



Revised Injection Work Plan

Former AGC Greenland Plant Hazardous
Waste Disposal Unit

PREPARED FOR
AGC Flat Glass America, Inc.

DATE
2 July 2024

REFERENCE
0698010

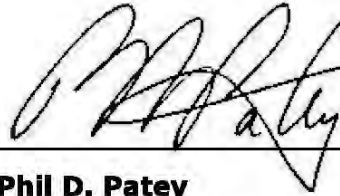


Revised Injection Work Plan

Former AGC Greenland Plant Hazardous Waste Disposal Unit
0698010



Matthew Cooley, P.G.
Managing Consultant



Phil D. Patey
Partner-in-Charge

Environmental Resources Management, Inc
901 Woodland Street
Suite 104
Nashville TN 37206
+1 615-656-7100

© Copyright 2024 by The ERM International Group Limited and/or its affiliates (ERM). All Rights Reserved.
No part of this work may be reproduced or transmitted in any form or by any means, without prior written permission of ERM.




Certification

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, and of those persons directly responsible for gathering the information. The information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

[Double click to insert signature]

Name

Job title



Christopher F. Ciment
Gen. Counsel & Secretary

CONTENTS

1.	INTRODUCTION	1
1.1	SITE LOCATION AND DESCRIPTION	1
1.2	SITE OWNERSHIP HISTORY	1
1.3	BACKGROUND	1
1.4	SITE SETTING	2
1.5	PREVIOUS ENVIRONMENTAL INVESTIGATIONS AND DATA ANALYSIS	3
2.	INJECTION WORK PLAN	4
2.1	DESCRIPTION OF REMEDIATION TECHNOLOGIES TO BE IMPLEMENTED	4
2.1.1	In-Situ Chemical Oxidation (ISCO)	4
2.1.2	Pump and Treat	5
2.2	PRE-INJECTION SUBSURFACE INVESTIGATION (BACKGROUND OXIDANT DEMAND)	5
2.2.1	Health and Safety	6
2.2.2	Site Preparation and Mobilization	6
2.2.3	Site Investigation Activities	6
2.2.4	Abandonment	8
2.2.5	Decontamination	8
2.2.6	Waste Management	8
2.2.7	Quality Assurance and Quality Control	9
2.2.8	Data Validation and Presentation	10
2.3	RCRA CLASS 2 PERMIT MODIFICATION	10
2.4	PRELIMINARY IN-SITU CHEMICAL OXIDATION REMEDIAL DESIGN	10
2.4.1	Preliminary Remedial Design	10
2.4.2	Injection Fluid Composition and Rationale	11
2.4.3	Injection Procedure and Equipment	11
3.	UNDERGROUND INJECTION CONTROL (UIC) PERMIT APPLICATION	11
4.	GROUNDWATER MONITORING PLAN	11
4.1	POST INJECTION GROUNDWATER MONITORING	11
4.2	QA/QC SAMPLING	12
5.	REPORTING	12
5.1	PRE-INJECTION SUBSURFACE INVESTIGATION REPORT	12
5.2	REVISED REMEDIAL DESIGN/UIC PERMIT SUBMITTAL	12
5.3	POST-INJECTION AND GROUNDWATER MONITORING REPORT	13
6.	SCHEDULE	13
FIGURE 1	SITE LOCATION MAP	
FIGURE 2	SITE LAYOUT MAP	
FIGURE 3	GROUNDWATER MONITORING WELL LOCATION MAP	
FIGURE 4	POTENTIOMETRIC SURFACE MAP FALL 2022	



FIGURE 5	SOIL BORING LOCATION MAP
FIGURE 6	PROPOSED SUPPLEMENTAL SOIL BORING LOCATION MAP
FIGURE 7	RADIAL ZONE OF INFLUENCE MAP
TABLE 1	SUMMARY OF VOCS IN SOIL
TABLE 2	SUMMARY OF CHLORINATED ETHENES IN GROUNDWATER
APPENDIX A	SOIL BORING LOGS
APPENDIX B	STANDARD OPERATING PROCEDURES
APPENDIX C	CURRENT UIC PERMIT

ACRONYMS AND ABBREVIATIONS

Acronyms	Description
AOC	Area of Concern
BGS	Below Ground Surface
BOD	Background Oxidant Demand
COCs	Constituents of Concern
CSM	Conceptual Site Model
ERM	Environment Resources Management Southeast
GPR	Ground Penetrating Radar
HASP	Health and Safety Plan
IDW	Investigation-Derived Waste
IMP	Incident Management Plan
JHAs	Job Hazard Analyses
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PID	Photoionization Detector
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
RI	Remedial Investigation
SESD	Science and Ecosystems Support Division
TCL	Target Compound List
TDEC	Tennessee Department of Environment and Conservation
TDEC-DWR	Tennessee Department of Environment and Conservation Division of Water Resources
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds





1. INTRODUCTION

Environmental Resources Management, Inc. (ERM) has prepared this Revised Injection Work Plan for the Former AGC Greenland Plant Hazardous Waste Disposal Unit (the "Site") located at 600 Cardinal Way Road, Church Hill, Tennessee 37642. The Site is regulated by the Tennessee Department of Environment and Conservation (TDEC) Division of Solid Waste Management (DSWM) and operates under Post-Closure Hazardous Waste Permit No. TNHW-169. The conditions of the permit require AGC to continue post-closure care including maintenance and monitoring of the closed hazardous waste disposal unit, and to continue remediation efforts to remedy and investigate the groundwater contaminant plume.

The objective of this Injection Work Plan is to obtain approval from TDEC-DSWM to conduct a supplemental site investigation, modify the current RCRA Class 2 Permit, and perform in-situ chemical oxidation (ISCO) injections in the source area. The purpose of the ISCO injections is to reduce the concentrations of volatile organic compounds (VOCs) in Site groundwater to ultimately cease operation of the pump and treatment system.

1.1 SITE LOCATION AND DESCRIPTION

The Site is located within the Stony Point, Tennessee Quadrangle of the United States Geological Survey (USGS) 7.5-minute topographic quadrangle map (**Figure 1**). The Site comprises the northern portion of the parcel identified as Hawkins County Parcel ID 055 029.00. As depicted in **Figure 2**, the area of concern (AOC) encompasses a former concrete tank (closed by removal), located along the west exterior wall of the Site building.

