Final

Background Study for Metals for RVAAP-66 Facility-wide Groundwater

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912QR-16-D-0003
Delivery Order No. W912QR-18-F-0337

Prepared for:

United States Army Corps of Engineers
Louisville District

Prepared by:

Leidos
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14. ABSTRACT

This study provides the evaluation process and final determination of background concentrations for metals in groundwater at the former Ravenna Army Ammunition Plant.

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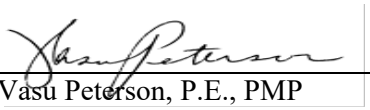
(Documentation to be provided once concurrence is issued.)

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

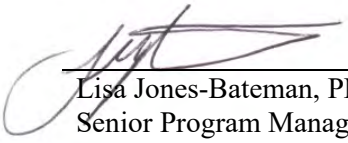
Leidos has completed the Background Study for Metals for RVAAP-66 Facility-wide Groundwater, Former Ravenna Army Ammunition Plant. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing United States Army Corps of Engineers (USACE) policy. In addition, an independent verification was performed to ensure all applicable changes were made per regulatory and Army comments.

August 6, 2019
Jed Thomas, P.E., PMP — Date
Study Team Leader



August 6, 2019
Vasu Peterson, P.E., PMP — Date
Review Team Leader

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



August 6, 2019
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ACRONYMS AND ABBREVIATIONS

95UTL	95% Upper Tolerance Limit
amsl	above mean sea level
AOC	Area of Concern
bgs	below ground surface
CJAG	Camp James A. Garfield
FWGWMP	Facility-wide Groundwater Monitoring Program
gpm	gallons per minute
KM	Kaplan-Meier
ND	Non-Detect
NTU	Nephelometric Turbidity Unit
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
RI	Remedial Investigation
ROS	Robust Regression on Order Statistics
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SAS®	Statistical Analysis Software
SVOC	Semi-volatile Organic Compound
S-W	Shapiro-Wilk
USACE	U.S. Army Corps of Engineers
USP&FO	U.S. Property and Fiscal Officer
VOC	Volatile Organic Compound
WBG	Winklepeck Burning Grounds

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1.0 INTRODUCTION

Leidos has been contracted by the U.S. Army Corps of Engineers (USACE), Louisville District to execute the performance work statement titled "Groundwater Investigation and Reporting Services, Ravenna Army Ammunition Plant (RVAAP) Restoration Program." The RVAAP Restoration Program includes the RVAAP-66 Facility-wide Groundwater Area of Concern (AOC) at the Camp James A. Garfield (CJAG) Joint Military Training Center. These investigation and reporting services are conducted in support of the Facility-wide Groundwater Monitoring Program (FWGWMP).

This work is being performed under a firm-fixed price basis in accordance with USACE, Louisville District Contract No. W912QR-16-D-0003, Delivery Order No. W912QR-18-F-0337.

1.1 PURPOSE

Background refers to the concentration of chemical substances that have not been affected by current or past site activities. Background sampling is often conducted to help distinguish site-related contamination from naturally occurring or other non-site-related chemicals. This information is useful in evaluating whether a site has impacted various media and to help in the evaluation and selection of a remedy for a site (Ohio EPA 2009).

The purpose of this study is to calculate background concentrations for metals within the varying groundwater aquifers within CJAG to assist in decision making regarding the Facility-wide Groundwater AOC during the completion of the remedial investigation (RI).

1.2 SCOPE

The scope of this study is to use acquired data per the *Remedial Investigation Work Plan for Groundwater and Environmental Investigation Services for RVAAP-66 Facility-wide Groundwater* (TEC-Weston 2016, herein referred to as the RI Work Plan) and establish background concentrations for metals in groundwater at the former RVAAP. Background groundwater concentrations will be established for the four different geologic aquifers at CJAG (Unconsolidated, Homewood, Upper Sharon, and Basal Sharon Conglomerate).

1.3 REPORT ORGANIZATION

The remaining sections of this study are organized as follows:

- Section 2.0. Previous Background Investigations,
- Section 3.0. Facility Description,
- Section 4.0. Background Well Study,
- Section 5.0. Conclusions and Recommendations, and
- Section 6.0. References.

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2.0 PREVIOUS BACKGROUND INVESTIGATIONS

Previous investigations and assessments have been performed to establish (and assess) background concentrations used to support the RVAAP Restoration Program. This section summarizes the 1998 background study and 2008 background calculation update. In addition, this section provides the previous groundwater background concentrations that will be updated at the conclusion of this study.

2.1 1998 BACKGROUND STUDY

In 1998, USACE finalized the *Sampling and Analysis Plan Addendum for the Phase II Remedial Investigation of the Winklepeck Burning Grounds and Determination of Facility-wide Background at the Ravenna Army Ammunition Plant* (SAIC 1998, herein referred to as the Sampling and Analysis Plan [SAP] Addendum). A portion of the scope of this SAP Addendum was to present a plan to characterize facility-wide background soil, sediment, surface water, and groundwater data to augment the Phase I RI background investigation and to adequately determine a range of background chemical data for these media.

Field activities per the SAP Addendum were conducted in April and May 1998. The following provides the rationale for placing the background wells, as presented in Section 2.4.4.1 of the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds* (SAIC 2001, herein referred to as the Winklepeck Burning Grounds [WBG] Phase II RI Report):

> "Fourteen monitoring wells were installed throughout RVAAP in areas believed to be unaffected by facility operations with the concurrence of the OEPA. Seven monitoring wells were completed in the unconsolidated, unconfined water table unit. Seven wells were completed in bedrock of the Sharon Member of the Pennsylvanian Pottsville Formation. This placement of the wells allows an evaluation of regional flow and chemical quality in both the shallow unconsolidated and deeper bedrock-saturated zones that underlie RVAAP. In addition, the placement of the bedrock monitoring wells offers an opportunity to expand the limited knowledge currently available on the subsurface geology at RVAAP. It was originally proposed that the background monitoring wells be paired at seven locations on the eastern half of the installation. However, when drilling began, it was discovered that some of the proposed locations were underlain by Hiram Till deposits greater than 15.7-m (50-ft) thick, making them undesirable drilling locations for bedrock monitoring wells. This was the case at BKGmw-013 and BKGmw-004. Similarly, there was insufficient glacial cover to install shallow, unconsolidated zone, monitoring wells beside the bedrock wells BKGmw-006, -008, -010, -012, and -015. As a result, four of the unconsolidated zone monitoring wells (BKGmw-005, -016, -017, and -019) were relocated to upgradient or native areas on the western half of the installation. Wells BKGmw-005 and BKGmw-016 are placed in the Lavery Till; whereas the remaining wells are in the Hiram Till assemblage."

Table 2-1 presents the background monitoring well construction data for the wells installed and sampled to support the 1998 background study. Figure 2-1 presents the locations of the monitoring wells used in the 1998 background study.

Background groundwater samples were analyzed for target analyte list metals and cyanide; two of these samples were additionally analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Groundwater samples analyzed for dissolved metals were filtered immediately after sample collection using a negative pressure filtration system with 0.45-µm pores. The groundwater background samples were divided into four groups: 1) bedrock, unfiltered; 2) bedrock, filtered; 3) unconsolidated, unfiltered; and 4) unconsolidated, filtered.

The methodology and summary statistics for determining background concentrations in these four groups are presented in Section 4.1.2 of the WBG Phase II RI Report (SAIC 2001) and will not be restated in this study. Table 2-2 of this report presents the background concentrations established in the study.

Table 2-1. Screened Intervals of 1998 Background Monitoring Wells

Well ID	Total Depth (ft bgs)	Screened Interval (ft BTOC)	Lithology in Screened Interval
Background Wells Screened in the Unconsolidated Aquifer			
BKGmw-004	19.5	11.6 – 21.6	Medium-grained sand
BKGmw-005	19	10.7 – 20.7	Medium-grained sand
BKGmw-013	25.5	17.7 – 27.7	Sand-gravel-silt
BKGmw-016	19	10.9 – 20.9	Sand and silt
BKGmw-017	34.8	25.7 – 35.8	Medium-grained sand and silt
BKGmw-019	34	25.5 – 35.5	Silty sand and gravel
BKGmw-021	19	10.2 – 20.3	Medium-grained sand
Background Wells Screened in Bedrock			
BKGmw-006	35.1	27.2 – 37.2	Well-sorted sandstone
BKGmw-008	25	17.2 – 27.7	Poorly sorted sandstone
BKGmw-010	22	11.4 – 21.4	Interbedded sandstone/shale
BKGmw-012	59.8	42.1 – 52.1	Shale
BKGmw-015	51	32.6 – 52.6	Shale
BKGmw-018	24.7	17 – 27	Sandstone
BKGmw-020	30.7	23 – 33	Shale

bgs = Below ground surface.
BTOC = Below top of casing.
ft = Feet.
ID = Identification.
TOC = Total organic carbon.

Table 2-2. Background Groundwater Concentrations from the 1998 Background Study

Chemical	Groundwater-Unconsolidated (mg/L)		Groundwater-Bedrock (mg/L)	
	Filtered	Unfiltered	Filtered	Unfiltered
Aluminum	NA	48	NA	9.41
Antimony	0	0.0043	0	0
Arsenic	0.0117	0.215	0	0.0191
Barium	0.0821	0.327	0.256	0.241
Beryllium	0	0	0	0
Cadmium	0	0	0	0
Calcium	115	194	53.1	48.2
Chromium	0.0073	0.0852	0	0.0195
Cobalt	0	0.0463	0	0
Copper	0	0.289	0	0.017
Cyanide	0	0	0	0
Iron	0.279	195	1.43	21.5
Lead	0	0.183	0	0.023
Magnesium	43.3	58.4	15	13.7
Manganese	1.02	2.86	1.34	1.26
Mercury	0	0.00025	0	0
Nickel	0	0.117	0.0834	0.0853
Potassium	2.89	7.48	5.77	6.06
Selenium	0	0.0057	0	0
Silver	0	0	0	0
Sodium	45.7	44.7	51.4	49.7
Thallium	0	0.0024	0	0
Vanadium	0	0.0981	0	0.0155
Zinc	0.0609	0.888	0.0523	0.193

mg/L = Milligrams per liter.
NA = Not available. Aluminum results were rejected in validation.

2.2 2008 BACKGROUND CALCULATION UPDATE

The background wells continued to be sampled during various semi-annual sampling events conducted under the FWGWMP. The *Facility-wide Groundwater Monitoring Program Background Calculation Update* (ECATS 2008) used sample results from the second quarter of 2005 and third quarter of 2007 to recalculate background concentrations.

This report calculated the background concentrations using two different methods:

- The quartile method as outlined by the Ohio Environmental Protection Agency (Ohio EPA), and
- The 95% Upper Tolerance Limit (95UTL) of groundwater concentrations.

This report concluded the following:

> "The two statistical approaches provided a distribution of values that were both higher and lower than the original background values. The database is much stronger now than when the original background values were calculated; therefore the current values may be more reliable. The quartile approach focuses on values that fall outside the middle 50% of the data, resulting in the loss of useful

information and providing artificially low calculated background concentrations. Therefore the 95UTL approach is recommended because it ensures that the background concentration calculated encompasses 95% of the data used for background analysis."

The report also indicated the following regarding managing exceedances:

"Using discrete background values to measure compliance offers a binary approach: the sample is either less than or greater than the deemed background value. This approach may be useful as a screening measure. However, for inorganic compounds, it may be prudent to consider the newly developed approaches to determine background without comparing individual results.

For organic compounds, the conventional approach is to assume that any detection is an exceedance. A method that incorporates interpretation such as the frequency of detection or trends in detection, the qualification of the result and any other mitigating considerations would render a more practical and useful basis for decision making.

For both inorganic and organic data, the most meaningful approach is the one that best meets the objectives of the FWGWMP as it moves forward. The objectives may change as the program moves from delineation to remediation and risk-based closure. Therefore periodic review of the background database is recommended."

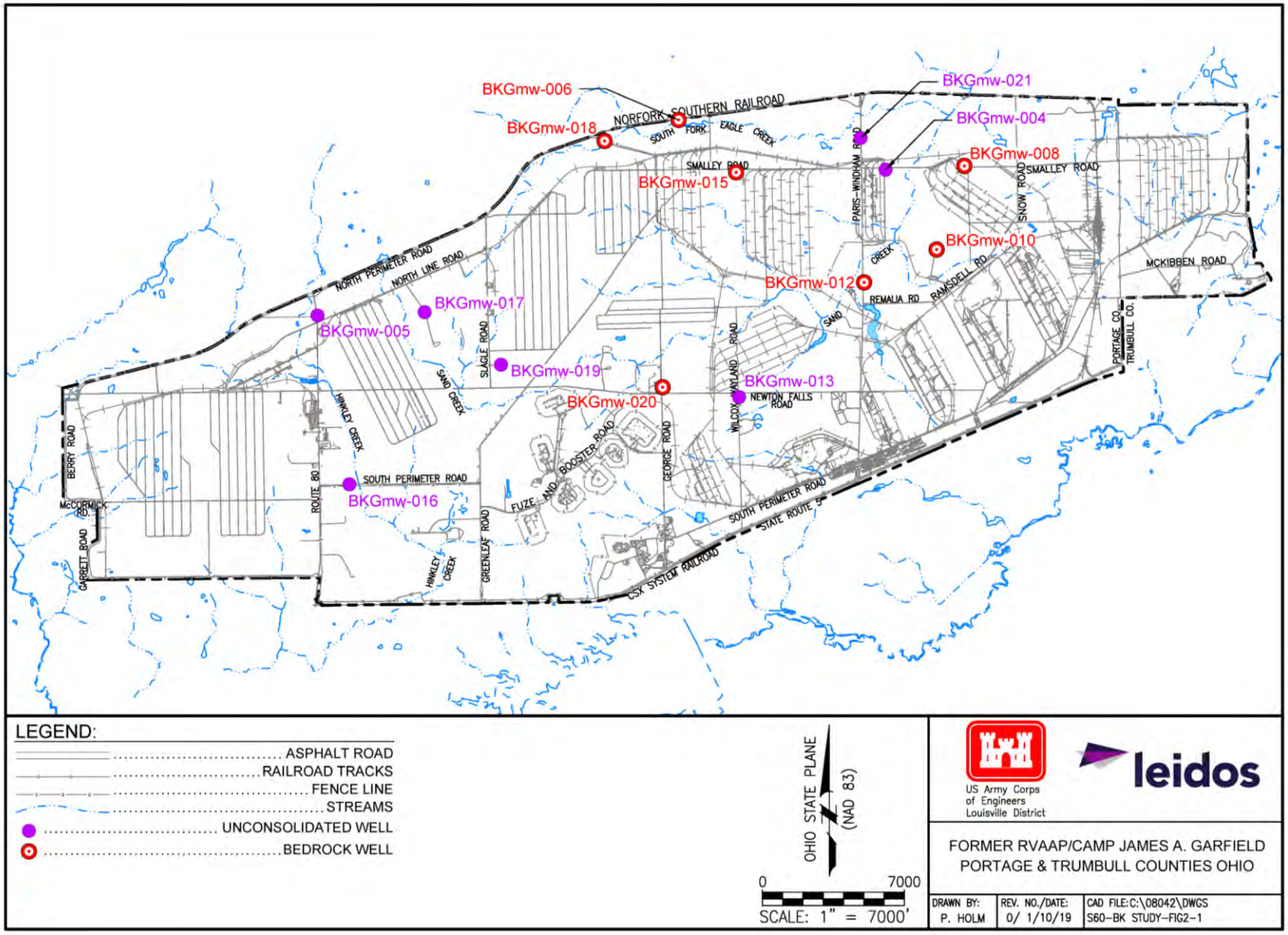

Figure 2-1. Monitoring Wells Used in 1998 Background Study

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3.0 FACILITY DESCRIPTION

This section provides a brief history of activities at the former RVAAP, as well as describes the site geology and hydrogeology that is pertinent in understanding and evaluating the Facility-wide Groundwater AOC.

3.1 FACILITY DESCRIPTION

The former RVAAP, now known as CJAG, located in northeastern Ohio within Portage and Trumbull counties, is approximately 3 miles east/northeast of the city of Ravenna and 1 mile north/northwest of the city of Newton Falls (Figure 3-1). The facility is approximately 11 miles long and 3.5 miles wide. The facility is bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad to the south; Garrett, McCormick, and Berry Roads to the west; the Norfolk Southern Railroad to the north; and State Route 534 to the east. In addition, the facility is surrounded by the communities of Windham, Garrettsville, Charlestown, and Wayland. The facility is federal property, which has had multiple accountability transfers amongst multiple Army agencies, making the property ownership and transfer history complex. The most recent administrative accountability transfer occurred in September 2013 when the remaining acreage (not previously transferred) was transferred to the U.S. Property and Fiscal Officer (USP&FO) for Ohio and subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a military training site.

3.2 SITE GEOLOGY

Surface geology at CJAG generally consists of glacial till deposits from the Wisconsinan glacial advance, with occasional outcrops of bedrock of the Pottsville Formation. North-south trending pre-glacial valleys in the central and western portions of CJAG were generally deepened by scouring and subsequently buried during two minor glacial advances and retreats. The Wisconsinan glacial advances first deposited the Lavery Till and later deposited the Hiram Till, as presented in Figure 3-2. The uppermost bedrock underlying CJAG consists of several units of the Pennsylvanian-age Pottsville Formation, as shown in Figure 3-3. Figure 3-4 is a cross-section location map, and Figures 3-5 and 3-6, adapted from the 2017 Annual Report (TEC-Weston 2018), present cross-sections trending east-west and north-south, respectively, which illustrate the geology underlying CJAG. The Pottsville Formation varies significantly in composition both vertically and laterally, ranging from coarse, permeable sandstones to impermeable shales.

Due to the variation in composition, the Pottsville Formation is subdivided into members and units, as discussed in the subsections below. The base unit of the Pottsville Formation is sandstone, which is locally conglomeratic and underlain by Mississippian-age shale of the Cuyahoga Formation (Winslow and White 1966).

3.2.1 Unconsolidated

The surface of the eastern two-thirds of the CJAG property is composed of the clay-rich and relatively impermeable sediments of the Hiram Till and associated outwash plain deposits. The

western third of CJAG is covered by the Lavery Till, a silty, sandy deposit with occasional cobbles and sporadic boulders (Winslow and White 1966). The first Wisconsinan glacial advance deposited the Lavery Till at a thickness of 20–40 ft. The second advance covered only the eastern two-thirds of CJAG, depositing the Hiram Till (Kammer 1982). The Hiram Till consists of 12% sand, 41% silt, and 47% illite and chlorite clay minerals, and ranges in thickness from 5–15 ft below ground surface (bgs). In the far northeastern corner of CJAG, the Hiram Till overlies thin beds of sandy outwash material. Across CJAG, the thickness of unconsolidated soil ranges from less than 3 ft to approximately 45 ft (Author unknown 1998; as cited in the Integrated Natural Resources Management Plan [OHARNG 2014]).

3.2.2 Homewood Sandstone

The Homewood Sandstone Member is the uppermost Member of the Pottsville Formation, and it is present in the western portion of CJAG. The Homewood Member consists of a range of well-sorted, coarse-grained, white quartzose sandstone to a tan, poorly sorted, clay-bonded, micaceous, medium- to fine-grained sandstone. Thin shale layers are prevalent in the Homewood Member, as indicated by a darker gray shade of color. The Homewood Sandstone Member lies unconformably upon the Mercer Member of the Pottsville Formation and often forms a caprock (Winslow and White 1966).

3.2.3 Mercer Shale

The Mercer Shale Member consists of silty to carbonaceous shale, thin coal, underclay, and limestone layers with abundant thin, discontinuous sandstone lenses in the upper portion. This member occurs in the western portion of CJAG along eroded/incised slopes; however, it is not well documented at CJAG. The Mercer Member is underlain by the Massillon Sandstone Member (Winslow and White 1966).

3.2.4 Massillon Sandstone

The Massillon Sandstone Member consists of coarse- to medium-grained micaceous sandstone beds, which are commonly cross-bedded and often separated by shale beds. The separating silty sandy shale beds can be up to 50 ft thick and contain plant fragments. The sandstone beds contain rounded granules and quartz pebbles in some locations, but do not create thick conglomerate beds. The Massillon Sandstone unconformably overlies the Shale Unit of the Sharon Member of the Pottsville Formation (Winslow and White 1966).

3.2.5 Sharon Shale

The Sharon Member of the Pottsville Formation contains two distinct units, the Upper Sharon and the Basal Sharon Conglomerate. The Upper Sharon is composed of thin gray to black sandy to micaceous shale lenses, containing thin coal, underclay, and sandstone lenses. This unit is present in the western portion of CJAG, but was eroded from the eastern portion of the property before the Massillon Sandstone was deposited. The Sharon Shale Unit overlies the Sharon Sandstone/Conglomerate Unit (Winslow and White 1966).

3.2.6 Basal Sharon Conglomerate

The Basal Sharon Conglomerate Unit is the basal portion of the Pottsville Formation and is a highly porous, loosely cemented, permeable, cross-bedded, frequently fractured, and weathered sandstone. The conglomerate portion consists of well-rounded quartz pebbles and granules with little sand-sized matrix or cement. The conglomerate typically occurs within the lower (deeper) portions of the unit, which lies unconformably upon the Mississippian-age shale of the Cuyahoga Formation (Winslow and White 1966).

3.2.7 Cuyahoga Shale

The Meadville Shale is the uppermost unit of the Mississippian-age Cuyahoga Group. It consists of a micaceous blue-gray sandy shale with flagstone and clay-ironstone layers. The Meadville Shale overlies the Sharpsville Sandstone of the Cuyahoga Group, which overlies the Orangeville Shale of the Cuyahoga group (Winslow and White 1966). While previously mapped in limited extent on the eastern portion of CJAG (Portage Environmental 2004), subsequent studies (TEC-Weston 2016) indicate the mapped unit is actually the Sharon Member.

3.3 SITE HYDROGEOLOGY

Throughout CJAG, depth to groundwater ranges from less than 1 ft bgs to more than 115 ft bgs, with static water elevations occurring between approximately 930–1,176 ft above mean sea level (amsl). Table 3-1 provides the aquifer depths relative to ground surface and sea level.

