FINAL
FEASIBILITY STUDY REPORT
GREAT LAKES REGION
GENERAL MITCHELL INTERNATIONAL AIRPORT
CG019

128th AIR REFUELING WING
WISCONSIN AIR NATIONAL GUARD BASE
MILWAUKEE, WISCONSIN

Contract #: W9133L-14-D-0002
Delivery Order 0002

August 31, 2020

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Certification for Contractors Statement of Technical Review

Wood Environment & Infrastructure Solutions, Inc. (Wood) has completed this Feasibility Study Report for the National Guard Bureau at General Mitchell International Airport in Milwaukee, Wisconsin. Notice is hereby given that a review has been conducted that is appropriate to the level of risk and complexity inherent in the project as defined in the Wood (formerly Amec Foster Wheeler) Quality Assurance Plan. During the independent technical review, compliance with established policy principles and procedures, using justified and valid assumptions, was verified. This included review of assumptions, methods, procedures, and materials used in analyses; the appropriateness of data used and the level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with the law and existing policy.

Nicole H Rottet

8/31/2020

Nicole Rottet, CPG
Hydrogeologic Review

Date

Significant concerns and explanation of the resolutions are documented within the project file. As noted above, all concerns resulting from the technical review of the project have been considered.

Saamih Bashir

8-31-2020

Saamih Bashir, P.E, PMP
Engineering Review/Project Manager

Date

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ACRONYMS

amsl	above mean sea level
ANG	Air National Guard
ARARs	Applicable or Relevant and Appropriate Requirements
ARW	Air Refueling Wing
Base	Wisconsin Air National Guard 128th Air Refueling Wing at General Mitchell International Airport in Milwaukee, Wisconsin
bgs	below ground surface
BTOC	below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	code of federal regulations
CG019	Vinyl Chloride Groundwater Contamination, Site
cm/s	centimeters per second
COCs	Constituents of Concern
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
ES	enforcement standard
ERP	Environmental Restoration Program
°F	degrees Fahrenheit
FS	Feasibility Study
ft	feet/foot
GAC	granular activated carbon
GMIA	General Mitchell International Airport
GRA	general response actions
gpm	gallons per minute
GWQS	groundwater quality standards
HDR	Henningson, Durham, Richardson Inc.
ICs	institutional controls
IRP	Installation Restoration Program
ISCO	In-Situ Chemical Oxidation
JFOF	Jet Fuel Offloading Facility
lb	Pounds
LTM	long-term monitoring
µg/L	microgram per liter
MNA	Monitored Natural Attenuation
NCP	National Contingency Plan
NFA	No Further Action
NFRAP	No Further Remedial Action Planned
NGB	National Guard Bureau
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
NR	WDNR Chapter Natural Resources
OM&M	operation, maintenance and monitoring
OSHA	Occupational Safety and Health Administration
PAL	Preventative Action Limit
POL	Petroleum, Oil, and Lubrication
POTW	Publicly Owned Treatment Works
RAOs	Remedial Action Objectives

RCL	Residual Contaminant Levels
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROI	radius of influence
RR	Remediation and Redevelopment
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SI	Site Investigation
SVE	soil vapor extraction
SVOCs	Semi-Volatile Organic Compounds
TBC	to be considered
TOC	Total Organic Carbon
ug/L	micrograms per liter
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
WANG	Wisconsin Air National Guard
WDNR	Wisconsin Department of Natural Resources
Wood	Wood Environment & Infrastructure Solutions, Inc.

EXECUTIVE SUMMARY

The purpose of this Feasibility Study (FS) is to evaluate an appropriate range of remedial alternatives that will reduce risks to human health and the environment at one site at the Wisconsin Air National Guard (WANG) 128th Air Refueling Wing (ARW) (Base) at General Mitchell International Airport (GMIA) in Milwaukee, Wisconsin. This FS report has been prepared by Wood Environment & Infrastructure Solutions, Inc. (Wood) and describes the objectives, procedures, and activities conducted during the FS for the location identified as:

- CG019 - Vinyl Chloride (VC) Groundwater Contamination (Site)

At CG019, the objective of the Remedial Investigation (RI) activities (completed May 2017 to August 2017, with the RI report completed by Wood [formerly Amec Foster Wheeler Environment & Infrastructure, Inc.] in 2019) was to fully delineate the nature and extent of site-specific contaminants in soil and groundwater, in support of the FS. The objective of this FS is to determine the most reasonable remediation strategy for the Site. Soil and groundwater samples collected during the RI were analyzed for volatile organic compounds (VOCs). Detected soil contaminant concentrations were compared against Wisconsin Department of Natural Resources (WDNR) Chapter Natural Resources (NR) 720 Remediation and Redevelopment (RR) Industrial Direct Contact Residual Contaminant Levels (RCL) and RR Groundwater RCL programs. Detected groundwater contaminant concentrations were compared against WDNR Chapter NR 140 Enforcement Standards (ESs).

Based on analytical results from the field activities conducted at CG019, VOCs were detected exceeding criteria in groundwater only in select locations. Soil samples collected did not exhibit concentrations of contaminants above criteria. Therefore, this FS for Site CG019 is designed only for groundwater contamination at the Site.

Based on the data collected during the RI activities, an FS was completed for the Site. Following a preliminary screening of technologies, the following four alternatives were chosen for Individual Analysis.

<u>Alternative 1: No Action</u>

The "No Action" general response actions (GRA) does not involve any remedial action; therefore, groundwater at CG019 would be allowed to continue in its current state, and no action would be conducted to remove or remediate the contamination. No access restrictions would be put into place, and no deed restrictions are placed on the Site. The National Contingency Plan (NCP) requires that "No Action" be included among the GRAs evaluated in every FS, as detailed in 40 code of federal regulations (CFR) 300.430(e)(6), as a basis of comparison.

Alternative 2: Monitored Natural Attenuation (MNA) and Institutional Controls (ICs)

Alternative 2 includes the establishment of ICs in accordance with the United States Environmental Protection Agency (USEPA) and WDNR to restrict the use of groundwater from the Site. The ICs will provide notice that there is groundwater contamination in a localized area and will remain in effect until monitoring indicates that Constituents of Concern (COC) concentrations are below the applicable cleanup criteria. MNA sampling and reporting would be conducted until Site COCs are below clean-up criteria.

Alternative 3: Groundwater Extraction and Treatment

Alternative 3 includes the installation of groundwater extraction wells in combination with ex-situ treatment of the extracted groundwater using granular activated carbon (GAC). Treated groundwater would then be discharged to the storm or sanitary sewer per permit requirements.

For hydraulic control of the Site an estimated 10 extraction wells with a pumping rate of 25 gallons per minute (gpm) each is used for the purposes of this FS. However, a pumping test should be completed prior to implementation to determine the true hydraulics at the Site.

The groundwater treatment system would treat the extracted groundwater using GAC. The groundwater would flow through two 10,000 pounds (lbs) GAC tanks in series (lead/lag configuration), then be discharged to the storm or sanitary sewer. A National Pollutant Discharge Elimination System (NPDES) or sanitary discharge permit would be required with permitted limits of all COCs. Sampling of COCs would be required per the permit to meet effluent limits and to determine carbon changeout frequency.

Alternative 4: Chemical Injections Plus MNA

Alternative 4 includes In-Situ chemical injections followed by MNA. Injections would be completed using direct-push injection points to inject the chemicals into the groundwater COC plume. Several different chemical injection materials are appropriate for chlorinated VOCs in groundwater (i.e., 3-D Microemulsion™, emulsified vegetable oil, etc.). MNA would be required following injections to monitor the reduction in Site COCs until concentrations are below site clean-up criteria.

Based on the results of this FS for Site CG019, it is recommended to implement chemical injections followed by MNA and long-term monitoring (LTM) (Alternative #4) to reduce site COCs to below WDNR ES criteria. LTM data will be used to determine when Site COC concentrations have decreased below applicable standards, at which point a request for No Further Action will be completed.

1.0 INTRODUCTION

Wood Environment & Infrastructure Solutions, Inc. (Wood) was contracted by the National Guard Bureau (NGB) under Contract # W9133L-14-D-0002, Delivery Order 0002, to conduct Remedial Investigations (RI) and Feasibility Studies (FSs) at the Newly Evaluated Restoration Sites, at the Wisconsin Air National Guard (WANG) 128th Air Refueling Wing (ARW) (Base) at General Mitchell International Airport (GMIA) in Milwaukee, Wisconsin (**Figure 1**). This FS has been completed to address further remedial action at the following site evaluated during RI activities:

- CG019 - Vinyl Chloride (VC) Groundwater Contamination (Site)

The remaining five sites investigated during RI activities (RW010, OW014, TU014, CB018a, and CB018b) were determined during the RI to warrant No Further Action (NFA). Wood will petition the Wisconsin Department of Natural Resources (WDNR) for NFA for these five sites in a separate No Further Remedial Action Planned (NFRAP) Decision Document. The location of the Base is shown on **Figure 1** and the Site is shown on **Figure 2.**

This FS was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), WDNR environmental clean-up statutes and rules, and the *Air National Guard (ANG) Environmental Restoration Program (ERP) Investigation Guidance* (ANG, 2009). The FS was prepared following the CERCLA outline, however all elements required by the WDNR NR 722 Standards for Selecting Remedial Actions are incorporated.

1.1 Project Purpose and Scope

The purpose of this FS is to evaluate an appropriate range of remedial alternatives that will reduce risks to human health and the environment at CG019. This evaluation is based upon data, analyses, and all available information generated during historical investigations and the current RI/FS process.

1.2 Feasibility Study Organization

The components of this FS include:

- **Section 1.0 (Introduction)** provides basic purpose of the FS and its objectives, and the regulatory status of the Site.

- **Section 2.0 (Conceptual Site Model)** presents aspects of the conceptual site model (CSM) that support the evaluation of remedial technologies, and pre-design data needs or gaps that are expected to be addressed prior to refining the remedial approach for the Site, if necessary.
- **Section 3.0 (Identification and Screening of Technologies)** details the four steps through which remedial technologies are identified and screened.
  - The first step establishes the Remedial Action Objectives (RAOs), which specify Constituents of Concern (COCs), media of concern, and associated remediation goals, including Applicable or Relevant and Appropriate Requirements (ARARs).
  - The second step establishes medium-specific general response actions (GRAs) (e.g., treatment, containment, and institutional action) to satisfy the RAOs.
  - The third step establishes potentially applicable remedial technologies and associated process options (specific processes within each technology type) that are listed and evaluated for technical feasibility. This step reduces the number of potentially applicable technology types and process options to those that may be effectively implemented at the Site.
  - The final step is the preliminary evaluation of process options based on relative effectiveness, technical and administrative feasibility, and relative cost. The final outcome of **Section 3.0** is a list of process options, which either on their own or in combination may achieve the established RAOs.
- **Section 4.0 (Development and Screening of Alternatives)** utilizes the process options developed in **Section 3.0** and assembles them to form a range of site-wide alternatives to meet the established RAOs. These alternatives are evaluated to ensure they are effective (i.e., protective of human health and the environment), implementable at the Site, and cost effective based on rough order of magnitude costs. The results of this evaluation will determine which preliminary alternatives will be retained for detailed analysis.

  This evaluation also presents detailed descriptions and individual analyses of features unique to each alternative according to each of the nine FS required evaluation criteria, for applicable media at the Site. Evaluations include a description of: the proposed technologies; detailed assessments of the overall protection of human health and the environment; compliance with the ARARs; long-term effectiveness and performance; reduction of toxicity, mobility, or volume through treatment; Short-Term Effectiveness; feasibility; cost; State/support agency acceptance; and community acceptance.

This section provides a comparative analysis to evaluate the relative performance of each alternative in relation to each specific evaluation criterion. This section includes a comparison of the final options for the groundwater remediation alternative, including the comparison table and relevant associated costs for consideration for the Site.

- **Section 5.0 (Summary)** presents the recommendations and preferred remedial alternative for the Site.
- **Section 6.0 (References)** Includes the list of references used throughout the report.

1.3 Facility Background Information

The WANG base located at GMIA houses the 128th ARW. The core mission of the 128th ARW is to transfer fuel to United States Military and Allied aircraft, provide aero-medical evacuation, and to lift personnel and equipment to strategic locations in a cost-effective manner. The following sections provide background information for the Site, including the description of past operations, prior investigations, and remedial actions. This information was adapted from the *Preliminary Assessment/Site Investigation Report for Compliance Restoration Program* (Leidos, 2015) and other project documents referenced below.

1.3.1 Site Description History

Site CG019 is located in the southern portion of Guard Central. The Site is located within the active Jet Fuel Offloading Facility (JFOF) site and previously closed Installation Restoration Program (IRP) Sites 4 (Westshore pipeline release) and 5 (landfill). Previous investigations at CG019 have detected VC in shallow monitoring wells (at depths of approximately 5 to 20 feet [ft] below ground surface [bgs]) and piezometers (at depths of approximately 30 to 40 ft bgs) in the southern portion of Guard Central. VC has also been detected in groundwater during investigations of the Petroleum, Oil, and Lubrication (POL) Facility in the southwestern corner of the Base. No known source area for the VC impact has been identified, however, the impacted area appears to be localized along the drainage ditch on the north side of Prime Beef Drive.

There appears to be two water bearing units at CG019. The upper water bearing zone at the Site primarily consists of sandy material to a depth of approximately 10 ft bgs, with an average depth to the upper water bearing zone of approximately 7 ft bgs. The sand material is underlain by silt and clay materials with discontinuous sand lenses to a depth of approximately 30 ft bgs. The lower water bearing zone consists of a sandy unit that begins at approximately 30 ft bgs and extends to at least 45 ft, which is the maximum depth that has been explored during previous investigation activities at the Site. COCs have previously been detected in both the upper and lower water bearing zones which indicates hydraulic communication between the two zones is likely.

1.3.2 Summary of Previous Investigations

Semi-Annual Groundwater Monitoring, October 2012 through February 2016

Semi-annual groundwater monitoring has been conducted for the JFOF. Wood has reviewed historical reports, including groundwater monitoring reports prepared by Henningson, Durham, Richardson Inc. (HDR) from approximately October 2012 through February of 2016. VC has been detected in multiple wells/piezometers throughout the central southern portion of the Guard Central parcel during investigations (HDR, 2016). Historically, groundwater samples in the shallow zone (5 to 20 ft bgs) have exhibited VC detections. Based on the groundwater sampling activities conducted in 2014 and 2015, concentrations of VC at two wells, exceeded the WDNR 140 Enforcement Standard (ES) value of 0.20 micrograms per liter (ug/L), including: CG019-MW-102 (0.29J ug/L) and CG019-MW-114 (0.24J ug/L). In the deep zone (30-40 ft bgs), VC was detected at concentrations exceeding WDNR NR 140 ES limits at CG019-MW-7P (2.6 ug/L), CG019-MW-13P (0.25J ug/L), CG019-MW-100P (5.0 ug/L), and CG019-MW-112P (0.52 ug/L).

2014 Site Investigation

Due to the historic detections of VC in multiple wells/piezometers throughout the central portion of the Guard Central parcel, CG019 was included as a site to be investigated during a 2014 Site Investigation (SI).

During the 2014 SI sampling event conducted by Leidos (Leidos, 2015), three soil boring/temporary monitoring wells were installed. Four soil samples and three groundwater samples were collected from three locations to investigate VC contamination at CG019. Samples were analyzed for volatile organic compounds (VOCs) only. VC was detected in one groundwater sample, exceeding the WDNR NR 140 ES. VC was not detected in the remaining samples. Soil samples collected during the investigation exhibited concentrations below laboratory detection limits for all VOCs.

2016 Remedial Investigation

During the 2016 RI conducted by Wood, 14 existing monitoring wells were sampled, 10 soil borings were advanced, 18 soil samples were collected from the 10 soil boring locations, 10 new monitoring wells were installed, and two rounds of groundwater samples were collected from each newly installed monitoring well. Samples were analyzed for VOCs only.

VOCs were not observed exceeding criteria in any of the soil samples. VC was the only analyte detected in groundwater in exceedance of WDNR NR 140 ES criteria. Groundwater samples collected during the 2016 RI from the newly installed and existing monitoring well network indicated that VC was only present in the deep wells at the Site (~30-40 ft bgs). VC had previously been detected in shallow zone wells (5-20 ft bgs) during the semi-annual groundwater sampling events from 2012 through 2015. Two deep wells (40 to 50 ft bgs) installed in the vicinity of the highest concentrations of VC observed during the semi-annual groundwater monitoring [2014 SI] exhibited concentrations below WDNR NR 140 ES criteria.

In addition, methylene chloride was detected in 34 of 40 groundwater samples at concentrations ranging from 0.28 ug/l to 0.85 ug/L, below the WDNR NR 140 ES criteria of 5 ug/L, but above the WDNR NR 140 Preventative Action Level (PAL) of 0.5 ug/L. It should be noted the PAL is a screening level, and not an enforceable criterion. Methylene chloride is a common laboratory contaminant, and exceedances were flagged as “estimated” and “biased high” by the laboratory. Therefore, based on the concentrations observed and the data validation flags, the detections appear to be attributed to laboratory interference and not representative of site conditions.

VC concentrations in groundwater have been delineated horizontally and vertically and appear to be located only in the deep zone (30 to 40 ft bgs). VC has not been detected above the WDNR NR 140 ES criteria (0.20 ug/L) in the shallow zone (5 to 20 ft bgs) since the second semi-annual sampling event of 2015. During the second semi-annual sampling event in 2015, VC was detected in only two shallow wells, CG019-MW-102 (0.29J ug/L), and CG019-MW-114 (0.24J ug/L). Both VC detections were flagged as “estimated” and “biased high” by the laboratory. The previous two sampling events at both CG019-MW-102 and CG019-MW-114 were non-detect.

2.0 CONCEPTUAL SITE MODEL

This section provides a summary of the site-specific parameters including land use, hydraulic information, environmental parameters, COCs, the identified and potential release mechanisms, a description of the physical characteristics, and the migration tendencies of the COCs. The purpose of the CSM is to guide the evaluation of remedial alternatives and support the remedial strategy recommended in this FS.

2.1 General Mitchell Air National Guard Base

The following sections provide information on the environmental setting at the GMIA, located in Milwaukee, Wisconsin. This information was adapted from the *Preliminary Assessment/Site Investigation Report for Compliance Restoration Program, General Mitchell International Airport, Wisconsin Air National Guard, Milwaukee, Wisconsin* (Leidos, 2015) and from other resources as referenced below.

2.1.1 Site Location

GMIA is located approximately five miles south of the downtown business district of the City of Milwaukee, in Milwaukee County, Wisconsin. GMIA occupies approximately 2,180 acres of land. The existing WANG facility was constructed in 1962, when base expansion was necessary to accommodate growth. The 128th ARW occupies four main areas at GMIA, referred to as Guard Central, Guard West, Guard East, and Guard South (**Figure 1**). Guard Central includes the largest portion of the Base and is the location of buildings and the Site discussed within this FS Report unless otherwise specified. The Site is located in the southern portion of Guard Central. Guard Central houses main administration, equipment storage and vehicle maintenance, an aircraft apron, and parking.

2.1.2 Climate

The climate in the GMIA area is strongly influenced by Lake Michigan. Winds off the lake affect temperatures and precipitation considerably in the spring and early summer. During the winter months, the prevailing winds are westerly. The greatest rainfall occurs in May and maximum average snowfall occurs in January. The 2012 average daily temperature in the spring and fall ranged from 46.2 degrees Fahrenheit (°F) to 75.4 °F (National Oceanic and Atmospheric Administration [NOAA], 2013).

2.1.3 Topography

GMIA is located approximately 5 miles south of the downtown business district of the city of Milwaukee, in Milwaukee County, Wisconsin. Wisconsin is located in the Lake Michigan Basin in the northern United States. The Base is located in the Great Lakes Plain physiographic region within the Eastern Ridges and Lowlands geographical province (Wisconline, 2013). The surface topography of the Base is relatively flat with an average elevation of approximately 670 ft above mean sea level (amsl).

2.1.4 Geology

The geology of the Milwaukee area is characterized by thick Paleozoic rocks overlain by sediment deposits consisting of unsorted till, deposited as ground and end moraines, and sorted and stratified outwash and glacial lake deposits (OpTech, 1996). Unconsolidated deposits range from approximately 80 to 140 ft bgs and overlay bedrock composed of Silurian age limestone and dolomite.

Shallow stratigraphy at the Base is composed of glacial deposits generally consisting of either fill material or organic material overlain by a thinner clay unit to an average depth of 7 ft bgs. A sand unit is typically encountered that extends to depths of 25 ft bgs (OpTech, 1996).

Surface soils at GMIA have been classified as clayey land by the Soil Conservation Service (SCS). Clayey land is a miscellaneous land type consisting of fill areas and “cut” or “borrow” areas. This land type ranges from clay to silty clay loam, may contain glacial till, and is 1 to 5 ft thick (SCS, 1971).

2.1.5 Surface Water Hydrology

The Base is located approximately 2.5 miles west of Lake Michigan, the primary source of drinking water for the Milwaukee area. Rivers in the area include the Milwaukee River and Menomonee River, both approximately 5 miles to the north, and the Root River, approximately 8 miles to the west. The nearest creek to the Base is Oak Creek, approximately one-half mile to the west (OpTech, 1996).

In the Guard South area and the Guard West area, surface water drains south through drainage ditches into Oak Creek, and eventually to Lake Michigan. Surface water at the majority of Guard East and Guard Central drains through both surface drainage ditches and enclosed storm sewers into a storm water detention pond known as “Bailey’s Pond”. According to the Base EM, the surface water then drains into Wilson Park Creek, then to the Kinnickinnic River and eventually to Lake Michigan. In the Guard South area, surface water drains to drainage ditches, which discharge to the Kinnickinnic River and eventually to Lake Michigan.

2.1.6 Hydrogeology

Regionally, the general direction of groundwater flow is toward Lake Michigan to the east. Groundwater moves within the water table system above bedrock and in a confined system beneath it. In the vicinity of the Base, the prevalence of localized thick layers of clay restricts the hydraulic connection between the shallow and deeper bedrock aquifer.

Within the water table system above bedrock, there are two water bearing zones at GMIA where the COCs have been historically detected. The upper water bearing zone is typically encountered at approximately 6 to 8 ft bgs. Historical reports indicate that shallow groundwater at GMIA generally flows northwest toward topographically low, marshy areas that intercept the shallow groundwater (OpTech, 1996). However, during the 2014 SI and 2016 RI activities, groundwater levels taken from monitoring wells on Base have indicated groundwater flows generally to the east in the shallow (5 to 20 ft bgs) zone.

For the lower water bearing zone, groundwater is typically encountered between approximately 25 to 40 ft bgs and generally flows to the north-northwest across GMIA. However, site wells have consistently indicated groundwater flowing generally to the east in the lower zone during investigation activities. Based on hydraulic testing and water levels in paired monitoring and piezometer wells collected on 5 August 2013 it appears a vertical gradient across the installation is in the downward direction. This suggests that localized infiltration and recharge to the water table is occurring across the Base (HDR, 2014).

During 2014 SI activities groundwater was first encountered within the unconsolidated deposits from 2.8 to 11.0 ft bgs at Guard Central. Across Guard Central, depths to the first encounter of groundwater generally increased from west to east and north to south.

2.1.7 Critical Habitat and Threatened/Endangered Species

According to the U.S. Fish and Wildlife Service (USFWS), the following mammals, birds, insects, plants, and reptiles are federally endangered, threatened, proposed, and/or listed as candidate species in Milwaukee County, USFWS Environmental Conservation Online System (ECOS, 2019):

- *Red knot (Calidris canutus rufa)* – Threatened
- *Northern Long-Eared Bat (Myotis septentrionalis)* – Threatened

- *Rusty Patched Bumble Bee (Bombus affinis)* - Endangered

2.2 CG019

2.2.1 Hydrogeology

There are two water bearing zones at Site CG019, shallow (5 to 20 ft bgs) and deep (30 to 40 bgs). Depth to water in the shallow zone is has typically been encountered between approximately 3.50 ft below top of casing (BTOC) to 6.0 ft bgs BTOC in monitoring wells during site investigations. The deep zone groundwater is located in a confined aquifer with groundwater levels typically encountered between approximately 4.1 ft (CG019-MW-112P) BTOC, to 14.1 ft BTOC, at CG019-MW-109P, in monitoring wells on Site (**Appendix B, Table 1**). In general, the groundwater flows to the east in both the shallow and deep zones.

Slug testing was performed at CG019-MW-201, CG019-MW-206, and CG019-MW-209 by Wood from 25 October 2016 through 2 November 2016. Results from the slug tests estimated hydraulic conductivity at Site CG019 between $6.76E^{-05}$ centimeters per second (cm/s) to $1.99E^{-04}$ cm/s with an average conductivity of $2.43E^{-04}$ cm/s. Results from the slug testing indicate soils at CG019 have low permeability.

Groundwater parameters (**Appendix B, Table 2**) collected at the Site during RI activities ranged as follows:

- pH ranged from approximately 6.9 to 8.0
- Dissolved Oxygen levels range from 0.04 to 0.16 milligrams per liter.
- Oxygen reduction potential levels ranged from approximately -50 to 200 millivolts.

2.2.2 Constituents of Concern

Analytical results from soil samples collected from soil borings at CG019 during RI activities indicate that there are no COCs in exceedance of the Wisconsin Remediation and Redevelopment (RR) Program residual contaminant levels (RCLs) (**Appendix B, Table 3**).

Analytical results from the RI investigation from existing and newly installed permanent groundwater monitoring well samples indicate COC concentrations were non-detect or detected below applicable criteria for all VOCs in groundwater except VC. VC exceeded the WDNR NR 140 ES value of 0.20 ug/L at five monitoring well locations (CG019-MW-7P, CG019-MW-100P, CG019-MW-102P, CG019-MW-112P, and CG019-MW-207). VC concentrations ranged from 1.0

to 5.8 ug/L. VC concentrations in the remainder of the groundwater samples were either below applicable criteria, or non-detect (**Appendix B, Table 4)**.

COCs

Soils – None

Groundwater – vinyl chloride

2.2.3 Vapor Intrusion Screening

A vapor intrusion (VI) screening was completed on for the groundwater impacts at the Site following WDNR RR 800 guidelines. The only COC at the Site is currently VC in the groundwater. The groundwater interval that has exceedances of the WDNR NR 140 ES are located in the deep zone at depths of approximately 30 to 40 ft bgs, which is overlain by a clean water leans (shallow zone) in the 5 to 20 ft bgs range. Concentrations in the shallow zone for VC were non-detect during the 2016 sampling event, while the concentrations in the deep zone ranged from non-detect in multiple wells, to 5.8 ug/L in CG019-MW-100P.

Section 3.4.2 of WDNR NR 800 "When groundwater contamination is deep and the water table is clean, the clean water prevents the migration of vapors into the vadose zone. Vapor intrusion is not a risk from the contaminated groundwater in that scenario". Therefor if the shallow zone is below VI limits, then VI is not a risk at the Site. The groundwater concentration posing a potential vapor risk for VC is calculated by using the equation in Table 6a of WDNR NR 800. The calculations for VC are listed below:

C_{gw} = VAL / (H x AF x 1000)

C_{gw} = groundwater concentration that could cause a VAL exceedance (ug/L)

VAL = vapor action level – 28 ug/m^3 from WI Vapor Quick Look-Up Table based on 2017 EPA screening levels (referenced from Section 6.2.5 of WDNR NR 800)

AF = Attenuation Factor - 0.001 (for residential or small commercial building)

H = Henry's Constant for VC – 0.828 From EPA VISL spreadsheet as referenced in WI Vapor Quick Look-Up Table

Therefore, C_{gw} = 33.82 ug/L in groundwater. As the shallow, and deep groundwater concentrations for VC are below 33.82 ug/L, there is no VI risk at the Site.

2.2.4 Release Mechanisms

Based on a review of historical documentation, there is no known source of the VC contamination at the Site. The VC concentrations have historically been generally located along the length of the storm drainage ditch running along the north side of Prime Beef Drive.

2.2.5 Nature and Extent

Soil data was collected at CG019 during the 2016 RI activities using a direct-push technology rig to advance sample collection equipment for the collection of discrete soil samples for the purpose of evaluating potential subsurface soil impacts. Soil samples were collected and analyzed for VOCs.

Groundwater data was collected at CG019 from 14 existing and 10 newly installed permanent monitoring wells. Groundwater samples collected were submitted for laboratory analysis of VOCs.

Soils

Analytical results from soil samples collected during RI activities indicated VOC concentrations were either non-detect or were below applicable Wisconsin RR RCLs. Therefore, no COCs are present in soils at the Site (**Appendix B, Table 3**).

Groundwater

Analytical results from permanent monitoring wells indicate VC as the only COC in exceedance of the WDNR NR 140 ES criteria. Analytical data from shallow zone monitoring wells collected indicated COCs were below applicable criteria or non-detect. Five monitoring wells in the deep zone (CG019-MW-7P, CG019-MW-100P, CG019-MW-102P, CG019-MW-112P, and CG019-MW-207) indicated exceedances of VC at concentrations exceeding ES criteria (**Appendix B, Table 4**). Given this, the groundwater COCs at the Site are adequately delineated horizontally by permanent monitoring wells CG019-MW-101P, CG019-MW-111P, CG019-MW-201, CG019-MW-202, CG019-MW-203, CG019-MW-205, CG019-MW-208, CG019-MW-209, and CG019-MW-210. The groundwater is vertically delineated by permanent monitoring wells CG019-MW-204, and CG019-MW-206. **Figure 3** shows the approximate extent of groundwater impacts.

2.2.6 Pre-Design Evaluation

This CSM comprises site specific data required to estimate the area potentially requiring remediation, select appropriate RAOs, and identify applicable remedial technologies. Updates to the CSM with additional source area data needs will, if obtained, provide a better evaluation of applicable remedial technologies. Assumptions regarding the pertinent source area characteristics and settings are primarily based on information collected during the 2016 RI. Some additional understanding to source area CSM comes from historical investigations conducted in 2014. Based on these limitations, the feasibility of applicable source area remedial technologies discussed herein may need to change due to the following data needs:

- Location of all on-site utilities: The Site is located along Prime Beef Drive and near the POL facility. A complete layout of all utilities is needed to adequately plan for any remedial option for the source zone. Utilities may need to be protected, braced, or re-routed, if located in the remedial area.
- Concentrations of geochemical parameters in groundwater should be collected simultaneously with future sampling to estimate pre-treatment needs for groundwater extraction/treatment process options.
- Pre-design and or pilot/bench studies will be conducted as appropriate for the chosen technology.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The NCP requires the remedial alternative evaluation process be initiated by developing RAOs, identifying GRAs that address the RAOs, and performing an initial screening of applicable remedial technologies and process options. The following sections detail these activities.

Development of RAOs, as defined by the United States Environmental Protection Agency (USEPA), consists of medium-specific or operable unit-specific goals for protecting human health and the environment (USEPA, 1988). Once RAOs have been established, GRAs must be identified, which consist of broad approach remedial measures that can potentially achieve RAOs. GRAs may encompass numerous remedial technologies and remedial technology process options.

3.1 Remedial Action Objectives

To develop RAOs and GRAs, site-specific COCs and s must be identified. The following sections discuss COCs and ARARs applicable to the Site.

3.1.1 Constituents of Concern

Soil COCs and their respective clean-up criteria are presented in **Table 3-1** below.

Table 3-1. Soil Constituents of Concern and Clean-Up Criteria

Site	Constituent	Clean-Up Criteria
CG019	None	Not Applicable

Groundwater COCs and their respective groundwater quality standards (GWQS) are listed in **Table 3-2** below.

Table 3-2. Groundwater Constituents of Concern and Clean-Up Criteria

Site	Constituent	Clean-Up Criteria* (ug/L)
CG019	vinyl chloride	0.20

Notes:
* WDNR NR 140 ES
µg/L - micrograms per liter

3.1.2 Appropriate, Relevant, and Applicable Requirements

The NCP (42 code of federal regulations [CFR] 300) defines “applicable” requirements as: “those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility citing laws that specifically address a hazardous substance, pollutant, contaminant, removal action, location, or other circumstance found at a CERCLA site." Only those promulgated state standards identified by a state in a timely manner that are substantive and equally or more stringent than federal requirements may be applicable.

The NCP further defines "relevant and appropriate" requirements as: "those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility citing laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, removal action, location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site." Like "applicable" requirements, the NCP also provides that only those promulgated state requirements identified in a timely manner and are more stringent than corresponding federal requirements may be relevant and appropriate. The USEPA identifies three basic types of ARARs including chemical-specific, action-specific, and location-specific.

Non-promulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. However, such requirements may be useful and are "to be considered" (TBC). TBC requirements [40 CFR §300.400(g)(3)] complement ARARs but do not override them. They are useful for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

The sections below introduce and define the various types of ARARs for CERCLA sites while the below tables contain ARARs and TBC requirements for the Site. It should be noted that the information presented below considers and is consistent with the Federal Aviation Administration's Base Master Plan.

3.1.2.1 Location-Specific ARARs

Location-specific ARARs pertain to existing site features. Location-specific ARARs place restrictions on constituent concentrations or remedial/removal activities solely based on-site setting or location (e.g., within or adjacent to wetlands, floodplains, existing landfills, disposal areas, and places of historical or archeological significance).

Potential location-specific ARARs that are applicable or relevant and appropriate for the Site are listed in **Table 3-3**.

Table 3-3. Location-Specific ARARs

Standard, Requirement, Criteria, or Limitation	Description	Potential ARARs or TBC
Base		
Limitation	Site is located along/beneath Prime Beef Drive, a main road on the base, and adjacent to the POL facility. Any remedial activities will require maintaining the mission of the base. All precautions will need to be taken to reduce disruption to base operations.	TBC

3.1.2.2 Chemical-Specific ARARs

Chemical-specific ARARs govern the extent of site clean-up by providing clean-up levels or a basis for calculating clean-up levels. For example, health-, or risk-based numerical values for the soil may be selected as the clean-up goals for the COCs for the Site. Based on this scenario, chemical-specific ARARs may be used to indicate acceptable criteria for establishing remediation and disposal requirements for assessing the effectiveness of removal action alternatives. Thus, chemical-specific ARARs establish acceptable concentrations of constituents in various media. The chemical specific ARARs for the Site are presented in **Table 3-4**.

Table 3-4. Chemical-Specific ARARs

Standard, Requirement, Criteria, or Limitation	Description	Potential ARARs or TBC
Federal		
SDWA National Primary Drinking Water Standards 40 CFR Part 141, Subpart B, pursuant to 42. USC §§ 300g-1 and 300j-9	Establishes maximum contaminant levels for specific contaminants, which are health-based standards for public drinking water systems.	ARARs
Clean Air Act - National Emission Standards for Hazardous Air Pollutants 40 CFR Part 61, Subparts N, O, P pursuant to 42 USC §7412	Sets emission standards for certain industrial pollutants and sources. No air emissions are anticipated after remediation.	ARARs
RFD USEPA Office of Research and Development Cancer Slope Factor, USEPA Environmental Criteria and Assessment Office, USEPA Carcinogen Assessment Group Health Advisories, USEPA Office of Drinking Water Health Effects Assessments, USEPA Environmental Criteria and Assessment Office USEPA Regional Screening Levels	These criteria are used during risk-based screening and the risk assessment to evaluate risks posed to human health by site conditions. Maximum exposure concentrations established during the risk assessment will be considered during identification and evaluation of remedial alternatives.	TBC
State		
WDNR NR 140 Enforcement Standards	Contains tables: • Drinking Water & Groundwater Quality Standards/Advisory Levels (Table 1) • Drinking Water & Groundwater Quality Public Welfare/Secondary Standards (Table 2)	ARARs
WDNR NR 714 Public Participation And Notification	Identifies the required public participation and notification activities for response actions undertaken pursuant to chs. NR 700 to 754	ARARs

Standard, Requirement, Criteria, or Limitation	Description	Potential ARARs or TBC
WDNR 722 Standards For Selecting Remedial Actions	Establishes minimum standards for identifying and evaluating remedial action options and selecting remedial actions	ARARs
WDNR 724 Remedial And Interim Action Design, Implementation, Operation, Maintenance And Monitoring Requirements	Specifies the requirements for the design, implementation, operation, maintenance and monitoring of remedial actions and certain types of interim actions	ARARs
NR 726 Case Closure	Specifies the minimum requirements and conditions that shall be met before the department may determine that a case related to a discharge of hazardous substances or environmental pollution at a specific site or facility may be closed	TBC

Notes:
ARAR - Appropriate, Relevant, and Applicable Requirement
CFR - Code of Federal Regulations
WDNR – Wisconsin Department of Natural Resources
USEPA - United States Environmental Protection Agency
SDWA - Safe Water Drinking Act
TBC - to be considered
USC - United States Code
RFD – Reference Dose

3.1.2.3 Action-Specific ARARs

Action-specific ARARs pertain to proposed site remedial actions and govern implementation of the selected site remedy. Action-specific ARARs set controls or restrictions on activities related to the management of contaminated and/or hazardous materials. After remedial action alternatives are developed, action-specific ARARs pertaining to proposed Site remedies provide a basis for assessing their feasibility and effectiveness. For example, action-specific ARARs may include hazardous waste management requirements, air and water emission standards, and Resource Conservation and Recovery Act (RCRA) landfill requirements. Potential action-specific ARARs that are applicable or relevant and appropriate are included in **Table 3-5**.

Table 3-5. Action-Specific ARARs

Standard, Requirement, Criteria, or Limitation	Description	Potential ARARs or TBC
Federal		
Off-Site Rule, 40 CFR 300.440 pursuant to CERCLA Section 121(d)(3);	Requires that CERCLA wastes may only be placed in a facility operating in compliance with the RCRA or other applicable Federal or State requirements. That section further prohibits the transfer of CERCLA wastes to a land disposal facility that is releasing contaminants into the environment and requires that any releases from other waste management units must be controlled.	ARARs
Threshold Limit Values, American Conference of Governmental Industrial Hygienists	Values established for air concentrations during remedial activities are enforced through OSHA (above).	TBC
OSHA Requirements (29 CFR Parts 1910, 1926, and 1904)	Health and safety requirements for workers engaged in on-site remedial activities are established under this act.	ARARs

Notes:
ARAR - Appropriate, Relevant, and Applicable Requirement
CFR - Code of Federal Regulations
USEPA - United States Environmental Protection Agency
CERCLA - Comprehensive Environmental Response Compensation, and Liability Act
OSHA – Occupational Safety and Health Administration
TBC - to be considered
USC - United States Code

3.2 Development of Remediation Goals

RAOs are goals to protect human health and the environment, to prevent or minimize exposure to contaminants, and to achieve compliance with ARARs (USEPA, 1988). The RAOs presented in **Table 3-6** were developed to serve as guidelines for the development and evaluation of remedial alternatives.

Table 3-6. Remedial Action Objectives

Groundwater	Soils
Remedial Action Objectives (RAOs)	
• Reduce the contaminant levels in groundwater to below WDNR applicable criteria; • Prevent exposure to contaminated groundwater that could be harmful to human health and the environment; and, • Eliminate future risk to human health by mitigating potential migration of COCs at concentrations above human health risk standards to surrounding environmental media.	• Not Applicable

Notes:
WDNR – Wisconsin Department of Natural Resources
COC – Constituent of Concern

3.3 General Response Actions

GRAs are broadly defined as actions that can reduce or eliminate the risk that contaminants present to human health or the environment. GRAs are media-specific measures that may be taken to satisfy the RAOs. **Table 3-7** presents the GRAs for groundwater and soil.

Table 3-7. General Response Actions by Media of Concern

Groundwater	Soil
General Response Actions (GRAs)	
• No Action • Institutional Controls • Containment • Monitored Natural Attenuation • In-Situ Technologies • Ex-Situ Technologies and Discharge	• Not Applicable

3.3.1 GRA – No Action

No Action implies that no remedial action would be conducted. The "No Action" GRA does not involve any remedial action; therefore, groundwater and soil at the Site would be allowed to continue in their current states, and no action would be conducted to remove or remediate the contamination. No access restrictions would be put into place, and no deed restrictions are placed on the Site. The NCP requires that "No Action" be included among the GRAs evaluated in every FS, as detailed in 40 CFR 300.430(e)(6). The "No Action" response would be evaluated for soil and groundwater media and provides a baseline for comparison to the other remedial response actions.