1.2 SITE OWNERSHIP HISTORY

According to the State of Tennessee Comptroller of the Treasury online Real Estate Assessment Data, AGC Flat Glass North America (AGC) purchased the Site in 1960. In August 2021, Cardinal FG acquired the Site; however, AGC retains the permit for the hazardous waste disposal unit.

1.3 BACKGROUND

The Site has been utilized as a manufacturer of glass for architectural applications since 1962. In 1980, an underground, open-top, concrete containment tank was installed and reportedly used to store phthalate plasticizers. The underground concrete tank was approximately 36 feet long and nine (9) feet wide. A release was identified, and impacts were discovered in the surrounding soil and groundwater.

The tank and surrounding soils were excavated and transported off-site in November 1988. With concerns of damaging the foundation of the manufacturing building, the site was closed as a landfill. As part of the closure process, the impacted area was capped with compacted clay and



bentonite in May of 1991. A concrete barrier was additionally installed over the impacted area and final closure was certified on June 15, 1991.

Two (2) piezometers (P-1 and P-2) and 14 groundwater monitoring wells (MW-1 through MW-14) were installed upgradient and downgradient of the source area as part of the groundwater characterization and monitoring activities. On July 29, 1994, a groundwater pump and treatment remediation system was installed to remediate groundwater impacted with methylene chloride and PCE. Groundwater is currently extracted from three (3) extraction wells located downgradient of the source area, treated and reinjected immediately upgradient of the source area. The surface treatment system occurs in an enclosed remediation building adjacent to the source area. The treatment system was temporarily shut down to evaluate natural attenuation, as approved by TDEC. No significant natural attenuation occurred during the approved shut down period. The pump and treatment system was re-started in the spring of 2022 and remains operational.

1.4 SITE SETTING

This section includes a description of the physical characteristics of the Site and surrounding area. These descriptions are based on both published regional and Site-specific information.

Physical Setting

The AOC currently contains a concrete covered area, where the concrete waste collection tank was removed. The non-scope portion of the Site currently contains an active glass manufacturing facility surrounded by administrative buildings, a substation, storage for manufacturing, railway, and parking areas. The Site is surrounded by mostly residential lots and some industrial/manufacturing facilities. The Holston River is located to the east and south of the Site.

Topography

The Site facility is located on a relatively flat area, with ground elevations ranging from approximately 1,200 feet on the eastern portion of the Site and 1,280 feet above mean sea level (amsl) on the northwestern portion of the Site. The property surrounding the hazardous waste disposal unit generally slopes to the south-southwest towards the Holston River. The nearest surface water body to the Site is the Holston River, located approximately 3,385 feet south, east and west of the manufacturing facility. The Holston River flows from the northeast to the southwest.

Geology

According to the USDA Natural Resources Conservation Service (NRCS) Web Soil Survey (<http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>), the Site is primarily underlain by Holston-Urban land complex, which is classified as well drained soil. The geologic unit underlying the Site is Sevier Shale and consists of calcareous, bluish-gray shale, with thin gray limestone layers. Sandstone and siltstone are typically found on the eastern portions of this formation.



Boring logs included as part of a *Site Investigation Report* prepared by ERM for the Site dated March 3, 2023, indicate soil underlying the AOC consists primarily of sandy silt with clay to a maximum depth of 50 feet below ground surface (bgs). Bedrock was encountered within the AOC between 36 and 50 feet bgs. See **Appendix A**, for a copy of the boring logs reviewed.

Hydrogeology

Regional shallow groundwater flow direction is anticipated to mirror localized topography, which slopes generally to the south-southwest toward the Holston River. Localized areas can also drain toward tributaries of the Holston River.

According to the *2022 Annual Groundwater Monitoring Report* prepared by ERM for the Site dated June 19, 2023, the depths of groundwater in the area of the AOC are highly variable ranging from 17 to 48 feet bgs. Potentiometric maps depict groundwater flow direction to the south southwest, consistent with historic groundwater flow direction. The hydraulic gradient was calculated for the Spring and Fall sampling events and ranged between 0.063 ft/ft and 0.065 ft/ft. In addition, the groundwater velocity was calculated between 130 ft/year and 134 ft/year. These values were consistent with historic hydrogeologic conditions in the area of the AOC. See **Figure 3** for the groundwater monitoring well locations and **Figure 4** for the Fall 2022 Potentiometric Map.

Water Supply

According to the *Application for Authorization for Class V Underground Injection Well*, the drinking water supply for the Site is taken from Bradley Creek near its intersection with the Holston River.

1.5 PREVIOUS ENVIRONMENTAL INVESTIGATIONS AND DATA ANALYSIS

2023 Site Investigation Report

As previously stated, ERM prepared a *Site Investigation Report* for the Site dated March 3, 2023. The objective of the investigation was to assess the historical source area for residual COCs, which may be present in the unsaturated soil, the smear zone, and/or groundwater near the AOC. The scope of work was intended to yield sufficient data to screen corrective action technologies and determine if additional data are needed to evaluate, select, and implement a supplemental or alternative corrective action for the Site. Ten (10) soil borings were conducted within the AOC and three (3) soil samples were collected from each boring and submitted for laboratory analysis of volatile organic compounds (VOCs). No visual or olfactory signs of solvent impacts were noted in the soil boring logs. In addition, no elevated PID readings were observed in any of the borings conducted. The soil analytical results identified tetrachloroethene (PCE) and/or trichloroethene (TCE) above laboratory reporting limits all of the soil borings; however, no concentrations of PCE or TCE were identified exceeding the Industrial Regional Screening Levels for soil. The maximum concentrations of PCE and TCE are provided in the following table:



ERM

VOC	Industrial RSL (mg/kg)	Highest Concentration Detected (mg/kg)	Boring Location	Sample Depth (ft bgs)
PCE	100	0.384	SB-02	35-37.5
TCE	6	0.0131	SB-06	25-30

Based on the results of this investigation, it was determined the contaminant mass is primarily located in the saturated zone below the water table. The negligible mass remaining in the unsaturated zone was unlikely to contribute to the VOC plume in groundwater. See **Figure 5** for a copy of the Soil Boring Location Map and **Table 1** for the soil sampling data summary.