Table 3-1. Aquifer Depths Relative to Ground Surface and Sea Level

Aquifer	Aquifer Depths			
	Below Ground Surface		Elevation	
	Minimum Depth	Maximum Depth	Upper Elevation	Lower Elevation
Unconsolidated	1 ft bgs	11 ft bgs	930 ft amsl	1,175 ft amsl
Homewood	7.5 ft bgs	47 ft bgs	1,105 ft amsl	1,176 ft amsl
Upper Sharon	3 ft bgs	118 ft bgs	938 ft amsl	1,060 ft amsl
Basal Sharon Conglomerate	2 ft bgs	116 ft bgs	942 ft amsl	1,068 ft amsl

amsl = Above mean sea level.
bgs = Below ground surface.
ft = Feet.

Observed gradients indicate groundwater flows from bedrock highs in the western portion of the property toward stream valleys in the eastern portion. These latter areas act as discharge areas, as indicated by the static water levels in monitoring wells across the installation (Kammer 1982).

The majority of CJAG is composed of clay-rich glacial tills with low permeability and underlying bedrock formations with extremely variable, but relatively low, permeability. Typical yields from wells reported in the 1982 study as penetrating the "Sharon Conglomerate" range from 5–200 gallons per minute (gpm); yields from the overlying unconsolidated sediments are usually considerably lower. In addition, the thickness and permeability of the bedrock water-bearing formations at CJAG

vary considerably and have a strong effect on well yields, transmissivity, and hydraulic conductivity (Kammer 1982).

3.3.1 Unconsolidated

Groundwater occurs within the unconsolidated deposits in many areas of the facility. The thickness of the unconsolidated deposits at the facility ranges from thin to absent in the eastern and northeastern portions of the facility to an estimated 150 ft in pre-glacial valleys near the central portion of the facility. Because of the heterogeneous nature of the unconsolidated glacial material, groundwater flow paths likely exhibit local variations, which are difficult to determine.

The hydraulic gradient in the unconsolidated aquifer predominantly trends in an eastward direction; however, the unconsolidated zone shows numerous local flow variations influenced by topography and stream drainage patterns, with localized flow along preferential pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities than surrounding clay or silt-rich material. The local variations in flow direction suggest 1) groundwater in the unconsolidated deposits is generally in direct hydraulic communication with surface water, and 2) surface water drainageways may also act as groundwater discharge locations. In addition, topographic ridges between surface water drainage features act as groundwater divides in the unconsolidated deposits.

In the region of CJAG, groundwater recharge occurs via surface infiltration of precipitation along root zones, desiccation cracks, partings within the soil column, and general percolation through sand and gravel within buried valleys. Two large buried valleys occur southwest and northwest of the facility; wells in the unconsolidated aquifers in these valleys can yield up to 1,600 gpm. Monitoring wells that currently exist in unconsolidated material on the CJAG property range in depth from 14–130 ft bgs.

3.3.2 Homewood Sandstone

The uppermost bedrock aquifer at CJAG is the Homewood Sandstone, which is reportedly only capable of well yields less than 10 gpm (Kammer 1982). The Homewood aquifer is present in the central and western portions of the property. It is usually bound above by unconsolidated glacial till and below by the Mercer Member. Existing monitoring wells screened within the Homewood Sandstone Member range in depth from 19–50 ft bgs.

Review of regional geology maps (Winslow and White 1996) and historical monitored formation interval designations at CJAG during preparation of the Facility-wide RI Work Plan indicated certain groundwater monitoring wells in the area of the Fuze and Booster Quarry, including Load Lines 5 through 10, known as Fuze and Booster Hill, were likely incorrectly identified to be installed within the Homewood Sandstone Formation. Site stratigraphic descriptions collected during the installation of new monitoring wells in the Fuze and Booster Hill portion of the facility will be used to evaluate the lithology and presence of the Homewood Sandstone Formation in this area. Results of the lithologic review, the indicated effect of low-permeability shale units on groundwater vertical

migration, and any recommended revisions to monitored formation designations for groundwater wells in this portion of CJAG will be included in the pending RI Report.

3.3.3 Upper Sharon

The principal water-bearing aquifer at CJAG is the Sharon Sandstone/Conglomerate unit of the Pottsville Formation. Depending on the existence and depth of overburden, the Sharon Sandstone/Conglomerate unit ranges from an unconfined to a leaky artesian (semi-confined) aquifer. The Sharon Shale is a confining unit to the Upper Sharon aquifer where present in the western portion of the property. Water yields from area wells completed in the Sharon Sandstone/Conglomerate unit ranged from 30–400 gpm (USATHAMA 1978). Well yields of 5–200 gpm were reported for on-site bedrock wells completed in the Sharon Sandstone/Conglomerate unit (Kammer 1982). Existing monitoring wells screened within the Upper Sharon unit, including those in the Sharon Shale, range in depth from 12.6–213.5 ft bgs.

3.3.4 Basal Sharon Conglomerate

The Sharon Sandstone/Conglomerate Unit is the most productive unit of the Pottsville Formation and is the major bedrock aquifer in northeastern Ohio. A 1982 study reported that of the 71 groundwater wells that had been installed at the installation, 57 were completed in the Sharon Conglomerate, indicated by the study including the entire Sandstone/Conglomerate Unit of the Sharon Member, rather than the Basal Sharon Conglomerate aquifer currently described for CJAG. Data from the 1982 study indicated that the thickness of the Sharon Conglomerate ranges from 44–177 ft (Kammer 1982). Existing monitoring wells screened within the Sharon Conglomerate range in depth from 90–277 ft bgs.

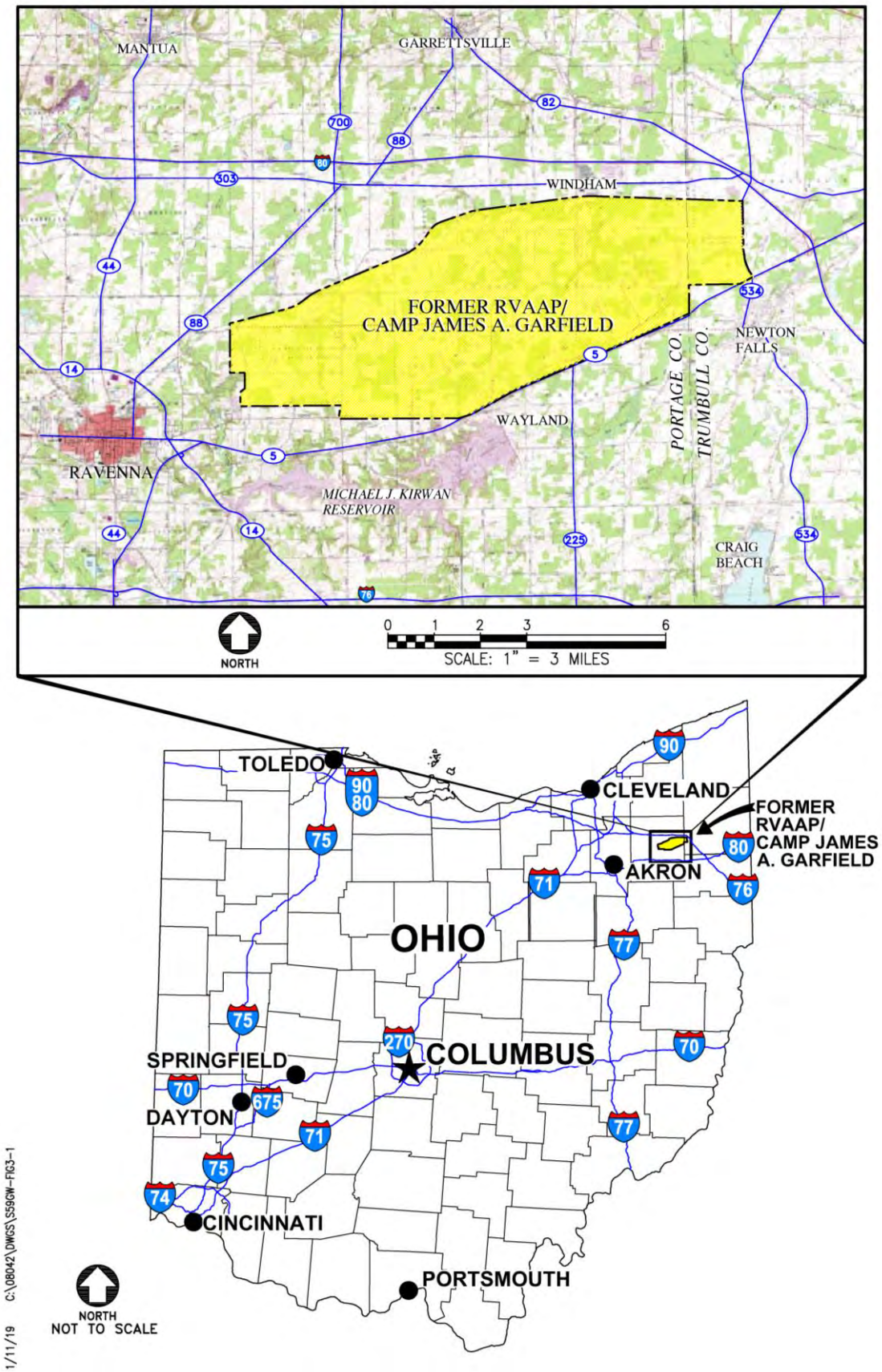


Figure 3-1. General Orientation and Location of Camp James A. Garfield

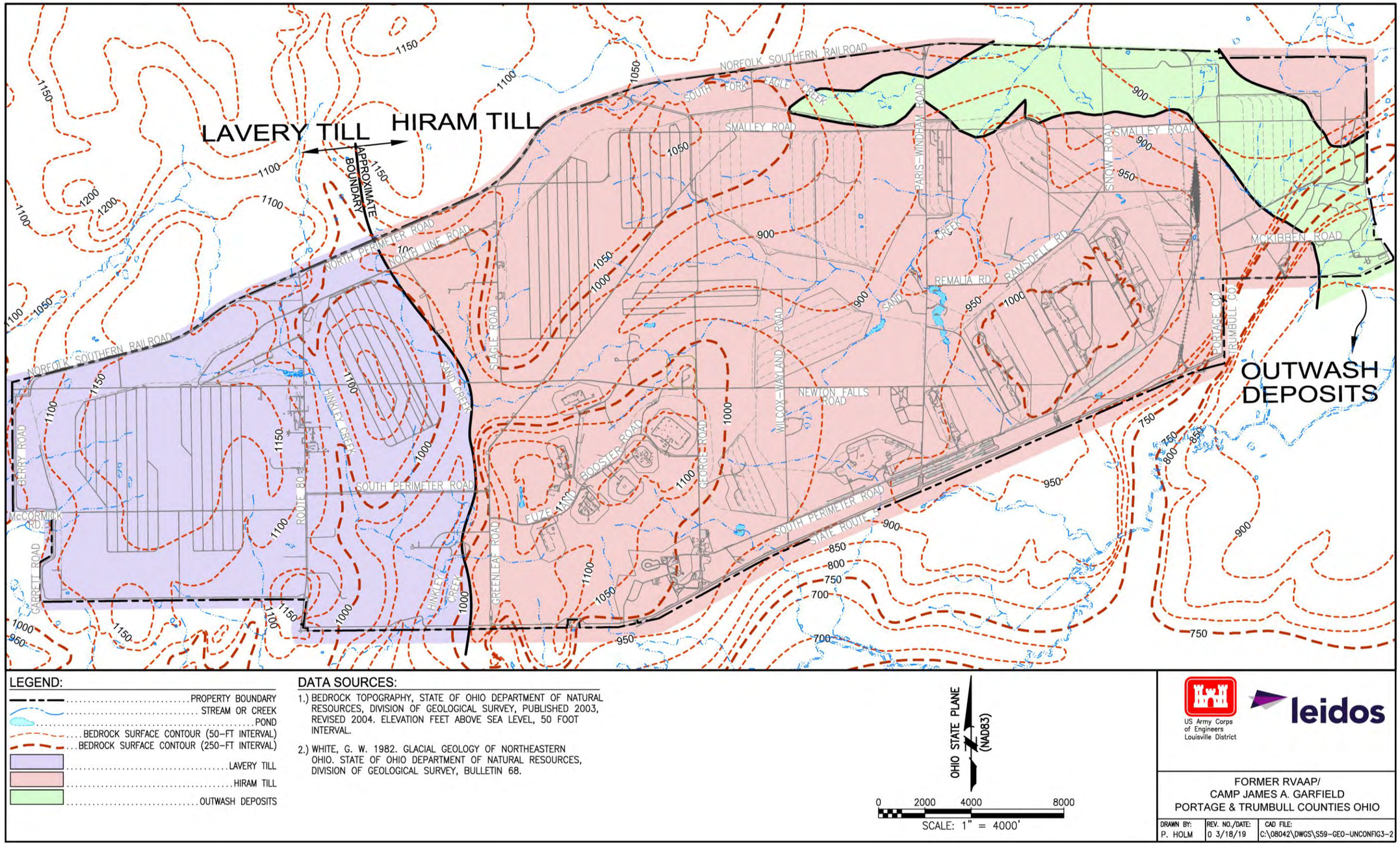


Figure 3-2. Geologic Map of Unconsolidated Deposits at Camp James A. Garfield

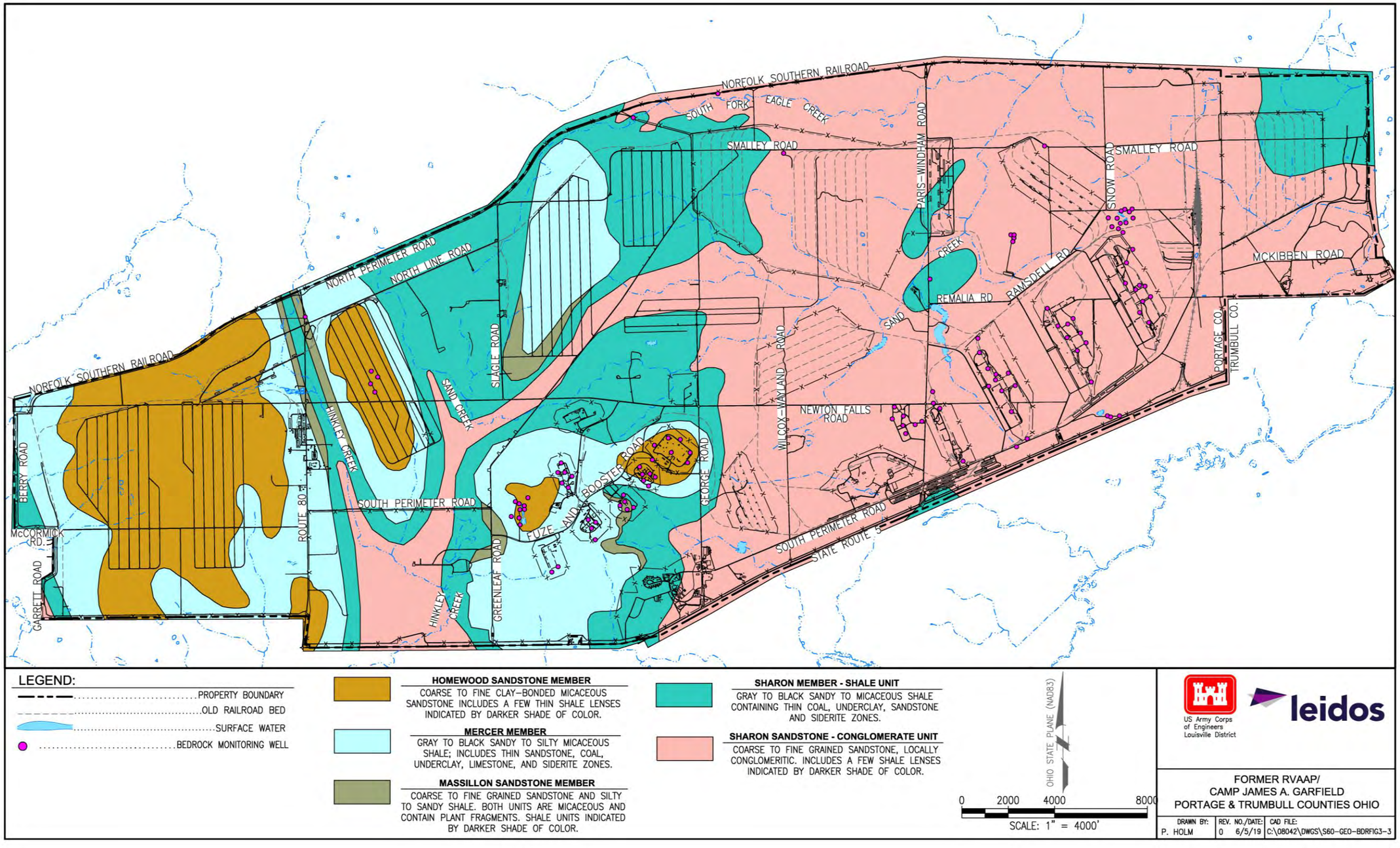


Figure 3-3. Geologic Bedrock Map and Stratigraphic Description of Units at Camp James A. Garfield

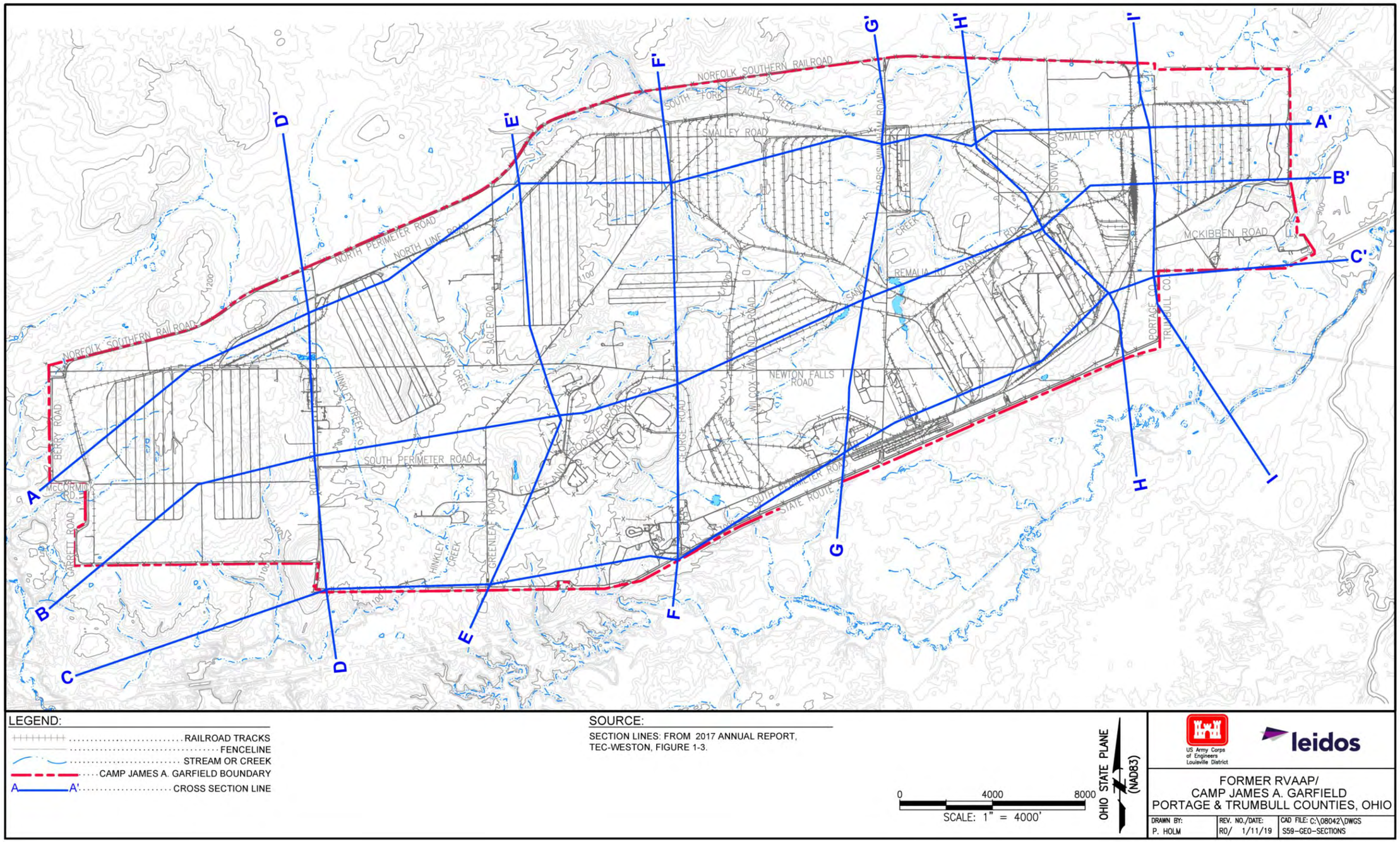
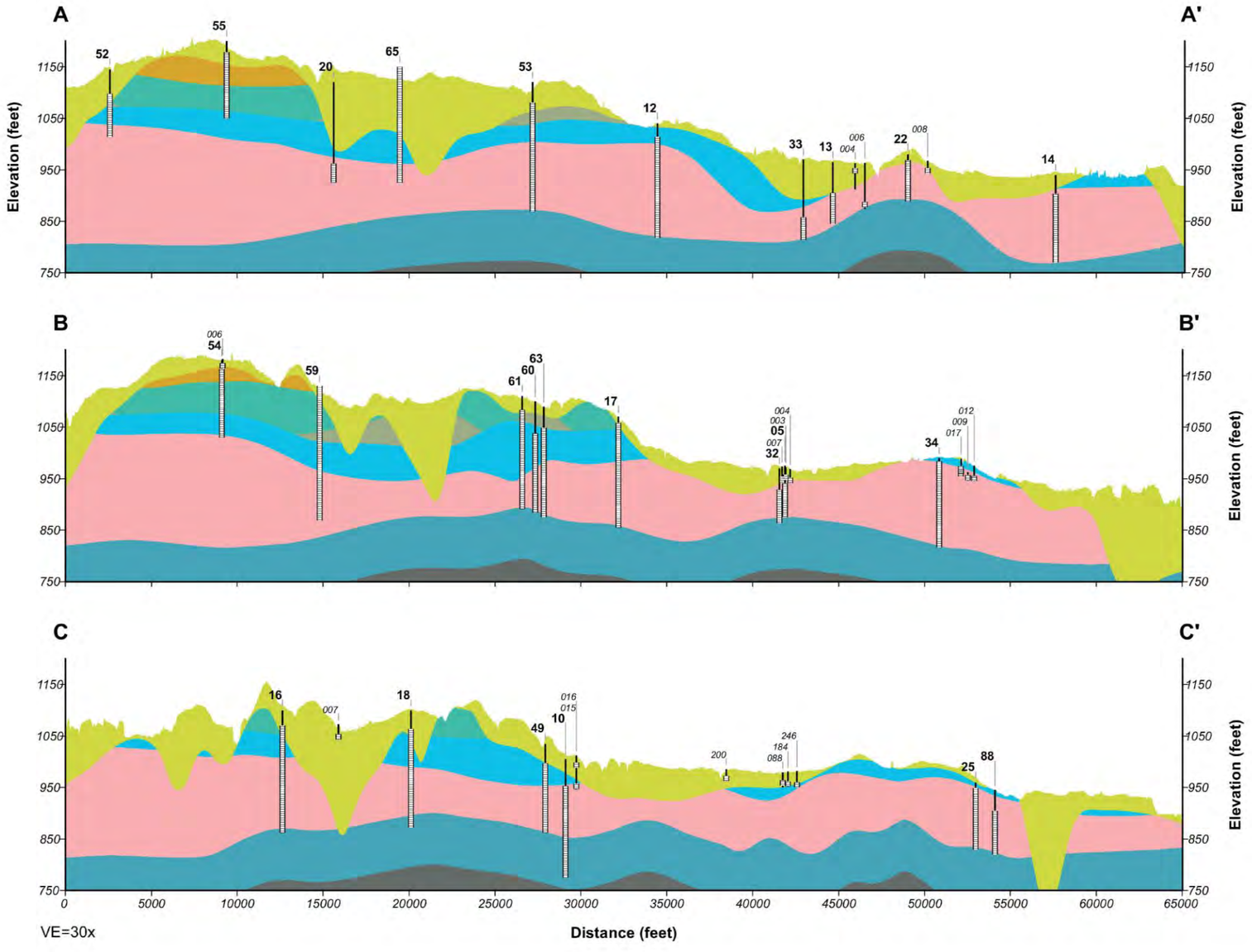


Figure 3-4. Line of Section Map



Legend

- AOC boundary
- Lines of Section

Site Wells

- Leader
- Casing
- Screen

Geology

- Unconsolidated
- Homewood Sandstone Member
- Mercer Member
- Massillon Sandstone Member
- Sharon Member, Shale Unit
- Sharon Member, Sandstone/Conglomerate Unit

Pottsville Formation

- Cuyahoga Group
- Berea Sandstone

SOURCE:

CROSS SECTIONS: FROM 2017 ANNUAL REPORT, TEC-WESTON, FIGURE 1-4.