3.3.2 GRA – Institutional Controls

Institutional controls (ICs) are generally administrative and legal tools that help minimize the potential for human exposure to contamination without construction or physically changing the Site. ICs are generally divided into four categories (government controls, proprietary controls, enforcement tools, and informational devices). ICs can be an effective means of eliminating possible pathways of exposure by restricting access to contaminated media and are usually required as a part of long-term remedial actions in accordance with the USEPA and WDNR. ICs do not reduce the toxicity, mobility, or volume of contamination, but are implemented to reduce the probability of physical contact with contaminated media while natural processes are occurring. ICs will be evaluated in conjunction with, rather than in lieu of, other GRAs.

3.3.3 GRA – Containment

Containment isolates and/or hydraulically controls contaminants at the Site to reduce risk of exposure to source materials and reduce the risk of ongoing contaminated groundwater migration towards downgradient receptors. Groundwater containment remedies may include groundwater extraction to reduce risks for impacted groundwater from continuing to migrate beyond the source area. A groundwater treatment facility is typically combined with groundwater extraction technologies unless extracted groundwater meets applicable discharge criteria. Additional containment may include a low permeable cap that would reduce risks of direct contact and risks from storm water infiltration through vadose soils and/or low permeable subsurface barriers around the source area to reduce groundwater venting, which contribute to the groundwater flux through the source area.

3.3.4 GRA – In-Situ Technologies

In-situ technologies consist of processes or actions that treat contaminants in-place utilizing methods to separate and remove contaminants or to degrade contaminants. In-situ technologies that separate and remove contaminants may include soil flushing, air-sparging, soil vapor extraction (SVE), and chemical oxidation. In-situ biological technologies involve the use of natural processes or the addition of microbes and/or nutrients to enhance natural biologic processes and facilitate the degradation of contaminants.

3.3.5 GRA – Ex-Situ Technologies and Discharge/Disposal

Ex-situ technologies and discharge or disposal consists of actions that treat contaminants after removal from the subsurface. In groundwater, ex-situ technologies can involve physical or chemical processes such as air-stripping, carbon adsorption, biological treatment, precipitation/co-precipitation, ion exchange, or reverse osmosis. When groundwater is treated ex-situ, it is generally discharged off-site or injected back into the aquifer. Ex-situ technologies may be combined with groundwater containment (extraction wells) to minimize the migration of the COC plume.

3.4 Identification and Screening of Technology Types and Process Options

In accordance with the NCP, potentially applicable technology types and process options are evaluated with respect to technical implementability. The term ‘technology types’ refers to general categories of technologies such as chemical treatment, biological treatment, and vertical barriers. The term ‘process options’ refers to the specific processes within each technology type. In this section, remedial technology types and process options are identified and screened per site and environmental media. A list of the retained technologies and the basis for retaining them are provided as **Table 3-8**.

Table 3-8. Screening of Remedial Action Technologies for IRP Sites Treatment and Screening of Alternatives

Screening of Potential Remedial Technologies and Process Options		Evaluation of Process Options for Soil and Groundwater				
General Response Action	Remedial Technology Type	Process Option	Description	Technology Retained For Groundwater	Technology Retained For Soil	Basis for Rejecting or Retaining Technology
No Action	No Action	No Action	Impact remains in place, no effort to reduce concentrations.	YES	NA	Retained, as required per NCP
Institutional Controls	Institutional Controls	Institutional Controls	Prohibit the use or disturbance of soil and groundwater at the Site. Concentration trends are monitored to determine movement towards RAOs without/after remedial measures.	YES	NA	Retained, as required per NCP
Containment	Physical/ Hydraulic Barriers	Extraction Wells	Prevent migration of impacted groundwater via collection in individual wells. Extracted water disposed of or treated on site, or offsite publicly owned treatment works (POTW).	YES	NA	Retained for groundwater to prevent migration of groundwater plume
		Infiltration Trench	Prevent migration of impacted groundwater via collection in infiltration galleries, ideal for low flow rates. Extracted water disposed of or treated on site, or offsite POTW.	NO	NA	Not retained for groundwater. Infiltration trench was not retained as COCs appear to be present in the lower confined aquifer. As the groundwater aquifer appears to be under pressure, a groundwater trench would produce significant amounts of groundwater for treatment.
		Capping	Low permeable soils, asphalt, or multimedia cap to prevent direct contact exposure and protect groundwater from COCs in unsaturated soil.	NO	NA	Not retained, does not reduce groundwater contaminants and groundwater COCs not present in shallow groundwater zone.
		Vertical Hydraulic Barrier	Minimize groundwater migration with low permeability wall site encapsulation	NO	NA	Not retained, does not reduce groundwater contamination.
In-Situ Treatment	Physical Processes/ Treatments	Monitored Natural Attenuation	Natural attenuation is a process that acts without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants. This in-situ process typically includes biodegradation, dispersion, advection, and volatilization.	YES	NA	Retained, may be effective for groundwater remediation depending on site conditions.
		Permeable Reactive Barrier - adsorption	Subsurface wall or funnel and gate that intercepts contaminated groundwater with a treatment material.	NO	NA	Not retained, does not reduce groundwater concentrations in plume. COC plume does not appear to be moving at a significant rate, PRB requires groundwater to flow through the barrier to capture COCs.
		Chemical Injections	In-situ chemical injection involves the injection or direct mixing of chemical reactants into groundwater and/or soil for the primary purpose of contaminant destruction.	YES	NA	Retained, may be effective for groundwater treatment for VOCs.
		Air Sparge/ Bio-Sparge and SVE	Air sparging is the process of directly injecting air into groundwater. Air sparging remediates groundwater and saturated soils by volatilizing contaminants and enhancing biodegradation. Vapors are removed by SVE and treated as required. Effective for VOCs and some Semi-Volatile Organic Compounds (SVOCs).	NO	NA	Not retained, air sparging requires the removal of the soil vapor. The lower groundwater zone is confined by a clay layer and appears to be under pressure. Therefore, there is no headspace to remove the soil vapors. Without soil vapor control, the injected air could migrate COCs.
		Thermal	The mobilizing or destruction of chemicals using heat	NO	NA	Not retained, although very effective for destruction of VOCs, SVE is required to remove the vapor phase COCs. Due to the confining clay layer and the deeper groundwater zone being under pressure, there is not a way to effectively remove the resultant soil vapors. Additionally, the location of the plume would require remedial activities in the roadway and near the POL facility which may affect the base mission.
Removal	Source Removal	Excavation and Disposal	Remove and dispose of impacted soil and groundwater as non-hazardous waste	NO	NA	Not retained. No source area soils identified; excavation does not directly treat groundwater COCs. Depth and location of COCs would make excavation infeasible.
	Groundwater Removal	Extraction System	Groundwater extraction and on-site treatment with disposal of treated groundwater to surface water or POTW.	YES	NA	Retained for groundwater treatment.

3.4.1 Preliminary Screening of Technologies

Potentially applicable technologies passing the preliminary screening are listed below for further evaluation. Technologies that have not been demonstrated in practice to be effective in addressing the site-specific issues, or that could not be implemented due to site-specific conditions, were eliminated from further consideration (see **Table 3-8**). The GRAs for the remaining remedial technologies were further evaluated for overall effectiveness, implementability, and relative cost, as described below:

- **Effectiveness:** Evaluate relative ability for technology to achieve RAOs in a reasonable timeframe, short-term and long-term. Short-term effectiveness encompasses potential effects to human health and environment during the construction and implementation periods, while long-term effectiveness encompasses the reliability and protectiveness of the technology after implementation.
- **Implementability:** Evaluate the ability to construct, operate, maintain, and monitor the technology's effectiveness during and after construction.
- **Cost:** The total cost of a given technology was not estimated during the preliminary screening described in this section. Relative cost considerations based on vendor communications and preliminary quotations, cost-estimating guides, prior projects, and engineering judgment, including overall construction, operation, maintenance and monitoring (OM&M) costs were used to preliminary screen potential technologies and processes. Detailed costs for remedial alternatives were developed in subsequent sections of this FS.

The evaluation and preliminary screening of potentially applicable remedial technologies for each GRA is described below.

3.4.1.1 No Action

No Action implies that no remedial action would be conducted. The "No Action" GRA does not involve any remedial action; therefore, groundwater and soil at the IRP Site would be allowed to continue in their current state, and no action would be conducted to remove or remediate the contamination. No access restrictions would be put into place, and no deed restrictions are placed on the Site. The NCP requires that "No Action" be included among the GRAs evaluated in every FS, as detailed in 40 CFR 300.430(e)(6).

Considerations for Effectiveness

"No Action" would not meet short-term RAOs for the Site. Long-term RAOs may be met for VC or, where naturally occurring and biological degradation can occur over time. However, site conditions would need to be favorable for degradation, and without monitoring there would be no way to verify conditions at the Site.

Considerations for Implementation

There are no considerations for implementation for taking no action.

Considerations for Cost

Taking no action at the Site would be the least expensive option for the Site.

Summary

No action at the Site would not reduce exposure risks at the Site. Although it is the most implementable and cheapest option, no action is not considered feasible at the Site as it may not reach site short and long term RAOs.

3.4.1.2 Institution Controls

ICs can be used to prohibit the use or disturbance of contaminated media at the Site. Concentration trends are monitored to determine movement towards RAOs.

Considerations for Effectiveness

ICs alone would not prevent groundwater migration. However, when combined with another technology, they can minimize the potential for human health or ecological exposure to the source area. Effective ICs may be used at some sites without the need for a containment cover, which would be used to isolate contaminants from directly contacting potential receptors, when preventing direct contact exposure is not a RAO or direct contact may be prevented with other engineering controls (e.g., fences or other restrictive barricades).

Considerations for Implementation

Institutional controls typically are grouped into the following categories (USEPA, 2012):

- Proprietary land use restrictions and maintenance agreements that may involve legal instruments.
- Governmental controls including permit conditions for future actions.
- Enforcement and permit tools with ICs are legal tools, such as administrative orders, Federal Facility Agreements, and Consent Decrees, that require compliance with other ICs.
- Informational devices including signage and fish consumption advisories that may be required until RAOs are met.

Considerations for Cost

Many ICs, such as maintenance and enforcement activities, may extend beyond 30-years, requiring financial assurance mechanisms to secure the responsible party financing for the ICs. These costs are relatively insignificant in comparison to other source area remedial technologies.

Summary

Proprietary land use restrictions as a primary remedial technology does not meet RAOs, however ICs may be combined with other technologies to meet remedial objects. Therefore, ICs will be further retained to be used in combination with other technologies.

3.4.1.3 Containment

Source containment involves confining contaminated substances in-situ through placement of hydraulic or physical barriers to prevent contact with and/or migration of the contaminated substances. The hydraulic containment approach includes a groundwater migration control system that extracts contaminated groundwater, treats the extracted groundwater as necessary, and discharges to a permitted outfall. Physical barriers were not retained from the initial screening process. The following containment process options were identified as potentially applicable and further evaluated during the preliminary screening process:

- Groundwater Extraction using Extraction Wells
- Groundwater Treatment - Granular Activated Carbon (GAC)

Considerations for Effectiveness

Groundwater Extraction using Extraction Wells

Groundwater migration control requires a groundwater extraction system to intercept impacted groundwater and reduce groundwater migration from the source area. The groundwater extraction technologies retained for preliminary screening include extraction wells. The technology is proven effective in the short term, however, over the long-term ferric iron and/or bacteria fouling is a common occurrence. In the event fouling occurs, a drilling rig with cleanout surge blocks are required for cleaning out extraction wells.

Due to the confined aquifer conditions, the radius of influence (ROI) for each extraction well is likely to be relatively low, making the required number of extraction wells and treatment flow rate relatively high. Therefore, an extraction well ROI may be limited or less than anticipated based on groundwater variations to be evaluated during pre-design evaluations

Groundwater Treatment - GAC

Extracted source area groundwater will require treatment prior to discharge to a permitted outfall, assumed to be the local publicly owned treatment works sanitary sewer. GAC is proven to be effective in the short term. As fouling parameters can negatively impact treatment components, additional changeouts and/or OM&M may be required.

Considerations for Implementation

Groundwater Extraction using Extraction Wells

Groundwater wells have been proven to be implementable at a wide range of depths and flow rates and require a limited amount of equipment. However, to cover a larger area, multiple wells are needed and an extraction well network may require prolonged construction time and interference with base operations during installation.

Groundwater Treatment - GAC

GAC treatment would require the following:

- A treatment building that will protect the vessels from weather and freezing conditions.
- Operations and maintenance, including system monitoring, sampling, GAC change outs, discharge permitting, and treatment building maintenance.
- The treatment system building, piping, controls, etc. are readily available and installation could be completed within a brief time frame (less than 6 months).

Considerations for Cost

Groundwater Extraction using Extraction Wells

Because of the limited ROI anticipated with extraction wells due to the low permeability of the soils as indicated by the slug testing, extraction well spacing is expected to be close and the price for the network of wells is expected to be relatively high. In addition, site conditions may require periodic well cleaning to maintain the design extraction rates from the extraction wells.

Groundwater Treatment - GAC

Capital costs for GAC are fairly high to install the carbon vessels. Carbon changeout frequency may be negatively impacted by groundwater fouling parameters and pre-treatment of the groundwater may be required, increasing costs for carbon and additional OM&M.

Summary

Due to the location of COCs in the deeper groundwater zone, extraction and GAC treatment may be appropriate for CG019. Therefore, this process option will be retained for further evaluation at the Site.

3.4.1.4 Monitored Natural Attenuation (MNA)

Natural attenuation is a process that acts without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants. This in-situ process typically includes biodegradation, dispersion, advection, and volatilization. Natural attenuation of constituents in groundwater would be monitored using the existing monitoring well network as well as newly installed wells.

Considerations for Effectiveness

MNA does not actively reduce the COC concentrations on Site.

Considerations for Implementation

MNA could be readily implemented at the Site. It is a proven alternative that has been implemented at other federal facility sites where groundwater has been impacted. Groundwater monitoring could be implemented in existing or newly installed monitoring wells.

Considerations for Cost

The capital costs associated with the MNA process option are relatively low and would only involve the installation of monitoring wells as needed. While monitoring would continue for more than 30 years, the overall present value costs of monitoring are relatively low since there is no active treatment system requiring maintenance.

Summary

While the MNA process option may not achieve the RAOs alone in the short-term (i.e., less than 30 years), it can be used as a baseline to compare against other alternatives and could be used effectively in combination with other alternatives (i.e., as a “polishing” step following the active treatment processes to treat COC concentrations). Therefore, this process option will be retained to be included as a baseline alternative or used in combination with other process options.

3.4.1.5 Chemical Injection

Chemical injection involves injection of an oxidant, or reducing agent, into injection points or permanent wells installed in the impacted groundwater zone to reduce COC concentrations. There are different injection chemicals to treat different COCs.

Considerations for Effectiveness

Chemical injection is a proven technology in reducing VOCs. The proper injectant for a site is determined by the COCs. VOCs or semi-volatile organic compounds (SVOCs) may be treated with an oxidant, while chlorinated VOCs (CVOC) substances would be treated by an oxidant or chemical reducing agents. For Site CG019, an anaerobic bioremediation approach is recommended. Dissolved oxygen (DO) less than 0.5 milligrams per liter (mg/L) and oxidation reduction potential (ORP) less than -100 millivolts (mV), within the treatment zone indicate that reducing conditions are present. The average ORP within the source area of the VC plume (MWs-207, 102P, 7P, 100P, and 112P) is -98.84 mV (range from -76.3 to -129.7 mV), and the average DO within the source area of the VC plume is 0.102 mg/L (range 0.06 to 0.14 mg/L), supporting that reducing conditions are present in the source area such that anaerobic dechlorination can occur. Injections would consist of an injectant (electron donor/source of hydrogen) and an addition of a bioaugmentation substrate to accelerate biological degradation rates.

The amount of injectant to be applied is calculated from the mass of COCs in the groundwater and soil. Application of the injectant material in the appropriate quantities and locations is critical for the success of treatment.

Considerations for Implementation

Injections can be performed through temporary injection points or permanent injection wells. As injections rely on a liquid or slurry being forced into the subsurface, it is best implemented in sandy or porous soils so the injectant materials can flow into the subsurface. Injections may be difficult in silty or clayey soils resulting in slower application rates or surfacing of material.

Considerations for Cost

The capital costs associated with chemical injections can be relatively low as injections can be done directly into the subsurface without installing permanent points. However, multiple rounds of injections may be needed to meet cleanup goals.

Summary

Chemical injections can be effective in reducing COC concentrations to meet RAOs. Therefore, this process option will be retained for further evaluation at CG019.

3.4.2 Summary of Retained Technologies for CG019

Each process option presented in **Table 3-8** was screened for applicability at the Site and either retained or not retained for further evaluation with regard to effectiveness, implementability, and cost. As a result of this screening process, the options carried forward for development of alternatives are as follows:

- No Action;
- MNA and ICs;
- Groundwater Extraction and Treatment (containment); and
- Chemical Injections plus MNA.

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Wood had evaluated remedial alternatives for the COCs at Site CG019 in this FS. The contents of this FS were developed in accordance with the *Air National Guard Environmental Restoration Program (ERP) Investigation Guidance (ANG, 2009),* the CERCLA; and the SARA.

This section presents the development and description of remedial alternatives assembled from combinations of technologies and associated process options carried forward from the technology screening in **Section 3.4**. The approach to development and screening, a description of each alternative, and the screening results are provided below. Although representative process options are identified in the alternatives, it should be recognized that these may be modified during the remedial design and implementation phases of the selected alternative due to updates to the CSM and pre-design evaluations, engineering considerations, localized site conditions, and/or new information. Cost changes (e.g., transportation and disposal charges), that may change prior to remediation and field conditions (e.g., utility crossings) that were not fully identified during the RI, will be evaluated further as part of the pre-design investigation and will be considered during the design of the selected remedial alternative.

The CERCLA remedial alternative selection process is used to identify and plan the implementation of CERCLA remedial actions that eliminate, reduce, or control risks to human health and the environment (40 CFR 300). Criteria for identifying possible applicable technologies to achieve these goals are provided in USEPA guidance (USEPA, 1988) and the NCP.

The NCP defines the following preferences in developing remedial action alternatives:

- Use of treatment to address the principal threats posed by a site, wherever practical.
- Use of engineering controls (e.g., containment) for waste that poses a relatively low, long-term threat and for which treatment is not practical.
- Implementation of a combination of actions, as appropriate, to achieve protection of human health and the environment.
- Use of ICs to supplement engineering controls for short- and long-term management to prevent or limit exposures.
- Selection of an innovative technology when the technology offers the potential for comparable or better treatment performance or implementability, fewer adverse impacts than other technologies, or lower costs than demonstrated technologies for similar levels of performance.

- Restoration of environmental media, such as groundwater, to their beneficial uses whenever practical and within a reasonable timeframe. When restoration of groundwater to beneficial uses is not practical, USEPA expects to minimize further migration of the contaminant plume, prevent human and environmental exposures to contaminated groundwater, and evaluate further risk reduction.
- Until source area soil concentrations have been exhausted or been remediated, this ongoing contaminant mass flux through the source area is expected to remain stable. Therefore, it is assumed that each alternative that does not remove the source material will require OM&M for a minimum of 30 years.

The purpose of the range of remedial alternatives is to present the decision-makers with several technical and economic options to achieve the RAOs. Remedial alternatives may be selected from the previous screening or be a combination of technologies. Regulatory preferences and considerations were also a factor in development of the remedial alternatives. The following alternatives were selected based on the initial screening process to be carried forward.

Common elements/assumptions for each alternative include the following:

- Staging areas for materials handling, dewatering, and water treatment will be required. It has been assumed that the areas immediately adjacent to the Site will serve as the staging area.
- Disposal of waste would be conducted in accordance with the off-site rule (CERCLA Section 121[d][3]) and with the disposal facility's permit requirements. It is assumed that all of the excavated material would be acceptable for disposal at a local non-hazardous waste landfill.
- ICs will be required, including access and use restriction for any areas where contamination is left in place.

Alternative 1: No Action

The "No Action" GRA does not involve any remedial action; therefore, groundwater at CG019 would be allowed to continue in its current state, and no action would be conducted to remove or remediate the contamination. No access restrictions would be put into place, and no deed restrictions are placed on the Site. The NCP requires that "No Action" be included among the GRAs evaluated in every FS, as detailed in 40 CFR 300.430(e)(6), as a basis of comparison.

Alternative 2: MNA and ICs

Alternative 2 includes the establishment of ICs in accordance with the USEPA and WDNR to restrict the use of groundwater from the Site. The ICs will provide notice that there is groundwater contamination in a localized area and will remain in effect until monitoring indicates that COC concentrations are below the applicable cleanup criteria. MNA sampling and reporting would be conducted until Site COCs are below clean-up criteria.

Alternative 3: Groundwater Extraction and Treatment

Alternative 3 includes the installation of groundwater extraction wells in combination with ex-situ treatment of the extracted groundwater using GAC. Treated groundwater would then be discharged to the storm or sanitary sewer per permit requirements.

For hydraulic control of the Site an estimated 10 extraction wells with a pumping rate of 25 gallons per minute (gpm) each is used for the purposes of this FS. However, a pumping test should be completed prior to implementation to determine the true hydraulics at the Site.

The groundwater treatment system would treat the extracted groundwater using GAC. The groundwater would flow through two 10,000 pounds (lbs) GAC tanks in series (lead/lag configuration), then be discharged to the storm or sanitary sewer. A National Pollutant Discharge Elimination System (NPDES) or sanitary discharge permit would be required with permitted limits of all COCs. Sampling of COCs would be required per the permit to meet effluent limits and to determine carbon changeout frequency.

Alternative 4: Chemical Injections plus MNA

Alternative 4 includes In-Situ chemical injections followed by MNA. Injections would be completed using direct-push injection points to inject the chemicals into the groundwater COC plume. Several different chemical injection materials are appropriate for chlorinated VOCs in groundwater (i.e., 3-d Microemulsion™, emulsified vegetable oil, etc.). MNA would be required following injections to monitor the reduction in Site COCs until concentrations are below site clean-up criteria.

4.1 Remedial Alternatives Evaluation

In this section of the FS, the retained alternatives are developed in more detail and evaluated against evaluation criteria as outlined by the NCP. This evaluation includes a comparative analysis of the relative performance of each alternative to the nine required assessment criteria.

4.1.1 Assessment Criteria

The NCP (Section 300.430) requires that the alternatives be compared with one another using nine evaluation criteria. The purpose of the comparison is to identify the relative advantages and disadvantages of each alternative. These nine criteria are divided into subcategories: Threshold Criteria, Primary Balancing Criteria, and Modifying Criteria, as follows:

- Threshold Criteria:
  - Overall Protection of Human Health and the Environment
  - Compliance with ARARs
- Primary Balancing Criteria:
  - Long-Term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility, or Volume through Treatment
  - Short-Term Effectiveness
  - Implementability
  - Cost
- Modifying Criteria:
  - State Acceptance
  - Community Acceptance

The three criteria categories are based upon the role of each criterion during the evaluation and remedy selection process. The two Threshold Criteria relate directly to statutory requirements that must be satisfied by a selected alternative. The five Primary Balancing Criteria represent the primary technical, cost, institutional, and risk factors that form the basis of the evaluation. The two Modifying Criteria are typically evaluated following the receipt of state agency and public comments on the Project Plan and will not be evaluated as a part of this FS.

4.1.2 Threshold Criteria

Overall Protection of Human Health and the Environment

Protection of human health and the environment is one of two threshold requirements that each alternative must meet in order to be eligible for selection as a remedy (the other being compliance with ARARs). This criterion evaluates how the alternative will reduce the risk from potential exposure pathways and considers any unacceptable risks potentially posed in the short- and long-term.

Compliance with ARARs

Compliance with ARARs is the second threshold requirement that each alternative must meet in order to be eligible for selection as a remedy. Alternatives are assessed to determine whether they meet ARARs or facility regulations and/or procedures. ARARs specific to the Site are discussed in **Section 3.1.2**.

4.1.3 Primary Balancing Criteria

Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence are evaluated with respect to the magnitude of residual risk associated with untreated media or treatment of residuals remaining once remedial action activities are complete and objectives have been met. In addition, the adequacy and reliability of controls, such as containment systems and ICs, necessary to manage untreated media or treatment residuals and wastes are also considered.

Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment assesses the degree to which the alternative employs treatment as the primary element that permanently and significantly reduces toxicity, mobility, or volume of contaminants. Factors to be considered include: the treatment/recycling process specific to site contaminants; the volume of material the alternative will treat; the degree of expected reduction in toxicity, mobility, or volume of contamination; the degree to which the treatment is irreversible; and, the type and quantity of residuals remaining following treatment.

Short-Term Effectiveness

Evaluation of short-term effectiveness determines whether alternatives are effective with relation to short-term risks that might be posed to the community during implementation of the alternative or until response objectives are met. Short-term risks include potential impacts to on-site workers and the environment during remedial action activities and the effectiveness and reliability of protective and/or mitigative measures. When determining which alternative is more effective in the short-term, risks (to the community, on-site workers, or the environment) must be weighed against the time to reach clean-up levels.

Implementability

Under this criterion, the technical and administrative feasibility of implementing each alternative is evaluated. The availability of needed materials and services is also considered. The technical feasibility considerations include the technical difficulties anticipated in construction, reliability of the selected technology, and ease of implementing the remedy. Administrative feasibility considers coordination of interested parties, as well as any required permits.

Cost

Cost estimates were calculated using capital costs (including both direct and indirect costs), annual OM&M costs, and net present value of capital and OM&M costs. The cost estimates are based on quotes obtained from Wisconsin vendors and disposal facilities, RS Means construction cost data, previous experience with similar projects, and USEPA cost estimating guidance for feasibility studies (USEPA, 2000). Cost estimates were compiled for the remedial action alternatives using typical construction scenarios assumed for the existing conditions and may be subject to change during the final design process. The provided cost estimates are primarily for comparing remedial action alternatives.

4.1.4 Individual Analysis of Alternatives

4.1.4.1 Alternative 1 – No Action

Pursuant to the NCP requirements and compliant with USEPA guidance (USEPA, 1988), the "No Action" alternative establishes baseline environmental conditions, as described in the RI section of this report, for comparison to other alternatives. Under this alternative, no remedial action would be taken, including monitoring of chemical concentrations in site media that would be left in place, and any identified contaminants are left "as is" without the implementation of any containment, removal, treatment, or other protective measures.

Overall Protection of Human Health and the Environment*:* The "No Action" alternative is not acceptable for source zone groundwater as concentrations currently exceed WDNR NR 140 ES criteria.

Compliance with ARARs: Because no action is being taken under this alternative, it will not meet the ARARs for groundwater. "No Action" does meet action and location specific ARARs as there would be no interference from remediation activities or interference with motor pool activities.

Long-Term Effectiveness and Permanence: This alternative provides no controls for exposure and no long-term management measures. The temporal stability of COCs distributed in groundwater have not been characterized, therefore additional contamination may be distributed as groundwater may vent through the area at a larger extent, as the COCs remain in the plume area over time. Therefore, “No Action” provides no reduction in risk to humans or the environment, and the risks may increase beyond the current ongoing and natural processes.

Reduction of Toxicity, Mobility, or Volume through Treatment: Since no remedial technologies are proposed, this alternative will not reduce the toxicity, mobility, or volume of contaminants through treatment. The concentration of COCs within the groundwater will continue to exceed WDNR NR 140 ES standards, as no action will be taken to reduce or isolate contamination in the plume area. This alternative will also not provide any action to address potential exposure pathways or migration due to transport. Therefore, this alternative will not meet this criterion.

Short-Term Effectiveness: This alternative will be ineffective during the short-term. Risks, or potential risks, to both human and ecological receptors from the source area will remain unchanged under the “No Action” alternative.

Implementability: The “No Action” alternative does not involve any construction and; therefore, could be implemented immediately. Issues concerning the availability of services, equipment, space, utilities, or manpower are not relevant for this alternative, and coordination with other agencies or permits is not required.

Cost: There are no costs associated with this alternative.

4.1.4.2 Alternative 2 – MNA and ICs

Alternative 2: MNA and ICs includes the following elements:

- Establishment of ICs for groundwater use
- MNA and reporting until site closure

MNA relies solely on subsurface natural attenuation processes to achieve site-specific RAOs as compared to other more active methods. Natural attenuation processes active in the MNA approach typically include physical, chemical, and/or biological processes that act without human intervention to reduce mass, toxicity, volume, mobility, or concentration of contaminants. In the environment chlorinated VOCs naturally attenuate primarily through biological pathways to chemically reduce COCs into harmless end products. Advection and dispersion of COCs within the plume will also cause concentrations to decline over time.

In order to monitor the progress of MNA and ultimately obtain site closure, a groundwater monitoring program would be needed. Several monitoring wells are currently positioned to monitor the natural attenuation of site contaminants. Final monitoring well locations and quantities would be decided based on discussions with project stakeholders; however, for the purposes of this FS, it is assumed that the current monitoring well network is sufficient.

ICs would be established in accordance with USEPA and WDNR to restrict groundwater from this area. ICs will provide notice that there is groundwater contamination in a localized area caused by a release and will remain in effect until monitoring indicates that COC concentrations at CG019 are below the clean-up criteria.

As previously discussed, it is not anticipated that MNA will achieve site clean-up levels in less than 30 years. Once clean-up levels are achieved and confirmed through groundwater monitoring in accordance with USEPA and WDNR, NFRAP would be requested and monitoring wells at the Site would be permanently abandoned.

This alternative would also include the development of all required reports, including, but not limited to:

- Long-Term Monitoring (LTM) Plan;
- Groundwater Monitoring Reports (it is assumed that a total of 36 groundwater monitoring reports would be required [years 1 and 2 would require quarterly monitoring reports, years 3 through 30 would require annual monitoring reports]);
- 5-Year Reviews (to include IC review);
- Well Abandonment/Site Closure Reports; and,
- No Further Response Action Planned Decision Document.

Overall Protection of Human Health and the Environment*:* Over the long-term, as biological reduction, advection and dispersion processes occur within the plume, concentrations of COCs will ultimately decline to levels below site-specific clean-up criteria, which is protective of both human health and the environment. However, this alternative will not be fully protective of human health and the environment until clean-up criteria have been reached.

Compliance with ARARs: This alternative would ultimately be compliant with chemical-, action-, and location-specific ARARs. The concentrations of COCs will naturally decline over time to acceptable concentrations. However, these concentrations will likely not be achieved within 30 years. Per CERCLA guidance, a maximum of 30 years will be used for the cost analysis.

Long-Term Effectiveness and Permanence*:* Implementation of this alternative will be effective and permanent in the long-term. The biological reduction, advection and dispersion processes that naturally occur in the plume are permanent and irreversible. This alternative would not result in any residual risk as a result of implementation. It is anticipated that the timeframe to reduce COC concentrations from their current highs is more than 30 years.

Reduction of Toxicity, Mobility, or Volume through Treatment: While implementation of this alternative will reduce the toxicity of the COC plume through biological process, advection, and dispersion, greater than 30 years are anticipated to be required to reach clean up criteria. Over time, COC concentrations will decrease, which will decrease the toxicity, mobility, and mass of COCs in the groundwater. Additional sampling for MNA parameters may be required to confirm the viability of MNA. However, this alternative does not meet the USEPA statutory preference for selecting remedial actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, and volume of the contaminants.

Short-Term Effectiveness**:** During the short-term, groundwater use restrictions will be placed on impacted groundwater at CG019. During remedial actions, workers could be exposed to contaminated groundwater during groundwater monitoring activities. These risks will be mitigated through use of proper personal protective equipment. Procedures and precautions would be implemented to minimize worker exposure to contaminants during any site work, and all remediation workers would be trained in hazardous waste operations as mandated by 29 CFR 1910.120.

Implementability: Implementation of this alternative is relatively easy. Initially, the establishment of ICs will be required by the USEPA and/or WDNR to limit access to impacted groundwater during LTM activities. LTM of COCs would commence until concentrations reach clean-up levels. All services required (environmental sampling activities, laboratory analysis, and environmental reporting) are readily available.

Cost: The total present value of this option is estimated to be $610,000, which includes environmental sampling activities, laboratory analysis, and environmental reporting. **Table 4-1** presents the estimated costs for Alternative 2. A detailed cost estimate is provided in **Appendix G**.

Table 4-1. Cost Summary for Alternative 2 – MNA and ICs

Description	Total Cost
Pre-work Activities (work plans, pilot testing, etc..)	$60,000
Annual Reporting Costs (2 years quarterly)	$70,000
Annual Reporting (28 years semi-annual)	$35,000
Project Total (Year 0)	**$125,000**
NPV[a] of 30 years LTM	**$485,000**
Net Project Total	**$610,000**

Notes:
[a] Net Present value based on 7% discount rate
LTM – long-term monitoring
All Costs are rounded to nearest $5,000
All cost estimates are made on a +50% / -30% level of accuracy

4.1.4.3 Alternative 3 – Groundwater Extraction and Treatment

Alternative 3: Groundwater Extraction and Treatment includes the following elements:

- Conduct pumping test and additional modeling to determine optimal flow rates and GAC sizing;
- Secure discharge permit through the publicly owned treatment works (POTW) or NPDES for effluent discharge;
- Installation of extraction wells, trenching, and groundwater treatment system;
- Operation and maintenance of ex-situ treatment system which has the capability to intercept the groundwater migrating through the plume area;
- LTM;
- Decommissioning of treatment following successful remediation, and,
- Site closure.

Alternative 3 includes the combination of a groundwater extraction wells with a GAC treatment system for treatment of the extracted groundwater and discharge to the storm or sanitary sewer system. For purposes of this FS it is assumed that a standalone treatment system would be constructed at CG019.

Prior to implementation, the following data needs would need to be completed;

- A pilot study is recommended, to gather the necessary data for a full-scale design. The pilot study would include installation of recovery well(s) and additional monitoring wells (as needed) to conduct a pumping test(s) to determine a more accurate hydraulic conductivity, and to evaluate the capture zone of the extraction wells and evaluate any adverse effects associated with implementation of the system;

- Additional groundwater sampling for GAC performance parameters and additional plume definition;
- Treatability study for GAC;
- Additional groundwater modeling to outline the capture zone for appropriate location of the extraction wells;
- Utility locations for trenching work and building usage; and
- Permitting (ANG work permits, discharge permits, building, electrical, etc.).

An estimated 10 extraction wells is anticipated for hydraulic control at the Site (**Figure 4**). An estimated 700 feet of trenching would be required to connect the extraction wells to the treatment system. Recovered groundwater would be pumped via subsurface piping to a treatment building (30-ft x 40-ft x 15-ft high) constructed on site. The building would need to include both heating, ventilation, and secondary containment. The utility trenches would also contain electrical and controls conduits for continuous read communications with level instruments to be included in the equalization tank and automated on/off and speed control for the extraction pumps. Due to the confined nature of the aquifer, the sandy soils, and hydraulic conductivity at the Site, an extraction rate of 25 gpm per well was estimated for this FS.

Extracted groundwater pumped to the treatment building would first enter an equalization tank to help regulate flow rates to the treatment vessels. A transfer pump would then send the water through a particulate filter vessel, to be designed to remove suspended solids that may restrict process water flow through the downstream GAC. The filter would then be followed by two 10,000 lb GAC vessels, plumbed in series to maintain a minimum of 10 min contact time to remove COCs to below discharge limits. Treated water would then be discharged to the storm or sanitary sewer under a NPDES or POTW discharge permit, as required.

System controls will be critical for proper operation. Power to all pumps would run through variable frequency drives and water levels inside the extraction wells would be monitored utilizing pressure transducers. Water level data from the extraction wells would be sent to a Programmable Logic Controller, which would control power output to the extraction pumps to maintain a pre-defined groundwater level in the wells. The system would be remotely monitored via a supervisory control and data acquisition system equipped with emergency shutdown and notification alarm conditions. In addition to remote monitoring, it is assumed that the operator would perform on-site visits once every two weeks for OM&M activities.

Potential GAC usage rates were estimated using adsorption rates used at similar sites and an assumed flow rate of 250 gpm total from the extraction wells. Due to the low levels of COCs (maximum VC concentration of 5.8 ug/L), carbon changeouts may be required more for fouling parameters (i.e. total organic carbon [TOC]) than for the adsorption of the VC in the media. Therefore, without data for the GAC performance parameters, an estimated changeout frequency of 6 months is used for this FS (**Appendix G**).

This alternative would also include the development of all required reporting, including, but not limited to:

- Pre-design Investigation, including pilot testing;
- Remedial Action Design;
- Remedial Action Work Plan subject to approval by WANG and WDNR;
- Remedial Action Completion Report; and
- LTM/OM&M reporting;
- 5-Year Reviews (to include IC review);
- Well Abandonment/Site Closeout Reports; and,
- No Further Response Action Planned Decision Document.

It should be noted that the assumptions set forth in this detailed description are for the purposes of this FS and associated costing.

Overall Protection of Human Health and the Environment: Alternative 3 will meet RAOs through a combination of isolating the plume area from potential receptors, and by reducing COC concentrations in groundwater that exceed the clean-up criteria, which is protective of human health. Uncertainty associated with hydraulic interception due to unknown variability in hydraulics would have to be met during a data needs investigation. This alternative would protect human health and the environment in both the short-term and the long-term as it would remove the risks associated with the COC concentrations in groundwater in the plume area.

Compliance with ARARs*:* This alternative will comply with chemical ARARs as the groundwater contamination will be isolated within the containment area and COCs extracted from the plume area. It is estimated that the treatment system may remain in operation for up to 30 years. Due to the diffuse nature of the plume, heterogeneity of the soils, and low concentration of COC criterion, extensive run times may be required. For the purposes of this FS, 30 years will be used for life cycle costing.

Location specific ARARs can be met with advanced planning with the WANG and airport with the location of the treatment building and compliance with all traffic and access restriction due to the location on the Base. The treatment building and access is estimated to be required for up to 30 years. Compliance during remediation activities can be managed as described in the implementability section.

Action Specific ARARs can be met with compliance with all ANG and airport procedures for access and use on the Base. Compliance during remediation activities can be managed as described in the implementability section.

Long-Term Effectiveness and Permanence: Groundwater extraction and treatment systems, and specifically the proposed GAC treatment system identified here, have been popular remedial technologies and have been proven effective at sites worldwide. Site conditions, such as soil conditions, at CG019 are appropriate for this technology, so the reliability of the technology to maintain the groundwater plume is high. The effective life of the system is estimated to exceed 30 years based on proven effectiveness.

The installation of the extraction wells will maintain hydraulic control of the Site by intercepting groundwater flowing through the plume area. The system removes COCs from the environment so further migration downgradient is reduced.

Long term vulnerabilities, although not unacceptable, include: more suitable for low K and less aquifer thickness, continuity of confining unit and aquifer thickness is unknown with existing data, OM&M is required to maintain inward gradient towards extraction wells, competitive adsorption to GAC may increase GAC consumption over required life, increase OM&M due to common solids infiltration into the extraction wells and treatment system.

***Reduction of Toxicity, Mobility, or Volume through Treatment**:* Alternative 3 substantially reduces the mobility of COCs downgradient of the plume area by removing groundwater venting through the plume. Toxicity and volume remain relatively unchanged throughout the life span of this alternative as source area contamination remains in place. A hydraulic study will be required to confirm that variability in groundwater flow can be managed with extraction wells and the treatment system.

