Definitely an issue with pump or motor, needs to be replaced. Will contact Thein. Increased B8 to 205 gpm (160 gpm), B5 to 405 gpm (350 gpm), and B9 to 305 gpm (205 gpm). Received VFD Fault, Pump Failed to Start, and High High Level alarms for B5 at 2:40 pm due to increase in flow rate, lowered flow rate back down to 350 gpm and restarted well.

Down time: 18 hours.

6/20/2022 B3 Pumphouse. Arrived at B3 pumphouse to cycle power to troubleshoot Communication Failure alarm. Tired to shut down B3 on remote connection, wouldn't shut down. Shut down manually in pumphouse. Shut off power to control panel. B3 finally shut off on main control panel. Checking voltages in control panel at pumphouse. Everything looks normal in panel. Switch well to auto (in pumphouse and main control panel). Well started, observed normal operation. No system ok light on. Returned to pumphouse 30 minutes later, system ok light on.

Down time: None.

6/21-23/2022 B4 Pumphouse. B4 off due to an issue with pump or motor, waiting for pump and motor replacement.

Down time: 72 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

June 2022

6/24/2022 B4 Pumphouse. GHD met Thein Well at site gate and went to the BB4 pumphouse. Completed safety meeting and collected static water level. Disabled alarms at B4 for replacement work. All riser pipes removed and in good condition with minimal build-up. Lead cable needs to be replaced with new pump and motor. Thein took apart the pump and motor and found that the motor bearings are worn down. Pump looks to be in good condition, will keep it as an emergency spare. Lowered B8 and B9 to normal flow rates. New pump, motor, and lead cable were installed in well. Restarted B4 at 13:45, observed normal operation.

Down time: 15.0 hours.

6/26/2022 B4 Pumphouse. B4 VFD Fault alarm email at 12:50 am. Discovered B4 down due to the VFD Fault during the remote monitoring in the morning. Switched B4 to Off and acknowledged the alarm. Restarted B4 at 10:50 and observed normal operation. Got a Low-low level alarm, water level at ~99 ft, Pump inlet at 108 feet, and low level set to alarm at 98 feet (10 ft above well). Lowered the alarm point to 8 feet above the well and acknowledged the alarm.

Down time: 10.0 hours.

6/28/2022 B4 Pumphouse. Navigated through the VFD interface to find the fault page. The last 2 Faults were "Motor Overload". They were Faults 01 and 02 on the list. However the time stamp was for the year 1970. The time and date in the interface was updated. After placing a hand on the divider between the high and low voltage cabinet sections and noticed how hot the divider was, the cooling fan inlet filter was removed to get more air flow through the cabinets. The elevated temperatures in the cabinet may be affecting the drive performance, but not enough to trip the drive out on a "High Temp" fault. The amp reading while on site were 75,70 and 73. I believe this is within the operating range but would like to verify these readings to what is on the manufacture name plate. B4 VFD Faulted at 22:58.

Down time: 1.5 hours.

6/28/2022 Treatment System and Well Field. Began normal Monthly Preventative maintenance.

Down time: 1.5 hours for B1, and 1.0 hour for B5, B6, B8, B9, and SC5.

6/29/2022 B4 Pumphouse. Found B4 VFD Fault. Went to site, observed B4 down and Fault Code 7 - Motor Overload. Cleared fault and acknowledged alarms. Switched B4 to Off. Lowered flow rate to 370 gpm (normally 380 gpm). Restarted well (10:15 AM), observed normal operation.

Down time: 11.5 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

June 2022

6/30/2022	B4 Pumphouse. Disabled some alarms for B4. At B4 around 9:45, and checked amps on each leg. 70/72/70, normal according to the motor name plate. Looked up the most recent faults: “Motor overload”. Set the time/date again in the drive. Found and logged other information. Called controls engineer with findings, who looked through the online manual and found the likely problem. The name plate info parameters in the drive are from the old motor that was just replaced. The previous motor had a Full Load Amps (FLA) of 67.70 and a Service Factor (SF) of 1.00%. The new motor FLA is 71 and the SF is 1.15%. Since the motor was running at 70-72 Amps, the VFD was shutting down to protect the motor. The new parameters were set in the drive. Had to switch to Local and stop the motor for this step. Off for less than 5 min. Set the flow back to 380 gpm from 370 gpm and observed normal operation. Enabled the alarms that were turned off earlier. Down time: None.
6/30/2022	Treatment System and Well Field. Completed normal Monthly Preventative maintenance. Down time: None.

July 2022

10/21/2021 - present	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 284 days (ending 7/31/2022)
7/5/2022	SC5 Pumphouse. GHD was notified that Xcel planned on completing electrical work near the SC5 pumphouse for the SGRS building and that SC5 needed to be shut down during the work. GHD arrived on site and disabled alarms for SC5. Shut down SC5 at 10:00 from the main control panel. Confirmed that pump was off at pumphouse. Shut down the UPS, and switched the main breaker, service disconnect, 480 volt disconnect, well/pump disconnect to OFF. Notified Xcel that the pumphouse power was off at 10:15. Xcel placed a lock on the service disconnect. Increased flow at B8 to 205 gpm and B9 to 230 gpm to maintain the minimum target flow rate. Xcel completed the electrical work and SC5 was restarted and operational at 13:35. B8 and B9 were set back to normal operational flow rate. Down time: 3.5 hours.
7/21/2022	B1 and B6 Pumphouses. During remote monitoring noticed that B1 was trending under 200 gpm, flow rate set point is 220 gpm, motor speed at 56-57 Hz. B6 running at around 140 gpm, flow rate set point is 150 gpm, motor speed at 60 Hz. Increased B8 to 175 gpm to account for the low flow in B1 and B6. Discussed observations with field tech, on site troubleshooting to occur during monthly preventative maintenance. Down time: None.
7/22/2022	B5 Pumphouse. Checked VFD name plate factor and set point factor to ensure it matches the new motor installed on 4/18/2022, both parameters are correct. High high level and low low flow alarms at 8:28 AM and 8:56 AM during check of VFD parameters. Down time: 1.0 hour.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

July 2022

7/25/2022	Treatment System and Well Field. Began normal Monthly and Quarterly Preventative maintenance. Down time: None.
7/25/2022	B1 and B6 Pumphouses. B1 flow rate at 191/193 gpm, flow rate set point at 220 gpm. Motor speed at 56 Hz, observed the motor speed acceleration and the reference point is 60 Hz. No clear reason why flow rate is low, further troubleshooting needed. Upon arrival to B6, the pump was cavitating. Removed the level probe and checked the pumping water level with water level meter. Flow rate at 139 gpm, flow rate set point 150 gpm, water level 128.6 feet. Set flow rate to 130 gpm, observed flow rate of 130 gpm and water level at 123.4 feet. Not observing cavitation anymore. Replaced level probe. Will need to schedule acid cleaning for well. Down time: None.
7/26/2022	Treatment System and Well Field. Completed normal Monthly and Quarterly Preventative maintenance. Down time: None.

August 2022

10/21/2021 - present	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 315 days (ending 8/31/2022)
8/1/2022	B4 Pumphouse. Received B4 VFD Fault and Pump Failed to Start alarm emails at 6:15 AM. GHD arrived on site at 8:00 AM and observed an overvoltage fault on the VFD in the B4 pumphouse. Cycled power to the VFD, acknowledged alarms, and restarted pump at 8:20 AM. Observed 69 Amps from the pump, pump is rated for 71 Amps. Observed normal operation and will continue to monitor for any further issues. Down time: 2.0 hours.
8/6/2022	B1 Pumphouse. During remote monitoring found a B1 Low low Flow Alarm. Acknowledged the alarm. Observed a negative flow rate with a 60 Hz motor speed. Shut down well. Left well down for ~15 minutes, then attempted to restart it. Again, observed a motor speed of 60 Hz with a negative flow rate. Receive another low low flow alarm. Shut down well and acknowledged alarm. GHD to site, arrived on site at 12:40 PM. B1 controls normal, started pump. Heard a heavy grinding/vibration from the well, no flow rate, and Amps were at 21. Shut down well. Determined that there was a possible issue with either the pump or motor, will need to be removed and replaced. Adjusted flow at B8 from 175 gpm to 212 gpm, B9 from 205 gpm to 296 gpm, and B4 from 378 gpm to 385 gpm. Total flow rate was 1,753 gpm when leaving site. Down time: 15.5 hours.
8/7-9/2022	B1 Pumphouse. B1 well off awaiting pump and motor replacement due to negative flow rate observed on 8/6/2022. Down time: 72 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

August 2022

8/7/2022	Treatment System and Well Field. Received multiple alarm emails, headed to site. Arrived on site and found that the well field was down except for B13 and the 2 blowers were on. Channels 01 and 08 were active on the Autodialer, but received no call. Acknowledged alarms. Checked the Motor Control Center up front and found that the overloads were tripped on the WWP-3 control bucket. Pushed in and reset the overloads. Restarted system at 11:12 AM. Went to B13 and manually tripped the micro switch to stop the pump. Restarted system again at 11:20 AM. Well field began coming online, WWP-3 motor started but the ECV would not open. Wet well high level alarm causing the well field to shut down. Exercised the operating solenoid valve for ECV-3. Cleared alarms and restarted the system again. WWP-3 started and the ECV opened normally. Observed normal operation of treatment system. Then went to check on why the autodialer did not call out. Called number of autodialer, went straight to voicemail. Observed 1 to 2 bars of signal strength, status blinking green, cellular is solid orange, power is solid red. Cycled power to the cellular modem and tried calling again, went straight to voicemail. Ran a system fail call out test, autodialer called out. Began the alarm message then there was a dial tone again in the background, the message cycled through 3 times without an acknowledgement. Acknowledged the message, but received no call from the answering service. Further troubleshooting needed. Observed normal operation of WWP-3 and treatment system. Down time: B3 for 2.0 hours, B4, B5, B6, and SC5 for 10 hours, B8 for 7.0 hours, and B9 for 11 hours.
8/7-8/2022	B9 Pumphouse. Received B9 VFD Fault at 6:22 PM on 8/7. Acknowledged and restarted B9 remotely at 5:45 AM on 8/8, observed normal operation. Received another VFD Fault alarm email at 6:13 AM. Restarted B9 at 8:40 AM. There were no fault codes recorded on the VFD. GHD off site. Received another VFD Fault at 9:27 AM. GHD back to site at 1:40 PM. Acknowledged alarms and cleared faults in the VFD. Restarted B9 at 2:00 PM. VFD fan is not spinning, casing is hot. Tried to spin the fan manually, it started running - blowing hot air out the top of the VFD. Left cabinet open to a bit to cool down. Removed a fan from a spare VFD, shut down B9 and disabled alarms. Swapped current fan with the new one from spare in the VFD at B9. Connected power to the VFD and started it, fan started right. Restarted B9 at 2:40 PM and enabled alarms. Observed normal operation. Down time: 10.0 hours.
8/10/2022	B1 Pumphouse. Thein well arrived on site at 10:20 AM to remove and replace the B1 pump and motor. Pump and motor were removed, and it was found that the motor shaft is broken internally, the pump is still in good condition. Replaced motor with new one and reused pump. Restarted B1 at 2:00 PM, observed normal operation. Down time: 14.5 hours.
8/12/2022	B3 Pumphouse. B3 Communication Failure alarm email at 3:56 PM. Restarted well and observed normal operation. Down time: 6 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

August 2022

8/13-14/2022

Treatment System and Well Field. Received Pump 3 Failed to Start and Wet Well 1 High Water Level alarm emails at 9:39 PM on 8/13. Discovered treatment system down due to alarm emails during remote monitoring. B13 and blowers were still running. Acknowledged alarms, attempted to restart system remotely. Clicked the system start button at 11:04 AM. Well field began operating ~11:08, Pump 4 operating at 11:08. All wells, blowers, and Pump 4 operating at 11:10 AM, total flow rate ~1,796 gpm. Tried to start Pump 3, and it tripped the Pump 3 Failed to Start alarm again. Acknowledged alarms. Clicked system stop at 11:12 AM. Observed 1,950 gpm of flow began manually shutting down wells, system off at 11:16 AM. Tried to shut off B13. Headed to site. Arrived at site, checked system, blowers running and B13 still running. Acknowledged alarms and reset Pump 3 in the main panel up front. Channels 01 and 08 were active on the Autodialer. Cycled power to autodialer. Need to look into why the autodialer didn't call out. Restarted system at 12:07, wells began coming on, well field, blowers, and Pump 4 on. Waiting for Pump 3. Pump 3 failed to start again, no change in pump condition (no movement or noise). Shut down system by pressing system stop button. Tried to reset Pump 3 again on the main panel up front, but continued to get Pump 3 Failed to Start Alarms. Couldn't hear the pump trying to start, possibly something is wrong with the fuses. Contact field technician to do further troubleshooting. Manually went and shut down B13 by tripping the microswitch. Pump 4 and blowers off when got back to Building 116. Left treatment system down for further troubleshooting. Field technician arrived on site at 4:10 PM. Troubleshooting WWP-3 Failed to start. Viewing the electrical schematic drawings, Overload relay reset is pushing in normally, acting like it is not tripped. Found the control relay (In the new cabinet) that powers the starter coil at the Pump 3 motor control bucket. Control relay is working correctly and getting 120 volt power to the starter coil. Coil is not engaging. Called Preferred Electric for assistance. Talked about the issue and what has been tried so far. Preferred Electric will be onsite at 7:00 AM tomorrow morning. Going to partial start up system with only Pump 4 operating. Pressed

System Start at 5:45 PM, began with wells SC5, B1, B13, B5, B4 and B9 running. Observed the operating Wet Well level, getting close to the Wet Well High Level float activating. Shutdown B9 at 5:55 PM, shutdown B4 at 5:58 PM. Total influent flow is at around 709 gpm, wet well level slowly dropping, will leave the system in this condition. Operating pumphouses are SC5, B1, B13, and B5. Will continue to check the system remotely this evening to see if any changes are needed. GHD off site at 6:20 PM. Remote check of the system at 7:50 PM and 9:00 PM, operating normally.

Down time: B1, B5, and SC5 for 20 hours, B3 for 21 hours, and B4, B6, B8, and B9 for 25 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

August 2022

8/15/2022 Treatment System and Well Field. Arrived on site at 6:40 AM. Preferred Electric on site and talked over what steps were taken to troubleshoot yesterday. Found that a component of the overload block on the Pump 3 starter was the issue. There is a metal tab on the A phase that was tripped and not resetting. Reset that tab with a screwdriver. Tripped and reset the tab a few times with no issues. Started Pump 3 in hand. Pump 3 started with no issues, switched pump to off. Manually tripped and reset the tab a few more times with no further issues. Also found that one of the phase wires that is going from the bottom of the bucket disconnect to the top of the starter was actually up against the side of the starter housing and a plastic tab attached to the coil was rubbing on the wire. The wire was moved away, taped the insulation and repositioned out of the way. Very tight quarters inside the bucket. This condition may have kept the coil from fully engaging. Switched Pump 3 control into auto. Enabled the wells that were off at 7:25 AM. Observed full operation of the treatment system at 7:35 AM. Checked Pump 3 operating Amps, were ~82. Name plate is 91.3 Amps, so it is running within/below it's operating range. Normal operation observed.

Down time: B3 for 7 hours, and B4, B6, B8, and B9 for 8.5 hours.

8/16/2022 Treatment System and Well Field. Received a Pump 3 Failed to Start alarm at 5:32 AM. GHD arrived on site at 7:10 0532 – Received an email from the system that WWP-3 Failed, checked main control center bucket for Pump 3. The overload (phase A) was tripped again. Reached out to Preferred Electric, will bring some replacement overloads to site. Removed the overload from the A phase leg (marked with an X) and swapped with the overload on the C phase. This was done (as step one) to see if the trip problem follows the overload to the C phase. If the trip occurs on the A phase again, the investigation would move onto the wiring and/or motor, and if the C phase trips, the problem is most likely the overload itself and will be replaced. Test ran Pump 3 for a short time to observe the pump shaft then ran the pump again to check and observe the operation of the motor. Enabled a partial system start at 9:15 AM, Pump 3 set as the lead pump. Wells SC5, B1, B13, and B5 operating. Monitoring Amps of Pump 3, on start the Amps spiked around 300 then settled down to around 82. Observed normal operation, started the rest of the wells. Treatment system fully operating at 9:46 AM. Normal operation observed.

Down time: B3 for 2.0 hours, and B1, B4, B5, B6, B8, B9, and SC5 for 4.0 hours.

8/16/2022 Treatment System and Well Field. Began normal Monthly and Quarterly Preventative maintenance.
Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

August 2022

8/19/2022

Treatment System and Well Field. Received Pump 3 Failed to Start and Wet Well High Level alarms at 12:30 PM, treatment system down. GHD on site to response at 1:15 PM, manually shutdown B13 by switching the microswitch. Preferred Electric on site at 1:25 PM, replaced overloads for Pump 3. Restarted treatment system at 1:45 PM, switched Pump 3 to the lead pump. B3 would not start with other wells. B3 Communication Failure alarm at 1:30 PM. Reset power in B3 pumphouse PLC, pump tried to start and shut off immediately. Switched pump from auto to off on main control panel. Switched Pump 4 to the lead pump. Troubleshooted communication issue by cycling power to control panel at pumphouse, switched B3 back to auto at pumphouse and main control panel. Restarted B3 and observed normal operation at 3:40 PM. Observed normal operation of the treatment system.

Down time: B1, B13, B3, B4, B5, B6, B8, B9, and SC5 for 1.5 hours.

8/20-21/2022

Treatment System and Well Field. Pump 3 and 4 Failed to Start, Blower 3 and 4 Failed to Start, and Wet Well High High Level alarms at 9:45 PM on 8/20. Noticed that there were alarm emails sent out last night at 6:50 AM. Arrived on site at 7:50 AM. There is a fusible link open to the building transformer and water flowing out back door. B13 remained on, ECV failed to close. Manually turned pump off at the pumphouse using the microswitch. Partial power at main control panel. Opened the disconnect for Pump 4, opened cabinet to check power. Checked volts Phase to Ground – A 208, B 522, C 223, Phase to Phase A-B 618, A-C 509, B-C 532. Configuration is Delta, causing feedback and erratic readings. Called Xcel power out line to report the incident at 8:13 AM. Called Xcel dispatch at 8:15 AM, someone will head out to site to assist. Checked all the pumphouses, all normal. Powered down control panel and opened main disconnect in electrical room. Xcel on site at 9:08 AM. Xcel said that the issue is most likely after the fuse in the transformer, not upstream. Xcel replaced the fuse, the fuse held for around 30 seconds then blew again. Contacted Preferred Electric. Xcel taking pictures and contacting Emergency Repairs department at Xcel. Xcel sent the transformer information to the engineers and construction departments at Xcel, probably will not have a plan till mid morning tomorrow. Xcel is recommending that a replacement generator gets lined up. Contacted project team and gave them an update. Project team and Preferred Electric working on a replacement plan, temporary power, and notifying agencies. GHD off site at 11:40.

Down time: B3 for 26.0 hours, B1, B4, B5, B6, B8, and B9 for 25 hours, and SC5 for 24.0 hours.

8/22/2022

Treatment System and Well Field. Treatment system and well field down awaiting temporary power to Building 116 due to the failed transformer.

Down time: All wells for 24.0 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

August 2022

8/23/2022 Treatment System and Well Field. GHD arrived on site at 7:00 AM to oversee the installation of the generator for temporary power to Building 116. Preferred Electric already on site, discussed the plan and where things are run from. Preferred Electric began working on getting the connections ready for the generator. Generator arrived on site at 9:15 AM, Preferred began hooking up the generator to the motor control panel and main control panel. Control panel and motor control panel hooked up to generator at 11:15 AM. PLC screen on and full of alarms. Acknowledged all the alarms, switched all pumps, blowers, and wells to OFF to ensure none accidently started. Saw that B13 was on. Went to pumphouse to shut it down. Already off upon arrival. Returned to Building 116. Tried to start Blower 3 to test if the rotation is correct. Blower 3 would not start. Tried Blower 4, would not start. Checked resets, Blower 4 reset was tripped. Started Blower 4 from the motor control panel, worked normally. Shut down Blower 4. Tried to start Blower 4 with the control panel, started normally, shut down. Tried to start Blower 3, it started temporarily then stopped. Preferred began checking the wires and found that one of the lead wires were shorted or that the motor was shorted. Preferred began troubleshooting wiring. Preferred determined that the shorted wire has a small cut in the casing which may have gotten water in it when the wet well overflowed and was causing the short. They switched the shorted wire with the ground. Tried to start Blower 3 with the main control panel and observed normal operation. Checked to see if Pump 3 and 4 are rotating correctly by starting them in hand and observing the shaft rotation. Tried to start Pump 4 and heard a click but pump did not start. Tried Pump 3 and observed normal operation. Checked reset for Pump 4, normal. Then checked fuses for Pump 4 and one of the fuses was blown. Replaced the blown fuse with an extra from the shop. Started Pump 4 and observed normal operation. At 2:00 PM, began switching pumps and blowers to auto, they started automatically. Switched extraction wells to auto. Clicked System Start and began observing the well field coming online. System operating normally. Notified project team that the system was operational again. Checked on data logger and remote connection. Cycled power to data logger and firewall. Able to connect to the VPN and view the system remotely, unable to connect to the data logger via the online portal. Reached out to control engineer. Will watch for nightly emails and check back with the controls engineer tomorrow. Treatment system operating normally.
Down time: All wells for 16.0 hours.

8/24/2022 B13 Pumphouse. Troubleshooting B13 EVC to ensure well shuts down when system fails. Shutdown the B13 at 8:20 AM, forced pump to stop by tripping the microswitch. Isolated the valve by closing both upstream and downstream gate valves, vented all water pressure from the valve body. Removed select control piping and the valve cover. Found the sealing section of the valve to be fouled with buildup (manganese), cleaned off components with a scrapper and wire brush. Removed, cleaned, and inspected the valve stem indicator. Lubricated the stems o rings and sanded down some minor imperfections, reassembled the valve cover parts. Cleaned, scrapped the valve body to cover mating surface. Installed valve cover, connected piping, replaced a cracked ½ inch ball valve (from stock) on the upstream side of the valve body. Installed and adjust the microswitch trip doughnut on the valve stem indicator. Opened the 2 isolation valves, cleared the building entry alarm, panel system ok light now on. Remotely started the pump, the operating solenoid valve energized right away and the valve opened. Adjusted the opening and closing speed valves, exercised the valve through a few cycles, normal operation. Pump on around 10:30 AM.

Down time: 2.0 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

August 2022

8/26/2022 Treatment System and Well Field. Pump 3 Failed to Start alarm email at 3:03 AM, noticed the email and connected to the system remotely at 6:00 AM. Pump 4 running and the wellfield was cycling. Tried to reset and start Pump 3, failed again. Arrived on site at 6:35 AM. Pump 3 phase 1 and 3 overloads tripped, reset. Cycled the pump, pump on then began to make a laboring sound and sporadic buzz. Switched Pump 3 to off, before the valve closed to stop the pump, it began to run smoothly with no buzz. Left the pump off for about 5 minutes. Switched control to ON, pump started with no issues. The pump cycled normally for 2 cycles, during the third cycle, the motor began laboring again and observed the pump shaft stop. Quickly stopped the pump at the panel, pump off immediately. Electrical smell from motor. Reached out to Thein for thoughts. Call with Thein, update of observations, check pump shaft for rotation. Can uncouple the motor from the pump in place to check the motor operation, but hard to tell for sure with no load. Contacted Preferred Electric to discuss the issue, someone will come out first thing Monday morning to test/Meg the motor and lines from the MCC bucket to the local disconnect. Can rotate the pump shaft freely. Shutdown wells B8, B3, B4, B6, and B9 at 8:20 AM, wells that remain on are SC-5, B13, B1, and B5. Pump 4 cycled off. Switched B4 to on. Total influent flow rate at 1,090 gpm. Wet well level is getting close to the high level float, reduced B4 flow setpoint to 200 gpm. Total influent rate 910 gpm. Switched B4 off at 9:10 AM, Pump 4 could not keep up. Diesel Dogs and United Rental onsite at 9:15 AM. Shutdown system and generator off at 9:27 AM. Generator plumbed to the fuel cell. Restarted system at 9:50 AM, system not starting. Acknowledged all alarms. Call to United Rental, didn't turn on the generator main breaker before leaving site. Main breaker to on, heard it engage. Restarted system at 10:20 AM. Observed normal operation of operating wells and pumps.

Down time: B1 for 3.0 hours, B5 and SC5 for 3.5 hours, B3 for 14.5 hours, B4 for 17.0 hours, and B6, B8, and B9 for 17.5 hours.

8/27-28/2022 B3, B4, B6, B8, and B9 Pumphouses. B3, B4, B6, B8, and B9 shutdown awaiting Pump 3 repair, only Pump 4 operating.

Down time: B3 for 47.0 hours, and B4, B6, B8, and B9 for 48.0 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

August 2022

8/29/2022 Treatment System and Well Field. GHD arrived on site at 7:00 AM. Preferred Electric arrived on site and gave them a quick rundown of the issues Pump 3 was having when shutdown on last Friday (8/26). Preferred Electric is working on checking the motor, used an megger/ohm meter to test the windings. Phase to Ground and Phase to Phase. All ok but getting towards the upper threshold. Motor is old. Megged the wires from the local disconnect to the motor, all looks good. Left the motor wires disconnected and closed the disconnect up at the starter bucket. Started the pump in hand to check the voltage to the motor. Voltage to Ground is good, voltage phase to phase normal. Checked the tightness of all the connections in the starter bucket, some were a bit loose, tightened down. Wired motor back up to the leads. Bumped the motor, normal start, 85 amps. Enabled wells B3, B4, B6, B8, and B9. Observed another Pump 3 start and run. Well field fully operational at 9:35 AM. Preferred Electric mentioned that the grounding on the generator may be insufficient, they took some pictures and do further determination. Opened the door to the generator connections. Generator shut off. System down. Restarted generator, five min warm up then closed the disconnect. Restarted the system, system operating again. Pump 3 seems to be operating okay, told Thein not to come at 9:39 AM. Preferred Electric left site at 10:25 AM. Pump 3 motor started to make the same noise, laboring as before. Shut down the pump and select wells at 10:40 AM. Call to Preferred Electric, returning to the site. Preferred Electric arrived back on site at 11:30 AM, looking at the motor starter. Contactors were showing pitting, concerned these may be part of the issue. Swapped out the coil and contactors with the starter on the shelf. Cleaned the contactors with emery cloth. Started and observed pump/motor operation at 12:40 PM. Enabled the rest of the wells. The pump cycled a few times, normal operation. Cycled about 7-8 times, normal operation. Preferred Electric will take the starter back to the shop and get it rebuilt with the parts needed and return it to the site. Observed normal operation of the treatment system. Pump 3 Failed to Start alarm email at 6:22 PM. Treatment system down, restarted Pump 4 and B1, B13, B5, and SC5. Further troubleshooting needed.

Down time: B3 and B8 for 17.5 hours, B4 for 20.5 hours, and B6 and B9 for 17.0 hours.

8/29/2022 Treatment System and Well Field. Completed normal Monthly and Quarterly Preventative maintenance.
Down time: None.

8/30/2022 Treatment System and Well Field. New autodialer modem has been installed. Successfully tested both an outgoing and incoming call using cell phone to the autodialer. The set up sheet is posted inside the autodialer cabinet that explains what the lights mean when in the normal state. The backup battery that the modem is plugged into was tested, normal voltage, at 10.1 VDC. The auto dialer is now active.

Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

August 2022

8/30/2022	Treatment System and Well Field. GHD and Preferred Electric on site at 6:35 AM. Discussed the troubleshooting of Pump 3, found that the overloads for Pump 3 were not tripped. Found that the fuse for the relay that powers the starter coil was tripped (FU-115), need a replacement fuse. Opened FU-117, blowers turned off. Drawing shows FU-117 as a spare. Reset the alarms, blowers now on, pushed System Start. Alarm email sent out for the blower fail alarm. Opened FU-105, Auto dialer. Put this fuse in FU-115, started Pump 3, fuse blew. Took out the fuse for the panel light (FU-103), disconnected the 120 volt wires in the bucket and tested each section. Got to testing the coil itself and the fuse blew again. No fuses available nearby to replace. Communication failure alarm emails sent out for B1 and B3. Bumped up the alarm trip delay from 180 seconds to 240 seconds for these 2 locations. Frequent alarms. Preferred Electric onsite at 11:30, installed new starter for Pump 3. Tested coil, contactors without a load, normal operation. Tested starter operation with the disconnect open at the pump, voltage good. Enabled the shutdown pumphouses. Pump 3 cycled the pump a few times with no faults. Treatment system operating fully at 2:10 PM. All controls to auto and observed operation. On cycling, the starter for Pump 3 did chatter/engaged twice during the starts. Took the peak amps on start with Pump 4 already running plus both blowers on, 467 amps. May be right at the top of what the generator can handle, switched the lead pump over to Pump 3 and observed a couple starts of Pump 4. Contactor engages more solidly and smoothly with less of a pull/surge on the generator on startup. No chatter or hesitation on the Pump 3 starter when Pump 4 starts. Observed normal operation. Down time: B3 for 11.0 hours, B4 and B8 for 16.0 hours, and B6 and B9 for 15.0 hours.
8/31/2022	SC5 Pumphouse. SC5 officially switched to be controlled under the new SGRS treatment system. Will remain under operation of the SGRS for the foreseeable future. Down time: 13.5 hours.