2022 Annual Groundwater Monitoring Report

As previously stated, ERM prepared a *2022 Annual Groundwater Monitoring Report* for the Site dated June 19, 2023. The semi-annual and annual groundwater sampling events were conducted as part of the requirements set forth in Section IV RCRA Permit TNHW-169. As part of the groundwater investigation, monitoring wells MW-01, MW-02, MW-03, MW-05, MW-06, MW-07, MW-08, MW-09, MW-10, MW-11, and MW-14 were purged and sampled in February, March and August of 2022. Based on the groundwater analytical results, concentrations of tetrachloroethene, trichloroethene and/or 1,1-dichloroethene exceeded its respective Maximum Contaminant Level (MCL) in groundwater monitoring wells MW-02, MW-03, MW-05 and MW-07. Monitoring wells MW-02, MW-03, MW-05 are located adjacent to the source area; and monitoring well MW-07 is located downgradient of the source area immediately adjacent to extraction well EW-2. The area with the highest concentrations of impacts were identified in monitoring wells MW-02, MW-03, and MW-05, adjacent to the source area, and are being properly managed by the remediation system. See **Table 2** for the 2022 Groundwater Analytical Results (reference **Figure 3** for well locations).

2. INJECTION WORK PLAN

The following sections describe the proposed remediation technology, pre-injection soil sampling event, requirements of a RCRA Class 2 Permit Modification, and the preliminary remedial design.

2.1 DESCRIPTION OF REMEDIATION TECHNOLOGIES TO BE IMPLEMENTED

Based on the conclusions of the previously submitted *Site Investigation Report*, two (2) technologies are considered both effective and implementable under the current site conditions. These technologies include In-situ Chemical Oxidation and Pump and Treat.

2.1.1 IN-SITU CHEMICAL OXIDATION (ISCO)

Chemical oxidation is a direct chemical reaction involving the application or injection of oxidants into soil or groundwater to destroy or chemically transform the contaminants. Typically, with



organic chemicals (carbon based) this reaction results in their conversion to carbon dioxide and water.

A number of oxidants can be used to remediate VOCs. They are, in order of decreasing oxidative strength, ozone, persulfate, hydrogen peroxide, and permanganate. Of these oxidants, persulfate and permanganate are the most widely used and are generally commercially available.

Oxidants injected in the subsurface will react with any organic materials encountered, including naturally occurring organic matter. The background oxidant demand, also known as the soil oxidant demand, is measured prior to oxidant delivery so that sufficient oxidant can be delivered to the subsurface to oxidize both the naturally occurring organic matter and the contaminants targeted by ISCO.

Because the primary COCs present at the Site are chlorinated ethenes, selection of ISCO for implementation at this Site would involve injection of permanganate. Permanganate has been selected over other commercially available oxidants like persulfate. Permanganate has a sufficient oxidative strength to breakdown chlorinated ethenes, and active permanganate can persist in the subsurface for a period of several years, which allows for increased distribution when compared to other oxidants with a shorter half-life, like persulfate. In addition, permanganate does not require an activating agent to reach full oxidative strength, as is required by persulfate.

Based on the geology in the area of the AOC, the oxidant could be effectively applied to the subsurface via pressurized injection through direct push injection points. In addition, based on Site geology, low background oxidant demand (BOD) is expected; however, confirmation sampling of BOD will be performed prior to implementation of the ISCO treatment.

2.1.2 PUMP AND TREAT

A pump and treat system is currently in operation at the site. As noted previously, the pump and treat system consists of a series of three (3) groundwater extraction wells which pump groundwater to an above ground air stripper for removal of VOCs. The treated groundwater is reinjected into the subsurface to the northeast of the treatment area, consistent with a UIC permit for the site. As discussed in Section 2.3, the pump and treat system will continue to operate, but with modifications.

2.2 PRE-INJECTION SUBSURFACE INVESTIGATION (BACKGROUND OXIDANT DEMAND)

The following sections present the Site investigation field activities proposed to assess Site soils for the potential presence COCs under the concrete engineered cap, and to determine the value of background oxidant demand (BOD) in site soil.



2.2.1 HEALTH AND SAFETY

ERM will prepare a Site-specific Health and Safety Plan (HASP) for the protection of on-site workers, the surrounding community, and the environment during Site investigation activities. The HASP will include development of an incident management plan (IMP), task-specific Job Hazard Analyses (JHAs) to identify and address potential job hazards and procedures prior to field mobilization.

2.2.2 SITE PREPARATION AND MOBILIZATION

Prior to mobilizing to Site, ERM will notify the Site manager/client of schedule and discuss options to minimize disruptions to Site activities. Equipment and supplies will be mobilized to the Site following authorization to proceed. An equipment storage and decontamination area will be established within a secure area at the Site.

2.2.3 SITE INVESTIGATION ACTIVITIES

The following field activities are proposed based on a review of available Site data to meet the objectives of this Work Plan. This section provides a discussion of the proposed sample locations and rationale for placement, sample collection methods, management of investigation-derived waste, pre-investigation surveying, and health and safety.

The findings from previous Site activities were used to assist in the selection of sample locations to meet the requirements of a comprehensive Site investigation in accordance with Tennessee Department of Environment and Conservation, Division of Remediation Rule 0400-15-01-09.

Field activities will be conducted at the Site to assess subsurface geologic conditions and evaluate soil at the Site. Proposed investigation activities include advancement of three (3) soil borings and collection of soil samples for laboratory analysis of soil oxidant demand. The analysis of soil oxidant demand will be utilized for calculating oxidant dosing for the proposed injections. All Site investigation activities will be conducted in accordance with EPA SESD procedures.

Figure 6 depicts the locations of the three (3) soil borings to be completed during the Site Investigation. The proposed drilling locations and total depths are preliminary in nature and may be modified in the field based on subsurface conditions encountered, access, utility locations, and/or observations by the field geologist. This investigation as illustrated in **Figure 6** involves penetrating the concrete engineered barrier in three (3) locations.