***Short-Term Effectiveness**:* Alternative 3 would be effective in the short-term at reducing the concentrations in the groundwater plume by removing groundwater impacted by COCs in the plume. Contaminated groundwater is extracted at depth and pumped to the treatment building, limiting human and ecological exposure. Installation of the extraction wells and the associated system piping would involve installation activities into the contaminated groundwater table. Therefore, procedures and precautions would be implemented to minimize worker exposure to contaminants and all remediation workers would be trained in hazardous waste operations as mandated by 29 CFR 1910.120.

Implementability: The implementability of this alternative is considered moderate. All required equipment is readily available. A source of power is assumed to be available at the Site to run the system, which will operate continuously (24 hours per day and 7 days per week) for an estimated 30 years. The equipment and procedures for replacing GAC and collecting and monitoring groundwater samples are routine. Additional planning with the Base would be required to minimize disruption to the Base mission during installation activities.

Cost: The present value cost of Alternative 3 for CG019 is estimated to be $12,630,000, for a groundwater extraction and treatment system, annual OM&M, and LTM and reporting. Refer to **Table 4-2** below for the cost estimation for Alternative 3. Note that annual OM&M cost is estimated with treated groundwater discharging to the sanitary sewer. A detailed cost estimate is provided in **Appendix G**.

Table 4-2. Cost Summary for Alternative 3 – Groundwater Extraction and Treatment

Description	Total Cost
Pre-Work Activities – Work Plans, pre-design evaluation, Pilot Testing, etc.	$325,000
System Design, Installation and Operation, Demobilization	$2,535,000
Annual OM&M	$725,000
Project Total (Year 0)	**$3,650,000**
NPV[a] of 30 years Operation	**$8,980,000**
Net Project Total	**$12,630,000**

Notes:
[a] Present value based on 7% discount rate
All Costs are rounded to nearest $5,000
All cost estimates are made on a +50% / -30% level of accuracy

4.1.4.4 Alternative 4 – Chemical Injections Plus MNA

Alternative 4: Chemical Injections plus MNA includes the following elements:

- Conduct pilot testing and additional modeling to determine optimal injectant rates and amounts;
- Secure injection waiver through WDNR;
- Execution of chemical injections through direct injection points;
- Performance and LTM, and,

- Site closure.

Chemical injections for chlorinated VOCs general involves treating to enhance anaerobic bioremediation, or reductive dechlorination. Biological reductive dechlorination is often catalyzed by certain species of bacteria. Sometimes the bacterial species are highly specialized for organochlorine respiration and even a particular electron donor, as in the case of *Dehalococcoides* and *Dehalobacter*. Complete reductive dechlorination results in the chlorinated compounds being transformed to non-toxic, dissolved gases such as ethene and ethane.

Chemical injections can be performed in either permanent injection points or by direct-push temporary injection points. Several different chemical injection materials are appropriate for chlorinated VOCs in groundwater (i.e., 3-D MicroEmulsion®, EHC®, etc.) as an electron donor and generally injections of a bioaugmentation substrate to accelerate biological degradation rates by increasing the amount of appropriate microbes to the area.

For the purpose of this FS the injection plan was designed as treatment lines placed perpendicular to the direction of groundwater flow due to the large area of the plume. Treatment lines were placed approximately 50 ft apart on average, and injection points approximately 12 ft within rows, for a total of approximately 60 points, to ensure overlap (**Figure 5**). Injection material is estimated at 350 lbs of electron donor and 0.5 liters of substrate per point.

Upon completion of the injection, performance monitoring will be conducted to monitor post-remedial effectiveness. It is assumed that the results of the performance monitoring, will indicate that COC concentrations within the target treatment zone would reach applicable criterion within 24 months of completion of the injection. Reducing conditions in the aquifer at levels conducive to reductive dechlorination may remain for 3 years or longer.

Once it has been established that the injection remedy itself is considered complete, monitoring would begin in accordance with USEPA and WDNR requirements. For the purposes of this FS, it is assumed that four rounds of monitoring would be required to verify concentrations of COCs remain below applicable criteria. Monitoring wells involved in the MNA polishing step would continue to be monitored until GWQSs are met.

This alternative would also include the development of all required reports, including, but not limited to:

- Remedial Action Work Plan (including the results of a pilot study) subject to approval by USEPA and WDNR;
- After Action Report;

- Groundwater Monitoring Reports (it is assumed that a total of 12 groundwater monitoring reports would be required [quarterly reporting for first 24 months, semi-annual for following 2 years]);
- Well Abandonment/Site Closeout Reports; and,
- No Further Response Action Planned Decision Document.

It should be noted that the assumptions set forth in this detailed description are for the purposes of this FS and associated costing. Prior to implementation of this alternative, a pilot study should be conducted to collect the necessary data for a full-scale injection design. The pilot study would minimally consist of groundwater and soil oxidant demand analysis, which would refine the assumptions associated with injection rates and optimal injection chemical to be used and proper concentrations for the impacted groundwater.

***Overall Protection of Human Health and the Environment**:* Alternative 4 would be protective of human health and the environment in that the contaminant mass would be reduced. The target active treatment goal throughout the aquifer is estimated to be met within approximately 4 years (assuming two years for treatment, and two years for monitoring).

***Compliance with ARARs**:* The implementation of chemical injections plus MNA would comply with chemical-specific ARARs in the long-term after treatment. COC concentrations would be reduced approximately 2 years from the implementation of the alternative. It is anticipated that MNA would be an effective final polishing step in this process to bring concentrations of COCs to the final GWQS. The anticipated timeframe to attenuate COCs in this aquifer zone is approximately 3 years. During the execution of this alternative, all federal, state, and local requirements would be followed.

Location and Action specific ARARs will be met, as following remedial activities there will be no interference with the Base mission. The Site will be returned to the same state after activities are complete. Compliance during remediation activities can be managed as described in the implementability section.

Long-Term Effectiveness and Permanence: This alternative would be effective and permanent in the long-term. The treatment will reduce the COCs into harmless byproducts, destroying them permanently and reducing overall COC concentrations in the plume.

Reductive dechlorination is a proven technology that would be effective in destroying significant quantities of COCs within the ROI of the injection wells and downgradient via advective flow. Depending on the type of injectant used, downgradient treatment may be effective due to the persistent nature of some injectants that could last for months to years in the subsurface.

Reduction of Toxicity, Mobility, or Volume through Treatment*:* Alternative 4 would reduce the toxicity, mobility, and volume of contaminated groundwater through permanent treatment of COCs through reductive dechlorination. This alternative does meet the USEPA statutory preference for selecting remedial actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, and/or volume of the contaminants.

Short-Term Effectiveness: Alternative 4 would be effective in the short-term by quickly reducing COC concentrations and potential exposure to contaminants. It is estimated that the highest concentrations of COCs would be reduced within approximately 2 years of implementation. Reduction of COC concentrations to GWQSs would occur via MNA.

Installation of injection points would involve drilling into contaminated groundwater and the injection process would require remediation workers to handle injectant materials. All remediation workers would be trained in hazardous waste operations as mandated by 29 CFR 1910.120.

Implementability: Chemical injections plus MNA would be readily implementable and would not require the installation of permanent piping or hosing, limiting disruption to the Base. All required equipment, including "off-the-shelf" systems are available. Injection chemicals are commercially available and have been used to reduce significantly greater levels of contamination of the target COCs at other sites. A source of power is available at the Site to run the injection pumps. The power supply would only be required intermittently during injection events. The equipment and procedures for injecting collecting and monitoring groundwater samples are routine and regular OM&M is not necessary.

Sufficient space is available for the implementation of Alternative 4. However, injections would require multiple injection points be drilled into the subsurface in and near current infrastructure, therefore, additional planning with Base personnel would be required to limit activities possibly interfering with the Base mission/operations. Prior to implementation, permits, such as an underground injection variance would be obtained. It is estimated that a single round of injections would require approximately 2 months to complete. The estimated timeframe to complete this alternative through site closure is 5 years.

Cost: The total estimated cost for the recommended alternative would be approximately $1,010,000. **Table 4-3** presents the estimated costs for chemical injections. A detailed cost estimate is provided in **Appendix G**.

Table 4-3. Cost Summary for Alternative 4 – Chemical Injections

Description	Total Cost
Pre-Work Activities – Work Plans, pre-design evaluation, Pilot Testing, etc.	$230,000
Design, and Implementation	$465,000
Annual LTM	$70,000
Project Total (Year 0)	**$760,000**
NPV[a] of 5 Years LTM	**$250,000**
Project Total	**$1,010,000**

Notes:
[a] Present value based on 7% discount rate
All Costs are rounded to nearest $5,000
All cost estimates are made on a +50% / -30% level of accuracy

4.2 Comparative Analyses of Options

Alternative 1 (No Action) does not meet either of the threshold criteria necessary to be selected as the preferred alternative. Therefore, based on the performance in the primary balancing criteria, this alternative is not eligible for selection and will not be further discussed/evaluated.

Alternative 2 (MNA and ICs) would achieve short and long-term overall protection of human health and the environment and will comply with ARARs through short term restrictions and long-term natural attenuation. Due to the prolonged length of time for natural attenuation to occur, this alternative could take more than 30 years to reach clean-up criteria. However, as historic trends of VC in groundwater are declining across the Site, there appears to be little risk of COCs migrating from the Site. Once restriction on groundwater use are completed, there is no relevant pathway for human exposure in the COCs impacted groundwater zone (approximately 30-40 ft bgs).

Alternative 3 (Groundwater Extraction and Treatment) would achieve ARARs by hydraulically containing the groundwater plume through active remediation by pumping groundwater out of extraction wells. Extracted groundwater would then be treated through GAC vessels and discharged to the storm or sanitary sewers. Groundwater extraction will minimize plume migration until COCs in groundwater reduce to below clean-up levels by natural attenuation. A groundwater extraction and treatment system is expected to be a long-term treatment option that may take over 30 years for completion and would also include long-term OM&M of the treatment system. OM&M would include equipment cleaning, repairs, replacement, and carbon changeouts.

Alternative 4 (Chemical Injections Plus MNA) would achieve ARARs by actively changing the aquifer to reducing conditions and increasing reductive dechlorination. Chemicals would be applied to the subsurface through direct injection points into the COC plume at the required depths. Injection activities would last approximately 2 months. During injection activities, coordination with the WANG would be required to limit the interference with Base operations. COCs would be expected to decline below cleanup criteria in approximately 24 months, followed by three years of MNA.

A full comparison of the Alternatives is detailed in **Table 4-4** below:

Table 4-4. CG019 – Summary of Comparative Analysis

	Criterion	Alternative 1: No Action	Alternative 2: MNA and ICs	Alternative 3: Groundwater Extraction and Treatment	Alternative 4: Chemical Injections
Threshold Criteria	*Overall Protection of Human Health and the Environment*	**1** - would not be protective	**3** + would be protective of human health with groundwater use restrictions	**3** + would hydraulically contain the COC plume	**4** + would permanently breakdown plume COCs
Threshold Criteria	*Compliance with ARARs*	**1** - would not comply with ARARs	**3** + will comply with ARARs	**3** + will comply with ARARs	**3** + will comply with ARARs
Primary Balancing Criteria	*Long-Term Effectiveness and Permanence*	**1** - will not be able to verify effectiveness or permanence over the long-term	**3** + permanently breaks down COCs through reductive dechlorination - requires continued monitoring	**3** + hydraulic control of the COCs on site - requires OM&M of system and large amount of energy	**4** + permanent remedy + no system requiring OM&M - Site utilities and location of buildings require additional engineering
Primary Balancing Criteria	*Reduction of Toxicity, Mobility, or Volume through Treatment*	**1** - would not provide treatment and thus toxicity, mobility or volume would not be reduced through treatment.	**1** + will not reduce mobility of COCs	**3** + will eliminate mobility of COCs	**4** + remedy is irreversible + will reduce mass of COCs

Criterion		Alternative 1: No Action	Alternative 2: MNA and ICs	Alternative 3: Groundwater Extraction and Treatment	Alternative 4: Chemical Injections
	Short-Term Effectiveness	**1** - will not reach site closure - will not utilize ICs to minimize exposure + no added risk to the community, workers, or the environment resulting from implementation.	**3** + ICs will restrict groundwater use, therefore human exposure + no risks during implementation	**4** + reduce mobility of COCs through hydraulic control of site + minimal risks during implementation	**4** + Short term breakdown of COCs on site +remedy is irreversible - minimal risks during implementation
	Implementability	**5** + no issues with implementability	**5** + no issues with implementability	**3** + reliable technology + contractors and supplies readily available - trenching and underground utilities or obstructions could make implementation difficult - piping and trenching requirements may interfere with Base mission and future development plans. - continued OM&M and discharge costs	**4** + contractors/ supplies readily available + one-time event, no ongoing maintenance - underground utilities or obstructions could make implementation difficult - Multiple rounds of injections may be required to reach goals
	Cost	**5** + No cost	**4** + Relatively low costs throughout project - Long term project	**1** - High capitol and OM&M costs -Long term project	**3** + Moderate capital costs + relatively short-term project - Multiple rounds of injections may be required to reach goals
	***Total Score*[a]**	**15**	**22**	**19**	**26**
	***Total Present Value*[b]**	**$0**	**$610,000**	**$12,630,000**	**$1,010,000**

Notes:

Ranking: 5-Excellent performance; 4-Good/acceptable performance; 3-Average/acceptable performance; 2-Below average performance; 1-Unsatisfactory performance

[a] Total Score does not account for costs

[b] Cost is the total present value assuming a 7% discount rate for OMM activities and rounded to nearest $5,000

All cost estimates are made on a +50% / -30% level of accuracy

4.3 Conclusions and Recommendations

Based on the comparative analysis of the Alternatives, Alternative 4 – Chemical Injections plus

MNA is selected for the remediation of Site CG019. Chemical injections, via temporary injection points, designed to enhance anaerobic bioremediation, or reductive dechlorination in the source area followed by MNA should decrease levels of VC below the WDNR NR 140 ES criteria. Prior to execution of this alternative, additional aquifer data should be collected to verify geo-chemical conditions are appropriate for biological remediation. A small-scale pilot test may be appropriate to determine the appropriate injection materials. Additionally, an evaluation of the monitoring well network for LTM should be completed and additional wells installed if needed. Upon reaching applicable criteria, site closure will be requested using the WDNR closure request form 4400-202 when appropriate.

Prior to implementing the selected remedy at Site CG019, a full remediation design will be completed and submitted in a Remedial Action Work Plan. The work plan will include details including recommendations for minimizing plume migration, preferential pathways and short-circuiting along with all required local, state, and federal permitting and variances required to complete the work.

5.0 SUMMARY

Soil

Analytical results from soil samples collected from soil borings at CG019 indicate that there are no COCs in exceedance of the RCLs.

Groundwater

Analytical results from existing and newly installed permanent groundwater monitoring well samples indicate COC concentrations were non-detect or detected below applicable criteria for all VOCs except VC. VC exceeded the WDNR NR 140 ES value of 0.20 ug/L at five monitoring well locations (CG019-MW-7P, CG019-MW-100P, CG019-MW-102P, CG019-MW-112P, and CG019-MW-207). Concentrations ranged from 1.0 to 5.8 ug/L.

Recommendations

Based on the data collected during the RI activities, an FS was completed for the Site. The following four alternatives were chosen for Individual Analysis:

- Alternative 1: No Action
- Alternative 2: MNA and ICs
- Alternative 3: Groundwater Extraction and Treatment
- Alternative 4: Chemical Injections Plus MNA

Based on the results of the FS for Site CG019, it is recommended to implement Alternative #4, Chemical Injections Plus MNA and LTM to reduce Site COCs to below WDNR NR 140 ES criterion. LTM data will be used to determine when Site COC concentrations have decreased below applicable standards, at which point a request for No Further Action will be completed.

6.0 REFERENCES

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FIGURES

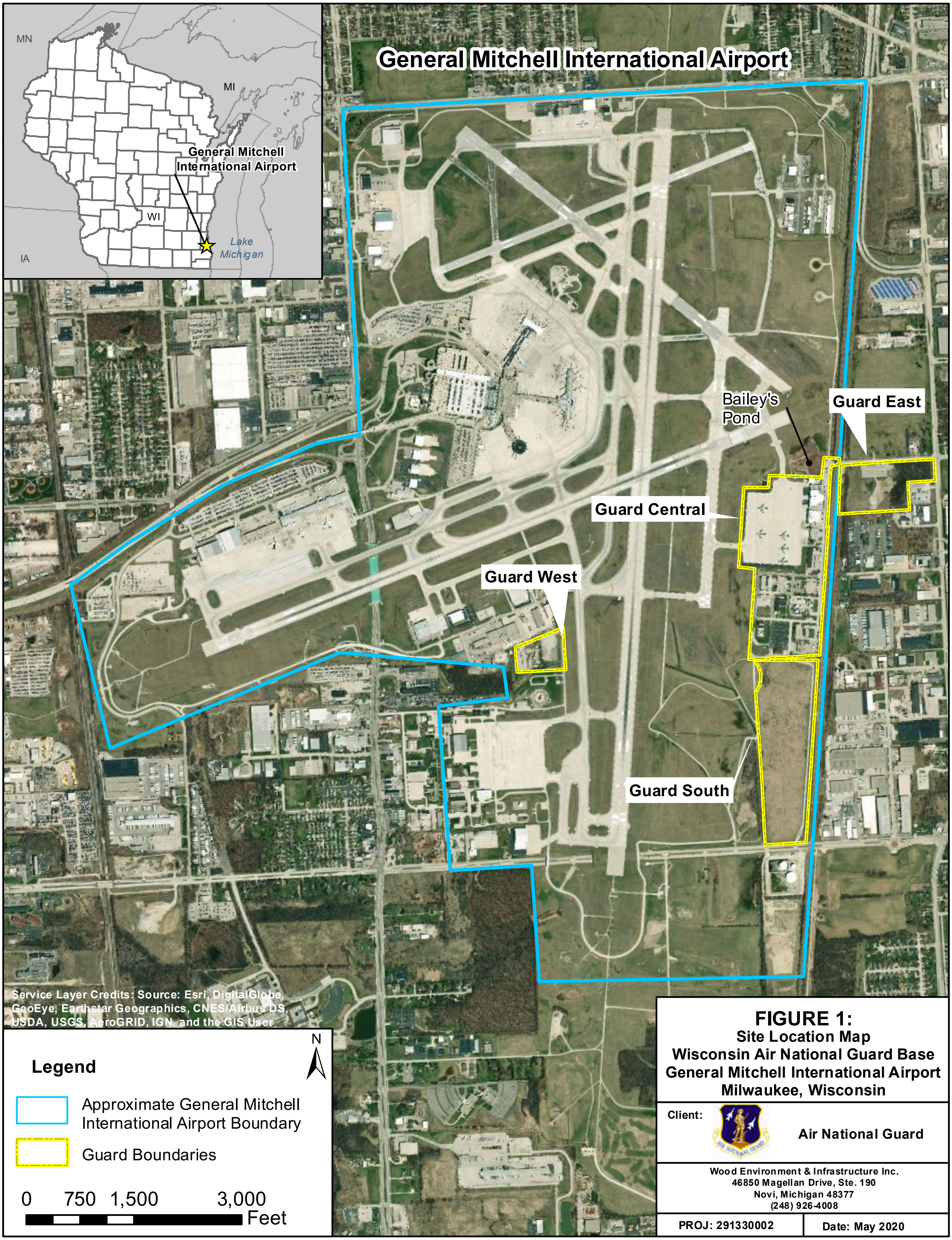

FIGURE 1:
Site Location Map
Wisconsin Air National Guard Base
General Mitchell International Airport
Milwaukee, Wisconsin

Path: G:\GeneralMitchell_291330002.0004.4a\a_MXD\2019\Fig1_Site_Map.mxd

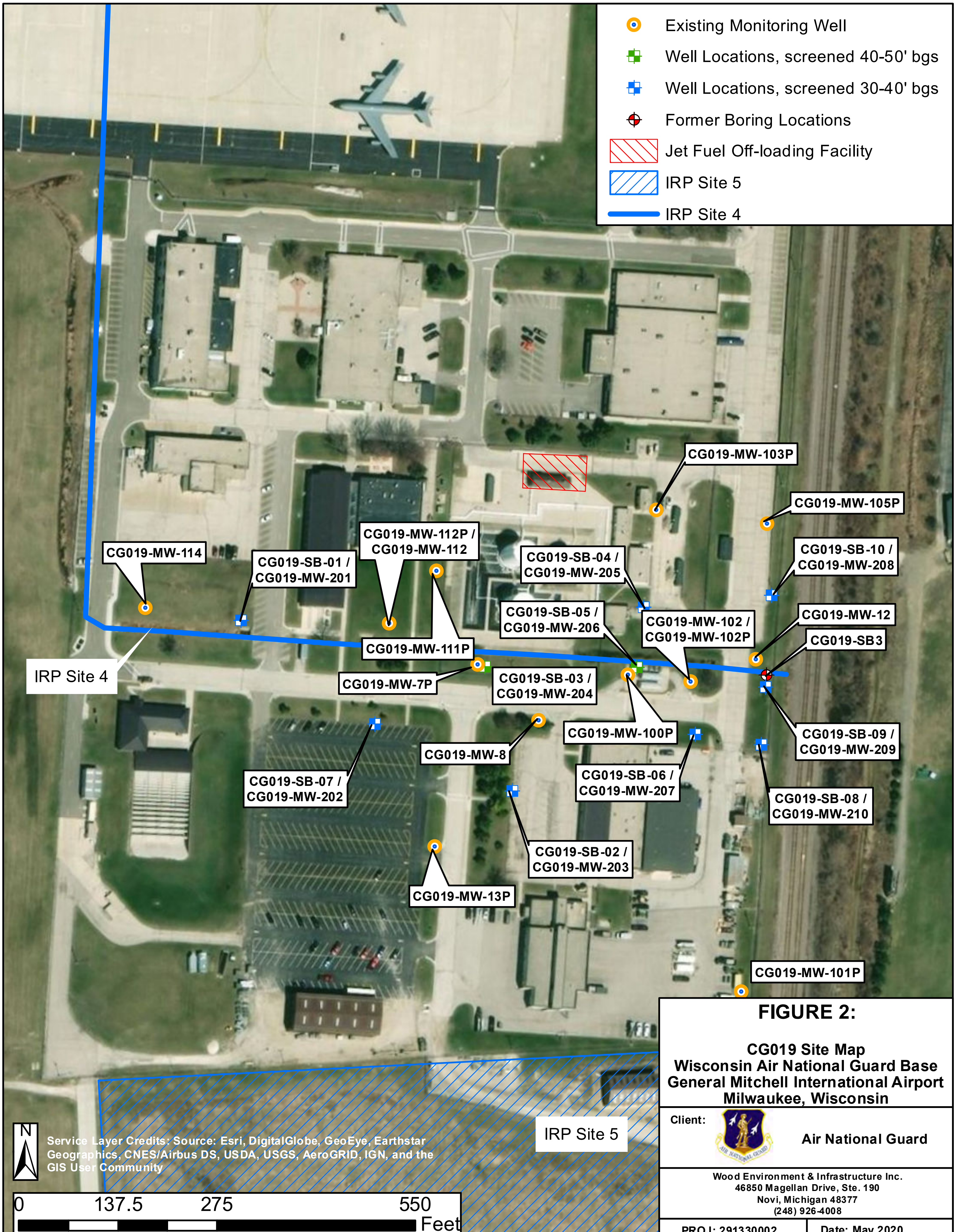

FIGURE 2:

CG019 Site Map
Wisconsin Air National Guard Base
General Mitchell International Airport
Milwaukee, Wisconsin

Client: Air National Guard

Wood Environment & Infrastructure Inc.
46850 Magellan Drive, Ste. 190
Novi, Michigan 48377
(248) 926-4008

PROJ: 291330002 | Date: May 2020

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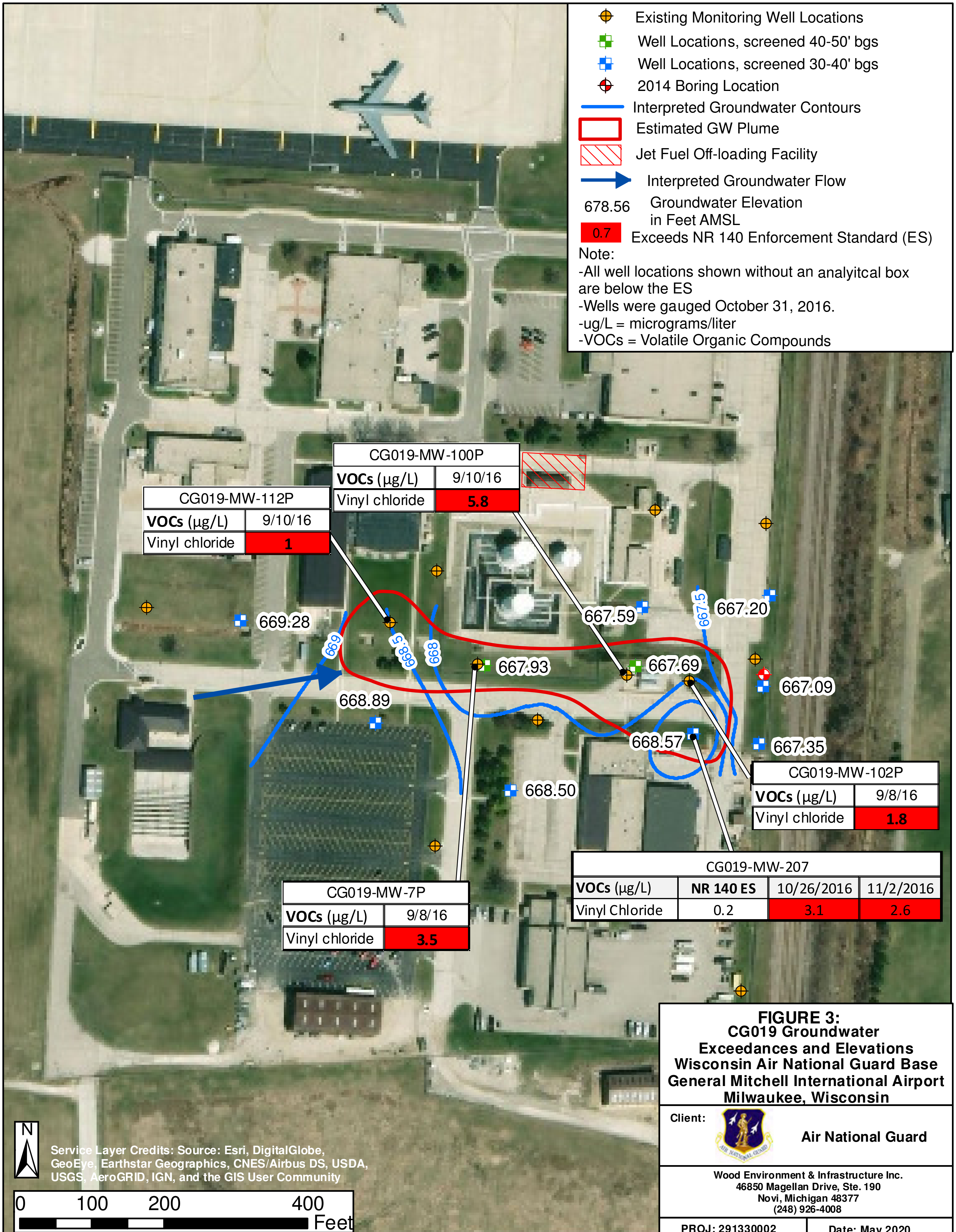

CG019-MW-100P	
VOCs (µg/L)	9/10/16
Vinyl chloride	**5.8**

CG019-MW-112P	
VOCs (µg/L)	9/10/16
Vinyl chloride	**1**

CG019-MW-102P	
VOCs (µg/L)	9/8/16
Vinyl chloride	**1.8**

CG019-MW-207			
VOCs (µg/L)	NR 140 ES	10/26/2016	11/2/2016
Vinyl Chloride	0.2	3.1	2.6

CG019-MW-7P	
VOCs (µg/L)	9/8/16
Vinyl chloride	**3.5**

FIGURE 3:
CG019 Groundwater Exceedances and Elevations Wisconsin Air National Guard Base General Mitchell International Airport Milwaukee, Wisconsin

Client: Air National Guard

Wood Environment & Infrastructure Inc.
46850 Magellan Drive, Ste. 190
Novi, Michigan 48377
(248) 926-4008

PROJ: 291330002 | Date: May 2020

Path: G:\GeneralMitchell_291330002.0004.4a\a_MXD\2020\Figure3_CG019_Chembox_JAN62017.mxd

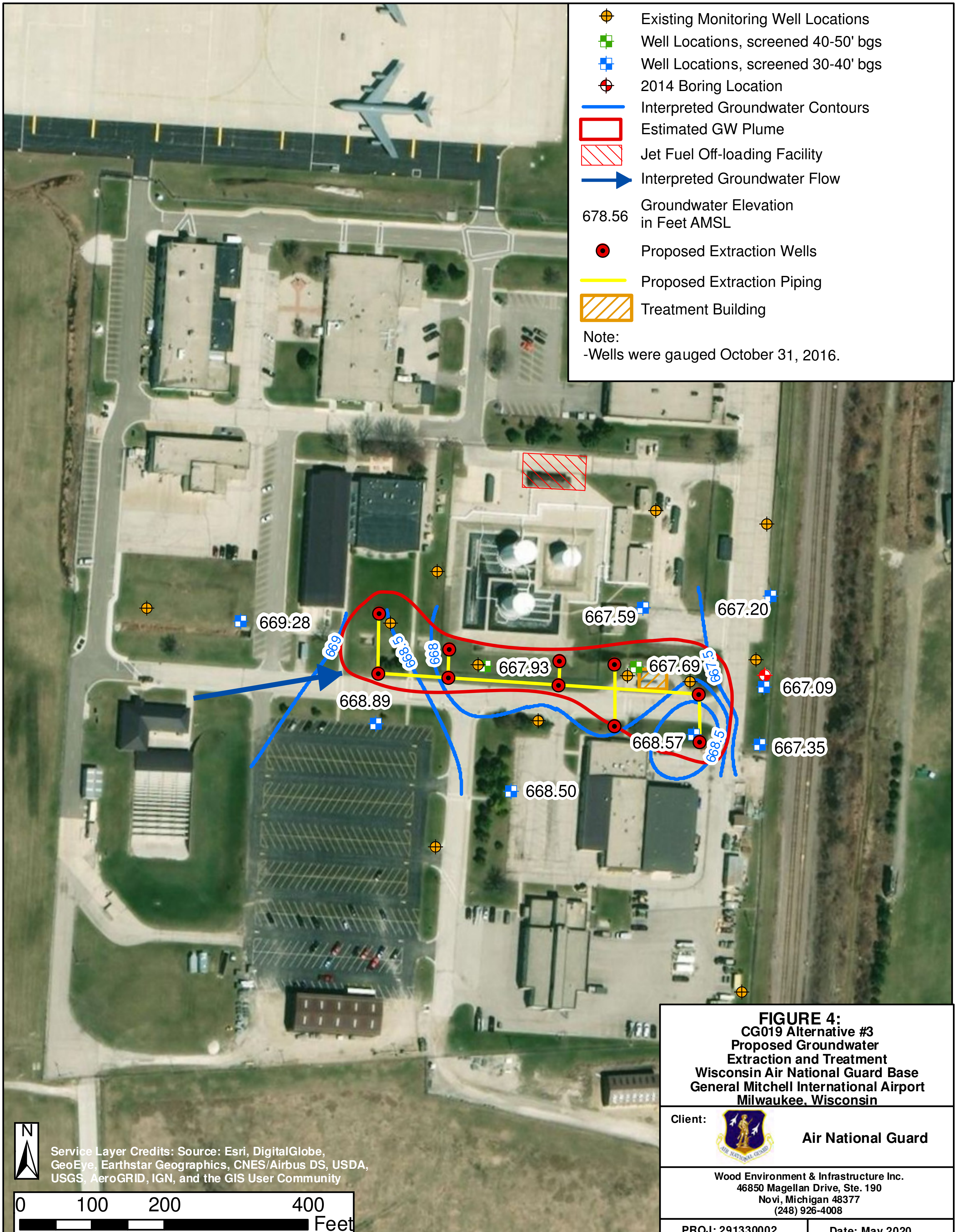

FIGURE 4:
CG019 Alternative #3
Proposed Groundwater Extraction and Treatment
Wisconsin Air National Guard Base
General Mitchell International Airport
Milwaukee, Wisconsin

Client: Air National Guard

Wood Environment & Infrastructure Inc.
46850 Magellan Drive, Ste. 190
Novi, Michigan 48377
(248) 926-4008

PROJ: 291330002	Date: May 2020

Path: G:\GeneralMitchell_291330002.0004.4a\a_MXD\2020\Figure4_ProposedExtractionandTreatment.mxd

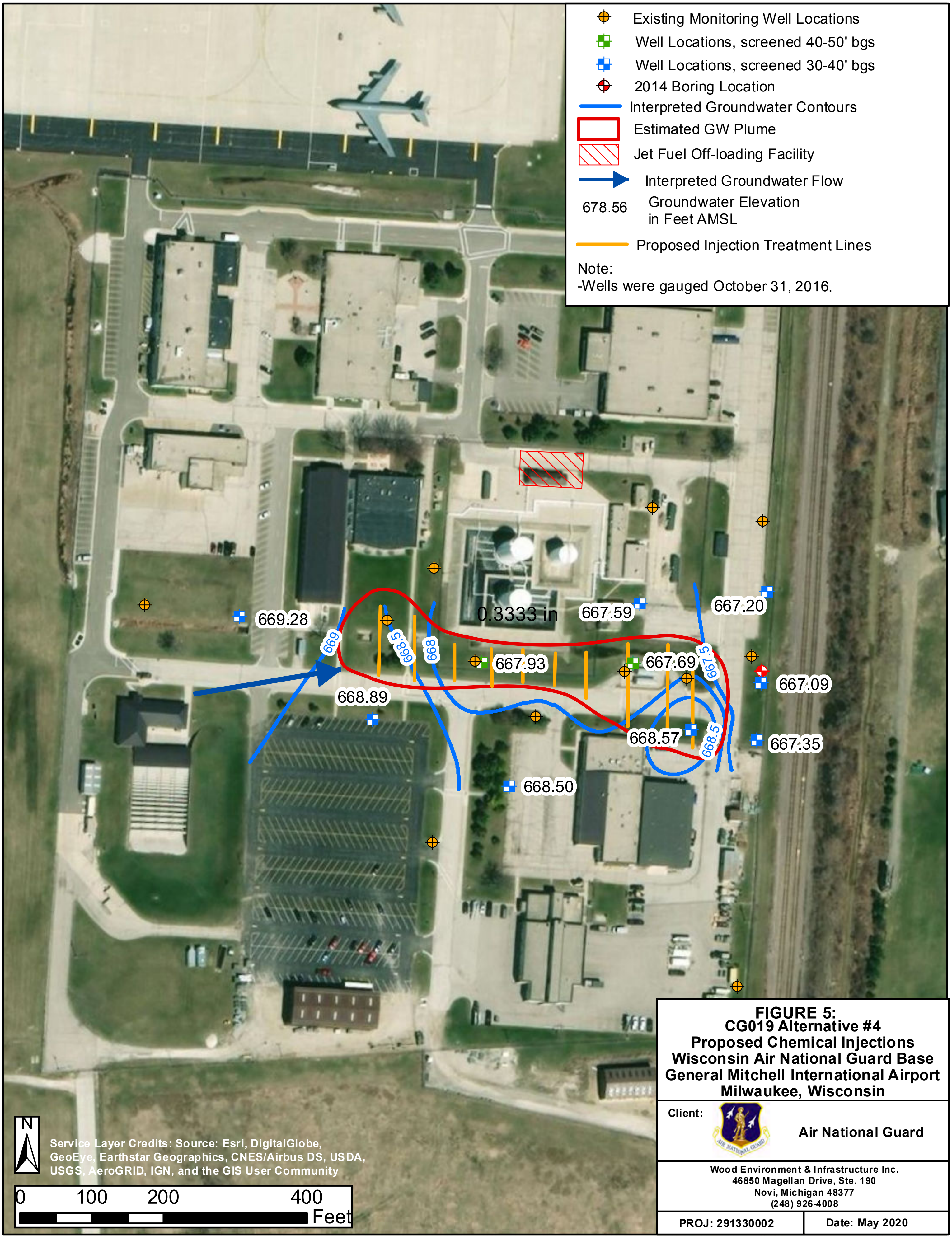

FIGURE 5:
CG019 Alternative #4
Proposed Chemical Injections
Wisconsin Air National Guard Base
General Mitchell International Airport
Milwaukee, Wisconsin

Client: **Air National Guard**

Wood Environment & Infrastructure Inc.
46850 Magellan Drive, Ste. 190
Novi, Michigan 48377
(248) 926-4008

PROJ: 291330002	Date: May 2020

Path: G:\GeneralMitchell_291330002.0004.4a\a_MXD\2020\Figure5_ProposedExtractionandTreatment.mxd

APPENDIX A

SOIL BORING LOGS

SOIL BORING LOG

Amec Foster Wheeler
Environment & Infrastructure, Inc.
46850 Magellan Drive Suite 190
Novi MI 48377
Telephone: 2489264008
Fax: 2489264009

Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-01	**Date Started:**	09/27/2016
Drilling Contractor:	Mateco	**Date Completed:**	09/27/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	4
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	40	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	40	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	40	**Weather Conditions:**	70s, partly cloudy

Depth (ft) 0.0	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
4	S-1	8	7.5/8	0-3" 3"-9" 9"-2.5' 2.5-4 4-5	0-1= 0.0 1-2=3.5 2-3=340.3 190.7	No No Yes		Clay, some sand, low plasticity, firm, moist, brown, trace organics Sand, fine to coarse, some gravel, little clay, moist, tan Clay, some sand, firm, moist, low plasticity, tan Clay, little sand, high plasticity, soft, gray, moist Sandy clay, little sand, very stiff, low plasticity, wet, black	Clay, some sand, low plasticity, firm, moist, brown, trace organics Sand, fine to coarse, some gravel, little clay, moist, tan Clay, some sand, firm, moist, low plasticity, tanCg019-sb-01-092716-1-21-2 Clay, little sand, high plasticity, soft, gray, moistCg019-sb-092716-3-4 Sandy clay, little sand, very stiff, low plasticity, wet, black
8	S-1	8	7.5/8	5-8 8-40	2.9	No		Clay with some sand, grayish brown, wet, high plasticity Clay, with sand, grayish brown, wet, very soft	8-40 Logged off auger flights Clay with some sand, grayish brown, wet, high plasticity Clay, with sand, grayish brown, wet, very soft
12	S-1	8	7.5/8						
16			/						
20			/						

Notes:

Technician Signature: [signature]

Technician Name: Faisal Hussain

QA/QC'd by: **QA/QC Date:**

SOIL BORING LOG

Amec Foster Wheeler
Environment & Infrastructure, Inc.
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Telephone: 2489264008
Fax: 2489264009

Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-02	**Date Started:**	09/27/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/04/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	6.5
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	40	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	40	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	40	**Weather Conditions:**	Partly cloudy

Depth (ft)	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
0.0									
	1	40	5.83/40	0-4	0.0	No		Clay, firm, little sand, high plasticity, moist, firm 0-1, soft 1-4	Logged off auger flights from 8-40 Clay, firm, little sand, high plasticity, moist, firm 0-1, soft 1-4
				4-6	0.0	Yes		Clay, few sand, high plasticity, soft, moist, brown	Clay, few sand, high plasticity, soft, moist, brownCg019-sb-02-092716-4-5
				6-8	0.0	No		Sand, fine grain, trace gravel, few silt, tan	Cg019-sb-02-092716-5-6 Sand, fine grain, trace gravel, few silt, tan
				8-15		No		Sandy clay, light brown/gray, wet, soft, low plasticity	Sandy clay, light brown/gray, wet, soft, low plasticity
4				15-40				Sand with clay, wet, fine to coarse grain, brown	Sand with clay, wet, fine to coarse grain, brown
8	1	40	5.83/40						
12	1	40	5.83/40						
16			/						
20			/						

Notes:

Technician Signature: [signature]