September 2022

10/21/2021 - present	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: 345 days (ending 9/30/2022).
8/31/2022 - present	SC5 Pumphouse. SC5 officially switched to be controlled under the new SGRS treatment system. Will remain under operation of the SGRS for the foreseeable future. Down time: 733.5 hours (ending 9/30/2022).
9/2/2022	B1, B4, B5, B6, B8, and B9 Pumphouses. Increased flow rates for the following wells to account for SC5 being permanently switched to the SGRS treatment system: B1 to 220 gpm (from 210 gpm), B4 to 390 gpm (from 380 gpm), B5 to 370 gpm (from 350 gpm), B6 to 140 gpm (from 130 gpm), B8 to 180 gpm (from 160 gpm), and B9 to 220 gpm (from 205 gpm). Down time: None.
9/6/2022	B3 Pumphouse. B3 Communication Failure alarm at 1:17 PM, resulting in B3 shutting down. Acknowledged alarm and restarted well. Observed normal operation. Down time: 2 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

September 2022

9/7/2022	Treatment System and Well Field. GHD arrived on site and noticed that the generator was not running and the treatment center was flooding down to the basement. B13 did not shut off with the rest of the treatment system and well field, shut B13 manually off at the pumphouse. Notified United Rentals of the generator failure, they will send a technician out to look into the issue. Began pumping out the wet well to get the level down, setup a Honda generator to pump the building basement into the wet well. Notified PD at 10:30 AM. United Rentals technician on site at 11:33 AM, planning to complete a forced regen and reset the unit. Generator restarted at 12:50 PM. Power restored to Building 116, cleared alarm emails and restarted treatment system. Observed normal operation of the treatment system. United Rentals technician left site at 1:35 PM. Will return to check on the generator later this week. Purchased and replaced battery for autodialer. Noticed that the data logger was stuck in a power restart cycle, reinstalled program, and observed normal operation of the data logger. Tested autodialer call out, received call. Observed normal operation and GHD left site. Down time: B1, B4, B5, B6, and B9 for 12.5 hours, B3 for 6 hours, B8 for 13.5 hours, and B13 for 2.0 hours.
9/8/2022	Treatment System and Well Field. Treatment System went down again around 2:00 AM. Received a call from the auto dialer and Arvig Communication that the power was off at Building 116. GHD responded and arrived onsite at 2:28 am to check on things. Had to manually shut off B13 at the pumphouse. No flooding. United Rental technician and Preferred Electric onsite at 7:00 AM. Preferred Electric will contact United Rentals to push for a replacement generator. Treatment system restarted and operating at 9:00 AM. The generator manufacturer is going to send a technician out today to inspect the unit. The treatment system will have to be powered down again for this work. Replacement generator arrived on site at 5:30 PM, shut down treatment system so the temporary generator can be hooked up. Still observing issues with B13 controls. Treatment system restarted at 6:45 PM. Wet Well Pump 4 wouldn't start, found that the ½ amp fuse in the MCC cabinet was blown. Replaced the fuse. Observed normal operation. Down time: B1, B4, B5, B6, and B9 for 8.0 hours, B3 and B13 for 4.5 hours, and B8 for 9.0 hours.
9/9/2022	B13 Pumphouse. Troubleshooting B13 Communication issue, B13 would remain running even when the main control panel was switched to off. Performed troubleshooting with controls engineer onsite along with another control engineer working remotely on the control program. Connected to the local PLC and found that the PLC had a major fault, cleared the fault and returned the PLC to local control. Communication is now normal. Observed normal operation. Down time: 2.5 hours.
9/9/2022	Treatment System and Well Field. United Rental on site at 5:00 PM to move the fuel cell for the emergency generator next to the replacement generator installed on 9/8/2022. GHD shutdown treatment system at 5:10 PM. United Rental moved fuel cell and plumbed the fuel cell to the replacement generator. Restarted treatment system at 5:32 PM, observed normal operation. Down time: B3 for 2.5 hours and B8 for 1.0 hour.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

September 2022

9/10/2022 Treatment System and Well Field. GHD received a call from Preferred Electric that the generator was off due to an unknown reason at 8:08 PM. Received call from autodialer that the power is out at Building 116 at 8:14 PM. Received call from United Rentals informing GHD that the generator shutdown due to the fuel delivery vendor opening the high voltage cabinet on the emergency generator while looking for the fuel port. There is a safety switch on this door that will shutdown the generator if opened while the emergency generator is operating. GHD arrived on site at 8:48 PM. Generator was restarted by fuel vendor with the help of United Rentals. Restarted treatment system at 9:05 PM and observed normal operation. Added a LOTO lock on the high voltage cabinet door.

Down time: B4, B5, B6, and B9 for 1.0 hour, and B8 for 1.5 hours.

9/12/2022 B3 Pumphouse. B1, B3, and B4 Communication Failure alarm emails at 4:25 PM. Connected to the treatment system remotely and acknowledged B3 Communication Failure alarm. B3 was off due to the alarm, restarted B3. Observed normal operation. B1 and B4 were operating normally.

Down time: 1.0 hour.

9/12/2022 B5 Pumphouse. B5 low low level alarm at 2:05 PM. Main control screen shows water level above pump at 9.6 feet. Low low level set point is set at 5.0 ft. Reviewed data logger information from the day, did not show the water level dropping below 9.0 ft all day. Will need to review why the alarm was sent.

Down time: None.

9/13/2022 B6 Pumphouse. B6 Communication Failure alarm at 8:26 AM. Acknowledged alarm and observed B6 operating normally.

Down time: None.

9/22/2022 Treatment System and Well Field. Received call from autodialer at 9:00 AM from autodialer that power at Building 116 is off. Arrived on site at 9:30 AM, generator off, DEF level at 0%, low DEF level. Filled DEF with 12.5 gallon, now at 100%. Reset generator at 9:50 AM. Wet Well Pump 4 failed to start, control fuse blew again. Replaced fuse and tried to restart pump, blew again. Once Pump 3 was off, opened disconnect for Pump 4. Replaced fuse, closed disconnect, fuse did not blow. Switched Pump 4 to Hand, wouldn't start. Can hear the relay in the panel click, but no action at the main control cabinet. Contacted Preferred Electric for further assistance. Started B1, B13, B4, and B5, started treatment system, placed Wet Well Pump 3 to Auto. Left Pump 4 off. Influent flow rate at 1,045 gpm. Preferred Electric arrived on site at 12:25 PM, began troubleshooting the main control cabinet. Determined that one of the relays may have been stuck. Switched Pump 4 to Hand at 1:35 PM, observed normal operation. Enabled the rest of the extraction wells and switched Pump 4 to Auto. Treatment system operating normally at 2:05 PM. Observed normal operation.

Down time: B1, B3, B4, and B5 for 2.5 hours, B13 for 1.0 hour, and B6, B8, and B9 for 5.0 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

September 2022

9/26/2022	B1 Pumphouse. During site inspection noticed that a mist was coming out of pressure gauge ball valve, versus the normal water at the B1 pumphouse. Also, noticed a trickling sound from inside the well casing. Contacted field tech for further investigation. Once field tech arrived at pumphouse, it was determined that there is a possible leak in the riser pipe causing air to get into the piping. GHD contacted Thein for further troubleshooting. Sent a video of the noise to Thein, they determined that the well is actually causing a vortex and pushing air into the pipes. Decreased flow rate to 190 gpm to accommodate. Observed normal operation, no trickling water and water coming from the pressure gauge. Well redevelopment will be scheduled for the spring. Down time: 1.5 hours.
9/29/2022	Treatment System and Well Field. Began normal Monthly Preventative maintenance. Down time: None.
9/30/2022	Treatment System and Well Field. Completed normal Monthly Preventative maintenance. Down time: None.
9/30/2022	B8 and B9 Pumphouse. Increased B8 flow rate to 195 gpm from 180 gpm and B9 flow rate to 230 gpm from 220 gpm to account for B1 lowered flow rate on 9/26/2022. Down time: None.

Appendix G.3

Inspection and Maintenance Activities, Fiscal Year 2021, Site K, OU2

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Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B1

5/2/2022 B1 Pumphouse. Upon arrival to site, discovered B1 alarms for Pump Failed to Start and VFD Faulted the previous day (5/1/2022) resulting in 4.7 hours of downtime. Alarms were acknowledged and alarms immediately went off again. Went to B1 pumphouse, extraction well off, System Okay light not on. Observed F004 VFD fault (undervoltage) on VFD unit. Acknowledged alarms, restarted well. Instant VFD fault, Fault F013 (ground connection). Spoke with field tech about issue. Shut down B1 and acknowledged alarms. Determined that electric connections needed to be checked, may be a motor issue. Electrician heading to site. Preferred Electric on site at 12:45, and determined the motor has shorted due to inconsistent voltage readings from lead cable. Reviewing other wire connections and VFD, VFD is operating normally. Determined the issue is either with the motor and/or lead cable. Need to replace motor and pump. Began to reach out to vendor to set up pump and motor replacement. Left extraction well B1 off until replacement pump and motor have been installed. The flow rates of B5, B8, and B9 were increased to maintain the minimal operation flow rate.

Down time: 24 hours.

5/4/2022 B1 Pumphouse. GHD arrived on site to oversee the replacement of the pump and motor for the B1 extraction well. Collected static water level and checked what changes were needed to install the transducer into the well. Disabled Building entry and VFD fault alarms for B1. Thein Well arrived on site at 9:15, discussed issue with well and plan for the day. Thein removed the riser pipes and water level pipe, then removed the pump and motor. Thein confirmed that motor had shorted and needs replacement. Thein installed a new motor and pump, and lowered it back into the well. The lead cable and riser pipes were reused. Once the pump and motor were fully installed, the flow rate of B5, B8, and B9 were lowered to normal operating flow rates. The water level pipe was lowered 2 ft to allow for the installation of the transducer. Restarted B1 at 12:48 to auto, shut down well immediately, as motor is running backwards. Thein rewired the motor and B1 was restarted. Observed normal operation of B1. Enabled the disabled alarms.

Down time: 37.5 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B1

5/24/2022 B1 Pumphouse. Heard leak or cavitation in the B1 well, pressure needle is bouncing around. Determined that the water falling from the screen may be causing the abnormal water level reading. Got new water level tape and got a reading of 128 feet. Set tape at 125 feet and stopped pump remotely. Water level hit 125 feet probe instantly. Set point to 75% manually, switched to hand. Pump on 75%, 30 Hz, 0 gpm. Bumped up to 100%, Hz still at 30 Hz. Switched control from PLC to local. Ramped up the motor to 60 Hz. Hz instantly dropped down to 56 Hz, flow rate at 205 gpm (97/98 psi). To PLC, Hz at 30 and 0 gpm. Motor speed would not change with the change in set point. Switched control panel to local control, speed ramped up to 56 Hz and 217 gpm (max amp setting in controller 589 VDC?). Flow rate down to 206 gpm, controller HIM Reference 60 Hz. VDC lower at 56 Hz than at 30 Hz. Need control engineer input. Back to PLC control. Spoke with controls engineer, possible an issue with the VFD settings (limiting factor).

Down time: None.

7/21/2022 B1 and B6 Pumphouses. During remote monitoring noticed that B1 was trending under 200 gpm, flow rate set point is 220 gpm, motor speed at 56-57 Hz. B6 running at around 140 gpm, flow rate set point is 150 gpm, motor speed at 60 Hz. Increased B8 to 175 gpm to account for the low flow in B1 and B6. Discussed observations with field tech, on site troubleshooting to occur during monthly preventative maintenance.

Down time: None.

7/25/2022 B1 and B6 Pumphouses. B1 flow rate at 191/193 gpm, flow rate set point at 220 gpm. Motor speed at 56 Hz, observed the motor speed acceleration and the reference point is 60 Hz. No clear reason why flow rate is low, further troubleshooting needed. Upon arrival to B6, the pump was cavitating. Removed the level probe and checked the pumping water level with water level meter. Flow rate at 139 gpm, flow rate set point 150 gpm, water level 128.6 feet. Set flow rate to 130 gpm, observed flow rate of 130 gpm and water level at 123.4 feet. Not observing cavitation anymore. Replaced level probe. Will need to schedule acid cleaning for well.

Down time: None.

8/6/2022 B1 Pumphouse. During remote monitoring found a B1 Low low Flow Alarm. Acknowledged the alarm. Observed a negative flow rate with a 60 Hz motor speed. Shut down well. Left well down for ~15 minutes, then attempted to restart it. Again, observed a motor speed of 60 Hz with a negative flow rate. Receive another low low flow alarm. Shut down well and acknowledged alarm. GHD to site, arrived on site at 12:40 PM. B1 controls normal, started pump. Heard a heavy grinding/vibration from the well, no flow rate, and Amps were at 21. Shut down well. Determined that there was a possible issue with either the pump or motor, will need to be removed and replaced. Adjusted flow at B8 from 175 gpm to 212 gpm, B9 from 205 gpm to 296 gpm, and B4 from 378 gpm to 385 gpm. Total flow rate was 1,753 gpm when leaving site.

Down time: 15.5 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B1

8/7-9/2022	B1 Pumphouse. B1 well off awaiting pump and motor replacement due to negative flow rate observed on 8/6/2022. Down time: 72 hours.
8/10/2022	B1 Pumphouse. Thein well arrived on site at 10:20 AM to remove and replace the B1 pump and motor. Pump and motor were removed, and it was found that the motor shaft is broken internally, the pump is still in good condition. Replaced motor with new one and reused pump. Restarted B1 at 2:00 PM, observed normal operation. Down time: 14.5 hours.
9/26/2022	B1 Pumphouse. During site inspection noticed that a mist was coming out of pressure gauge ball valve, versus the normal water at the B1 pumphouse. Also, noticed a trickling sound from inside the well casing. Contacted field tech for further investigation. Once field tech arrived at pumphouse, it was determined that there is a possible leak in the riser pipe causing air to get into the piping. GHD contacted Thein for further troubleshooting. Sent a video of the noise to Thein, they determined that the well is actually causing a vortex and pushing air into the pipes. Decreased flow rate to 190 gpm to accommodate. Observed normal operation, no trickling water and water coming from the pressure gauge. Well redevelopment will be scheduled for the spring. Down time: 1.5 hours.

Pumphouse B3

3/10/2022	Pumphouses B3 and B13. ECV maintenance for B3 and B13 pumphouses. Down time: B3 and B13 for 1 hour.
6/12/2022	B3 Pumphouse. B3 Communication Failure alarm email at 19:20. Remotely connected to the treatment system and acknowledged the alarm. B3 is "Green" on the TGRS screen. 224 gpm. Pulled up the B3 screen. Pump is green, but 0 gpm. No Alarms. To Alarm Page 5, B3 No Alarms box is lit green. Communications Failure alarm is red. Disabled/Enabled the alarm, now normal. The system appears to be operating normally. Down time: None.
6/19/2022	B3 Pumphouse. B3 Communication Failure was found during the remote monitoring. Acknowledged alarm and attempted to reset the pump remotely with no response. Will head to site later to troubleshoot, by cycling the power to the controls/wireless modem and check connections. Checked B3's status before heading to site, acknowledged Communication Failure alarm and was able to restart B3 remotely at 13:40. Will continue to monitor. Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B3

6/20/2022	B3 Pumphouse. Arrived at B3 pumphouse to cycle power to troubleshoot Communication Failure alarm. Tired to shut down B3 on remote connection, wouldn't shut down. Shut down manually in pumphouse. Shut off power to control panel. B3 finally shut off on main control panel. Checking voltages in control panel at pumphouse. Everything looks normal in panel. Switch well to auto (in pumphouse and main control panel). Well started, observed normal operation. No system ok light on. Returned to pumphouse 30 minutes later, system ok light on. Down time: None.
8/12/2022	B3 Pumphouse. B3 Communication Failure alarm email at 3:56 PM. Restarted well and observed normal operation. Down time: 6 hours.
8/27-28/2022	B3, B4, B6, B8, and B9 Pumphouses. B3, B4, B6, B8, and B9 shutdown awaiting Pump 3 repair, only Pump 4 operating. Down time: B3 for 47.0 hours, and B4, B6, B8, and B9 for 48.0 hours.
9/6/2022	B3 Pumphouse. B3 Communication Failure alarm at 1:17 PM, resulting in B3 shutting down. Acknowledged alarm and restarted well. Observed normal operation. Down time: 2 hours.
9/12/2022	B3 Pumphouse. B1, B3, and B4 Communication Failure alarm emails at 4:25 PM. Connected to the treatment system remotely and acknowledged B3 Communication Failure alarm. B3 was off due to the alarm, restarted B3. Observed normal operation. B1 and B4 were operating normally. Down time: 1.0 hour.

Pumphouse B4

11/25-26/2021	B4 Pumphouse. During TGRS remote monitoring on 11/26, B4 alarms for VFD Fault and Pump Failed to Start were discovered. No alarm emails were sent out. B4 shut down at 1:00 PM on 11/25. Alarms were acknowledged and the well restarted at 11:00 AM on 11/26. Flow rate was lowered to 390 gpm. Down time: 22 hours.
12/20/2021	B4 Pumphouse. During the site inspection a small leak in the piping going to the pressure gauge was found in B4 pumphouse. Ball valve going to the pressure gauge piping was shut to temporarily stop the leak until repairs could occur the next day. Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B4

12/21/2021	B4 Pumphouse. The leak was coming from the side of the ball valve body. No spare ball valves in that size were on site, two spare ball valves and some additional brass pipe were purchased for the repair. B4 was shut down for repair at 10:45. Ball valve was replaced and B4 was restarted at 10:55. No leaks observed. Normal operation observed. Down time: 10 minutes.
5/8/2022	B4 Pumphouse. B4 VFD Fault and Pump Failed to Start alarms at 18:11 on 5/7/2022 (4.8 hours down time). Alarms were found and acknowledged. B4 was restarted and normal operation was observed. Down time: 10.4 hours.
5/11/2022	B4 Pumphouse. B4 VFD Fault alarm at 14:00, alarm was acknowledged. B4 was restarted and normal operation was observed. Down time: 3.5 hours.
6/4-5/2022	B4 Pumphouse. Received an alarm email for UPS Power Failure at 10:41 PM on 6/4/2022. Alarm email was not seen until remote monitoring the next morning. B4 appeared to be operating normally via the remote monitoring viewing connection. Attempted to acknowledge alarm, alarm would not shut off. Updated project team on B4 status. Down time: 24.0 hours.
6/6/2022	B4 Pumphouse. Arrived on site, B4 UPS Power Failure alarm still on. B4 appeared to be running still. Upon arriving to the B4 pumphouse, it was discovered that B4 was off, the flow meter was off, the System OK light and any other light in the control panel were off, no lights on the UPS Power unit inside control panel, and could not hear the motor running down the well. B4 was shut down on the main control panel by switching it to the OFF position. The green status did not change when flipped to OFF. The control panel in the pumphouse, showed 0.00 Hz and FAULTED, Fault Code 4037. The fault was cleared and control of the pump was switched to Local on the pumphouse control panel. Set the reference to 57.0 Hz, and started the motor. The speed instantly jumped to 57 Hz, could hear the pump and motor starting down the well, normal pressure on the pressure gauge, and could hear water moving through the pipes. The flow meter was still off and the main control panel status is unchanged. The UPS still has no lights on. Flipped the pumphouse control panel to PLC, and the motor automatically goes to 0 Hz. Reached out to project team for troubleshooting assistance and restarted B4 in Local mode. Down time: 24.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B4

6/7/2022 B4 Pumphouse. Returned to B4 pumphouse first thing in the morning, found that the well had faulted again. Tested the power to the outlet that the UPS is plugged into with a phone charger, no power. Flipped the CB-301 breaker, instantly got power to the control cabinet and flow meter, and the system ok light flipped on. I switched the well to PLC control on the pumphouse control panel and observed normal operation for around 10 minutes, then received another UPS Power Failure alarm. Shut down the well and acknowledged the alarm. Moved the plug-in that was in the UPS outlet to the outlet that was just tested. B4 was restarted and normal operation was observed. It was determined that the UPS unit has failed or the UPS battery unit needs to be replaced. Will order replacement unit.

Down time: 11.0 hours.

6/17/2022 B4 Pumphouse. The new UPS was installed in the B4 pumphouse control cabinet today. It was discovered that the back of the panel where the original UPS was mounted was somewhat hot to the touch. This may be part of the reason the previous UPS failed. After ensuring that the unit will fit without interference of the inner panel door, it was decided to place the UPS on top of the mounting bracket on the floor of the cabinet. Had to rewire the power cord to the PLC temporarily so it could reach the back of the UPS. The pump was down for approximately 10 minutes for the installation. After the work was completed, all alarms were acknowledged and started B4 at 14:55. Observed normal operation.

Down time: None.

6/20/2022 B4 Pumphouse. B4 VFD Fault and Pump Failed to Start alarm emails around 4:00. GHD onsite at 7:13, Fault Code 12 (overcurrent). Cycled VFD disconnect. Acknowledged alarms and reset B4 to Auto. VFD Faulted immediately. Shut down B4. Disconnected pump leads in cabinet and acknowledged alarms. Seeing normal output reading, may need to troubleshoot VFD. Had to leave site for another project, contacted project team. Met with controls engineer to continue to troubleshoot. Disabled Building entry alarm for B4. Checked voltage reading on lead cable, motor rated for 77 volts. Shut off power to VFD. Got VFD fault, acknowledged. Reconnected leads, and restarted VFD. Everything going into VFD looks good. Flipped B4 to Hand at 12:13, heard VFD start, but 0 Hz and 0 gpm. Main control panel showed green and 3.9 gpm, no flow or Hz observed at pumphouse. Switch B4 off, switched to Local tried to start and faulted right away. Low low flow alarm, acknowledged alarm. VFD faulted immediately when trying to start in Local. Same resistance on windings, motor not shorted. Disconnected pump and started VFD, started up normally (went right to 54 Hz). Something is causing the motor to run harder than it needs to. A little unbalanced on what it is sending out per leg. Voltage, putting out what it is supposed to be. Definitely an issue with pump or motor, needs to be replaced. Will contact Thein. Increased B8 to 205 gpm (160 gpm), B5 to 405 gpm (350 gpm), and B9 to 305 gpm (205 gpm). Received VFD Fault, Pump Failed to Start, and High High Level alarms for B5 at 2:40 pm due to increase in flow rate, lowered flow rate back down to 350 gpm and restarted well.

Down time: 18 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B4

6/21-23/2022	B4 Pumphouse. B4 off due to an issue with pump or motor, waiting for pump and motor replacement. Down time: 72 hours.
6/24/2022	B4 Pumphouse. GHD met Thein Well at site gate and went to the BB4 pumphouse. Completed safety meeting and collected static water level. Disabled alarms at B4 for replacement work. All riser pipes removed and in good condition with minimal build-up. Lead cable needs to be replaced with new pump and motor. Thein took apart the pump and motor and found that the motor bearings are worn down. Pump looks to be in good condition, will keep it as an emergency spare. Lowered B8 and B9 to normal flow rates. New pump, motor, and lead cable were installed in well. Restarted B4 at 13:45, observed normal operation. Down time: 15.0 hours.
6/26/2022	B4 Pumphouse. B4 VFD Fault alarm email at 12:50 am. Discovered B4 down due to the VFD Fault during the remote monitoring in the morning. Switched B4 to Off and acknowledged the alarm. Restarted B4 at 10:50 and observed normal operation. Got a Low-low level alarm, water level at ~99 ft, Pump inlet at 108 feet, and low level set to alarm at 98 feet (10 ft above well). Lowered the alarm point to 8 feet above the well and acknowledged the alarm. Down time: 10.0 hours.
6/28/2022	B4 Pumphouse. Navigated through the VFD interface to find the fault page. The last 2 Faults were "Motor Overload". They were Faults 01 and 02 on the list. However the time stamp was for the year 1970. The time and date in the interface was updated. After placing a hand on the divider between the high and low voltage cabinet sections and noticed how hot the divider was, the cooling fan inlet filter was removed to get more air flow through the cabinets. The elevated temperatures in the cabinet may be affecting the drive performance, but not enough to trip the drive out on a "High Temp" fault. The amp reading while on site were 75,70 and 73. I believe this is within the operating range but would like to verify these readings to what is on the manufacture name plate. B4 VFD Faulted at 22:58. Down time: 1.5 hours.
6/29/2022	B4 Pumphouse. Found B4 VFD Fault. Went to site, observed B4 down and Fault Code 7 - Motor Overload. Cleared fault and acknowledged alarms. Switched B4 to Off. Lowered flow rate to 370 gpm (normally 380 gpm). Restarted well (10:15 AM), observed normal operation. Down time: 11.5 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B4

6/30/2022 B4 Pumphouse. Disabled some alarms for B4. At B4 around 9:45, and checked amps on each leg. 70/72/70, normal according to the motor name plate. Looked up the most recent faults: “Motor overload”. Set the time/date again in the drive. Found and logged other information. Called controls engineer with findings, who looked through the online manual and found the likely problem. The name plate info parameters in the drive are from the old motor that was just replaced. The previous motor had a Full Load Amps (FLA) of 67.70 and a Service Factor (SF) of 1.00%. The new motor FLA is 71 and the SF is 1.15%. Since the motor was running at 70-72 Amps, the VFD was shutting down to protect the motor. The new parameters were set in the drive. Had to switch to Local and stop the motor for this step. Off for less than 5 min. Set the flow back to 380 gpm from 370 gpm and observed normal operation. Enabled the alarms that were turned off earlier.

Down time: None.

8/1/2022 B4 Pumphouse. Received B4 VFD Fault and Pump Failed to Start alarm emails at 6:15 AM. GHD arrived on site at 8:00 AM and observed an overvoltage fault on the VFD in the B4 pumphouse. Cycled power to the VFD, acknowledged alarms, and restarted pump at 8:20 AM. Observed 69 Amps from the pump, pump is rated for 71 Amps. Observed normal operation and will continue to monitor for any further issues.

Down time: 2.0 hours.

8/27-28/2022 B3, B4, B6, B8, and B9 Pumphouses. B3, B4, B6, B8, and B9 shutdown awaiting Pump 3 repair, only Pump 4 operating.

Down time: B3 for 47.0 hours, and B4, B6, B8, and B9 for 48.0 hours.

9/2/2022 B1, B4, B5, B6, B8, and B9 Pumphouses. Increased flow rates for the following wells to account for SC5 being permanently switched to the SGRS treatment system: B1 to 220 gpm (from 210 gpm), B4 to 390 gpm (from 380 gpm), B5 to 370 gpm (from 350 gpm), B6 to 140 gpm (from 130 gpm), B8 to 180 gpm (from 160 gpm), and B9 to 220 gpm (from 205 gpm).

Down time: None.

Pumphouse B5

4/4/2022 B5 Pumphouse. B5 UPS Power Fail alarm, extraction well still running. Alarm acknowledged. Went to B5 pumphouse, extraction well running normally. System okay light was off. UPS had no indicator lights on. Remotely stopped B5, cycled power to the controls and powered on the UPS. Restarted B5 and observed normal operation at 1725. System okay light back on.

Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B5

4/13/2022	B5 Pumphouse. B5 VFD Fault and Pump Failed to Start alarms at 21:46 on 4/12/2022, no alarm emails sent. Alarms acknowledged and well restarted. B5 VFD Fault, Pump Failed to Start, and Low-Low Flow alarms again ~15 minutes after restart. Alarms acknowledged and well restarted. Will continue to monitor well status. Down time: 24 hours.
4/14/2022	B5 Pumphouse. Noticed during remote monitoring that B5 was down due to alarms for VFD Fault and Pump Failed to Start, no alarm emails were sent out. GHD arrived on site at 15:30, B5 System ok light on, no faults currently listed on the VFD Display. All power going into the VFD is normal. Cycled through VFD fault history, dates and times are not set correctly. Faults listed are undervoltage, IO time-out, ground fault, and overvoltage. Started well remotely and the VFD immediately recorded an overvoltage fault. Attempted to start well at pumphouse (local), also got an immediate overvoltage fault. Possible issue with VFD or pump/motor. Need to coordinate with an electrician to come to site to test pump windings to determine if pump/motor needs replacement. Left B5 off over night awaiting further troubleshooting and increased flow rate of other boundary wells (B4, B8, B9) to maintain minimum flow rate. Down time: 24 hours.
4/15/2022	B5 Pumphouse. GHD and Preferred Electric on site at 9:55. B5 still off and no faults shown on VFD. Electrician unlanded power leads to pump and restored power. The control panel was put in Local control and started VFD, the VFD ramped up to 60 Hz with no issue or faults. VFD appears to be operating normally. Put multimeter to pump leads and got continuity to ground from every leg, which indicates a possible issue with the motor. Electrician left site to get additional equipment for further troubleshooting. GHD found a spare pump and motor that would fit the well if a replacement was needed. Electrician returned to site and checked megger lines, no readings were shown indicating very low resistance short to ground. These results determined that the motor has dead shorted, pump and motor will need to be replaced. GHD and Preferred off site at 11:45. GHD coordinated with Thein well to replace pump and motor as soon as possible. B5 will remain off until replacement. Down time: 24 hours.
4/16-17/2022	B5 Pumphouse. B5 off awaiting pump and motor replacement. B4, B8, and B9 flow rates increased to maintain minimum flow rate. Down time: 48 hours.
4/18/2022	B5 Pumphouse. GHD and Thein on site at 11:00 for B5 pump and motor replacement. Thein removed riser pipes and pump/motor from extraction well. Thein determined that both the pump and motor were damaged. Thein replaced the B5 pump and motor. B5 was restarted at 17:25. Observed normal operation. B4 and B9 flow rates decreased to normal operation. Down time: 18.5 hours

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B5

5/20/2022 B5 Pumphouse. High temperature were observed in the B5 pumphouse in the prior week, and the vent fan appeared to not be working. The B5 pumphouse vent fan was replaced.
Down time: None.

7/22/2022 B5 Pumphouse. Checked VFD name plate factor and set point factor to ensure it matches the new motor installed on 4/18/2022, both parameters are correct. High high level and low low flow alarms at 8:28 AM and 8:56 AM during check of VFD parameters.
Down time: 1.0 hour.

9/2/2022 B1, B4, B5, B6, B8, and B9 Pumphouses. Increased flow rates for the following wells to account for SC5 being permanently switched to the SGRS treatment system: B1 to 220 gpm (from 210 gpm), B4 to 390 gpm (from 380 gpm), B5 to 370 gpm (from 350 gpm), B6 to 140 gpm (from 130 gpm), B8 to 180 gpm (from 160 gpm), and B9 to 220 gpm (from 205 gpm).
Down time: None.

9/12/2022 B5 Pumphouse. B5 low low level alarm at 2:05 PM. Main control screen shows water level above pump at 9.6 feet. Low low level set point is set at 5.0 ft. Reviewed data logger information from the day, did not show the water level dropping below 9.0 ft all day. Will need to review why the alarm was sent.
Down time: None.

Pumphouse B6

11/22/2021 B6 Pumphouse. During the daily inspection, a vibration was felt on the floor of the B6 pumphouse around the well. Field technician was notified and will assess the problem tomorrow.
Down time: None.

11/23/2021 B6 Pumphouse. Field technician determined that operation of B6 was not normal and there may be an issue with the connection between the pump and motor. B6 was shut down and the flow rates of the following wells were increased to maintain the minimum total flow rate of the TGRS treatment system: B3 to 234 gpm, B4 to 405 gpm, and B9 to 300 gpm. Received two alarm emails, VFD Faulted and Pump Failed to Start, for B4 at 6:20 PM. Alarms were acknowledged and B4 was restarted. Normal operation was observed and the flow rate was lowered to 395 gpm.
Down time: B4 for 2.0 hours and B6 for 12.0 hours.