US Army Corps of Engineers Louisville District

leidos

FORMER RVAAP/
CAMP JAMES A. GARFIELD
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\08042\DWGS
P. HOLM	1/11/19	S59-GEO-CS-EW

Figure 3-5. East-West Cross-Sections (A-C)

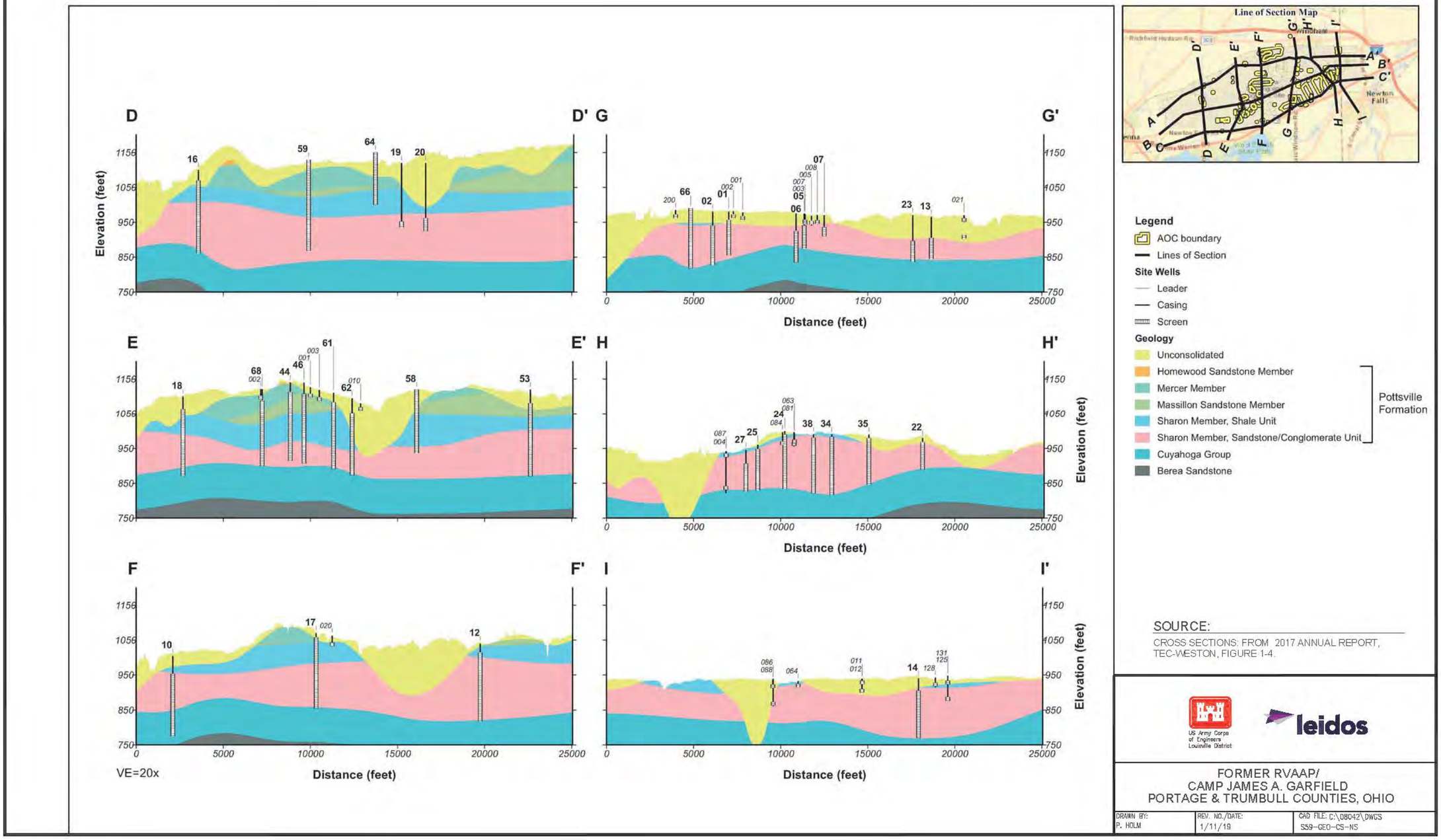


Figure 3-6. North-South Cross-Sections (D-I)

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4.0 BACKGROUND WELL STUDY

As indicated in previous sections, separate studies have evaluated and calculated the groundwater background concentrations at the former RVAAP. Since its inception, the Army has considered the FWGWMP to be a fluid program, allowing for re-evaluation. Given that the FWGWMP has been in place since 2004, the Army, coordinating with Ohio EPA, has established a monitoring well network, appropriate data, and statistical evaluation to calculate final background concentrations for use in evaluating potential groundwater contamination at CJAG.

4.1 BACKGROUND MONITORING WELL NETWORK

The RI Work Plan (TEC-Weston 2016) established the monitoring well network for calculating the background concentrations in each aquifer. Wells were selected and placed in accordance with the *Technical Guidance Manual for Groundwater Investigations, Chapter 5 Monitoring Well Placement* (Ohio EPA 2007), which states "Background monitoring wells generally are placed hydraulically upgradient of the pollution source. The wells should provide samples that are unaffected by facility operations and representative of background ground water quality."

As part of the RI Work Plan, a focused file review and geographic information systems queries were conducted to ascertain the locations, screen depths, aquifer intervals, and historical groundwater chemistry results for all existing background wells at CJAG. Wells with obvious chemical of potential concern impacts were immediately discarded from further consideration. Remaining background wells were then placed onto newly developed plan-view maps that illustrate groundwater flow and chemistry conditions, differentiated by aquifer. In addition, hydrogeologic cross-sections were developed to depict these conditions in profile. Lastly, EarthVision® software was employed to create three-dimensional depictions of CJAG, including the positioning of selected background wells.

By applying these steps, a holistic determination of the existing background well locations within the AOC, with the important assimilation of highly variable vertical and horizontal groundwater flow patterns, contaminant plume positions and migration patterns, groundwater/surface water interface conditions, and hydraulic communication between aquifers was made to ensure the most representative existing background wells were retained in the background well.

The following subsections present the monitoring well network for each of the four aquifers. As a generalized approach with inherent conservative assumptions, a minimum of three background wells per bedrock aquifer, plus at least one Unconsolidated aquifer background well near each of the three CJAG portions (eastern, central, and western), were established. This resulted in 14 wells being representative of background. Appendix A contains the boring logs associated with these background wells.

4.1.1 Unconsolidated

Monitoring wells BKGmw-005, BKGmw-016, BKGmw-017, and BKGmw-021 were selected to be in the monitoring well network to determine the background concentrations for the Unconsolidated aquifer. All four of these wells were included in the original 1998 background study. Figure 4-1 shows the location of these background wells, as well as the location of all other wells screened in the Unconsolidated aquifer.

4.1.2 Homewood Sandstone

Monitoring wells FWGmw-005, BKGmw-022 (identified as FWBKG-HSS1 in the RI Work Plan), and BKGmw-023 (identified as FWBKG-HSS2 in the RI Work Plan) were selected to be in the monitoring well network to determine the background concentration for the Homewood Sandstone aquifer. Monitoring well FWGmw-005 existed prior to the approval of the RI Work Plan, installed in 2012. Monitoring wells BKGmw-022 and BKGw-023 were installed in 2016. Figure 4-2 shows the location of these background wells, as well as the location of all other wells screened in the Homewood Sandstone.

4.1.3 Upper Sharon

Monitoring wells BKGmw-006, BKGmw-008, BKGmw-015, and BKGmw-018 were selected to be in the monitoring well network to determine the background concentration for the Upper Sharon aquifer. All four of these wells were included in the original 1998 background study. Figure 4-3 shows the location of these background wells, as well as the location of all other wells screened in the Upper Sharon aquifer.

4.1.4 Basal Sharon Conglomerate

Monitoring wells SCFmw-006, BKGmw-024 (identified as FWBKG-SCON1 in the RI Work Plan), and BKGmw-025 (identified as FWBKG-SCON2 in the RI Work Plan) were selected to be in the monitoring well network to determine the background concentration for the Basal Sharon Conglomerate aquifer. Monitoring well SCFmw-006 existed prior to the approval of the RI Work Plan, installed in 2009. Monitoring wells BKGmw-024 and BKGw-025 were installed in 2016. Figure 4-4 shows the location of these background wells, as well as the location of all other wells screened in the Basal Sharon Conglomerate.

4.2 STATISTICAL EVALUATION OF DATA

This section presents the statistical methods to be used to calculate the background level of metals (and other inorganic/indicator parameters as needed) for all pertinent water-bearing units (aquifers) at CJAG.

Data preparation and statistical analyses were performed in accordance with applicable methods described in the following guidance:

- *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance* (USEPA 2009).
- Use of Background for Remedial Response Sites (Ohio EPA 2009).
- Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring (Ohio EPA 2018), Chapter 12 Groundwater Data Analysis.

The primary application for statistical evaluation was Statistical Analysis Software (SAS®) version 9.4. SAS programs were written in accordance with the statistical methodology provided in ProUCL Version 5.1.002 Technical Guide (USEPA 2015). Using SAS programs is much more efficient than the ProUCL software, because SAS® can process hundreds of chemicals simultaneously for many groups of data in much less time than ProUCL.

4.2.1 Establishing the Data Set

4.2.1.1 Data Collection and Preparation

Samples from the background wells used for this study were collected from November 2016 to December 2017. All 14 background wells had dedicated bladder pumps that were sampled using the well purging and sampling procedures outlined in RI Work Plan (TEC-Weston 2016). Table 4-1 presents the specific sample events in which each well within the monitoring network was sampled. The groundwater results for metals used in this background study are presented in Appendix B, Table B-1. Tables B-2 through B-4 present chemical data and field parameters associated with these samples, which were used to assess usability of data within the final background data set.

The raw background data were segregated by aquifer monitoring zone, monitoring well, date collected, and inorganic chemical. The concentration units used in this study were standardized to mg/L.

Table 4-1. Sampling Events Used in Background Calculations

Well	November 2016	April 2017	August 2017	December 2017	Total Samples Used in Study
Unconsolidated (8 total samples)					
BKGmw-005	X	X	--	X	3
BKGmw-016	X	X	--	X	3
BKGmw-017	X	##	--	##	1
BKGmw-021	--	X	--	##	1
Homewood Sandstone (11 total samples)					
BKGmw-022	X	X	X	X	4
BKGmw-023	X	X	X	X	4
FWGmw-005	X	X	--	X	3
Upper Sharon Sandstone (11 total samples)					
BKGmw-006	X	X	--	X	3
BKGmw-008	X	X	--	X	3
BKGmw-015	--	X	--	X	2
BKGmw-018	X	X	--	X	3
Basal Sharon Conglomerate (11 total samples)					
BKGmw-024	X	X	X	X	4
BKGmw-025	X	X	X	X	4
SCFmw-006	X	X	--	X	3

X = Well was sampled and the results were used in the calculation of groundwater background concentrations.
-- = Well was not sampled during the specified sampling event.
= Sample was collected, but results were not included in the calculation of groundwater background concentrations.

4.2.1.2 Duplicates

Duplicate samples were collected to evaluate the effects of sample collection, handling, and analysis on the parent sample. Duplicate samples were collected at six wells: one from the Unconsolidated and Basal Sharon Conglomerate aquifers and two from the Homewood Sandstone and Upper Sharon aquifers.

Consistent agreement was found between the measured concentrations in the duplicate samples (Tables B-1through B-3). For this study, results from duplicate samples were evaluated against the parent sample on a chemical-by-chemical basis and handled as follows:

- If both the parent and duplicate samples had a chemical that was detected, the lower concentration of the two was used in the background study data set.
- If one sample had a chemical that was detected and the other sample did not have a detected concentration, the detected concentration was used in the background study data set.
- If both samples had a chemical concentration that was not detected, the smaller reporting limit was used in the background study data set.

4.2.1.3 Anthropogenic Detections

Per the *Use of Background for Remedial Response Sites* (Ohio EPA 2009), background sampling should be conducted at locations that have not been affected by the site or site-related anthropogenic activities. Accordingly, anthropogenic chemical results were evaluated in the background data set.

Table 4-2 presents concentrations of anthropogenic chemicals detected within the samples included in the background concentration data set.

The wells that had these detected concentrations were BKGmw-022, BKGmw-023, BKGmw-024, BKGmw-025, and SCFmw-006. These results and wells were evaluated for use in this summary and are summarized below.

- The samples associated with BKGmw-022, BKGmw-023, and BKGmw-025 were retained in the background data set, since these wells are at the far western portion of CJAG and clearly hydraulically upgradient and not impacted by previous or current facility activities.
- The samples associated with BKGmw-024 were retained in the background data set, since this well is at the northern portion of CJAG and clearly hydraulically upgradient and not impacted by previous or current facility activities.
- The samples associated with SCFmw-006 were retained in the background data set, since this well is at the northern portion of CJAG, hydraulically upgradient and not impacted by previous or current facility activities, and the anthropogenic chemicals were only low-level polycyclic aromatic hydrocarbons.

The evaluation of anthropogenic chemicals in the background data set did not result in exclusion of samples or wells from the data set.

Table 4-2. Anthropogenic Chemicals Detected in Background Wells

Well	Sample Type	Date Collected	Analysis	Chemical	Concentration (mg/L)	Qualifier
Homewood Sandstone						
BKGmw-022	Field Duplicate	4/21/2017	VOCs	Toluene	0.00037	J
BKGmw-022	Grab	4/21/2017	VOCs	Toluene	0.00038	J
BKGmw-022	Grab	8/2/2017	VOCs	Acetone	0.0021	J
BKGmw-022	Grab	12/1/2017	SVOCs	Benz(a)anthracene	0.0000076	J
BKGmw-022	Grab	12/1/2017	SVOCs	Benzo(b)fluoranthene	0.0000041	J
BKGmw-022	Grab	12/1/2017	SVOCs	Naphthalene	0.0000086	J
BKGmw-022	Grab	12/1/2017	SVOCs	Phenanthrene	0.000011	J
BKGmw-023	Grab	11/15/2016	SVOCs	Benz(a)anthracene	0.000019	J
BKGmw-023	Grab	11/15/2016	SVOCs	Benzo(b)fluoranthene	0.000023	J
BKGmw-023	Grab	11/15/2016	SVOCs	Benzo(ghi)perylene	0.000024	J
BKGmw-023	Grab	11/15/2016	SVOCs	Benzo(k)fluoranthene	0.000021	J
BKGmw-023	Grab	11/15/2016	SVOCs	Chrysene	0.000026	J
BKGmw-023	Grab	11/15/2016	SVOCs	Dibenz(a,h)anthracene	0.000025	J
BKGmw-023	Grab	11/15/2016	SVOCs	Indeno(1,2,3-cd)pyrene	0.000019	J
BKGmw-023	Grab	11/15/2016	VOCs	Chloroform	0.00033	J
BKGmw-023	Grab	4/20/2017	Perchlorate	Perchlorate	0.000026	J
BKGmw-023	Grab	8/2/2017	VOCs	Acetone	0.0021	J
BKGmw-023	Grab	8/2/2017	VOCs	Chloroform	0.00013	J
BKGmw-023	Field Duplicate	12/1/2017	Perchlorate	Perchlorate	0.000038	J
BKGmw-023	Grab	12/1/2017	Perchlorate	Perchlorate	0.000031	J
BKGmw-023	Field Duplicate	12/1/2017	PCBs	PCB-1254	0.000097	J
BKGmw-023	Grab	12/1/2017	SVOCs	Benz(a)anthracene	0.000007	J
BKGmw-023	Field Duplicate	12/1/2017	SVOCs	Naphthalene	0.000012	J
Basal Sharon Conglomerate						
BKGmw-024	Grab	8/7/2017	VOCs	Acetone	0.0021	J
BKGmw-024	Grab	12/5/2017	SVOCs	Benzo(b)fluoranthene	0.0000038	J
BKGmw-024	Grab	12/5/2017	SVOCs	Naphthalene	0.000015	J
BKGmw-025	Grab	11/15/2016	VOCs	Chloroform	0.0013	
BKGmw-025	Grab	11/15/2016	VOCs	Ethylbenzene	0.0016	
BKGmw-025	Grab	11/15/2016	VOCs	Xylenes, total	0.0064	

Table 4-2. Anthropogenic Chemicals Detected in Background Wells (continued)

Well	Sample Type	Date Collected	Analysis	Chemical	Concentration (mg/L)	Qualifier
BKGmw-025	Grab	4/26/2017	SVOCs	Naphthalene	0.000046	J
BKGmw-025	Grab	8/2/2017	VOCs	2-Hexanone	0.00029	J
BKGmw-025	Grab	8/2/2017	VOCs	Acetone	0.003	J
BKGmw-025	Grab	8/2/2017	VOCs	Chloroform	0.0002	J
BKGmw-025	Grab	8/2/2017	VOCs	Ethylbenzene	0.00029	J
BKGmw-025	Grab	8/2/2017	VOCs	Xylenes, total	0.0009	J
BKGmw-025	Grab	12/1/2017	Perchlorate	Perchlorate	0.000027	J
BKGmw-025	Field Duplicate	12/1/2017	PCBs	PCB-1254	0.00013	J
BKGmw-025	Grab	12/1/2017	PCBs	PCB-1254	0.00008	J
BKGmw-025	Field Duplicate	12/1/2017	SVOCs	Benz(a)anthracene	0.000006	J
BKGmw-025	Grab	12/1/2017	SVOCs	Benz(a)anthracene	0.0000066	J
BKGmw-025	Field Duplicate	12/1/2017	SVOCs	Fluoranthene	0.0000049	J
BKGmw-025	Field Duplicate	12/1/2017	SVOCs	Naphthalene	0.000051	J
BKGmw-025	Grab	12/1/2017	SVOCs	Naphthalene	0.000056	J
BKGmw-025	Field Duplicate	12/1/2017	SVOCs	Phenanthrene	0.00001	J
SCFmw-006	Grab	11/15/2016	SVOCs	Benz(a)anthracene	0.000093	J
SCFmw-006	Grab	11/15/2016	SVOCs	Benzo(a)pyrene	0.000075	J
SCFmw-006	Grab	11/15/2016	SVOCs	Benzo(b)fluoranthene	0.00013	
SCFmw-006	Grab	11/15/2016	SVOCs	Benzo(ghi)perylene	0.00012	
SCFmw-006	Grab	11/15/2016	SVOCs	Benzo(k)fluoranthene	0.000086	J
SCFmw-006	Grab	11/15/2016	SVOCs	Chrysene	0.00009	J
SCFmw-006	Grab	11/15/2016	SVOCs	Dibenz(a,h)anthracene	0.000066	J
SCFmw-006	Grab	11/15/2016	SVOCs	Fluoranthene	0.00012	
SCFmw-006	Grab	11/15/2016	SVOCs	Fluorene	0.000029	J
SCFmw-006	Grab	11/15/2016	SVOCs	Indeno(1,2,3-cd)pyrene	0.00014	
SCFmw-006	Grab	11/15/2016	SVOCs	Phenanthrene	0.000076	J
SCFmw-006	Grab	11/15/2016	SVOCs	Pyrene	0.0001	

mg/L = Milligrams per liter.
PCB = Polychlorinated biphenyl.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

4.2.1.4 Turbidity Assessment

Historical samples collected at the facility have had elevated turbidity (>10 nephelometric turbidity units [NTUs]). The turbidity of the samples within the data set was assessed. Of the data set, only the samples shown in Table 4-3 had turbidity greater than 10 NTU. As a result of this assessment, it was determined to exclude the April and December 2017 samples from BKGmw-017 from the background study data set.

Table 4-3. Sample Events with Turbidity Greater than 10 NTU

Well	Sample Event	Sample Date	Turbidity (NTU)
Unconsolidated			
BKGmw-017	April 2017	4/20/17	158
BKGmw-017	December 2017	12/4/17	57.4
Homewood Sandstone			
FWGmw-005	November 2016	11/9/16	11
Upper Sharon			
None			
Basal Sharon Conglomerate			
SCFmw-006	November 2016	11/15/16	10.4

NTU = Nephelometric turbidity unit.

4.2.1.5 Outliers

The background data sets were screened for outliers by use of probability and box plots, which are presented in Appendix C.1. The distributions were determined using all samples within each aquifer for the metals. The probability and box plots indicated that sample BKGmw-021 from December 2017 was an outlier for lead (Figure C.1-12), so the sample was deleted from the data set.