Technician Name: Faisal Hussain

QA/QC'd by:

QA/QC Date:

SOIL BORING LOG

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Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-03	**Date Started:**	09/27/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/13/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	4
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	50	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	50	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	50	**Weather Conditions:**	Partly cloudy

Depth (ft)	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
0.0									
	1	8	7/8	0-1	0.0			Clay, little fine sand, low plasticity, firm, moist, dark brown	Clay, little fine sand, low plasticity, firm, moist, dark brown Clay, little fine sand, low plasticity, firm, moist, tanCg019-sb-03-092716-1-2 Silt, some fine sand, firm, dry, tanCg019-sb-03-092716-2-3 Clay, few sand, low plasticity, soft, moist tan Sand, few silt, trace gravel, wet, tan
				1-2	0.0	Yes		Clay, little fine sand, low plasticity, firm, moist, tan	
				2-3	0.0	Yes		Silt, some fine sand, firm, dry, tan	
				3-3.5	0.0	No		Clay, few sand, low plasticity, soft, moist tan	
4				3.5-4	0.0	No		Sand, few silt, trace gravel, wet, tan	
	1	8	7/8	8-31		No		Sand with clay, fine to coarse grain, wet, gray	Logged via split spoon Sand with clay, fine to coarse grain, wet, gray Gravel, coarse, wet, some sand, medium to coarse Clay, stiff, gray, low plasticity, some sand, Sand, fine grain, wet, gray, little silt Clay, stiff, low plasticity, moist, gray, little fine to coarse sand
				31-36				Gravel, coarse, wet, some sand, medium to coarse	
				36-40				Clay, stiff, gray, low plasticity, some sand,	
				40-45				Sand, fine grain, wet, gray, little silt	
8				45-48				Clay, stiff, low plasticity, moist, gray, little fine to coarse sand	
12	1	8	7/8	48-50		No		No recovery	No recovery
16			/						
20			/						

Notes:

Technician Signature: [signature]

Technician Name: Faisal Hussain

QA/QC'd by:

QA/QC Date:

SOIL BORING LOG

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Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-04	**Date Started:**	09/27/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/19/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	40
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	40	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	8	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	40	**Weather Conditions:**	Partly cloudy

Depth (ft) 0.0	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
				0-4"	0.0	No	CL	Clay, few fine sand, trace fine gravel, low plasticity, moist, dark brown	Clay, few fine sand, trace fine gravel, low plasticity, moist, dark brown
				4"-1'	0.0	No	Sw	Sand, fine, little fine gravel, trace silt, dry, tan	Sand, fine, little fine gravel, trace silt, dry, tan
	1	0-4	3/4	1'-2.5'	0.0	Yes	CL	Clay, few fine sand, high plasticity, firm, moist, brown	Clay, few fine sand, high plasticity, firm, moist, brownCg019-sb-04-092716-1-2
				2.5-3.5	0.0	No	Gw	Fine gravel, few fine sand, trace silt, wet, brown	Cg019-sb-04-092716-2-2.5 Fine gravel, few fine sand, trace silt, wet, brown
4				3.5-6	0.0	No	CL	Clay, little fine gravel, high plasticity, soft, wet, grayish brown 5.5-6 black	Clay, little fine gravel, high plasticity, soft, wet, grayish brown 5.5-6 black
				6-8	0.0	No	Sw	Sand, fine, little clay, trace fine, gray/black	8-40 logged off auger flights Sand, fine, little clay, trace fine, gray/black
				8-25	--	No	Sw	Sand, fine, little clay, trace fine gravel, gray wet	Sand, fine, little clay, trace fine gravel, gray wet
	1	0-4	3/4	25-40	--	No	Sw	Sand with clay, wet, fine	Sand with clay, wet, fine
8									
	1	0-4	3/4						
12									
			/						
16									
			/						
20									

Notes:

Technician Signature: [signature]

Technician Name: Faisal Hussain

QA/QC'd by:

QA/QC Date:

SOIL BORING LOG

amec foster wheeler

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Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-05	**Date Started:**	09/27/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/13/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	1
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	50	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	50	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	50	**Weather Conditions:**	Partly cloudy

Depth (ft)	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
0.0									
	1	0-8	6.17/8	0-4	0.0	Yes	CL	Clay, little coarse sand, high plasticity, soft, wet at 1, brown, @ 2' gravel seam, fine, few fine sand, grayish brown at 3.5	Clay, little coarse sand, high plasticity, soft, wet at 1, brown, @ 2' gravel seam, fine, few fine sand, grayish brown at 3.5Cg019-sb-05-092716-3-4 Clay, few fine sand, high plasticity, soft, wet, black to 6 ft, 6-7.5 greenish black, 7.5 to 8 brown, 4.5-5 organics seam, moist, black, firm Clay, few fine sand, high plasticity, soft, wet, tan Clay with sand, fine sand, soft, wet, grayish brown Sand, coarse grain, few silts, wet, grayish brown,
				4-8	0.0	No	CL	Clay, few fine sand, high plasticity, soft, wet, black to 6 ft, 6-7.5 greenish black, 7.5 to 8 brown, 4.5-5 organics seam, moist, black, firm	
				8-10		No	CL	Clay, few fine sand, high plasticity, soft, wet, tan	
				10-12		No	CL	Clay with sand, fine sand, soft, wet, grayish brown	
4				12-16		No	Saw	Sand, coarse grain, few silts, wet, grayish brown,	
	1	0-8	6.17/8	16-27		No	Sw	Sand, fine to coarse grain, wet, grayish brown, @24' 3" of silty fine sand seam	Sand, fine to coarse grain, wet, grayish brown, @24' 3" of silty fine sand seam Clay, few fine sand, high plasticity, firm, moist, brown Sand, fine to coarse, wet brown Clay, few fine sand, high plasticity, hard, moist, brown
				27-28			CL	Clay, few fine sand, high plasticity, firm, moist, brown	
				28-30			Sw	Sand, fine to coarse, wet brown	
				30-31			CL	Clay, few fine sand, high plasticity, hard, moist, brown	
8									
	1	0-8	6.17/8	31-40	--	No	CL	Clay with sand, wet, gray/light brown, firm	Split spoon Clay with sand, wet, gray/light brown, firm Sand, wet, fine to coarse, grain Sandy clay, soft, gray, wet, low plasticity Clay, stiff, wet, some sand, low plasticity, gray Sandy clay, soft, low plasticity, wet gray
				40-42	--	No	Sw	Sand, wet, fine to coarse, grain	
				42-43		No	CL	Sandy clay, soft, gray, wet, low plasticity	
				43-44		No	CL	Clay, stiff, wet, some sand, low plasticity, gray	
12				44-45		No	CL	Sandy clay, soft, low plasticity, wet gray	
	4	45-50	Na/50	45-46			Sw	Sand, fine, little silt, gray, wet	Split spoon Sand, fine, little silt, gray, wet Clay, stiff, gray/light brown, high plasticity, wet Clay, stiff, light brown/gray, medium plasticity, wet from 48-49, dry from 49-50.
				46-48			CL	Clay, stiff, gray/light brown, high plasticity, wet	
				48-50			CL	Clay, stiff, light brown/gray, medium plasticity, wet from 48-49, dry from 49-50.	
16									
			/						
20									

Notes:

Technician Signature:

Technician Name:
Faisal Hussain

QA/QC'd by: **QA/QC Date:**

SOIL BORING LOG

Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-06	**Date Started:**	09/27/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/03/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	8
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	40	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	40	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	40	**Weather Conditions:**	Partly cloudy

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Depth (ft) 0.0	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
4	1	12	9.5/12	0-2	0.0	No	CL	Clay, few fine sand, low plasticity firm dry brown, trace organics	Clay, few fine sand, low plasticity firm dry brown, trace organics Clay, few fine sand, little fine gravel, low plasticity firm dry Clay, few fine sand, low plasticity firm dry brown, little siltCg019-sb-092716-3-4 Silt, firm, dry, little fine sand, brown Clay, few sand, low plasticity, firm, moist, blackCg019-sb-092716-6-7
				2-2.5	0.0	No	Cl	Clay, few fine sand, little fine gravel, low plasticity firm dry	
				2.5-4	0.0	Yes	Cl	Clay, few fine sand, low plasticity firm dry brown, little silt	
				4-6	0.0	No	ML	Silt, firm, dry, little fine sand, brown	
				6-8	0.0	No	Cl	Clay, few sand, low plasticity, firm, moist, black	
8	1	12	9.5/12	8-11.5	0.0	No	Cl	Clay, few fine sand, high plasticity, wet, grayish tan	12-40 logged off auger flights Clay, few fine sand, high plasticity, wet, grayish tan Sand, little clay, fine, wet grayish brown Clay, wet, low plasticity, soft, brown Sand with clay, fine to medium grain, wet, grayish brown
				11.5-12	0.0	No	SM	Sand, little clay, fine, wet grayish brown	
				12-25			Cl	Clay, wet, low plasticity, soft, brown	
				25-40			SM	Sand with clay, fine to medium grain, wet, grayish brown	
12	1	12	9.5/12						
16			/						
20			/						

Notes:

Technician Signature: [signature]

Technician Name: Faisal Hussain

QA/QC'd by:

QA/QC Date:

SOIL BORING LOG

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Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-007	**Date Started:**	09/27/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/18/2016
Drilling Personnel:	Gary swift, Tim Hiler	**Depth to Water Table:**	6
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	40	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	40	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	40	**Weather Conditions:**	Partly cloudy

Depth (ft)	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
0.0									
	1	0-4	2.6/4	0-1.5	0.0	No	CL	Clay, few fine sand, low plasticity, moist, stiff, dark brown	Clay, few fine sand, low plasticity, moist, stiff, dark brown Sand, fine, little fine gravel, few clay, moist, black Clay, few fine sand, low plasticity, stiff, moist, grayish brownCg019-sb-092716-3-4
				1.5-2	0.0	No	Sw	Sand, fine, little fine gravel, few clay, moist, black	
				2-4	0.0	Yes	CL	Clay, few fine sand, low plasticity, stiff, moist, grayish brown	
4									
	1	0-4	2.6/4	4-5	0.0	No	CL	Clay,trace fine sand, high plasticity, firm,moist, brown	Clay,trace fine sand, high plasticity, firm,moist, brown Silt, little fine sand, very hard, moist, orangish tanCg019-sb-092716-5-6 Sand, fine, few silt, wet at 6', orangish tan
				5-6	0.0	Yes		Silt, little fine sand, very hard, moist, orangish tan	
				6-8	0.0	No	Sw	Sand, fine, few silt, wet at 6', orangish tan	
8									
	1	0-4	2.6/4	8-15	--	No	Sw	Sand, fine to medium, little clay, wet, brown	Logged off auger flights Sand, fine to medium, little clay, wet, brown Sand and clay, fine grain, very wet, brown, soup like
				15-40	--	No		Sand and clay, fine grain, very wet, brown, soup like	
12									
			/						
16									
			/						
20									

Notes:

Technician Signature: [signature]

Technician Name: Faisal Hussain

QA/QC'd by:

QA/QC Date:

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Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-08	**Date Started:**	09/29/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/05/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	6
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	40	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	40	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	40	**Weather Conditions:**	Partly cloudy

Depth (ft)	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
0.0									
	1	4	3.83/4	0-1	0.0	No	Cl	Clay, little fine sand and fine gravel, trace organics, firm, low plasticity moist, brown	Clay, little fine sand and fine gravel, trace organics, firm, low plasticity moist, brown Silt, little sand, firm, dry, dark brownCg019-sb-08-092916-1-3 Clay, few fine sand, low plasticity, hard, moist, dark brown Silty sand, fine sand, trace gravel, dry,tan Sand, fine grain, little fine gravel, trace silt, moist black
				1-2	0.0	Yes	ML	Silt, little sand, firm, dry, dark brown	
				2-2.8	0.0	No	Cl	Clay, few fine sand, low plasticity, hard, moist, dark brown	
				2.8-3	0.0	No	ML	Silty sand, fine sand, trace gravel, dry,tan	
4				3-3.3	0.0	No		Sand, fine grain, little fine gravel, trace silt, moist black	
	1	4	3.83/4	3.3-4.5	0.0	No	Cl	Clay, little fine sand, low plasticity, hard, moist, brown	Clay, little fine sand, low plasticity, hard, moist, brown Clay, little fine sand, few fine gravel, low plasticity, soft, moist, brown Clay, little fine sand, high plasticity, firm, moist, black, wet @6'Cg019-sb-08-092916-5-6 Silt, little fine sand, soft, no plasticity, gray Clay, dark brown, soft, wet, low plasticity
				4.5-5.5	0.0	No	Cl	Clay, little fine sand, few fine gravel, low plasticity, soft, moist, brown	
				5.5-7.5	0.0	Yes	CL	Clay, little fine sand, high plasticity, firm, moist, black, wet @6'	
				7.5-8	0.0	No	ML	Silt, little fine sand, soft, no plasticity, gray	
8				8-13		No	CL	Clay, dark brown, soft, wet, low plasticity	
	1	4	3.83/4	13-40		No	CL	Sand with clay, brown, fine to medium clay, wet	Logged off auger flights Sand with clay, brown, fine to medium clay, wet
12									
			/						
16									
			/						
20									

Notes:

Technician Signature:

Technician Name: Faisal Hussain

QA/QC'd by:

QA/QC Date:

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Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-09	**Date Started:**	09/29/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/12/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	6.0
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	40	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	40	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	40	**Weather Conditions:**	Partly cloudy

Depth (ft) 0.0	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
	1	0-8	7.08/8	0-4	0.0	Yes	CL	Clay, little fine sand, trace fine gravel, trace organics to 2ft, low plasticity, firm, dry, brown	Clay, little fine sand, trace fine gravel, trace organics to 2ft, low plasticity, firm, dry, brownCg019-sb-09-092916-3-4 Clay, little fine sand, low plasticity, firm, moist, dark brown Clay, little fine sand, low plasticity, hard, moist, dark grayCg019-sb-09-092916-5-6 Sandy clay, firm, fine to medium grain sand, trace fine gravel, wet Sand, fine, little silt, wet, grayish tan
				4-4.5	0.0	No	CL	Clay, little fine sand, low plasticity, firm, moist, dark brown	
				4.5-6	0.0	Yes	CL	Clay, little fine sand, low plasticity, hard, moist, dark gray	
				6-7	0.0	No	CL	Sandy clay, firm, fine to medium grain sand, trace fine gravel, wet	
4				7-8	0.0	No	SW	Sand, fine, little silt, wet, grayish tan	
	1	0-8	7.08/8	8-35		No	CL	Sandy clay, wet, low plasticity, brown, stiff	Logged off auger flights Sandy clay, wet, low plasticity, brown, stiff Clay, very soft, wet, med plasticity, brown,
8				35-40		No	CL	Clay, very soft, wet, med plasticity, brown,	
12	1	0-8	7.08/8						
16			/						
20			/						

Notes:

Technician Signature:

Technician Name: Faisal Hussain

QA/QC'd by:

QA/QC Date:

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Project Name:	CG019	**Project Number:**	29133002.0004.3F
Location ID:	Cg019-sb-10	**Date Started:**	09/29/2016
Drilling Contractor:	Mateco	**Date Completed:**	10/12/2016
Drilling Personnel:	Zach Martin, Steve Muth	**Depth to Water Table:**	6
Drilling Method:	Direct Push Methods/hollow stem auger	**Sample Collection Method:**	Macrocore
Borehole Diameter (in):		**Sample Analysis:**	Chlorinated VOCs
Total Drilled Depth (ft):	40	**Logged By:**	Faisal Hussain
Total Sampled Depth (ft):	49	**Other Amec Foster Wheeler Representatives:**	Charles Hackel
Refusal Surface Depth (ft):	0		
Bottom of Borehole (ft):	40	**Weather Conditions:**	Partly cloudy

Depth (ft)	Sample Number	Depth Interval(ft)	Recovery/ Penetration	Sample Depth (ft)	PID/FID	Sample Collected	USCS Group Symbol	Sample Description and Classification NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency	Notes and Remarks
0.0									
	1	0-12	11.17/12	0-0.5	0.0	No	SW	Sand. Fine grain, few fine gravel, few silt, dry, tan	Based on previous investigations water is assumed to be at 6 ft bgs Sand. Fine grain, few fine gravel, few silt, dry, tan Clay, few fine sand, high plasticity, hard, moist, tanCg019-sb-10-092916-3-4 Clay, few fine sand, high plasticity, very hard, moist, tanCg019-sb-10-092916-6-7 Clay, few fine sand, high plasticity, very hard, moist, tan
				0.5-4	0.0	Yes	CL	Clay, few fine sand, high plasticity, hard, moist, tan	
				4-8	0.0	Yes		Clay, few fine sand, high plasticity, very hard, moist, tan	
				8-12	0.0	No		Clay, few fine sand, high plasticity, very hard, moist, tan	
4									
	1	0-12	11.17/12	12-20	--	No	CL	Clay, brown, stiff, low plasticity, moist	Logged off auger flights Clay, brown, stiff, low plasticity, moist Clay, very stiff, low plasticity, gray, wet Sandy clay, wet, very soft, low plasticity
				20-30	--	No	CL	Clay, very stiff, low plasticity, gray, wet	
				30-40	--	No	CL	Sandy clay, wet, very soft, low plasticity	
8									
	1	0-12	11.17/12						
12									
			/						
16									
			/						
20									

Notes:

Technician Signature:

Technician Name: Faisal Hussain

QA/QC'd by:

QA/QC Date:

APPENDIX B

REMEDIAL INVESTIGATION ANALYTICAL TABLES

Table 1
Permanent Wells Groundwater Elevations
General Mitchell Air National Guard - 128th Air Refueling Wing

Well ID	Northing	Easting	Well Casing Elevation (feet amsl)	Top of Well Screen Elevation (feet amsl)	Total Depth of Well (feet bgs)	Bottom of Well Screen Elevation (feet amsl)	9-Sep-2016		24-Oct-2016		31-Oct-2016	
							Depth to Water (feet)	Groundwater Elevation (feet amsl)	Depth to Water (feet)	Groundwater Elevation (feet amsl)	Depth to Water (feet)	Groundwater Elevation (feet amsl)
CG019												
Existing wells												
CG019-MW-08	NA	NA	NA	NA	13.61	NA	4.84	NA	NS	NS	NS	NS
CG019-MW12	NA	NA	NA	NA	13.91	NA	5.95	NA	NS	NS	NS	NS
CG019-MW13P	NA	NA	NA	NA	35.2	NA	8.11	NA	NS	NS	NS	NS
CG019-MW100P	NA	NA	NA	NA	36.55	NA	4.71	NA	NS	NS	NS	NS
CG019-MW102	NA	NA	NA	NA	20	NA	5.14	NA	NS	NS	NS	NS
CG019-MW102P	NA	NA	NA	NA	34.32	NA	7.3	NA	NS	NS	NS	NS
CG019-MW103P	NA	NA	NA	NA	40.04	NA	6.64	NA	NS	NS	NS	NS
CG019-MW105P	NA	NA	NA	NA	39.11	NA	9.11	NA	NS	NS	NS	NS
CG019-MW109P	NA	NA	NA	NA	45.91	NA	14.11	NA	NS	NS	NS	NS
CG019-MW111P	NA	NA	NA	NA	40.6	NA	4.22	NA	NS	NS	NS	NS
CG019-MW112	NA	NA	NA	NA	18.8	NA	3.61	NA	NS	NS	NS	NS
CG019-MW112P	NA	NA	NA	NA	32.2	NA	4.07	NA	NS	NS	NS	NS
CG019-MW114	NA	NA	NA	NA	30.8	NA	1.04	NA	NS	NS	NS	NS
CG019-MW07P	NA	NA	NA	NA	33.61	NA	4.45	NA	NS	NS	NS	NS
New Monitoring Wells												
CG019-MW-201	349395.41	2565232.878	669.785	641.39	38.40	631.39	NS	NS	0.00	669.79	0.50	669.29
CG019-MW-202	349245.879	2565413.966	673.682	643.58	40.10	633.58	NS	NS	5.10	668.58	4.79	668.89
CG019-MW-203	349146.301	2565599.863	675.458	646.26	39.20	636.26	NS	NS	6.73	668.73	6.96	668.50
CG019-MW-204	349320.241	2565568.804	672.257	634.51	47.75	624.51	NS	NS	6.08	666.18	4.33	667.93
CG019-MW-205	349393.381	2565791.438	672.901	642.90	40.00	632.90	NS	NS	5.80	667.10	5.31	667.59
CG019-MW-206	349311.522	2565778.826	673.295	638.70	44.60	628.70	NS	NS	6.30	667.00	5.60	667.70
CG019-MW-207	349215.135	2565855.596	675.666	646.87	38.80	636.87	NS	NS	11.05	664.62	7.10	668.57
CG019-MW-208	349404.169	2565968.605	674.698	645.45	39.25	635.45	NS	NS	8.14	666.56	7.50	667.20
CG019-MW-209	349277.562	2565955.192	675.061	646.41	38.65	636.41	NS	NS	9.36	665.70	7.97	667.09
CG019-MW-210	349198.502	2565946.323	675.396	646.60	38.80	636.60	NS	NS	8.85	666.55	8.05	667.35

Notes:
bgs = below ground surface
amsl = above mean sea level
All water levels recorded within a 24 hour period

Table 2
Permanent Wells Groundwater Parameters
General Mitchell Air National Guard - 128th Air Refueling Wing

Groundwater Sample ID	Date	Temperature (ºC)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)
CG019							
Groundwater Sample ID	**Date**	**Temperature (ºC)**	**pH**	**Conductivity (mS/cm)**	**Dissolved Oxygen (mg/L)**	**ORP (mV)**	**Turbidity (NTU)**
CG019-MW-201	10/27/2016	11.8	6.98	1.76	0.09	-49.1	32
CG019-MW-202	10/26/2016	12.1	7.47	2	0.08	8.2	No Data
CG019-MW-203	10/27/2016	11.2	7.24	1.65	0.16	192.7	19.4
CG019-MW-204	10/27/2016	9.3	7.38	1.78	0.15	-52.6	18.5
CG019-MW-205	10/26/2016	11.8	7.6	1.84	0.04	-0.7	No Data
CG019-MW-206	10/26/2016	11.8	7.98	1.25	0.10	-31.7	16.2
CG019-MW-207	10/26/2016	11.9	7.15	2.78	0.06	-76.3	25
CG019-MW-208	10/26/2016	11	7.63	0.646	0.23	57.5	74.8
CG019-MW-209	10/26/2016	10.6	7.74	0.632	0.07	-51	20
CG019-MW-210	10/26/2016	11.6	7.37	1.06	0.1	-11	33
CG019-MW-201	11/1/2016	13.6	6.97	1.62	0.06	-34	12.9
CG019-MW-202	11/2/2016	13.7	6.91	1.78	0.09	8	4.07
CG019-MW-203	11/2/2016	13.3	7.15	1.58	0.03	17.8	48.4
CG019-MW-204	11/3/2016	13.6	7.22	2.55	0.03	-73.8	7.06
CG019-MW-205	11/3/2016	13.6	6.67	1.62	0.03	3.6	4.37
CG019-MW-206	11/2/2016	13.1	7.34	1.41	0.09	-34.3	6.34
CG019-MW-207	11/3/2016	13.7	6.86	2.66	0.12	-51.7	5
CG019-MW-208	11/3/2016	12.7	7.5	0.67	0.05	100.7	1681
CG019-MW-209	11/2/2016	13.1	7.58	0.99	0.05	-38.1	12.79
CG019-MW-210	11/2/2016	13.8	7.35	1.55	0.05	-37.2	4.98

Notes:
1) °C - degrees Celsius
2) mS/cm - milliSiemens per centimeter
3) mg/L - milligram per liter
4) ORP - oxidation reduction potential
5) mV - millivolt
6) NTU - nephelometric turbidity unit
*Over range: Turbidity exceeds 4000 NTU

Table 3
CG019 Soil Analytical Data
General Mitchell Air National Guard - 128th Air Refueling Wing

Sample Location	CAS	WDNR RR Program Soil RCLs for Direct Contact, Industrial Scenario (ug/kg)	WDNR RR Program Groundwater Protective RCLs (ug/kg)	CB019-SB-01		CG019-SB-02						CG019-SB-03				CG019-SB-04				CG019-SB-05	
Date Collected				9/27/16		9/27/16						9/27/2016				9/27/2016				9/27/2016	
Depth				1-2		3-4		4-5		5-6		1-2		2-3		1-2		2-2.5		0-1	
Criteria Reference			2																		
Volatile Organic Compounds																					
1,1,1,2-Tetrachloroethane	630-20-6	12,900	26.7	<39	U	<31	U	<33	U	<29	U	<31	U	<34	U	<31	U	<32	U	<35	U
1,1,1-Trichloroethane	71-55-6	640,000	70.1	<34	U	<27	U	<29	U	<26	U	<27	U	<29	U	<27	U	<28	U	<31	U
1,1,2,2-Tetrachloroethane	79-34-5	3,690	0.078	<73	U	<57	U	<61	U	<54	U	<58	U	<62	U	<58	U	<60	U	<65	U
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	910000	NA	<57	U	<45	U	<48	U	<43	U	<46	U	<49	U	<46	U	<47	U	<51	U
1,1,2-Trichloroethane	79-00-5	734	1.6	<30	U	<23	U	<25	U	<22	U	<24	U	<25	U	<24	U	<24	U	<27	U
1,1-Dichloroethane	75-34-3	23,700	241.7	<29	U	<23	U	<25	U	<22	U	<23	U	<25	U	<23	U	<24	U	<26	U
1,1-Dichloroethene	75-35-4	1,190,000	2.5	<39	U	<31	U	<32	U	<29	U	<31	U	<33	U	<31	U	<32	U	<35	U
1,1-Dichloropropene	563-58-6	NA	NA	<39	U	<31	U	<33	U	<29	U	<31	U	<34	U	<31	U	<32	U	<35	U
1,2,3-Trichlorobenzene	87-61-6	818,000	NA	<88	UJ	<69	UJ	<74	UJ	<66	UJ	<70	UJ	<75	UJ	<70	UJ	<72	UJ	<79	UJ
1,2,3-Trichloropropane	96-18-4	95	0.086	<78	U	<62	U	<66	U	<58	U	<62	U	<67	U	<62	U	<64	U	<70	U
1,2,4-Trichlorobenzene	120-82-1	98,700	NA	<100	U	<80	U	<85	U	<76	U	<81	U	<87	U	<81	U	<83	U	<91	U
1,2-Dibromo-3-chloropropane	96-12-8	99	0.086	<160	U	<130	U	<140	U	<120	U	<130	U	<140	U	<130	U	<130	U	<150	U
1,2-Dichlorobenzene	95-50-1	376,000	584.0	<72	U	<57	U	<60	U	<54	U	<57	U	<62	U	<57	U	<59	U	<65	U
1,2-Dichloroethane	107-06-2	3,030	1.4	<36	U	<28	U	<30	U	<27	U	<29	U	<31	U	<29	U	<30	U	<32	U
1,2-Dichloroethene, Total	540-59-0	NA	NA	<110	U	<84	U	<90	U	<80	U	<85	U	<92	U	<85	U	<88	U	<96	U
1,2-Dichloropropane	78-87-5	6,620	1.7	<46	U	<36	U	<38	U	<34	U	<36	U	<39	U	<36	U	<37	U	<41	U
1,3-Dichlorobenzene	541-73-1	297,000	576.4	<19	U	<15	U	<16	U	<14	U	<15	U	<16	U	<15	U	<15	U	<17	U
1,3-Dichloropropane	142-28-9	1,490,000	NA	<50	U	<40	U	<42	U	<37	U	<40	U	<43	U	<40	U	<41	U	<45	U
1,4-Dichlorobenzene	106-46-7	17,500	72	<42	U	<33	U	<35	U	<31	U	<33	U	<36	U	<33	U	<34	U	<38	U
2,2-Dichloropropane	594-20-7	191,000	NA	<54	U	<42	U	<45	U	<40	U	<42	U	<46	U	<43	U	<44	U	<48	U
2-Chlorotoluene	95-49-8	907,000	NA	<25	U	<20	U	<21	U	<19	U	<20	U	<21	U	<20	U	<20	U	<22	U
4-Chlorotoluene	106-43-4	253,000	NA	<37	U	<29	U	<31	U	<28	U	<30	U	<32	U	<30	U	<31	U	<33	U
Bromochloromethane	74-97-5	154,000	NA	<80	U	<63	U	<67	U	<59	U	<63	U	<68	U	<63	U	<65	U	<71	U
Bromodichloromethane	75-27-4	976,000	0.2	<36	U	<28	U	<30	U	<27	U	<28	U	<31	U	<28	U	<29	U	<32	U
Chlorobenzene	108-90-7	761,000	67.9	<36	U	<28	U	<30	U	<27	U	<29	U	<31	U	<29	U	<30	U	<32	U
Chloroethane	75-00-3	2,120,000	113.3	<200	U	<160	U	<170	U	<150	U	<160	U	<170	U	<160	U	<160	U	<180	U
Chloromethane	74-87-3	720,000	7.8	<55	U	<43	U	<46	U	<41	U	<44	U	<47	U	<44	U	<45	U	<49	U
cis-1,2-Dichloroethene	156-59-2	2,040,000	20.6	<79	U	<62	U	<66	U	<59	U	<63	U	<68	U	<63	U	<65	U	<71	U
cis-1,3-Dichloropropene	10061-01-5	1,210,000	NA	<22	U	<17	U	<18	U	<16	U	<17	U	<18	U	<17	U	<18	U	<19	U
Dibromochloromethane	124-48-1	34,100	NA	<68	U	<53	U	<57	U	<51	U	<54	U	<58	U	<54	U	<56	U	<61	U
Dichlorodifluoromethane	75-71-8	571,000	1,543.1	<120	U	<95	U	<100	U	<90	U	<95	U	<100	U	<96	U	<99	U	<110	U
Methylene Chloride	75-09-2	1,070,000	NA	<100	U	<83	U	**110**	J	<78	U	<83	U	<90	U	<83	U	<86	U	**130**	J
Hexachlorobutadiene	87-68-3	7,450	NA	<63	UJ	<49	UJ	<52	UJ	<47	UJ	<50	UJ	<54	UJ	<50	UJ	<51	UJ	<56	UJ
Tetrachloroethene	127-18-4	153,000	2.3	<71	U	<56	U	<59	U	<53	U	<56	U	<60	U	<56	U	<58	U	<63	U
Tetrachloromethane	56-23-5	4,250	1.9	<37	U	<29	U	<31	U	<28	U	<29	U	<32	U	<29	U	<30	U	<33	U
trans-1,2-Dichloroethene	156-60-5	1,850,000	31	<28	U	<22	U	<23	U	<21	U	<22	U	<24	U	<22	U	<23	U	<25	U
trans-1,3-Dichloropropene	10061-02-6	1,510,000	NA	<37	U	<29	U	<31	U	<28	U	<29	U	<32	U	<29	U	<30	U	<33	U
Trichloroethene	79-01-6	8,810	2	<88	U	<69	U	<74	U	<66	U	<70	U	<75	U	<70	U	<72	U	<79	U
Trichlorofluoromethane	75-69-4	1,230,000	NA	<76	UJ	<60	UJ	<64	UJ	<57	UJ	<60	UJ	<65	UJ	<61	UJ	<62	UJ	<68	UJ
Trichloromethane	67-66-3	2,130	2,238.7	<37	U	<29	U	<31	U	<28	U	<29	U	<32	U	<29	U	<30	U	<33	U
Vinyl chloride	75-01-4	2,030	0.069	<75	U	<59	U	<63	U	<56	U	<59	U	<64	U	<60	U	<61	U	<67	U

Table 3
CG019 Soil Analytical Data
General Mitchell Air National Guard - 128th Air Refueling Wing

Sample Location	CAS	WDNR RR Program Soil RCLs for Direct Contact, Industrial Scenario (ug/kg)	WDNR RR Program Groundwater Protective RCLs (ug/kg)	CG019-SB-06				CG019-SB-07				CG019-SB-08				CG019-SB-09					
Date Collected				9/27/2016				9/27/2016				9/29/2016				9/29/2016					
Depth				3-4		6-7		3-4		5-6		1-3		5-6		3-4		5-6		5-6 (Duplicate)	
Criteria Reference			2																		
Volatile Organic Compounds																					
1,1,1,2-Tetrachloroethane	630-20-6	12,900	26.7	<30	U	<42	U	<28	U	<28	U	<40	U	<39	U	<25	U	<29	U	<0.35	U
1,1,1-Trichloroethane	71-55-6	640,000	70.1	<26	U	<36	U	<24	U	<24	U	<35	U	<34	U	<22	U	<25	U	<0.30	U
1,1,2,2-Tetrachloroethane	79-34-5	3,690	0.078	<56	U	<77	U	<52	U	<52	U	<73	U	<73	U	<47	U	<53	U	<0.64	U
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	910000	NA	<44	U	<61	U	<41	U	<41	U	<58	U	<57	U	<37	U	<42	U	<0.51	U
1,1,2-Trichloroethane	79-00-5	734	1.6	<23	U	<32	U	<21	U	<21	U	<30	U	<30	U	<19	U	<22	U	<0.26	U
1,1-Dichloroethane	75-34-3	23,700	241.7	<23	U	<31	U	<21	U	<21	U	<30	U	<29	U	<19	U	<21	U	<0.26	U
1,1-Dichloroethene	75-35-4	1,190,000	2.5	<30	U	<41	U	<28	U	<28	U	<39	U	<39	U	<25	U	<28	U	<0.34	U
1,1-Dichloropropene	563-58-6	NA	NA	<30	U	<42	U	<28	U	<28	U	<40	U	<39	U	<25	U	<29	U	<0.35	U
1,2,3-Trichlorobenzene	87-61-6	818,000	NA	<67	UJ	<93	UJ	<62	UJ	<63	UJ	<89	UJ	<88	UJ	<56	UJ	<64	U	<0.78	U
1,2,3-Trichloropropane	96-18-4	95	0.086	<60	U	<83	U	<56	U	<56	U	<79	U	<78	U	<50	U	<57	U	<0.69	U
1,2,4-Trichlorobenzene	120-82-1	98,700	NA	<78	U	<110	U	<72	U	<73	U	<100	U	<100	U	<65	U	<75	U	<0.90	U
1,2-Dibromo-3-chloropropane	96-12-8	99	0.086	<130	U	<170	U	<120	U	<120	U	<160	U	<160	U	<100	U	<120	U	<1.4	U
1,2-Dichlorobenzene	95-50-1	376,000	584.0	<55	U	<55	U	<51	U	<52	U	<73	U	<72	U	<46	U	<53	U	<0.64	U
1,2-Dichloroethane	107-06-2	3,030	1.4	<28	U	<38	U	<26	U	<26	U	<37	U	<36	U	<23	U	<26	U	<0.32	U
1,2-Dichloroethene, Total	540-59-0	NA	NA	<82	U	<110	U	<76	U	<76	U	<110	U	<110	U	<68	U	<78	U	<0.95	U
1,2-Dichloropropane	78-87-5	6,620	1.7	<35	U	<48	U	<32	U	<33	U	<46	U	<45	U	<29	U	<33	U	<0.40	U
1,3-Dichlorobenzene	541-73-1	297,000	576.4	<15	U	<20	U	<13	U	<14	U	<19	U	<19	U	<12	U	<14	U	<0.17	U
1,3-Dichloropropane	142-28-9	1,490,000	NA	<39	U	<53	U	<36	U	<36	U	<51	U	<50	U	<32	U	<37	U	<0.44	U
1,4-Dichlorobenzene	106-46-7	17,500	72	<32	U	<45	U	<30	U	<30	U	<42	U	<42	U	<27	U	<31	U	<0.37	U
2,2-Dichloropropane	594-20-7	191,000	NA	<41	U	<57	U	<38	U	<38	U	<54	U	<53	U	<34	U	<39	U	<0.47	UJ
2-Chlorotoluene	95-49-8	907,000	NA	<19	U	<26	U	<18	U	<18	U	<25	U	<25	U	<16	U	<18	U	<0.22	U
4-Chlorotoluene	106-43-4	253,000	NA	<29	U	<40	U	<26	U	<27	U	<38	U	<37	U	<24	U	<27	U	<0.33	U
Bromochloromethane	74-97-5	154,000	NA	<61	U	<84	U	<57	U	<57	U	<80	U	<79	U	<51	U	<58	U	<0.71	U
Bromodichloromethane	75-27-4	976,000	0.2	<27	U	<38	U	<25	U	<25	U	<36	U	<36	U	<23	U	<26	U	<0.32	U
Chlorobenzene	108-90-7	761,000	67.9	<28	U	<38	U	<26	U	<26	U	<37	U	<36	U	<23	U	<26	U	<0.32	U
Chloroethane	75-00-3	2,120,000	113.3	<150	U	<210	U	<140	U	<140	U	<200	U	<200	U	<130	U	<150	U	<1.8	U
Chloromethane	74-87-3	720,000	7.8	<42	U	<59	U	<39	U	<39	U	<56	U	<55	U	<35	U	<40	U	<0.49	U
cis-1,2-Dichloroethene	156-59-2	2,040,000	20.6	<61	U	<84	U	<56	U	<57	U	<80	U	<79	U	<51	U	<58	U	<0.70	U
cis-1,3-Dichloropropene	10061-01-5	1,210,000	NA	<17	U	<23	U	<15	U	<15	U	<22	U	<21	U	<14	U	<16	U	<0.19	U
Dibromochloromethane	124-48-1	34,100	NA	<52	U	<72	U	<48	U	<49	U	<68	U	<68	U	<43	U	<50	U	<0.60	U
Dichlorodifluoromethane	75-71-8	571,000	1,543.1	<92	U	<130	U	<85	U	<86	U	<120	U	<120	U	<77	U	<88	U	<1.1	U
Methylene Chloride	75-09-2	1,070,000	NA	<81	U	<110	U	<75	U	<75	U	<110	U	<100	U	<67	U	<77	U	<0.93	U
Hexachlorobutadiene	87-68-3	7,450	NA	<48	UJ	<66	UJ	<44	UJ	<45	UJ	<63	UJ	<62	UJ	<40	UJ	<46	U	<0.55	U
Tetrachloroethene	127-18-4	153,000	2.3	<54	U	<75	U	<50	U	<50	U	<71	U	<70	U	<45	U	<52	U	<0.63	U
Tetrachloromethane	56-23-5	4,250	1.9	<28	U	<39	U	<26	U	<26	U	<37	U	<37	U	<24	U	<27	U	<0.33	U
trans-1,2-Dichloroethene	156-60-5	1,850,000	31	<21	U	<29	U	<20	U	<20	U	<28	U	<28	U	<18	U	<20	U	<0.25	U
trans-1,3-Dichloropropene	10061-02-6	1,510,000	NA	<28	U	<39	U	<26	U	<26	U	<37	U	<37	U	<24	U	<27	U	<0.33	U
Trichloroethene	79-01-6	8,810	2	<68	U	<93	U	<62	U	<63	U	<89	U	<88	U	<56	U	<64	U	<0.78	U
Trichlorofluoromethane	75-69-4	1,230,000	NA	<58	UJ	<81	UJ	<54	UJ	<54	UJ	<77	UJ	<76	UJ	<49	UJ	<56	U	<0.68	U
Trichloromethane	67-66-3	2,130	2,238.7	<29	U	<39	U	<26	U	<27	U	<37	U	<37	U	<24	U	<27	U	<0.33	U
Vinyl chloride	75-01-4	2,030	0.069	<58	U	<79	U	<53	U	<54	U	<76	U	<75	U	<48	U	<55	U	<0.66	U

Table 3
CG019 Soil Analytical Data
General Mitchell Air National Guard - 128th Air Refueling Wing

Sample Location	CAS	WDNR RR Program Soil RCLs for Direct Contact, Industrial Scenario (ug/kg)	WDNR RR Program Groundwater Protective RCLs (ug/kg)	CG019-SB-10					
Date Collected				9/29/2016					
Depth				3-4		5-6		3-4 (Duplicate)	
Criteria Reference			2						
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	630-20-6	12,900	26.7	<24	U	<27	U	<0.34	U
1,1,1-Trichloroethane	71-55-6	640,000	70.1	<21	U	<23	U	<0.30	U
1,1,2,2-Tetrachloroethane	79-34-5	3,690	0.078	<45	U	<49	U	<0.63	U
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	910000	NA	<35	U	<39	U	<0.50	U
1,1,2-Trichloroethane	79-00-5	734	1.6	<18	U	<20	U	<0.26	U
1,1-Dichloroethane	75-34-3	23,700	241.7	<18	U	<20	U	<0.26	U
1,1-Dichloroethene	75-35-4	1,190,000	2.5	<24	U	<26	U	<0.34	U
1,1-Dichloropropene	563-58-6	NA	NA	<24	U	<27	U	<0.34	U
1,2,3-Trichlorobenzene	87-61-6	818,000	NA	<54	UJ	<59	UJ	<0.77	U
1,2,3-Trichloropropane	96-18-4	95	0.086	<48	U	<53	U	<0.68	U
1,2,4-Trichlorobenzene	120-82-1	98,700	NA	<63	U	<69	U	<0.89	U
1,2-Dibromo-3-chloropropane	96-12-8	99	0.086	<100	U	<110	U	<1.4	U
1,2-Dichlorobenzene	95-50-1	376,000	584.0	<44	U	<49	U	<0.63	U
1,2-Dichloroethane	107-06-2	3,030	1.4	<22	U	<25	U	<0.32	U
1,2-Dichloroethene, Total	540-59-0	NA	NA	<66	U	<72	U	<0.93	U
1,2-Dichloropropane	78-87-5	6,620	1.7	<28	U	<31	U	<0.40	U
1,3-Dichlorobenzene	541-73-1	297,000	576.4	<12	U	<13	U	<0.16	U
1,3-Dichloropropane	142-28-9	1,490,000	NA	<31	U	<34	U	<0.44	U
1,4-Dichlorobenzene	106-46-7	17,500	72	<26	U	<28	U	<0.37	U
2,2-Dichloropropane	594-20-7	191,000	NA	<33	U	<36	U	<0.47	UJ
2-Chlorotoluene	95-49-8	907,000	NA	<15	U	<17	U	<0.22	U
4-Chlorotoluene	106-43-4	253,000	NA	<23	U	<25	U	<0.32	U
Bromochloromethane	74-97-5	154,000	NA	<49	U	<54	U	<0.69	U
Bromodichloromethane	75-27-4	976,000	0.2	<22	U	<24	U	<0.31	U
Chlorobenzene	108-90-7	761,000	67.9	<22	U	<25	U	<0.32	U
Chloroethane	75-00-3	2,120,000	113.3	<120	U	<140	U	<1.7	U
Chloromethane	74-87-3	720,000	7.8	<34	U	<37	U	<0.48	U
cis-1,2-Dichloroethene	156-59-2	2,040,000	20.6	<49	U	<54	U	<0.69	U
cis-1,3-Dichloropropene	10061-01-5	1,210,000	NA	<13	U	<15	U	<0.19	U
Dibromochloromethane	124-48-1	34,100	NA	<42	U	<46	U	<0.59	U
Dichlorodifluoromethane	75-71-8	571,000	1,543.1	<74	U	<81	U	<1.0	U
Methylene Chloride	75-09-2	1,070,000	NA	<64	U	<71	U	<0.91	U
Hexachlorobutadiene	87-68-3	7,450	NA	<38	UJ	<42	UJ	<0.55	U
Tetrachloroethene	127-18-4	153,000	2.3	<43	U	<48	U	<0.61	U
Tetrachloromethane	56-23-5	4,250	1.9	<23	U	<25	U	<0.32	U
trans-1,2-Dichloroethene	156-60-5	1,850,000	31	<17	U	<19	U	<0.24	U
trans-1,3-Dichloropropene	10061-02-6	1,510,000	NA	<23	U	<25	U	<0.32	U
Trichloroethene	79-01-6	8,810	2	<54	U	<60	U	<0.77	U
Trichlorofluoromethane	75-69-4	1,230,000	NA	<47	UJ	<52	UJ	<0.66	U
Trichloromethane	67-66-3	2,130	2,238.7	<23	U	<25	U	<0.32	U
Vinyl chloride	75-01-4	2,030	0.069	<46	U	<51	U	<0.65	U

Table 3 Notes
General Mitchell Air National Guard - 128th Air Refueling Wing

400 Exceeds GW protections RCLs
400 Exceeds Industrial Direct Contact
400 Exceeds Non-Industrial Direct Contact

Notes:
Criteria from Wisconsin Department of Natural Resources (WDNR) Chapter NR 720, November 11, 2013
mg/kg: milligrams per kilogram
µg/kg: micrograms per kilogram
< : not detected at or above value
U: The analyte concentration is less than the detection limit.
B: A target analyte was detected in an associated blank QC sample.
DUP: Field duplicate sample
ID: Insufficient data to develop criterion.
UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
M: Calculated criterion is below analytical target detection limit, therefore, criterion defaults to the target detection limit.
NA: Not Analyzed
R = The sample result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria.
Q = The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
NC: No Criteria
RCL: Residual Contaminant Levels
Bolded values indicate concentrations above detection limits
Shaded value indicates exceedance of criteria.
J: Estimated detected concentration.
M: Calculated criterion is below analytical target detection limit, therefore, criterion defaults to the target detection limit.
NA: Not Analyzed
NC: No Criteria
RCL: Residual Contaminant Levels
Bolded values indicate concentrations above detection limits
Shaded value indicates exceedance of criteria.