11/24-29/2021 B6 Pumphouse. B6 shut down awaiting replacement of the pump and motor.
Down time: 144 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B6

11/30/2021	B6 Pumphouse. GHD and Thein on site at 10:00 AM. Power was shut down to the B6 pump and the riser pipes, pump, and motor were removed from the B6 well. Five of the six riser pipes were in good condition, the closest riser pipe to the pump and motor had significant build-up on the outside and was replaced. There were no evident issues with the pump or motor removed from the well. The new pump and motor were connected and placed into the well with the riser pipes. Once the pump, well, and riser pipe were in place, power was restored to the pump and B6 was turned on at 3:03 PM with an initial flow rate of 215 gpm, at this flow rate Thein observed a water level of ~116-117 feet, which would only give ~10 feet of clearance above the well. Thein thought that the vibration felt before could be due to cavitation of the well. The flow rate for B6 was dropped to 170 gpm where a water level of 103.7 feet was observed. Normal well operation was observed. A transducer was installed in the water level pipe in B6 at 120 feet. The transducer needs to be wired and calibrated. Down time: 19 hours.
2/7/2022	Pumphouses B6. Troubleshooting installation of B6 transducer for water level measurements. B6 was shut down and reviewed transducer wiring connections. Noticed that the wires from the transducer to the pumphouse control panel were not wired to the correct landing. Moved wires 5011 and 5021 from the 5111 and 5121 slots to the 5011 and 5021 slots. This was confirmed by reviewing and comparing to the B5 pumphouse wiring in control panel, where a transducer was already installed. Still not able to see any water level readings on the TGRS control panel. Began checking power to connections and was seeing no power in the wires from the transducer, re-landed the 5011 and 5021 wires and found power running from the transducer connection to the input wiring. Still not seeing any water level readings on the TGRS control panel, possible programming issue. Will need to review transducer install procedure and programming with controls engineer. Down time: None.
2/11/2022	Pumphouse B6. Explained transducer installation issues with controls engineer. Determined that calibration information needed to be entered into the PLC program. Controls engineer entered the proper calibration information provided by the manufacturer into the program. Observed water level reading on TGRS control panel. Will confirm water level reading shown on TGRS control panel with field reading. Down time: None.
2/15/2022	Pumphouse B6. Confirmed water level reading shown on TGRS control panel for B6 extraction well matches the water level measured in the field. Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B6

5/10/2022	B6 Pumphouse. While conducting preventative maintenance at the B6 pumphouse, there was a noise coming from the well that sounded like cavitation, the pressure gage was fluctuating as well. At the main control panel, the water level was showing 120.3’ and -0.3 above the pump. Flow showing 165.3 with the set point at 170 gpm. Reduced the flow set point to 160 gpm, no change in the water level. Reduced the flow further to 150 gpm and the water level came up to 118.3’. The well is no longer making noise and the pressure is steady. Flow was reduced at around 1355. Increased the flow at B8 from 140 gpm to 160 gpm to help with the reduced flow at B6. Possible acid cleaning needed at the well. Down time: None.
7/21/2022	B1 and B6 Pumphouses. During remote monitoring noticed that B1 was trending under 200 gpm, flow rate set point is 220 gpm, motor speed at 56-57 Hz. B6 running at around 140 gpm, flow rate set point is 150 gpm, motor speed at 60 Hz. Increased B8 to 175 gpm to account for the low flow in B1 and B6. Discussed observations with field tech, on site troubleshooting to occur during monthly preventative maintenance. Down time: None.
7/25/2022	B1 and B6 Pumphouses. B1 flow rate at 191/193 gpm, flow rate set point at 220 gpm. Motor speed at 56 Hz, observed the motor speed acceleration and the reference point is 60 Hz. No clear reason why flow rate is low, further troubleshooting needed. Upon arrival to B6, the pump was cavitating. Removed the level probe and checked the pumping water level with water level meter. Flow rate at 139 gpm, flow rate set point 150 gpm, water level 128.6 feet. Set flow rate to 130 gpm, observed flow rate of 130 gpm and water level at 123.4 feet. Not observing cavitation anymore. Replaced level probe. Will need to schedule acid cleaning for well. Down time: None.
8/27-28/2022	B3, B4, B6, B8, and B9 Pumphouses. B3, B4, B6, B8, and B9 shutdown awaiting Pump 3 repair, only Pump 4 operating. Down time: B3 for 47.0 hours, and B4, B6, B8, and B9 for 48.0 hours.
9/2/2022	B1, B4, B5, B6, B8, and B9 Pumphouses. Increased flow rates for the following wells to account for SC5 being permanently switched to the SGRS treatment system: B1 to 220 gpm (from 210 gpm), B4 to 390 gpm (from 380 gpm), B5 to 370 gpm (from 350 gpm), B6 to 140 gpm (from 130 gpm), B8 to 180 gpm (from 160 gpm), and B9 to 220 gpm (from 205 gpm). Down time: None.
9/13/2022	B6 Pumphouse. B6 Communication Failure alarm at 8:26 AM. Acknowledged alarm and observed B6 operating normally. Down time: None.

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Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B8

12/20/2021	B8 Pumphouse. Flow rate was increased to 205 gpm from 140 gpm to maintain the minimum total flow rate for the treatment system since the current well flow rates were not maintaining a 1,745 gpm total flow rate. Down time: None.
8/27-28/2022	B3, B4, B6, B8, and B9 Pumphouses. B3, B4, B6, B8, and B9 shutdown awaiting Pump 3 repair, only Pump 4 operating. Down time: B3 for 47.0 hours, and B4, B6, B8, and B9 for 48.0 hours.
9/2/2022	B1, B4, B5, B6, B8, and B9 Pumphouses. Increased flow rates for the following wells to account for SC5 being permanently switched to the SGRS treatment system: B1 to 220 gpm (from 210 gpm), B4 to 390 gpm (from 380 gpm), B5 to 370 gpm (from 350 gpm), B6 to 140 gpm (from 130 gpm), B8 to 180 gpm (from 160 gpm), and B9 to 220 gpm (from 205 gpm). Down time: None.
9/30/2022	B8 and B9 Pumphouse. Increased B8 flow rate to 195 gpm from 180 gpm and B9 flow rate to 230 gpm from 220 gpm to account for B1 lowered flow rate on 9/26/2022. Down time: None.

Pumphouse B9

8/7-8/2022	B9 Pumphouse. Received B9 VFD Fault at 6:22 PM on 8/7. Acknowledged and restarted B9 remotely at 5:45 AM on 8/8, observed normal operation. Received another VFD Fault alarm email at 6:13 AM. Restarted B9 at 8:40 AM. There were no fault codes recorded on the VFD. GHD off site. Received another VFD Fault at 9:27 AM. GHD back to site at 1:40 PM. Acknowledged alarms and cleared faults in the VFD. Restarted B9 at 2:00 PM. VFD fan is not spinning, casing is hot. Tried to spin the fan manually, it started running - blowing hot air out the top of the VFD. Left cabinet open to a bit to cool down. Removed a fan from a spare VFD, shut down B9 and disabled alarms. Swapped current fan with the new one from spare in the VFD at B9. Connected power to the VFD and started it, fan started right. Restarted B9 at 2:40 PM and enabled alarms. Observed normal operation. Down time: 10.0 hours.
8/27-28/2022	B3, B4, B6, B8, and B9 Pumphouses. B3, B4, B6, B8, and B9 shutdown awaiting Pump 3 repair, only Pump 4 operating. Down time: B3 for 47.0 hours, and B4, B6, B8, and B9 for 48.0 hours.

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Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B9

9/2/2022 B1, B4, B5, B6, B8, and B9 Pumphouses. Increased flow rates for the following wells to account for SC5 being permanently switched to the SGRS treatment system: B1 to 220 gpm (from 210 gpm), B4 to 390 gpm (from 380 gpm), B5 to 370 gpm (from 350 gpm), B6 to 140 gpm (from 130 gpm), B8 to 180 gpm (from 160 gpm), and B9 to 220 gpm (from 205 gpm).

Down time: None.

9/30/2022 B8 and B9 Pumphouse. Increased B8 flow rate to 195 gpm from 180 gpm and B9 flow rate to 230 gpm from 220 gpm to account for B1 lowered flow rate on 9/26/2022.
Down time: None.

Pumphouse B13

1/18/2022 Pumphouse B13. During the Quarterly Preventative Maintenance, found that the operating solenoid valve was not energized during normal operation at B13 pumphouse. Further troubleshooting required another person onsite to help with verifying correct wiring/tracing and troubleshooting ECV operation.

Down time: None.

1/20/2022 Pumphouse 13. Troubleshooting and testing ECV operation with second person at pumphouse B13. Operating solenoid valve was not energized during normal operation. Found that the wire to the operating solenoid valve was not landed on the terminal strip. Preformed a remote stop of the pump and powered down the controls (PLC, UPS). Ensured that the wire was dead and landed the wire onto the terminal strip. Powered up the controls and remotely started the pump. The solenoid valve is operating/energizing correctly now. Normal operation of solenoid valve observed.

Down time: None.

1/24/2022 Pumphouse 13. Found that the Electric Check Valve (ECV) was not operating correctly on 1-18-2022. Troubleshooting with controls engineer reviewing the electrical drawings. Wiring at both pumphouse B13 and B3 were checked. It was determined that the microswitch was wired Normally Open when it should be wired to Normally Closed. Remotely stopped the pump and powered down the PLC and UPS in pumphouse B13. The cover of the microswitch was removed to get the wiring. Verified the wires were dead, switched wire 4061 to the Norma;ly Closed terminal. Powered up the controls and started the pump remotely. Remotely stopped the pump. Observed normal operation. Further cleaning of the ECV is needed.

Down time: None.

3/10/2022 Pumphouses B3 and B13. ECV maintenance for B3 and B13 pumphouses.
Down time: B3 and B13 for 1 hour.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse B13

8/24/2022 B13 Pumphouse. Troubleshooting B13 EVC to ensure well shuts down when system fails. Shutdown the B13 at 8:20 AM, forced pump to stop by tripping the microswitch. Isolated the valve by closing both upstream and downstream gate valves, vented all water pressure from the valve body. Removed select control piping and the valve cover. Found the sealing section of the valve to be fouled with buildup (manganese), cleaned off components with a scrapper and wire brush. Removed, cleaned, and inspected the valve stem indicator. Lubricated the stems o rings and sanded down some minor imperfections, reassembled the valve cover parts. Cleaned, scrapped the valve body to cover mating surface. Installed valve cover, connected piping, replaced a cracked ½ inch ball valve (from stock) on the upstream side of the valve body. Installed and adjust the microswitch trip doughnut on the valve stem indicator. Opened the 2 isolation valves, cleared the building entry alarm, panel system ok light now on. Remotely started the pump, the operating solenoid valve energized right away and the valve opened. Adjusted the opening and closing speed valves, exercised the valve through a few cycles, normal operation. Pump on around 10:30 AM.

Down time: 2.0 hours.

9/9/2022 B13 Pumphouse. Troubleshooting B13 Communication issue, B13 would remain running even when the main control panel was switched to off. Performed troubleshooting with controls engineer onsite along with another control engineer working remotely on the control program. Connected to the local PLC and found that the PLC had a major fault, cleared the fault and returned the PLC to local control. Communication is now normal. Observed normal operation.

Down time: 2.5 hours.

Pumphouse SC1

10/7/2021 SC1 Pumphouse. Received an SC1 Failed to Start Pump alarm at 8:30 AM. Remote connection showed SC1 was down. Acknowledged alarm. When arrived on site observed that there was no power to the SC1 pumphouse and that the flow meter was not moving. Attempted to turn on SC1 at the control panel in the treatment building, received a second Failed to Start Pump alarm. Acknowledged alarm. Contacted the Arcadis site personnel overseeing the SGRS construction work to ask about any site work occurring near the SC1 pumphouse. Arcadis verified that the power to the SC1 pumphouse had been shut down for construction work occurring near the SC1 pumphouse. The power was restored to the pumphouse and SC1 was restarted at 2:00 PM. Observed normal operation.

Down time: 3.5 hours.

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Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse SC1

10/12/2021 SC1 Pumphouse. SC1 was shut down at 7:17 AM for SGRS construction work near SC1. Disabled AC Power Fail, UPS Power Fail, Pump Failed to Start, and Communication Failure alarms for SC1. Received a call from Arcadis site personnel overseeing the SGRS construction work notifying us that during excavation on the west side of the SC1 pumphouse a 3" HDPE pipe had been broken. Reviewed site plans and determined that the broken pipe was the SC1 pumphouse discharge line to the forcemain. GHD arrived on site at 11:00 AM to meet with Arcadis and the contractor. The 3" HDPE pipe was pinched with an excavator bucket. Reviewed the damage to the pipe and the site plans with Arcadis and the contractor. Confirmed that the broken pipe was the SC1 discharge line and began troubleshooting ideas to repair the line. It was determined that since the line was pressured, to make the repair the discharge line would need to be isolated or the entire TGRS forcemain would need to be drained. Attempts to locate the isolation valve for SC1 was made. The valve was not found. The construction crew proposed pinching the discharge line on the forcemain side to make the repair. This repair plan was approved by GHD and Arcadis. SC5 was shut down at 3:45 PM to reduce the level of the contaminates in the water in the event that another leak would occur. The damaged section of pipe was cut and removed. The new section was defaced and then heated to fuse the old section with the new section. Once the repair was completed , SC1 was turned on at 5:00 PM and no leaks were observed. All the previously disabled alarms for SC1 were enabled. SC5 was turned on at 5:05 PM. Normal operation of SC1 and SC5 were observed.

Down time: SC1 for 4.5 hours and SC5 for 1.5 hours.

10/15/2021 SC1 Pumphouse. SC1 was shut down at 9:30 AM for SGRS work near the SC1 pumphouse. SC1 was remotely turned back on at 3:17 PM. Normal operation was observed.

Down time: 1.5 hour.

10/18/2021 SC1 Pumphouse. SC1 was shut down at 7:48 AM for SGRS work near the SC1 pumphouse. Power was shut off to the pumphouse at 8:15 AM. After work was complete the power was restored to the SC1 pumphouse at 12:16 PM and SC1 was turned back on at 12:30 PM. Upon arrival back to the SC1 pumphouse, a leak from the connection of the influent pipe and the well was discovered. Arcadis was notified and SC1 was shut down at 12:47 PM. The influent pipe appeared to have moved downward due to the removal of dirt around it. The pipe was stabilized using wooden stakes. SC1 was turned back on at 1:09 PM. Normal operation was observed of the pump. The flow meter was not moving.

Down time: 5.0 hours.

10/19/2021 SC1 Pumphouse. SC1 was shut down at 7:20 AM to clean the flow meter. Flow meter removed and cleaned. Reinstalled flow meter and started SC1 at 7:55 AM. Observed normal operation.

Down time: 1.5 hours.

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Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse SC1

10/21/2021-10/31/2021	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. Down time: SC1 and SC5 for 264 hours.
10/21/2021-11/30/2021	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. Down time: SC1 for 980.5 hours and SC5 for 984 hours.
11/18/2021	SC1 Pumphouse. GHD and Thein on-site at 8:50 AM. Reviewed problem and SC1 influent pipe pitless adapter. Determined that the compression fitting to the influent pipe is loose and was causing the leak. Removed the compression fitting and a short section of the influent pipe. Installed a new barbed fitting to the new section of influent pipe and a new fitting to the nipple of the pitless adapter. The new section of pipe connected to the existing section of the influent pipe. The area under the influent pipe was backfilled to provide support. Down time: None.
10/21/2021-12/31/2021	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. Down time: SC1 for 1,724.5 hours and SC5 for 1,728 hours.
10/21/2021-1/31/2022	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. SC5 was restarted on 1/26/2022, see further notes below. Down time: SC1 for 103 days and SC5 for 97.5 days.
10/21/2021-2/28/2022	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 131 days.
10/21/2021-3/31/2022	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 162 days.
10/21/2021-4/30/2022	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 192 days.
10/21/2021 - 5/31/2022	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 223 days.

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Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse SC1

10/21/2021 - 6/30/2022	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 253 days.
10/21/2021 - 7/31/2022	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 284 days.
10/21/2021 - 8/31/2022	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: SC1 for 315 days.
10/21/2021 - 9/30/2022	SC1 Pumphouse. SC1 was shut off due to connection to the SGRS treatment system. SC1 will not return to operation until the SGRS treatment system begins operation. Down time: 345 days.

Pumphouse SC5

10/21/2021-10/31/2021	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. Down time: SC1 and SC5 for 264 hours.
10/21/2021-11/30/2021	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. Down time: SC1 for 980.5 hours and SC5 for 984 hours.
10/21/2021-12/31/2021	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. Down time: SC1 for 1,724.5 hours and SC5 for 1,728 hours.
12/7/2021	SC5 Pumphouse. Arcadis notified GHD that pressure caps were installed on all SGRS connections and ready to restart SC5 that morning. GHD opened the new isolation valve at 3:05 PM while Arcadis observed pressure caps. SC5 was turned on at the control panel at 3:30 PM. Arcadis notified GHD that the pressure caps did not hold at the new SGRS Building pressure cap and to shut down SC5. SC5 was shut down at 3:39 PM by turning off the disconnect breaker in the SC5 pumphouse (and later on the control panel in Building 116). The new isolation valve was closed at 4:01 PM. Leak also discovered at Site G SGRS connections by Arcadis. Water from leak was left to infiltrate into the ground and all appropriate parties were notified of the spill. SC5 and new isolation valve will be off and closed, respectively, until further notice. Down time: 23.9 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse SC5

12/14/2021	SC5 Pumphouse. SC5 disconnect breaker was turned back on to restore power to SC5 pumphouse. Observed normal operation. Down time: None.
10/21/2021- 1/31/2022	SC1 and SC5 Pumphouse. SC1 and SC5 off for the completion of the Site I and forcemain SGRS work and Line W capping. SC5 was restarted on 1/26/2022, see further notes below. Down time: SC1 for 103 days and SC5 for 97.5 days.
1/25/2022	Pumphouse SC5. The flow rate set point was lowered to 40 gpm while the well was still off. B8's flow rate was lowered to 175 gpm to account for SC5 restart. Arcadis notified that the 14" isolation valve was opened at 8:10. At 8:24 SC5 was started with a flow set point of 40 gpm. SC5 flow rate was not increasing beyond 0.9 gpm after serval minutes of operation. Went to the SC5 pumphouse to troubleshot. No obvious issues, called field tech to assist. Confirmed normal operation with pump and motor. Tried replacing analog card with spare, no change in operation. Switched control panel in pumphouse to Local control (vs. PLC control) and manually set motor speed to 41 Hz. Observed flow of 45.2 gpm on flow meter and PLC control screen. Manually lowered flow to ~40 gpm to complete pressure test. Will continue to troubleshoot once pressure test for SGRS connections is completed. After 4 hours of SC5 operating at 40 gpm and no leaks at the SGRS connections, manually increased motor speed to 52.85 Hz and flow rate of 79.5 gpm. After over 2 hours of SC5 operating at 80 gpm and no leaks at the SGRS connections, SC5 was shut down from the PLC control panel. Attempted to restart SC5 from the PLC control panel and observed same operation as seen previously. Will need to set SC5 flow rate from pumphouse until further troubleshooting can be completed. Shut down SC5 at 4:23. Down time: 19.5 hours.
1/26/2022	SC5 Pumphouse. Contacted Arcadis and confirmed no leaks at the SGRS connections overnight. Restarted SC5 from the PLC control panel, observed green status, 4 gpm, and 30 Hz. Went to the SC5 pumphouse, observed 0.00 gpm on the pumphouse flow meter. Switched SC5 to Local control from PLC control, immediately the motor speed jumped to 52.85 Hz and a flow rate of ~80 gpm on the flow meter. Manually set motor speed to 49.65 Hz and a flow rate of 69.94 gpm on pumphouse meter. System ok light on. Lowered flow rate to 70 gpm due to a low water level above pump was observed, waiting for confirmation on readings. Returned to Building 116 and lowered B8 flow rate to 140 gpm to account for SC5 flow. Observed normal SC5 operation on the PLC control screen. Down time: 12.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse SC5

1/27/2022	SC5 Pumphouse. Troubleshooting the communication issue observed at SC5 on January 25th. Confirmed that all the VFD parameters on the SC5 control panel in the pumphouse looked normal. Confirmed that the VFD was communicating with the PLC normally. Switched the control of SC5 from Local control to PLC control. The motor speed began to increase to the desired speed (slowly), did not operate as seen previously. Increased flow setpoint to 80 gpm on the PLC control panel, motor ramped up to 80 gpm in ~ 1 min. Checked water level above pump and determined that the transmitter in the pump is located 20 feet above, no low water level issue. Normal operation observed. Down time: 1.5 hours.
4/18/2022	SC5 Pumphouse. GHD on-site to shut down SC5 for SGRS work. GHD contacted SGRS contractor to notify them that SC5 is getting shut down. Lower SC5 flow rate to 10 gpm, then shut down SC5 at 9:30 from Building 116. Confirmed SC5 off at pumphouse. Went to SC4 pumphouse and followed procedure to start the well. SC4 started at 9:57. Let SC4 to run for at least 4 hours to dilute the forcemain water for safer SGRS work. Returned to SC4 pumphouse and shut down SC4 at 14:17. Closed the 14" isolation valve to the east side of the forcemain. Notified SGRS contractor and Arcadis that SC5 was shut down and the isolation valve was closed and they are set to go for their work on the SC5 SGRS connection. Down time: 13.5 hours.
4/19-20/2022	SC5 Pumphouse. SC5 off during SGRS work to SC5 SGRS connection. B8 flow rate increased to maintain minimum flow rate. Down time: 48 hours.
4/21/2022	SC5 Pumphouse. SGRS contractor notified GHD that the SC5 SGRS connection work was complete in the afternoon of Wednesday, April 20th. GHD arrived on site to restart SC5 at 7:00. Notified SGRS contractor that GHD is ready to restart SC5. SGRS contractor watching SC5 connection and two other representatives watching Site G and Site I connections. Opened 14" isolation valve at 7:13 and notified SGRS contractor. After one hour of isolation valve being open, confirmed with SGRS contractor that there were no leaks or issues with the connections. Went to SC5 pumphouse and opened the isolation valve to the forcemain. Started SC5 with a flow rate of 10 gpm at 8:17, then increased flow rate to 40 gpm. SGRS contractor notified GHD that there is a small leak and to shut down SC5 temporarily. SC5 off at 8:23. SGRS contractor notified GHD that leak had been repaired and to restart SC5. Restarted SC5 at 8:27 at 10 gpm. Increased flow to 40 gpm. Lower B8 flow rate to 180 gpm. After 30 minutes, increased SC5 flow rate to 60 gpm and decreased B8 flow rate to 140 gpm. After 30 minutes, confirmed no leaks or issues with SGRS connections then increased SC5 flow rate to 80 gpm. After 1 hour of operation at 80 gpm, checked Site I SGRS connections, no leaks observed. Notified SGRS contractor of no leaks at Site I and that GHD is leaving site. Observed normal operation at SC5. Down time: 10.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse SC5

6/6/2022	SC5 Pumphouse. Notified SGRS crew that GHD was ready to shut down SC5, and that we would be running SC4 in preparation for Site I and Site G manifold work. Shut down SC5 on main control panel at 13:29. Confirmed that SC5 was off at pumphouse. Arrived at the SC4 pumphouse and realized that the hose and piping has changed since the last start up due to Annual Sampling Event, unable to run SC4 from well into forcemain. Went to SC3, power already cut to SC3 pumphouse for new electrical connections to the SGRS. Spoke with Project Manager and Project Director about the situation, Project Manager and Project Director approved plan to leave isolation valve open overnight and close the next morning. Updated SGRS crew on the new plan and increased B8 to 205 gpm to account for SC5 being down. Down time: 9.5 hours.
6/7/2022	SC5 Pumphouse. Arrived on site, packed T-handle into work truck and headed to the isolation valve. Closed isolation valve and confirmed everything is operating normally at the main control panel in Building 116. Notified the SGRS crew that the isolation valve is closed and they are set to begin their work. They notified me that they would complete the depressurizing of the lines today so they can begin their work first thing on Wednesday morning. Down time: 24.0 hours.
6/8/2022	SC5 Pumphouse: Received a call from the SGRS crew at 13:00 that they have completed the work to the manifolds at Site I and Site G. We decided it would be best to start the restart process first thing the next morning since the SGRS crew would be leaving site at 15:00 and we would only have two hours on crew onsite in the event of a leak or issue. Down time: 24.0 hours.
6/9/2022	SC5 Pumphouse. Arrived on site and observed normal operation of the TGRS. Opened isolation valve at 7:30 and notified SGRS crew that it was open (will leave isolation valve open without SC5 operating for 4 hours). Left the isolation valve with the T-handle in it (went to complete Annual Sampling). SGRS contractor to site by isolation valve in case of issue or leak. Confirmed no leaks or issues at Site I or Site G with SGRS crew, started SC5 at 40 gpm at 11:45. Decreased B8 to 160 gpm. Confirmed no leaks or issues at Site I or Site G with SGRS crew, increased SC5 to 80 gpm at 12:50. After tightening some bolts on one connection, no additional leaks or issues at Site I or Site G. SC5 operating normally. Picked up T-handle from isolation valve and returned it to Building 116. TGRS operating normally. Down time: 13.5 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Pumphouse SC5

7/5/2022 — SC5 Pumphouse. GHD was notified that Xcel planned on completing electrical work near the SC5 pumphouse for the SGRS building and that SC5 needed to be shut down during the work. GHD arrived on site and disabled alarms for SC5. Shut down SC5 at 10:00 from the main control panel. Confirmed that pump was off at pumphouse. Shut down the UPS, and switched the main breaker, service disconnect, 480 volt disconnect, well/pump disconnect to OFF. Notified Xcel that the pumphouse power was off at 10:15. Xcel placed a lock on the service disconnect. Increased flow at B8 to 205 gpm and B9 to 230 gpm to maintain the minimum target flow rate. Xcel completed the electrical work and SC5 was restarted and operational at 13:35. B8 and B9 were set back to normal operational flow rate.

Down time: 3.5 hours.

8/31/2022 — SC5 Pumphouse. SC5 officially switched to be controlled under the new SGRS treatment system. Will remain under operation of the SGRS for the foreseeable future.

Down time: 13.5 hours.

8/31/2022 - present — SC5 Pumphouse. SC5 officially switched to be controlled under the new SGRS treatment system. Will remain under operation of the SGRS for the foreseeable future.

Down time: 733.5 hours (ending 9/30/2022).

Treatment System

10/13/2021 — Treatment System and Well Field. Completed half of the routine monthly preventative maintenance.

Down time: None

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

10/20/2021 Treatment System and Well Field. Arrived on site at 11:00 AM to go over details of the TGRS forcemain drain. Shut down SC1 and SC5 at 11:45 AM. Went to SC4 pumphouse, noticed that the well had been repiped to pull water from the well instead of sending water into the forcemain. Went to the SC3 pumphouse, attempted to turn on SC3 but had an electrical short in the control panel. Determined since neither SC3 or SC4 was operational, SC1 and SC5 would remain shut down until all SGRS work and Line W capping was complete. Shut down TGRS and disarmed autodialer at 12:52 PM. Closed influent valve for the treatment system and the SC4/SC5 shut-off valve. Closed the main boundary line valve near B6 and opened the B12 boundary line valve. Went to B12 and observed water draining from the drain chamber, it appears that the valve was left partially open. Opened the B12 drain chamber valve completely and observed draining until no additional water was overflowing from the drain chamber or the valve box. Draining was completed at 3:53 PM. The manway to the drain chamber and the valve were closed. Closed the B12 boundary line valve and opened the main boundary line valve. Opened the influent valve for the treatment system and restarted the TGRS treatment system with boundary wells in Auto. The system was completely operational at 4:30 PM. The auto-dialer was re-armed. The flow rate for B8 was increased from 140 gpm to 205 gpm.
Down time: B1, B4, B5, B6, and B9 for 4.0 hours, B13 for 2.0 hours, SC1 for 16.0 hours, and SC5 11.0 hours.

10/21/2021 Treatment System and Well Field. Completed the remainder of the routine monthly preventative maintenance.
Down time: None

10/25/2021 Treatment System and Well Field. Arrived on site at 6:30 AM. Shut down TGRS and disarmed autodialer at 6:40 AM. Closed influent valve for the treatment system. Closed the main boundary line valve near B6 and opened the B12 drain chamber valve and manway. Opened the B12 boundary line valve. Went to B12 and observed water draining from the drain chamber. Observed draining until no additional water was overflowing from the drain chamber or the valve box. Draining was completed at 10:10 AM. Left B12 at 10:15 AM to observe the installation of the isolation valve. Once the new section was installed the isolation valve was closed. The manway to the drain chamber and the valve were closed at 1:35 PM. Closed the B12 boundary line valve and opened the main boundary line valve. Opened the influent valve for the treatment system and restarted the TGRS treatment system at 2:03 PM. No leaks observed from the new section of pipe or isolation valve. The system was completely operational and the auto-dialer was re-armed at 2:17 PM. Observed normal operation of the treatment system and wells.

Down time: B1, B4, B5, B6, B8, and B9 for 7.5 hours, B3 for 3.5 hours, B13 for 1.5 hours, SC1 and SC5 24.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

11/3-4/2021 Treatment System. Excavation and decommissioning of the east side of Line W by placing caps on the water line in two locations. Site 1 is located on the south portion of Line W east of the tie-in to SC1 and Site 2 is located on the north portion of Line W east of valve 1365 (the connection to SC2 and SC3). SC4 and SC1 were turned on after the capping was completed to test the caps. No leaks were observed from the newly installed caps. A leak was observed from the pitless adapter at SC1. SC1 was shut off and the leak stopped after adjusting the influent pipe from the SC1 well. A pressure of 90 psi was observed from piping within the SC1 pumphouse. The influent and effluent ball valves were closed to relieve pressure from the influent line until Line W can be drained.

Down time: None.

11/4/2021 Treatment System and Well Field. Arrived on-site at 7:00 AM, disarmed autodialer and shut down TGRS treatment system. Once treatment system completely off, opened the Rice Creek Discharge valve. Observed draining from the Rice Creek discharge culvert. Alerted Arcadis that draining of the discharge line had begun. Observed draining from discharge culvert for ~2 hours. Notified Arcadis that they could begin work on the SGRS discharge line tie-in. At 2:40 PM, after being notified by Arcadis that the SGRS tie-in was complete, the Rice Creek Discharge valve was closed, the TGRS treatment system was re-started, and the autodialer was re-armed. No leaks were observed from the new SGRS discharge line tie-in and normal operation observed from TGRS treatment system.

Down time: B1, B4, B5, B6, and B9 for 7.5 hours, B13 for 2.0 hours, B3 for 2.5 hours, and B8 for 8.5 hours.

11/8/2021 Treatment System and Well Field. Arrived on-site at 10:00 AM, disarmed autodialer and shut down TGRS Treatment system. Open B12 drain chamber valve and removed manway cover to B12 drain chamber. Closed the main boundary line valve and opened the B12 boundary line valve. Observed water draining from the B12 drain chamber and valve box. Opened new isolation valve with Arcadis. At 3:03 PM, GHD began pumping water out of the B12 drain chamber to winterize the B12 boundary line. Opened the isolation gate valves in the B10, B7, and B12 pumphouses. Once water was pumped down, the B12 boundary line valve was closed and the main boundary line valve was opened. New isolation valve was closed and the TGRS treatment system was restarted at 3:39 PM. The B12 drain chamber manway was closed and the B12 drain chamber valve was left open for winter. The autodialer was re-armed and normal operation of the TGRS treatment system and valve was observed.

Down time: B1, B4, B5, B6, B8, and B9 for 5.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

12/7/2021 Treatment System and Well Field. Began receiving various alarm emails at 7:40 from treatment system and pumphouses. Treatment system and well field down due to a possible power outage. GHD arrived on site and assessed the power at Building 116 and pumphouses B8 and B6. Power was normal at all three locations. Autodialer was found to be blinking upon arrival and was disabled temporally. All alarms were acknowledged and cleared. Treatment system and well field restarted at 9:40. Autodialer was enabled and normal. Observed normal operation. Determined that alarms and treatment system shut down was caused by brief power outage.

Down time: 2.0 hours at B1, B4, B5, B6, B8, and B9.

12/7/2021 Treatment System. Attempted to install new SIM card into Juniper modem for PLC. Unable to get IP address set up for new SIM card. Re-installed previous SIM card and set date to install new SIM card another day. Observed normal operation.

Down time: None.

12/16/2021 Treatment System and Well Field. GHD received a call from Time Communication at 2:24 and received multiple alarm emails. Remotely connected to the treatment system and it showed power issues at the site, treatment system down. Lost remote connection and unable to reconnect at 3:02. GHD traveled to site and checked power at Building 116 and various pumphouses, power appeared to be on and operating normally. All alarms were acknowledged on and control panel. Restarted treatment system at 4:15, observed normal operation.

Down time: 2.0 hours at B1, B4, B5, B6, B8, and B9.

1/18/2022 Treatment System and Well Field. Normal monthly prevenative maintenance was started.
Down time: None.

1/20/2022 Treatment System and Well Field. Normal monthly prevenative maintenance was completed.
Down time: None.