2.2.3.1 UTILITY CLEARANCE

Prior to initiating intrusive subsurface work, ERM will notify the Tennessee public One Call service (Tennessee811) to mark utilities in the project area. A private utility locator will be used to identify potential subsurface utilities and anomalies in the vicinity of proposed soil boring locations using electromagnetic (EM) and ground-penetrating radar (GPR) equipment, and other appropriate geophysical surveying methods capable of identifying potential subsurface debris.



A subcontractor will utilize soft-digging techniques (e.g., air-knife and vacuum extraction) in an attempt to preclear all accessible proposed boring locations to a minimum depth of five feet bgs. Prior to initiating soft-digging, the concrete engineered barrier will be saw cut to create access for soft-dig equipment. During vacuum clearance activities, an ERM employee will collect grab soil samples at approximate depths of 2- and 4-feet bgs for field screening. A hand-held photo-ionization detector (PID) will be used to screen for total organic vapors and the geologist will record notes of visual and olfactory observations, including soil conditions indicating the potential presence of NAPL. Based on field observations, soils samples may be collected for laboratory analysis.

2.2.3.2 DIRECT PUSH AND/OR SONIC SAMPLING

Subsurface soils will be assessed to obtain the following information required to refine the CSM for the Site:

- Nature and extent of cVOCs in soils related to Site AOC;
- Site-specific geologic setting, including lithology and depth of stratigraphic units;
- Field screening data of soils; and
- An estimate of the volume of soil material containing cVOCs above regulatory screening criteria within and around the AOC.
- Obtained a value of background oxidant demand for site soils.

A drilling subcontractor will utilize direct-push technology (i.e. Geoprobe®) or sonic drilling to complete three (3) soil borings. Soil cores will generally be advanced to approximately 50 feet bgs or to refusal (if direct-push technology). Soil samples (lithological or environmental) will be logged by a qualified geologist. A description of the core sample will be recorded on the Soil Boring Log form to document the following:

- Color photographs of the total core length;
- Date and time of sample collection;
- Sample recovery (depth in feet of recovery compared to penetration);
- Physical soil description will follow the Universal Soil Classification System format. An example of a typical soil description will include: stiff, gray, stratified, SILTY CLAY, trace sand, etc. Additional descriptions such as saturation, or moisture, etc., will also be noted in the field records, when present;
- Visual stratification, structure, and texture;
- Organic matter or anthropogenic debris; and
- Photoionization detector readings.

One (1) soil sample from each boring will be collected from the saturated soils representative of the target treatment area beneath the concrete engineered barrier. This data will be utilized to determine the mass of oxidant required to overcome background demand in the ISCO remedial design. In addition, during field logging, should elevated PID readings or indication of



visual/olfactory impacts be identified beneath the concrete engineered barrier, one (1) soil sample will be obtained from the area of greatest impact above the saturated zone and will be analyzed for volatile organic compounds (VOCs).

Groundwater samples will not be collected as part of the proposed Supplemental Site Investigation.

Investigative samples and quality control blank samples (reference **Section 2.2.7**) will be placed in laboratory-supplied containers and placed in a cooler on ice. The samples and associated chain of custody forms will then be submitted to a State-accredited laboratory for analysis of the following parameters:

Background Oxidant Demand (BOD); and
Target compound list (TCL) VOCs via USEPA SW-846 Method 8260B, if warranted.

Drilling and sampling activities will be conducted in accordance with ERM Standard Operating Procedures (SOPs). **Appendix B** contains a copy of the relevant SOPs; please note that ERM SOPs were developed in accordance with EPA SESD procedures.

2.2.4 ABANDONMENT

Following boring advancement and completion of sample collection, each borehole will be abandoned by backfilling with cement-bentonite grout using a tremie-pipe to place the grout from the base to within six inches of the surrounding surface grade. Additional grout will be installed if any sloughing occurs during curing of the grout. The upper six inches of each boring will be backfilled with a six-inch column of concrete to match the surrounding grade and repair of the engineered cap.

2.2.5 DECONTAMINATION

A decontamination pad will be constructed prior to the start of work to collect wash water generated during decontamination. All non-dedicated, non-disposable reusable equipment potentially coming into contact with Site media during sample collection (e.g., drill rods, sampling equipment) will be washed and rinsed after each use. A pressure washer will be used to clean the sampling equipment after the completion of each soil boring, and prior to moving to the next sample location.

2.2.6 WASTE MANAGEMENT

Decontamination fluids and other wastewater generated during the investigation will be transferred to a polyethylene tank or 55-gallon drums staged at the Site. A sample of the water will be collected for waste characterization analysis for purposes of disposal at the conclusion of the investigation. All containers will be clearly labeled with indelible marker and waste tracking labels. The containers will be marked with the type of waste, location generated, date collected, and waste classification.



Excess soils generated during field activities will be placed in 55-gallon drums to be staged at the Site. The IDW drums will be covered at the conclusion of each day to keep rainwater out and control the release of potential nuisance odors. A sample of the soils will be collected for waste characterization analysis at the conclusion of the project. The material will be managed for off-site disposal at a licensed disposal facility based on the analytical sample results.

2.2.7 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) procedures will be used to ensure that technical data generated during sampling activities are accurate, complete and representative of actual field conditions.

Several types of field QA/QC samples will be collected, along with the field samples collected for laboratory analysis, to ensure that all work performed and data produced are of known, documented, and satisfactory quality. QA/QC sampling procedures will include the following:

Duplicate samples are collected to measure sampling precision or the variability of the matrix. One blind field duplicate sample will be collected for each ten (10) soil samples collected for laboratory analysis. Duplicate samples will be collected from randomly selected sampling locations and depth intervals with observed low to moderate impacts.

Rinse blanks are collected to assess decontamination procedures used to clean the field sampling equipment. Rinse blanks will be obtained by pouring distilled water over decontaminated sample equipment and collecting the rinsate in laboratory provided sample glassware. One rinsate sample per each type of field equipment used (e.g., hand auger, direct-push macrocore) will be collected during the investigation and submitted for laboratory analysis.

Trip blanks are used to assess potential cross-contamination from the container and preservative during transport, field handling, and storage. Trip blanks will be provided by the analytical laboratory and consist of 40 milliliter (ml) vials filled with reagent grade de-ionized water. One trip blank will be included with each cooler submitted to the laboratory for analysis.