Table 4
CG019 Permanent Wells Groundwater Analytical Data
General Mitchell Air National Guard - 128th Air Refueling Wing

Sample ID	CAS	NR 140 ES	NR 140 PAL	CG019-MW-7P		CG019-MW-08		CG019-MW-12		CG019-MW-13P		CG019-MW-100P		CG019-MW-101P		CG019-MW-102		CG019-MW-102P		CG019-MW-103P		CG019-MW-105P				CG019-MW-111P	
Date Sampled				9/8/16		9/10/16		9/8/16		9/10/16		9/10/16		9/10/16		9/8/16		9/8/16		9/8/16		9/8/16		9/8/2016 (Dup)		9/10/16	
Criteria Reference		1	2																								
Volatile Organic Compounds																											
1,1,1,2-Tetrachloroethane	630-20-6	70	7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,1-Trichloroethane	71-55-6	200	40	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,2,2-Tetrachloroethane	79-34-5	0.2	0.02	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,2-Trichloroethane	79-00-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1-Dichloroethane	75-34-3	850	85	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
1,1-Dichloroethene	75-35-4	7	0.7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1-Dichloropropene	563-58-6	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,3-Trichlorobenzene	87-61-6	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,3-Trichloropropane	96-18-4	60	12	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,4-Trichlorobenzene	120-82-1	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dibromo-3-chloropropane	96-12-8	0.2	0.02	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U
1,2-Dichlorobenzene	95-50-1	600	60	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dichloroethane	107-06-2	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	**4**		<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dichloroethene, Total	540-59-0	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	**0.89**	J	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
1,2-Dichloropropane	78-87-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,3-Dichlorobenzene	541-73-1	600	120	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,3-Dichloropropane	142-28-9	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,4-Dichlorobenzene	106-46-7	75	15	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
2,2-Dichloropropane	594-20-7	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
2-Chlorotoluene	95-49-8	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
4-Chlorotoluene	106-43-4	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Bromochloromethane	74-97-5	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Bromodichloromethane	75-27-4	0.6	0.06	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Chlorobenzene	108-90-7	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Chloroethane	75-00-3	400	80	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
Chloromethane	74-87-3	30	3	**0.38**	J	<0.60	U	<0.60	U	<0.60	U	<0.60	U	**0.41**	J	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
cis-1,2-Dichloroethene	156-59-2	70	7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	**0.89**	J	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
cis-1,3-Dichloropropene	10061-01-5	0.4	0.04	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Dibromochloromethane	124-48-1	60	6	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Dichlorodifluoromethane	75-71-8	1,000	200	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Methylene Chloride	75-09-2	5	0.5	**0.38**	J	<0.60	U	<0.60	U	**0.28**	J	**0.42**	J	**0.79**	J	<0.60	U	**0.36**	J	**0.28**	J	**0.28**	J	<0.60	U	**0.59**	J
Hexachlorobutadiene	87-68-3	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
Tetrachloroethene	127-18-4	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Tetrachloromethane	56-23-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
trans-1,2-Dichloroethene	156-60-5	100	20	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
trans-1,3-Dichloropropene	10061-02-6	0.4	0.04	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichloroethene	79-01-6	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichlorofluoromethane	75-69-4	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichloromethane	67-66-3	6	0.6	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Vinyl chloride	75-01-4	0.2	0.02	**3.5**		<0.60	U	<0.60	U	<0.60	U	**5.8**		<0.60	U	<0.60	U	**1.8**		<0.60	U	<0.60	U	<0.60	U	<0.60	U
MNA																											
Methane	74-82-8	NA	NA	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Alkalinity (mg/L of CaCO3)	ALK	NA	NA	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Sulfide (mg/L)	18496-25-8	NA	NA	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Total Organic Carbon (TOC) (mg/L)	TOC	NA	NA	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Iron	7439-89-6	300	150	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Dissolved Iron	7439-89-6	300	150	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Nitrate (mg/L)	14797-55-8	10	2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Nitrite (mg/L)	14797-65-0	10	2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Sulfate (mg/L)	14808-79-8	250	125	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

Table 4
CG019 Permanent Wells Groundwater Analytical Data
General Mitchell Air National Guard - 128th Air Refueling Wing

Sample ID	CAS	NR 140 ES	NR 140 PAL	CG019-MW-112		CG019-MW-112P		CG019-MW-114		CG019-MW-201						CG019-MW-202						CG019-MW-203					
Date Sampled				9/10/16		9/10/16		9/10/16		10/27/16		11/1/16		11/1/2016 (Duplicate)		10/26/16		11/2/16		11/2/2016 (Duplicate)		10/27/16		10/27/2016 (Duplicate)		11/2/16	
Criteria Reference		1	2																								
Volatile Organic Compounds																											
1,1,1,2-Tetrachloroethane	630-20-6	70	7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,1-Trichloroethane	71-55-6	200	40	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,2,2-Tetrachloroethane	79-34-5	0.2	0.02	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	U
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	IJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	U	<0.60	UJ
1,1,2-Trichloroethane	79-00-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1-Dichloroethane	75-34-3	850	85	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
1,1-Dichloroethene	75-35-4	7	0.7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1-Dichloropropene	563-58-6	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,3-Trichlorobenzene	87-61-6	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	UJ	<0.60	U
1,2,3-Trichloropropane	96-18-4	60	12	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,4-Trichlorobenzene	120-82-1	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	UJ	<0.60	U
1,2-Dibromo-3-chloropropane	96-12-8	0.2	0.02	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U
1,2-Dichlorobenzene	95-50-1	600	60	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dichloroethane	107-06-2	5	0.5	**0.88**	J	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dichloroethene, Total	540-59-0	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
1,2-Dichloropropane	78-87-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,3-Dichlorobenzene	541-73-1	600	120	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,3-Dichloropropane	142-28-9	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,4-Dichlorobenzene	106-46-7	75	15	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
2,2-Dichloropropane	594-20-7	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	UJ	<1.0	UJ	<1.0	UJ	<1.0	UJ	<1.0	U	<1.0	U	<1.0	UJ	<1.0	UJ	<1.0	U
2-Chlorotoluene	95-49-8	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
4-Chlorotoluene	106-43-4	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Bromochloromethane	74-97-5	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Bromodichloromethane	75-27-4	0.6	0.06	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Chlorobenzene	108-90-7	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	UJ	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Chloroethane	75-00-3	400	80	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
Chloromethane	74-87-3	30	3	<0.60	U	<0.60	U	**0.42**	J	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
cis-1,2-Dichloroethene	156-59-2	70	7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
cis-1,3-Dichloropropene	10061-01-5	0.4	0.04	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	UJ	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	**NA**	
Dibromochloromethane	124-48-1	60	6	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	UJ	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Dichlorodifluoromethane	75-71-8	1,000	200	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ
Methylene Chloride	75-09-2	5	0.5	**0.32**	J	**0.39**	J	**0.34**	J	**0.6**	J,Q	<0.60	U	**0.3**	J,Q	**0.4**	J,Q	**0.31**	J,B	**0.43**	J,B	**0.45**	J,Q	**0.5**	J,Q	**0.38**	J,B
Hexachlorobutadiene	87-68-3	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	UJ	<1.0	U
Tetrachloroethene	127-18-4	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Tetrachloromethane	56-23-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
trans-1,2-Dichloroethene	156-60-5	100	20	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
trans-1,3-Dichloropropene	10061-02-6	0.4	0.04	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichloroethene	79-01-6	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichlorofluoromethane	75-69-4	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichloromethane	67-66-3	6	0.6	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Vinyl chloride	75-01-4	0.2	0.02	<0.60	U	**1.0**		<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
MNA																											
Methane	74-82-8	NA	NA	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Alkalinity (mg/L of CaCO3)	ALK	NA	NA	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Sulfide (mg/L)	18496-25-8	NA	NA	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Total Organic Carbon (TOC) (mg/L)	TOC	NA	NA	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Iron	7439-89-6	300	150	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Dissolved Iron	7439-89-6	300	150	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Nitrate (mg/L)	14797-55-8	10	2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Nitrite (mg/L)	14797-65-0	10	2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
Sulfate (mg/L)	14808-79-8	250	125	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

Table 4
CG019 Permanent Wells Groundwater Analytical Data
General Mitchell Air National Guard - 128th Air Refueling Wing

Sample ID	**CAS**	**NR 140 ES**	**NR 140 PAL**	CG019-MW-204				CG019-MW-205				CG019-MW-206				CG019-MW-207						CG019-MW-208			
Date Sampled				10/27/16		11/3/16		10/26/16		11/3/16		10/26/16		11/2/16		10/26/16		10/26/2016 (Duplicate)		11/2/16		10/26/16		11/2/16	
Criteria Reference		1	2																						
Volatile Organic Compounds																									
1,1,1,2-Tetrachloroethane	630-20-6	70	7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,1-Trichloroethane	71-55-6	200	40	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,2,2-Tetrachloroethane	79-34-5	0.2	0.02	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NA	NA	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ
1,1,2-Trichloroethane	79-00-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1-Dichloroethane	75-34-3	850	85	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
1,1-Dichloroethene	75-35-4	7	0.7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1-Dichloropropene	563-58-6	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,3-Trichlorobenzene	87-61-6	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	UJ	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,3-Trichloropropane	96-18-4	60	12	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,4-Trichlorobenzene	120-82-1	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dibromo-3-chloropropane	96-12-8	0.2	0.02	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U	<2.0	U
1,2-Dichlorobenzene	95-50-1	600	60	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dichloroethane	107-06-2	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dichloroethene, Total	540-59-0	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
1,2-Dichloropropane	78-87-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,3-Dichlorobenzene	541-73-1	600	120	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,3-Dichloropropane	142-28-9	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,4-Dichlorobenzene	106-46-7	75	15	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
2,2-Dichloropropane	594-20-7	NA	NA	<1.0	UJ	<1.0	U	<1.0	UJ	<1.0	U	<1.0	UJ	<1.0	UJ	<1.0	UJ	<1.0	UJ	<1.0	U	<1.0	UJ	<1.0	U
2-Chlorotoluene	95-49-8	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
4-Chlorotoluene	106-43-4	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Bromochloromethane	74-97-5	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Bromodichloromethane	75-27-4	0.6	0.06	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Chlorobenzene	108-90-7	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Chloroethane	75-00-3	400	80	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
Chloromethane	74-87-3	30	3	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
cis-1,2-Dichloroethene	156-59-2	70	7	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
cis-1,3-Dichloropropene	10061-01-5	0.4	0.04	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Dibromochloromethane	124-48-1	60	6	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Dichlorodifluoromethane	75-71-8	1,000	200	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ
Methylene Chloride	75-09-2	5	0.5	**0.53**	J,Q	**0.38**	J,Q	**0.5**	J,Q	**0.37**	J,Q	**0.52**	J,Q	**0.48**	J,Q	**0.57**	J,Q	**0.85**	J,Q	**0.38**	J,B	**0.73**	J,Q	**0.38**	J,B
Hexachlorobutadiene	87-68-3	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U	<1.0	U
Tetrachloroethene	127-18-4	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Tetrachloromethane	56-23-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
trans-1,2-Dichloroethene	156-60-5	100	20	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
trans-1,3-Dichloropropene	10061-02-6	0.4	0.04	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichloroethene	79-01-6	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichlorofluoromethane	75-69-4	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichloromethane	67-66-3	6	0.6	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Vinyl chloride	75-01-4	0.2	0.02	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	<0.60	U	**3.1**		**3.3**		**2.6**		<0.60	U	<0.60	U
MNA																									
Methane	74-82-8	NA	NA	NS		NS		NS		NS		NS		NS		**59**		NS		NS		NS		NS	
Alkalinity (mg/L of CaCO3)	ALK	NA	NA	NS		NS		NS		NS		NS		NS		**560**		NS		NS		NS		NS	
Sulfide (mg/L)	18496-25-8	NA	NA	NS		NS		NS		NS		NS		NS		<0.016		NS		NS		NS		NS	
Total Organic Carbon (TOC) (mg/L)	TOC	NA	NA	NS		NS		NS		NS		NS		NS		**5.4**		NS		NS		NS		NS	
Iron	7439-89-6	300	150	NS		NS		NS		NS		NS		NS		**11,000**		NS		NS		NS		NS	
Dissolved Iron	7439-89-6	300	150	NS		NS		NS		NS		NS		NS		**1700**		NS		NS		NS		NS	
Nitrate (mg/L)	14797-55-8	10	2	NS		NS		NS		NS		NS		NS		<0.050	U	NS		NS		NS		NS	
Nitrite (mg/L)	14797-65-0	10	2	NS		NS		NS		NS		NS		NS		<0.075	U	NS		NS		NS		NS	
Sulfate (mg/L)	14808-79-8	250	125	NS		NS		NS		NS		NS		NS		**150**		NS		NS		NS		NS	

Table 4
CG019 Permanent Wells Groundwater Analytical Data
General Mitchell Air National Guard - 128th Air Refueling Wing

Sample ID / Date Sampled	CAS	NR 140 ES	NR 140 PAL	CG019-MW-209				CG019-MW-210			
				10/26/16		11/2/16		10/26/16		11/2/16	
Criteria Reference		1	2								
Volatile Organic Compounds											
1,1,1,2-Tetrachloroethane	630-20-6	70	7	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,1-Trichloroethane	71-55-6	200	40	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1,2,2-Tetrachloroethane	79-34-5	0.2	0.02	<0.60	U	<0.60	U	<0.60	UJ	<0.60	U
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NA	NA	<0.60	UJ	<0.60	UJ	<0.60	U	<0.60	UJ
1,1,2-Trichloroethane	79-00-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1-Dichloroethane	75-34-3	850	85	<1.0	U	<1.0	U	<1.0	U	<1.0	U
1,1-Dichloroethene	75-35-4	7	0.7	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,1-Dichloropropene	563-58-6	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,3-Trichlorobenzene	87-61-6	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,3-Trichloropropane	96-18-4	60	12	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2,4-Trichlorobenzene	120-82-1	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dibromo-3-chloropropane	96-12-8	0.2	0.02	<2.0	U	<2.0	U	<2.0	U	<2.0	U
1,2-Dichlorobenzene	95-50-1	600	60	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dichloroethane	107-06-2	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,2-Dichloroethene, Total	540-59-0	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U
1,2-Dichloropropane	78-87-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,3-Dichlorobenzene	541-73-1	600	120	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,3-Dichloropropane	142-28-9	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
1,4-Dichlorobenzene	106-46-7	75	15	<0.60	U	<0.60	U	<0.60	U	<0.60	U
2,2-Dichloropropane	594-20-7	NA	NA	<1.0	UJ	<1.0	U	<1.0	UJ	<1.0	U
2-Chlorotoluene	95-49-8	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
4-Chlorotoluene	106-43-4	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Bromochloromethane	74-97-5	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Bromodichloromethane	75-27-4	0.6	0.06	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Chlorobenzene	108-90-7	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Chloroethane	75-00-3	400	80	<1.0	U	<1.0	U	<1.0	U	<1.0	U
Chloromethane	74-87-3	30	3	<0.60	U	<0.60	U	**0.37**	J	<0.60	U
cis-1,2-Dichloroethene	156-59-2	70	7	<0.60	U	<0.60	U	<0.60	U	<0.60	U
cis-1,3-Dichloropropene	10061-01-5	0.4	0.04	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Dibromochloromethane	124-48-1	60	6	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Dichlorodifluoromethane	75-71-8	1,000	200	<0.60	UJ	<0.60	UJ	<0.60	UJ	<0.60	UJ
Methylene Chloride	75-09-2	5	0.5	**0.68**	J,Q	**0.45**	J,B	**0.75**	J,Q	**0.48**	J,B
Hexachlorobutadiene	87-68-3	NA	NA	<1.0	U	<1.0	U	<1.0	U	<1.0	U
Tetrachloroethene	127-18-4	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Tetrachloromethane	56-23-5	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U
trans-1,2-Dichloroethene	156-60-5	100	20	<0.60	U	<0.60	U	<0.60	U	<0.60	U
trans-1,3-Dichloropropene	10061-02-6	0.4	0.04	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichloroethene	79-01-6	5	0.5	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichlorofluoromethane	75-69-4	NA	NA	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Trichloromethane	67-66-3	6	0.6	<0.60	U	<0.60	U	<0.60	U	<0.60	U
Vinyl chloride	75-01-4	0.2	0.02	<0.60	U	<0.60	U	<0.60	U	<0.60	U
MNA											
Methane	74-82-8	NA	NA	NS		NS		**73**		NS	
Alkalinity (mg/L of CaCO3)	ALK	NA	NA	NS		NS		**300**		NS	
Sulfide (mg/L)	18496-25-8	NA	NA	NS		NS		<0.016	U	NS	
Total Organic Carbon (TOC) (mg/L)	TOC	NA	NA	NS		NS		**6.4**		NS	
Iron	7439-89-6	300	150	NS		NS		**1700**		NS	
Dissolved Iron	7439-89-6	300	150	NS		NS		**640**		NS	
Nitrate (mg/L)	14797-55-8	10	2	NS		NS		<0.050	U	NS	
Nitrite (mg/L)	14797-65-0	10	2	NS		NS		<0.075	U	NS	
Sulfate (mg/L)	14808-79-8	250	125	NS		NS		**100**		NS	

Table 4 Notes
General Mitchell Air National Guard - 128th Air Refueling Wing

400	Exceeds Enforcement Standard (ES)
400	Exceeds Preventative Action Limits (PALs)

Notes:

Criteria from Wisconsin Department of Natural Resources (WDNR) Chapter NR140, July, 2015

Data in microgram per liter (µg/L)

mg/kg: milligrams per kilogram

< : not detected at or above value

U: The analyte concentration is less than the detection limit.

B: A target analyte was detected in an associated blank QC sample.

DUP: Field duplicate sample

ID: Insufficient data to develop criterion.

J: Estimated detected concentration.

UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

M: Calculated criterion is below analytical target detection limit, therefore, criterion defaults to the target detection limit.

NA: Not Analyzed

R = The sample result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria.

Q = The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.

NC: No Criteria

RCL: Residual Contaminant Levels

Bolded values indicate concentrations above detection limits

Shaded value indicates exceedance of criteria.

MNA Parameters were collected for internal evaluation and were not evaluated against criteria.

APPENDIX C

WELL CONSTRUCTION LOGS

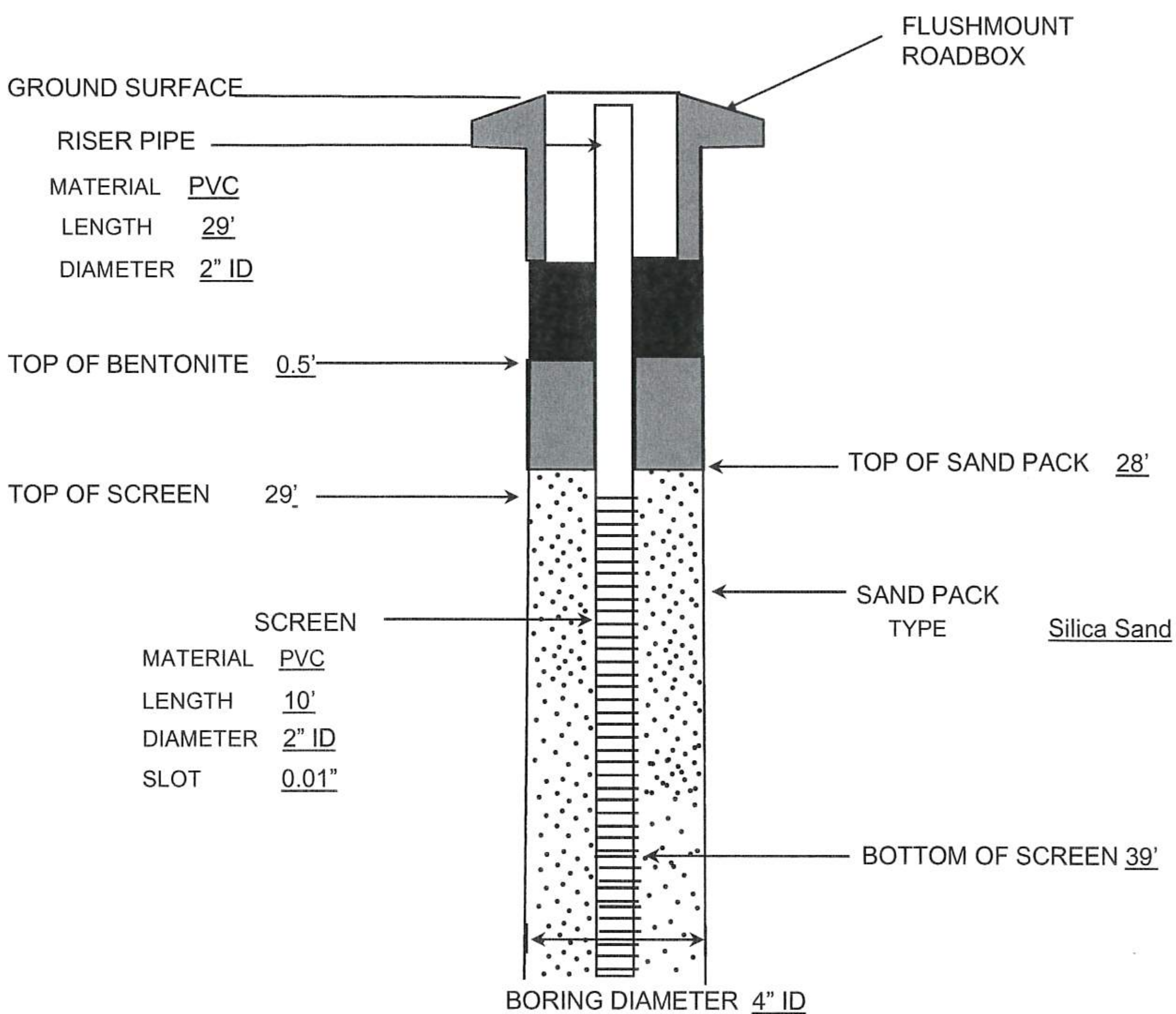
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED: 09/27/2016 WELL NUMBER: CG019-MW-201

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS: CG019 INSPECTOR: JWR

Groundwater Elevation: 0.5'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

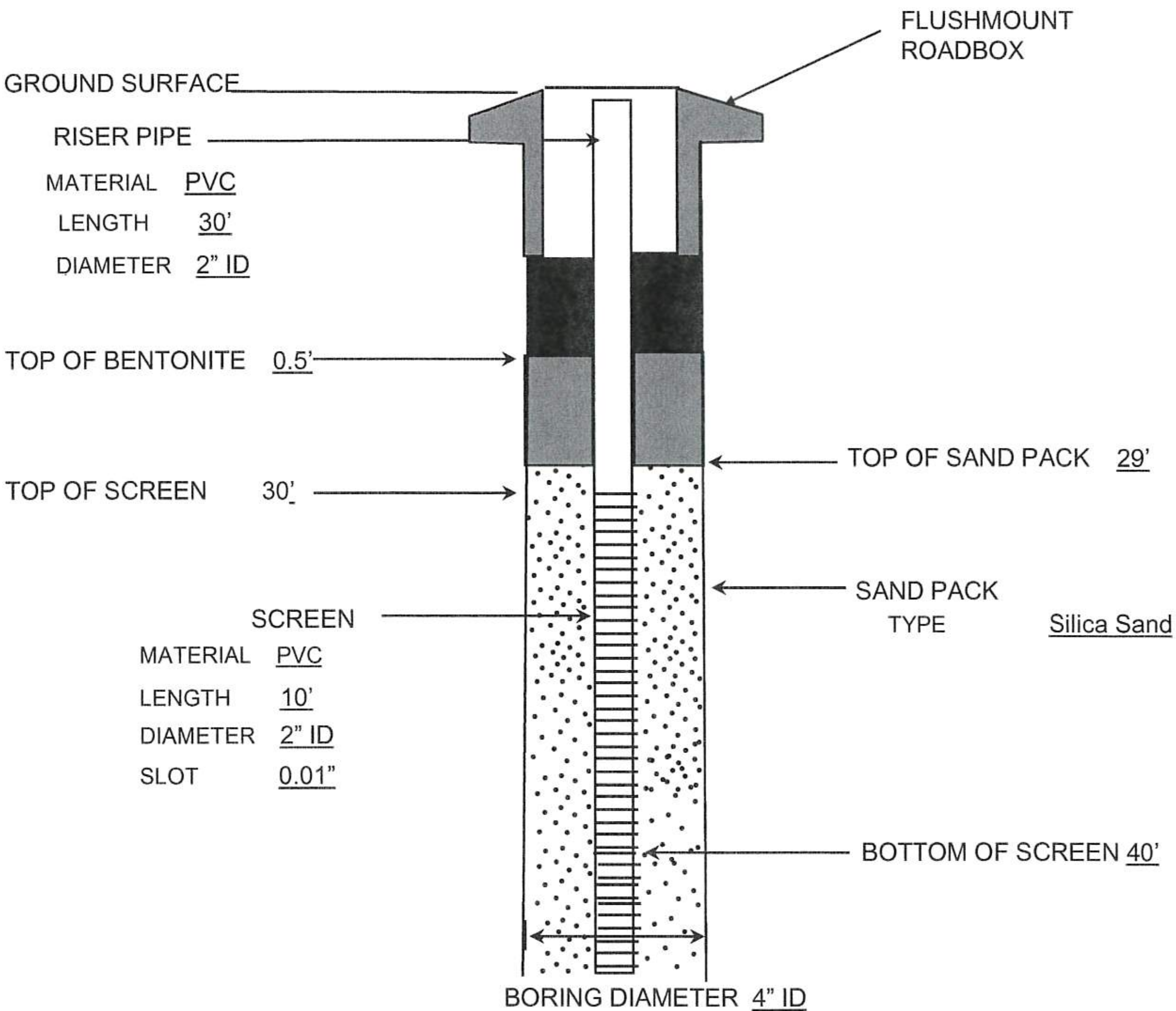
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED: 10/18/2016 WELL NUMBER: CG019-MW-202

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS: _CG019___ INSPECTOR: JWR_

Groundwater Elevation: 0.5'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

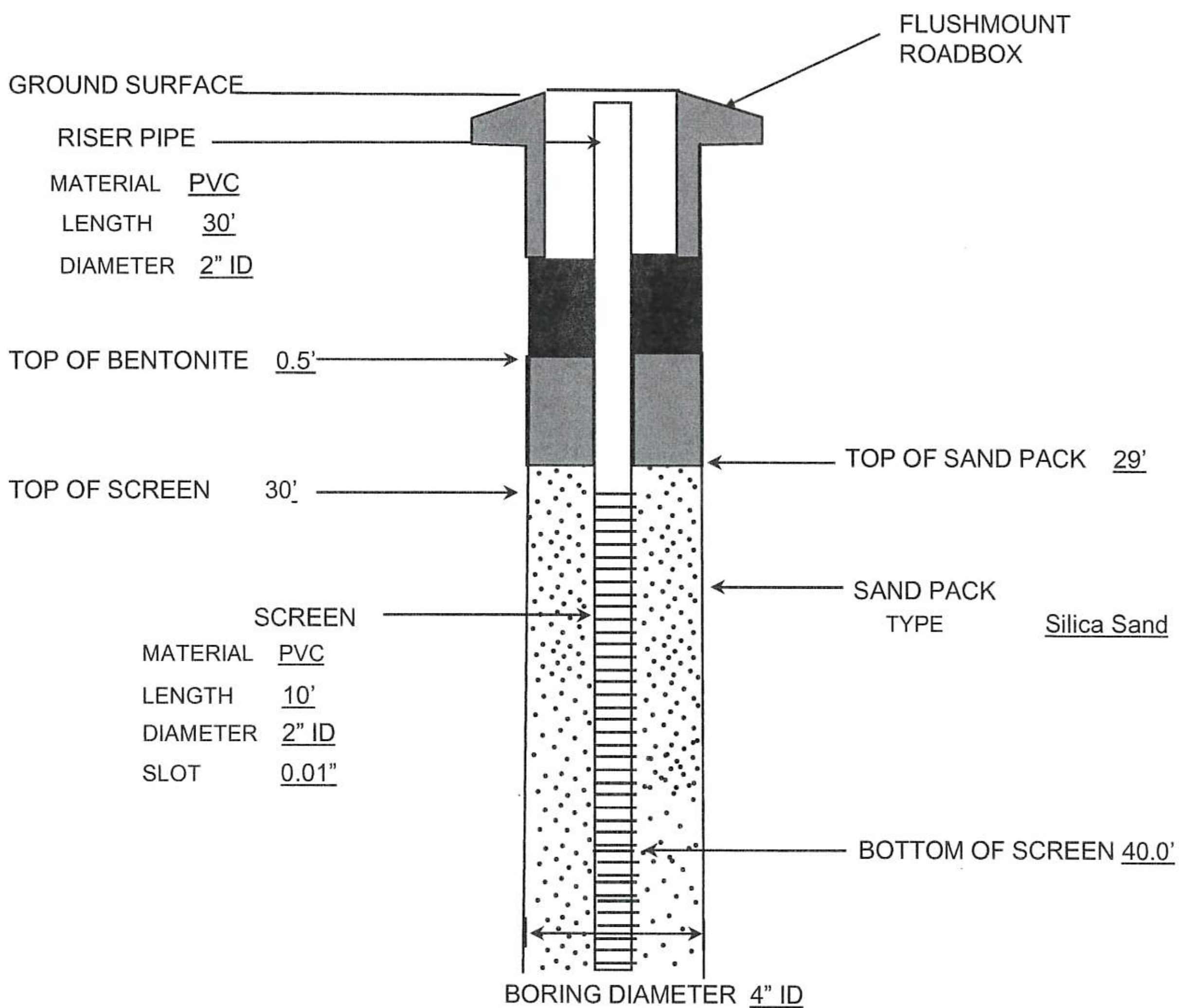
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED: 10/04/2016 WELL NUMBER: CG019-MW-203

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS: _CG019___ INSPECTOR: JWR_

Groundwater Elevation: 7'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

WELL CONSTRUCTION DIAGRAM

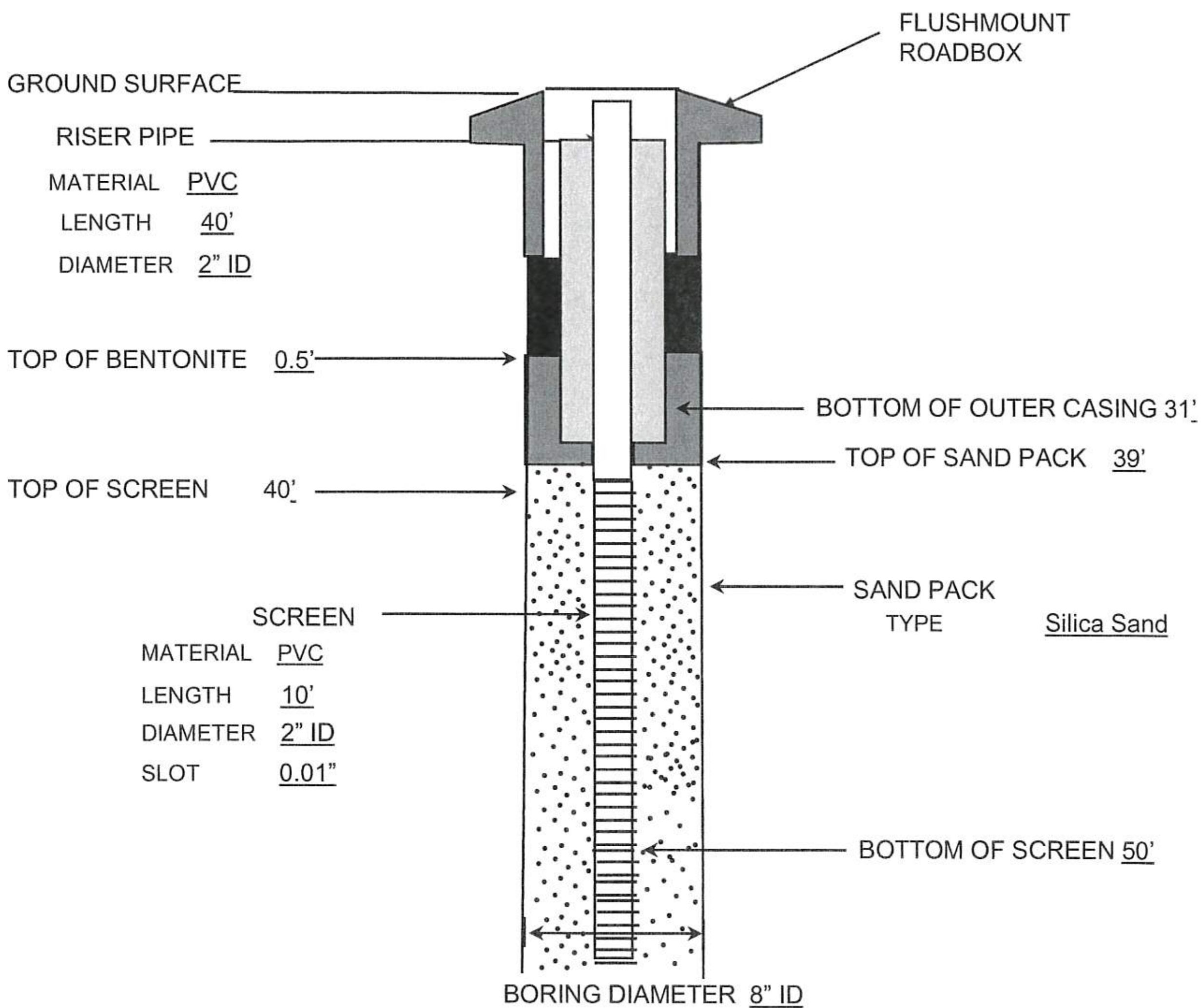
amec foster wheeler

PROJECT NAME: General Mitchell ANG DATE INSTALLED:10/13/2016 WELL NUMBER: CG019-MW-204