2/11/2022 Treatment System and Well Field. Normal monthly preventative maintenance was conducted.
Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

2/21/2022 Treatment System. During site inspection, noticed that the pressure gauges for the treatment system effluent, wet well pump 3, and wet well pump 4 were fluctuating and there was a slight gurgling/humming noise. Reached out and discussed issue and possible troubleshooting steps with field tech once off site. Returned to site to troubleshoot. Issue was still occurring. Ran sink faucet in treatment system room connected to effluent water and noticed possible air bubbles disrupting the water flow. Shut down B4 and Pump 3. Pump 3 was taking a while to shut down. Noticed that the valve wasn't closing (micro switch stick wasn't moving and back pressure pilot was stuck inside). Drained the back pressure pilot using ball valve at base. As this was occurring, the valve began to close and the pump shut down. Observed no pressure fluctuating while Pump 3 was down. Restarted B4 and Pump 3. B4 started normally. Pump 3 attempted to start, received two alarms (Failed to Start and Valve Failed to Stay Open). Acknowledged alarms. Received alarm that Wet Well 1 Level was too high, this shut down the entire treatment system and well field. Restarted treatment system and waited until Pump 3 started. Observed normal pressure from treatment system effluent, Pump 3, and Pump 4 (no fluctuating). Appeared some air bubbles got into Pump 3 or forcemain. Observed normal operation.
Down time: None.

2/24/2022 Treatment System. Arrived onsite and could hear the same noise from 2/21/22 (a slight gurgling/humming) while entering the building. Found that ECV #3 was not closing when directed, causing the wet well level to drop below the pump inlet resulting in Pump 3 cavitating. Troubleshooting revealed 2 issues with wet well Pump 3: (1) The inline filter was blanked out from sediment fouling and was not allowing water to get to the top of the ECV forcing it to close. The filter was replaced. Since Pump 3 was barely operating before Pump 4 was replaced with a smaller pump/motor, a considerable amount of sediment built up in time over on the side of the wet well where Pump 3 sits. Now that Pump 3 is running much more, this sediment is now being sucked into the pump and filter. The fouled filters have placed in an area to dry completely. The filters were inspected, it appears that the filters are mostly blanking out on the surface and not penetrating the media too much itself, creating a layer that water cannot pass through. The used filters were cleaned off and will attempt to use them again. The filters will be swapped out every 2 weeks instead of monthly and will be monitored for any changing conditions. (2) The 3-way solenoid valve (SV) that operates the back pressure sustaining pilot was sticking in the open position when the coil power is off. During normal pump operation, once the pump is started the 3-way SV is energized which in turn opens the pilot which creates a “slow leak” off the top of the valve and allows it to open. When the pump is directed to stop/close, the 3-way is deenergized which closes the pilot, stops the “leak” and the valve is forced closed using the pump pressure. The valve stem then closes “in” releasing the micro switch which stops power to the motor. So the 3-way SV was stuck open, keeping the pilot open, keeping the valve open and motor running. The 3-way SV was replaced with a cleaned/refurbish one from stock.

Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

2/28/2022 Treatment System. Noticed recently that ECV #4 was closing very slowly, if not at all when directed. Did some troubleshooting to identify the problem. Determined that the valve was getting insufficient water pressure to close. Shut down the TGRS system at 1510 and disabled the autodialer. Noticed that B13 was not turning off, will troubleshoot this issue later. Opened the electrical disconnect for Pump 4 and closed the isolation valve between ECV 4 and the discharge force main. Vented all pressure from the valve control piping and removed a section of piping from the inlet side of the valve that provides high pressure for valve closing. The pipe that was tapped into the valve body was very fouled, cleaned out the pipe. Didn't want to remove this pipe due to the rusty condition where it is tapped into the valve body. Also replaced the ¼ inch globe valve with a ball valve to make it much easier to inspect and clean without having to remove. Inspected and verified proper operation of the check valve on this section. Next, removed a section of control piping that included the ECV opening speed angle valve. Valve was very fouled and operation was suspect. Replaced this angle valve with a new one from stock. After the replacement work was completed, the isolation valve was slowly opened. Checked and tightened any connections for leaks, all good. Closed the power disconnect to Pump 4. Pressed the System Start at 1550, well field came up normally and enabled autodialer. Observed normal valve operation.

Down time: None.

3/5/2022 Treatment System. Various alarm emails began at 13:28 and an autodialer call was received at 14:24. Traveled to site, arrived on site at 14:50. Found power issues at B5 meter, phases A and B flashing. Opened the disconnects for the VFD panel and the main in the pumphouse. Call to Xcel Energy dispatch and Power Out Line. Powered down all the other pumphouses (B9, B6, B3, B4, B13, B1, SC5). Found meter at B7 and SC4 flashing. Power issues at Building 116. Opened the disconnects for wet well pumps 3 and 4 at the motor control center. Powered down the PLC/control panel and autodialer. Opened the disconnect for the shop heater and the treatment center heaters, opened the local disconnects for the wet well pumps 3 and 4 and blowers 3 and 4. No call from Xcel as of 16:40. Left site. Received call from Xcel at 17:30, went back to site. Met with Xcel at 18:25, discussed power issue. Xcel tried a fuse in one of the switches and it blew. Unable to locate the problem. No obvious issues. Will resume troubleshooting tomorrow, left treatment system off.

Down time: B1, B4, B5, B6, B8, B9, and SC5 for 8.5 hours, and B3 and B13 for 9.5 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

3/6/2022	Treatment System. Reached out to Xcel to get a ETA for repair, Xcel was already in site. Received call from Xcel, they have isolated the issue to a pole along Pillsbury Ave, west of Building 116. Xcel said there is a "tracking" (electrical short) occurring at the top of the pole. A different crew has to come to the site for this type of repair. Xcel called it in and requested for it to be expedited. Xcel gave GHD contact information to the foreman and request they call with an ETA when they will began the repair. Received call that a crew is heading to site. At 13:45 GHD and Xcel arrived on site. Xcel was able to energize the lines and issues seems to be resolved. Closed all the open disconnects in the pumphouses and in Building 116. Powered up the PLC. Many alarms began appearing, clearing/acknowledging alarms. First attempted to start the system, did not start. Returned to a few pumphouses and turned on the UPSs. Tried to start the system again, Blowers 3 and 4 failed. Both overloads were tripped at the motor control center up front, reset. Started system again, blowers started and well field began to come up. Went to SC5 and closed both disconnects. System fully up and operational at 16:20. Reset autodialer. Xcel explained that the carry-over jumpers needed to be replaced. The jumpers and pins were replaced. These have a porcelain isolator and both were older and cracked. The third carry over jumper was in good condition. System operating normally. Down time: B1, B4, B5, B6, B8, B9, and SC5 for 18.0 hours, and B3 and B13 for 9.5 hours.
3/9/2022	Treatment System. Normal Monthly Preventative maintenance was started. Down time: None.
3/10/2022	Treatment System. Normal Monthly Preventative maintenance was completed. Down time: None.
3/13/2022	Treatment System. Alarm emails began at 7:16, autodialer call at 7:48, called Xcel Energy power outage line and the White Bear Lake dispatch line. GHD on site at 8:50, found the electric meter at B5 was completely off, began to follow power outage restart steps. Xcel Energy on site at 9:00, found that a vehicle hit a ground wire at the first power pole on site from Sherer Brothers Lumber resulting in the wire snaping from the ground and tripping open two fusible links. Xcel restored power to the site at 10:20. GHD began powering up the UPSs at the pumphouses and powered up Building 116. Cleared and acknowledged the alarms. Started the treatment system at 11:10. Treatment system and well field operating normally. GHD notified Xcel that the system was on and operating normally. Down time: B1, B4, B5, B6, B8, B9, and SC5 for 4.0 hours, B13 for 1.5 hour, and B3 for 2.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

4/11-12/2022	Treatment System and Well Field. Normal Monthly Preventative maintenance was completed. Down time: B1 for 1.5 hours, B4, B6, B8, B9, and SC5 for 2.0 hours.
5/10/2022	Treatment System and Well Field. Began normal Monthly Preventative maintenance. Down time: None.
5/25/2022	Treatment System and Well Field. Completed normal Monthly Preventative maintenance. Down time: B1 for 1.5 hours; B3, B4, B5, B6, B9, and SC5 for 2.0 hours.
6/28/2022	Treatment System and Well Field. Began normal Monthly Preventative maintenance. Down time: 1.5 hours for B1, and 1.0 hour for B5, B6, B8, B9, and SC5.
6/30/2022	Treatment System and Well Field. Completed normal Monthly Preventative maintenance. Down time: None.
7/25/2022	Treatment System and Well Field. Began normal Monthly and Quarterly Preventative maintenance. Down time: None.
7/26/2022	Treatment System and Well Field. Completed normal Monthly and Quarterly Preventative maintenance. Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

8/7/2022 Treatment System and Well Field. Received multiple alarm emails, headed to site. Arrived on site and found that the well field was down except for B13 and the 2 blowers were on. Channels 01 and 08 were active on the Autodialer, but received no call. Acknowledged alarms. Checked the Motor Control Center up front and found that the overloads were tripped on the WWP-3 control bucket. Pushed in and reset the overloads. Restarted system at 11:12 AM. Went to B13 and manually tripped the micro switch to stop the pump. Restarted system again at 11:20 AM. Well field began coming online, WWP-3 motor started but the ECV would not open. Wet well high level alarm causing the well field to shut down. Exercised the operating solenoid valve for ECV-3. Cleared alarms and restarted the system again. WWP-3 started and the ECV opened normally. Observed normal operation of treatment system. Then went to check on why the autodialer did not call out. Called number of autodialer, went straight to voicemail. Observed 1 to 2 bars of signal strength, status blinking green, cellular is solid orange, power is solid red. Cycled power to the cellular modem and tried calling again, went straight to voicemail. Ran a system fail call out test, autodialer called out. Began the alarm message then there was a dial tone again in the background, the message cycled through 3 times without an acknowledgement. Acknowledged the message, but received no call from the answering service. Further troubleshooting needed. Observed normal operation of WWP-3 and treatment system.

Down time: B3 for 2.0 hours, B4, B5, B6, and SC5 for 10 hours, B8 for 7.0 hours, and B9 for 11 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

8/13-14/2022 Treatment System and Well Field. Received Pump 3 Failed to Start and Wet Well 1 High Water Level alarm emails at 9:39 PM on 8/13. Discovered treatment system down due to alarm emails during remote monitoring. B13 and blowers were still running. Acknowledged alarms, attempted to restart system remotely. Clicked the system start button at 11:04 AM. Well field began operating ~11:08, Pump 4 operating at 11:08. All wells, blowers, and Pump 4 operating at 11:10 AM, total flow rate ~1,796 gpm. Tried to start Pump 3, and it tripped the Pump 3 Failed to Start alarm again. Acknowledged alarms. Clicked system stop at 11:12 AM. Observed 1,950 gpm of flow began manually shutting down wells, system off at 11:16 AM. Tried to shut off B13. Headed to site. Arrived at site, checked system, blowers running and B13 still running. Acknowledged alarms and reset Pump 3 in the main panel up front. Channels 01 and 08 were active on the Autodialer. Cycled power to autodialer. Need to look into why the autodialer didn't call out. Restarted system at 12:07, wells began coming on, well field, blowers, and Pump 4 on. Waiting for Pump 3. Pump 3 failed to start again, no change in pump condition (no movement or noise). Shut down system by pressing system stop button. Tried to reset Pump 3 again on the main panel up front, but continued to get Pump 3 Failed to Start Alarms. Couldn't hear the pump trying to start, possibly something is wrong with the fuses. Contact field technician to do further troubleshooting. Manually went and shut down B13 by tripping the microswitch. Pump 4 and blowers off when got back to Building 116. Left treatment system down for further troubleshooting. Field technician arrived on site at 4:10 PM. Troubleshooting WWP-3 Failed to start. Viewing the electrical schematic drawings, Overload relay reset is pushing in normally, acting like it is not tripped. Found the control relay (In the new cabinet) that powers the starter coil at the Pump 3 motor control bucket. Control relay is working correctly and getting 120 volt power to the starter coil. Coil is not engaging. Called Preferred Electric for assistance. Talked about the issue and what has been tried so far. Preferred Electric will be onsite at 7:00 AM tomorrow morning. Going to partial start up system with only Pump 4 operating. Pressed System Start at 5:45 PM, began with wells SC5, B1, B13, B5, B4 and B9 running. Observed the operating Wet Well level, getting close to the Wet Well High Level float activating. Shutdown B9 at 5:55 PM, shutdown B4 at 5:58 PM. Total influent flow is at around 709 gpm, wet well level slowly dropping, will leave the system in this condition. Operating pumphouses are SC5, B1, B13, and B5. Will continue to check the system remotely this evening to see if any changes are needed. GHD off site at 6:20 PM. Remote check of the system at 7:50 PM and 9:00 PM, operating normally.

Down time: B1, B5, and SC5 for 20 hours, B3 for 21 hours, and B4, B6, B8, and B9 for 25 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

8/15/2022 Treatment System and Well Field. Arrived on site at 6:40 AM. Preferred Electric on site and talked over what steps were taken to troubleshoot yesterday. Found that a component of the overload block on the Pump 3 starter was the issue. There is a metal tab on the A phase that was tripped and not resetting. Reset that tab with a screwdriver. Tripped and reset the tab a few times with no issues. Started Pump 3 in hand. Pump 3 started with no issues, switched pump to off. Manually tripped and reset the tab a few more times with no further issues. Also found that one of the phase wires that is going from the bottom of the bucket disconnect to the top of the starter was actually up against the side of the starter housing and a plastic tab attached to the coil was rubbing on the wire. The wire was moved away, taped the insulation and repositioned out of the way. Very tight quarters inside the bucket. This condition may have kept the coil from fully engaging. Switched Pump 3 control into auto. Enabled the wells that were off at 7:25 AM. Observed full operation of the treatment system at 7:35 AM. Checked Pump 3 operating Amps, were ~82. Name plate is 91.3 Amps, so it is running within/below it's operating range. Normal operation observed.

Down time: B3 for 7 hours, and B4, B6, B8, and B9 for 8.5 hours.

8/16/2022 Treatment System and Well Field. Received a Pump 3 Failed to Start alarm at 5:32 AM. GHD arrived on site at 7:10 0532 – Received an email from the system that WWP-3 Failed, checked main control center bucket for Pump 3. The overload (phase A) was tripped again. Reached out to Preferred Electric, will bring some replacement overloads to site. Removed the overload from the A phase leg (marked with an X) and swapped with the overload on the C phase. This was done (as step one) to see if the trip problem follows the overload to the C phase. If the trip occurs on the A phase again, the investigation would move onto the wiring and/or motor, and if the C phase trips, the problem is most likely the overload itself and will be replaced. Test ran Pump 3 for a short time to observe the pump shaft then ran the pump again to check and observe the operation of the motor. Enabled a partial system start at 9:15 AM, Pump 3 set as the lead pump. Wells SC5, B1, B13, and B5 operating. Monitoring Amps of Pump 3, on start the Amps spiked around 300 then settled down to around 82. Observed normal operation, started the rest of the wells. Treatment system fully operating at 9:46 AM. Normal operation observed.

Down time: B3 for 2.0 hours, and B1, B4, B5, B6, B8, B9, and SC5 for 4.0 hours.

8/16/2022 Treatment System and Well Field. Began normal Monthly and Quarterly Preventative maintenance.
Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

8/19/2022 Treatment System and Well Field. Received Pump 3 Failed to Start and Wet Well High Level alarms at 12:30 PM, treatment system down. GHD on site to response at 1:15 PM, manually shutdown B13 by switching the microswitch. Preferred Electric on site at 1:25 PM, replaced overloads for Pump 3. Restarted treatment system at 1:45 PM, switched Pump 3 to the lead pump. B3 would not start with other wells. B3 Communication Failure alarm at 1:30 PM. Reset power in B3 pumphouse PLC, pump tried to start and shut off immediately. Switched pump from auto to off on main control panel. Switched Pump 4 to the lead pump. Troubleshooted communication issue by cycling power to control panel at pumphouse, switched B3 back to auto at pumphouse and main control panel. Restarted B3 and observed normal operation at 3:40 PM. Observed normal operation of the treatment system.

Down time: B1, B13, B3, B4, B5, B6, B8, B9, and SC5 for 1.5 hours.

8/20-21/2022 Treatment System and Well Field. Pump 3 and 4 Failed to Start, Blower 3 and 4 Failed to Start, and Wet Well High High Level alarms at 9:45 PM on 8/20. Noticed that there were alarm emails sent out last night at 6:50 AM. Arrived on site at 7:50 AM. There is a fusible link open to the building transformer and water flowing out back door. B13 remained on, ECV failed to close. Manually turned pump off at the pumphouse using the microswitch. Partial power at main control panel. Opened the disconnect for Pump 4, opened cabinet to check power. Checked volts Phase to Ground – A 208, B 522, C 223, Phase to Phase A-B 618, A-C 509, B-C 532. Configuration is Delta, causing feedback and erratic readings. Called Xcel power out line to report the incident at 8:13 AM. Called Xcel dispatch at 8:15 AM, someone will head out to site to assist. Checked all the pumphouses, all normal. Powered down control panel and opened main disconnect in electrical room. Xcel on site at 9:08 AM. Xcel said that the issue is most likely after the fuse in the transformer, not upstream. Xcel replaced the fuse, the fuse held for around 30 seconds then blew again. Contacted Preferred Electric. Xcel taking pictures and contacting Emergency Repairs department at Xcel. Xcel sent the transformer information to the engineers and construction departments at Xcel, probably will not have a plan till mid morning tomorrow. Xcel is recommending that a replacement generator gets lined up. Contacted project team and gave them an update. Project team and Preferred Electric working on a replacement plan, temporary power, and notifying agencies. GHD off site at 11:40.

Down time: B3 for 26.0 hours, B1, B4, B5, B6, B8, and B9 for 25 hours, and SC5 for 24.0 hours.

8/22/2022 Treatment System and Well Field. Treatment system and well field down awaiting temporary power to Building 116 due to the failed transformer.

Down time: All wells for 24.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

8/23/2022 Treatment System and Well Field. GHD arrived on site at 7:00 AM to oversee the installation of the generator for temporary power to Building 116. Preferred Electric already on site, discussed the plan and where things are run from. Preferred Electric began working on getting the connections ready for the generator. Generator arrived on site at 9:15 AM, Preferred began hooking up the generator to the motor control panel and main control panel. Control panel and motor control panel hooked up to generator at 11:15 AM. PLC screen on and full of alarms. Acknowledged all the alarms, switched all pumps, blowers, and wells to OFF to ensure none accidently started. Saw that B13 was on. Went to pumphouse to shut it down. Already off upon arrival. Returned to Building 116. Tried to start Blower 3 to test if the rotation is correct. Blower 3 would not start. Tried Blower 4, would not start. Checked resets, Blower 4 reset was tripped. Started Blower 4 from the motor control panel, worked normally. Shut down Blower 4. Tried to start Blower 4 with the control panel, started normally, shut down. Tried to start Blower 3, it started temporarily then stopped. Preferred began checking the wires and found that one of the lead wires were shorted or that the motor was shorted. Preferred began troubleshooting wiring. Preferred determined that the shorted wire has a small cut in the casing which may have gotten water in it when the wet well overflowed and was causing the short. They switched the shorted wire with the ground. Tried to start Blower 3 with the main control panel and observed normal operation. Checked to see if Pump 3 and 4 are rotating correctly by starting them in hand and observing the shaft rotation. Tried to start Pump 4 and heard a click but pump did not start. Tried Pump 3 and observed normal operation. Checked reset for Pump 4, normal. Then checked fuses for Pump 4 and one of the fuses was blown. Replaced the blown fuse with an extra from the shop. Started Pump 4 and observed normal operation. At 2:00 PM, began switching pumps and blowers to auto, they started automatically. Switched extraction wells to auto. Clicked System Start and began observing the well field coming online. System operating normally. Notified project team that the system was operational again. Checked on data logger and remote connection. Cycled power to data logger and firewall. Able to connect to the VPN and view the system remotely, unable to connect to the data logger via the online portal. Reached out to control engineer. Will watch for nightly emails and check back with the controls engineer tomorrow. Treatment system operating normally.

Down time: All wells for 16.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

8/26/2022

Treatment System and Well Field. Pump 3 Failed to Start alarm email at 3:03 AM, noticed the email and connected to the system remotely at 6:00 AM. Pump 4 running and the wellfield was cycling. Tried to reset and start Pump 3, failed again. Arrived on site at 6:35 AM. Pump 3 phase 1 and 3 overloads tripped, reset. Cycled the pump, pump on then began to make a laboring sound and sporadic buzz. Switched Pump 3 to off, before the valve closed to stop the pump, it began to run smoothly with no buzz. Left the pump off for about 5 minutes. Switched control to ON, pump started with no issues. The pump cycled normally for 2 cycles, during the third cycle, the motor began laboring again and observed the pump shaft stop. Quickly stopped the pump at the panel, pump off immediately. Electrical smell from motor. Reached out to Thein for thoughts. Call with Thein, update of observations, check pump shaft for rotation. Can uncouple the motor from the pump in place to check the motor operation, but hard to tell for sure with no load. Contacted Preferred Electric to discuss the issue, someone will come out first thing Monday morning to test/Meg the motor and lines from the MCC bucket to the local disconnect. Can rotate the pump shaft freely. Shutdown wells B8, B3, B4, B6, and B9 at 8:20 AM, wells that remain on are SC-5, B13, B1, and B5. Pump 4 cycled off. Switched B4 to on. Total influent flow rate at 1,090 gpm. Wet well level is getting close to the high level float, reduced B4 flow setpoint to 200 gpm. Total influent rate 910 gpm. Switched B4 off at 9:10 AM, Pump 4 could not keep up. Diesel Dogs and United Rental onsite at 9:15 AM. Shutdown system and generator off at 9:27 AM. Generator plumbed to the fuel cell. Restarted system at 9:50 AM, system not starting. Acknowledged all alarms. Call to United Rental, didn't turn on the generator main breaker before leaving site. Main breaker to on, heard it engage. Restarted system at 10:20 AM. Observed normal operation of operating wells and pumps.

Down time: B1 for 3.0 hours, B5 and SC5 for 3.5 hours, B3 for 14.5 hours, B4 for 17.0 hours, and B6, B8, and B9 for 17.5 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

8/29/2022	Treatment System and Well Field. GHD arrived on site at 7:00 AM. Preferred Electric arrived on site and gave them a quick rundown of the issues Pump 3 was having when shutdown on last Friday (8/26). Preferred Electric is working on checking the motor, used an megger/ohm meter to test the windings. Phase to Ground and Phase to Phase. All ok but getting towards the upper threshold. Motor is old. Megged the wires from the local disconnect to the motor, all looks good. Left the motor wires disconnected and closed the disconnect up at the starter bucket. Started the pump in hand to check the voltage to the motor. Voltage to Ground is good, voltage phase to phase normal. Checked the tightness of all the connections in the starter bucket, some were a bit loose, tightened down. Wired motor back up to the leads. Bumped the motor, normal start, 85 amps. Enabled wells B3, B4, B6, B8, and B9. Observed another Pump 3 start and run. Well field fully operational at 9:35 AM. Preferred Electric mentioned that the grounding on the generator may be insufficient, they took some pictures and do further determination. Opened the door to the generator connections. Generator shut off. System down. Restarted generator, five min warm up then closed the disconnect. Restarted the system, system operating again. Pump 3 seems to be operating okay, told Thein not to come at 9:39 AM. Preferred Electric left site at 10:25 AM. Pump 3 motor started to make the same noise, laboring as before. Shut down the pump and select wells at 10:40 AM. Call to Preferred Electric, returning to the site. Preferred Electric arrived back on site at 11:30 AM, looking at the motor starter. Contactors were showing pitting, concerned these may be part of the issue. Swapped out the coil and contactors with the starter on the shelf. Cleaned the contactors with emery cloth. Started and observed pump/motor operation at 12:40 PM. Enabled the rest of the wells. The pump cycled a few times, normal operation. Cycled about 7-8 times, normal operation. Preferred Electric will take the starter back to the shop and get it rebuilt with the parts needed and return it to the site. Observed normal operation of the treatment system. Pump 3 Failed to Start alarm email at 6:22 PM. Treatment system down, restarted Pump 4 and B1, B13, B5, and SC5. Further troubleshooting needed. Down time: B3 and B8 for 17.5 hours, B4 for 20.5 hours, and B6 and B9 for 17.0 hours.
8/29/2022	Treatment System and Well Field. Completed normal Monthly and Quarterly Preventative maintenance. Down time: None.
8/30/2022	Treatment System and Well Field. New autodialer modem has been installed. Successfully tested both an outgoing and incoming call using cell phone to the autodialer. The set up sheet is posted inside the autodialer cabinet that explains what the lights mean when in the normal state. The backup battery that the modem is plugged into was tested, normal voltage, at 10.1 VDC. The auto dialer is now active. Down time: None.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

8/30/2022	Treatment System and Well Field. GHD and Preferred Electric on site at 6:35 AM. Discussed the troubleshooting of Pump 3, found that the overloads for Pump 3 were not tripped. Found that the fuse for the relay that powers the starter coil was tripped (FU-115), need a replacement fuse. Opened FU-117, blowers turned off. Drawing shows FU-117 as a spare. Reset the alarms, blowers now on, pushed System Start. Alarm email sent out for the blower fail alarm. Opened FU-105, Auto dialer. Put this fuse in FU-115, started Pump 3, fuse blew. Took out the fuse for the panel light (FU-103), disconnected the 120 volt wires in the bucket and tested each section. Got to testing the coil itself and the fuse blew again. No fuses available nearby to replace. Communication failure alarm emails sent out for B1 and B3. Bumped up the alarm trip delay from 180 seconds to 240 seconds for these 2 locations. Frequent alarms. Preferred Electric onsite at 11:30, installed new starter for Pump 3. Tested coil, contactors without a load, normal operation. Tested starter operation with the disconnect open at the pump, voltage good. Enabled the shutdown pumphouses. Pump 3 cycled the pump a few times with no faults. Treatment system operating fully at 2:10 PM. All controls to auto and observed operation. On cycling, the starter for Pump 3 did chatter/engaged twice during the starts. Took the peak amps on start with Pump 4 already running plus both blowers on, 467 amps. May be right at the top of what the generator can handle, switched the lead pump over to Pump 3 and observed a couple starts of Pump 4. Contactor engages more solidly and smoothly with less of a pull/surge on the generator on startup. No chatter or hesitation on the Pump 3 starter when Pump 4 starts. Observed normal operation. Down time: B3 for 11.0 hours, B4 and B8 for 16.0 hours, and B6 and B9 for 15.0 hours.
9/7/2022	Treatment System and Well Field. GHD arrived on site and noticed that the generator was not running and the treatment center was flooding down to the basement. B13 did not shut off with the rest of the treatment system and well field, shut B13 manually off at the pumphouse. Notified United Rentals of the generator failure, they will send a technician out to look into the issue. Began pumping out the wet well to get the level down, setup a Honda generator to pump the building basement into the wet well. Notified PD at 10:30 AM. United Rentals technician on site at 11:33 AM, planning to complete a forced regen and reset the unit. Generator restarted at 12:50 PM. Power restored to Building 116, cleared alarm emails and restarted treatment system. Observed normal operation of the treatment system. United Rentals technician left site at 1:35 PM. Will return to check on the generator later this week. Purchased and replaced battery for autodialer. Noticed that the data logger was stuck in a power restart cycle, reinstalled program, and observed normal operation of the data logger. Tested autodialer call out, received call. Observed normal operation and GHD left site. Down time: B1, B4, B5, B6, and B9 for 12.5 hours, B3 for 6 hours, B8 for 13.5 hours, and B13 for 2.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

9/8/2022	Treatment System and Well Field. Treatment System went down again around 2:00 AM. Received a call from the auto dialer and Arvig Communication that the power was off at Building 116. GHD responded and arrived onsite at 2:28 am to check on things. Had to manually shut off B13 at the pumphouse. No flooding. United Rental technician and Preferred Electric onsite at 7:00 AM. Preferred Electric will contact United Rentals to push for a replacement generator. Treatment system restarted and operating at 9:00 AM. The generator manufacturer is going to send a technician out today to inspect the unit. The treatment system will have to be powered down again for this work. Replacement generator arrived on site at 5:30 PM, shut down treatment system so the temporary generator can be hooked up. Still observing issues with B13 controls. Treatment system restarted at 6:45 PM. Wet Well Pump 4 wouldn't start, found that the ½ amp fuse in the MCC cabinet was blown. Replaced the fuse. Observed normal operation. Down time: B1, B4, B5, B6, and B9 for 8.0 hours, B3 and B13 for 4.5 hours, and B8 for 9.0 hours.
9/9/2022	Treatment System and Well Field. United Rental on site at 5:00 PM to move the fuel cell for the emergency generator next to the replacement generator installed on 9/8/2022. GHD shutdown treatment system at 5:10 PM. United Rental moved fuel cell and plumbed the fuel cell to the replacement generator. Restarted treatment system at 5:32 PM, observed normal operation. Down time: B3 for 2.5 hours and B8 for 1.0 hour.
9/10/2022	Treatment System and Well Field. GHD received a call from Preferred Electric that the generator was off due to an unknown reason at 8:08 PM. Received call from autodialer that the power is out at Building 116 at 8:14 PM. Received call from United Rentals informing GHD that the generator shutdown due to the fuel delivery vendor opening the high voltage cabinet on the emergency generator while looking for the fuel port. There is a safety switch on this door that will shutdown the generator if opened while the emergency generator is operating. GHD arrived on site at 8:48 PM. Generator was restarted by fuel vendor with the help of United Rentals. Restarted treatment system at 9:05 PM and observed normal operation. Added a LOTO lock on the high voltage cabinet door. Down time: B4, B5, B6, and B9 for 1.0 hour, and B8 for 1.5 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2022
TGRS - BGRS, OU2
Arden Hills, Minnesota

Treatment System

9/22/2022	Treatment System and Well Field. Received call from autodialer at 9:00 AM from autodialer that power at Building 116 is off. Arrived on site at 9:30 AM, generator off, DEF level at 0%, low DEF level. Filled DEF with 12.5 gallon, now at 100%. Reset generator at 9:50 AM. Wet Well Pump 4 failed to start, control fuse blew again. Replaced fuse and tried to restart pump, blew again. Once Pump 3 was off, opened disconnect for Pump 4. Replaced fuse, closed disconnect, fuse did not blow. Switched Pump 4 to Hand, wouldn't start. Can hear the relay in the panel click, but no action at the main control cabinet. Contacted Preferred Electric for further assistance. Started B1, B13, B4, and B5, started treatment system, placed Wet Well Pump 3 to Auto. Left Pump 4 off. Influent flow rate at 1,045 gpm. Preferred Electric arrived on site at 12:25 PM, began troubleshooting the main control cabinet. Determined that one of the relays may have been stuck. Switched Pump 4 to Hand at 1:35 PM, observed normal operation. Enabled the rest of the extraction wells and switched Pump 4 to Auto. Treatment system operating normally at 2:05 PM. Observed normal operation. Down time: B1, B3, B4, and B5 for 2.5 hours, B13 for 1.0 hour, and B6, B8, and B9 for 5.0 hours.
9/29/2022	Treatment System and Well Field. Began normal Monthly Preventative maintenance. Down time: None.
9/30/2022	Treatment System and Well Field. Completed normal Monthly Preventative maintenance. Down time: None.