The QA/QC samples shall be identified with a coded identifier in the same format as other identifiers used with the sample matrix. Both the coded and actual identifiers will be recorded in the field notebook. The coded identifier will be used on the Chain-of-Custody forms.

Laboratory QA/QC measures include Matrix Spike (MS) samples that are analyzed to determine the effect of the sample matrix on the accuracy of the analytical results. The MS is the addition of a known amount of analyte to a normal sample in the lab. Matrix Spike Duplicates (MSDs) are the second of a pair of lab matrix spike samples and are analyzed to check the precision of analytical procedures. Triplicate sample volume will be collected at random sample locations at a 5% frequency to serve as MS/MSD samples.



2.2.8 DATA VALIDATION AND PRESENTATION

The laboratory analytical results, duplicate, rinsate, trip, and matrix spike/matrix spike duplicate results, holding times, and surrogate recoveries will be reviewed for compliance and acceptability by an ERM QA/QC reviewer in accordance with the guidelines set forth in USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic and Inorganic Analyses" (1994). The QA/QC of laboratory data, field data and boring logs will be conducted prior to assimilating the data into summary tables and maps for the refinement of the current CSM.

2.3 RCRA CLASS 2 PERMIT MODIFICATION

A RCRA Permit Class 2 Modification will be required prior to the remediation activities. The permit modification will specify that an alternative remedial action will be implemented that will modify the current pump and treatment system. The permit modification will include turning off extraction wells EW-01 and EW-03, the injection of chemical oxidant in the source area, and a subsequent performance monitoring period. Extraction well EW-02 will remain in operation. All routine groundwater sampling and potentiometric surface mapping will continue in order to monitor plume stability during ISCO implementation. The performance monitoring period is anticipated to be one to two years to enable a determination as to whether supplemental injection is needed.

The shutdown of a portion of the pump and treatment system is needed to 1.) ensure that the oxidant remains in the targeted treatment zone, rather than being drawn more rapidly toward the extraction wells and 2.) ensure the oxidant does not get drawn into the pump and treatment system, potentially damaging the system.

2.4 PRELIMINARY IN-SITU CHEMICAL OXIDATION REMEDIAL DESIGN

Due to the small size of the treatment area and low concentrations of contaminants of concern, a pilot test was not warranted prior to full scale implementation. As described below, a conservative approach has been taken to ensure the treatment area would be adequately saturated with the injectant.

2.4.1 PRELIMINARY REMEDIAL DESIGN

A total of 20 direct push technology (DPT) injection points will be advanced within the AOC for delivery of a 5% wt/wt sodium permanganate solution. The injection points will be advanced within the area of known impacts, adjacent to, and within the concrete cap (e.g. removed concrete underground storage tank). The treatment depth will be approximately 25- to 45-ft below ground surface, resulting in a treatment zone thickness of approximately 20 feet. Injection intervals will occur every five (5) feet, with five (5) total injection intervals per injection point. Based on the geology at the Site, a conservative radius of influence of ten feet per injection point was utilized (reference **Figure 7**).



2.4.2 INJECTION FLUID COMPOSITION AND RATIONALE

The ISCO remediation will include injection of a sodium permanganate solution to facilitate destruction of chlorinated ethenes. For planning purposes, the ISCO injections will include the injection of 1,300-gallons of 5% wt/wt sodium permanganate solution into each injection point. A total of 26,000-gallons of solution will be injected into the impacted area. The design injection volume at each point will replace no more than 20% of the pore space (assuming an effective porosity of 0.30). The 30% effective porosity value is a conservative value based on the published geologic information for soil types identified during the previous soil investigation at the Site. The current 5% wt/wt solution is based on an assumed background oxygen demand of no more than 2%. The injection volume and permanganate concentration will be updated based on the background oxidant demand results following the initial background oxidant demand sampling and after each injection as necessary to maintain the desired conditions for effective remediation.

2.4.3 INJECTION PROCEDURE AND EQUIPMENT

The sodium permanganate solution will be batch mixed in 500-gallon tanks on an injection trailer for injection into the subsurface. Water obtained from the municipal water system will be used to prepare the sodium permanganate solution. Fluids will be injected using a grout pump capable of generating up to 100 psi. The anticipated injection pressure is 10 to 50 psi depending on Site-specific conditions. The actual injection pressure will be determined in the field based on changes in water table elevation observed during the injection.

3. UNDERGROUND INJECTION CONTROL (UIC) PERMIT APPLICATION

The Site currently holds an Underground Injection Control (UIC) permit dated May 27, 2022, and expires May 27, 2027. The ISCO injection involves the release of oxidant (sodium permanganate) to groundwater. ERM understands that this activity must also be conducted under an UIC permit. Upon approval of this Injection Work Plan, ERM will contact TDEC Division of Water Resources (TDEC-DWR) to determine whether a modification to the existing permit would be required, or if an additional UIC permit would be necessary to perform the work underlined in this plan. The current UIC permit is included in **Appendix C** for reference and will be submitted to the UIC board under a separate cover for review.

4. GROUNDWATER MONITORING PLAN

4.1 POST INJECTION GROUNDWATER MONITORING

Post injection groundwater sampling will be obtained from the bi-annual groundwater sampling events and will be utilized to evaluate the effectiveness of the ISCO remediation activities. Groundwater samples will be analyzed for VOCs by EPA Method 8260B. Five (5) pre-existing



monitoring wells (MW-02, MW-03, MW-05, MW-10 and MW-14) will be sampled as part of the bi-annual sampling events to evaluate the ISCO remediation performance.

4.2 QA/QC SAMPLING

Refer to Section 2.2.7 for a detailed description of the QA/QC procedures. Blind duplicate samples are proposed for groundwater samples at a range of one (1) blind duplicate sample per 10 standard samples. Additionally, one (1) trip blank per cooler will be prepared by the laboratory for transport and analysis during monitoring well sampling activities. QA/QC groundwater samples will be analyzed for VOCs by EPA Method 8260B. QA/QC samples will be evaluated in regard to standard industry data quality indicators including bias, completeness, comparability, precision, and method sensitivity.