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS:_CG019___ INSPECTOR: JWR_

Groundwater Elevation: 5.5'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

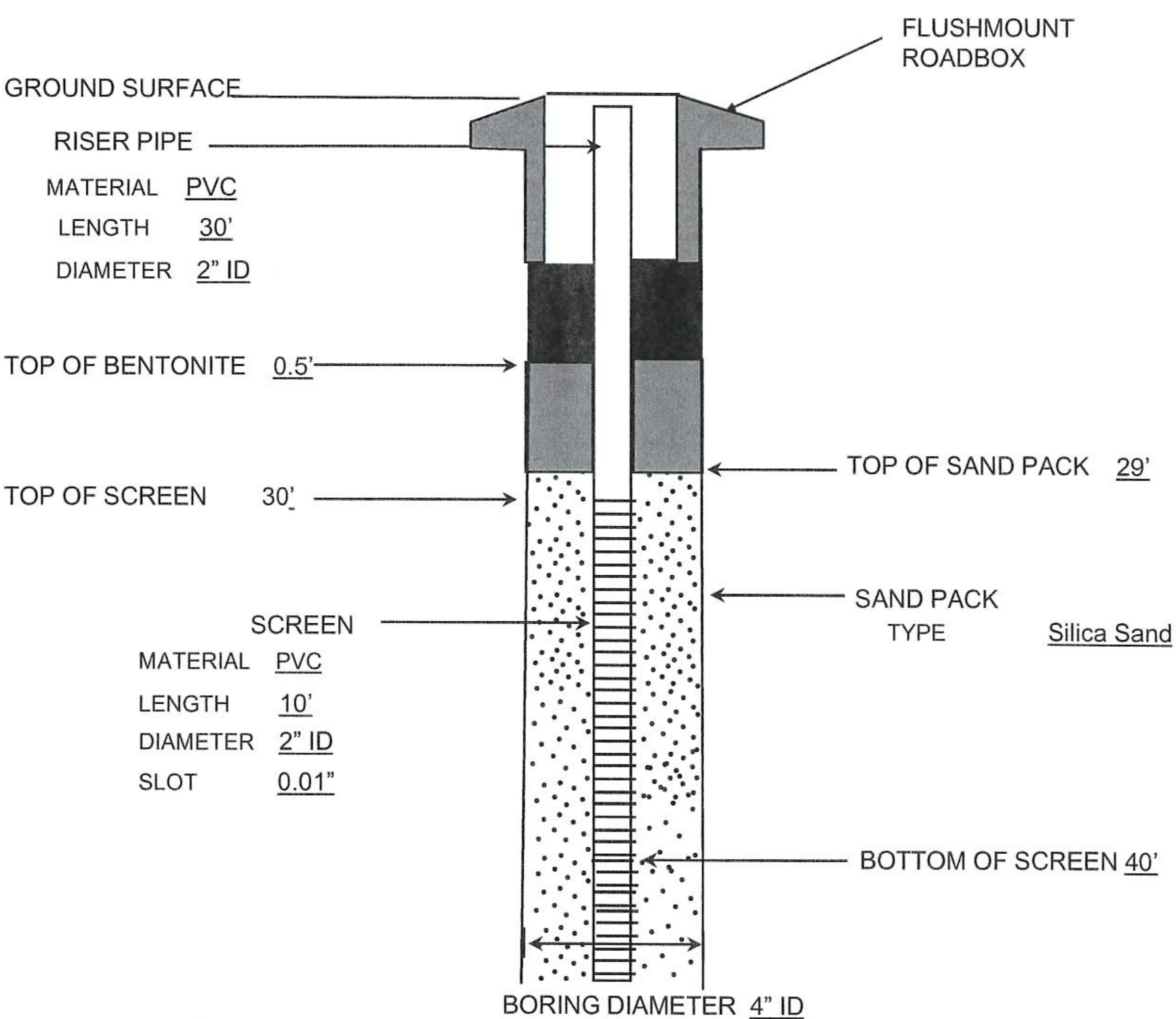
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED: 10/19/2016 WELL NUMBER: CG019-MW-205

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS: _CG019___ INSPECTOR: JWR

Groundwater Elevation: 0.5'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

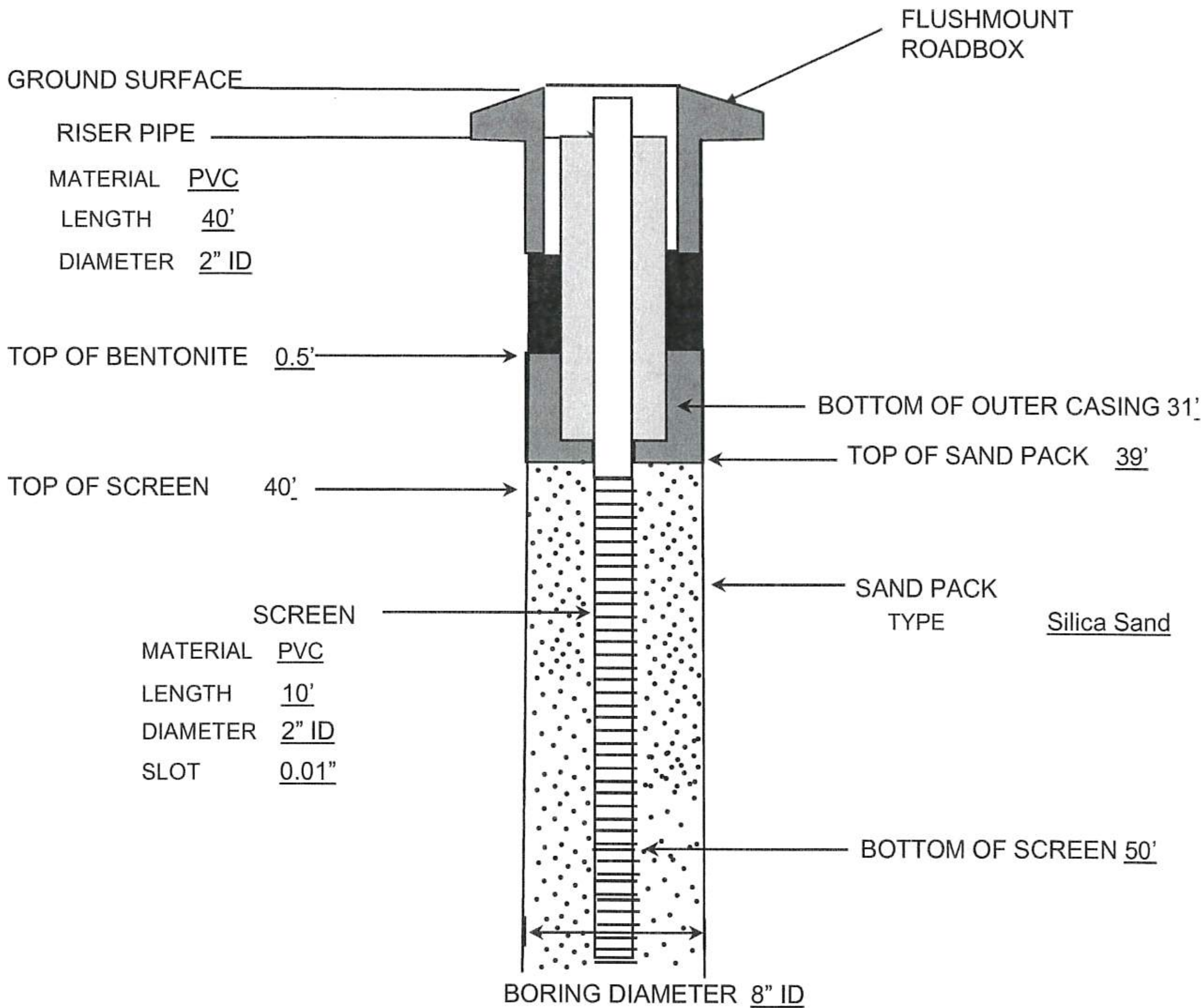
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED:10/13/2016 WELL NUMBER: CG019-MW-206

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS:_CG019___ INSPECTOR: JWR

Groundwater Elevation: 5.5'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

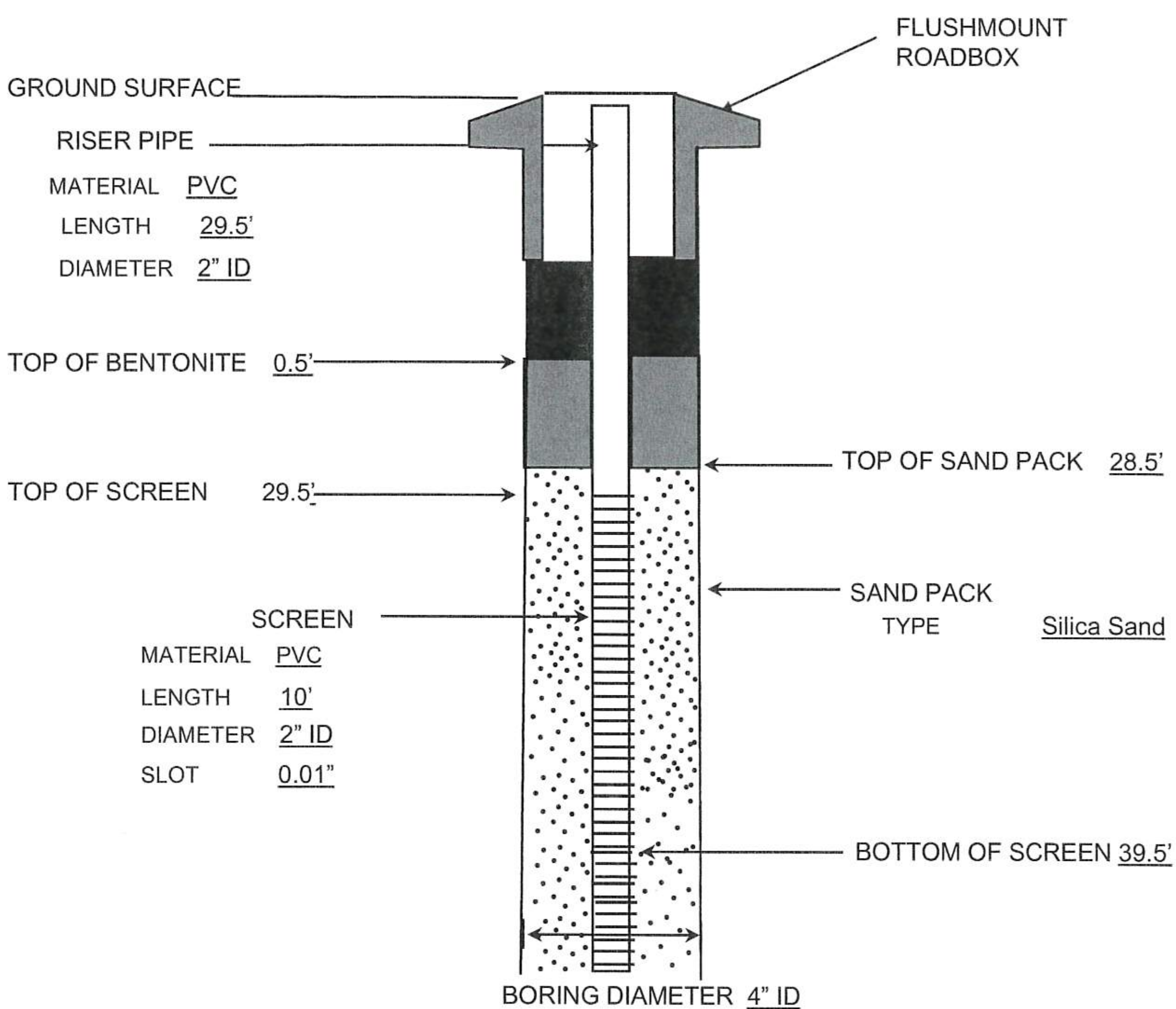
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED: 10/03/2016 WELL NUMBER: CG019-MW-207

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS: CG019 INSPECTOR: JWR

Groundwater Elevation: 7'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

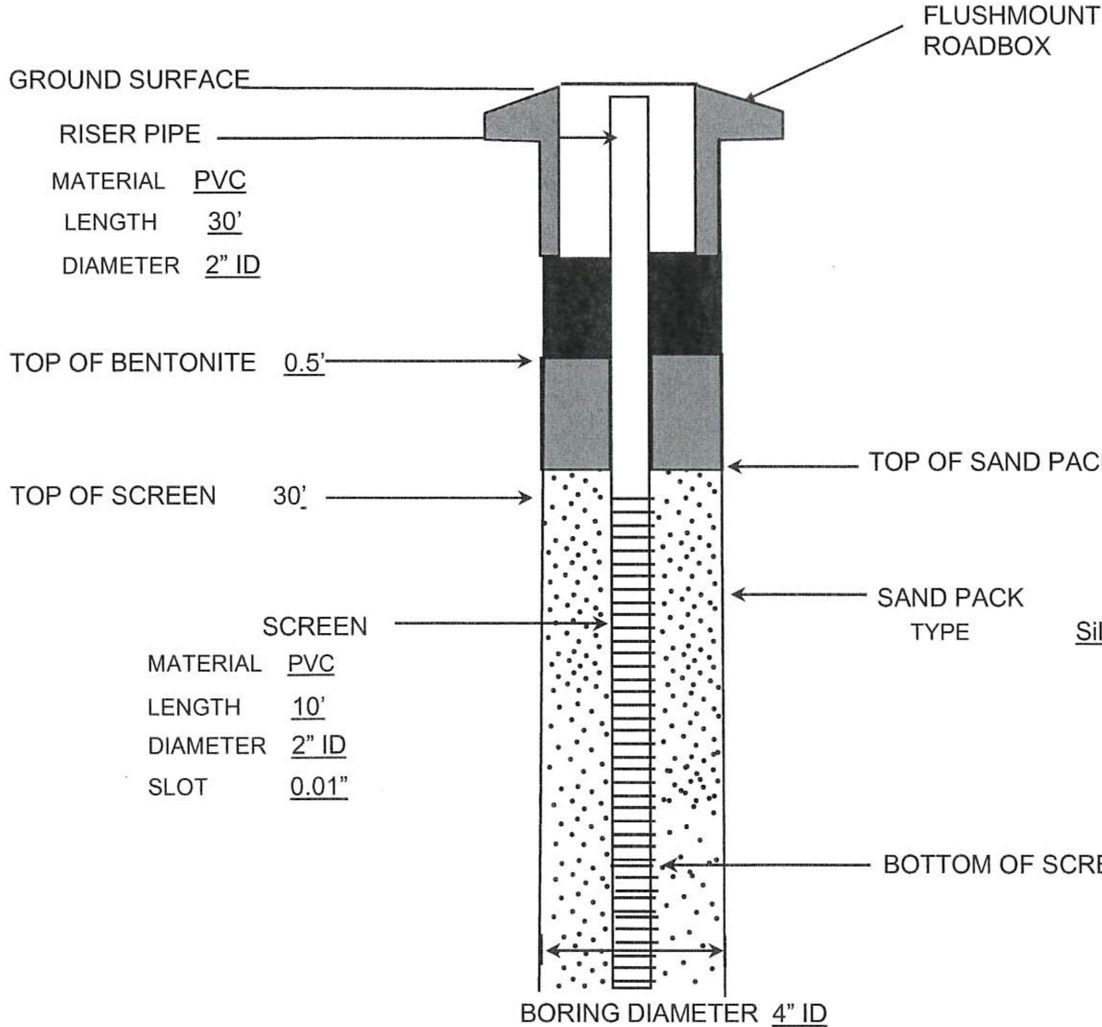
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED: 10/12/2016 WELL NUMBER: CG019-MW-208

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS: CG019___ INSPECTOR: JWR

Groundwater Elevation: 8'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

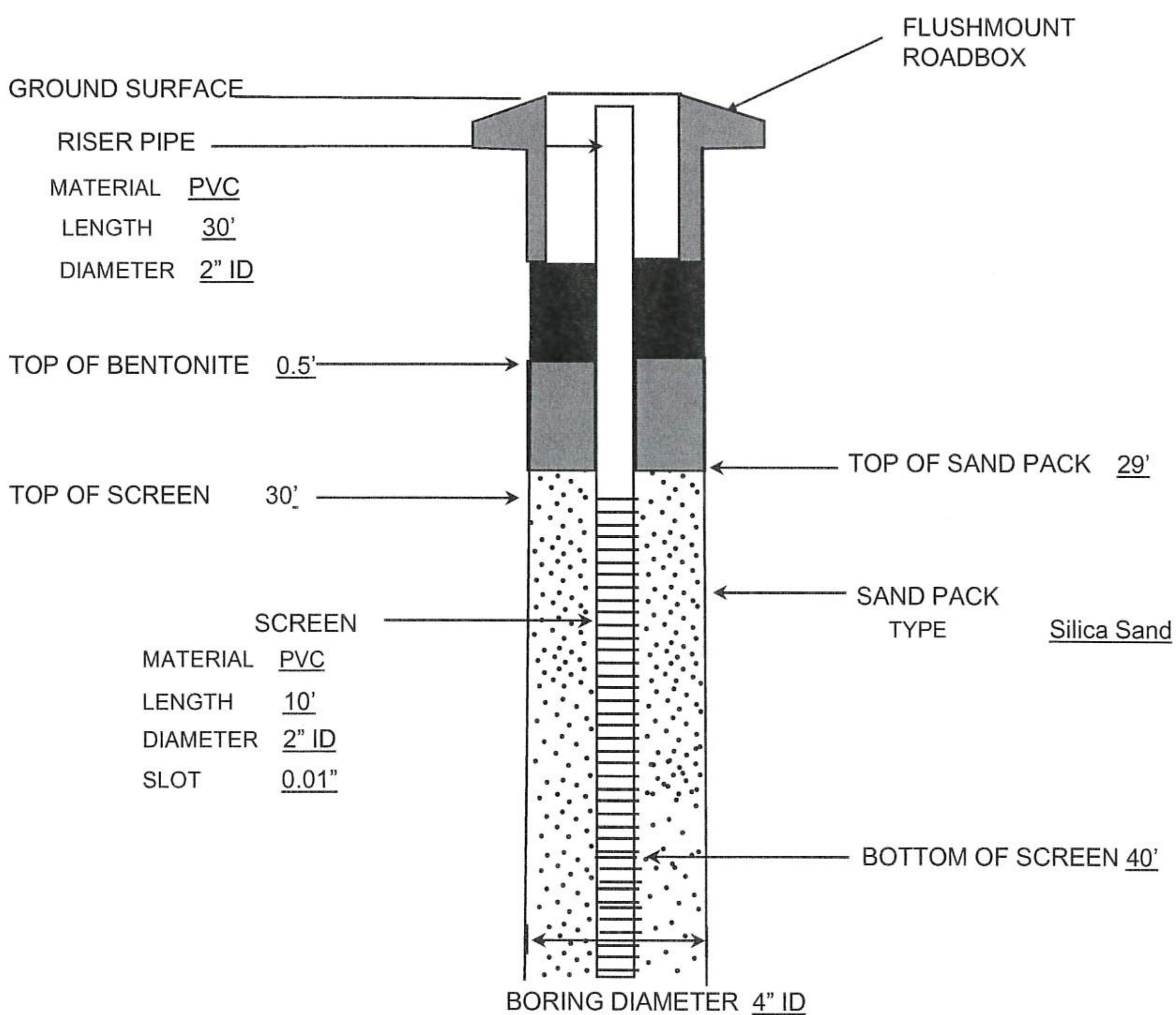
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED: 10/12/2016 WELL NUMBER: CG019-MW-209

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS: CG019 INSPECTOR: JWR

Groundwater Elevation: 8'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

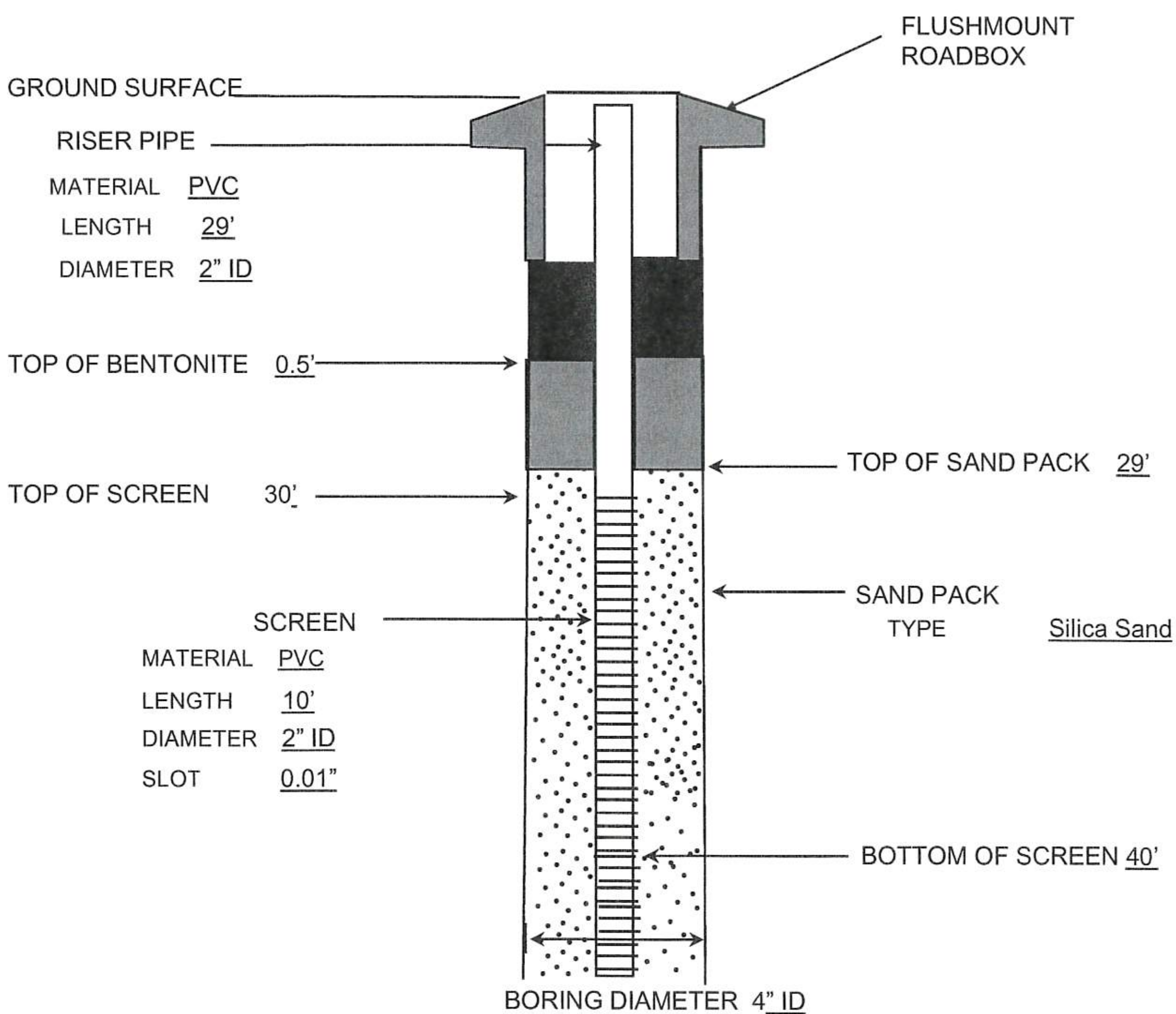
WELL CONSTRUCTION DIAGRAM

PROJECT NAME: General Mitchell ANG DATE INSTALLED: 10/5/2016 WELL NUMBER: CG019-MW-210

PROJECT NUMBER: 291330002 DRILLING COMPANY: Mateco METHOD: : Hollow Stem

REMARKS: _CG019___ INSPECTOR: JWR

Groundwater Elevation: 8'



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

APPENDIX D

WELL DEVELOPMENT LOGS

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ______

Facility/Project Name	County Name	Well Name	
General Mitchell Air National Guard	Milwaukee	CG019-MW-201	
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well ID Number**
	41		

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ______ ☐

3. Time spent developing well: 30 min.

4. Depth of well (from top of well casisng): 37.50 ft.

5. Inside diameter of well: 2.00 in.

6. Volume of water in filter pack and well casing: 6.11 gal.

7. Volume of water removed from well: 20.0 gal.

8. Volume of water added (if any): 0.0 gal.

9. Source of water added ______

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	0.00 ft.	28.0 ft.
Date	b.	10/19/2016 (mm/dd/yyyy)	__/__/____ (mm/dd/yyyy)
Time	c.	2:22 ☐ a.m. ☒ p.m.	2:52 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		___ inches	___ inches
13. Water clarity		Clear ☐ 10 Turbid ☒ 15 (Describe) >4000 NTU	Clear ☐ 20 Turbid ☐ 25 (Describe) 1028 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

	Before Development	After Development
14. Total suspended solids	___ mg/l	___ mg/l
15. COD	___ mg/l	___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ______

Facility/Project Name	County Name	Well Name
General Mitchell Air National Guard	Milwaukee	CG019-MW-202

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	41		

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ______ ☐

3. Time spent developing well: 11 min.

4. Depth of well (from top of well casisng): 38.85 ft.

5. Inside diameter of well: 2.00 in.

6. Volume of water in filter pack and well casing: 5.09 gal.

7. Volume of water removed from well: 20.0 gal.

8. Volume of water added (if any): 0.0 gal.

9. Source of water added ______

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	7.62 ft.	13.15 ft.
Date	b.	10/19/2016 (mm/dd/yyyy)	__/__/____ (mm/dd/yyyy)
Time	c.	9:22 ☒ a.m. ☐ p.m.	9:33 ☒ a.m. ☐ p.m.
12. Sediment in well bottom		___ inches	___ inches
13. Water clarity		Clear ☐ 10 / Turbid ☒ 15	Clear ☐ 20 / Turbid ☒ 25
(Describe)		>4000 NTU	3077 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

	Before Development	After Development
14. Total suspended solids	___ mg/l	___ mg/l
15. COD	___ mg/l	___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☒ Other ☐ ______

Facility/Project Name	County Name	Well Name	
General Mitchell Air National Guard	Milwaukee	CG019-MW-203	
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well ID Number**
	41		

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ______ ☐

3. Time spent developing well: 20 min.

4. Depth of well (from top of well casisng): 38.76 ft.

5. Inside diameter of well: 2.00 in.

6. Volume of water in filter pack and well casing: 5.18 gal.

7. Volume of water removed from well: 20.0 gal.

8. Volume of water added (if any): 0.0 gal.

9. Source of water added ______

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 6.96 ft.	24.74 ft.
Date	b. 10/19/2016 (mm/dd/yyyy)	__/__/____ (mm/dd/yyyy)
Time	c. 9:22 ☒ a.m. ☐ p.m.	9:33 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	___ inches	___ inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) >4000 NTU	Clear ☐ 20 Turbid ☐ 25 (Describe) 1732 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	___ mg/l	___ mg/l
15. COD	___ mg/l	___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________

Facility/Project Name	County Name	Well Name	
General Mitchell Air National Guard	Milwaukee	CG019-MW-204	
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well ID Number**
	41		

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ________ ☐

3. Time spent developing well 25 min.

4. Depth of well (from top of well casisng) 47.73 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 7.78 gal.

7. Volume of water removed from well 20.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added ________

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	0.0 ft.	39.15 ft.
Date	b.	10/20/2016 (mm/dd/yyyy)	__/__/____ (mm/dd/yyyy)
Time	c.	12:05 ☐ a.m. ☒ p.m.	12:30 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		73.56 inches	____ inches
13. Water clarity		Clear ☐ 10 Turbid ☒ 15 (Describe) >4000 NTU	Clear ☐ 20 Turbid ☐ 25 (Describe) 2572 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	____ mg/l	____ mg/l
15. COD	____ mg/l	____ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ______

Facility/Project Name	County Name	Well Name
General Mitchell Air National Guard	Milwaukee	CG019-MW-205

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	41		

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method
- surged with bailer and bailed ☐ 41
- surged with bailer and pumped ☐ 61
- surged with block and bailed ☐ 42
- surged with block and pumped ☐ 62
- surged with block, bailed and pumped ☐ 70
- compressed air ☐ 20
- bailed only ☐ 10
- pumped only ☒ 51
- pumped slowly ☐ 50
- Other ______ ☐

3. Time spent developing well 25 min.

4. Depth of well (from top of well casisng) 39.95 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 7.78 gal.

7. Volume of water removed from well 20.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added ______

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing) a.	5.75 ft.	19.15 ft.
Date b. (mm/dd/yyyy)	10/20/2016	
Time c.	10:50 ☒ a.m. ☐ p.m.	10:58 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	15.0 inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) >4000 NTU	Clear ☒ 20 Turbid ☐ 25 (Describe) 48 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ____________

Facility/Project Name	County Name	Well Name	
General Mitchell Air National Guard	Milwaukee	CG019-MW-206	
Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	41		

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ____________ ☐

3. Time spent developing well 7 min.

4. Depth of well (from top of well casisng) 44.57 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 6.44 gal.

7. Volume of water removed from well 25.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added ____________

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 5.06 ft.	18.80 ft.
Date	b. 10/20/2016 (mm/dd/yyyy)	__/__/____ (mm/dd/yyyy)
Time	c. 1:08 ☐ a.m. ☒ p.m.	1:15 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	14.0 inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15	Clear ☐ 20 Turbid ☒ 25
(Describe)	>4000 NTU	>4000 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ______

Facility/Project Name	County Name	Well Name	
General Mitchell Air National Guard	Milwaukee	CG019-MW-207	
Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	41		

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ______ ☐

3. Time spent developing well: 7 min.

4. Depth of well (from top of well casisng): 38.10 ft.

5. Inside diameter of well: 2.00 in.

6. Volume of water in filter pack and well casing: 5.34 gal.

7. Volume of water removed from well: 20.0 gal.

8. Volume of water added (if any): 0.0 gal.

9. Source of water added ______

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	5.31 ft.	16.28 ft.
Date	b.	10/20/2016 (mm/dd/yyyy)	__/__/____ (mm/dd/yyyy)
Time	c.	1:08 ☐ a.m. ☒ p.m.	1:15 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		14.0 inches	___ inches
13. Water clarity		Clear ☐ 10 Turbid ☒ 15	Clear ☐ 20 Turbid ☒ 25
(Describe)		>4000 NTU	258 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	___ mg/l	___ mg/l
15. COD	___ mg/l	___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ______

Facility/Project Name	County Name	Well Name	
General Mitchell Air National Guard	Milwaukee	CG019-MW-208	
Facility License, Permit or Monitoring Number	**County Code**	**Wis. Unique Well Number**	**DNR Well ID Number**
	41		

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ______ ☐

3. Time spent developing well 20 min.

4. Depth of well (from top of well casisng) 39.25 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 5.21 gal.

7. Volume of water removed from well 8.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added ______

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	7.26 ft.	DRY ft.
Date	b. (mm/dd/yyyy)	10/20/2016	10/21/2016
Time	c.	5:05 ☐ a.m. ☒ p.m.	7:46 ☒ a.m. ☐ p.m.
12. Sediment in well bottom		___ inches	___ inches
13. Water clarity		Clear ☐ 10 / Turbid ☒ 15 (Describe) 2986 NTU	Clear ☐ 20 / Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

	Before	After
14. Total suspended solids	___ mg/l	___ mg/l
15. COD	___ mg/l	___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm:

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: ______ Last Name: ______
Facility/Firm: ______
Street: ______
City/State/Zip: ______

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: ______
Print Name: ______
Firm: ______

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ______

Facility/Project Name	County Name	Well Name
General Mitchell Air National Guard	Milwaukee	CG019-MW-209

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	41		

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ______ ☐

3. Time spent developing well 7 min.

4. Depth of well (from top of well casing) 38.65 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 5.25 gal.

7. Volume of water removed from well 10.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added ______

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	9.12 ft.	34.28 ft.
Date (mm/dd/yyyy)	b.	10/14/2016	
Time	c.	2:12 ☐ a.m. ☒ p.m.	2:20 ☐ a.m. ☒ p.m.
12. Sediment in well bottom		inches	inches
13. Water clarity		Clear ☐ 10 Turbid ☒ 15 (Describe) >4000 NTU	Clear ☐ 20 Turbid ☒ 25 (Describe) >4000 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ____________

Facility/Project Name	County Name	Well Name	
General Mitchell Air National Guard	Milwaukee	CG019-MW-210	
Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	41		

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☒ 51
   - pumped slowly ☐ 50
   - Other ____________ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casing) 38.80 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 5.01 gal.

7. Volume of water removed from well 40.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added ____________

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 8.05 ft.	24.0 ft.
Date	b. 10/14/2016 (mm/dd/yyyy)	__/__/____ (mm/dd/yyyy)
Time	c. 12:58 ☐ a.m. ☒ p.m.	1:57 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	___ inches	___ inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe) 2057 NTU	Clear ☒ 20 Turbid ☐ 25 (Describe) 33 NTU

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	___ mg/l	___ mg/l
15. COD	___ mg/l	___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Reid Last Name: Crawford
Firm: Amec Foster Wheeler

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Faisal Last Name: Hussain
Facility/Firm: Amec Foster Wheeler
Street: 46850 Magellen Dr Ste 190
City/State/Zip: Novi, MI 48377

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: F. Hussain
Print Name: Faisal Hussain
Firm: Amec Foster Wheeler

NOTE: See instructions for more information including a list of county codes and well type codes.

APPENDIX E

WELL SAMPLING FORMS

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-08	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	4.84	**Date:**	09/09/2016
Total Depth of Well:	13.61	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 1.4; 3 X = 4.3
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	12

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
12:10		200							Pump Started
12:20	4.99	200	16.4	6.17	1.66	0.12	-60.3	61	
12:25	4.99	200	15.9	6.30	1.68	0.07	-59.4	69	
12:30	4.99	200	16.0	6.34	1.70	0.06	-60.9	70	
12:35	4.99	200	16.0	6.36	1.71	0.07	-60.3	52.6	
12:40	4.99	200	15.9	6.38	1.73	0.05	-62.1	47.9	
12:45	4.99	200	15.9	6.39	1.75	0.05	-62.6	43.0	
12:48	4.99	200	16.1	6.39	1.77	0.04	-63.6	38.0	
12:51	4.99	200	16.1	6.41	1.78	0.03	-63.6	37.2	

Stability Reached (Y/N): Yes If No, Provide Explanation

Final Values:	16.1	6.41	1.78	0.03	-63.6	37.2	

Sample ID:	CG019-mw-08-090916	**Sample Date:**	09/09/2016
Sample Depth:		**Sample Collection Time:**	12:51
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	4.99

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 8.77 * 7.48 gal/ft^3
= 1.4

Technician Signature:

Technician Name (print)**:** Faisal Hussain

Notes:

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-12	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	5.95	**Date:**	09/08/2016
Total Depth of Well:	13.91	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 1.3; 3 X = 3.9
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	12

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
16:40		200							Pump Started
16:50	6.11	200	17.4	6.96	2.01	0.15	-94.8	3576	
16:55	6.43	200	17.5	6.65	1.90	0.21	-60.1	70	
17:00	6.75	200	17.6	6.65	1.98	0.12	-54.1	115	
17:05	6.91	200	17.8	6.18	1.98	0.09	-52.7	127	
17:08	7.01	200	17.7	6.21	1.98	0.09	-52.6	60.5	
17:11	7.13	200	17.9	6.24	1.97	0.10	-51.2	50.7	
17:14	7.21	200	17.6	6.23	1.98	0.09	-48.9	44.8	

Stability Reached (Y/N): Yes If No, Provide Explanation

Final Values:	**17.6**	**6.23**	**1.98**	**0.09**	**-48.9**	**44.8**	

Sample ID:	CG019-mw-12-090816	**Sample Date:**	09/08/2016
Sample Depth:		**Sample Collection Time:**	17:14
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	7.21

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 7.96 * 7.48 gal/ft^3
= 1.3

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

amec foster wheeler

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-13P	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	8.11	**Date:**	09/09/2016
Total Depth of Well:	35.2	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 4.4; 3 X = 13.3
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	34

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
11:10		200							Pump Started
11:20	8.31	200	17.0	6.88	1.23	3.34	191.7	5.36	
11:25	8.31	200	17.2	6.55	1.23	2.92	193.9	9.13	
11:30	8.31	200	17.2	6.77	1.23	2.83	192.6	7.11	
11:35	8.31	200	16.9	6.40	1.23	2.86	192.1	6.86	
11:38	8.31	200	16.7	6.45	1.23	2.84	192.1	6.11	

Stability Reached (Y/N): Yes If No, Provide Explanation

	Temp.	pH	SEC	DO	ORP	Turbidity
Final Values:	16.7	6.45	1.23	2.84	192.1	6.11

Sample ID:	CG019-mw-13P-090916	**Sample Date:**	09/09/2016
Sample Depth:		**Sample Collection Time:**	11:38
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	8.31

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 27.09 * 7.48 gal/ft^3
= 4.4

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-100p	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	4.71	**Date:**	09/09/2016
Total Depth of Well:	36.55	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 5.2; 3 X = 15.7
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	35

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
10:20		200							Pump Started
10:30	4.81	200	17.4	7.04	1.50	0.96	-105.9	6.72	
10:35	4.81	200	17.4	7.03	1.50	0.34	-103.4	6.75	
10:40	4.81	200	17.7	7.01	1.54	0.19	-105.1	4.67	
10:45	4.81	200	17.7	7.00	1.56	0.14	-105.2	6.75	
10:48	4.81	200	17.5	7.00	1.57	0.13	-105.9	5.13	
10:51	4.81	200	17.7	7.00	1.58	0.11	-106.3	7.11	

Stability Reached (Y/N): Yes If No, Provide Explanation

	Temp.	pH	SEC	DO	ORP	Turbidity
Final Values:	17.7	7.00	1.58	0.11	-106.3	7.11

Sample ID:	CG019-mw-100P-090916	**Sample Date:**	09/09/2016
Sample Depth:		**Sample Collection Time:**	10:51
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	4.81

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 31.84 * 7.48 gal/ft^3
= 5.2

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

amec foster wheeler

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-102	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	5.14	**Date:**	09/08/2016
Total Depth of Well:	20.0	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 2.4; 3 X = 7.3
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	19.0

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
18:10		200							Pump Started
18:20	5.21	200	14.2	6.68	1.81	0.15	-73.8	8.93	
18:25	5.21	200	14.4	6.64	1.72	0.09	-74.8	4.93	
18:30	5.21	200	14.3	6.64	1.69	0.08	-75.1	5.27	
18:33	5.21	200	14.2	6.63	1.67	0.10	-75.3	6.97	
18:36	5.21	200	14.3	6.63	1.66	0.08	-75.5	3.68	

Stability Reached (Y/N): Yes   If No, Provide Explanation

	Temp.	pH	SEC	DO	ORP	Turbidity
Final Values:	14.3	6.63	1.66	0.08	-75.5	3.68

Sample ID:	CG019-mw-102-090816	**Sample Date:**	09/08/2016
Sample Depth:		**Sample Collection Time:**	18:36
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	5.21

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 14.86 * 7.48 gal/ft^3
= 2.4

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name: General Mitchell CG019
Project Number: 291330002.0004.3F

Well ID:	CG019-mw-102P	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	7.3	**Date:**	09/08/2016
Total Depth of Well:	34.32	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 4.4; 3 X = 13.3
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	33

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
17:30		200							Pump Started
17:40	8.71	200	15.2	9.30	0.83	0.33	93.2	53.2	
17:45	9.11	200	14.6	9.20	0.84	0.19	91.4	26.1	
17:50	10.11	200	14.2	8.32	0.88	0.11	-179.5	43.7	
17:55	10.49	200	14.1	7.65	0.90	0.10	-149.2	12.61	
17:58	10.57	200	14.1	7.51	0.91	0.09	-132.1	10.19	
18:01	10.19	200	14.1	7.46	0.91	0.09	-129.7	10.66	
Final Values:			**14.1**	**7.46**	**0.91**	**0.09**	**-129.7**	**10.66**	

Stability Reached (Y/N): Yes — If No, Provide Explanation

Sample ID:	CG019-mw-102p-090816	**Sample Date:**	09/08/2016
Sample Depth:		**Sample Collection Time:**	18:01
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	10.66

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 27.02 * 7.48 gal/ft^3
= 4.4

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-103p	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	6.64	**Date:**	09/08/2016
Total Depth of Well:	40.04	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 5.5; 3 X = 16.4
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	38