Appendix H

TGRS Chemical Data

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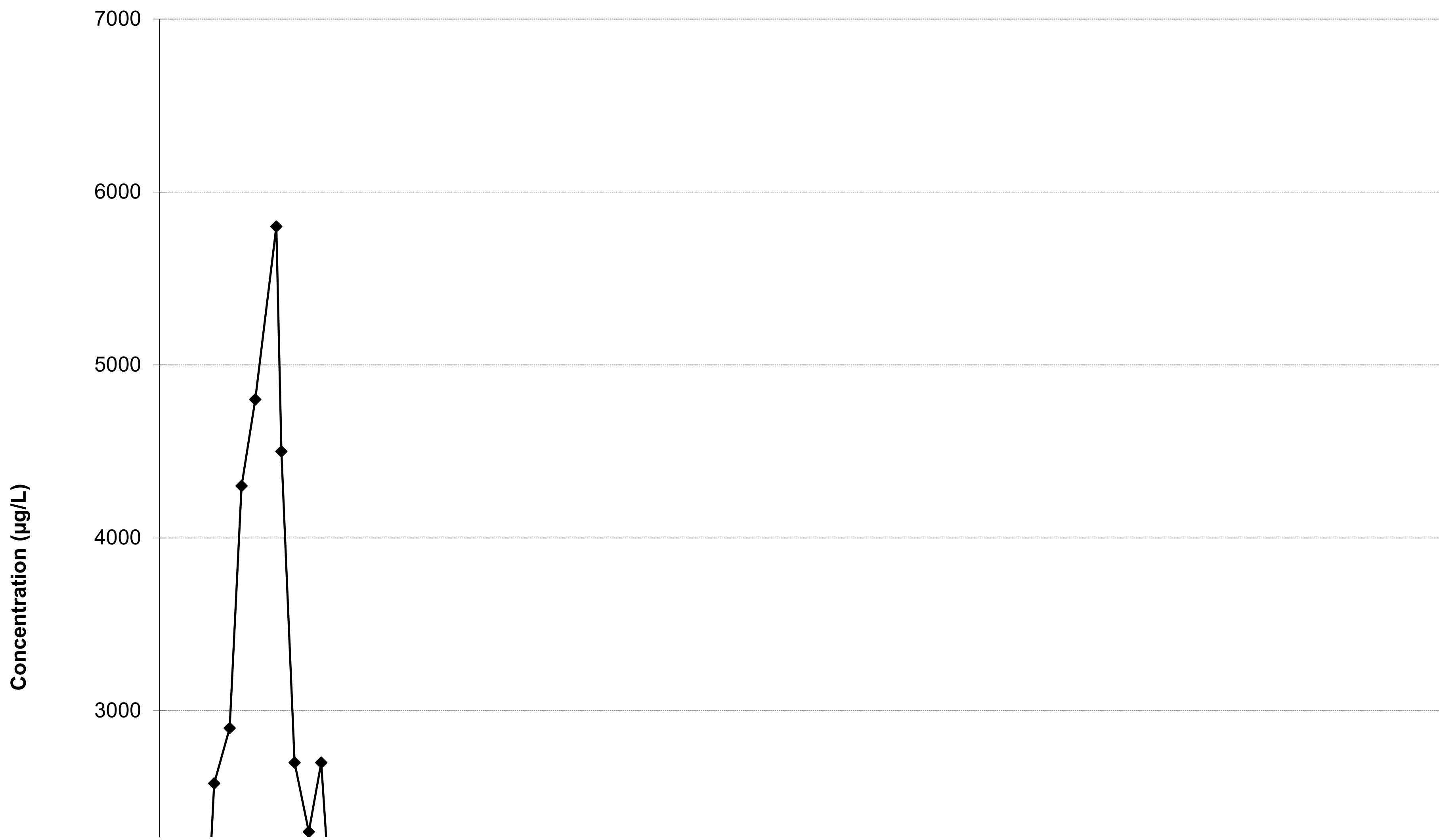
Appendix H.1

TGRS Extraction Wells – Trichloroethene versus Time

APPENDIX H.1

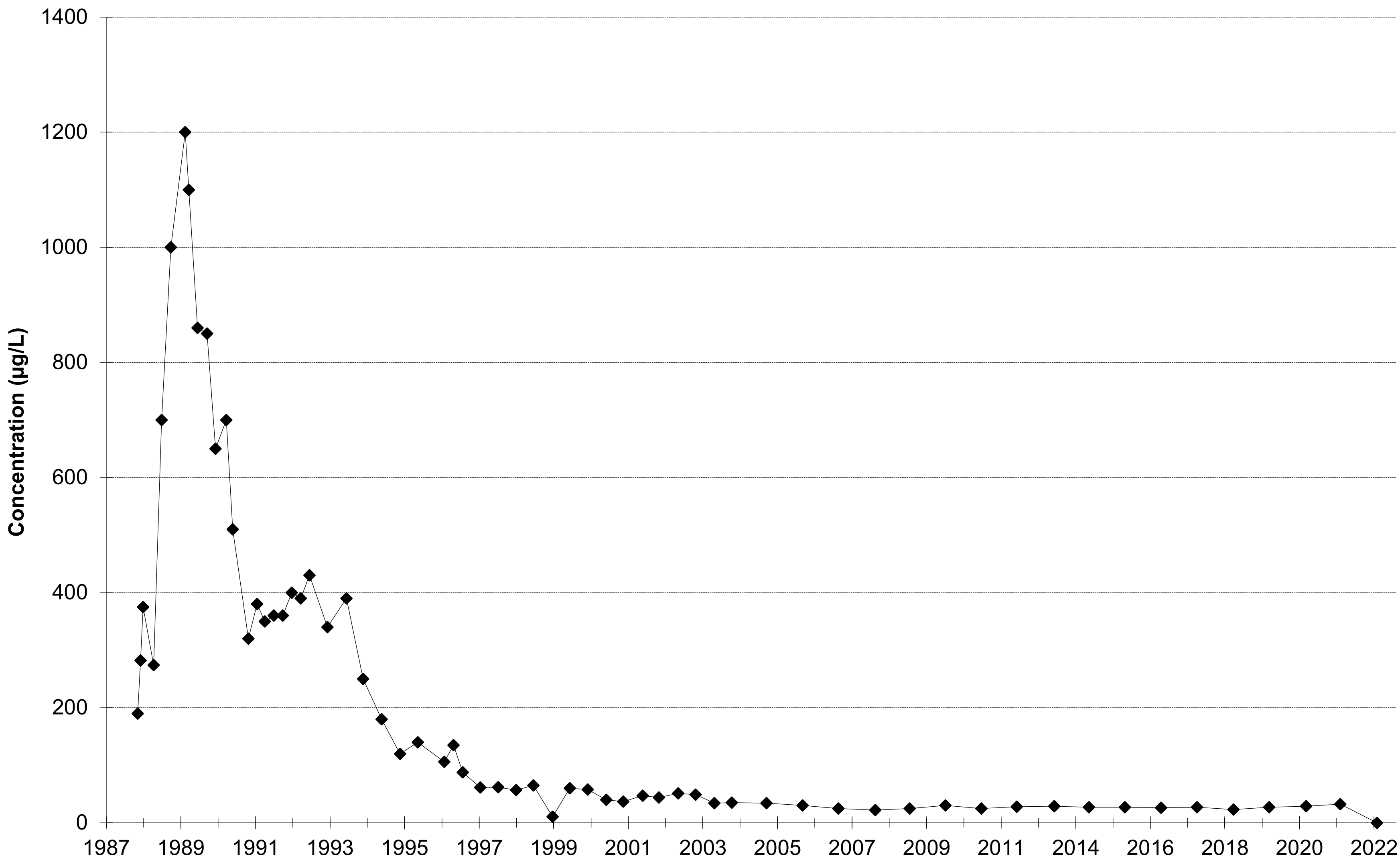
EXTRACTION WELL B1 - TCE VS.TIME



Note: Samples reporting concentrations less than the detection limit were plotted as zero.