5. REPORTING

5.1 PRE-INJECTION SUBSURFACE INVESTIGATION REPORT

Following completion of the pre-injection subsurface investigation, a Pre-Injection Subsurface Investigation Report will be submitted to TDEC within 45 days of receipt of analytical data. This report will include:

- Soil boring logs;
- Any analytical data collected during the subsurface investigation (BOD and, if collected, VOCs);
- Figures with soil boring locations;
- Any deviations from the Work Plan;
- Summary of subsurface investigation activities;
- EPA SESD documents used;
- Record of all field parameters taken during soil boring procedures;
- Completed Chain of Custody and QA/QC Procedures;
- If VOC data is collected, concentration maps for TCE and PCE; and
- Updated timeline for ISCO Injection.

5.2 REVISED REMEDIAL DESIGN/UIC PERMIT SUBMITTAL

Upon completion of the pre-injection subsurface investigation, the preliminary remedial design will be revised if necessary. The revised remedial design will be provided to TDEC-DWR to determine whether a modification to the existing UIC permit would be required, or if an additional UIC permit would be necessary to perform the work underlined in this plan. The revised design and UIC Permit application (if necessary) will also be provided to TDEC Division of Solid Waste Management.



5.3 POST-INJECTION COMPLETION AND GROUNDWATER MONITORING REPORT

A Post-Injection Completion and Groundwater Monitoring Report will be submitted to TDEC within 45 days following the receipt of the first round of post injection groundwater sampling. The report will include:

- Drilling activities, boring logs, and soil analytical results;
- Injection methods, volume quantities, and locations;
- Post injection groundwater sampling results;
- Plume concentration maps for TCE and PCE; and
- Conclusions and Recommendations.

It is noted that semi-annual and annual groundwater sampling will still be performed and reported on an annual basis, separate from this report.

6. SCHEDULE

This section outlines the anticipated time schedule for activities related to the Work Plan. The table below presents estimates for the start/duration of each task and the anticipated days to complete those tasks.

As previously stated, a RCRA Permit Class 2 Modification will be required prior to the remediation activities. The permit modification will specify that an alternative remedial action (e.g. ISCO injections) will be implemented and modification of the current pump and treatment system will occur (shutdown of EW-01 and EW-03, with EW-02 to remain operational). Upon approval of this Work Plan by TDEC, ERM will begin to prepare the permit modification documentation. After the permit modification and public meeting have been completed, the modification documentation will be provided to TDEC for approval. It is estimated that the Injection Work Plan can be completed within approximately 6 to 8 months after approval of the Injection Work Plan and Class 2 Permit Modifications. The field tasks and estimated time for completion described in this Work Plan will be completed in the following general order upon approval:

Task	Anticipated Start Date	Anticipated Duration
Injection Work Plan approval	July 2024	30 days
Pre-Injection Subsurface Investigation	July/August 2024, dependent on driller availability and agency approval of Work Plan	6 to 8 weeks
Submit Pre-Injection Subsurface Investigation Report	Within 45 days following receipt of analytical data	-----
Finalize ISCO dosing requirements	August 2024, dependent on completion of pre-injection subsurface investigation	30 days



ERM

Task	Anticipated Start Date	Anticipated Duration
RCRA Class 2 Permit Modification and UIC Permit submittal	August 2024	3 to 6 months, dependent upon public comment, agency approval
ISCO injection, pump and treat system modification	Spring 2025	30 days
Initial groundwater monitoring	Fall 2025, at least six months post-injection	2 days
Post-Injection Completion and Groundwater Monitoring Report	Within 45 days following receipt of analytical data	-----



FIGURE 1	SITE LOCATION MAP
FIGURE 2	SITE LAYOUT MAP
FIGURE 3	GROUNDWATER MONITORING WELL LOCATION MAP
FIGURE 4	POTENTIOMETRIC SURFACE MAP FALL 2022
FIGURE 5	SOIL BORING LOCATION MAP
FIGURE 6	PROPOSED SUPPLEMENTAL SOIL BORING LOCATION MAP
FIGURE 7	RADIAL ZONE OF INFLUENCE MAP

DRAWN BY: CJI - ABE
V:\scuser\dcsisf5011\paulus\Projects\11\110000\2008-09-Church_Hill_TN\000\2008_11_10\501_SLM.mxd. REVISION: 11/07/2008. SCALE: 1:25,000 when printed at 8.5x11