The probability and box plots were regenerated with the results for the outlier sample removed (Appendix C.2). The probability and box plots indicated formal statistical outlier testing was not necessary.

4.2.1.6 Piper Diagram Evaluation

The concentrations of major cations and anions for each background well sample were plotted on Piper diagrams (also called trilinear plots) to visualize the dominant chemistry of each sample. The plots show the percentage of milliequivalents of each cation or anion relative to the total for cations or anions. Wells with similar chemistry will plot close to each other on the Piper diagram.

Table 4-4 lists the concentrations in milliequivalents per liter for each background groundwater sample that had been analyzed for major cations and anions. The table also lists the percent charge balance difference for each sample. The charge balance difference should be 0% if all ions have been accounted for. A positive charge balance difference indicates that more cations than anions were measured. A negative charge balance difference indicates more anions. For the 32 samples measured from 14 background wells, the charge balance difference ranged from -7.42% to 6.19% with an average of -0.43%. This indicates that the major ions have been accounted for.

Piper diagrams for the background well samples are presented in Appendix D. Most of the samples from the Unconsolidated aquifer are plotted in the left point of the diamond (Figure D-1), which indicates samples dominated by calcium carbonate. One sample from well BKGmw-016 collected in April 2017 plotted more toward the top point of the diamond. That sample had lower concentrations of ions and a higher proportion of sulfate than other samples from that well. This indicates that the sample was influenced by recent runoff rather than by equilibrium with soil contact. Generally, the wells selected to represent the Unconsolidated aquifer background have similar chemistry.

The samples from the Homewood Sandstone aquifer also plotted in the left corner of the diamond (Figure D-2). These samples are dominated by calcium carbonate. The closeness of the points plotted on the Piper diagram indicates that the wells selected to represent the Homewood Sandstone aquifer background have similar chemistry.

The samples from the Upper Sharon aquifer showed much more scatter on the Piper diagram than the other aquifers (Figure D-3). Well BKGmw-006 had a higher proportion of chloride than the other wells in the aquifer, while well BKGmw-015 had lower chloride and sulfate than the other wells. The scatter of the points plotted on the Piper diagram indicates that the Upper Sharon aquifer may be more heterogeneous than the other aquifers.

In contrast, the samples from the three wells from the Basal Sharon Conglomerate aquifer plotted very close to each other on the Piper diagram (Figure D-4). These samples are dominated by calcium carbonate. The closeness of the points plotted on the Piper diagram indicates that the wells selected to represent the Basal Sharon Conglomerate aquifer background have similar chemistry.

Plotting all of the background well samples on the same Piper diagram shows that the water chemistry is similar for all of the aquifers and is dominated by calcium, magnesium, and carbonate (Figure D-5). The chemistry was very consistent for the Homewood Sandstone and Basal Sharon Conglomerate aquifers and showed more variability in the Unconsolidated and Upper Sharon aquifers.

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Table 4-4. Concentrations (meq/L) of Major Cations and Anions in Background Wells

Aquifer	Well	Date Collected	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	CO3/HCO3	Sulfate (SO4)	Chloride (Cl)	pH	Charge Balance %	Sum of Cations (meq/L)	Sum of Anions (meq/L)
Unconsolidated	BKGmw-005	11/9/2016	3.74	1.48	0.391	0.0639	4	1.08	0.0705	6.75	4.89	5.68	5.15
Unconsolidated	BKGmw-005	4/19/2017	3.84	1.4	0.1	0	4.6	0.77	0.0166	6.56	-0.39	5.34	5.38
Unconsolidated	BKGmw-005	12/1/2017	3.09	1.32	0.335	0.0435	4	1.04	0.0649	6.81	-3.17	4.79	5.10
Unconsolidated	BKGmw-016	11/9/2016	3.24	1.56	0.313	0.0409	4.2	0.916	0.175	7.26	-1.21	5.16	5.29
Unconsolidated	BKGmw-016	4/19/2017	0.599	0.428	0.157	0	0.34	0.75	0.0451	4.93	2.11	1.18	1.13
Unconsolidated	BKGmw-016	12/4/2017	3.44	1.81	0.339	0	4.2	0.812	0.141	7.22	4.13	5.59	5.15
Unconsolidated	BKGmw-017	11/9/2016	5.99	4.03	1.17	0.0691	6.99	3.12	0.0536	7.16	5.10	11.26	10.17
Unconsolidated	BKGmw-021	4/21/2017	4.24	3.46	0.522	0	6.99	1.04	0.102	6.76	0.51	8.22	8.14
Homewood Sandstone	BKGmw-022	4/21/2017	1.1	0.518	0.144	0.00639	1.26	0.52	0	6.73	-0.37	1.77	1.78
Homewood Sandstone	BKGmw-022	12/1/2017	1.05	0.551	0.117	0.0169	1.38	0.562	0.0705	6.9	-7.42	1.73	2.01
Homewood Sandstone	BKGmw-023	4/20/2017	3.54	1.48	0.435	0.011	4.2	1.31	0.31	---	-3.08	5.47	5.82
Homewood Sandstone	BKGmw-023	12/1/2017	3.19	1.56	0.396	0.0187	3.8	1.25	0.338	6.99	-2.02	5.17	5.38
Homewood Sandstone	FWGmw-005	11/9/2016	2.4	1.32	0.287	0.0435	2.4	1.08	0.0903	6.22	6.19	4.04	3.57
Homewood Sandstone	FWGmw-005	4/19/2017	2.35	1.23	0.309	0.0222	2.8	1.02	0.0903	6.28	0.03	3.91	3.91
Homewood Sandstone	FWGmw-005	12/1/2017	2	1.15	0.265	0.0307	2.6	1.08	0.0846	6.74	-4.45	3.44	3.76
Upper Sharon Sandstone	BKGmw-006	11/8/2016	3.74	1.89	2.48	0.0435	3.8	1.15	3.1	6.36	0.70	8.16	8.04
Upper Sharon Sandstone	BKGmw-006	4/24/2017	3.39	1.65	2.48	0.0358	3.8	1.15	3.1	6.32	-3.14	7.55	8.04
Upper Sharon Sandstone	BKGmw-006	12/5/2017	3.04	1.65	2.35	0.0358	3.8	1.1	2.65	6.66	-3.26	7.07	7.55
Upper Sharon Sandstone	BKGmw-008	11/8/2016	1.05	0.683	0.27	0.013	1.36	0.583	0.0762	6.07	-0.11	2.01	2.02
Upper Sharon Sandstone	BKGmw-008	4/18/2017	1.2	0.757	0.309	0	1.56	0.666	0.107	6.34	-1.49	2.26	2.33
Upper Sharon Sandstone	BKGmw-008	12/6/2017	0.948	0.609	0.27	0.0148	1.24	0.583	0.0903	6.41	-1.88	1.84	1.91
Upper Sharon Sandstone	BKGmw-015	4/19/2017	1.6	1.07	0.565	0.12	2.8	0.144	0.0223	6.75	6.16	3.35	2.96
Upper Sharon Sandstone	BKGmw-015	12/5/2017	1.4	0.987	0.565	0.128	3	0.0916	0.0259	6.56	-0.60	3.08	3.11
Upper Sharon Sandstone	BKGmw-018	11/8/2016	2.45	0.543	0	0.0251	2.2	0.77	0.0931	6.11	-0.79	3.01	3.06
Upper Sharon Sandstone	BKGmw-018	4/20/2017	1.15	0.23	0.139	0	1.14	0.291	0.0931	6.22	-0.20	1.52	1.52
Upper Sharon Sandstone	BKGmw-018	12/5/2017	2.74	0.716	0.178	0.0281	3.2	0.666	0.133	6.53	-4.29	3.67	4.00
Basal Sharon Conglomerate	BKGmw-024	4/20/2017	3.74	1.73	0.478	0.0358	5.19	0.708	0.192	6.99	-0.91	5.98	6.09
Basal Sharon Conglomerate	BKGmw-024	12/5/2017	3.44	1.73	0.522	0.0486	5.39	0.666	0.175	7.24	-4.13	5.74	6.24
Basal Sharon Conglomerate	BKGmw-025	4/26/2017	3.74	1.48	0.426	0	4.8	0.479	0.0846	7.35	2.64	5.65	5.36
Basal Sharon Conglomerate	BKGmw-025	12/1/2017	3.19	1.4	0.383	0.0235	4.6	0.458	0.0931	7.37	-1.46	5.00	5.15
Basal Sharon Conglomerate	SCFmw-006	4/18/2017	3.14	1.23	0.435	0.0511	4.2	0.583	0.11	7.46	-0.26	4.86	4.89
Basal Sharon Conglomerate	SCFmw-006	12/5/2017	2.84	1.23	0.435	0.0435	4.2	0.437	0.0762	7.53	-1.65	4.56	4.71

--- = Not Analyzed.
CO3/HCO3 = Carbonate/bicarbonate.
Concentrations in milliequivalents per liter (meq/L).

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4.2.1.7 Final Sample Size

The RI Work Plan indicated that less than eight samples per aquifer will not be used to calculate the background concentrations. This is consistent with the guidance specified in the *Use of Background for Remedial Response Sites* (Ohio EPA 2009).

The assessment in this section evaluated if samples were potentially impacted by facility-related contamination, had questionable water quality, or if they were a potential outlier. Eleven samples were determined to be adequate for use in the background concentration calculation for each of the Homewood Sandstone, Upper Sharon, and Basal Sharon Conglomerate aquifers. Eight samples were determined to be adequate for use in the background concentration calculation for the Unconsolidated aquifer. This number of samples is minimally adequate, as recommended by ProUCL (USEPA 2015).

4.2.2 Calculation of Background Values

The determination of background levels followed the *Use of Background for Remedial Response Sites* (Ohio EPA 2009) recommendation for employing a method commonly associated with a graphical technique for detecting outliers from a population (i.e., box plot and lognormal probability plot). These methods were used to select a reasonably-protective estimation of an upper-bound value of the data set for each aquifer. Background concentration levels were calculated using the following equation:

$$U = Q_3 + 1.5\ (Q_3 - Q_1)$$

Where Q_1 is the lower quartile, Q_3 is the upper quartile, and $(Q_3 - Q_1)$ is the interquartile range. The multiplicative factor of 1.5 was used as recommended (Ohio EPA 2009). The upper cutoff value U was used as the background concentration level and will be compared to samples taken on site on a point-by-point basis.

4.2.3 Data Distribution

The distribution of each data set was made by examining probability (Q-Q) plots and the use of distribution goodness-of-fit tests. The Shapiro-Wilk (S-W) test was used to determine whether data follow a normal distribution (using raw values) or lognormal distribution (using log-transformed values). An alpha level of 0.05 was used for distribution goodness-of-fit testing. For data sets with non-detects (NDs), Robust Regression on Order Statistics (ROS) techniques were used to estimate ND values in goodness-of-fit testing. If the distribution goodness-of-fit testing indicated that the data do not fit normal or lognormal distributions, the data were assumed to have come from a population having an unknown distribution (nonparametric).

4.2.4 Censored Data

For concentrations flagged below the reporting limit, an imputed ND data value was used in the statistical analysis. If the ND percentage was no more than 15%, each ND observation was replaced

with one half the reporting limit in the statistical evaluation, since project quantitation levels were not reported. For higher ND percentages up to 50%, the Kaplan-Meier (KM) technique was used to estimate Q_3, Q_1, and U. If the ND percentage exceeded 50% but was less than 100%, the maximum detected concentration was selected for U. If all results were NDs, then U was assigned the value of 0.

4.3 RESULTS

Table 4-5 shows the calculated background levels for each of the four aquifers for total metals. The summary statistics, including sample size, percentage of NDs, mean, standard deviation, skewness, median, minimum concentrations, maximum concentrations, and the proposed background level, were tabulated for each aquifer and are shown in Appendix E, Tables E-1 through E-4.

Table 4-5. Groundwater Background Concentrations for Metals

Chemical	Background (mg/L)			
	Unconsolidated	Homewood Sandstone	Upper Sharon	Basal Sharon Conglomerate
Metals				
Aluminum	0.386	0.43	0.038	0.049
Antimony	0	0	0	6.0E-04
Arsenic	0.003	0.008	0.003	0.048
Barium	0.034	0.177	0.035	0.145
Beryllium	0	0	0	2.3E-04
Cadmium	0	0	0	0
Calcium	107	143	118	93
Chromium	0.002	0.007	0	7.4E-04
Chromium, hexavalent	0	0	0	0
Cobalt	8.3E-04	0.003	0.001	0.005
Copper	0.005	0.002	0.001	6.9E-04
Iron	1.91	22.3	2.08	2.56
Lead	9.9E-04	3.2E-04	0.002	2.2E-04
Magnesium	55.3	37.5	38.9	30
Manganese	0.075	0.56	0.198	1.03
Mercury	0	0	0	0
Nickel	0.002	0.005	0.002	0.014
Potassium	4.84	2.01	3.38	2.9
Selenium	9.9E-04	0	0.001	0
Silver	0	0	0	0
Sodium	18.2	21.0	129	15.3
Thallium	0	0	0	9.7E-05
Vanadium	5.0E-04	7.0E-04	8.5E-04	0
Zinc	0.005	0.011	0.009	0.003

Background = Q3 + 1.5(Q3 - Q1), as described in the RVAAP Final Remedial Investigation Work Plan, p. 1-26.
mg/L = Milligrams per liter.

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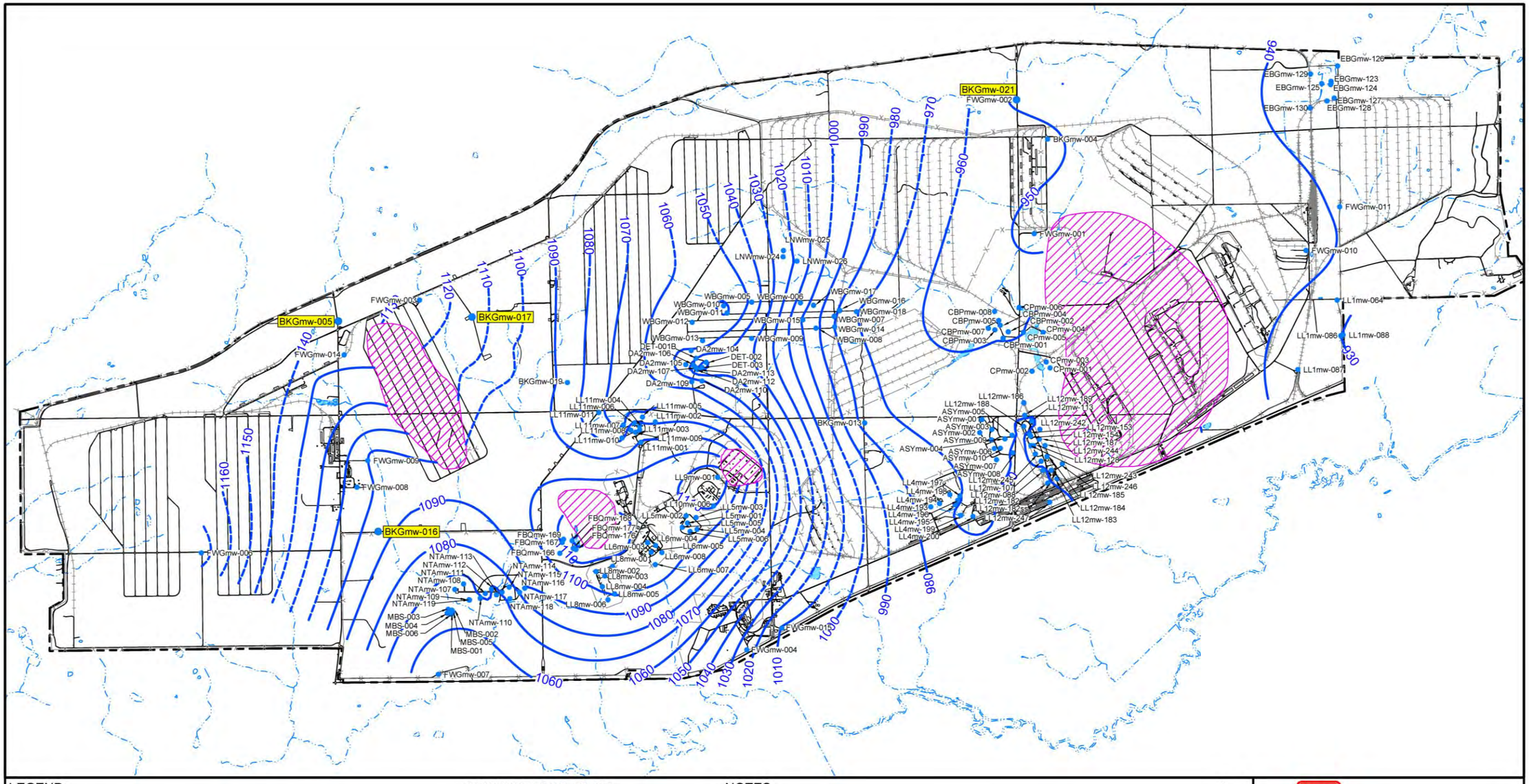


Figure 4-1. Monitoring Wells Used in Current Background Study – Unconsolidated Aquifer

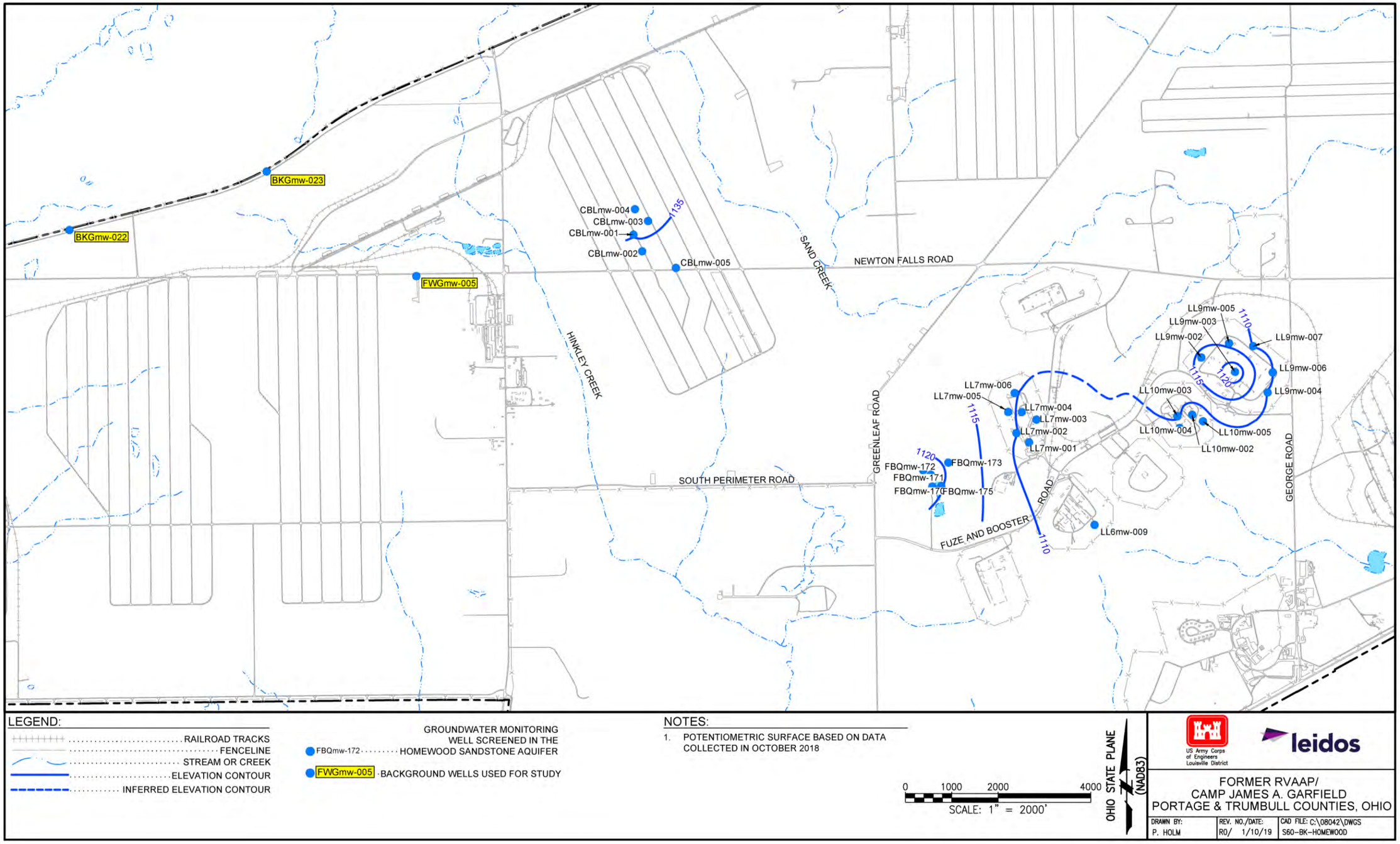
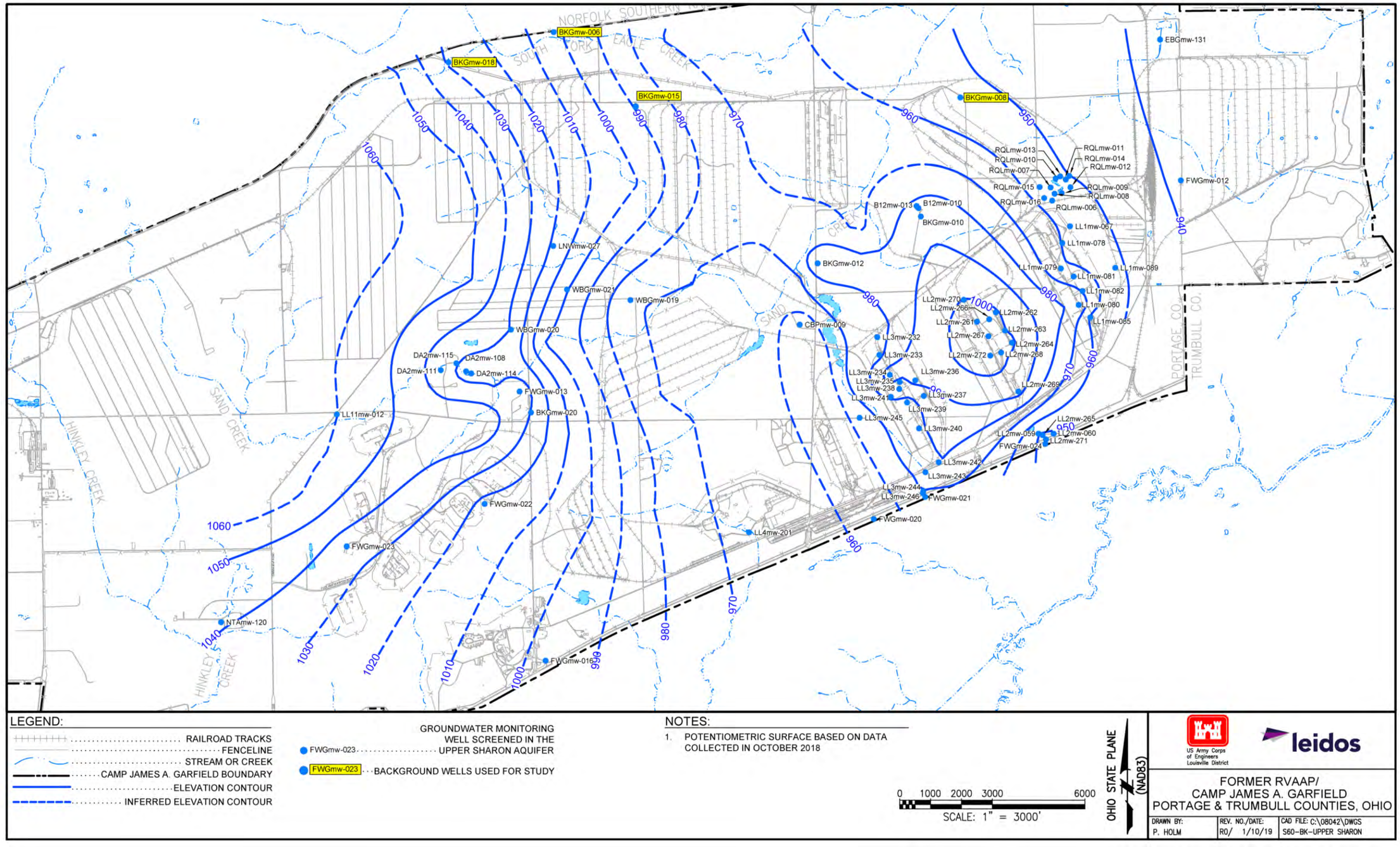