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
14:55		200							Pump Started
14:55	6.61	200	17.2	7.83	1.33	0.18	-76.0	89.5	
15:00	6.61	200	16.3	7.70	1.42	0.27	-76.0	64.9	
15:05	6.61	200	17.0	7.52	1.46	0.16	-77.9	32.1	
15:10	6.61	200	16.9	7.47	1.49	0.13	-79.2	14.0	
15:13	6.61	200	16.8	7.42	1.51	0.12	-80.3	7.70	
15:16	6.61	200	16.8	7.39	1.51	0.12	-80.3	7.39	
15:19	6.61	200	16.9	7.29	1.51	0.13	-81.8	6.67	

Stability Reached (Y/N): Yes   If No, Provide Explanation

	Temp.	pH	SEC	DO	ORP	Turbidity
Final Values:	**16.9**	**7.29**	**1.51**	**0.13**	**-81.8**	**6.67**

Sample ID:	CG019-mw-103p-090816	**Sample Date:**	09/08/2016
Sample Depth:		**Sample Collection Time:**	15:19
Duplicate Collected:	Yes	**Additional QA/QC:**	No
Duplicate ID:	CG019-FD-090816-01	**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	6.61

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 33.40 * 7.48 gal/ft^3
= 5.5

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

amec foster wheeler

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-105p	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	9.11	**Date:**	09/08/2016
Total Depth of Well:	39.11	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 4.9; 3 X = 14.8
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	38

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
15:55		200							Pump Started
16:05	9.11	200	17.0	8.30	0.61	0.12	140.1	25.2	
16:10	9.11	200	17.2	8.09	0.61	0.10	129.1	9.54	
16:15	9.11	200	17.3	7.98	0.61	0.08	103.1	5.77	
16:20	9.11	200	17.3	7.95	0.61	0.08	78.3	5.11	
16:23	9.11	200	17.4	7.94	0.61	0.09	53.4	6.61	
16:26	9.11	200	17.5	7.93	0.61	0.10	47.9	7.11	
		Final Values:	**17.5**	**7.93**	**0.61**	**0.10**	**47.9**	**7.11**	

Stability Reached (Y/N): Yes — If No, Provide Explanation

Sample ID:	CG019-mw-105p-090816	**Sample Date:**	09/08/2016
Sample Depth:		**Sample Collection Time:**	16:26
Duplicate Collected:	Yes	**Additional QA/QC:**	No
Duplicate ID:	CG019-FD-090816-01	**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	9.11

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 30.00 * 7.48 gal/ft^3
= 4.9

Technician Signature:

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-109P	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	14.11	**Date:**	09/09/2016
Total Depth of Well:	45.91	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 5.2; 3 X = 15.6
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	44

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
09:20		200							Pump Started
09:30	14.91	200	13.8	7.47	0.495	0.24	256.1	14.2	
09:35	14.91	200	13.8	7.49	0.490	0.18	247.1	11.3	
09:40	14.91	200	13.6	7.51	0.489	0.16	239.1	12.39	
09:45	14.91	200	13.7	7.57	0.479	0.12	226.6	9.98	
09:48	14.91	200	13.7	7.58	0.474	0.12	222.8	9.13	
09:51	14.91	200	13.9	7.59	0.473	0.11	219.8	8.77	
09:54	14.91	200	13.7	7.59	0.472	0.10	218.3	6.13	

Stability Reached (Y/N): Yes — If No, Provide Explanation

Final Values:	Temp.	pH	SEC	DO	ORP	Turbidity
	13.7	**7.59**	**0.472**	**0.10**	**218.3**	**6.13**

Sample ID:	CG019-mw-109P-090916	**Sample Date:**	09/09/2016
Sample Depth:		**Sample Collection Time:**	09:54
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	14.91

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 31.80 * 7.48 gal/ft^3
= 5.2

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-111p	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	4.22	**Date:**	09/09/2016
Total Depth of Well:	40.6	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 6.0; 3 X = 17.9
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	39

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
		200							Pump Started
08:53		180	14.8	6.55	1.80	.52	74.2	12.9	
08:58		180	15.1	6.77	1.88	.16	-31.4	5.18	
09:03		180	15.0	6.90	1.94	.13	-60.2	4.39	
09:08		180	15.1	6.95	1.97	.11	-68.8	5.40	
09:13		180	15.2	6.97	2.01	.10	-78.8	4.72	
09:18		180	15.2	6.99	2.04	0.10	-85.7	4.30	
09:23		180	15.5	7.00	2.07	0.08	-87.0	4.30	
09:28	4.39	180	15.6	7.01	2.09	0.09	-85.4	4.62	

Stability Reached (Y/N): Yes   If No, Provide Explanation

Final Values:	**15.6**	**7.01**	**2.09**	**0.09**	**-85.4**	**4.62**	

Sample ID:	CG019-mw-111P-090916	**Sample Date:**	09/09/2016
Sample Depth:		**Sample Collection Time:**	09:30
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	4.39

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 36.38 * 7.48 gal/ft^3
= 6.0

Technician Signature:

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-112	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	3.61	**Date:**	09/09/2016
Total Depth of Well:	18.8	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 2.5; 3 X = 7.5
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	17

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
10:00		200							Pump Started
10:15		170	17.9	7.35	.95	.16	-6.6	44.5	
10:20		170	17.8	7.18	.94	.09	-37.0	31.6	
10:25		170	17.9	7.21	.94	.09	-37.3	24.0	
10:30		170	17.7	7.28	.94	.12	-24.3	17.8	
10:35		170	17.7	7.27	.94	.09	-37.7	13.3	
10:40		170	17.7	7.28	.94	.22	-31.5	10.72	
10:45		170	17.4	7.30	.94	.11	-85.4	8.00	
10:50		170	17.9	7.31	.94	.08	-92.4	14.1	
10:55		170	17.8	7.31	.93	.07	-89.8	12.333	
11:00		170	17.0	7.30	.94	0.08	-97.9	9.09	
11:05		170	17.5	7.33	.93	0.07	-118.6	8.67	
11:10		170	18.0	7.34	.93	0.06	-127.2	5.96	
11:15	3.72	170	18.2	7.34	.94	0.05	-122.4	4.96	

Stability Reached (Y/N): Yes   If No, Provide Explanation

Final Values:	18.2	7.34	.94	0.05	-122.4	4.96		

Sample ID:	CG019-mw-112-090916	**Sample Date:**	09/09/2016
Sample Depth:		**Sample Collection Time:**	11:18
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	3.72

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 15.19 * 7.48 gal/ft^3
= 2.5

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-112p	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	4.07	**Date:**	09/09/2016
Total Depth of Well:	32.2	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 4.6; 3 X = 13.8
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	32.4

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
11:25		120							Pump Started
11:40			16.4	7.25	1.02	0.07	-43.9	12.6	
11:45			15.9	7.23	1.02	.16	-9.0	11.6	
11:50			15.5	7.22	1.01	.22	2.4	10.38	
11:55			15.0	7.22	1.01	.25	-.4	10.50	
12:00			14.7	7.22	1.00	.27	4.5	10.77	
12:05			14.5	7.20	1.01	.16	-11.2	12.31	
12:10			14.5	7.08	1.25	.27	-62.6	14.9	
12:15			14.7	7.04	1.50	.16	-86.4	22.6	
12:20			14.8	7.06	1.58	.07	--101.6	24.4	
12:25			14.7	7.07	2.00	.12	-99.1	25.6	
12:30			14.8	7.07	1.68	.17	-92.8	23.2	
12:35			14.9	7.07	1.69	.14	--104.6	22.1	

Stability Reached (Y/N): Yes If No, Provide Explanation

	Temp.	pH	SEC	DO	ORP	Turbidity
Final Values:	**14.9**	**7.07**	**1.69**	**.14**	**--104.6**	**22.1**

Sample ID:	CG019-mw-112P-090916	**Sample Date:**	09/09/2016
Sample Depth:		**Sample Collection Time:**	12:38
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	10.33

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 28.13 * 7.48 gal/ft^3
= 4.6

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell CG019	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-114P	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	1.04	**Date:**	09/09/2016
Total Depth of Well:	30.8	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 4.9; 3 X = 14.6
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	29

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
13:01									Pump Started
13:15			14.1	7.20	1.67	0.07	-102.9	32.1	
13:20			14.2	7.20	1.68	0.04	-109.2	31.7	
13:25			13.9	7.20	1.67	0.03	-113.7	31.4	
13:30	1.33	200	14	7.20	1.68	0.03	-116.3	31.5	

Stability Reached (Y/N): Yes If No, Provide Explanation

	Temp.	pH	Conductance	DO	ORP	Turbidity
Final Values:	14	7.20	1.68	0.03	-116.3	31.5

Sample ID:	CG019-mw-114-090916	**Sample Date:**	09/09/2016
Sample Depth:		**Sample Collection Time:**	13:32
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	1.33

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 29.76 * 7.48 gal/ft^3
= 4.9

Technician Signature: [signature]

Notes:

Technician Name (print): Faisal Hussain

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

Site Name:	General Mitchell	**Project Number:**	291330002.0004.3F
Well ID:	CG019-mw-07p	**Sample Technician:**	Faisal Hussain
Initial Depth to Water:	4.45	**Date:**	09/08/2016
Total Depth of Well:	33.61	**Well Diameter (inches):**	2
Method of Purging:	Pumping	**Casing Volumes (gal):**	1 X = 4.8; 3 X = 14.3
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	32

Time	Water Level (feet)	Flow Rate (gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
	Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
13:50		200							Pump Started
13:50	6.71	200	17.4	7.91	1.32	0.46	-69.3	672	
13:55	7.41	200	16.8	7.50	1.31	0.36	-77.3	91.2	
14:00	9.03	200	16.2	7.29	1.31	0.22	-74.3	98.1	
14:05	10.00	200	15.7	7.16	1.30	0.15	-76.1	19.1	
14:03	10.31	200	15.7	7.13	1.29	0.14	-77.3	7.73	
14:06	10.50	200	15.6	7.10	1.30	0.12	-77.1	7.19	
14:09	10.66	200	15.5	7.08	1.29	0.11	-77.3	6.51	
Stability Reached (Y/N):		Yes		If No, Provide Explanation					
		Final Values:	15.5	7.08	1.29	0.11	-77.3	6.51	

Sample ID:	CG019-mw-07p-090816	**Sample Date:**	09/08/2016
Sample Depth:		**Sample Collection Time:**	14:09
Duplicate Collected:	No	**Additional QA/QC:**	No
Duplicate ID:		**Blank ID(s):**	
Method of Sampling:	Low Flow	**Total Volume Purged:**	2.5
Analysis/Method(s):	Chlorinated VOCs	**Depth to Water After Sampling:**	10.66

Instruments (Manufacturer, Model, and Serial No.):

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
LaMotte 2020 Fa0997 YSI Pro plus Fa01078

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2 (in)/12 (in/ft))/2)^2 * 29.16 * 7.48 gal/ft^3
= 4.8

Technician Signature:

Notes:

Transcription error when recording times

Technician Name (print):

Faisal Hussain

QA/QC'd by: **QA/QC Date:**

APPENDIX F

SLUG TEST MEMO

DATE: January 13, 2017
PROJECT: ANG Base General Mitchell IA
SUBJECT: Slug Testing and Analysis
PREPARED BY: Kurt L. Cunningham, CPG

1.0 INTRODUCTION

This Technical Memorandum documents slug testing implemented to estimate hydraulic conductivity (K) or permeability of contaminated aquifers associated with several project areas of the ANG Base General Mitchell International Airport, Milwaukee, Wisconsin (Site). The testing was completed by Amec Foster Wheeler Environment and Infrastructure, Inc. (Amec Foster Wheeler) on behalf of the Michigan Air National Guard.

2.0 FIELD ACTIVITIES

Amec Foster Wheeler completed slug tests at sixteen groundwater monitoring wells from five project areas listed in Section 5.7 of the RI Report. The resulting data were evaluated to estimate the hydraulic conductivity of the screened aquifer, as described in the results section of this report.

2.1 Schedule

Fieldwork was conducted October 25 to November 8, 2016.

2.2 Personnel

The fieldwork was completed by Amec Foster Wheeler geologist Reid Crawford and engineer and Matt Lipiec. Analysis was completed by Amec Foster Wheeler geologist Kurt L. Cunningham, CPG.

2.3 Procedures

Water levels were measured using an electronic water level probe to indicate the initial static height of water in each well prior to testing. The water levels measured from top of casing for each of the tested wells are presented in the RI Report. Each test was initiated by displacing a volume of water with a polyvinyl chloride (PVC) slug attached to polypropylene twine. For falling head slug tests, the slug was quickly submerged and the falling water level recorded as it returned to the static level. The rising head test was performed by quickly removing the submerged slug and the rising water level recorded as it returned to static level in the test well. Water levels were recorded with a Solinst Level Logger data logger pressure transducer. Each set, falling head and rising head, of tests was repeated three times in each well. However, a few of the wells did not respond to the slug due to fluctuation in the water table at the time of the testing.

3.0 PRE-ANALYSIS DATA PROCESSING

Raw data recorded by the data logger was processed as described in this section to provide standardized results for subsequent analysis.

3.1 Displacement Measurements

Water levels were recorded as absolute pressure measured in feet of water above the transducer. The pressure transducer was lowered into the test well prior to test initiation and allowed to acclimate to the water temperature. The height of water above the transducer was measured continuously prior to test initiation for a time to establish static head. For each test, the water level displacement was calculated as the difference between the initial and induced water level. After the aquifer returned to near static conditions, another test was initiated, recorded, and the water level displacement calculated.

3.2 Initial Displacement

The measured initial displacement was estimated based on the maximum displacement recorded during the beginning of the test. The theoretical initial displacement was calculated based on the slug volume and casing radius. Slugs were 1.05 inch in diameter and 20.5 inches long and 1.25-inch diameter by 31.125 inches long. The corresponding displacement volumes for the slug were 0.011, and 0.032 ft^3 The volume of the slugs (V_{slug}) were 0.011 and 0.032 ft^3, respectively.

And the volume of one foot of casing (V_{case}) is:

Casing Radius (ft)	Casing Length	V_{case} (ft^3)
0.085	1	0.023

And the theoretical initial displacement is: *Vslug* divided by *Vcase*:

Slug length (in)	V_{slug} (ft^3)	V_{case} (ft^3)	Ho (ft)
31.125	0.032	0.023	1.37
20.5	0.011	0.023	0.48

Note that the slug displacement should be considered an upper bound for the initial displacement parameter.

3.3 Test Start Time

The test start time was estimated as the time at which the maximum displacement was observed. Elapsed time was calculated as the difference between the start time and the measurement time.

3.4 Normalized Data Sets

Normalized data sets were constructed as pairs of elapsed time (seconds) versus displacement (feet) measurements. Displacement values were further normalized by dividing the measured displacement by the initial displacement. Data sets were normalized to aid comparison of multiple tests at a single well, and to verify assumptions that will be adopted during the test analysis. If the aquifer characteristics and/or well conditions have not changed between tests, then the multiple tests should plot along an identical profile.

4.0 ANALYSIS

Static groundwater elevation and total well depth measurements are presented in Table 1. The relevant well geometry factors are also summarized in Table 1. Well geometry factors were obtained from soil boring logs and well construction diagrams. The logs and diagrams are included in the RI report. The aquifer thickness parameter was approximated as the height of water in the well.

4.1 Verification of Conventional Theory

Conventional theory maintains that normalized test response from multiple tests should plot coincidently if the underlying assumptions are valid. This means that the normalized response should be independent of initial displacement volume and induced flow direction (rising or falling head) (Butler, 1998). To the extent that they do not coincide, an explanation of the deviation should be sought. The basic assumptions inherent in conventional theory include:

- The aquifer is homogeneous and of uniform thickness
- The test well is fully or partially penetrating
- The aquifer is confined or unconfined
- A volume of water is injected into or discharged from the well instantaneously
- There is no low permeability skin-zone surrounding the well screen due to incomplete well development

If the normalized data do not plot coincidentally, then the validity of these assumptions should be examined.

Referring to the normalized data plots in Appendix A, recovery plots match reasonably well at the tested monitoring wells, indicating that the data are suitable for analysis.

Data analysis was conducted using methods suggested by Butler (1998). Butler recommends classifying wells as screened below the water table in unconfined and confined aquifers (Class I), wells screened across the water table in unconfined aquifers (Class II) and wells screened in high permeability aquifers (Class III). The subject wells were classified as Class I and Class II for the purpose of this analysis. The data were analyzed using the Bouwer & Rice (1976) method for consistency.

The computer program Aqtesolv™ (HydroSOLVE, 2007) was used to complete the required calculations and analysis. The graph analysis and data sets are included in Appendix B. The results are summarized in Table 1.

5.0 REFERENCES

Bouwer, H. and R. C. Rice. *A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells*. Water Resources Research. V.12, p. 423-428, 1976.

Butler, J.J., Jr. 1997. *The Design, Performance, and Analysis of Slug Test Results*. Boca Raton, Lewis Publishers.

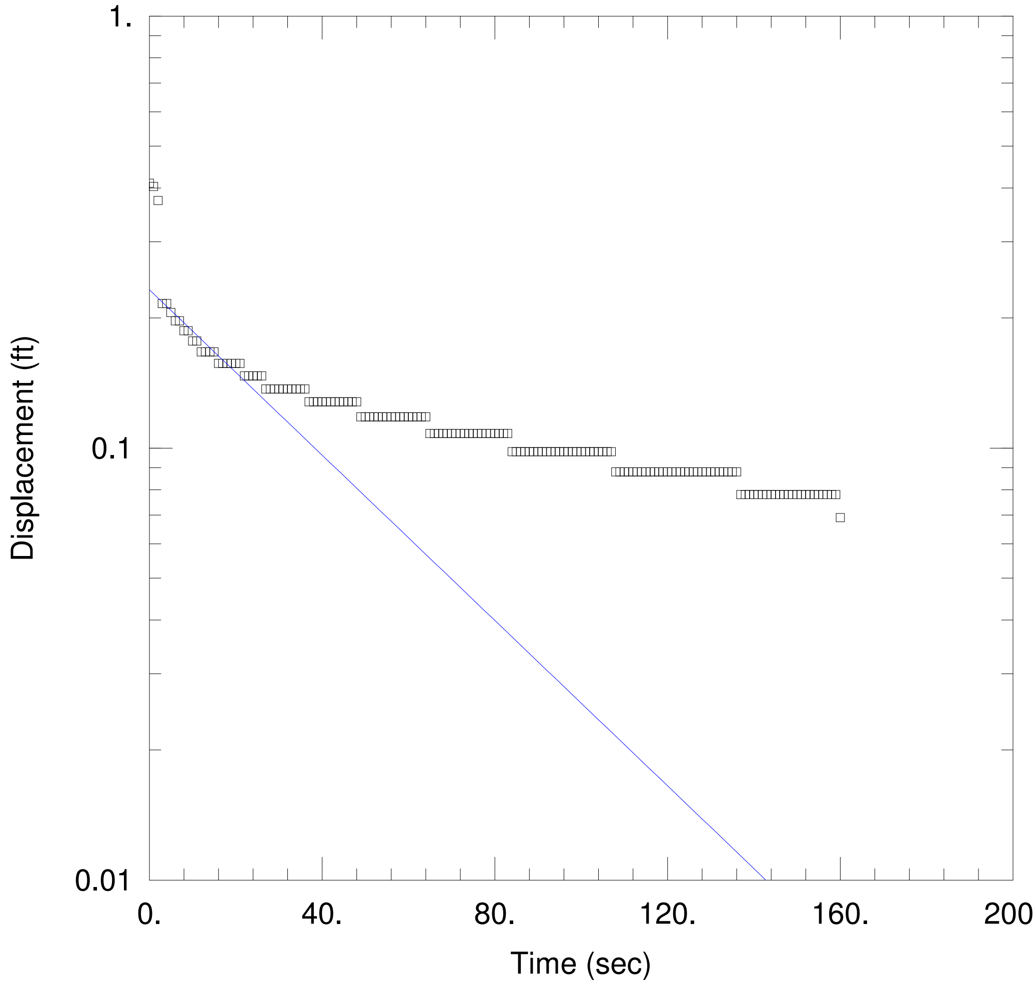
"*Aqtesolv® for Windows, Version 4.5*." HydroSOLVE, Inc., 2303 Horseferry Court, Reston, VA 20191.

TABLES

Area	Well ID	Hydraulic Conductivity (K)		Notes:	Average K for the Area	Date of Test
		Early Data	Late Data			
CB018a	MW201	8.24E-04			4.59E-04	10/25/16
	MW202	4.26E-04				10/25/16
	MW203	1.27E-04				10/25/16
CB018b	MW201	8.27E-03			5.02E-03	10/25/16
	MW203	1.77E-03		Little usable data		10/25/16
	MW206			Not enough data to evaluate		10/25/16
CG019	MW201	7.73E-04			2.43E-04	11/2/16
	MW206	1.99E-04	7.81E-05			10/25/16
	MW209	9.65E-05	6.76E-05			10/25/16
OW014	MW201			Not enough data to evaluate	1.41E-02	
	MW202	2.41E-02		Little usable data		11/4/16
	MW203	4.00E-03				11/4/16
	MW204			Not enough data to evaluate		
RW010	MW206	6.27E-03	2.28E-04		3.25E-03	10/28/16
	MW207			Not enough data to evaluate		
	MW208			Not enough data to evaluate		

APPENDIX A

GRAPHIC DATA ANALYSIS



Data Set: C:\...\cb018aMW201.aqt
Date: 01/13/17
Time: 14:10:45

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

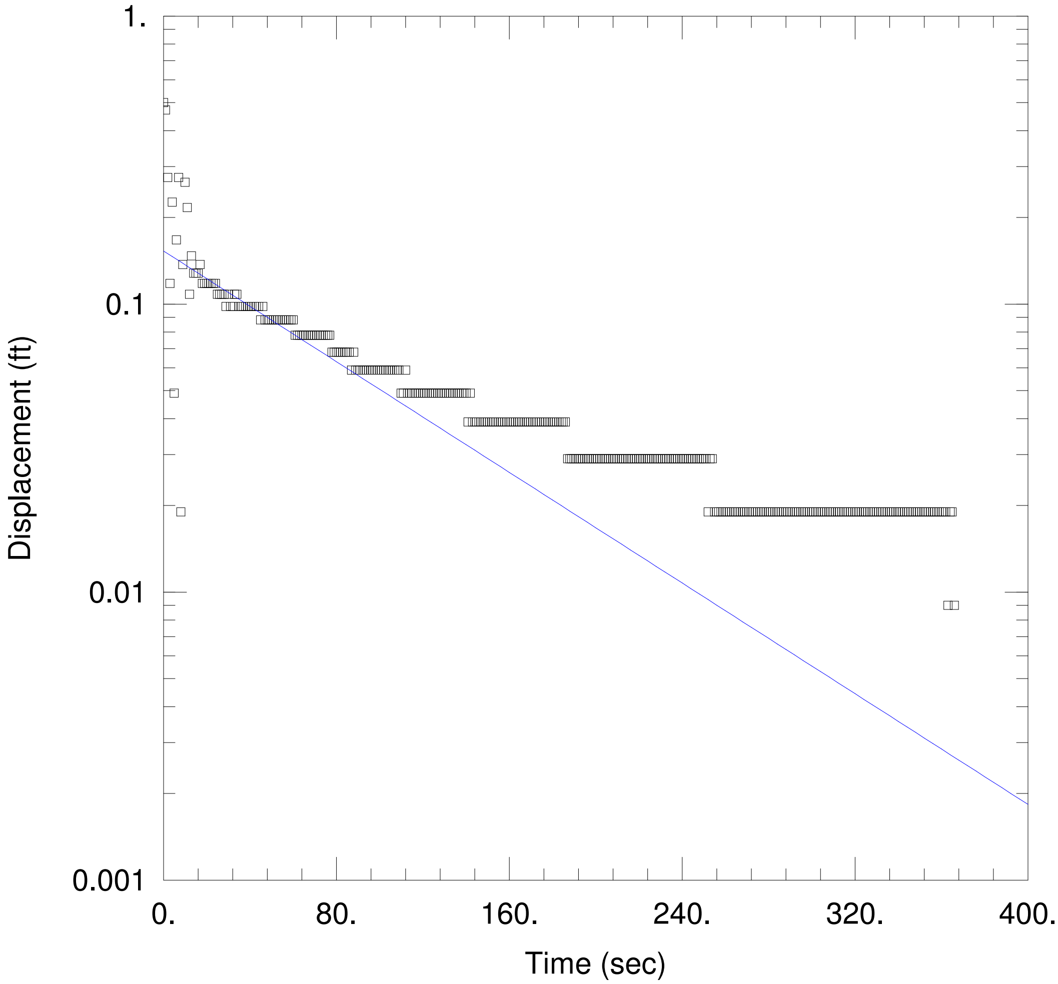
WELL DATA (cbb018aMW201)

Initial Displacement: 0.41 ft
Static Water Column Height: 9. ft
Total Well Penetration Depth: 12. ft
Screen Length: 10. ft
Casing Radius: 0.0801 ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.000828 cm/sec
y0 = 0.2325 ft



Data Set: C:\...\cb018aMW202.aqt
Date: 01/13/17 Time: 14:11:23

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

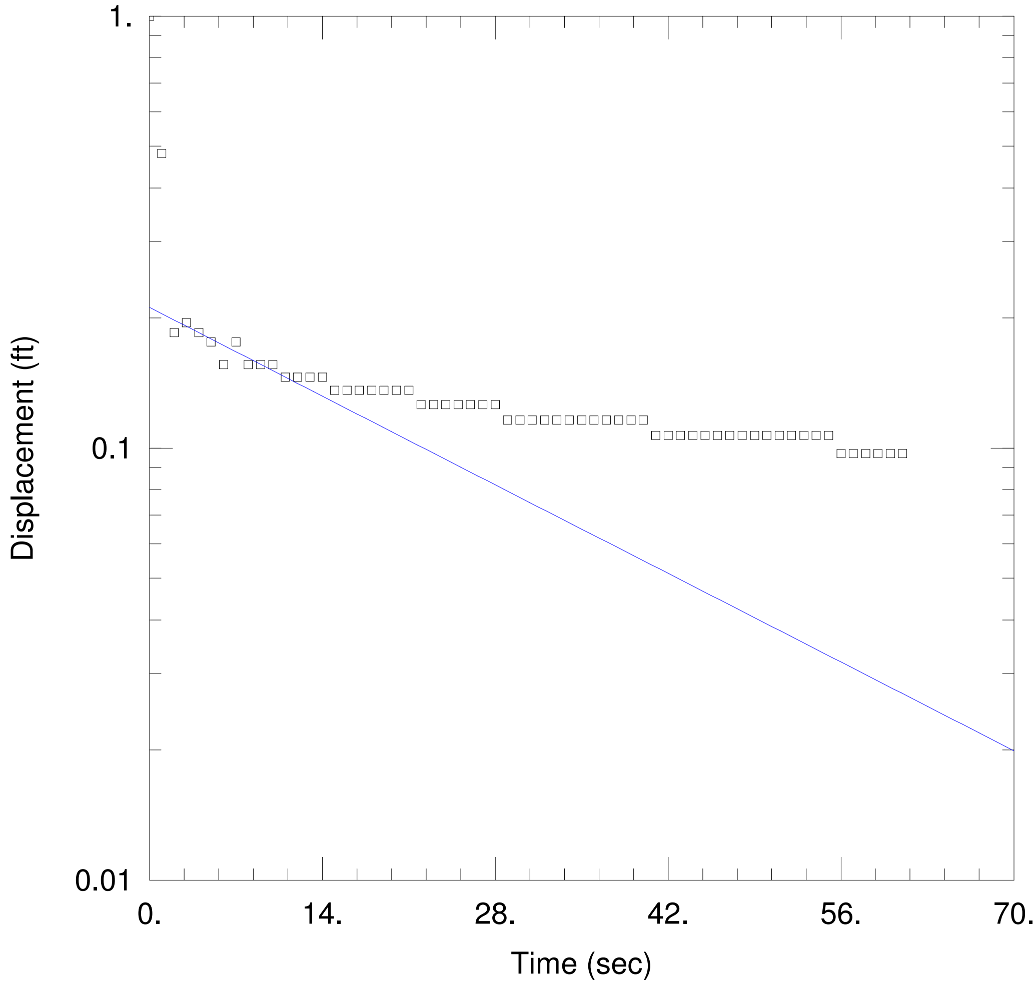
WELL DATA (cb018aMW202)

Initial Displacement: 0.5 ft
Static Water Column Height: 9. ft
Total Well Penetration Depth: 14. ft
Screen Length: 10. ft
Casing Radius: 0.0801 ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0004264 cm/sec
y0 = 0.1528 ft



Data Set: C:\...\cb018aMW203.aqt
Date: 01/13/17 Time: 14:11:44

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

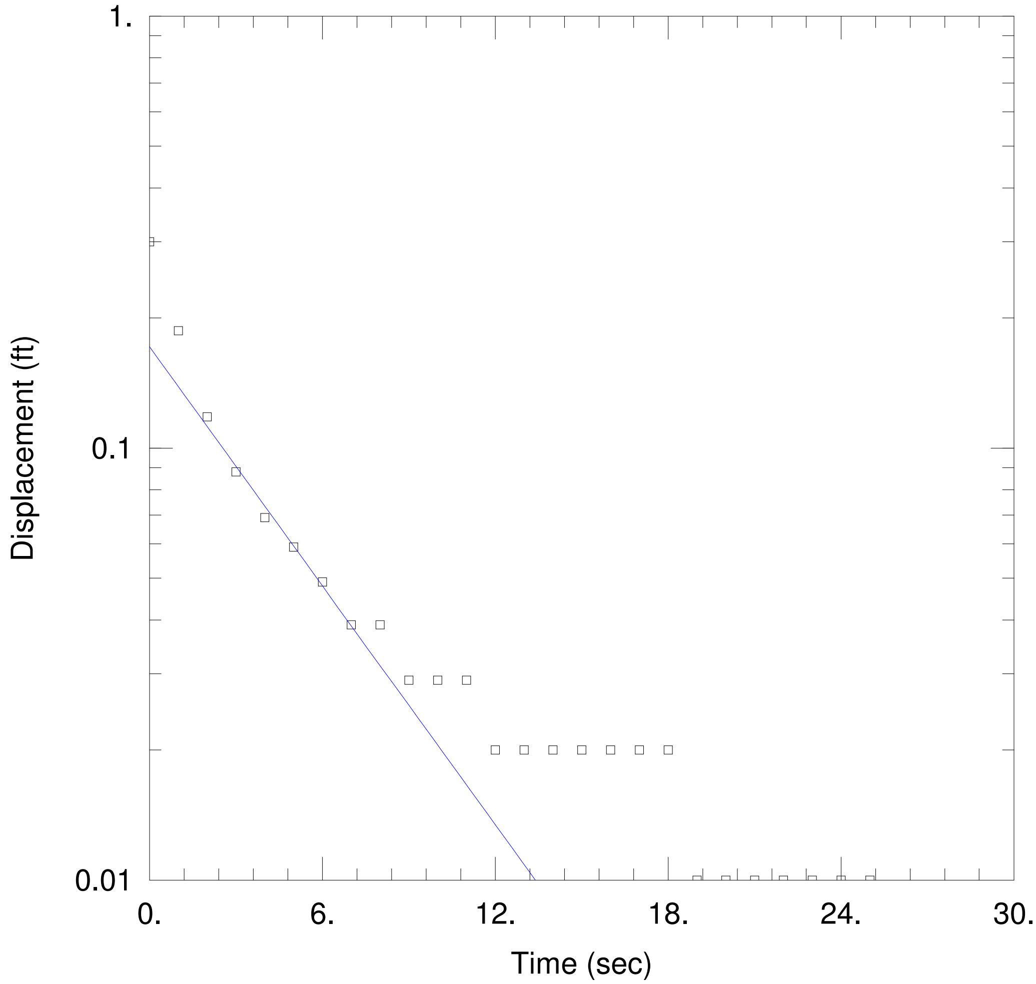
WELL DATA (cb018aMW203)

Initial Displacement: 1. ft
Static Water Column Height: 9. ft
Total Well Penetration Depth: 12. ft
Screen Length: 10. ft
Casing Radius: 0.0801 ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001269 cm/sec
y0 = 0.2116 ft



Data Set: C:\...\cb018bMW201.aqt
Date: 01/13/17 Time: 14:12:05

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft Anisotropy Ratio (Kz/Kr): 0.2

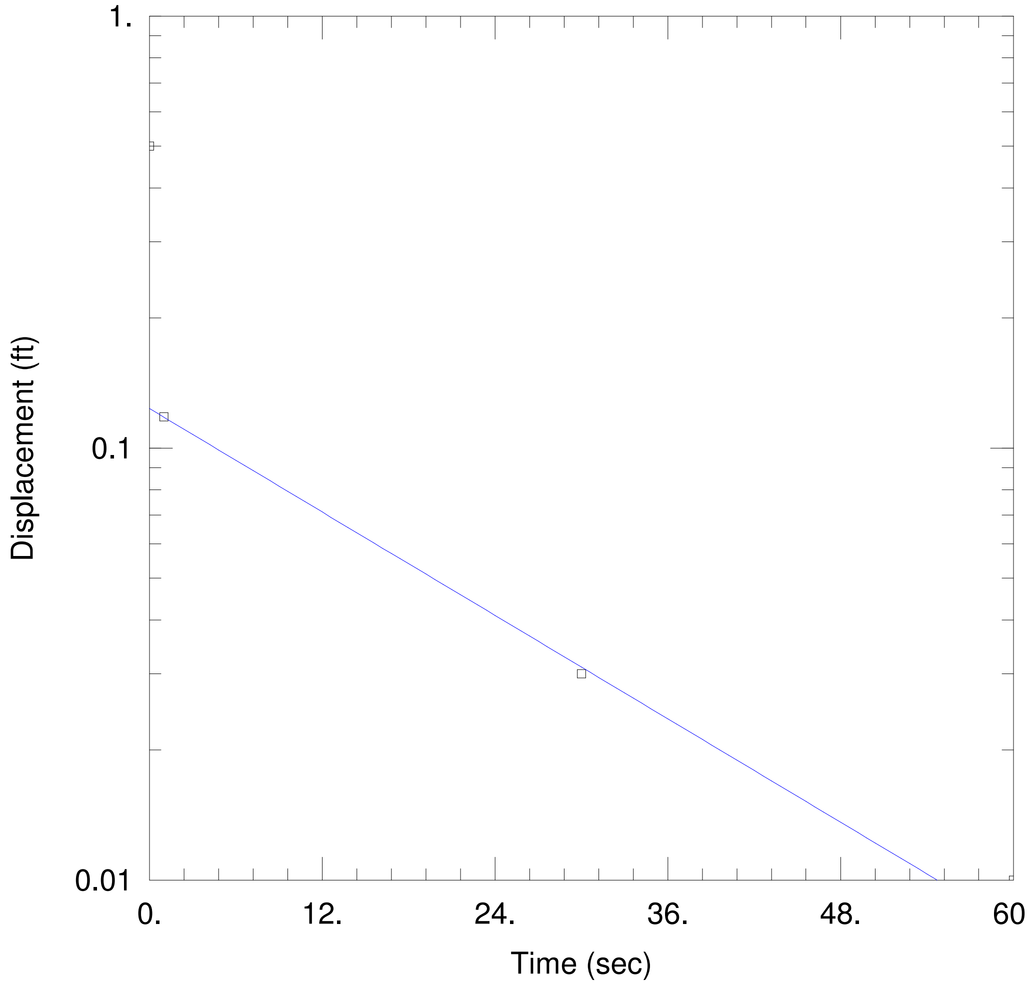
WELL DATA (cb018bMW201)

Initial Displacement: 0.3 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.0801 ft
Static Water Column Height: 9. ft
Screen Length: 10. ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.008274 cm/sec
y0 = 0.1715 ft



Data Set: C:\...\cb018bMW203.aqt
Date: 01/13/17 | Time: 14:12:22

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

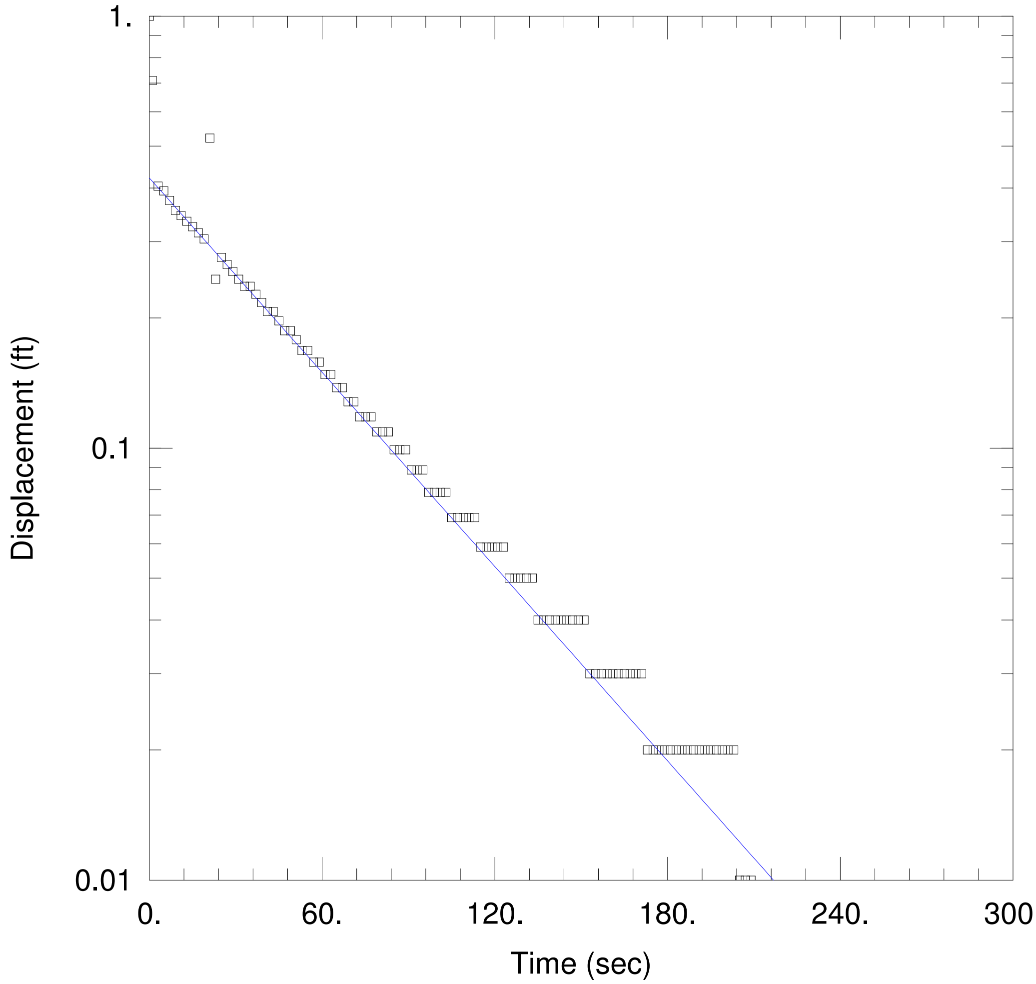
WELL DATA (cb018bMW203)

Initial Displacement: 0.5 ft
Static Water Column Height: 9. ft
Total Well Penetration Depth: 14. ft
Screen Length: 10. ft
Casing Radius: 0.0801 ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001771 cm/sec
y0 = 0.1234 ft