- Legend**
- Remedial Investigation Area
 - Site Boundary

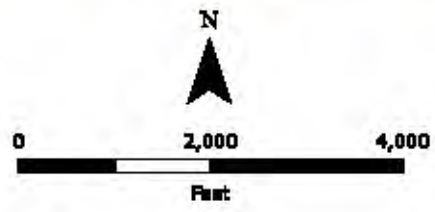
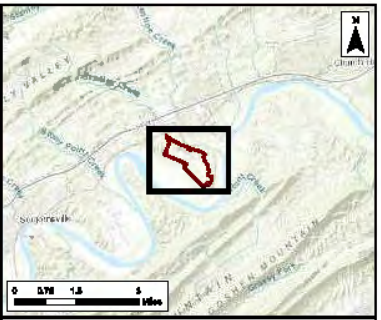
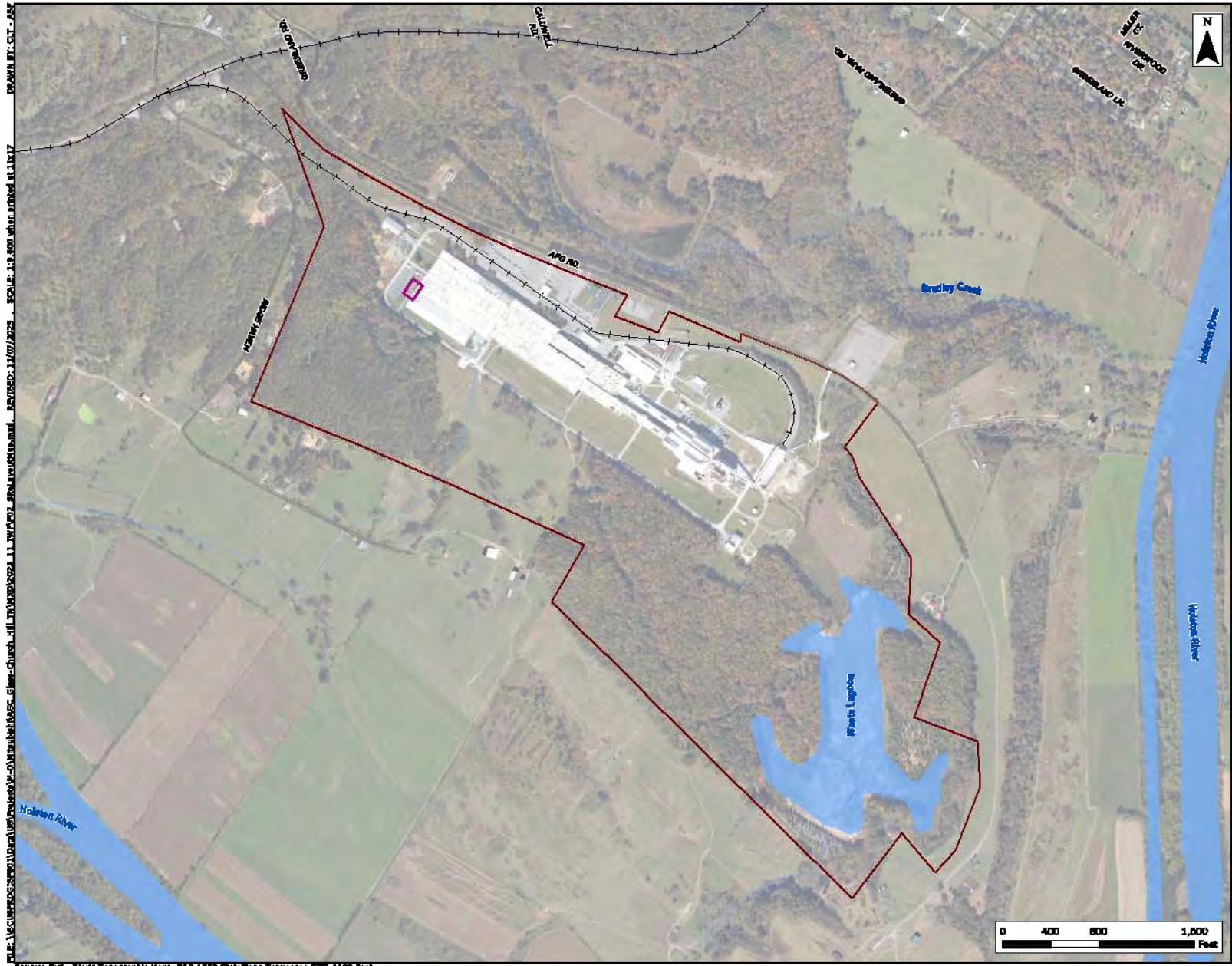


Figure 1
Site Location Map
Hazardous Waste Disposal Unit
Former AGC Greenland Plant
Church Hill, Tennessee



Source: Eri - World Topographic Map; NAD 1983 StatePlane Tennessee FIPS 4100 Feet

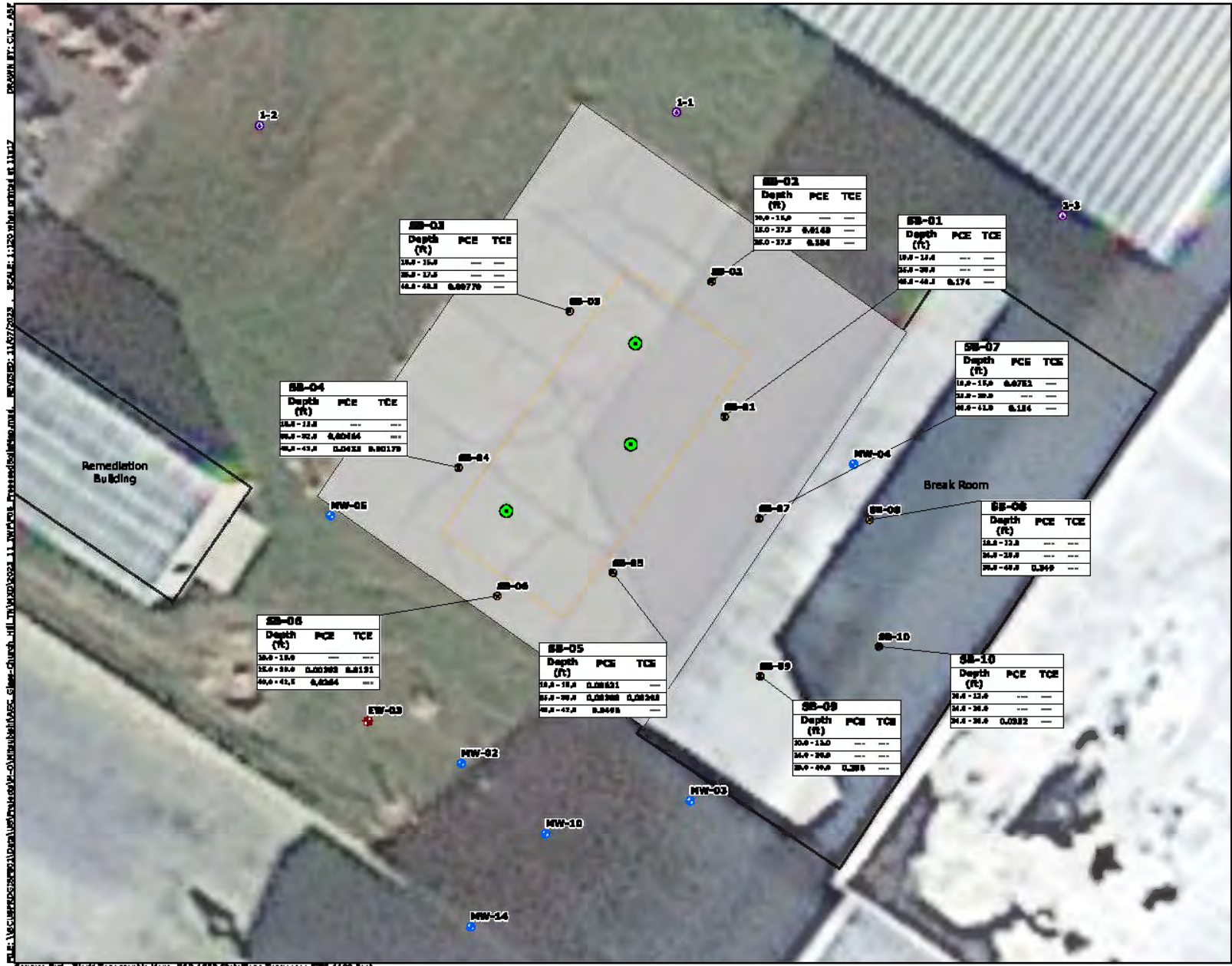


- Legend**
- Remedial Investigation Area
 - Site Boundary
 - Lakes & Rivers
 - Roads
 - Railroads