Figure 4-2. Monitoring Wells Used in Current Background Study – Homewood Sandstone Aquifer



LEGEND:

- RAILROAD TRACKS
- FENCELINE
- STREAM OR CREEK
- CAMP JAMES A. GARFIELD BOUNDARY
- ELEVATION CONTOUR
- INFERRED ELEVATION CONTOUR

GROUNDWATER MONITORING WELL SCREENED IN THE UPPER SHARON AQUIFER

- FWGmw-023 — UPPER SHARON AQUIFER
- FWGmw-023 — BACKGROUND WELLS USED FOR STUDY

NOTES:

1. POTENTIOMETRIC SURFACE BASED ON DATA COLLECTED IN OCTOBER 2018

0 1000 2000 3000 6000

SCALE: 1" = 3000'

OHIO STATE PLANE (NAD83)

US Army Corps of Engineers Louisville District

leidos

FORMER RVAAP/
CAMP JAMES A. GARFIELD
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\08042\DWGS
P. HOLM	R0/ 1/10/19	S60-BK-UPPER SHARON

Figure 4-3. Monitoring Wells Used in Current Background Study – Upper Sharon Aquifer

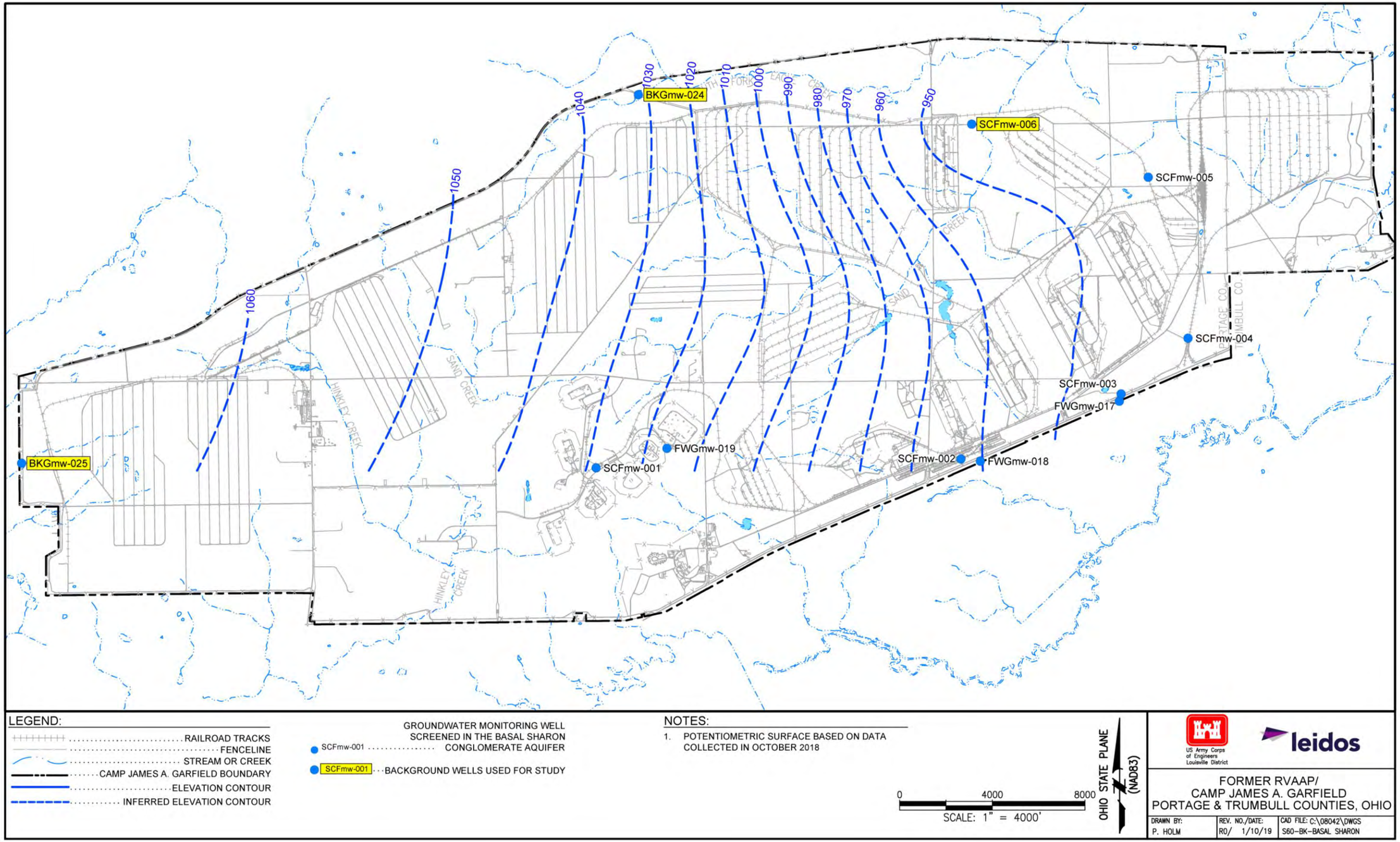


Figure 4-4. Monitoring Wells Used in Current Background Study – Basal Sharon Conglomerate Aquifer

5.0 CONCLUSIONS AND RECOMMENDATIONS

Background sampling is often conducted to help distinguish site-related contamination from naturally occurring or other non-site-related chemicals. The purpose of this study is to calculate background concentrations for metals within the various groundwater aquifers within CJAG to assist in decision making regarding the Facility-wide Groundwater AOC. Background groundwater concentrations presented in Table 4-5 have been established for the four different geologic aquifers at CJAG (Unconsolidated, Homewood, Upper Sharon, and Basal Sharon Conglomerate).

Site-specific background concentrations of these naturally occurring metals may be used in the risk assessment and risk management processes for the RI of the Facility-wide Groundwater AOC. Its application will allow for reducing the number of chemicals carried through the quantitative risk assessment process in an effort to simplify and focus the evaluation on site-related risk drivers, and will allow for the use of background in risk management as part of remedy selection for the AOC.

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6.0 REFERENCES

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APPENDIX A

Background Well Network – Boring Logs

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APPENDIX A.1

Unconsolidated Wells – Boring Logs

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HTRW DRILLING LOG

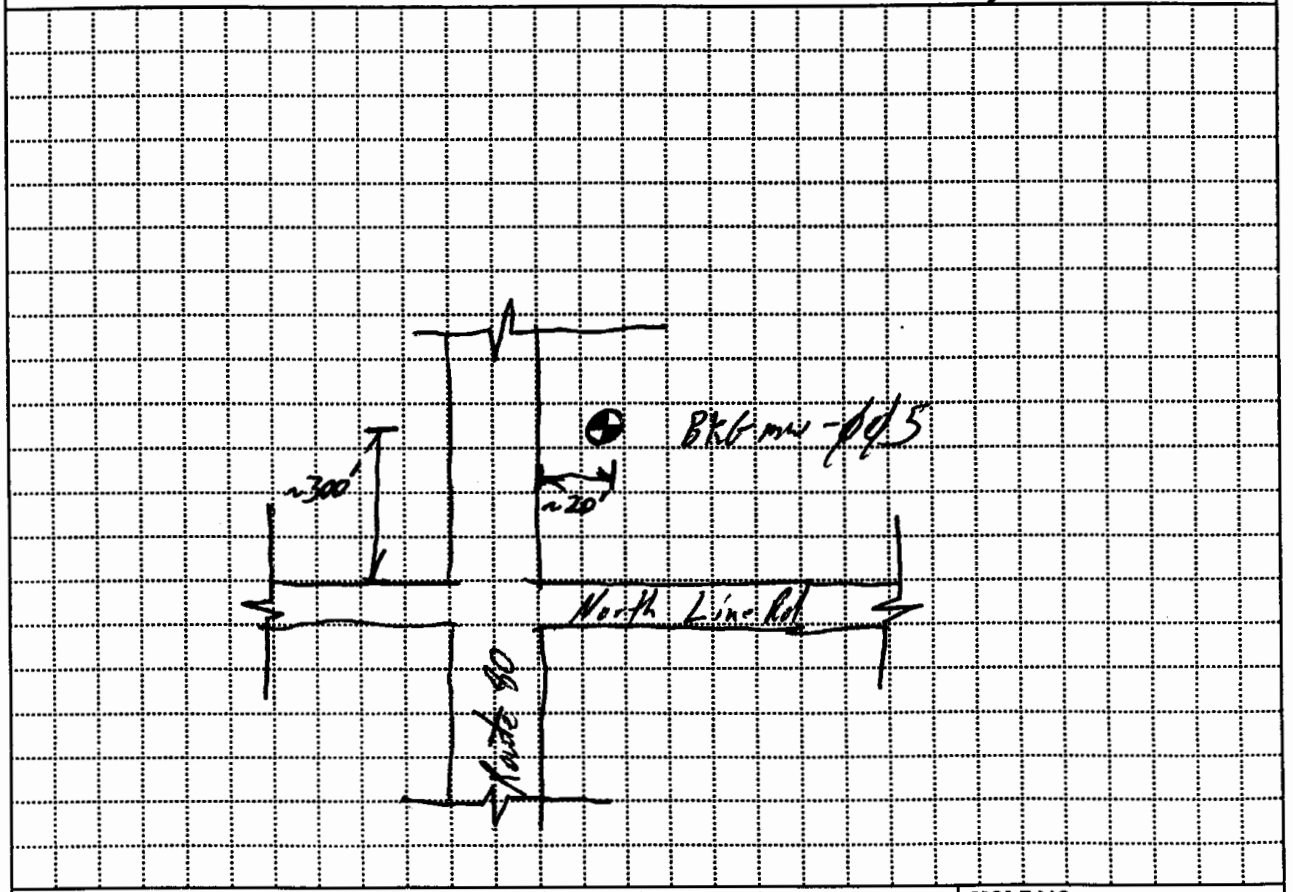
DISTRICT Louisville Corps		HOLE NUMBER BKGmw-005
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR Bowser Morner	SHEET 1 OF 2
3. PROJECT Phase II RI at WinklepeckBurning Ground and Background Investigation	4. LOCATION RVAAP	DCS 9-29-98
5. NAME OF DRILLER Maynard Lahti	6. MANUFACTURERS DESIGNATION OF DRILL Failing F-7	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 9¼" ID HSA 2" Ø 2 ft length split spoon 4" Ø Continuous split spoon, 5 ft length 3" Ø 2½ ft length shelby tube	8. HOLE LOCATION NE of intersection of 2+80 N Line 2d. 2-25 9. SURFACE ELEVATION 1049.69 DCS 9-29-98	
	10. DATE STARTED 4 May 98	11. DATE COMPLETED 5 May 98
12. OVERBURDEN THICKNESS NA	15. DEPTH GROUNDWATER ENCOUNTERED 10.0 ft	
13. DEPTH DRILLED INTO ROCK NA	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE 19.0 ft	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY) Prior to well installation 7.30 ft	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	✓	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY	OTHER (SPECIFY	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
0-1', 1-3', 3-12'	NA	/	Explosives	Semi VOA's		

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
		✓		

LOCATION SKETCH/COMMENTS SCALE: NA



PROJECT Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP

HOLE NO. BKGmw-005

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

HOLE NUMBER BKG mw-005

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR Brad Bell | SHEET 2 of 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	1 2	SILTY SAND; sand ~ 50%, silt ~ 40%, gravel ~ 10%; Mod Yellowish Brown; subrounded, poorly sorted; low plasticity; moist dense (SM)	PID - 0ppm LEL - 0% O_2 - 20.8%	NA	BKG 814	(1430hr) - 1-3 ft Bkgrnd 8-9-9-14 Sample collected w/ 2" ϕ 2ft length Split Spoon 75% recovery
	3 4 5 6	SAME AS ABOVE Note: 7-8 ft (1535 hr.) proceeded additional sample	PID - 0ppm LEL - 0% O_2 - 20.8%	NA	BK 815 (7/8 ft)	- 3-4 ft collected w/ 2" ϕ split spoon 6 blows: 13-16 - Converted to 4" ϕ continuous Spl. if barrel 5 ft length (8-9 ft - 80% recovery) - Wet cutting present @ 10 ft bgs
	7				NA	- Saturated cuttings present @ 11 ft bgs.
	8 9 10 11 12	SAND; sand ~ 75%, silt ~ 15%, gravel ~ 10%; Mod Yellowish Brown; mod sorted; subrounded; soft, wet; non plastic; (SP) Interbedded Sandy silt 9-11 ft	PID - 0ppm LEL - 0% O_2 - 20.8%	NA	BK 815 (7-8 ft)	- Trigged H_2O @ 8.8 ft bgs (1514 hrs) - 3" ϕ Shelby Tube (25% recovery) collected 12-14 ft bgs - H_2O trigged @ 7.6 ft bgs (1546 hrs)
	13 14	Note: 25% recovery Shelby Tube 12-14 ft bgs	PID - 0ppm LEL - 0% O_2 - 20.8%	✓	NA	(9-12 ft run, 100% recovery)
	15 16 17 18 19	SAND; sand: med ~ 70%, silt ~ 15%, gravel 15%; Mod Yellowish Brown; med sorted; subrounded; soft; wet; non plastic (SP)	PID - 0ppm LEL - 0% O_2 - 20.8%	NA	NA	- @ 1515hr H_2O @ 7.30 ft bgs - 14-19 ft run 25% recovery
		TD = 19.0 ft bgs				

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PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation | N562288.445 | E2340835.864 | ELEV. 1149.443 | HOLE NO. BKG mw-005

MONITORING WELL INSTALLATION LOG HOLE NUMBER: BKGrnw-005

PROJECT: Phase II RI @ WBG and Background Investigation INSPECTOR: Burt Baker

SHEET 1 OF 1

MONITORING WELL ID: BKGrnw-005

INSTALLATION START: DATE: 4 May 94 TIME: 1625

INSTALLATION FINISH: DATE: 5 May 94 TIME: 1000

ANNULAR SPACE MATERIALS INVENTORY:

GRANULAR FILTER PACK: TYPE: Global #7 Silica Sand QUANTITY: 5 / 50-lb bags

BENTONITE SEAL: TYPE: 3/8" Baroid 30 Bentonite Pellets QUANTITY: 2 buckets

GROUT: TYPE: Bill Hunt Type I, Portland QUANTITY: 2 / 94-lb bags

DESCRIPTION OF WELL SCREEN:

SLOT SIZE (inches): .010 SLOT CONFIGURATION: Horizontal

TOTAL OPEN AREA PER FOOT OF SCREEN: —

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Johnson

TYPE OF MATERIAL BETWEEN BOTTOM OF BORING AND SCREEN: Global #7 Silica Sand

DESCRIPTION OF WELL CASING:

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Johnson

JOINT DESIGN AND COMPOSITION: Manufactured Flush Threaded

CENTRALIZERS DESIGN AND COMPOSITION: NA

DESCRIPTION OF PROTECTIVE CASING:

NOMINAL INSIDE DIAMETER: 4"x4" Box COMPOSITION: Steel

SPECIAL PROBLEMS ENCOUNTERED DURING WELL CONSTRUCTION AND THEIR RESOLUTION:

NA

Was all well screen and casing material used for construction free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.)? YES [✓] NO [ ]

Was all well screen and casing material used for construction free of unsecured couplings, ruptures, and other physical breakage and/or defects? YES [✓] NO [ ]

Is deformation or bending of the installed well screen and casing minimized to the point of allowing the insertion and retrieval of a 1.0-inch bailer throughout the entire length of the completed well? YES [✓] NO [ ]

QUANTITY OF APPROVED WATER USED FOR FILTER PACK ENPLACEMENT: 0 gal.

RECORDED BY: [signature] 5 May 94
(Signature & Date)

QA CHECK BY: [signature] 6-2-98
(Signature & Date)

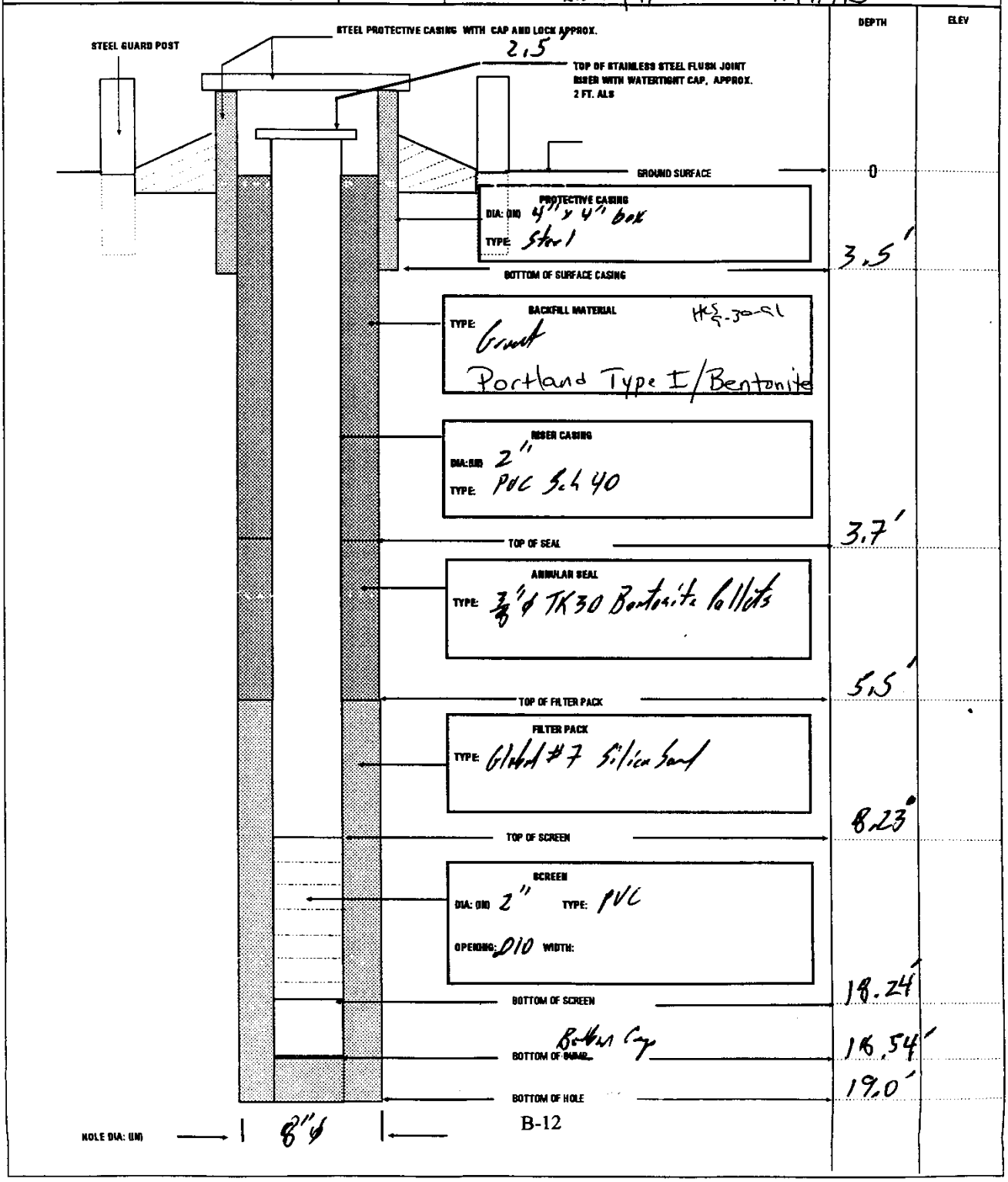
B-11

MONITORING WELL

PROJECT NAME: Phase II RI @ WBG and Background Investigation **DELIVERY ORDER NO:** 0060

WELL NUMBER: BKGmw-005 **BEGIN:** 4 May 96 **END:** 5 May 96

COORDINATES: N: 562288.445 E: 2340835.864 **REFERENCE POINT:** Top of Riser Pipe **ELEVATION:** MSL 1149.443