APPENDIX H.1

EXTRACTION WELL B2 - TCE VS. TIME

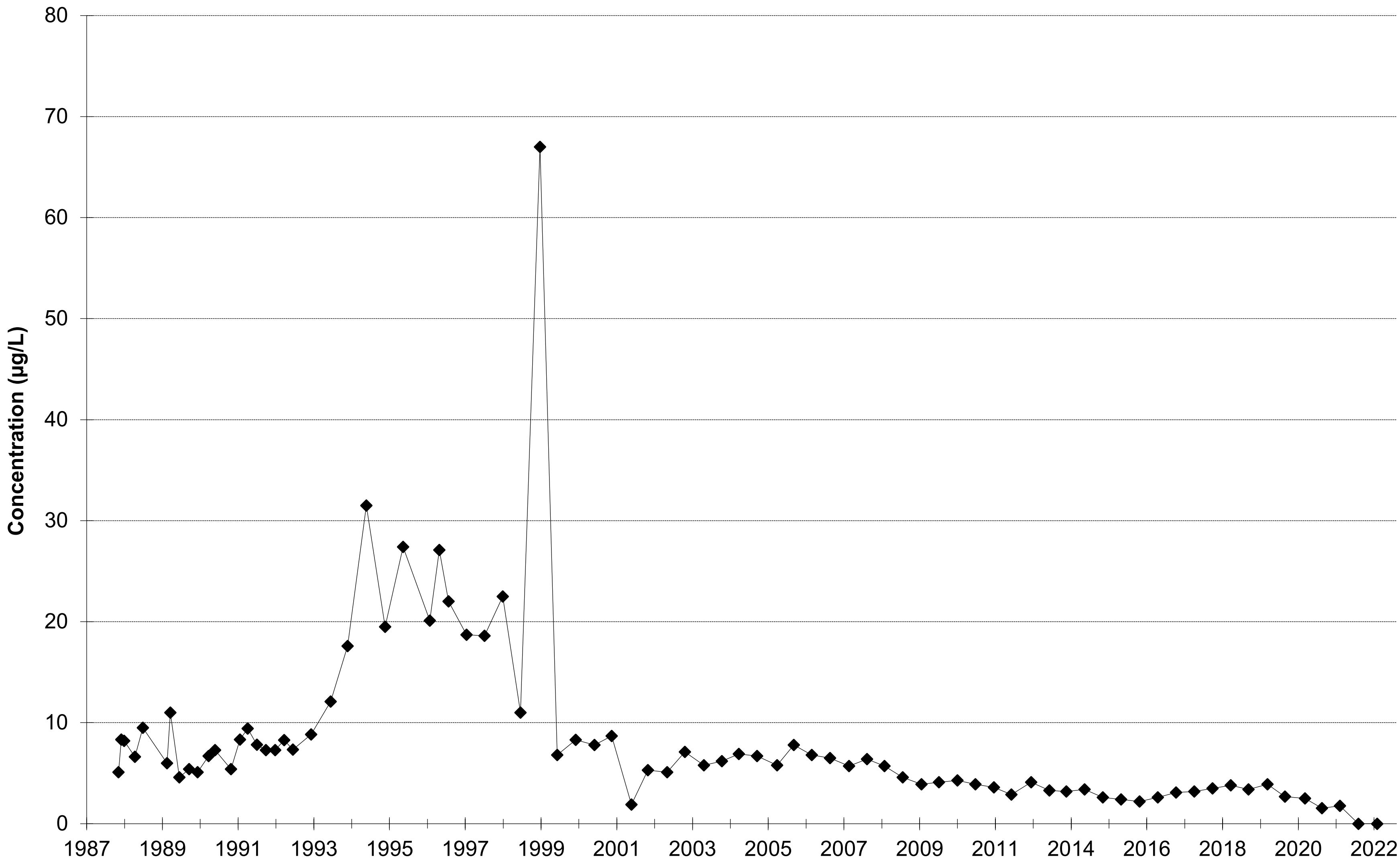


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B3 - TCE VS. TIME

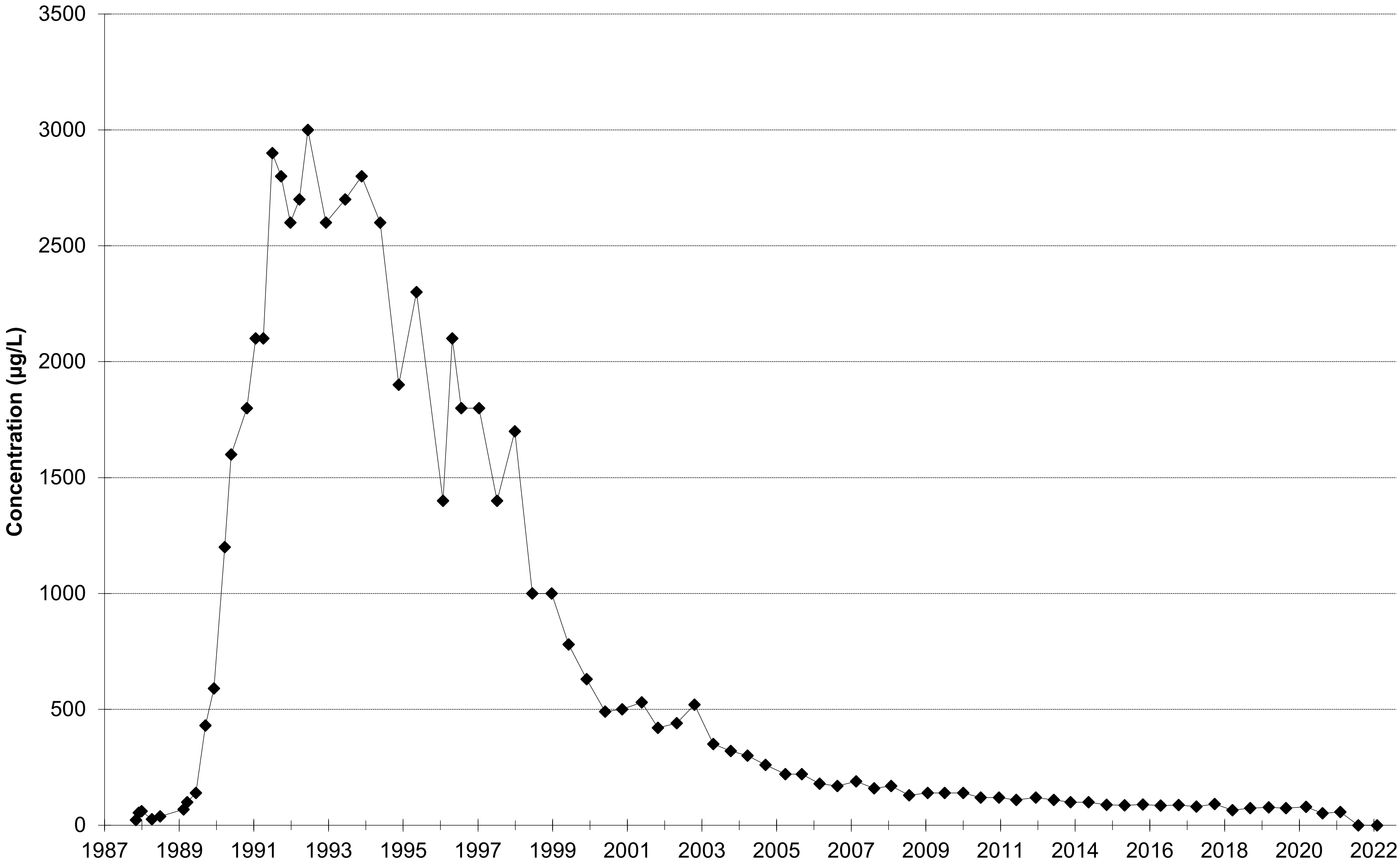


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B4 - TCE VS. TIME

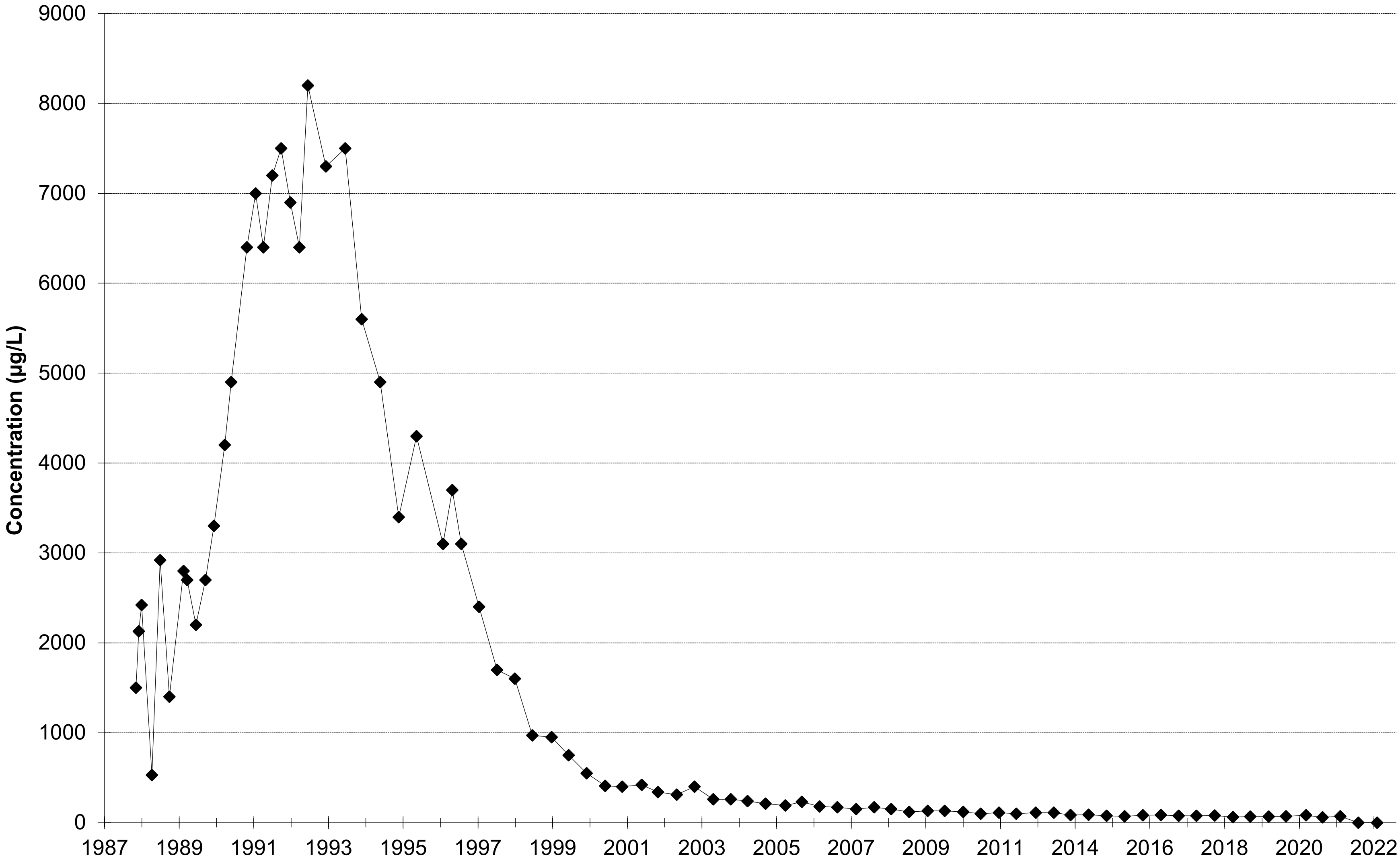


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B5 - TCE VS. TIME

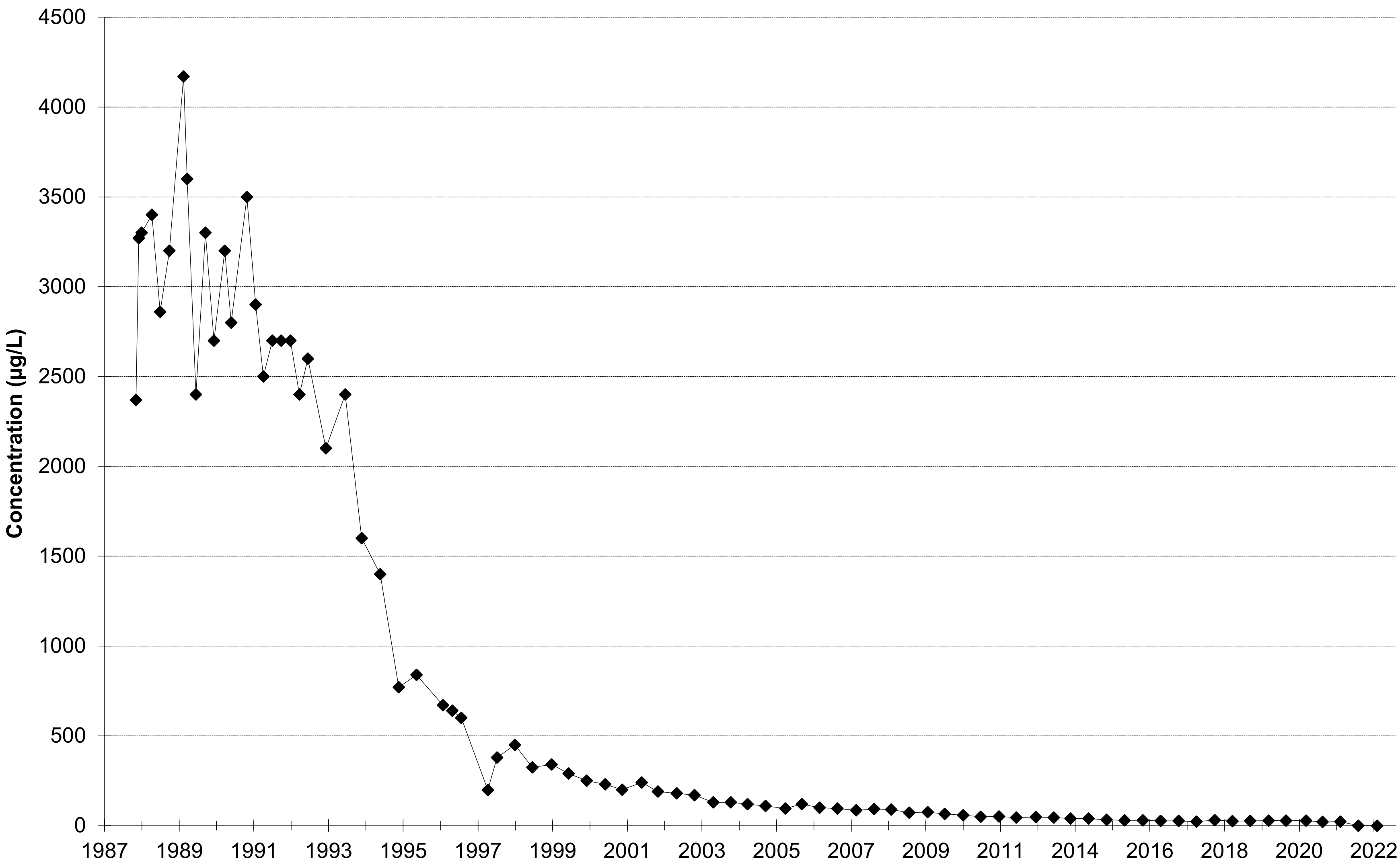


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B6 - TCE VS. TIME

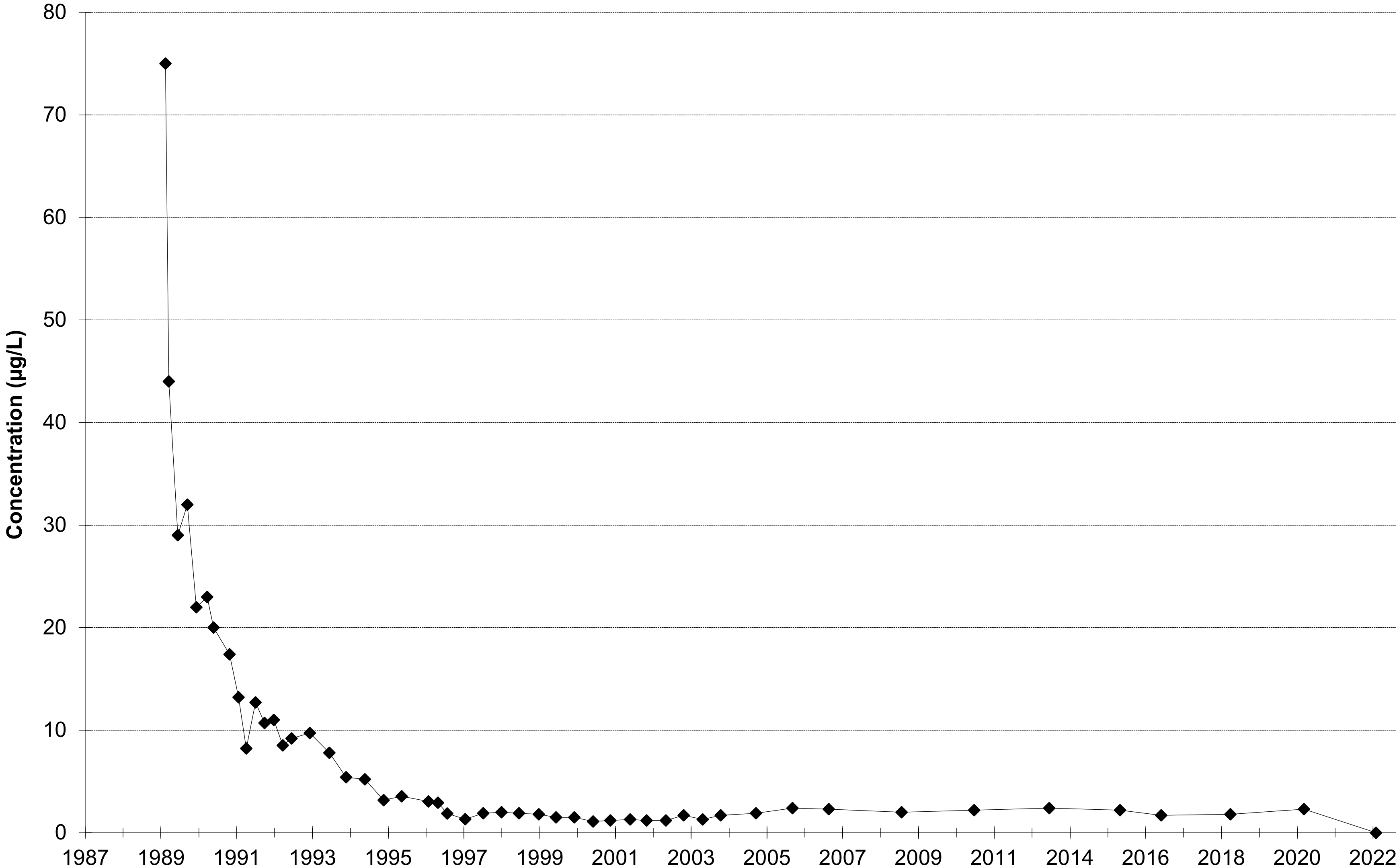


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B7 - TCE VS. TIME

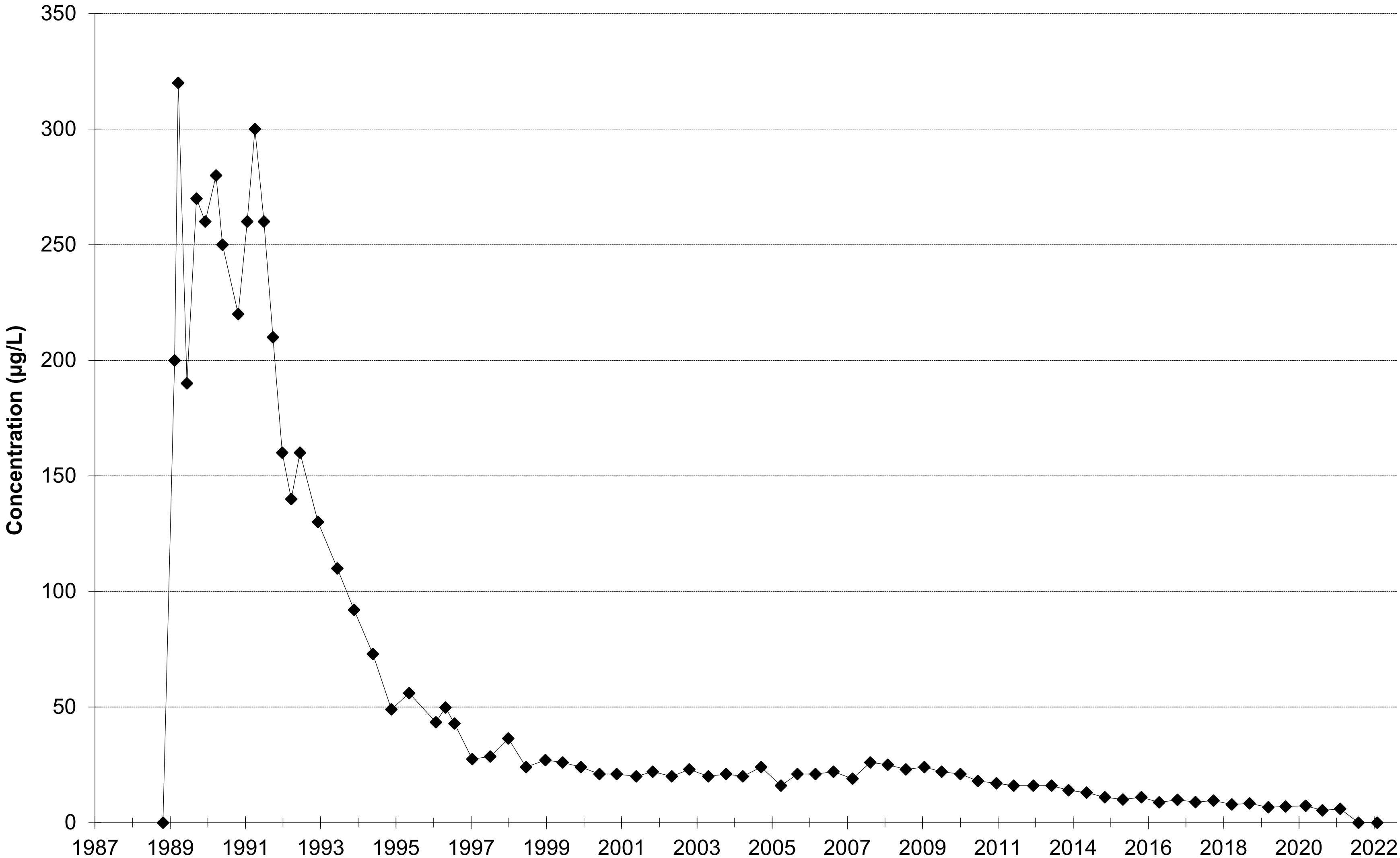


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B8 - TCE VS. TIME



Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

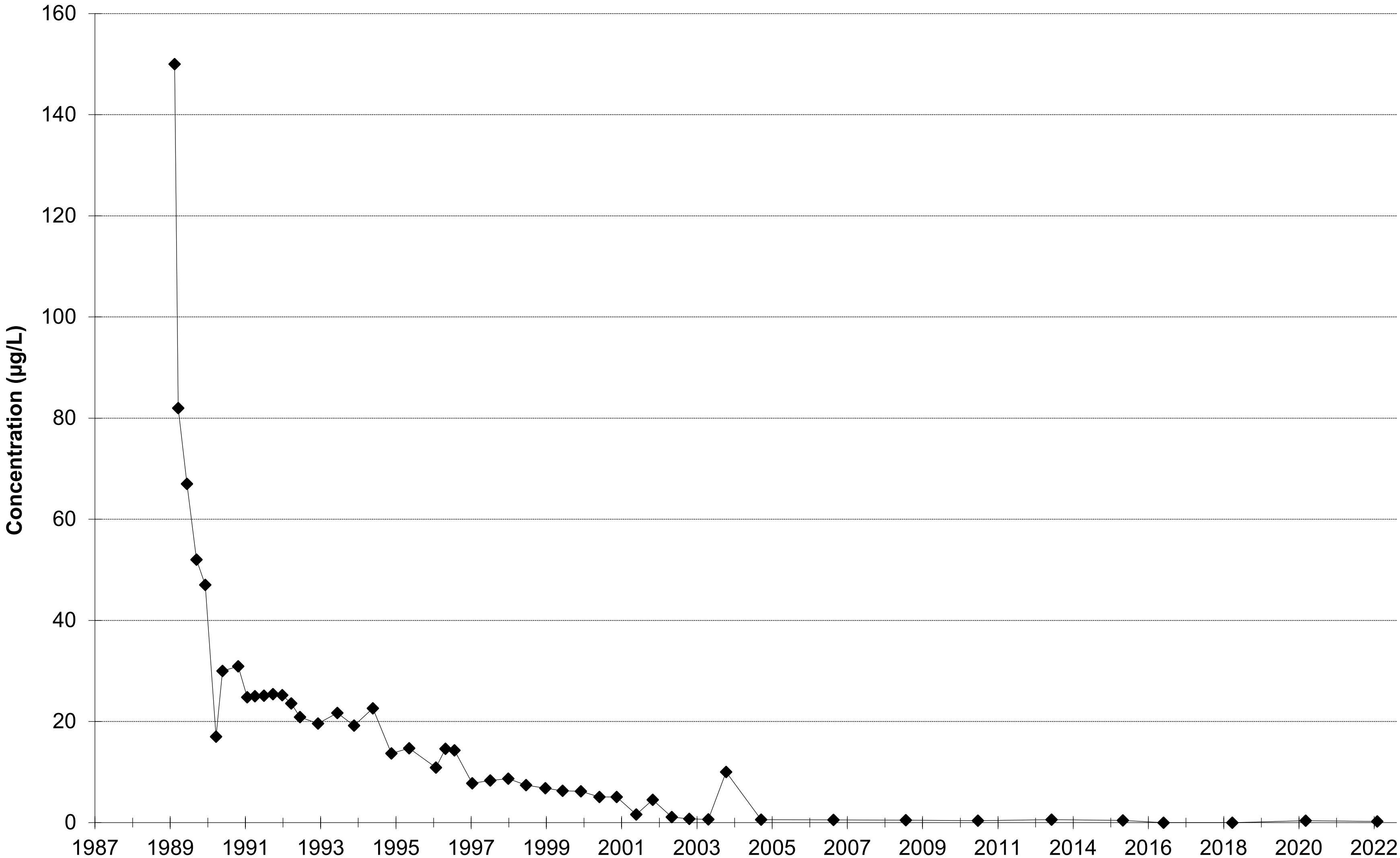
EXTRACTION WELL B9 - TCE VS. TIME

Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B10 - TCE VS. TIME

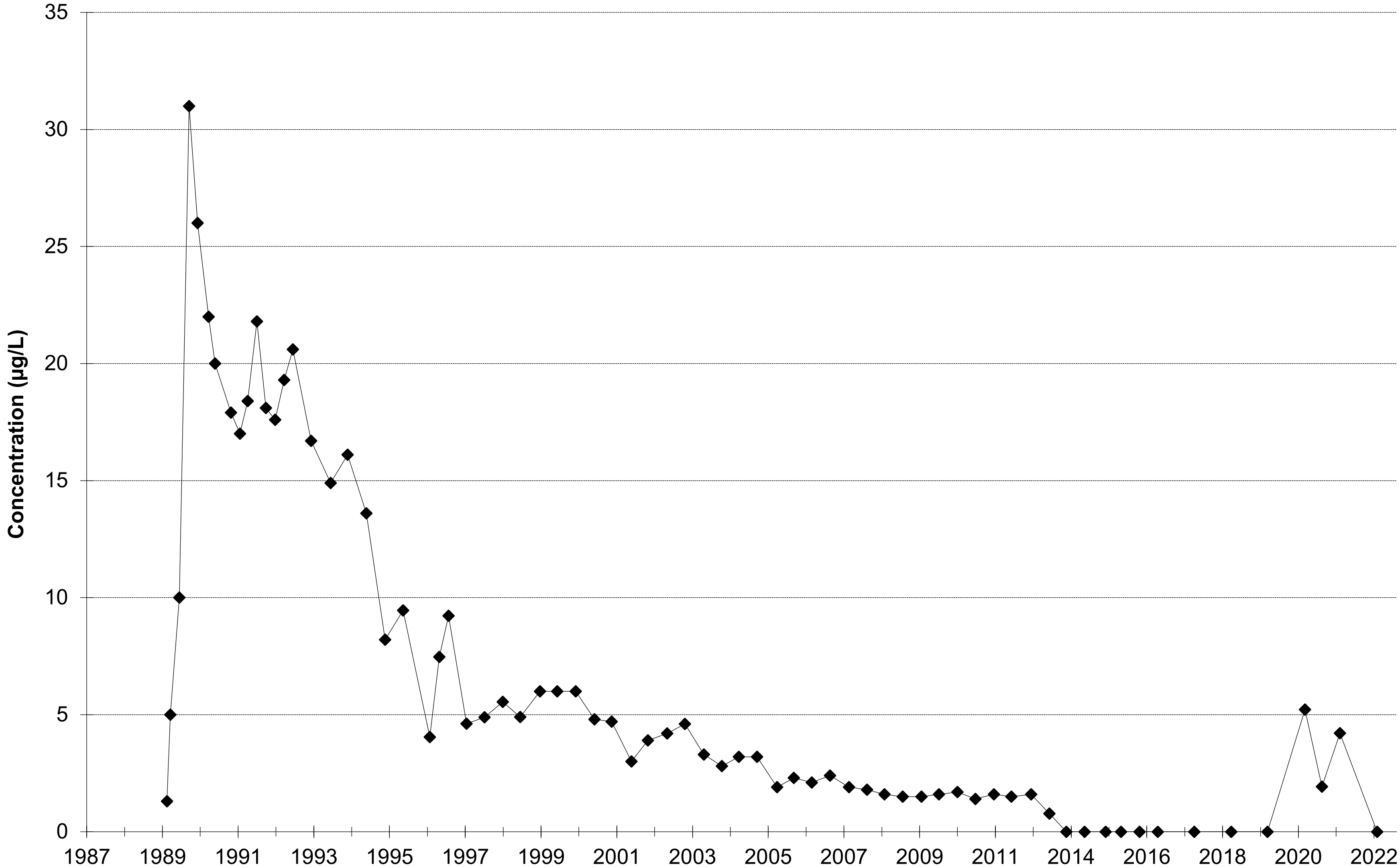


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B11 - TCE VS. TIME

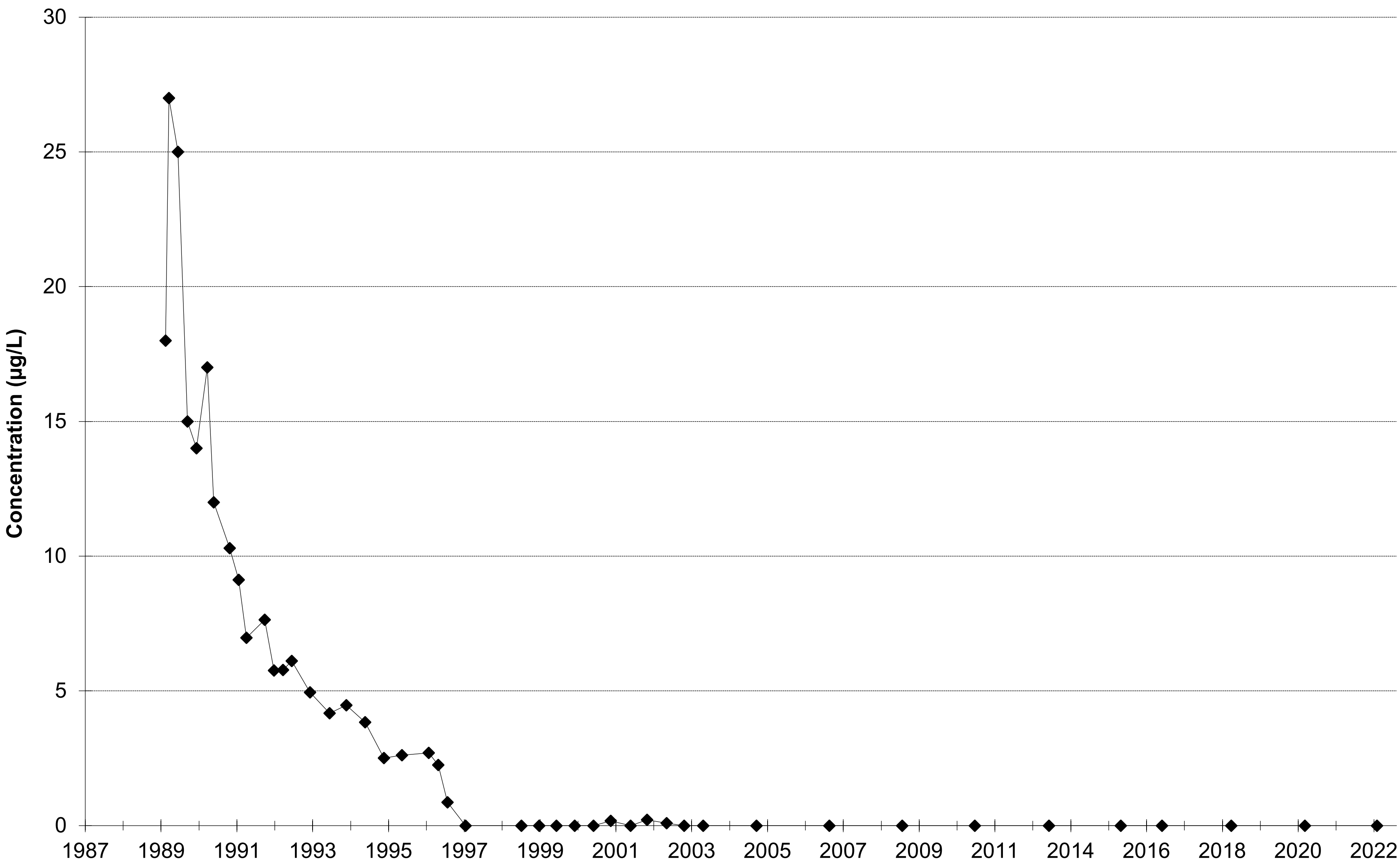


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B12 - TCE VS. TIME

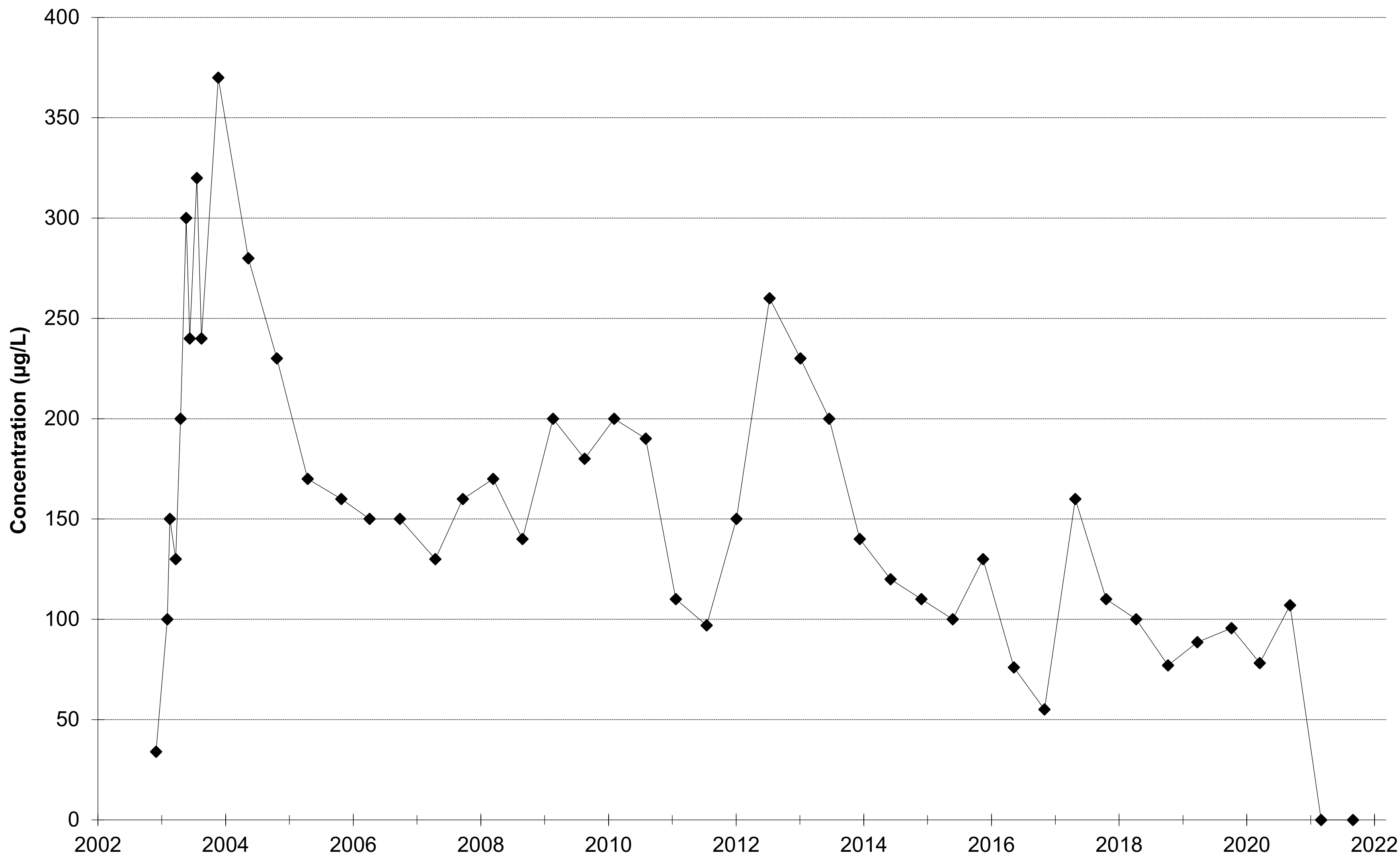


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL B13 - TCE VS. TIME

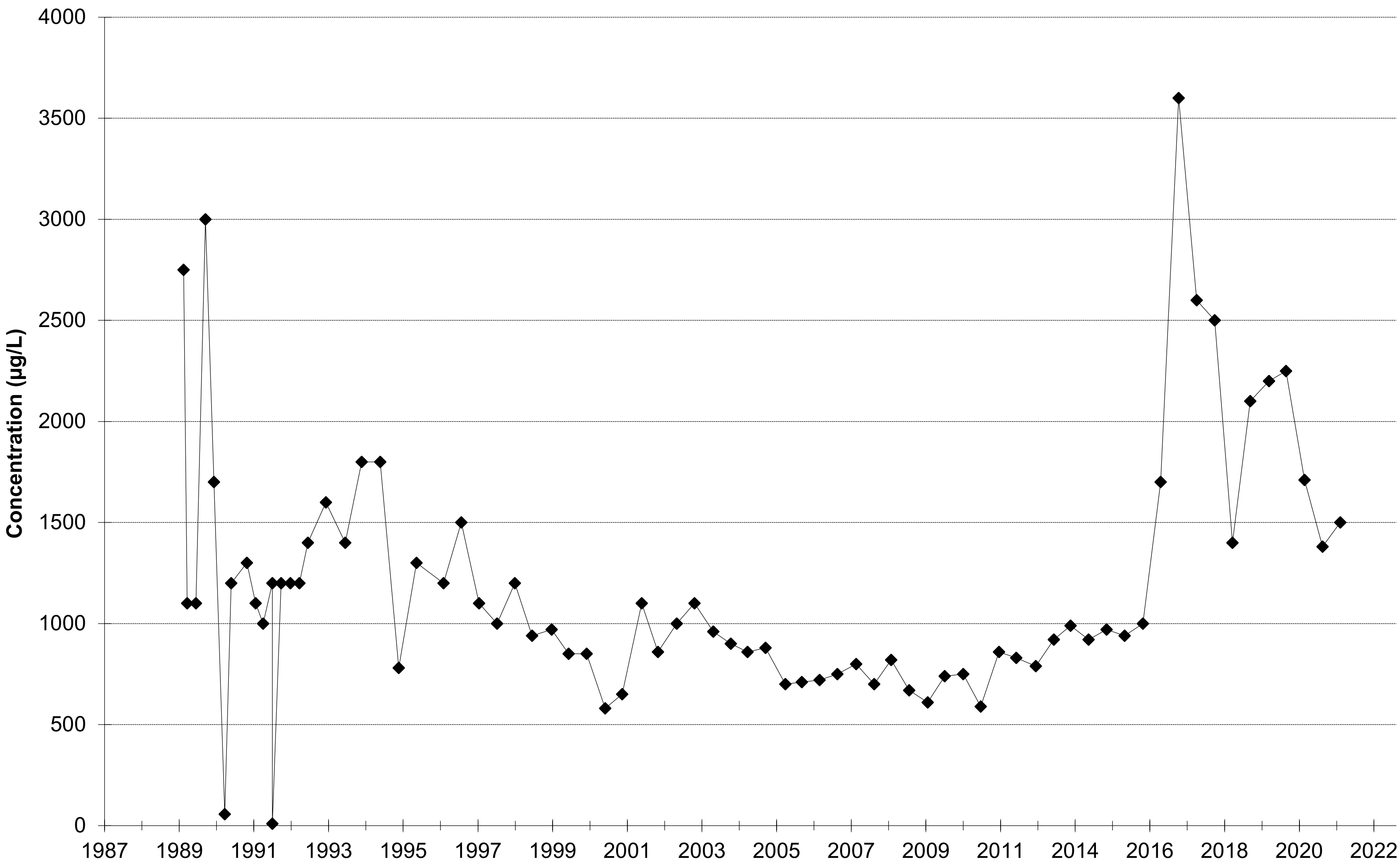


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL SC1 - TCE VS. TIME

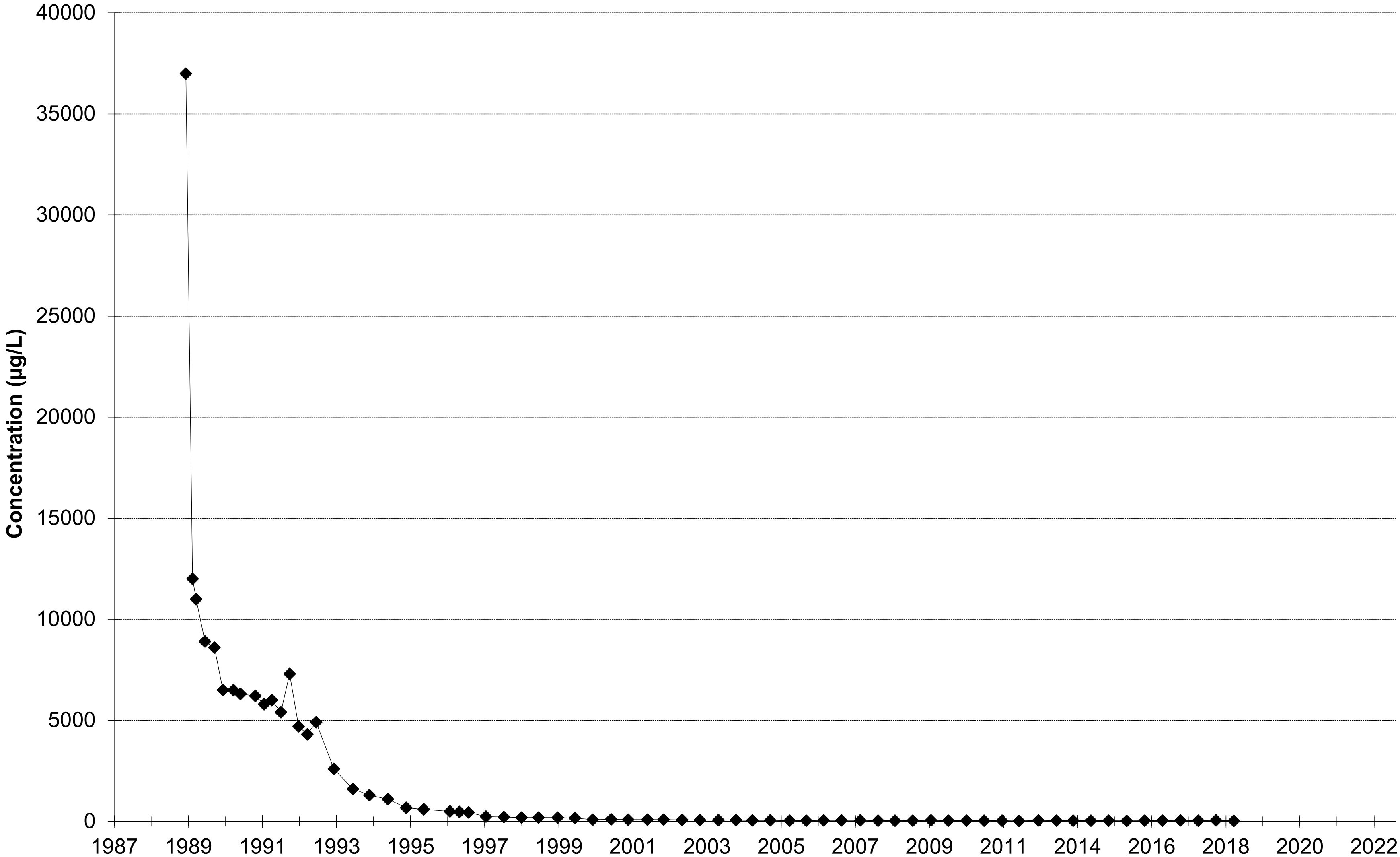


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL SC2 - TCE VS. TIME

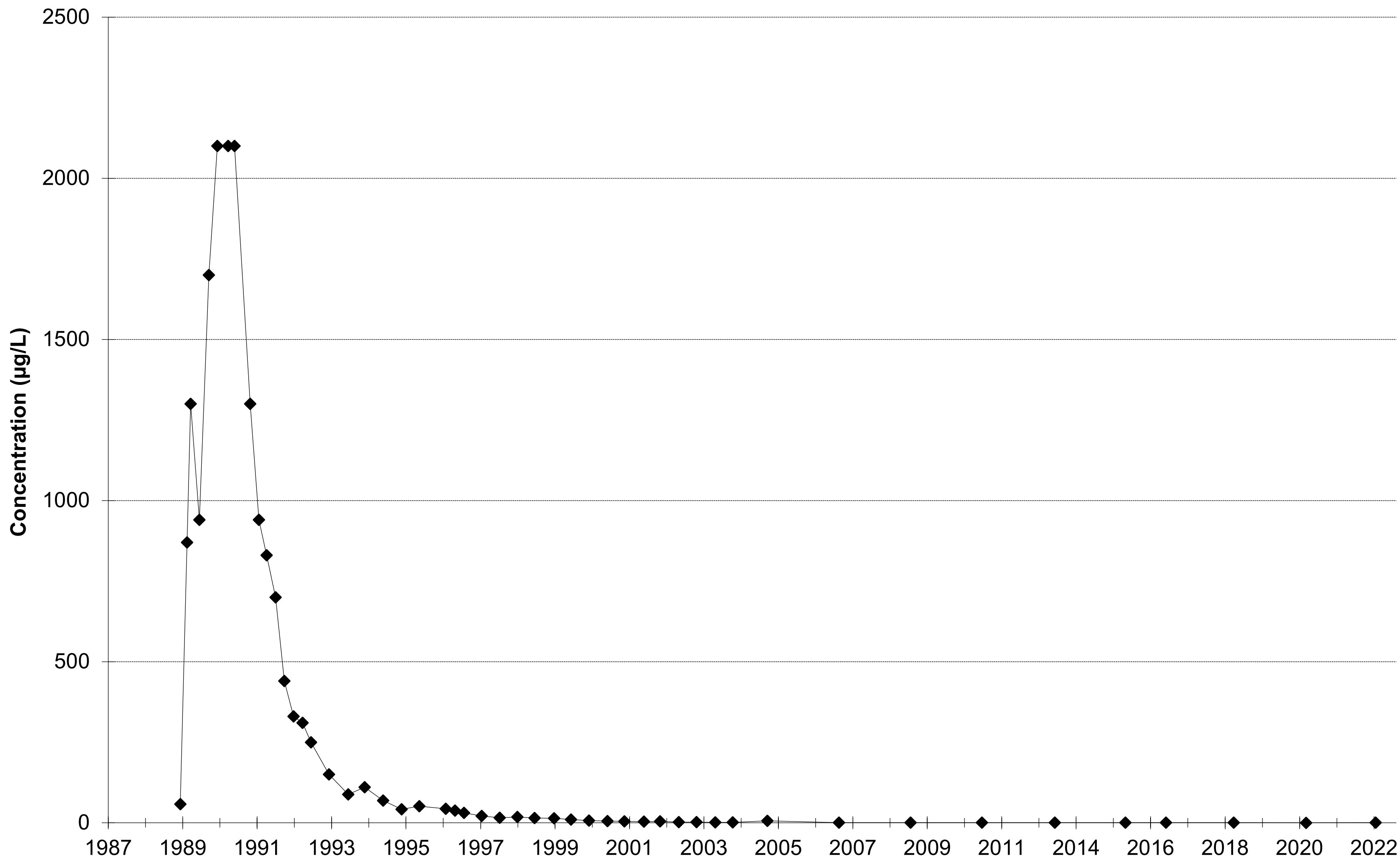


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL SC3 - TCE VS. TIME



Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

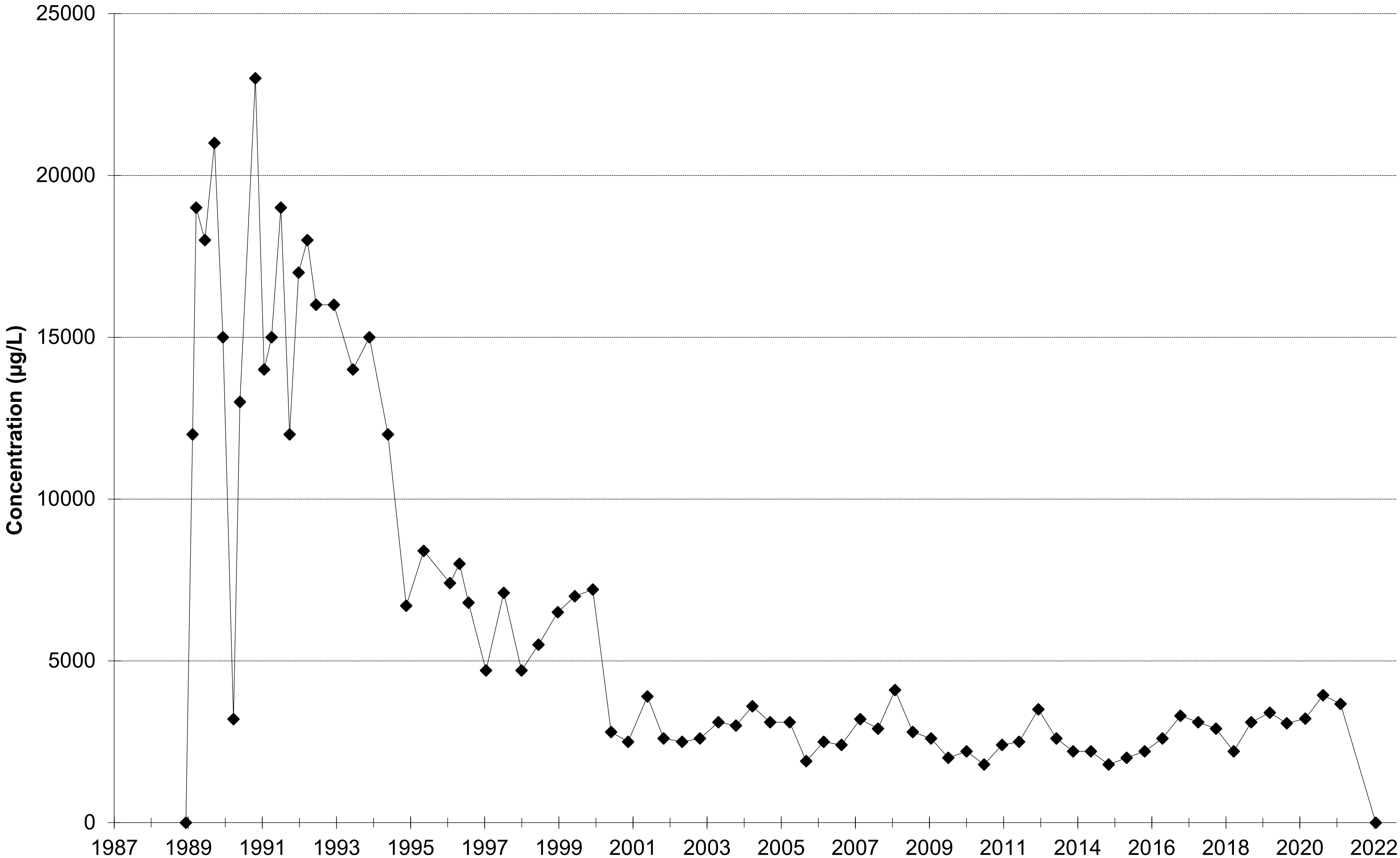
EXTRACTION WELL SC4 - TCE VS. TIME

Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

APPENDIX H.1

EXTRACTION WELL SC5 - TCE VS. TIME



Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 12594698 (1)

Appendix H.2

Influent/Effluent Database, Fiscal Year 2022, TGRS, OU2

Appendix H.2

Influent/Effluent Database
Fiscal Year 2022
TGRS - BGRS, 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	7.0	5.0	5.0
Location	Date		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TGRSE	10/08/2021		0.236 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.07 JL141JD25
TGRSE	11/15/2021		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.376 JP
TGRSE	11/15/2021	D	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.360 JP
TGRSE	12/10/2021		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.476 JP
TGRSE	12/10/2021	D	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.460 JP
TGRSE	01/14/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.364 JP
TGRSE	01/14/2022	D	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.435 JP
TGRSE	02/07/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.673 JP
TGRSE	03/04/2022		0.157 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.02
TGRSE	03/04/2022	D	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.01
TGRSE	04/06/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.19
TGRSE	04/06/2022	D	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.19
TGRSE	05/02/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.16
TGRSE	05/02/2022	D	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.20
TGRSE	06/06/2022		0.150 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.06
TGRSE	07/08/2022		0.162 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.38
TGRSE	07/08/2022	D	0.175 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.36
TGRSE	08/11/2022		0.170 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.27
TGRSE	08/11/2022	D	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.23
TGRSE	09/12/2022		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.335 JP
TGRSE	09/12/2022	D	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.378 JP

Appendix H.2

Influent/Effluent Database
Fiscal Year 2022
TGRS - BGRS, 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	7.0	5.0	5.0
Location	Date		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TGRSI	10/08/2021		31.4	1.66	2.52	< 1.00	2.56	1.20	176 JL141JD25
TGRSI	10/08/2021	D	36.7	1.91	2.97	< 1.00	2.85	1.29	201 JL141JD25
TGRSI	11/15/2021		1.38	0.899 JP	0.714 JP	< 1.00	1.31	0.956 JP	33.4
TGRSI	12/10/2021		1.97	0.857 JP	0.943 JP	< 1.00	1.34	1.35	41.8
TGRSI	01/14/2022		2.07	0.756 JP	1.18	< 1.00	1.26	0.812 JP	42.1
TGRSI	02/07/2022		9.56	2.05	1.93	< 1.00	1.29	1.06	74.2
TGRSI	02/07/2022	D	9.71	2.01	1.73	< 1.00	1.31	1.04	75.1
TGRSI	03/04/2022		23.5	1.97	2.11	< 1.00	1.44	1.24 JD21.3	110
TGRSI	04/06/2022		26.5	1.79	2.38	< 1.00	1.39	1.42 JC24.1	139
TGRSI	05/02/2022		27.7	1.79	2.54	< 1.00	1.01	1.01	127
TGRSI	06/06/2022		36.7	1.58	3.56	< 1.00	1.50	1.16	148
TGRSI	06/06/2022	D	35.0	1.52	3.85	< 1.00	1.59	1.17	146
TGRSI	07/08/2022		34.6	1.76	2.75	< 1.00	1.56	1.33	169
TGRSI	08/11/2022		35.6	1.82	2.83	0.118 JP	1.71	1.12	157
TGRSI	09/12/2022		1.93	0.999 JP	1.10	< 1.00	1.43	2.14	42.4

Notes:

(1) Cleanup levels for TGRS are from the OU2 ROD

D - Field Duplicate

JP - Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit

JL# - Result is qualified as estimated due to outlying LCS recovery. The following numerical value is the associated %LCS recovery.