Figure 2
Site Layout Map
 Hazardous Waste Disposal Unit
 Former AGC Greenland Plant
 Church Hill, Tennessee



Source: Esri - World Topographic Map; NAD 1983 StatePlane Tennessee FIPS 4100 Feet



Legend

- Proposed Soil Boring
- Monitoring Well
- Injection Well
- Extraction Well
- Soil boring
- Site Boundary
- Concrete Cap
- Building
- Former Tank Area

Notes:
 Soil samples collected in August 2022.
 PCE - Tetrachloroethene
 TCE - Trichloroethene
 All concentrations are in mg/kg.
 mg/kg - milligrams per kilogram
 --- Not detected
 SSL - Soil screening level
 MCL - Maximum Contaminant Level
 Boring Locations are approximate.
 Google Earth Aerial Imagery dated 20 November 2022.

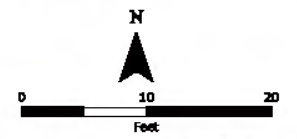


Figure 6
Proposed Supplemental
Soil Boring Location Map
 Hazardous Waste Disposal Unit
 Former AGC Greenland Plant
 Church Hill, Tennessee



Source: Esri - World Topographic Map; NAD 1983 StatePlane Tennessee FIPS 4100 Feet



TABLE 1 SUMMARY OF VOCS IN SOIL

TABLE 2 SUMMARY OF CHLORINATED ETHENES IN
GROUNDWATER

**Table 1 - Summary of Chlorinated Ethenes in Soil
Former AGC Greenland Plant Hazardous Waste Disposal Unit**

Soil Boring	Sample Depth (ft bgs)	PCE (mg/kg)	TCE (mg/kg)
RSL_Ind		100	6
Risk-based SSL		0.0051	0.00018
MCL-based SSL		0.0023	0.0018
SB-01	10-15	---	---
	25-30	---	---
	40-42	0.174	---
SB-02	10-15	---	---
	25-27.5	0.0148	---
	35-37.5	0.384	---
SB-03	10-15	---	---
	25-27.5	---	---
	40-42.5	0.00770	---
SB-04	10-15	---	---
	30-32.5	0.00464	---
	40-42.5	0.0435	0.00179
SB-05	10-15	0.00621	---
	25-30	0.00380	0.00293
	40-42.5	0.0496	---
SB-06	10-15	---	---
	25-30	0.00393	0.0131
	40-42.5	0.0264	---
SB-07	10-15	0.0752	---
	25-30	---	---
	40-42	0.154	---
SB-08	10-12	---	---
	24-26	---	---
	38-40	0.349	---
SB-09	10-12	---	---
	24-26	---	---
	38-40	0.296	---
SB-10	10-12	---	---
	24-26	---	---
	34-36	0.0332	---

--- = Non Detect

**Table 2 - Summary of VOCs in Groundwater
Former AGC Greenland Plant Hazardous Waste Disposal Unit**

Analyte	RSL MCL (ug/L)	RSL Tapwater (ug/L)	MW-01	MW-02	MW-02	MW-03	MW-05	MW-06	MW-07	MW-07	MW-08	MW-09	MW-10	MW-11	MW-11	MW-14
			(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Sample Date			02-22-2022	02-21-2022	08-25-2022	02-21-2022	02-21-2022	03-11-2022	02-21-2022	08-25-2022	02-21-2022	08-25-2022	08-25-2022	02-21-2022	08-25-2022	08-25-2022
Methylene chloride	5	NA	—	< 100	< 5.00	—	—	—	< 5.00	< 5.00	—	—	—	< 5.00	< 5.00	—
1,1,1-Trichloroethane	200	NA	—	< 20.0	< 1.00	—	—	—	< 1.00	< 1.00	—	—	—	< 1.00	< 1.00	—
Xylene, Total	10,000	NA	—	< 60.0	< 3.00	—	—	—	< 3.00	< 3.00	—	—	—	< 3.00	< 3.00	—
Tetrachloroethene	5	NA	< 1.00	504	491	1,130	228	< 1.00	11.7	9.19	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.19
Trichloroethene	5	NA	< 1.00	< 20.0	7.74	< 20.0	< 5.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
cis-1,2-Dichloroethene	70	NA	—	< 20.0	1.17	—	—	—	< 1.00	< 1.00	—	—	—	< 1.00	< 1.00	—
trans-1,2-Dichloroethene	100	NA	—	< 20.0	< 1.00	—	—	—	< 1.00	< 1.00	—	—	—	< 1.00	< 1.00	—
1,1-Dichloroethene	7	NA	—	< 20.0	10.1	—	—	—	< 1.00	< 1.00	—	—	—	< 1.00	< 1.00	—
1,1-Dichloroethane	NA	2.8	—	< 20.0	2.03	—	—	—	< 1.00	< 1.00	—	—	—	< 1.00	< 1.00	—

RSL MCL GW THQ 1.0 = EPA RSL Maximum Contaminant Level (MCL) for groundwater, based on a TR of 1E-06 and a THQ of 1, updated November 2022

RSL TAPWATER THQ1.0 = EPA RSL for Tapwater, based on a TR of 1E-06 and a THQ of 1, updated November 2022

Bold = Above laboratory reporting limit

Bold and Blue = Exceeds RSL MCL GW THQ 1.0

Bold font and Gray Shaded = Exceeds RSL TAPWATER

NA = Not Available/Applicable