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HTRW DRILLING LOG

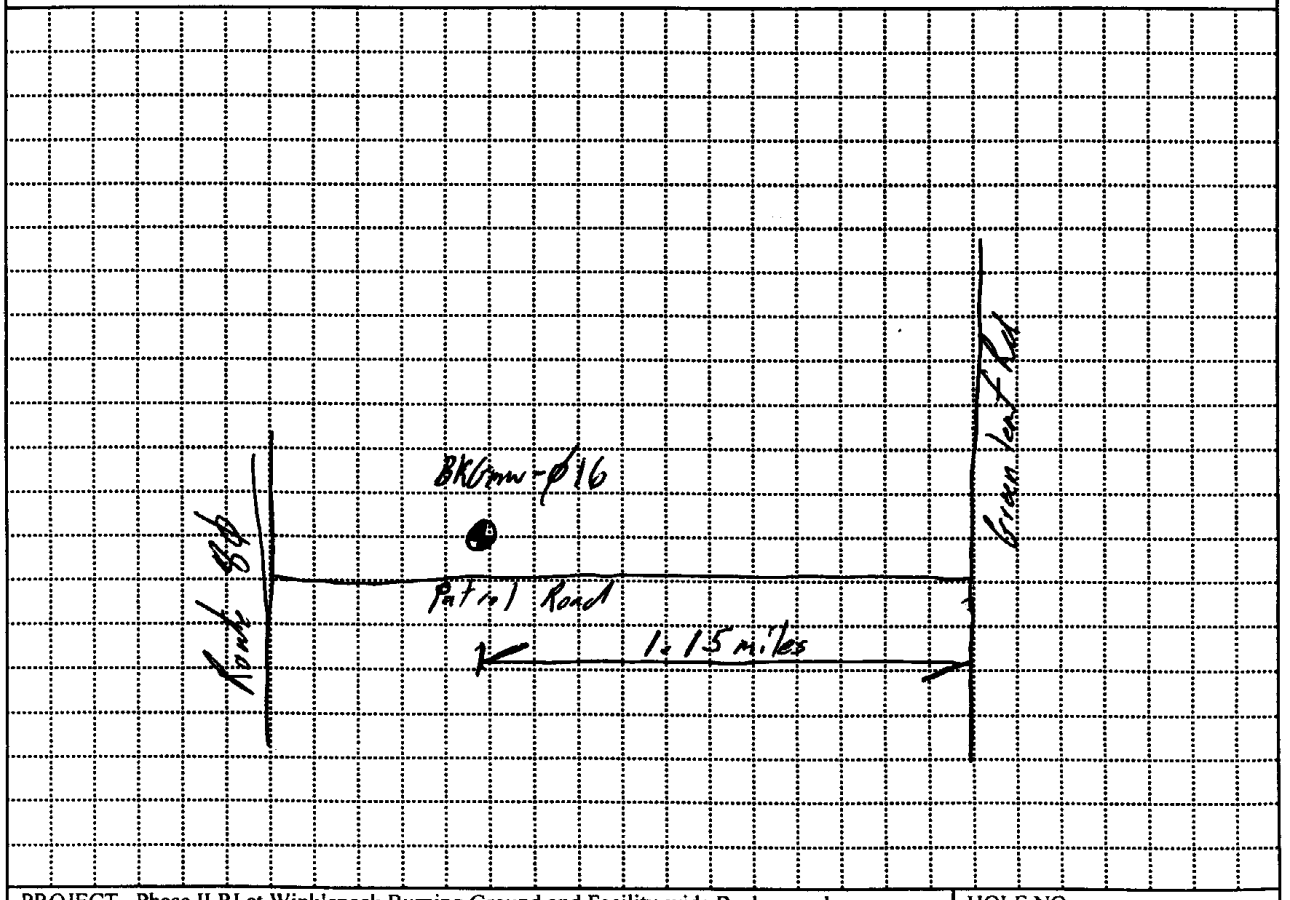
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR Bowser Morner	HOLE NUMBER BKGmw-016
3. PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation	4. LOCATION RVAAP	SHEET 1 SHEETS OF 2
5. NAME OF DRILLER Maynor / Lohr	6. MANUFACTURERS DESIGNATION OF DRILL Failing F-7	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 4¼" ID HSA's 2"ø / 2 Ft length Split Spoon 4"ø / 5 Ft length continuous split barrel 3"ø / 2.5 Ft length Shelby Tube	8. HOLE LOCATION on Patrol Rd	
	9. SURFACE ELEVATION 1096.10	
	10. DATE STARTED 5 May 98	11. DATE COMPLETED 5 May 98
12. OVERBURDEN THICKNESS NA	15. DEPTH GROUNDWATER ENCOUNTERED 10.0 Ft b/s	
13. DEPTH DRILLED INTO ROCK NA	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE 19.0 Ft	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY) Drilled Wtr @ 16 Ft / 16.45 min Stat. H_2O @ 2.90 Ft b/s	

18. GEOTECHNICAL SAMPLES	DISTURBED NA	UNDISTURBED ✓	19. TOTAL NUMBER OF CORE BOXES NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY	OTHER (SPECIFY	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
0-1', 1-3', 3-12'	NA	✓	Semi VOA	Explosives		

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
		✓		

LOCATION SKETCH/COMMENTS SCALE: NS



PROJECT Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP

HOLE NO. BKGmw-016

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR Brad Baker | HOLE NUMBER BKGmw-016 | SHEET 2 of 2

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	1	Clayey SILT; clay ~30%, silt ~60%, sand v. fine ~10%; Lt Yellowish Brown w/ variegated gray clay; poorly sorted; subrounded; med plasticity; firm; moist (ML)	PID-0ppm LEL-0% O_2-20.8%	NA	BKØ8MB 1109 hrs	1-3 Ft bls Blows 6-7-9-12 Sample collected w/ 2" Ø 2 Ft length Split Spoon 80% recovery
	3	SAME AS ABOVE	PID-0ppm LEL-0% O_2-20.8%	NA	NA	3-4 Ft collected w/ 2" Ø 2 Ft length split spoon; blows 15-15 - Converted to 4" Ø 5 Ft length continuous split barrel - 4-9 Ft run 95% recovery - Wet cuttings @ 7 Ft bls - Saturated cuttings present @ 10 Ft bls - 9-12 Ft run 100% recovery
	8.5	SAND; sand: coarse ~80%, granular ~10%, silt ~10%; Med Brown, subrounded; mod sorted; non plasticity; soft; wet (SP)	PID-0ppm LEL-0% O_2-20.8%	NA	BKØ8I9 (1145 hrs) 8.5-9.0 Ft	- Shelby Tube 12-14 Ft bls 0% recovery augered to 14 Ft - Attempted Shelby Tube 14-16 Ft bls
	9.0	Clayey SILT; clay ~25%, silt ~75%; Lt Bluish Gray; poorly sorted; subrounded; high med-high plasticity; Slight firm; moist (MH)	PID-0ppm LEL-0% O_2-20.8%	NA	NA	
	12.0	Shelby Tube - No Recovery	PID-0ppm LEL-0% O_2-20.8%	NA	NA	12-14 Ft Shelby - 0% recovery granular sand
	14	Shelby Tube - 75% Recovery	PID-0ppm LEL-0% O_2-20.8%	✓	NA	14-16 Ft Shelby Tube 75% recovery 1218 hr H_2O @ 4.20 Ft bls 1418 hr H_2O @ 2.80 Ft bls
	16	SAND; med-fine 85% silt-15%; Med Gray; well sorted; subrounded; Soft; no plasticity; wet (SP)	PID-0ppm LEL-0% O_2-20.8%	NA	NA	16-19 Ft run 33.3% recovery
	19	19 Ft = TD				

PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation N 553983.501 E 2342407.075 ELEV. 1096.419 | HOLE NO BKGmw-016

MONITORING WELL INSTALLATION LOG HOLE NUMBER: BKGmw-016

PROJECT: Phase II RI @ WBG and Background Investigation INSPECTOR: B. Baker

SHEET 1 OF 1

MONITORING WELL ID: BKGmw-016

INSTALLATION START: DATE: 5 May 98 TIME: 1400

INSTALLATION FINISH: DATE: 5 May 98 TIME: 1615

ANNULAR SPACE MATERIALS INVENTORY:

GRANULAR FILTER PACK: TYPE: Global #7 Silica Sand QUANTITY: 5 / 50-lb bags

BENTONITE SEAL: TYPE: 3/8" ϕ TR30 Bentonite Pellets QUANTITY: 1 bucket

GROUT: TYPE: Portland Type I / bentonite QUANTITY: 2 / 94-lb bags

DESCRIPTION OF WELL SCREEN:

SLOT SIZE (inches): .010 SLOT CONFIGURATION: Horizontal

TOTAL OPEN AREA PER FOOT OF SCREEN: —

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Johnson

TYPE OF MATERIAL BETWEEN BOTTOM OF BORING AND SCREEN: Global #7 Silica Sand

DESCRIPTION OF WELL CASING:

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Johnson

JOINT DESIGN AND COMPOSITION: Manufactured flush threaded

CENTRALIZERS DESIGN AND COMPOSITION: NA

DESCRIPTION OF PROTECTIVE CASING:

NOMINAL INSIDE DIAMETER: 4"x4" box COMPOSITION: Steel

SPECIAL PROBLEMS ENCOUNTERED DURING WELL CONSTRUCTION AND THEIR RESOLUTION:

NA

Was all well screen and casing material used for construction free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.)? YES [✓] NO [ ]

Was all well screen and casing material used for construction free of unsecured couplings, ruptures, and other physical breakage and/or defects? YES [✓] NO [ ]

Is deformation or bending of the installed well screen and casing minimized to the point of allowing the insertion and retrieval of a 1.0-inch bailer throughout the entire length of the completed well? YES [✓] NO [ ]

QUANTITY OF APPROVED WATER USED FOR FILTER PACK ENPLACEMENT: 0 gal

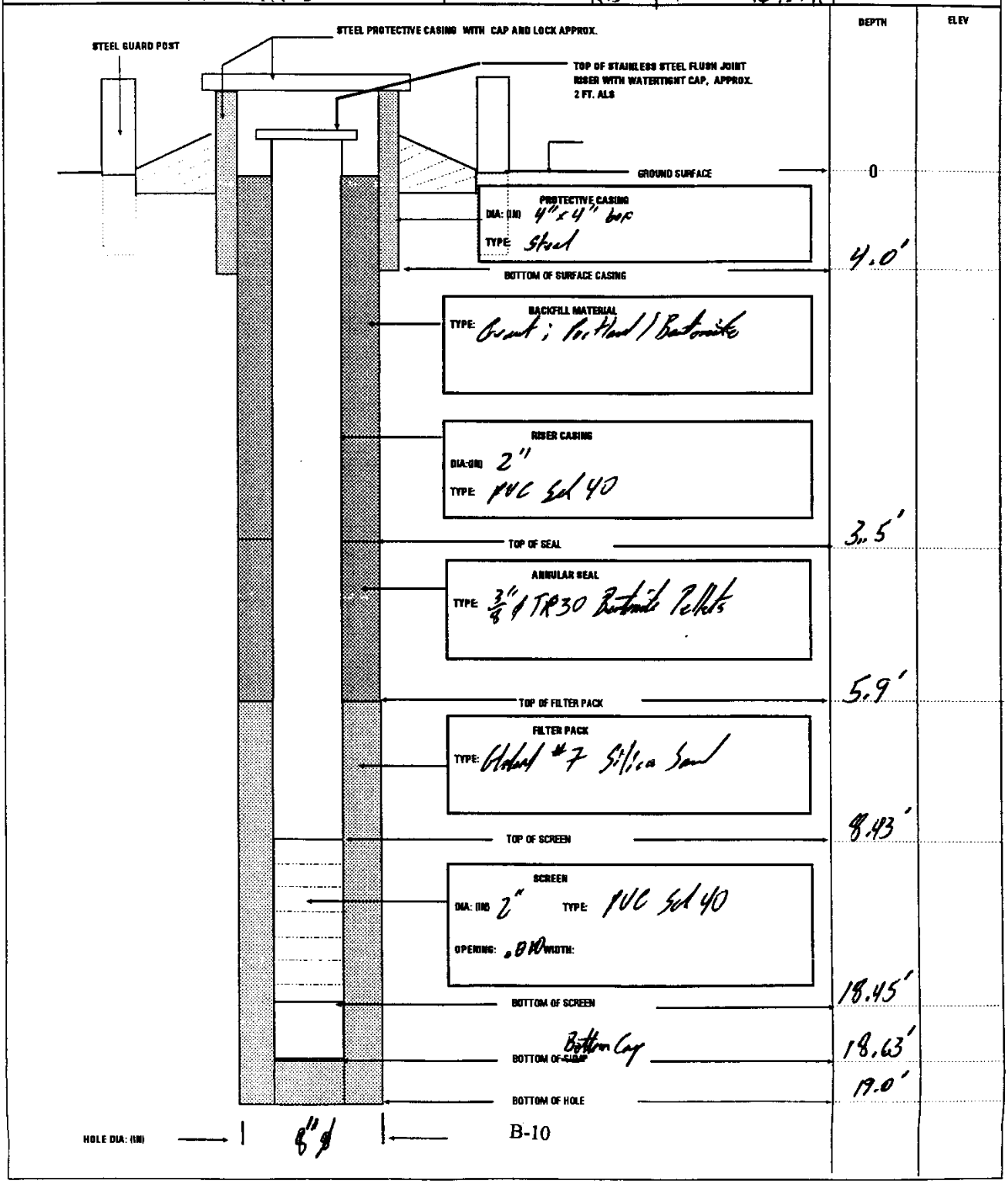
RECORDED BY: [signature] 5 May 98 (Signature & Date)

QA CHECK BY: [signature] 6-2-98 (Signature & Date)

MONITORING WELL

PROJECT NAME: Phase II RI @ WBG and Background Investigation **DELIVERY ORDER NO:** 0060

WELL NUMBER: BKG mw - 016	**BEGIN:** 5 May 98	**END:** 5 May 98
COORDINATES: N: 553983.501 E: 2342407.875	**REFERENCE POINT:** Top of Riser Pipe **ELEVATION:** 1098.419 MSL	



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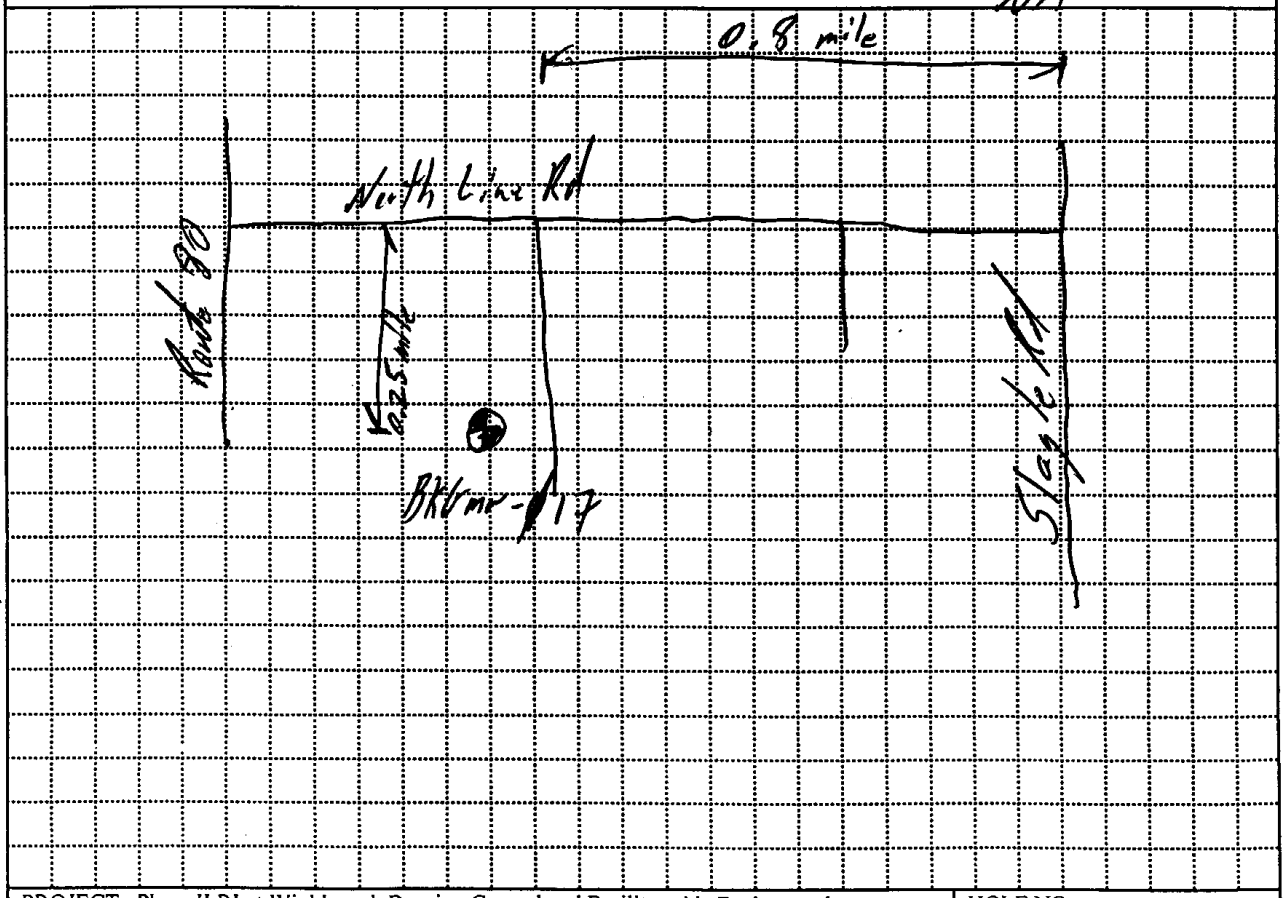
HTRW DRILLING LOG

DISTRICT Louisville Corps		HOLE NUMBER BKGmw-017
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR Bowser Morner	SHEET SHEETS OF
3. PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation	4. LOCATION RVAAP (HLS 4-25-98)	
5. NAME OF DRILLER Maynard Lahti	6. MANUFACTURERS DESIGNATION OF DRILL Failing F-7	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 4½" ID HSAs; 2"ø / 24" length, Split Spoon; 4"ø / 5ft length Continuous Split Barrel; 3"ø / 2.5ft length shelby tube	8. HOLE LOCATION N. Line Rd btwn Rt 80 & Slagle Rd	
	9. SURFACE ELEVATION 1130.69 (HLS 4-25-98)	
	10. DATE STARTED 6 May 98	11. DATE COMPLETED 6 May 98
12. OVERBURDEN THICKNESS Unknown	15. DEPTH GROUNDWATER ENCOUNTERED Drilled depth 26 ft bls; H2O rose to 15.16 ft bls (1054 hr)	
13. DEPTH DRILLED INTO ROCK NA	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE 34.8 ft	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY) (1305 hr) Hold @ 13.2 ft bls	

18. GEOTECHNICAL SAMPLES	DISTURBED NA	UNDISTURBED ✓	19. TOTAL NUMBER OF CORE BOXES NA			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY	OTHER (SPECIFY	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
0-1', 1-3', 3-12'	NA	✓	Semi VOA	Explosives	Cn	
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
		✓				

LOCATION SKETCH/COMMENTS SCALE: NA



PROJECT Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP

HOLE NO. BKGmw-017

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

HOLE NUMBER: BK Grnw-017

PROJECT: Phase II RI at WBG and Background Investigation | INSPECTOR: Brad Parker | SHEET: 1 of 2

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	1	Clayey SILT; silt ~ 60% clay ~ 25% v. fine sand ~ 15%; Lt yellowish Brown variegated ltgray; subrounded; poorly sorted; low plasticity; hard; moist (ML)	PID-0 ppm LEL-0% O_2-20.8%	NA	BK Ø826 (0918hr)	1-3 ft collected w/ 2" Ø / 2 ft length Split Spoon Blowsand 11-16-24-28 100% recovery
	2					
	3	SAME AS ABOVE	PID-0 ppm LEL-0% O_2-20.8%	NA		3-4 ft / 2 ft split spoon Blow count: 24-30
	4	SAME AS ABOVE	PID-0 ppm LEL-0% O_2-20.8%	NA	BK Ø827 (7.5-8.5 ft) (1055)	Converted to 4" Ø / 5 ft length continuous w/ lift barrel 4-9 ft run 100% recovery
	9	Silty CLAY; clay 50%, silt 40% granules 10%; Med Brown; well rounded gravel present; poorly sorted; subrounded; low-med plasticity; hard; moist (CL)	PID-0 ppm LEL-0% O_2-20.8%	NA		9-12 ft run 100% recovery
	12		PID-0 ppm LEL-0% O_2-20.8%	✓	NA	Shelby Tube 12-14 ft 95% recovery (0.9 ft)
	14	CLAY; clay ~ 60%, v. fine sand ~ 15% granules/gravel ~ 5%; Bluish Gray; gravel v. well rounded; poorly sorted; subrounded; high plasticity, firm; moist (CL)	PID 0 ppm LEL-0% O_2-20.8%	NA	NA	14-19 ft run 100% recovery
	16.5	SAME AS 9-12 ft lithology	PID-0 ppm LEL-0% O_2-20.8%	NA	NA	
	19	CLAY; clay ~ 95%, v. fine sand ~ 5% 5% granules/gravel; Med Greenish Gray; gravel - well rounded; poorly sorted; subrounded; high plasticity firm; moist (CL)	PID-0 ppm LEL-0% O_2-20.8%	NA	NA	19-24 ft run 90% recovery ~~Gray~~ Note ~~19.0-19.4 ft~~ 19.0-19.4 ft wet core
	24	SAME AS ABOVE	PID-0 ppm LEL-0% O_2-20.8%	NA	NA	24-29 ft run Bottom 3 ft of barrel - wet H2O typ @ 13.2 ft bls (1350 hr) 3.5 ft recovery (70%) H_2O typ @ 13.2 ft bls (1350 hr)
	29	SAND; fine-med ~ 90% silt ~ 10% gravel ~ 10%; Lt gray white; poorly sorted; subrounded; no plasticity; loose; moist (SP)	PID-0 ppm LEL-0% O_2-20.8%	NA	NA	

PROJECT: Phase II RI at Winklepeck Burning Ground and Background Investigation | HOLE NO: BK Grnw Ø17

HTRW DRILLING LOG

HOLE NUMBER BKGmw-017

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR Brad Baker | SHEET 2 of 2

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	29	SAND; sand, med ~ 85%, silt ~ 12%, gravel ~ 3%; Mod Greenish Gray; (Pale Interbed ~ 0.1 ft of well rounded granular sand; well sorted; subrounded; soft; moist (SP) Note: 31-32.0 ft sand zone is saturated	PID-0 ppm LEL-0% O_2-20.9%	NA	NA	29-34 ft run 70% recovery 3.5 ft
	34	TD = 34.0 ft				Note: Upon well installation borehole was tagged @ 34.8 ft b/s

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PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation N 562452.604 E 2346115.351 ELEV. 1132.799 | HOLE NO BKGmw-017