JC# - Result is qualified as estimated due to outlying continuing calibration result. The following numerical value is the associated % D value.

JD# - Result is qualified as estimated due to outlying relative percent difference from matrix spike analyses. The following numerical value is the associated relative percent difference.

Appendix I

Maros Decision Matrix

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Appendix I

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 I-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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Appendix J

Historical Design and Evaluation Details

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Appendix J.1

OU1: Deep Groundwater

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU1 – DEEP GROUNDWATER

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)1 – Deep Groundwater, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities related to OU1 – Deep Groundwater.

The 1993 OU1 ROD (Army et al. 1993) was amended in 2006 (Army et al. 2006a) to formalize adoption of groundwater quality statistical analysis. In 2020, an ESD (Army 2020a) was approved for changes to the treatment system to add 1,4-dioxane as a contaminant of concern (COC).

In early 2015, Minnesota Department of Health (MDH) notified the City of New Brighton (New Brighton) 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 New Brighton Contaminated Groundwater Recovery System (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 (ND). 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 in 2015 exceeding the MDH HRL. NBCGRS ceased pumping operations from the shallow aquifer on 15 April 2015. The city switched to preferential extraction from deep aquifer wells and outside water sources while evaluating removal technologies. A pilot study report for advanced oxidation (AO) technology for treatment of 1,4-dioxane was completed in August 2016.

OU1 optimization activities were conducted in October and November 2020 to fill existing data gaps, improve the overall OU1 conceptual site model, and support future remedial optimization by determining if an additional NBCGRS extraction well is recommended to improve contaminant extraction and, if so, to identify a well location that will maximize contaminant mass removal. This work included a program of downhole hydrostratigraphic and groundwater quality profiling on existing OU1 wells. The scope of work consisted of geophysical logging and vertical aquifer profiling of wells under pumping conditions. A final report consisting of the findings and recommendations from these activities was completed and submitted in July 2021 (Army 2022a).

REFERENCES

U.S. Army (Army). 2022a. *Final Operable Unit 1 Optimization Deep Groundwater – Phase II Geophysics Field Summary Report.* January.

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 1993. *Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 1 Record of Decision.* September.

———. 2006a. *Record of Decision Amendment [#1] for Operable Unit 1 (OU1). New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* May.

Appendix J.2

OU2: Shallow Soil Sites

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – SHALLOW SOIL AND DUMP SITES

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU) 2 – Shallow Soil and Dump Sites, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities at the OU2 – Shallow Soil and Dump Sites.

The 1997 OU2 Record of Decision (ROD) and subsequent Amendments and Explanation of Significant Differences (ESDs) address the shallow soil and dump sites. Relevant modifications to the 1997 OU2 ROD (U.S. Army [Army], U.S. Environmental Protection Agency [EPA], and Minnesota Pollution Control Agency [MPCA] 1997) include Amendments #1 (2007), #3 (2009a), #4 (2012), #5 (2014), and ESD #2 (2009b).

Through the OU2 Remedial Investigation (RI)/Feasibility Study (FS) process, Sites A, C, E, H, 129-3, and 129-5 were found to have inorganic and/or organic contaminants of concern (COCs) above the cleanup goals specified in Table 1 of the 1997 OU2 ROD. Unpermitted landfills, or dumps, were identified within Sites A, B, E, H, and 129-15. The 1997 OU2 ROD (page 2) describes nine remedy components to address the shallow soil and dump sites.

<u>Remedy Component #1 through #9 – Soil Remediation</u>
The nine remedy components specified in the 1997 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 Primer/Tracer Area (PTA) Stormwater Ditch, the eastern portion of the 135 PTA, 535 PTA, Minnesota Army National Guard (MNARNG) Environmental Baseline Survey (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 OU2 ESD #2 (2009b) and OU2 ROD Amendment #3 (2009a), respectively.

<u>Remedy Component #10 – Land Use Controls</u>
OU2 ROD Amendments and ESDs established land use controls (LUCs) as part of the remedy for shallow soil and dump sites where impacts remain-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.

Initial implementation was done when EPA and MPCA provided consistency approval for an OU2 land use control remedial design (LUCRD) document. Implementation will continue indefinitely unless further action is taken that would allow for unlimited use and unrestricted exposure.

EPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and it has been implemented by the Army and revised as necessary.

REFERENCES

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 1997. *Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 2 Record of Decision.* December.

———. 2007. *Record of Decision Amendment [#1] for Operable Unit 2 (OU2), Site C-2. New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* July.

———. 2009a. *Record of Decision Amendment #2 for Operable Unit 2 (OU2): Site I Groundwater, New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* May.

———. 2009b. *Explanation of Significant Differences #2 for Operable Unit 2 (OU2), Changes for Soil Sites, New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* May.

———. 2012. *Record of Decision Amendment #4 for Operable Unit 2 (OU2), New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* January.

———. 2014. *Record of Decision Amendment #5 for Operable Unit 2 (OU2), New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* March

Appendix J.3

OU2: Deep Soil Sites

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – DEEP SOIL SITES

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)2 – Deep Soil Sites, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities at the OU2 Deep Soil Sites.

For purposes of the 1997 OU2 Record of Decision (ROD), Sites D and G were considered deep soil sites because volatile organic compound (VOC) impacts extended to depths between 50 and 170 feet (U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency 1997). Some additional shallow-soil contaminants of concern (COCs) were also present at Site D, and Site G also contains a dump. The 1997 OU2 ROD (pages 2 to 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
- 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 11 of the FY 2022 TCAAP APR) and is not discussed 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 COCs) 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 the OU2 ROD Amendment #3 (2009).

REFERENCES

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 1997. *Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 2 Record of Decision.* December.

———. 2009. *Record of Decision Amendment #3 for Operable Unit 2 (OU2), New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* May.

Appendix J.4

OU2: Site A Shallow Groundwater

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – SITE A SHALLOW GROUNDWATER

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)2 – Site A Shallow Groundwater, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities with OU2 Site A Shallow Groundwater.

Shallow groundwater at Site A has been impacted by volatile organic compounds (VOCs) and antimony. The selected remedy in the 1997 OU2 Record of Decision (ROD) incorporates the use of a groundwater extraction system, which began operation 31 May 1994 (U.S. Army [Army], U.S. Environmental Protection Agency [EPA], and Minnesota Pollution Control Agency [MPCA] 1997). 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 24 September 2008, while implementation of monitored natural attenuation (MNA) was being evaluated.

Source characterization work has been completed. Stone & Webster Environmental Technology & Services (Stone & Webster) performed investigation work in 1997 and the Final Site A Investigation Report (Stone & Webster 1997) was issued 12 December 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.”

Shaw Environmental and Infrastructure, Inc. (Shaw, formerly Stone & Webster) completed removal of metal-contaminated soils in FY 1999. Construction of an air sparging (AS)/soil vapor extraction (SVE) system to remediate VOC-contaminated soils was completed by Stone & Webster in FY 2000, and 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 a concern regarding potential plume spreading. The AS system was being implemented voluntarily by the Army and was not a 1997 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 21 August 2002. The Army submitted a work plan clarification to EPA 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 5-3 and 5-4 of the FY 2022 TCAAP APR 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.

The original eight-well groundwater extraction system that was selected in the 1997 OU2 ROD began operation 31 May 1994. On 11 July 2000, with regulatory approval, extraction wells 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, EPA and MPCA approved the

Site A Shallow Groundwater: 10-Year Evaluation Report (Wenck Associates, Inc. [Wenck] 2008a). The 10-Year Report was prepared to fulfill a requirement of the 1997 OU2 ROD, which states that for shallow groundwater impacts 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 impacts were 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 EPA and MPCA.

In September 2008, EPA and MPCA approved the Site A Shallow Groundwater: Monitoring and Contingency Plan (Wenck 2008b), and EW-1 through EW-4 (the "first line" of extraction wells) were shut off on 24 September 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 this APR, and thus any changes to monitoring and contingency actions must be approved by EPA and MPCA through revisions to this APR.

The decision to proceed with MNA was based in part on the EPA and MPCA natural attenuation study at the site (2000) and follow-up MPCA/EPA microcosm studies that have verified that abiotic degradation of VOCs in Site A groundwater is occurring at substantial rates. Such degradation acts to reduce COC mass and mobility by breaking down the COCs 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 11 November 2015 Technical Memorandum submitted by the Army that documented the FY 2015 monitoring results and recommended changing the remedy to MNA, EPA and MPCA approved changing the remedy to MNA in lieu of groundwater extraction and discharge. This change was approved in OU2 ROD Amendment #6 in early FY 2018. These extraction wells are included in the monitoring plan for Site A. Therefore, they will not be sealed.

As part of a Site A Work Plan approved in October 2020, the Army conducted an additional groundwater and soil vapor investigation in 2021 as a contingency action. Six direct-push locations were sampled, three new monitoring wells (01U905, 01U906, and 01U907) were installed and sampled, and soil vapor sampling was conducted. These results demonstrated that the Site A shallow groundwater plume was not affecting the residential community to the north and the soil vapor results showed that the constituents of concern were all below MPCA residential Intrusion Screening Values and did not pose a risk to receptors.

Remedy Component #1 – Groundwater Monitoring

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 is used as a monitoring point in place of 01U108 due to an obstruction that has prevented monitoring since FY 2017. As of the end of FY 2020, 01U108 had been abandoned. In addition, the three new wells installed during the FY 2021 groundwater investigation (01U905, 01U906, and 01U907) have been added to the monitoring plan detailed in Appendix A.1.

Remedy Component #5 – Source Characterization/Remediation
Source area characterization work has been completed. Stone & Webster Environmental Technology & Services (Stone & Webster) performed investigation work in 1997 and the Final Site A Investigation Report (Stone & Webster 1997) was issued 12 December 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 of source area soil contamination has been completed. Shaw Environmental and Infrastructure, Inc. (Shaw, formerly Stone & Webster) completed removal of metal-contaminated soils in FY 1999. Construction of an 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 a concern regarding potential plume spreading. The AS system was being implemented voluntarily by the Army and was not a 1997 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 21 August 2002. The Army submitted a work plan clarification to EPA 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 5-3 and 5-4 of the FY 2022 TCAAP APR 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.

REFERENCES

Shaw. Trench Closeout Report.

Stone & Webster Environmental Technology & Services (Stone and Webster). 1997. *Final Site A Investigation Report.* December.

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 1997. *Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 2 Record of Decision.* December.

———. 2018. *Record of Decision Amendment #6 for Operable Unit 2 (OU2), New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* January.

Wenck and Keres Consulting, Inc. (Wenck). 2008a. *Site A Shallow Groundwater 10-year Evaluation Report.* July.

———. 2008b. *Site A Shallow Groundwater: Monitoring and Contingency Plan.* September.

Appendix J.5

OU2: Site C Shallow Groundwater

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – SITE C SHALLOW GROUNDWATER

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)2 – Site C Shallow Groundwater, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities related to OU2 – Site C Shallow Groundwater.

In FY 1997, the U.S. Army Environmental Command (USAEC) 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. It 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. The OU2 ROD Amendment #1 (U.S. Army [Army], U.S. Environmental Protection Agency [EPA], and Minnesota Pollution Control Agency [MPCA] 2007) incorporated the existing groundwater extraction system as the final remedy, prescribes four major components of the remedy for Site C.

On 13 November 2008, the groundwater system was shut off (with regulatory approval) because 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 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 2008) and was approved by EPA and MPCA in November 2008. The OU2 ROD Amendment #1 (2007) prescribes four major components of the remedy, and until a decision is made to formally change the remedy, the original components of the OU2 ROD Amendment #1 (2007) 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 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 this APR, and thus any changes to monitoring and contingency actions must be approved by EPA and MPCA through revisions to the Annual Performance Report (APR).

At some point, the remedy could be formally changed. This change would presumably require an Explanation of Significant Difference, at a minimum, or possibly a ROD amendment. Evaluation in future APRs will ultimately determine whether EPA, MPCA, and the Army should formally change the remedy, or, should the concentrations observed during annual monitoring events decrease, if the site should be closed.

Remedy Component #4 – Land Use Controls
In FY 2021, a goat fence was constructed in Site C. Currently no goats are housed there.

REFERENCES

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 2007. *Record of Decision Amendment [#1] for Operable Unit 2 (OU2), Site C-2. New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* July.

Wenck and Keres Consulting, Inc. (Wenck). 2008. *Site C Groundwater Extraction System Evaluation Report.* November.

Appendix J.6

OU2: Site I Shallow Groundwater

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – SITE I SHALLOW GROUNDWATER

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)2 – Site I Shallow Groundwater, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities related to OU2 – Site I Shallow Groundwater.

Volatile organic compounds (VOCs) have been identified in Unit 1 (perched aquifer) at Site I. The selected remedy in the 1997 OU2 Record of Decision (ROD) consisted of four components: groundwater monitoring, groundwater extraction, Publicly Owned Treatment Works (POTW) discharge, and additional characterization (U.S. Army [Army], U.S. Environmental Protection Agency [EPA], and Minnesota Pollution Control Agency [MPCA] 2007). Work related to Site I shallow groundwater and deep groundwater are discussed in Section 7 and Section 11 of the FY 2022 Annual Performance Report (APR), respectively.

Site I additional investigation and Predesign Investigation 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 (SVE), 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. The OU2 ROD Amendment #2 (2009) revised the requirements for shallow groundwater to groundwater monitoring, additional characterization, and land use controls (LUCs).

<u>Remedy Component #1 – Groundwater Monitoring</u>
In 2013, EPA and MPCA approved the abandonment of all Site I (Building 502) Unit 1 monitoring wells prior to the demolition of Building 502. Because well 01U667 was not replaced in FY 2022, no groundwater sampling was conducted during FY 2021. Once reinstalled, monitoring well 01U667 will be sampled annually in accordance with the FY 2022 - FY 2026 Monitoring Plan (Appendix A.1).

<u>Remedy Component #2 – Additional Investigation</u>
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 OU2 ROD Amendment #2 (2009) removed the groundwater extraction and POTW discharge component of the remedy.

See APR Section 11 and Appendix J.10 for Site I deep groundwater details, including, but not limited to: subsurface investigations, source area extraction well (SC-1) operation and re-routing from the Building 116 Treatment System, and installation of additional source area extraction wells (SC-9, SC-10, SC-11) and their connection to and operation within the new Source Area Groundwater Recovery System .

REFERENCES

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 1997. *Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 2 Record of Decision.* December.

———. 2007. *Record of Decision Amendment [#1] for Operable Unit 2 (OU2), Site C-2. New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* July.

———. 2009. *Record of Decision Amendment #2 for Operable Unit 2 (OU2): Site I Groundwater, New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* May.

Appendix J.7

OU2: Site K Shallow Groundwater

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – SITE K SHALLOW GROUNDWATER

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)2 – Site K Shallow Groundwater, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities related to OU2 – Site K Shallow Groundwater.

Remedy Component #1 – Groundwater Monitoring

In FY 2014, 15 Unit 1 monitoring wells were permanently abandoned, as approved by U.S. Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) on 14 August 2013 and 7 May 2014. In FY 2017, one Unit 1 monitoring well (01U047) was permanently abandoned as approved by EPA and MPCA in September 2017 and will not be reinstalled once the redevelopment activities are completed.

In 2020, the Army requested the U.S. Geological Survey (USGS) Maryland-Delaware-DC Water Science Center conduct a groundwater treatability study to assess bioremediation as a destructive remedy for volatile organic compounds (VOCs) in the Site K groundwater plume. Initial field work began in November 2020 and continued in FY 2021. This work included the installation of new wells where former wells 01U608, 01U609, and 01U611 were previously located. These wells (01U608R, 01U609R, and 01U611R) have been added to the water level monitoring list and/or the annual water quality sampling list consistent with the pre-2014 requirements of the wells they replaced.

Remedy Component #2 – Sentinel Wells

Remedy Component #2 included the installation of sentinel wells at the bottom of Unit 1 and top of Unit 3." (OU2 ROD, page 3; U.S. Army, EPA, and MPCA 1997). The Upper Unit 3 sentinel well was installed in February 2000 to monitor potential VOC 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 liquid to migrate beneath the trench along the Unit 1/Unit 2 interface. These four piezometers are screened at that interface. Figure 8-1 of the FY 2022 TCAAP APR shows the location of the Upper Unit 3 sentinel well (03U621) and the piezometers.

The piezometers (Unit 1 sentinel wells) were sampled in March 2000, with results showing no dense non-aqueous phase liquid presence at the Unit 1/Unit 2 interface, as discussed in the FY 2000 APR (Wenck Associates, Inc. 2001). This was a one-time sampling event, as required by the EPA and MPCA-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 regulatory 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 Predesign Investigation Work Plan. Subsequently, the well was incorporated into the regular TCAAP monitoring plan.

Remedy Component #3 – Hydraulic Containment

In FY 2014, the Building 103 slab was removed as part of the site redevelopment activities.

Upgradient well (01U625C) is obstructed. The cause of the obstruction is unknown. An unsuccessful attempt was made to remove the obstruction in the spring of 2017 and 2018 and again in the spring of 2019. Well 01U625C is not critical in the collection trench flow evaluation. Historically, this well has maintained a similar groundwater elevation as 01U625B and 01U625D (Appendix D, Comprehensive Groundwater Quality And Groundwater Level Database). Based on FY 2016, FY 2017, FY 2018, FY 2019, and FY 2020 groundwater elevation data showing the return to typical levels, the abandonment of 01U625C, without subsequent replacement, is recommended.

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 01U627) 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.

Remedy Component #7 – Additional Investigation

Remedy component #7 included the additional characterization of the unsaturated Unit 1 soil. (OU2 ROD, page 3; Army, EPA, and MPCA 1997). This remedy component was completed in 2001 and no changes or additional actions are recommended. See Appendix J-7 for details.

Analysis of 1,4-dioxane was added to all regularly scheduled Site K monitoring wells in 2015 and 2016. Due to low 1,4-dioxane concentrations in Unit 1 wells (less than 1 microgram per liter [µg/L]), no Unit 1 wells were required to be sampled for 1,4-dioxane in FY 2017. Monitoring well 03U621, screened in the deeper Unit 3 aquifer, had a 1,4-dioxane concentration exceeding the HRL in FY 2015, FY 2016, FY 2017, FY 2018, FY 2019, and FY 2020.

Historical 1,4-Dioxane details

1,4-Dioxane sampling and analysis was requested in March 2015 by EPA and MPCA within 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. Monitoring well 03U621, screened in the deeper Unit 3 aquifer, had a 1,4-dioxane concentration exceeding the health risk limit (HRL) in FY 2015, FY 2016, FY 2017, FY 2018, FY 2019, FY 2020, and FY 2021.

REFERENCES

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 1997. *Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 2 Record of Decision.* December.

———. 2007. *Record of Decision Amendment [#1] for Operable Unit 2 (OU2), Site C-2. New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* July.

Wenck Associates, Inc. 2001. *Installation Restoration Program, Twin Cities Army Ammunition Plant, Fiscal Year 2000 Annual Performance Report.* November.

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Technical Memorandum

January 13, 2023

To	Dave Brown, NGSS Linda Albrecht, Army	**Tel**	612-990-5008
Copy to	Lisa Poole, GHD	**Email**	shawn.horn@ghd.com
From	Shawn Horn, GHD Brian Sandberg, GHD/mg/202	**Ref. No.**	039669-50
Subject	Hydraulic Containment Evaluation Site K TCAAP Site Arden Hills, Minnesota		

At the request of USEPA, an evaluation of hydraulic containment of TCE exceeding the clean-up level (30 µg/L) during lowest, average and highest groundwater elevations near the collection trench was conducted. For this evaluation, 01U615 was used to determine minimum, average and maximum groundwater elevations measured near the collection trench since 2001. Until recently, groundwater elevation measurements at 01U615 were only conducted annually during the months of May or June. Table 1 provides the annual groundwater elevation measurements at well 01U615 since 2001.

As shown, the lowest elevation from the data set occurred in 2009 (875.59 ft. amsl) and the highest in 2014 (883.71 ft. amsl). The average elevation from the data set is 878.84 ft amsl, which is similar to the elevation for June 2021 (878.66 ft. amsl). Attachment 1 provides the hydrogeologic cross sections for 2009, 2014 and 2021. As shown, hydraulic flow was toward the trench during those events.

Table 1 also provides the annual and May monthly (the month before the annual sampling event) extraction rates from the trench and the TCE concentrations from 01U615 and downgradient wells 01U603, 01U617 and 01U621). Review of the table clearly shows the following:

1. TCE concentrations at the 3 downgradient wells were all less than 1 µg/L until 2014 while upgradient well 01U615 had TCE concentrations ranging between 1,800 and 7,300 µg/L. During this 13-year period, 6 of the years reported average annual extraction rates less than 10 gpm including 2009 (when 01U615 experienced the lowest May/June elevation) that had an annual average extraction rate of 8.50 gpm.
2. In 2014, the historical high groundwater elevation at 01U615 (and at other Site K monitoring wells) also had a first time TCE detection at well 01U603 of 2,000 µg/L. Downgradient wells 01U617 and 01U621 continued to show non-detectable TCE concentrations (less than 1 µg/L).
3. TCE concentrations at 01U603 decreased since 2014 and all downgradient wells from the trench have been at or below the TCE clean up level of 30 µg/L since 2016. During this 7-year period, 5 of the years reported average annual extraction rates less than 10 gpm including 2021 (when 01U615 experienced the average May/June elevation) that had an annual average extraction rate of 6.31 gpm.

Based on the above, it is clear that the Site K TCE plume has been contained by the collection trench during nearly all ground water elevation conditions experienced at the site since 2001 (and likely before). The one notable exception was in 2014, when Site K experienced historically high ground water elevations in the spring. Attachment 2 provides a picture taken in April 2014 of the area around the Site K treatment building showing the significant flooding. Even then, no detectable concentrations of TCE were reported for wells 01U617 and 01U621 indicating that the collection trench was likely containing the southernmost portion of the plume at that time.

Regards,

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Encl.

The Power of Commitment

Table 1
Collection Trench Extraction Rates and Surrounding Well Information
Site K Hydraulic Containment Memo
TCAAP - Arden Hills, Minnesota

	Collection Trench			Upgradient of Trench		Downgradient of Trench		
FY	Annual Volume (gal)	Annual Average Extraction Rate (gpm)	May Average Extraction Rate (gpm)	June/May GWE @ 01U615 (ft. amsl)	TCE @ 01U615 (µg/L)	TCE @ 01U603 (µg/L)	TCE @ 01U617 (µg/L)	TCE @ 01U621 (µg/L)
2001	6,703,140	12.75	18.36	877.30	1,800	<1.0	<1.0	<1.0
2002	6,251,440	11.89	17.10	876.90	2,700	<1.0	<1.0	<1.0
2003	5,169,650	**9.84**	13.06	876.90	7,300	<1.0	<1.0	<1.0
2004	4,583,340	**8.70**	10.69	877.88	7,100	<1.0	<1.0	<1.0
2005	4,601,560	**8.75**	**9.29**	876.28	2,700	<1.0	<1.0	<1.0
2006	6,053,220	11.52	14.76	876.66	3,400	<1.0	<1.0	<1.0
2007	5,500,580	10.47	13.07	875.74	6,500	<1.0	<1.0	<1.0
2008	5,990,410	11.37	15.43	876.27	4,400	<1.0	<1.0	<1.0
2009	4,467,780	**8.50**	**8.48**	875.59 (1)	4,600	<1.0	<1.0	<1.0
2010	6,197,380	11.79	12.68	876.43	3,700	<1.0	<1.0	<1.0
2011	6,451,130	12.27	13.13	879.76	2,500	<1.0	<1.0	<1.0
2012	4,669,250	**8.86**	13.15	880.13	3,400	<1.0	<1.0	<1.0
2013	4,921,090	**9.36**	13.35	879.49	3,300	<1.0	<1.0	<1.0
2014	6,187,096	11.77	13.24	883.71 (2)	3,400	2,000	<1.0	<1.0
2015	5,444,776	10.36	10.46	880.60	2,400	1,200	<1.0	<1.0
2016	5,861,506	11.12	11.71	878.50	1,700	30	<1.0	<1.0
2017	5,370,496	10.22	11.36	880.96	1,200	<1.0	<1.0	<1.0
2018	4,667,972	**8.88**	10.22	879.12	1,500	5.1	<1.0	<1.0
2019	5,060,254	**9.63**	10.93	882.92	1,900	2.2	<1.0	<1.0
2020	5,227,133	**9.92**	11.01	882.91	1,360	1.24	<1.0	<1.0
2021	3,314,732	**6.31**	10.40	878.66 (3)	1,770	3.24	<1.0	<1.0
2022	3,469,396	**6.60**	10.06	881.79	2,230	2.7	<1.0	<1.0
Average	**5,280,151**	**10.04**	**12.36**	**878.77**				

Notes:
Bold font indicates extraction rate less than 10 gpm
(1) - Minimum Groundwater Elevation (2001-2022)
(2) - Maximum Groundwater Elevation (2001-2022)
(3) - Average Groundwater Elevation (2001-2022)

TCE Cleanup level - 30 µg/L

Attachments

Attachment 1

Groundwater Elevation Data & Hydrogeologic Cross Sections

Legend

- MONITORING WELL LOCATION
- ANNUAL MONITORING LOCATION
- UNIT 3 SENTINEL WELL
- NOT CONTOURED
- POTENTIOMETRIC SURFACE
- TRENCH LOCATION
- (882.89) GROUNDWATER ELEVATION (FEET AMSL)

NOTE:

1) WELL NOMENCLATURE: ERIS OR MN UNIQUE # NAME (COMMON NAME)
2) BUILDING 103 DEMOLISHED IN 2006; CONCRETE SLAB REMAINS

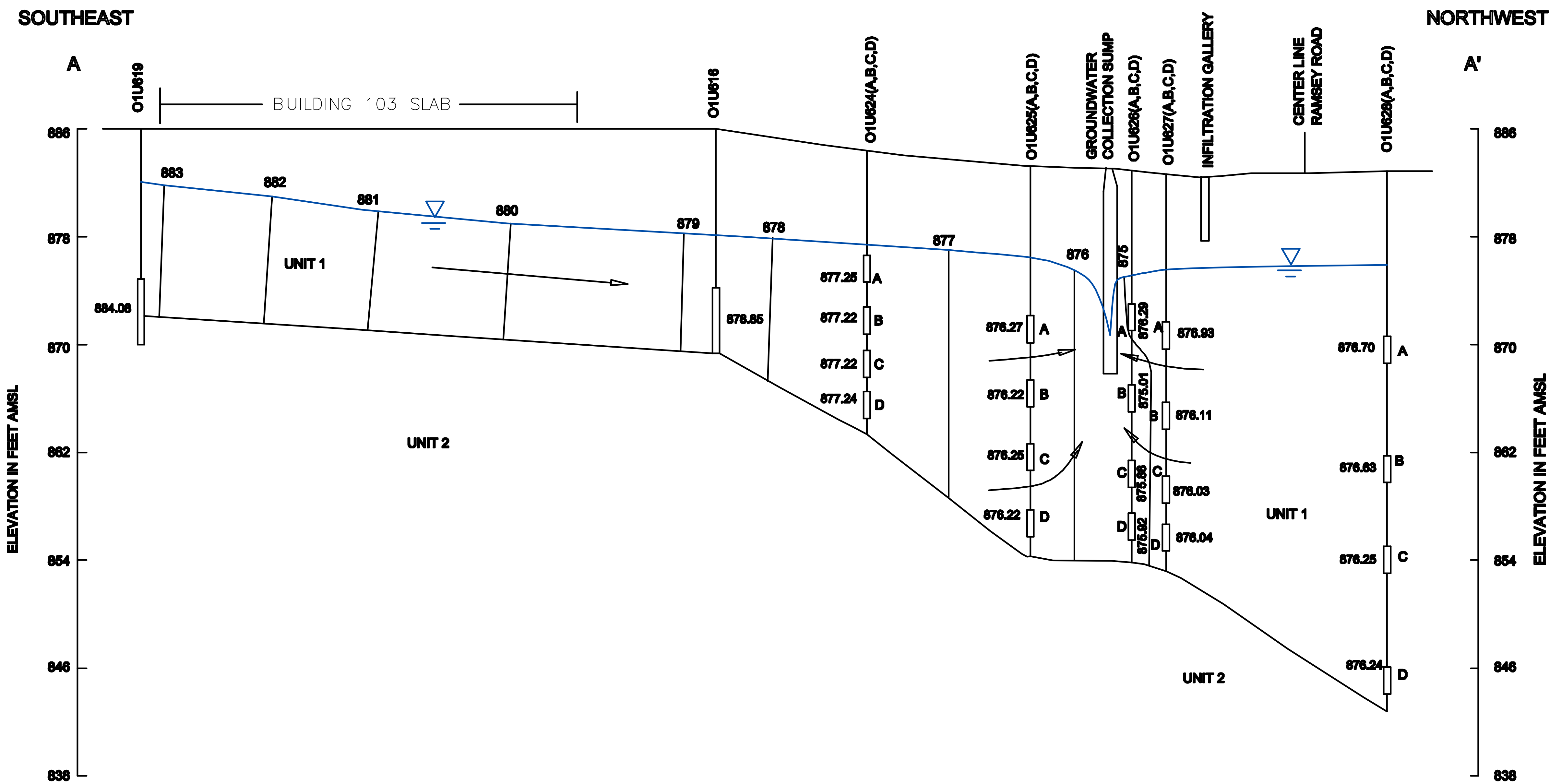
0 150 300 600 900 1,200
Feet

N

Geographic Information Systems

Stantec
4444 Centerville Road, Suite 140, White Bear Lake, MN 55127 Phone 651.653.9112 www.stantec.com

PREPARED FOR:				
ALLIANT TECHSYSTEMS TWIN CITY ARMY AMMUNITION PLANT ARDEN HILLS, MINNESOTA		SITE K, UNIT 1 AND UNIT 3 GROUNDWATER ELEVATION DATA 06/02/09		FIGURE: 9-2
JOB NUMBER: 182602056	DRAWN BY: TF	CHECKED BY: AG	APPROVED BY: AG	DATE: 12/14/09



LEGEND:

WATER TABLE

VERTICAL SCALE
1"=8'
8 16
APPROXIMATE SCALE (FEET)

HORIZONTAL SCALE
1"=40'
40 80
APPROXIMATE SCALE (FEET)