Data Set: C:\...\cg019MW201.aqt
Date: 01/13/17 Time: 14:13:06

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

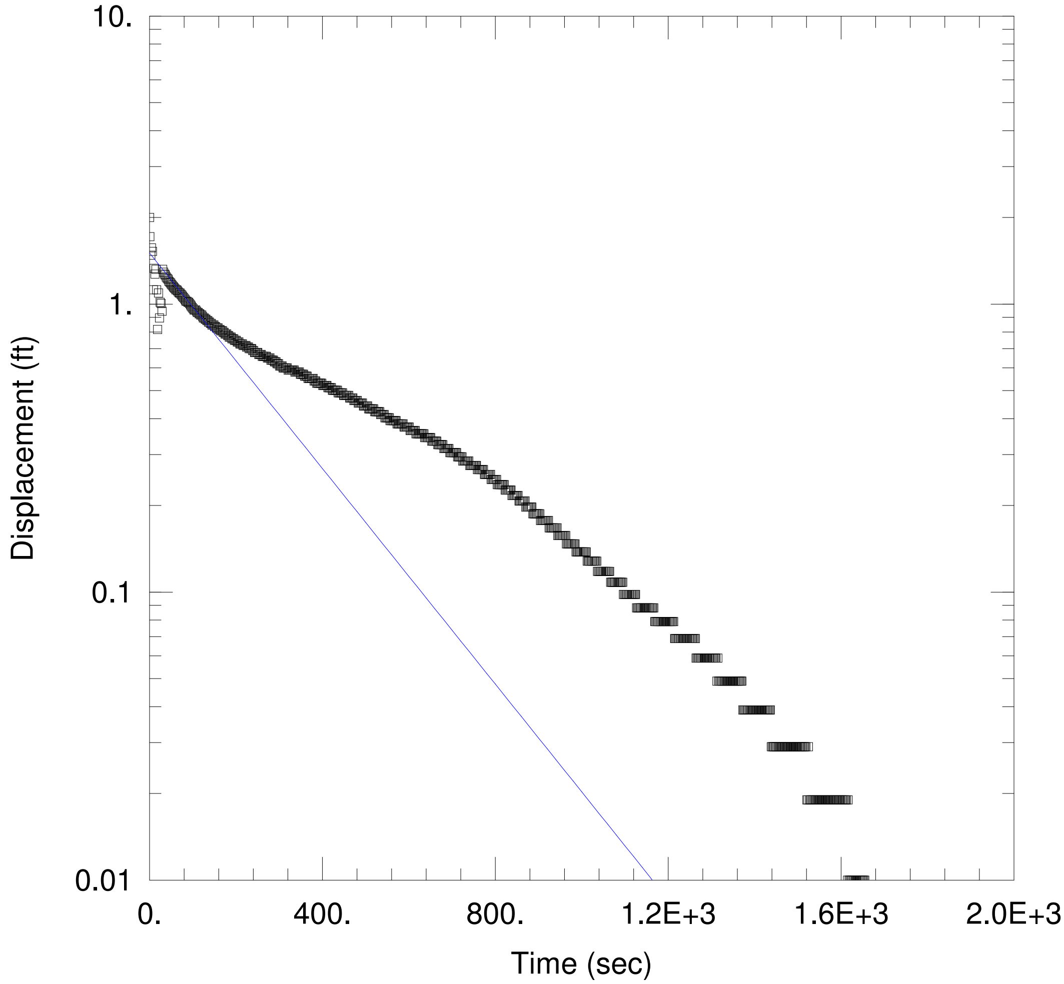
WELL DATA (cg019MW201)

Initial Displacement: 1. ft
Total Well Penetration Depth: 39. ft
Casing Radius: 0.0801 ft
Static Water Column Height: 9. ft
Screen Length: 10. ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0007728 cm/sec
y0 = 0.4217 ft



Data Set: C:\...\cg019MW206.aqt
Date: 01/13/17 | Time: 14:13:39

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

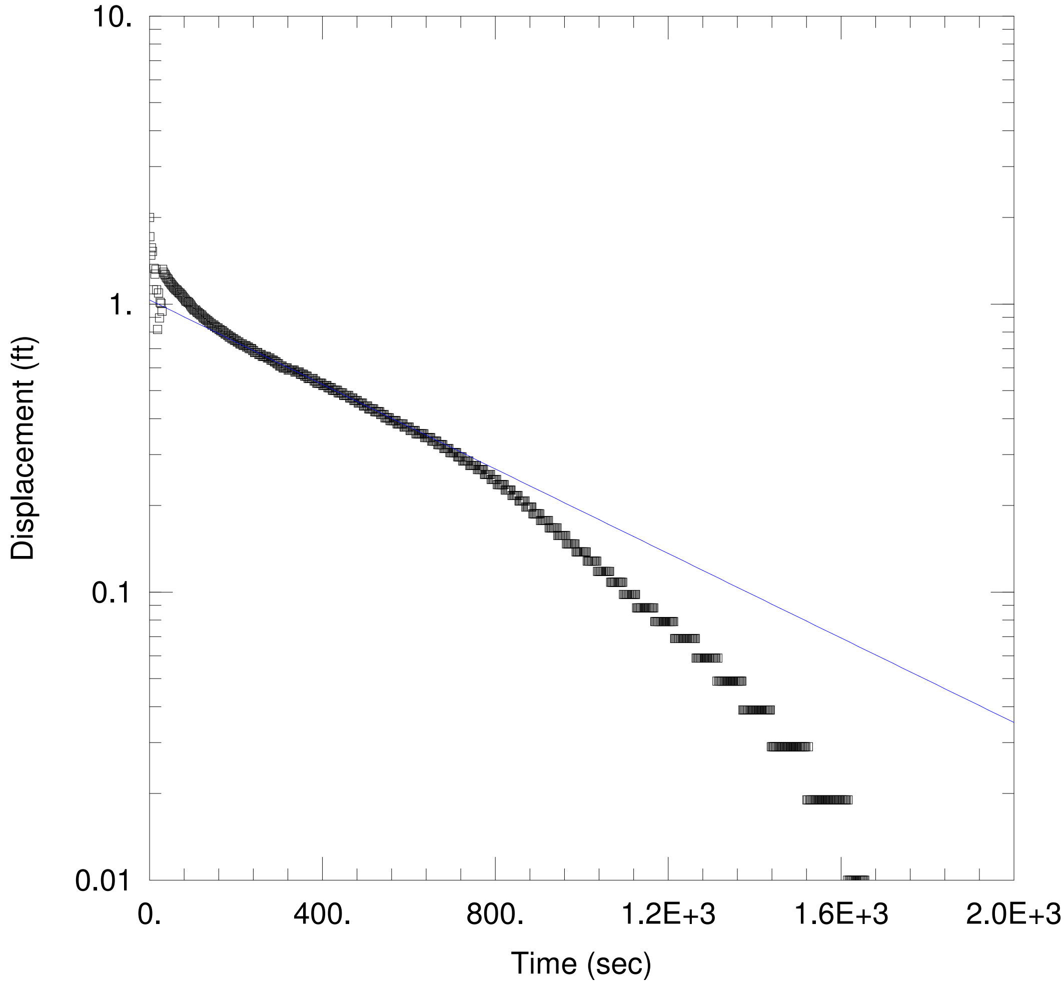
WELL DATA (cg019MW206)

Initial Displacement: 2. ft
Total Well Penetration Depth: 50. ft
Casing Radius: 0.0801 ft
Static Water Column Height: 9. ft
Screen Length: 10. ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0001992 cm/sec
y0 = 1.503 ft



Data Set: C:\...\cg019MW206-2.aqt
Date: 01/13/17 Time: 14:14:07

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

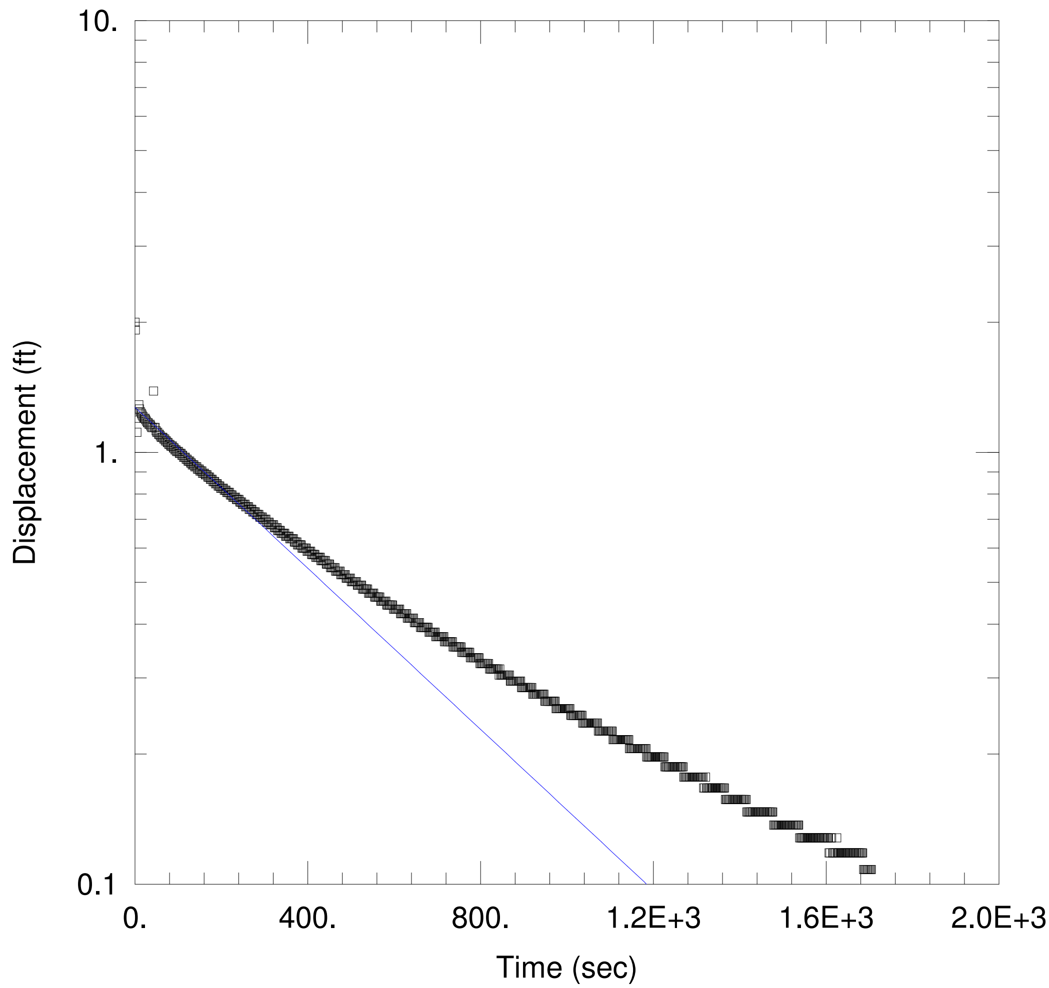
WELL DATA (cg019MW206)

Initial Displacement: 2. ft
Static Water Column Height: 9. ft
Total Well Penetration Depth: 50. ft
Screen Length: 10. ft
Casing Radius: 0.0801 ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 7.808E-5 cm/sec
y0 = 1.033 ft



Data Set: C:\...\cg019MW209.aqt
Date: 01/13/17 Time: 14:14:43

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft Anisotropy Ratio (Kz/Kr): 0.2

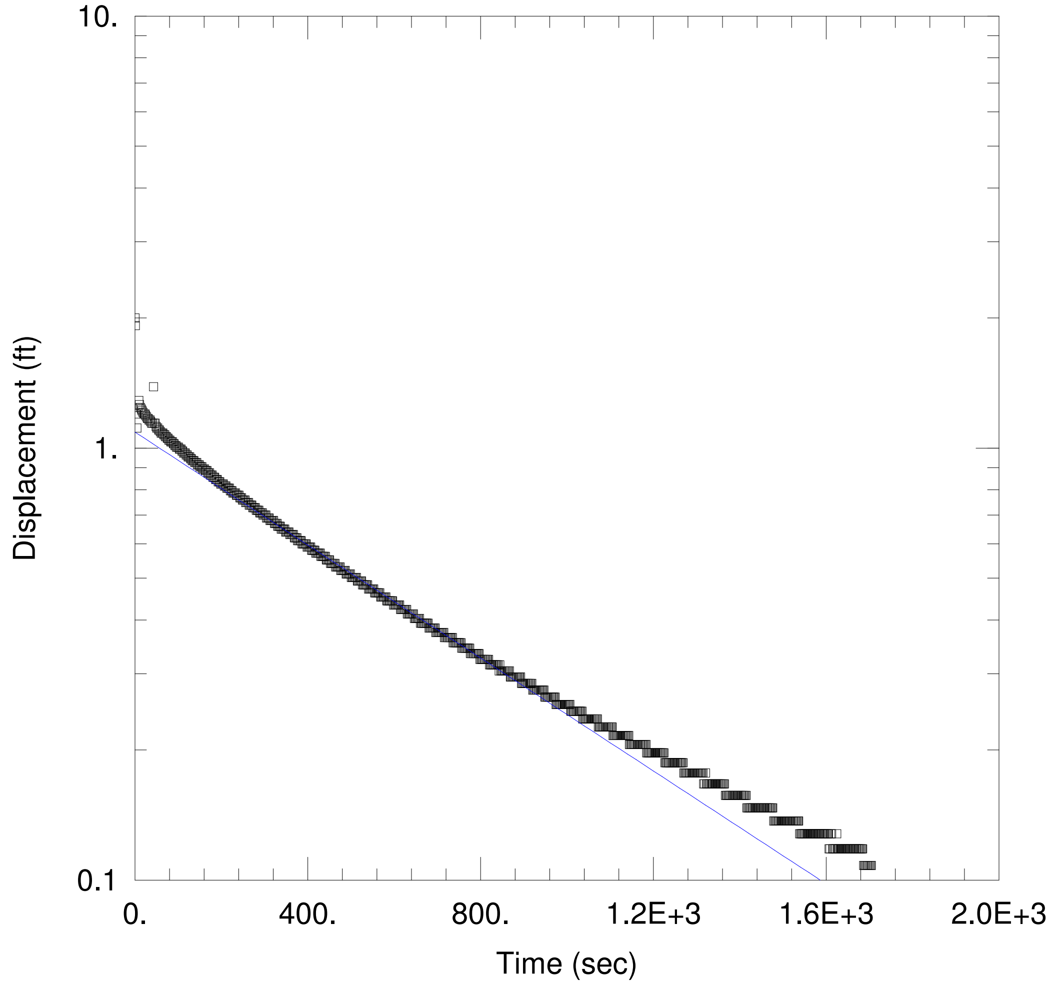
WELL DATA (cg019MW209)

Initial Displacement: 2. ft
Total Well Penetration Depth: 40. ft
Casing Radius: 0.0801 ft
Static Water Column Height: 9. ft
Screen Length: 10. ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 9.646E-5 cm/sec y0 = 1.271 ft



Data Set: C:\...\cg019MW209-2.aqt
Date: 01/13/17 Time: 14:15:19

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

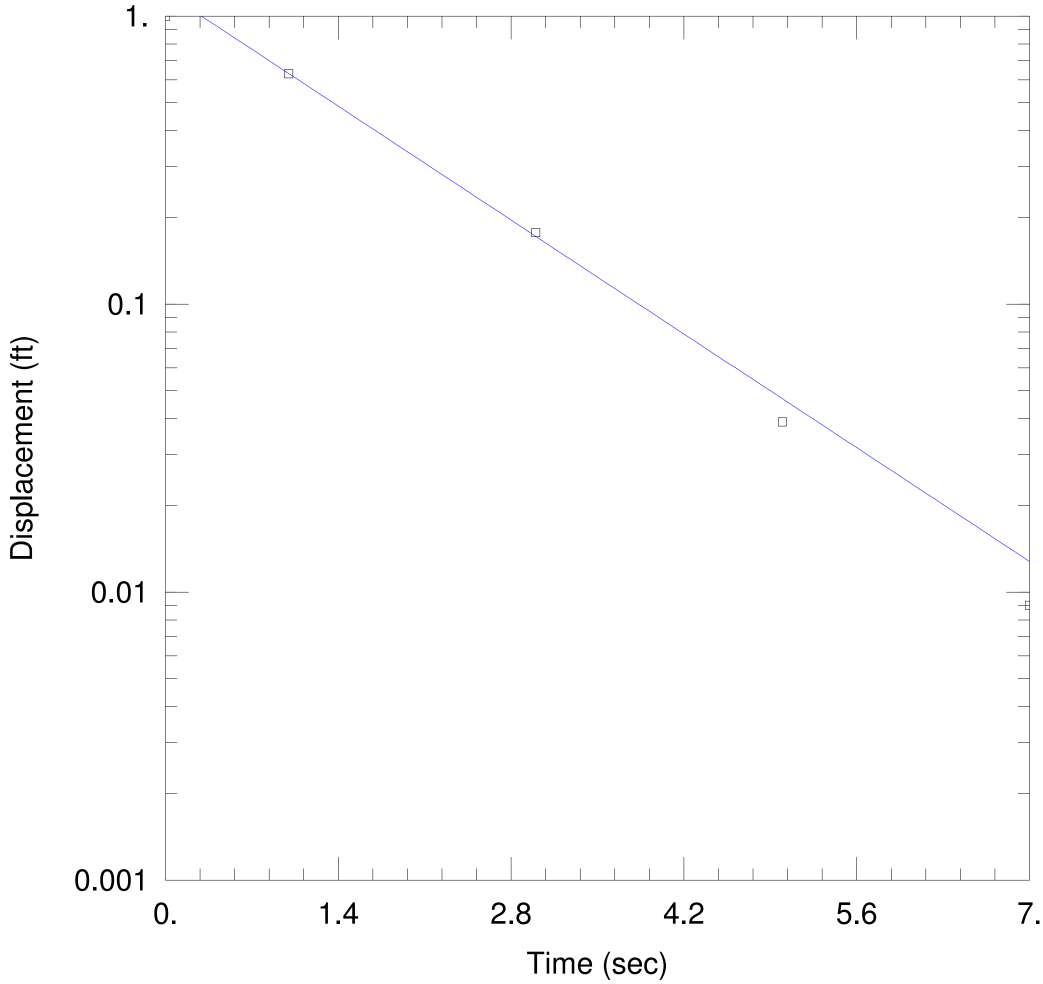
WELL DATA (cg019MW209)

Initial Displacement: 2. ft
Static Water Column Height: 9. ft
Total Well Penetration Depth: 40. ft
Screen Length: 10. ft
Casing Radius: 0.0801 ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 6.762E-5 cm/sec
y0 = 1.089 ft



Data Set: C:\...\ow014MW202.aqt
Date: 01/13/17 Time: 14:15:47

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

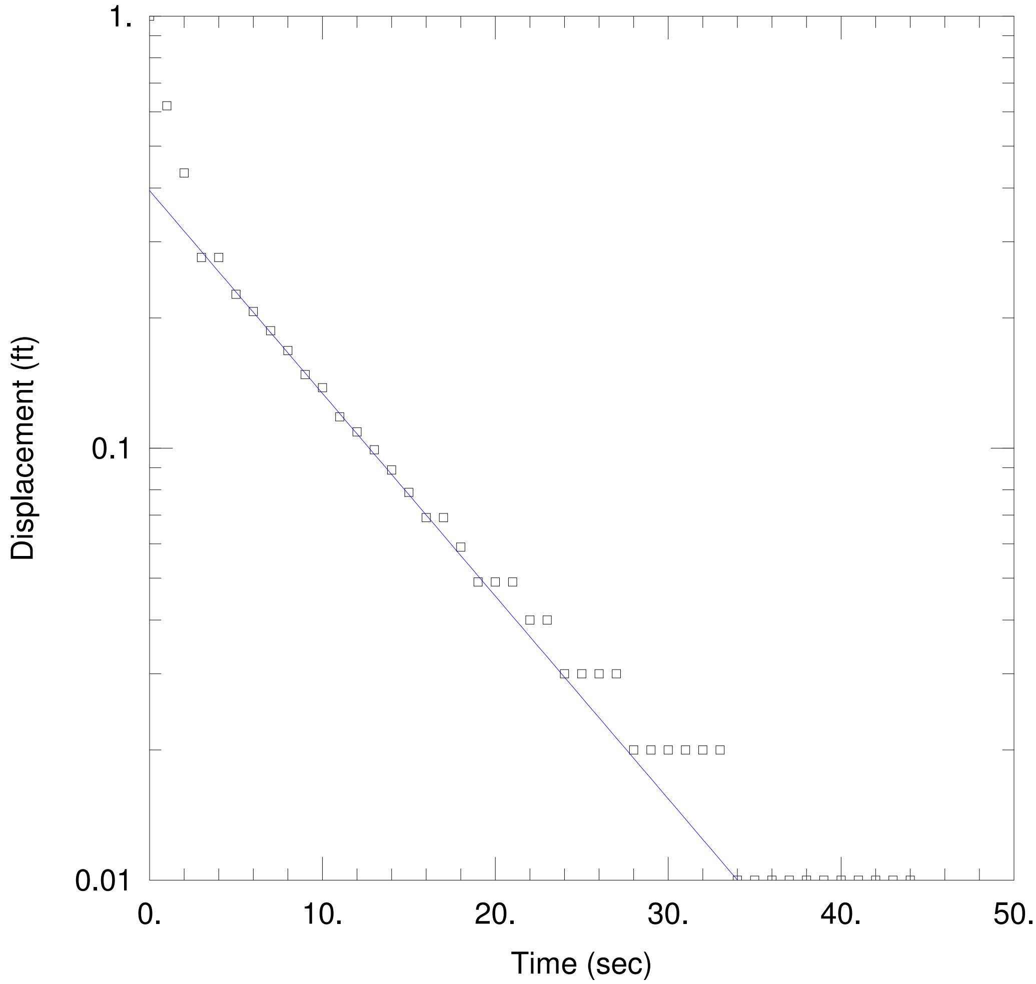
Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

WELL DATA (ow014MW202)

Initial Displacement: 1. ft
Static Water Column Height: 9. ft
Total Well Penetration Depth: 11. ft
Screen Length: 10. ft
Casing Radius: 0.0801 ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.02406 cm/sec
y0 = 1.208 ft



Data Set: C:\...\ow014MW203.aqt
Date: 01/13/17 | Time: 14:16:16

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

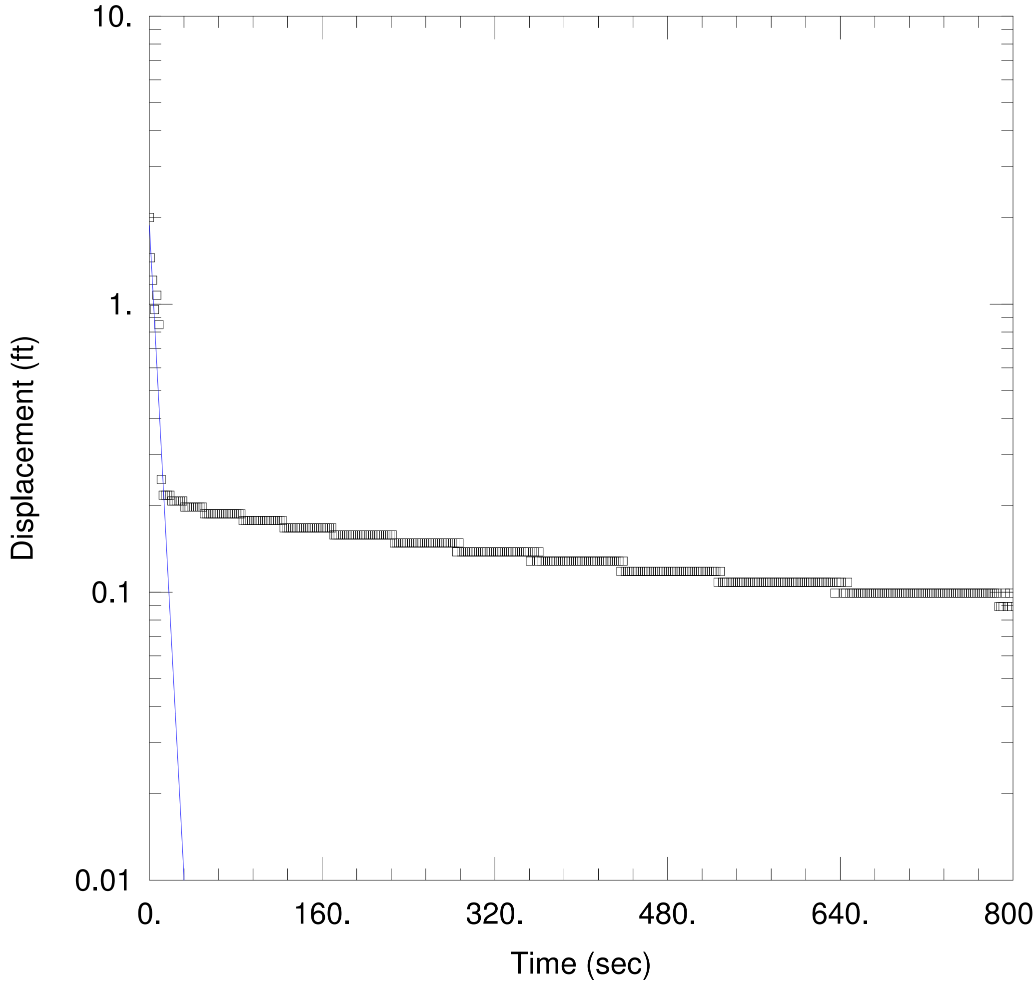
WELL DATA (OW014MW203)

Initial Displacement: 1. ft
Static Water Column Height: 9. ft
Total Well Penetration Depth: 11. ft
Screen Length: 10. ft
Casing Radius: 0.0801 ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.004001 cm/sec
y0 = 0.3943 ft



Data Set: C:\...\rw010MW206.aqt
Date: 01/13/17 | Time: 14:16:51

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

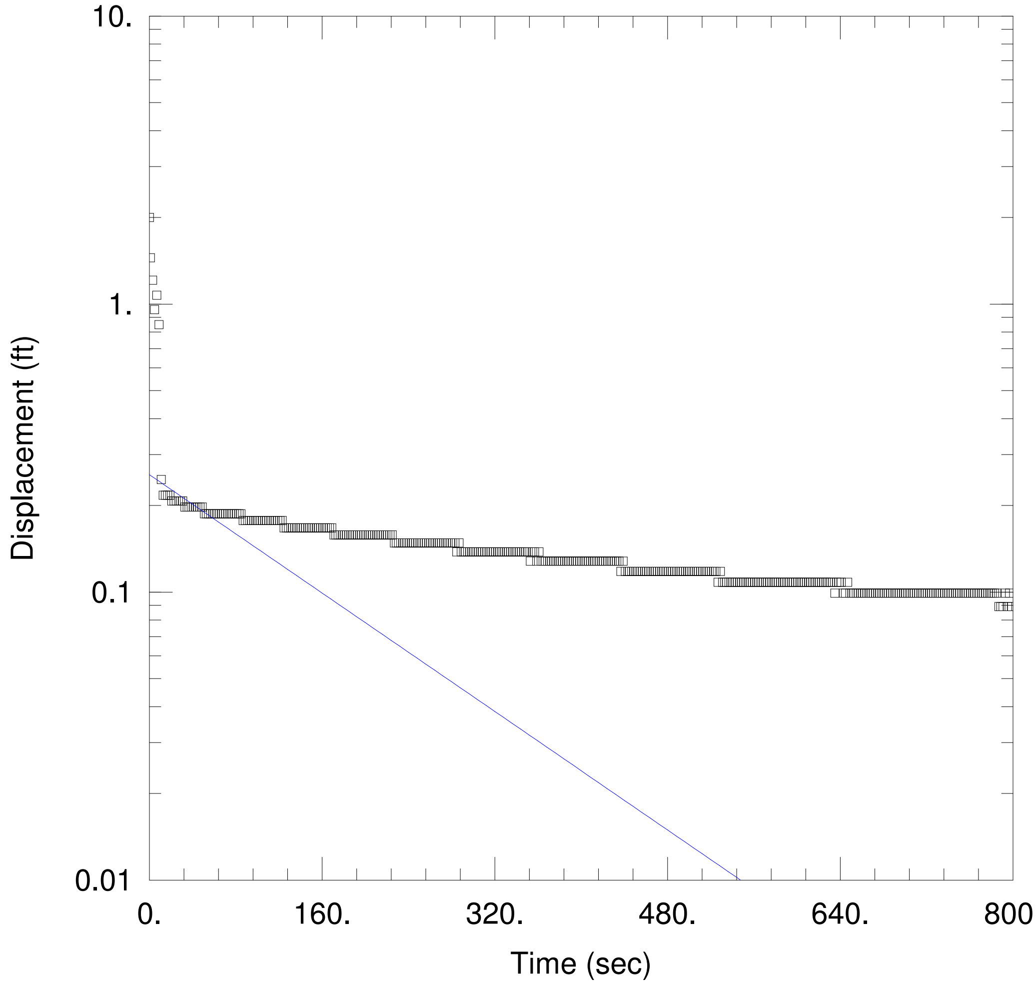
WELL DATA (New Well)

Initial Displacement: 2. ft
Total Well Penetration Depth: 14. ft
Casing Radius: 0.0801 ft
Static Water Column Height: 9. ft
Screen Length: 10. ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00627 cm/sec
y0 = 1.876 ft



Data Set: C:\...\rw010MW206-2.aqt
Date: 01/13/17
Time: 14:17:20

PROJECT INFORMATION

Company: Amec Foster Wheeler
Client: ANG
Location: General Mitchel
Test Date: 9/16/16

AQUIFER DATA

Saturated Thickness: 9. ft
Anisotropy Ratio (Kz/Kr): 0.2

WELL DATA (New Well)

Initial Displacement: 2. ft
Total Well Penetration Depth: 14. ft
Casing Radius: 0.0801 ft
Static Water Column Height: 9. ft
Screen Length: 10. ft
Well Radius: 0.0801 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0002281 cm/sec
y0 = 0.2555 ft

APPENDIX G

ALTERNATIVE PRICE ESTIMATIONS

CG019 General Mitchell, WI
Cost Estimate
Alternative #2 - MNA and ICs

Description	Quantity	Unit of Measure	Unit Price	Total Cost (Forecast)
PRE-WORK ACTIVITIES				
Pre-Work Works Plans, Schedule, Submittals, Permits	1	Lump Sum	$15,000	$15,000
LTM Work Plans and Specifications	1	Lump Sum	$10,000	$10,000
Institutional Controls Setup and Implementation	1	Lump Sum	$25,000	$25,000
Contingency (15%)	1	Lump Sum	$7,500	$7,500
			Subtotal	**$57,500**
Annual Reporting (2 years quarterly LTM)				
LTM sampling & analytical	1	lump sum	$20,000	$20,000
LTM reporting	4	each	$12,000	$48,000
			Subtotal	**$68,000**
Annual Reporting (28 years semi-annual LTM)				
LTM sampling & analytical	1	lump sum	$10,000	$10,000
LTM reporting	2	each	$12,000	$24,000
			Subtotal	**$34,000**

Project Total (Year 0)	**$125,500**
Annual Cost Total (First 2 Years)	**$68,000**
Annual Cost Total (Years 3-30)	**$34,000**
NPV of 30 years LTM	**$464,549**
Net Project Total	**$590,049**

Assumptions
Assumes continuous work with no encumbrance by ANG or airport operations. 7% used for NPV calculations
WORK PLANS, SCHEDULES AND PERMITS
Based on previous experience for similar construction tasks.
Institutional Controls
IC's assumed to include groundwater use restrictions.

CG019 - General Mitchell, WI
Cost Estimate
Alternative #3 - Groundwater Extraction and Treatment

Description - Construction	Quantity	Unit of Measure	Unit Price	Total Cost (Forecast)
PRE-WORK ACTIVITIES				
General Requirements (Mgmt, Site Supervision, Meetings, etc.)	1	Lump Sum	$100,000	$100,000
Pre-Work Works Plans, Schedule, Submittals, Permits	1	Lump Sum	$50,000	$50,000
Data Gap Investigation (work plans, additional borings, wells, sampling)	1	Lump Sum	$50,000	$50,000
Sample analytical	1	Lump sum	$25,000	$25,000
Pilot Testing	1	Lump Sum	$100,000	$100,000
			Subtotal	**$325,000**
DESIGN & OVERSIGHT				
Design (90%, Final)	1	Lump Sum	$150,000	$150,000
Work Plans and Specifications	1	Lump Sum	$30,000	$30,000
R&S Plan	1	Lump Sum	$2,500	$2,500
Engineering Support During Construction	1	Lump Sum	$40,000	$40,000
Project Management	1	Lump Sum	$20,000	$20,000
Oversight During Construction				
Senior Construction Manager	10	Weeks	$6,000	$66,000
Equipment Rental	10	Weeks	$1,000	$11,000
			Subtotal	**$319,500**
MOBILIZATION & SITE PREPERATION				
Mobilization	1	Lump Sum	$250,000	$250,000
Site Preparation, Temporary Facilities & Controls	1	Lump Sum	$175,000	$175,000
			Subtotal	**$425,000**
WELL AND PIPING INSTALLATION				
Extraction Wells, pads, completions	10	each	$5,000	$50,000
Piping to Extraction Wells	700	Linear Feet	$15	$10,500
Piping to Discharge	50	Linear Feet	$25	$1,250
Electrical and Instrumentation & Controls Conduit	200	Linear Feet	$25	$5,000
Pipe Leakage Testing	1	Lump Sum	$5,000	$5,000
			Subtotal	**$21,750**
BUILDING - 30'x40'x15'				
Building Foundation and Slabs	1	Lump Sum	$125,000	$125,000
Building Design, Fabrication, and Erection	1	Lump Sum	$150,000	$150,000
HVAC System	1	Lump Sum	$50,000	$50,000
Lighting and Power	1	Lump Sum	$60,000	$60,000
			Subtotal	**$385,000**
GRANULAR ACTIVATED CARBON SYSTEM				
Influent Equalization Tank (7,500 gal)	1	Each	$20,000	$20,000
Bag Filter Housings	3	Each	$4,000	$12,000
GAC Vessels (10,000 lb x2)	1	lump sum	$165,000	$165,000
Backwash Tank (2,500 gal)	1	Each	$4,000	$4,000
Effluent Equalization Tank (7,500 gal)	1	Each	$20,000	$20,000
Extraction pumps and motors	10	Each	$2,500	$25,000
Transfer Pumps	6	Each	$10,000	$60,000
Process Piping	1	Lump Sum	$90,000	$90,000
Electrical and Instrumentation & Controls	1	Lump Sum	$60,000	$60,000
PLC/SCADA Programming and Install	1	Lump Sum	$250,000	$250,000
			Subtotal	**$706,000**
GRANULAR ACTIVATED CARBON SYSTEM OPERATION				
Start-Up & Commissioning				
Site Operator	2	Months	$25,000	$50,000
Consumables	1	Lump Sum	$25,000	$25,000
			Subtotal	**$75,000**
TRANSPORTATION & DISPOSAL, SITE RESTORATION				
Excavation Transportation and Disposal (non-haz)	450	Tons	$35	$15,750
Site Restoration	1	Lump Sum	$15,000	$15,000
Demobilization	1	Lump Sum	$50,000	$50,000
			Subtotal	**$80,750**
Contractor Profit @ 10%	1	Lump Sum	**$169,350**	**$169,350**
CONTINGENCY (15%)	1	Lump Sum	**$350,700**	**$350,700**
			Remediation Total	**$2,533,050**

CG019 - General Mitchell, WI
Cost Estimate
Alternative #3 - Groundwater Extraction and Treatment

Description	Quantity	Unit of Measure	Unit Price	Total Cost (Forecast)
ICs and Reporting				
Institutional Controls	1	Lump Sum	$25,000	$25,000
Completion Report	1	Lump Sum	$45,000	$45,000
			Subtotal	**$70,000**
GRANULAR ACTIVATED CARBON SYSTEM ANNUAL OPERATION				
Annual Operation				
Carbon Costs	10	Tons	$2,800	$28,000
Carbon changeout mob costs	2	each	$5,000	$10,000
Bag Filters	100	Each	$20	$2,000
Site Operator	24	Days	$650	$15,600
Discharge Costs	131400000	gallons	$0.005	$614,840
LTM sampling	1	lump sum	$20,000	$20,000
LTM reporting	2	each	$12,000	$24,000
			Subtotal	**$714,440**
LABORATORY FEES				
Laboratory Analytical Fees - Influent, midfluent, effluent (2/month)	72	Each	$125	$9,000
			Subtotal	**$9,000**

Project Total (Year 0)	**$3,651,490**
Annual Cost Total	**$723,440**
NPV of 30 years operation	**$8,977,161**
Net Project Total	**$12,628,651**

Assumptions
Assumes continuous work with no encumbrance by airport operations.
WORK PLANS, SCHEDULES AND PERMITS
Based on previous experience for similar construction tasks.
MOBILIZATION
Duration of work assumed 8 weeks (1 week mobilization/site preparation, 6 weeks construction and site restoration, 1 week demobilization, includes 10% contingency), followed by start-up.
EARTHWORK
Assumes no utilities encountered. Trenching assumed to be 4' deep by 2' wide Assumes backfill to original grade in engineered soils footprint; displacement assumed to be negligible.
WASTE DISPOSAL
Assumes waste is disposed as Non-Hazardous. Sanitary discharge rate estimate at $3.50 per 100 cubic feet (748 gallons per 100 cubic feet) Safety factor for disposal quantities built into bulk density assumption (1.5 tons/BCY)
CONTRACTOR COSTS
Assumes 2 (draft and final) iterations of design. Oversight during construction assumes 1 staff on site; 50 hour weeks for 2 months, $114/hr, per diem for 5 days per week.

CG019 - General Mitchell, WI
Cost Estimate
Alternative #4 - Chemical Injections

Description	Quantity	Unit of Measure	Unit Price	Total Cost (Forecast)
PRE-WORK ACTIVITIES				
General Requirements (Mgmt, Site Supervision, Meetings, etc.)	1	Lump Sum	$100,000	$100,000
Pre-Work Works Plans, Schedule, Submittals, Permits	1	Lump Sum	$45,000	$45,000
Data Gap Investigation (work plans, additional borings, wells, sampling, analytical)	1	Lump Sum	$40,000	$40,000
Pilot Testing	1	Lump Sum	$45,000	$45,000
			Subtotal	**$230,000**
DESIGN & OVERSIGHT				
Design (90%, Final)	1	Lump Sum	$50,000	$50,000
Work Plans and Specifications	1	Lump Sum	$30,000	$30,000
Engineering Support During Activities	1	Lump Sum	$14,000	$14,000
Project Management	1	Lump Sum	$5,000	$5,000
Oversight During Construction				
Senior Construction Manager	4	Weeks	$6,000	$26,400
Equipment Rental	4	Weeks	$800	$3,520
			Subtotal	**$128,920**
MOBILIZATION & SITE PREPARATION				
Mobilization	1	Lump Sum	$10,000	$10,000
Site Preparation, Temporary Facilities, and Controls	1	Lump Sum	$10,000	$10,000
			Subtotal	**$20,000**
INJECTIONS				
Injection materials, shipping, taxes	1	lump sum	$95,000	$95,000
Direct Injection point installation	1	lump sum	$55,000	$55,000
Onsite mixing of material and injection	1	Lump Sum	$45,000	$45,000
Site Restoration	1	Lump Sum	$5,000	$5,000
Demobilization	1	Lump Sum	$5,000	$5,000
			Subtotal	**$205,000**
ContractorMarkup (10%)	1	Lump Sum	$22,500	$22,500
Contingency (15%)	1	Lump Sum	$87,588	$87,588
			Remediation Total	**$464,008**

Description	Quantity	Unit of Measure	Unit Price	Total Cost (Forecast)
Annual Reporting (3 years LTM)				
LTM sampling & analytical	1	lump sum	$20,000	$20,000
LTM reporting	4	each	$12,000	$48,000
			Subtotal	**$68,000**

Project Total	**$762,008**
Annual Cost Total	**$68,000**
NPV of 5 years LTM	**$246,012**
Net Project Total	**$1,008,020**

Assumptions
Assumes continuous work with no encumbrance by ANG or airport operations.
WORK PLANS, SCHEDULES AND PERMITS
Based on previous experience for similar construction tasks.
MOBILIZATION
contingency).
Injections
Assumes injection target area of 30 -40' bgs Assumes injection of electron donor and bioaugmentation substrate
Based on previous experience for similar construction tasks.
CONTRACTOR COSTS
Assumes 2 (draft and final) iterations of design. per diem for 5 days per week.