MONITORING WELL INSTALLATION LOG HOLE NUMBER: BKGmw-017

PROJECT: Phase II RI @ WBG and Background Investigation INSPECTOR: Brad Baker

SHEET 1 OF 1

MONITORING WELL ID: BKGmw-017

INSTALLATION START: DATE: 6 May 99 TIME: 1350

INSTALLATION FINISH: DATE: 6 May 99 TIME: 1500

ANNULAR SPACE MATERIALS INVENTORY:

GRANULAR FILTER PACK: TYPE: Gilbert #7 Silica Sand QUANTITY: 7/50-lb bags

BENTONITE SEAL: TYPE: 3/8" ø TR30 Bentonite Pellets QUANTITY: 2 buckets

GROUT: TYPE: Portland Type I Cement/Bentonite QUANTITY: 3/94-lb bags

DESCRIPTION OF WELL SCREEN:

SLOT SIZE (inches): .010 SLOT CONFIGURATION: Horizontal

TOTAL OPEN AREA PER FOOT OF SCREEN: —

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Johnson

TYPE OF MATERIAL BETWEEN BOTTOM OF BORING AND SCREEN: Gilbert #7 Silica Sand

DESCRIPTION OF WELL CASING:

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Johnson

JOINT DESIGN AND COMPOSITION: Manufactured Flush Threaded

CENTRALIZERS DESIGN AND COMPOSITION: N/A

DESCRIPTION OF PROTECTIVE CASING:

NOMINAL INSIDE DIAMETER: 4"x4' box COMPOSITION: Steel

SPECIAL PROBLEMS ENCOUNTERED DURING WELL CONSTRUCTION AND THEIR RESOLUTION:

Driller over ran filter pack placement - flushed back down hole; ~20 gal H2O used

Was all well screen and casing material used for construction free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.)? YES [✓] NO [ ]

Was all well screen and casing material used for construction free of unsecured couplings, ruptures, and other physical breakage and/or defects? YES [✓] NO [ ]

Is deformation or bending of the installed well screen and casing mininized to the point of allowing the insertion and retrieval of a 1.0-inch bailer throughout the entire length of the completed well? YES [✓] NO [ ]

QUANTITY OF APPROVED WATER USED FOR FILTER PACK ENPLACEMENT: ~20 gal

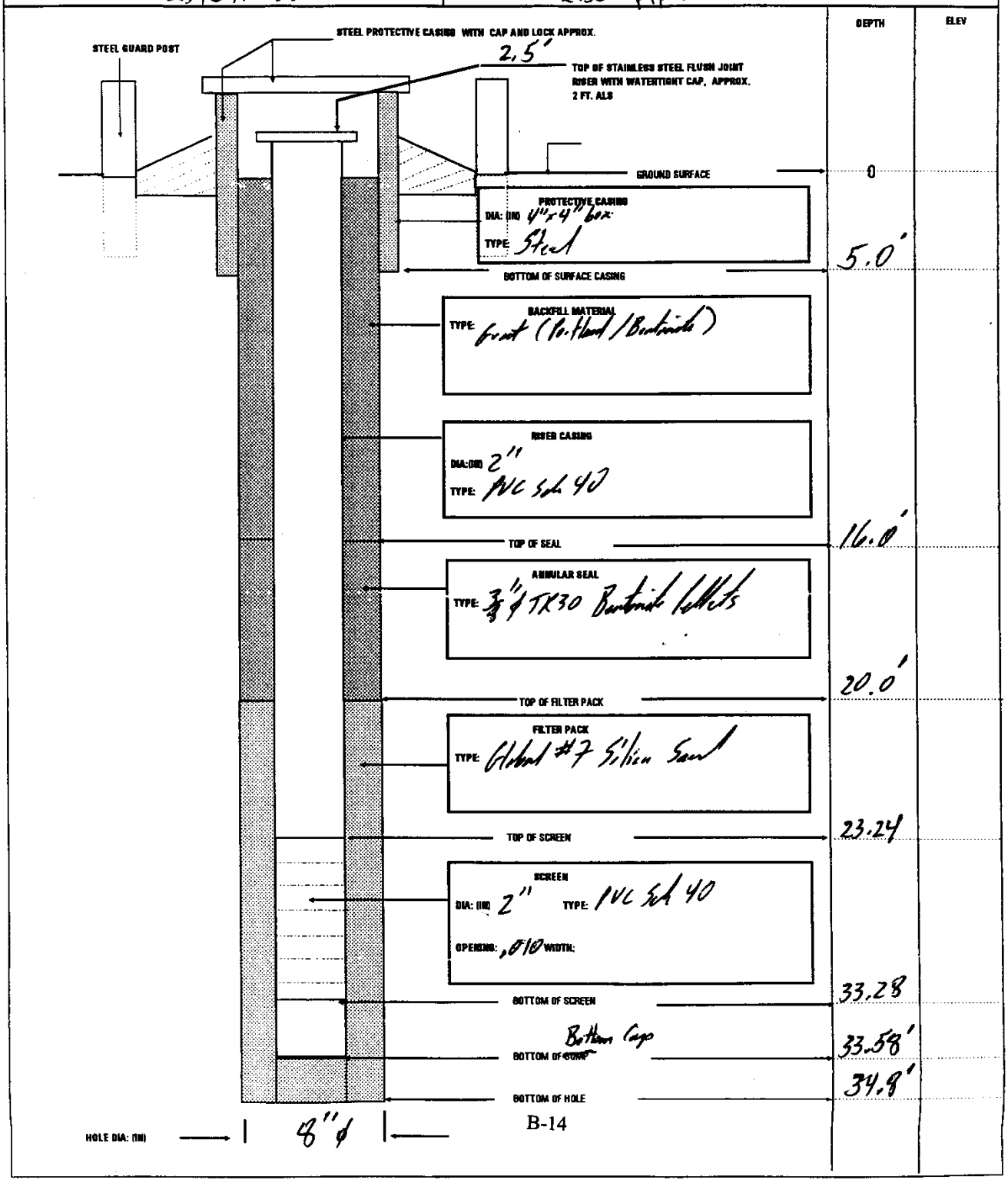
RECORDED BY: [signature] 6 May 99 (Signature & Date)

QA CHECK BY: [signature] (Signature & Date)

MONITORING WELL

PROJECT NAME: Phase II RI @ WBG and Background Investigation **DELIVERY ORDER NO:** 0060

WELL NUMBER: BKGmw-017	**BEGIN:** 6 May 98	**END:** 6 May 98
COORDINATES: N: 562452.004 E: 234611 5.351	**REFERENCE POINT:** top of Riser Pipe **ELEVATION:** 1132.58 MSL	



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HTRW DRILLING LOG

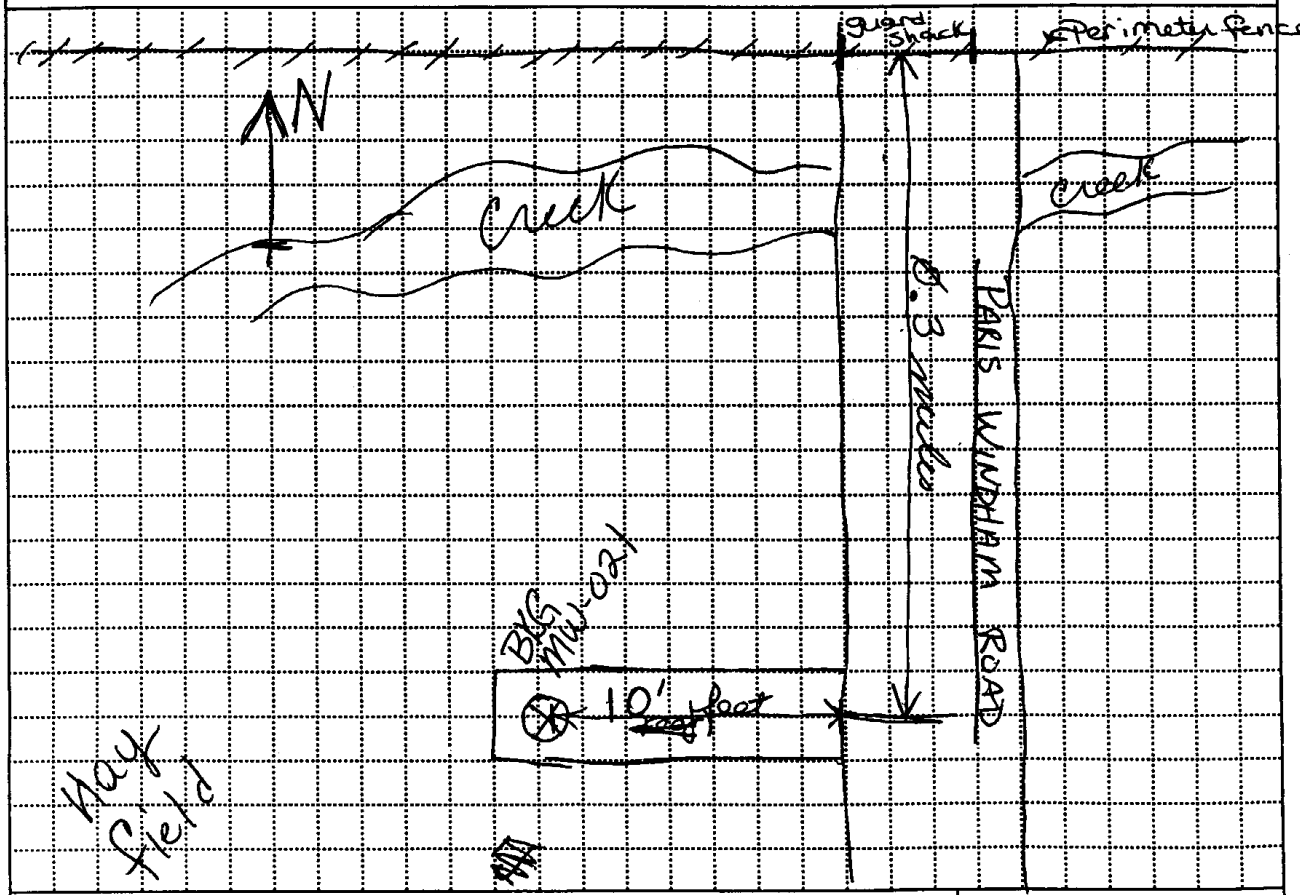
	DISTRICT Louisville Corps	HOLE NUMBER BKGmw-021
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR Dowser Morner	SHEET 1 OF SHEETS 2
3. PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation	4. LOCATION hay field at Ravenna	
5. NAME OF DRILLER Maynerd Lahti	6. MANUFACTURERS DESIGNATION OF DRILL Failing F7	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 6" Auger	8. HOLE LOCATION N pt of site - edge of hay field	
	9. SURFACE ELEVATION 969.71	
	10. DATE STARTED 5-8-98	11. DATE COMPLETED 5-8-98
12. OVERBURDEN THICKNESS >19'	15. DEPTH GROUNDWATER ENCOUNTERED ~~NA~~ ~11' BGS	
13. DEPTH DRILLED INTO ROCK N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED NA	
14. TOTAL DEPTH OF HOLE 19'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY) 17.22' @ 1045 5-8-98	

18. GEOTECHNICAL SAMPLES	DISTURBED X	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY	OTHER (SPECIFY	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
0-1', 1-3', 3-12'		X	Explosives			

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR Heather J Smith

LOCATION SKETCH/COMMENTS SCALE:



PROJECT Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP

HOLE NO. BKGmw-021

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

Heather Smith

HOLE NUMBER BKGmw-021

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR | SHEET 2 of 2

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
		• Clayey silt, 25% clay, Hard (ML) 70% silt, Med. yellowish brown w/ ~5% V. fine sand "wisp" of lt. grey, medium plasticity, moist, poorly sorted	0 %VOC, 0 PID, 20.7 O2		BK0822 @1'-3'	Blow count for 1'-3' intravel = 9, 12, 14. 0 recovery - rock lodging in shoe. Stopped at 1.4' and resampled. 50% recovery. 3-4' split-spoon blows 18-25 ~50% recovery
4		Slight color change @ to light yellowish brown @4'. • Core displays fissle characteristics. • other characteristics are same as above (till)		2 Geotech samples taken from 6'-7' and 9'-10'	BK0823 @5'-6'	4'→9' run = ~100% recovery
						9'→12' run = ~40% recovery - hit sand @ ~10', the sand did not recover well
10		(SP) Poorly graded sand with silt, med. grained sand, Subangular, ~~Moderately~~ → well sorted, Sand unit, very soft, 30-35% silt 65%-70% Sand	0%VOC, 0 PID, 20.7 O2	~~Geotech samples from 6'-7' and from 9'-10'~~ HLS 5-8-98	N/a	
12		Shelby tube appears to be sand on both ends.	0%VOC, 0 PID, 20.7 O2	Shelby tube 12'-14'	N/a	Shelby tube from 12'→14' - 3' of water evident on drill string upon Shelby tube removal. 100% recovery appears to be sand on both ends
14		Same sand as above, Poorly graded sand w/ silt (SP), med. Subangular grains, 35% silt ~ 65% sand. Moderately sorted, very soft				Wet cuttings @ 14' Saturated Cuttings @ ~18' bgs. Soft drilling to 18' then "stiffened up". drill string wet ~3½' from bottom upon removal from hole @ TD-19'. Water level at 17.22'
18'		Sandy clayey silt, lt. brownish yellow w/ lt. grey variations, 25% sand 25% clay 50% silt (ML)				at ~18' drilled into firmer clay
19		bottom of hole = 19'				

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PROJECT Phase II RI at Winkelpeck Burning Ground and Background Investigation N571016.748 E 2367622.953 | ELEV. 972.159 | HOLE NO. BKGmw-021

MONITORING WELL INSTALLATION LOG HOLE NUMBER: BLGmw-021

PROJECT: Phase II RI @ WBG and Background Investigation INSPECTOR: Heather Smith

SHEET 1 OF 1

MONITORING WELL ID: BLGmw-021

INSTALLATION START: DATE: 5-8-98 TIME: 1055

INSTALLATION FINISH: DATE: 5-9-98 TIME: 1405

ANNULAR SPACE MATERIALS INVENTORY:

GRANULAR FILTER PACK: TYPE: Global #7 Silica Sand QUANTITY: 5½ 50lb bags

BENTONITE SEAL: TYPE: 3/8" dia. TR30 Bentonite Pellets QUANTITY: 1½ 5 gal bucket

GROUT: TYPE: Portland Type I/Bentonite QUANTITY: 1 94-lb bag Portland Type I, bentonite

DESCRIPTION OF WELL SCREEN:

SLOT SIZE (inches): .010" SLOT CONFIGURATION: horizontal

TOTAL OPEN AREA PER FOOT OF SCREEN: ———

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch. 40 COMPOSITION: PVC

MANUFACTURER: Johnson

TYPE OF MATERIAL BETWEEN BOTTOM OF BORING AND SCREEN: Global #7 Silica Sand

DESCRIPTION OF WELL CASING:

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch. 40 COMPOSITION: PVC

MANUFACTURER: Johnson

JOINT DESIGN AND COMPOSITION: N/a

CENTRALIZERS DESIGN AND COMPOSITION: ———

DESCRIPTION OF PROTECTIVE CASING:

NOMINAL INSIDE DIAMETER: 4"x4" COMPOSITION: steel

SPECIAL PROBLEMS ENCOUNTERED DURING WELL CONSTRUCTION AND THEIR RESOLUTION:

NS

Was all well screen and casing material used for construction free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.)? YES [X] NO [ ]

Was all well screen and casing material used for construction free of unsecured couplings, ruptures, and other physical breakage and/or defects? YES [X] NO [ ]

Is deformation or bending of the installed well screen and casing minimized to the point of allowing the insertion and retrieval of a 1.0-inch bailer throughout the entire length of the completed well? YES [X] NO [ ]

QUANTITY OF APPROVED WATER USED FOR FILTER PACK ENPLACEMENT: 10 gal

RECORDED BY: Heather L Smith 5-8-98 QA CHECK BY: Matt Osborn 6-2-98

(Signature & Date) (Signature & Date)

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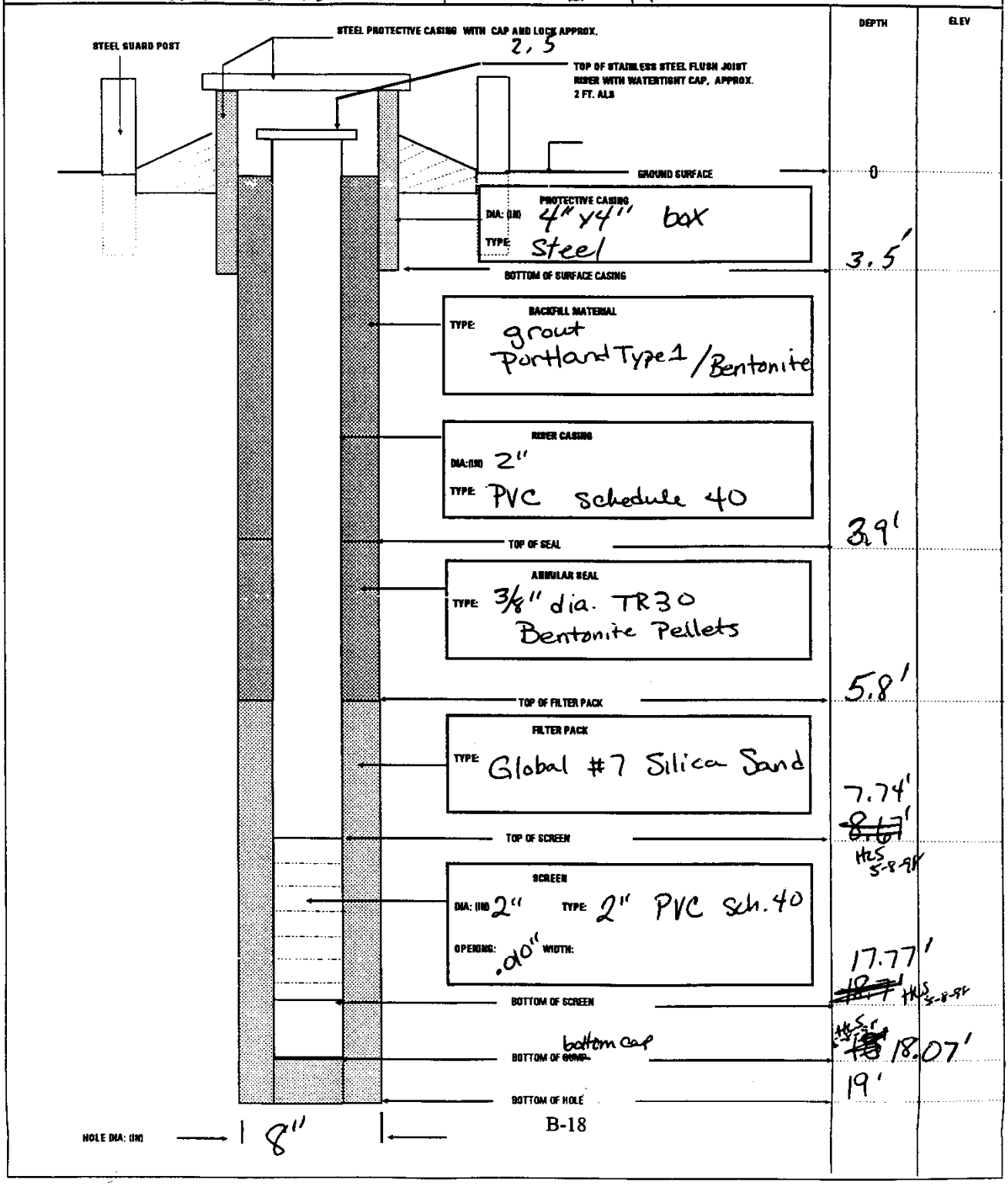
MONITORING WELL

PROJECT NAME: Phase II RI @ WBG and Background Investigation **DELIVERY ORDER NO:** 0080

WELL NUMBER: BKGmw-021	**BEGIN:** 1055	**END:** 1405
COORDINATES: N: 571016.748 E: 2367622.953	**REFERENCE POINT:** top of Riser Pipe	**ELEVATION:** 972.159 MSL



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APPENDIX A.2

Homewood Sandstone Wells – Boring Logs

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TEC-Weston Joint Venture

(BKGmw-022)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-HSS1

Company/Project: TEC-Weston Joint Venture/Facility-Wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud	Ground Surface Elevation: —		Datum: —
~~Sampling Device~~: Drill: Versa Sonic Model 1411	Borehole Diameter (inches): 6 7/8" (25'-38')		Total Depth (Feet): 38'
Date/Time Drilling Started: 8/16/16 1250	Date/Time Total Depth Reached: 8/16/16 1625		

Depth (feet)	Sampling: % Recov	Sampling: Sample Depth	Sampling: Blow Counts	Sampling: PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/ lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
2.0	100%			0.0 ppm			Silty Sand (SM)	(0.0-3.1'): Silty sand, light brown becoming slightly orange at ~2.6', dry, occasional roots at top, sub-rounded to sub-angular sandstone cobbles throughout (1/8"-1/2"), slightly micaceous	
4.0	100%			0.0 ppm			Silty Sand (SM)	(3.1'-5.0'): Silty sand, slightly orange with gray sandstone cobbles, (fine grained), dry, occasional quartz pebbles up to 1/4"	
6.0	100%			0.0 ppm			Sand (SW)	(5.0'-8.0'): Sand, light brown with tan streaks, very slightly moist, fine to medium grained, scattered orange angular sandstone pieces (<1/8"), micaceous, becoming very moist from 6.3' to 7.3'	
8.0									
10.0	100%			0.0 ppm			Silty Sand (SM)	(8.0'-12.7'): Silty sand, light brown with scattered orange zones, moist, weathered sandstone cobbles (typically <1/8")	
12.0									
14.0	100%			0.0 ppm			Silty Sand (SM)	(12.7'-15.0'): Silty sand, slightly moist, medium stiff, micaceous, occasional subrounded to rounded pebbles (up to 1/2")	
16.0	100%			0.0 ppm			Clayey Sand (SC)	(15.0'-20.0'): Clayey sand, brown at top grading to light gray downward, slightly moist to increasing moisture downward, weathered, medium stiff, scattered quartz pebbles (some up to 1/4")	Driller began drilling with water at 20'.
18.0									
20.0									

TEC-Weston Joint Venture

(BKGmw-022)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-H551

Company/Project: TEC-Weston Joint Venture/Facility-Wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud	Ground Surface Elevation: —		Datum: —
~~Sampling Device~~: Drill: Versa Sonic Model 1111	Borehole Diameter (inches): 6 7/8" (25'-38')		Total Depth (Feet): 38'
Date/Time Drilling Started: 8/16/16 1250	Date/Time Total Depth Reached: 8/16/16 1625		

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
22.0	10%			0.0 ppm			Lost Core and Sandstone	(20.0'-25.0'): Driller drilled from 20'-25', but only recovered 0.5'. That core was sandstone: gray, hard, mostly well cemented, mostly fine grained, unweathered.	Driller reported competent bedrock at ~22'. Temporary 8" steel Casing set to 25'
24.0									
26.0	100%			0.0 ppm			Sandstone (SS)	(25.0'-29.0'): Sandstone, top ~3' brown and becoming gray at base, slightly weathered at top to unweathered downward, fine to medium grained (Note: some of core crushed by drill).	
28.0									
30.0	100%			0.0 ppm			Sandstone (SS)	(29.0'-38.0'): Sandstone, gray, mostly unweathered, medium grained, hard, fractured at top (some high angle), large near-vertical fracture from ~34.7' to 35.6' (this zone took return water). Coal spars at base. Moderate cementation, slightly micaceous, bottom of borehole.	- Temporary 6" steel casing installed to 35' - Driller lost return water at large vertical fracture zone - Bottom of borehole
32.0									
34.0									
36.0									
38.0								Note: In instances where core loss has occurred and where "lost core" does not have its own entry, it is not possible to determine where the core loss occurred within a respective core run.	