Geographic Information Systems

Stantec

4444 Centerville Road, Suite 140, White Bear Lake, MN 55127 Phone 651.653.9112 www.stantec.com

PREPARED FOR:				
ALLIANT TECHSYSTEMS TWIN CITY ARMY AMMUNITION PLANT ARDEN HILLS, MINNESOTA		SITE K HYDROGEOLOGIC CROSS SECTION A-A' 06/02/09 (Q103)		FIGURE: 9-3
JOB NUMBER: 182602056	DRAWN BY: TF	CHECKED BY: AG	APPROVED BY: AG	DATE: 12/14/09

LEGEND

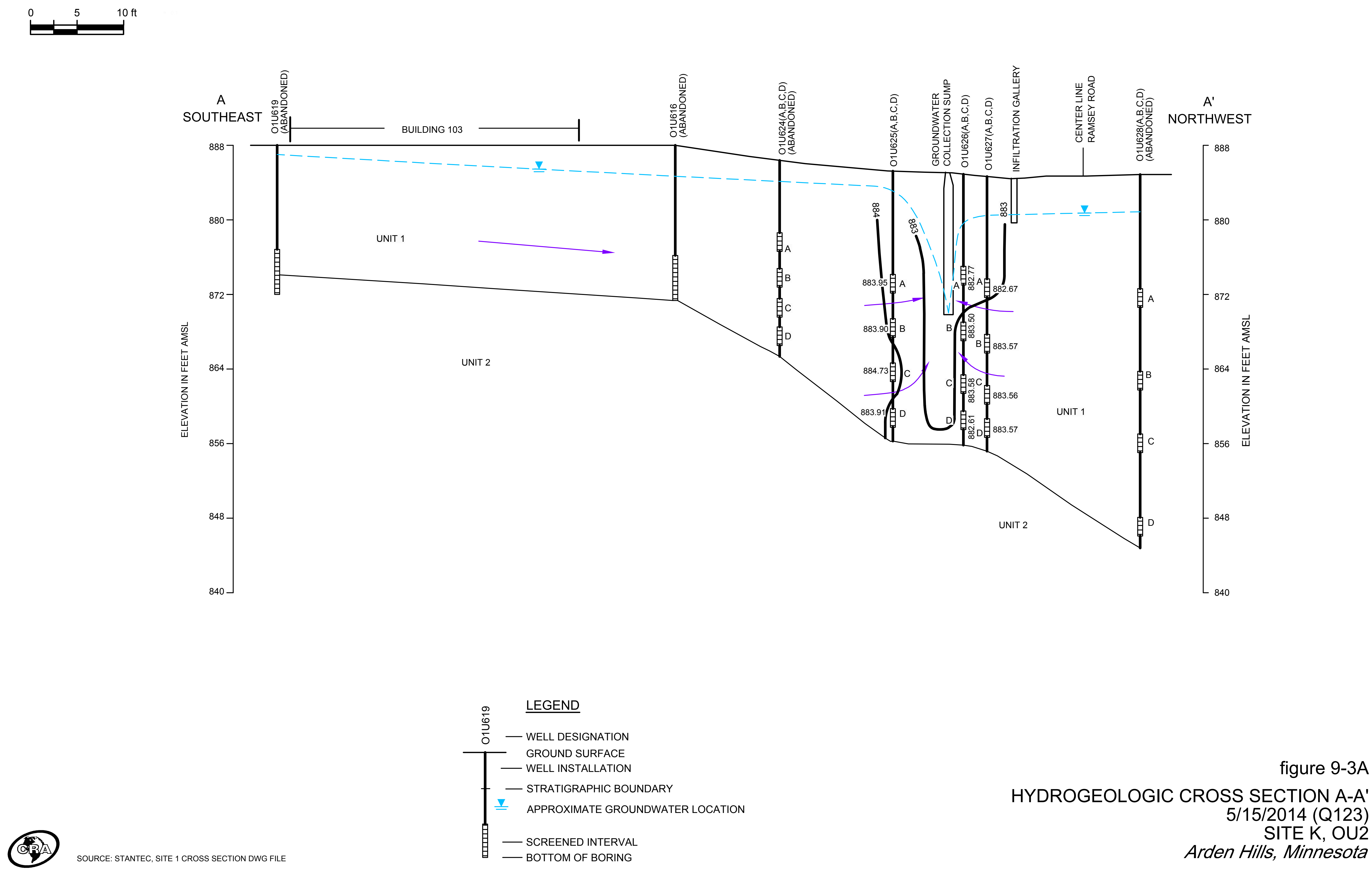
887.16	GROUNDWATER ELEVATION
*	NOT USED FOR CONTOURING
	GROUNDWATER ELEVATION CONTOUR
	ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION
	UNIT 3 SENTINAL WELL LOCATION
	SITE K COLLECTION TRENCH LOCATION

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

figure 9-2A

GROUNDWATER CONTOURS
UNIT 1 - MAY 15, 2014
SITE K, OU2
Arden Hills, Minnesota

039669-50(MEMO044)GIS-SP001 DEC 03/2015



SOURCE: STANTEC, SITE 1 CROSS SECTION DWG FILE

figure 9-3A

HYDROGEOLOGIC CROSS SECTION A-A'
5/15/2014 (Q123)
SITE K, OU2
Arden Hills, Minnesota

NOTES

882.16	GROUNDWATER ELEVATION
*	NOT USED FOR CONTOURING (UNIT 3 WELL)
#	NOT USED FOR CONTOURING (COLLECTED ON 8/9/2021)
(873.96)	BUILDING 102 ELEVATION (COLLECTED ON 9/15/2021)

BUILDING 103 DEMOLISHED IN 2006; CONCRETE SLAB REMOVED IN 2014

Paper Size ANSI B

0 40 80 120

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet

N

GHD

SITE K, OU2
ARDEN HILLS, MINNESOTA

GROUNDWATER CONTOURS
UNIT 1 - 1 JUNE 2021

Project No. 12563220-43
Revision No. -
Date 01/07/2022

FIGURE 8-2

Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP004.mxd
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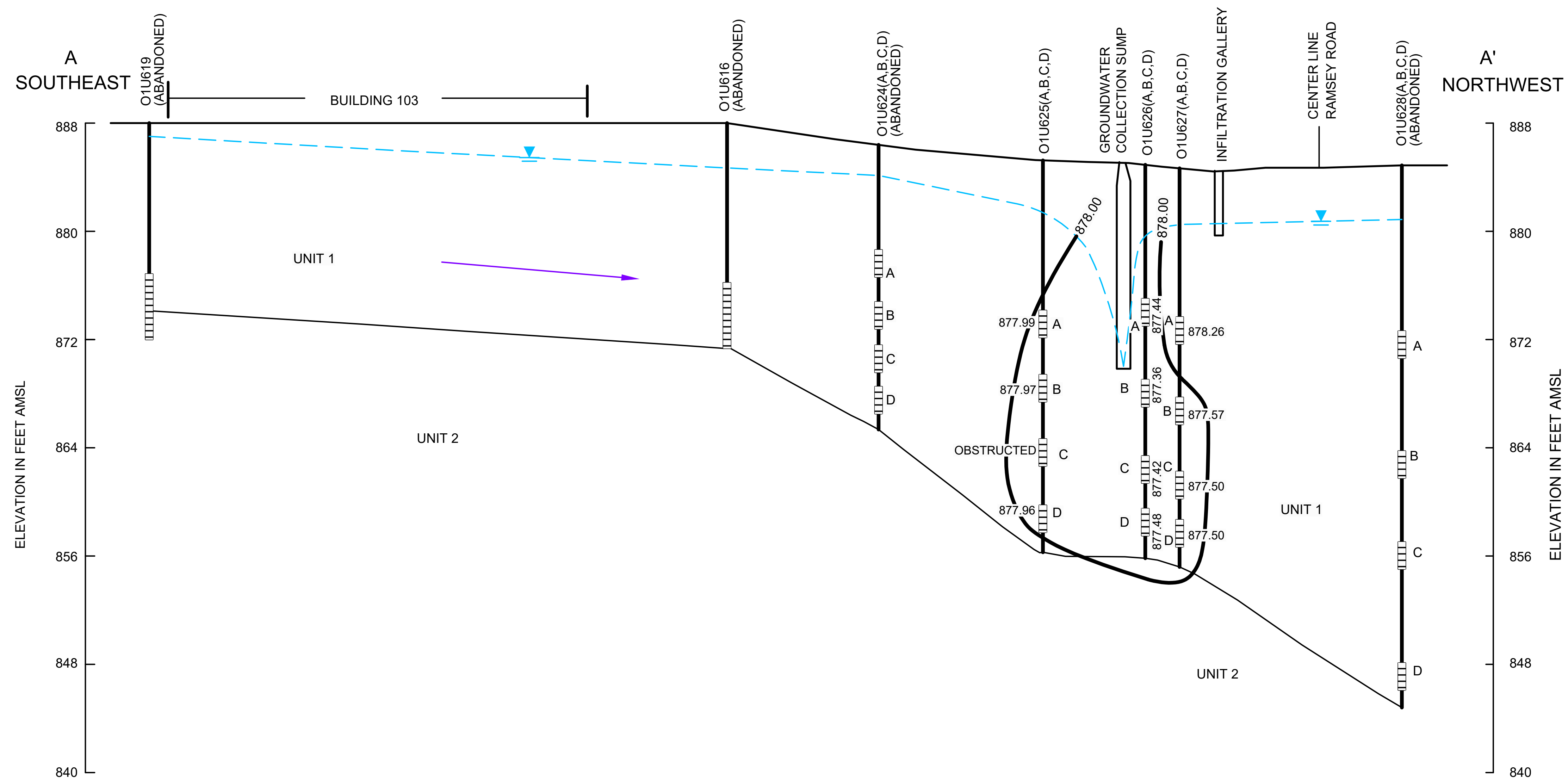

LEGEND

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

HORIZONTAL
1" = 10 ft
0 5 10Ft

0 5 10Ft
1" = 10 ft
VERTICAL

SITE K, OU2
ARDEN HILLS, MINNESOTA

Project No. **12563220**
Date **January 2022**

HYDROGEOLOGIC CROSS-SECTION A-A'
1 JUNE 2021

Figure 8-3

Filename: N:\US\St Paul\Projects\563\12563220\Digital_Design\ACAD\Figures\RPT001\12563220-GHD-0000-RPT-EN-0102_WA-001.DWG
Plot Date: 07 January 2022 10:46 AM

Attachment 2

2014 Site K Flooding Photograph

Appendix J.8

OU2: Building 102 Shallow Groundwater

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – BUILDING 102 SHALLOW GROUNDWATER

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)2 – Building 102 Shallow Groundwater, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities related to OU2 – Building 102 Shallow Groundwater.

The former Building 102, shown on Figure 9-1 of the FY 2022 TCAAP APR, 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 impact was discovered emanating from beneath Building 102 (discovered during the Phase I and Phase II Environmental Site Assessment in support of a 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 U.S. Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) in FY 2006. The U.S. Army (Army) then proceeded to address the remedy for Building 102 shallow groundwater as a non-time critical removal action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). To support the Engineering Evaluation/Cost Analysis, additional groundwater investigation was conducted in FY 2007 and FY 2008 to further define the extent and magnitude of groundwater impacts. Delineation was completed and contaminants of concern (COCs) were identified, including trichloroethene (TCE) and related chlorinated VOCs (TCE was found to be degrading to *cis*-1,2-DCE and vinyl chloride through abiotic degradation). The Engineering Evaluation/Cost Analysis documenting the additional investigation work and recommending a remedy for Building 102 shallow groundwater was approved by EPA and MPCA in FY 2008.

The Army Action Memorandum documenting the final remedy selection for Building 102 groundwater monitored natural attenuation (MNA) was signed in FY 2009. The remedy also includes land use controls (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). The OU2 ROD Amendment #4 (2012) formally documented selection of MNA and LUCs for the Building 102 groundwater remedy and thereby added this site to the OU2 remedy. Table ES-2 of the FY 2022 TCAAP APR, provides a summary of remedy components, performance standards, and compliance with the ROD.

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

<u>Remedy Component #2 – Groundwater Monitoring</u>

Following the sampling of 1,4-dioxane at Building 102 from FY 2015 through FY 2019, it was determined that it was not a COC in Building 102 shallow groundwater. Monitoring for 1,4-dioxane was discontinued at Building 102 beginning in FY2020.

Remedy Component #4 – Overall Remedy for Building 102 Shallow Groundwater

As part of Ramsey County's site redevelopment work, Ramsey County relocated a section of Rice Creek to create more space for construction of a new I-35W/County Road H interchange. The relocation work, which took place in early 2016, 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. Groundwater 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. 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 – April 2020 Sampling Event for the Rice Creek remeander, TCAAP Redevelopment" to Arcadis in January 2021. According to quarterly groundwater monitoring performed at Building 102 beginning in March 2017 after completion of the remeander through April 2020, there appear to be no impacts to groundwater quality. Ramsey County wells sampled in this event include 01URC1D, 01URC1S, 01URC2D, and 01URC2S. Vinyl chloride was detected in 01URC1D during the March 2017 event at a concentration of 0.058 microgram per liter (µg/L) and at a concentration of 0.086 µg/L during the August 2018 event, which are well below the MDH HRL of 0.2 µg/L. 01URC1D also had low level detections of cis-1,2-DCE in February 2018, August 2018, May 2019, and April 2020; concentrations were 5.7 µg/L, 2.9 µg/L, 1.9 µg/L and 2.2 µg/L, respectively, which are below the Minnesota Department of Health, health risk limit of 6 µg/L. As of the April 2020 groundwater monitoring event, there was no apparent change in the Building 102 plume configuration or groundwater flow. Bay West has recommended ceasing groundwater monitoring of the Rice Creek remeander monitoring wells as part of the FY 2020 reporting. For a more detailed summary of the Rice Creek remeander groundwater monitoring, refer to Bay West, 2020.

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 regulatory approval) due to installation of a storm water control basin. Ongoing efforts will be made by the Army to address any issues resulting from Ramsey County's development plans.

REFERENCES

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 2012. *Record of Decision Amendment #4 for Operable Unit 2 (OU2), New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* January.

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Appendix J.9

OU2: Aquatic Sites

HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – AQUATIC SITES

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)2 – Aquatic Sites, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities related to OU2 – 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 EPA and MPCA 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. Following comments to the draft FS, it was agreed by the Army 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, EPA 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, EPA, 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 10-1.

EPA 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 (2012), which documents selection of the recommended alternative, was signed in January 2012. The most recent revision, LUCRD Revision 6, was approved by EPA and MPCA in October 2020. This revision documents the partial delisting of soil, surface water, and sediment (not groundwater) at five aquatic sites located within OU2 (Rice Creek, Sunfish Lake, Marsden Lake North, Marsden Lake South, and Pond G).

EPA and MPCA provided consistency for the Pond G Remedial Design/Remedial Action Work Plan in March 2012, and the pond was treated in June 2012. The pond surface water was then monitored in FY 2012 and FY 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 Report 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 Comprehensive Environmental Response, Compensation, and Liability Act (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 Five-Year Reviews are not required for Pond G and as noted above, there are no monitoring or LUC requirements.

REFERENCES

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 2012. *Record of Decision Amendment #4 for Operable Unit 2 (OU2), New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota.* January.

U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM). 2004. *Tier II Ecological Risk Assessment Report, Twin Cities Army Ammunition Plant, Arden Hills, Minnesota*. December.

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Appendix J.10

OU2: Deep Groundwater – TGRS

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HISTORICAL DESIGN AND EVALUATION DETAILS
OU2 – TGRS DEEP GROUNDWATER

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)2 – Twin Cities Army Ammunition Plant Groundwater Recovery System (TGRS) Deep Groundwater, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year 2022 Annual Performance Report (APR), is to provide historical context for activities at the OU2 site.

Historical design has been previously discussed in various APRs to date. As a summary, an Interim Response Action Plan for TCAAP (U.S. Environmental Protection Agency [EPA] 1987) was prepared providing specific criteria for the Boundary Groundwater Recovery System which started on 19 October 1987. Initially operated as six extraction wells on the southwest OU2 boundary, the Boundary Groundwater Recovery System 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 trichloroethene (TCE) mass migrating from OU2 towards OU1 based on a 5 micrograms per liter (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 2021, the TGRS operates with ten wells including eight boundary extraction wells and two 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.

In FY 2003, the U.S. Army received regulatory 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 TGRS Global Operating Strategy (GOS) for the entire TGRS extraction system and a Micro Operating 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.

In 2013, the Minnesota Safe Drinking Water Limit (the health risk limit [HRL]) for 1,4-dioxane (an emerging contaminant of concern [COC]) was reduced from 30 µg/L to 1 µg/L. In early 2015, 1,4-dioxane was detected in New Brighton's water supply above the HRL. In March 2015, EPA and Minnesota Pollution Control Agency (MPCA) requested sampling and analysis for 1,4-dioxane to be included in 2015 and 2016 TCAAP groundwater sampling events at OU1, OU2, and OU3 monitoring and extraction wells. All locations sampled except two of the extraction wells (B1 and B11) had 1,4-dioxane concentrations exceeding the HRL. Samples collected from the TGRS influent and effluent indicated that no 1,4-dioxane concentration reduction was accomplished by the treatment system.

In 2017, the Army performed a remedy review with EPA and MPCA. The highest 1,4-dioxane concentrations were observed in wells near Site G at concentrations greater than 200 µg/L. Water impacted by 1,4-dioxane had historically been discharged from the TGRS treatment system at concentrations less than 20 µg/L to the gravel pit upgradient of Site K. Lesser concentrations have been identified on the western portion of the site, including at Site K (as described in Section 8 of the FY 2022 TCAAP APR).

Operation of the TGRS remedy has been effective in reducing COC concentrations at nearly all OU2 monitoring wells by more than 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.

A remedy review was conducted and approved by the regulators in June 2018 that presented the conceptual plan for improving containment in the source areas with additional extraction wells and installing a new treatment system targeting source area contamination. As a result, the Explanation of Significant Difference (ESD) #3 document dated 15 October 2020, was prepared to address the addition of 1,4-dioxane as a COC and remedial technologies to treat 1,4-dioxane. The ESD #3 (Army 2020) document lists the following improvements for the deep groundwater remedy:

- Installation of new source area extraction wells at Site D, Site G, and Site I
- Routing of the new source area extraction wells and one existing source area extraction well to a new advanced oxidation system, to remove and treat 1,4-dioxane and TCE
- Routing of the effluent from the Source Area Groundwater Recovery System (SGRS) to a co-located new air stripper to remove residual volatile organic compound (VOC) contaminants
- Discharge of the treated groundwater from the SGRS to the gravel pit

The Army completed subsurface investigations at Sites D, G and, I in 2020 and 2021. Seven new source area extraction wells were installed and, together with two existing wells (SC-1 and SC-5) form the source area groundwater extraction network that will be routed to the new SGRS treatment system where 1,4-dioxane and TCE will be removed prior to combining with TGRS effluent and discharging to the sand and gravel pit. As a result of SGRS extraction and treatment, 1,4-dioxane (and VOC) loading into the existing air stripping treatment system and gravel pit discharge will be reduced which, in turn, will eventually decrease 1,4-dioxane concentrations in groundwater across the site.

During FY 2021, the new SGRS was designed (with 100 percent design drawings issued in July 2021), and was under construction during 2022 until undergoing intermittent startup operations beginning in August 2022. Once completed, the SGRS will be a component of the TGRS.

TGRS MODIFICATIONS

As of September 2019, the TGRS has operated with ten wells including eight boundary extraction wells and two source control wells with treated effluent discharged to the gravel pit where it recharges overburden sands. Extraction well SC2 has been shut down since September 2018 (with agency approval) and is intended to be replaced as part of the TGRS improvements planned during FY 2022.

Remote connectivity control equipment began operating during FY 2021 to allow the remote monitoring of the TGRS and all operating extraction wells except SC1, B3, and B13 that are monitored manually.

As stated earlier, the SGRS is currently under construction with an estimated completion date of June 2022. Once completed, the combined groundwater extraction and treatment for on-site Deep Groundwater within OU2 will consist of the following:

- Nine operating source area groundwater extraction wells for enhanced contaminated mass removal at Site D, Site G and Site I
- One source area groundwater treatment system using advanced oxidation for treatment of 1,4-dioxane and TCE, and air stripping for treatment of residual VOCs
- Seven operating groundwater extraction wells along the southwestern portion of the property boundary for supplemental hydraulic containment, as needed
- One air stripping system to treat low VOC concentration boundary groundwater.

These modifications will result in increased mass removal of VOCs, destruction of 1,4-dioxane and more efficient hydraulic containment of the source areas. Long-term operating conditions of the full system will be determined after the SGRS is completed and tested. For more detailed discussion on historical modifications refer to previous APRs.

SUMMARY OF OPERATIONS

Previous APRs denote the Summary of Operations. As of 2021, the TGRS operates with ten wells including eight southwestern boundary extraction wells (B1, B3, B4, B5, B6, B8, B9, and B13) and two source control wells downgradient of interior OU2 source areas (SC1 and SC5). The TGRS layout is presented on Figure 11-1 of the FY 2022 TCAAP APR.

On 6 September 2018, GHD (on behalf of the Army) submitted an email to EPA and MPCA requesting to discontinue pumping at SC2 because of extensive maintenance due to fouling (the well was down since July 2018) with very little benefit in the way of hydraulic containment or mass removal (typical operation was near 30 gpm). EPA and MPCA agreed to the request in an email dated 11 September 2018. Additional extraction wells at Sites D, G, and I have been installed and are expected to be in full operation by June 2022.

SYSTEM OPERATION SPECIFICATIONS

Part of the remedy for deep groundwater at TCAAP is groundwater extraction originally consisting of 17 extraction wells connected by a force main to an air stripping treatment facility. The air stripping treatment facility was designed to include:

- Four air stripping towers
- Four air blowers that provide air to each tower
- Four wet wells that are used to accumulate extracted groundwater before pumping to the towers for treatment
- Four wet well pumps used to pump water from the wet wells to the treatment towers. 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 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 (WWP) 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 handle up to a maximum of 1,450 gpm
  - WWPs 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 is designed to provide 6,000 to 7,000 standard cubic feet per minute. The blowers for Towers 3 and 4 are designed to provide 9,000 to 14,000 standard cubic feet per minute

The treatment system was modified to allow for two air stripping tower treatments instead of the original design of four air stripping tower treatments, which resulted in a reduction of energy use while still meeting the 5 µg/L TCE effluent discharge limit. WWP#1 and WWP #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 programmable 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 WWPs according to high water levels occurring in the wet wells; and in turn, cycle-off the WWPs according to low levels occurring within these wet wells. The system operates such that the WWPs cycle rather than the extraction well pumps. The rationale 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.

REFERENCES

U.S. Environmental Protection Agency (EPA). 1987. *Interim Response Action Plan.*

U.S. Army (Army). 2020. *Explanation of Significant Differences #3, Change in Groundwater Treatment System and Addition of 1,4-Dioxane as a Contaminant of Concern, New Brighton/Arden Hills Superfund Site*. Final Report. October.

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Appendix J.11

OU3: Deep Groundwater

HISTORICAL DESIGN AND EVALUATION DETAILS
OU3 – DEEP GROUNDWATER

The purpose of the Historical Design and Evaluation Details for Operable Unit (OU)3 – Deep Groundwater, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year (FY) 2022 Annual Performance Report (APR), is to provide historical context for activities at the OU3 site.

The plume groundwater recovery system (PGRS) was an off-site groundwater extraction and treatment system and municipal potable water supply. The PGRS consisted of New Brighton Municipal (NBM) #13 and a granular activated carbon (GAC) treatment plant. The City of New Brighton (New Brighton) used the water for municipal supply. The PGRS was designed to contain the South Plume of volatile organic carbon (VOC) impacts emanating from the former TCAAP property and to prevent further downgradient migration. Recovered groundwater was treated and used by New Brighton to fulfill its municipal water supply demand.

The PGRS began operating on 3 May 1994. In 1997, the PGRS influent dropped below the 1992 OU3 Record of Decision (ROD) required limits for all VOCs. In December 1999, under an agreement with the regulators, the PGRS pumping rate was reduced from a nominal rate of 1,000 gallons per minute (gpm) to 400 gpm to help determine if the VOC concentration reductions 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 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 1992 OU3 ROD requirements.

The results of this evaluation were presented to the regulators on 6 September 2000, and a report titled “Plume History Evaluation, Operable Unit 3,” Conestoga-Rovers & Associates, Inc. (now GHD) (CRA), was submitted to the regulators on 10 October 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 regulators subsequently accepted.

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 throughout FY 2004, FY 2005, and FY 2006. New Brighton conducted an evaluation of its municipal system to, in part, determine the future use of the PGRS extraction well and treatment system. New Brighton decided the PGRS treatment system and well NBM #13 were not part of New Brighton’s long-term water supply plan. During FY 2007, the PGRS treatment system was dismantled and NBM #13 was abandoned.

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

REFERENCES

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 2006. *Record of Decision Amendment [#1] for Operable Unit 3 (OU3). New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota*. August.

Appendix J.12

Round Lake

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HISTORICAL DESIGN AND EVALUATION DETAILS ROUND LAKE

The purpose of the Historical Design and Evaluation Details for Round Lake, presented as an appendix to the Twin Cities Army Ammunition Plant (TCAAP) Fiscal Year 2022 Annual Performance Report (APR), is to provide historical context for activities Round Lake.

The *Tier II Ecological Risk Assessment Report* (U.S. Army Center for Health Promotion and Preventative Medicine [USACHPPM] 2004) for aquatic sites (including Round Lake), was approved by the U.S. Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) in December 2004. In June 2005, the U.S. Army (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) Feasibility Study (FS) in April 2010. After review of this report, EPA 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, EPA, 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.

EPA and MPCA provided consistency approval for the QAPP for Round Lake Sediment Investigation in January 2011. The sediment sampling work was completed in January to February 2011. A Draft Summary of Investigation Findings was submitted in May 2011, and a meeting between the Army, EPA, MPCA, the Minnesota Department of Natural Resources (MDNR), the U.S. Fish and Wildlife Service (USFWS), 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 EPA 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 EPA 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. EPA 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, EPA, and MPCA did not agree on the ecological risks and commensurate remedy associated with Round Lake. Given the difficulty reaching a consensus, the USAEC 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 EPA and MPCA in March 2014 indicated that significant disagreement remained. In April 2014, the Army, EPA, and MPCA entered an "informal dispute resolution" phase which continued in FY 2015 and FY 2016. In a teleconference between the EPA Region 5 Federal Facilities Chief and Headquarters Department of the Army personnel on 20 September 2016, an agreement was reached in which the Army would submit a revised Supplemental Remedial Investigation (SRI)-FS in the third quarter of FY 2017. The document was submitted for regulator review on 10 May 2017. The regulators provided written comments in July 2017, with the Army responses issued on 6 October 2017. At the end of FY 2018, a revised Final SRI-FS for Round Lake was prepared and submitted to EPA and MPCA on 7 September 2018.

A meeting was held on 18 June 2019 with USFWS, EPA, MPCA, and the Army to consider the current ecological risk to the ecosystem, understand USFWS goals for Round Lake, discuss remedial alternatives, and define the path forward for Round Lake. The Army provided the Round Lake SRI-FS USFWS comments and Army responses to the stakeholders on 19 September 2019. A meeting was held on 25 September 2019 with USFWS, EPA, MPCA, and the Army. The objectives of the meeting were to discuss comments on the SRI-FS, next steps in the CERCLA process, cleanup value, and the list of remedial alternatives. It was agreed that the SRI-FS would be revised based on the agreed upon cleanup value of 0.6 mean probable effect concentration quotient, the agreed list of alternatives, and comments on the SRI-FS. A call was held on 2 October 2019 with USFWS, EPA, MPCA, and the Army to discuss Applicable or Relevant and Appropriate Requirements (ARARs). The Army submitted the Draft Final SRI-FS for the Round Lake New Brighton/Arden Hills Superfund Site and September 2018 SRI-FS for Round Lake New Brighton/Arden Hills Superfund Site USFWS comments and Army responses to the stakeholders and USFWS, EPA, MPCA, and MDNR on 4 December 2019.

EPA and MPCA provided comments on the December 2019 draft of the SRI-FS on 17 and 21 January 2020, respectively. No comments were received from the USFWS before the planned Round Lake meeting was held on 25 February 2020. During the meeting, the Army agreed to prepare draft text to address the ARARs for USFWS review and approval (before the Remedial Action section in the SRI-FS). The USFWS stated that they wanted agreement on the ARARs prior to providing comments on the SRI-FS. MDNR provided comments on 13 April 2020 and a team call with the MDNR was held on 13 May 2020 to discuss their comments and draft Army responses, and the meeting minutes were sent out on 15 June 2020. The USFWS finally provided their comments on 22 May 2020 and the Army provided response on 27 June 2020 prior to the team call on 14 July 2020 to discuss the USFWS comments and Army responses. Draft minutes were provided on 28 July 2020.

The Army provided the Field Habitat Assessment Memo on 30 July 2020, describing the field habitat assessment that the Army planned to conduct in August. The field visit enabled the Army (with the MDNR and USFWS assistance) to verify habitat conditions for the Bald Eagle, Blanding Turtle, and Ghost Tiger Beetle around Round Lake. The assessment was completed on 20 August 2020 and was summarized in MDNR's Round Lake Remediation Planning Site Visit Report dated 31 August 2020.

A revised version of the Draft Final RI-FS was submitted on 17 August 2020. EPA provided a Consistency Letter on 24 August 2020, which requires a Draft Proposed Plan (PP) in 40 days (end of September 2020). A call was held with stakeholders on 1 September 2020 to discuss steps to finalize the SRI-FS. On 3 September 2020, MPCA issued a letter to EPA to request a 30-day extension for the completion of the SRI-FS to allow MPCA and MDNR to complete state coordination. EPA provided concurrence to MPCA's request for extension and the deadline for the Final SRI-FS was changed to 1 October 2020. MPCA provided an email on 2 October 2020 that revised their position on state acceptance of alternatives presented in the Round Lake SRI-FS based on state land use and management needs rather than solely MPCA acceptance based on protectiveness of benthic organisms. The revised MPCA position ranks Alternative 4 100 percent state acceptance, Alternative 8 at 25 percent state acceptance, and all others at zero percent state acceptance. Previously (per their Email from 26 August 2020) their position was Alternatives 4A, 4B, 6A, 6B, 8 and 9 were 100 percent desirable and Alternative 7 was 25 percent based on acceptance to benthic organisms.

Army submitted a "Request for extension to the FS and PP for Round Lake" on 14 October 2020, and it was approved by EPA on 16 October 2020 and MPCA on 19 October 2020. After submittal of the revised Final SRI-FS, which incorporated MPCA's latest comments on 27 October 2020, MPCA provided their Consistency Letter on 28 October 2020. The USFWS comments were provided on 23 November 2020, and the Army held a call with them to discuss the comments on 1 December 2020. The Army requested an additional extension for the SRI-FS to end of January 2021, dated 14 December 2020. The extension was approved by EPA and MPCA on 14 and 15 December 2020, respectively. Final approval letters from EPA and MPCA were received on 12 March 2021 and 15 March 2021, respectively.

REFERENCES

Pika Arcadis U.S., Inc. (JV). 2021. *Supplemental Remedial Investigation and Feasibility Study for Round Lake, New Brighton/Arden Hills Superfund Site*. Final. January.

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 2021. *Proposed Plan for TCAAP-31 Round Lake, New Brighton/Arden Hills/Twin Cities Army Ammunition Plant Superfund Site, Ramsey County, Minnesota*. Final. July.

U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM). 2004. *Tier II Ecological Risk Assessment Report, Twin Cities Army Ammunition Plant, Arden Hills, Minnesota*. December.