Cardno TEC | WESTON SOLUTIONS
TEC-Weston Joint Venture

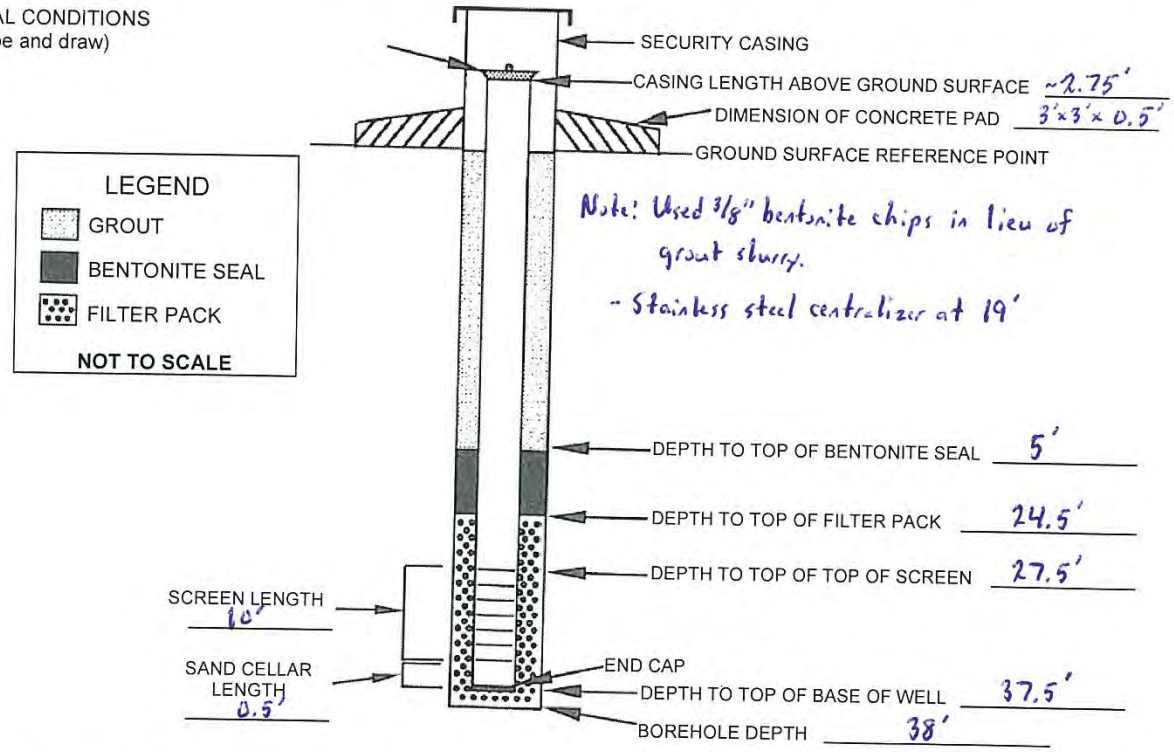
Well Construction Details

FIELD REPRESENTATIVE: Steve Stansfield (Cardno)
DRILLING CONTRACTOR: Duncan Brothers Drilling

DRILLING TECHNIQUE: Sonic
AUGER SIZE AND TYPE: N/A
BOREHOLE IDENTIFICATION: BKG-HSS1 (BKGmw-022)
BOREHOLE DIAMETER: 6 7/8" within screened interval
WELL IDENTIFICATION: BKG-HSS1 (BKGmw-022)
WELL CONSTRUCTION START DATE: 8/17/16
WELL CONSTRUCTION COMPLETE DATE: 8/26/16
SCREEN MATERIAL: 2" Schedule 40 PVC (0.010" slot)
SCREEN DIAMETER: 2.07" ID / 2.38" O.D.
STRATUM-SCREENED INTERVAL (FT): 10' Screen
CASING MATERIAL: 2" Schedule 40 PVC
CASING DIAMETER: 2.07" I.D. / 2.38" O.D.

TYPE OF FILTER PACK: Global #5 Sand
GRADATION: 12 x 20
AMT. OF FILTER PACK USED: 7.5 - 50 lb. bags
TYPE OF BENTONITE: 3/8" Chips
AMT. OF BENTONITE USED: 11 - 50 lb. bags
TYPE OF CEMENT: N/A
AMT. OF CEMENT USED: N/A
GROUT MATERIAL USED: 3/8" Bentonite Chips
DIMENSIONS OF SECURITY CASING: 8' x 6"
TYPE OF WELL CAP: 2" Torque Well Plug
TYPE OF END CAP: PVC Threaded
COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: Duncan Brothers Drilling
INSTALLATION OBSERVED BY: Steve Stansfield (Cardno)
DISCREPANCIES:

TEC-Weston Joint Venture

(BKGmw-023)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-HSS2

Company/Project: TEC-Weston Joint Venture/Facility-wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud	Ground Surface Elevation: —		Datum: —
~~Sampling Device~~: Drill: Versa Sonic Model 1111	Borehole Diameter (inches): 6 7/8" (29'-44')		Total Depth (Feet): 44'
Date/Time Drilling Started: 8/17/16 1320	Date/Time Total Depth Reached: 8/17/16 1615		

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
	100%			0.0			Topsoil	(0.0'-0.5') Topsoil, dark brown, moist, numerous roots	
	100%			0.0			CL	(0.5'-1.15') Clayey silt, brown, stiff, dry	
2.0								(1.15'-5.85'): Silty sand, light brown, mostly dry, stiff, scattered orange subangular sandstone pebbles, rare quartz pebbles (subrounded up to 1/4")	
4.0	100%			0.0 ppm			Silty Sand (SM)		
6.0									
8.0	100%			0.0 ppm			Silty Clay (CL)	(5.85'-10.0'): Silty clay, light brown, very slightly moist, medium stiff, scattered light gray clay inclusions, becoming crumbly near base.	
10.0									
12.0								(10.0'-20.0'): Clayey Sand, gray to light gray becoming brown downward, very soft, slightly moist becoming wetter downward, last 1.0' becoming more silty with abundant sandstone pebbles (< 1/4").	Note: Drillu had to use water to get material out of core barrel.
14.0									
16.0	100%			0.0 ppm			Clayey Sand (SC)		
18.0									
20.0									

Note: In instances where core loss has occurred and where "lost core" does not have its own entry, it is not possible to determine where the core loss occurred within a respective core run.

TEC-Weston Joint Venture

(BKGmw-023) **GEOLOGIC BOREHOLE LOG**

Borehole (Location) ID: BKG-H552

Company/Project: TEC-Weston Joint Venture/Facility-wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud	Ground Surface Elevation: —		Datum: —
Sampling Device: Drill: Versa Sonic Model 1411	Borehole Diameter (inches): 6 7/8" (29'-44')		Total Depth (Feet): 44'
Date/Time Drilling Started: 8/8/17/16 1320	Date/Time Total Depth Reached: 8/17/16 1615		

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
22.0								(20.0'-26.0') Sand: mainly unconsolidated and poorly cemented, gray, weathered with occasional unweathered/subrounded sandstone chips (< 1/8") and rounded quartz pebbles up to 1/4", micaceous.	Note: Driller had to use water to get material out of core barrel.
24.0	100%			0.0 ppm			Sand		Top of incompetent bedrock at 26'
26.0									
28.0	100%			0.0 ppm			Sandstone (SS)	(26.0'-28.5') Sandstone, highly weathered and poorly cemented (crumbly and friable), maroon with occasional orange streaks, coal spars at base, becoming more competent downward	- Driller set 8" temporary water casing to 29'. - Driller began drilling with water at 29'.
	100%			0.0			SS	(28.5-29') Sandstone, orangish, more competent than above	- Top of competent bedrock at 29'
30.0	100%			0.0 ppm			Siltstone	(29.0'-30.3') Siltstone, dark gray, very fine grained, hard, completely broken	
32.0							Lost Core	(30.3'-36.3'). Lost core. Driller lost 6.0' of core in 9.0' run.	Driller temporarily lost returns at ~36'
34.0	0.0%								
36.0									
38.0							Sandstone (SS)	(36.3'-42.1'): Sandstone, tan with gray interbeds, fine to medium grained, fractured throughout (some high angle to near vertical), iron stains throughout, micaceous, rare coal	
40.0	100%		0.0 ppm						
								spars in bedding planes, weathered, moderate cementation.	
42.0									
44.0	100%		0.0 ppm				Sandstone (SS)	(42.1'-44') Sandstone, gray, hard, well cemented, unweathered, fine to medium grained, rare coal spars.	Bottom of borehole at 44'

TEC-Weston Joint Venture

Well Construction Details

FIELD REPRESENTATIVE: Steve Stansfield (Cardno)
DRILLING CONTRACTOR: Duncan Brothers Drilling

DRILLING TECHNIQUE: Sonic
AUGER SIZE AND TYPE: N/A
BOREHOLE IDENTIFICATION: BKG-HSS2 (BKGmw-023)
BOREHOLE DIAMETER: 6 7/8" within Screened Interval
WELL IDENTIFICATION: BKG-HSS2 (BKGmw-023)

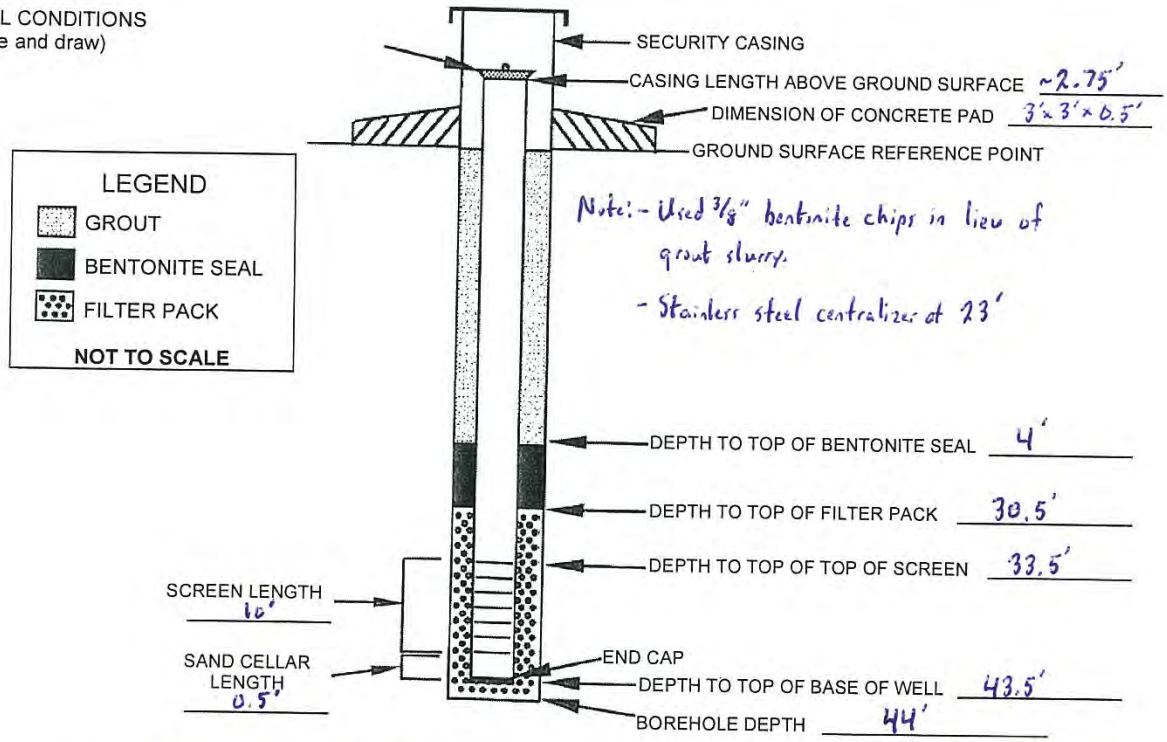
WELL CONSTRUCTION START DATE: 8/18/16
WELL CONSTRUCTION COMPLETE DATE: 8/26/16

SCREEN MATERIAL: 2" Schedule 40 PVC (0.01" Slot)
SCREEN DIAMETER: 2.07" I.D. / 2.38" O.D.
STRATUM-SCREENED INTERVAL (FT): 10' Screen
CASING MATERIAL: 2" Schedule 40 PVC
CASING DIAMETER: 2.07" I.D. / 2.38" O.D.

TYPE OF FILTER PACK: Global #5 Sand
GRADATION: 12 x 20
AMT. OF FILTER PACK USED: 5.5 - 50 lb. bags
TYPE OF BENTONITE: 3/8" Chips
AMT. OF BENTONITE USED: 14 - 50 lb. bags
TYPE OF CEMENT: N/A
AMT. OF CEMENT USED: N/A
GROUT MATERIAL USED: 3/8" Bentonite Chips

DIMENSIONS OF SECURITY CASING: 8' x 6"
TYPE OF WELL CAP: 2" Torque Well Plug
TYPE OF END CAP: PVC Threaded
COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: Duncan Brothers Drilling
INSTALLATION OBSERVED BY: Steve Stansfield (Cardno)
DISCREPANCIES:

HTRW DRILLING LOG

	DISTRICT: USACE - Louisville	BOREHOLE NUMBER: FWGmw-017 ~~005~~ (replacement)
1. COMPANY NAME: EQM	2. DRILLING SUBCONTRACTOR: Frontz Drilling	SHEET 1 OF 2

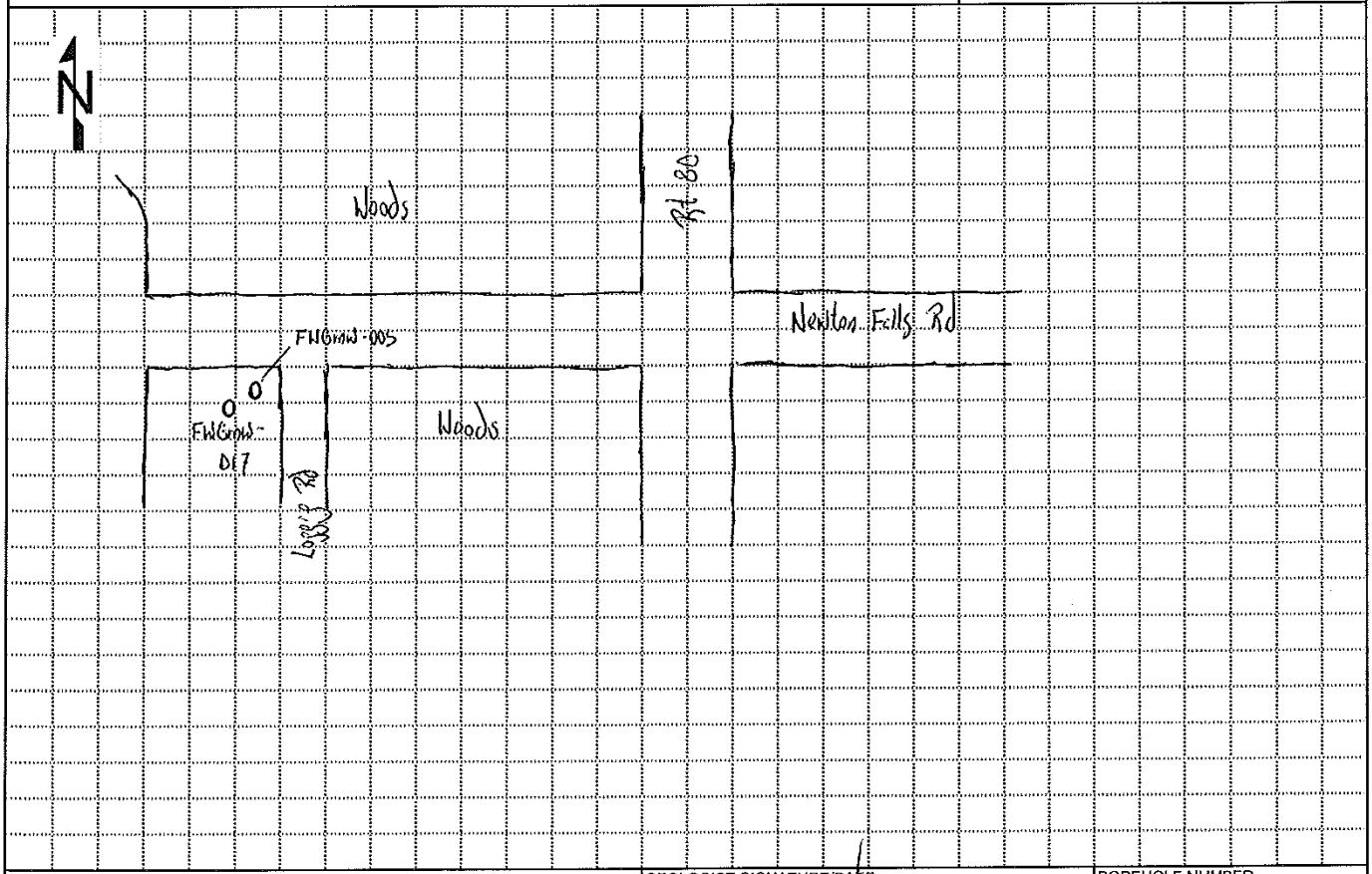
3. PROJECT: RVAAP-66 RI	4. LOCATION: RVAAP 8451 State Route 5 Ravenna, OH 44266
5. NAME OF DRILLER: Joe Tetel	6. MAKE/MODEL OF DRILL: CME 55
7. SIZES AND TYPES OF SAMPLING EQUIPMENT: 8 1/4" HSA; 2" x 24" split spoon	8. BOREHOLE LOCATION: Paired w/ FWGmw-005; Newton Falls west of Rt 80
	9. SURFACE ELEVATION/DATUM: 1167.50
	10. DRILL DATE/TIME STARTED: 4/2/12 COMPLETED: 4/2/12
	15. DEPTH GROUNDWATER ENCOUNTERED: 18 ft
	16. DEPTH TO WATER/ELAPSED TIME AFTER BOREHOLE COMPLETION: NA
12. OVERBURDEN THICKNESS: 17 ft	
13. DEPTH DRILLED INTO BEDROCK: 12.5 ft	17. OTHER WATER LEVEL MEASUREMENTS (INLCLUDE DATE/TIME): NA
14. TOTAL DEPTH OF BOREHOLE: 29.5 ft	

18. GEOTECHNICAL SAMPLES	UNDISTURBED: NA	DISTURBED: NA	19. TOTAL NUMBER OF CORE BOXES: NA	
20. CHEMICAL SAMPLES	CHEM: NA	RAD: NA	OTHER:	21. TOTAL CORE RECOVERY %: NA
22. DISPOSITION OF BOREHOLE	DATE STARTED/INSTALLED: 4/2/12		DATE COMPLETED/ABANDONED: 4/3/12	

BACKFILL TYPE: ☐ GROUT ☐ BENTONITE ☐ TEMPORARY WELL POINT ☑ MONITORING WELL

23. NOTES: BKG: ≤Background; BGS: Below Ground Surface; CPM: Counts per Minute; PPM: Parts per Million; ▽ : First Water Encountered; ▼ : Static Water Level; NA: Not Applicable

LOCATION SKETCH/COMMENTS — **SCALE:** None



PROJECT	GEOLOGIST SIGNATURE/DATE	BOREHOLE NUMBER
RVAAP-66 RI	4/2/12	FWGmw-~~017~~ 005 (replacement)

HTRW DRILLING LOG (continued)

DISTRICT: USACE - Louisville

BOREHOLE NUMBER: FWGmw-005 (replacement) (was 017)

1. COMPANY NAME: EQM

2. DRILLING SUBCONTRACTOR: Frontz Drilling

SHEET 2 OF 2

3. PROJECT: RVAAP-66 RI

4. LOCATION: RVAAP 8451 State Route 5, Ravenna, OH 44266

5. NAME OF DRILLER: Joe Teter

6. DIRECTION OF BOREHOLE: ☑ VERTICAL ☐ INCLINED DEGREES

7. NOTES PID MAKE/MODEL: Sirius MSA

PID SERIAL#: A2-1861

Colors from Munsell Soil Color Chart, Rev

WATER LEVEL MAKE/MODEL:

WATER LEVEL SERIAL#:

ELEVATION	DEPTH (Feet)	USCS	CLASSIFICATION OF MATERIALS	SPT DATA (0.5 Feet)	MONITORING (PPM/CPM)	REMARKS (Sample IDs/Depths/Core Box/Etc.)
	0-17		See well log for FWGmw-005			0-17 ft
	17-20	SS	Yellow-brn sand, weathered bedrock			17-20 ft
	20-22	SS	Yellow-brn sand, fn-med grained, well sorted, wet, weathered sandstone	50/2 R= 3/24		20-22 ft; 1450
	22-29	SS	Yellow-brn sand, fn-med grained, weathered sandstone Hard drilling @ 28.5 ft.			22-29 ft (from cuttings)
	30					
	35					
	40					

PROJECT: RVAAP-66 RI

GEOLOGIST SIGNATURE/DATE: [signature] 4/2/12

BOREHOLE NUMBER: FWGmw-005 (replacement) (was 017)

MONITORING WELL

PROJECT NAME: RVAAP-66 RI

PROJECT NO: 30174.0016.001.02

WELL NUMBER: FWGMW-017005 (replacement)

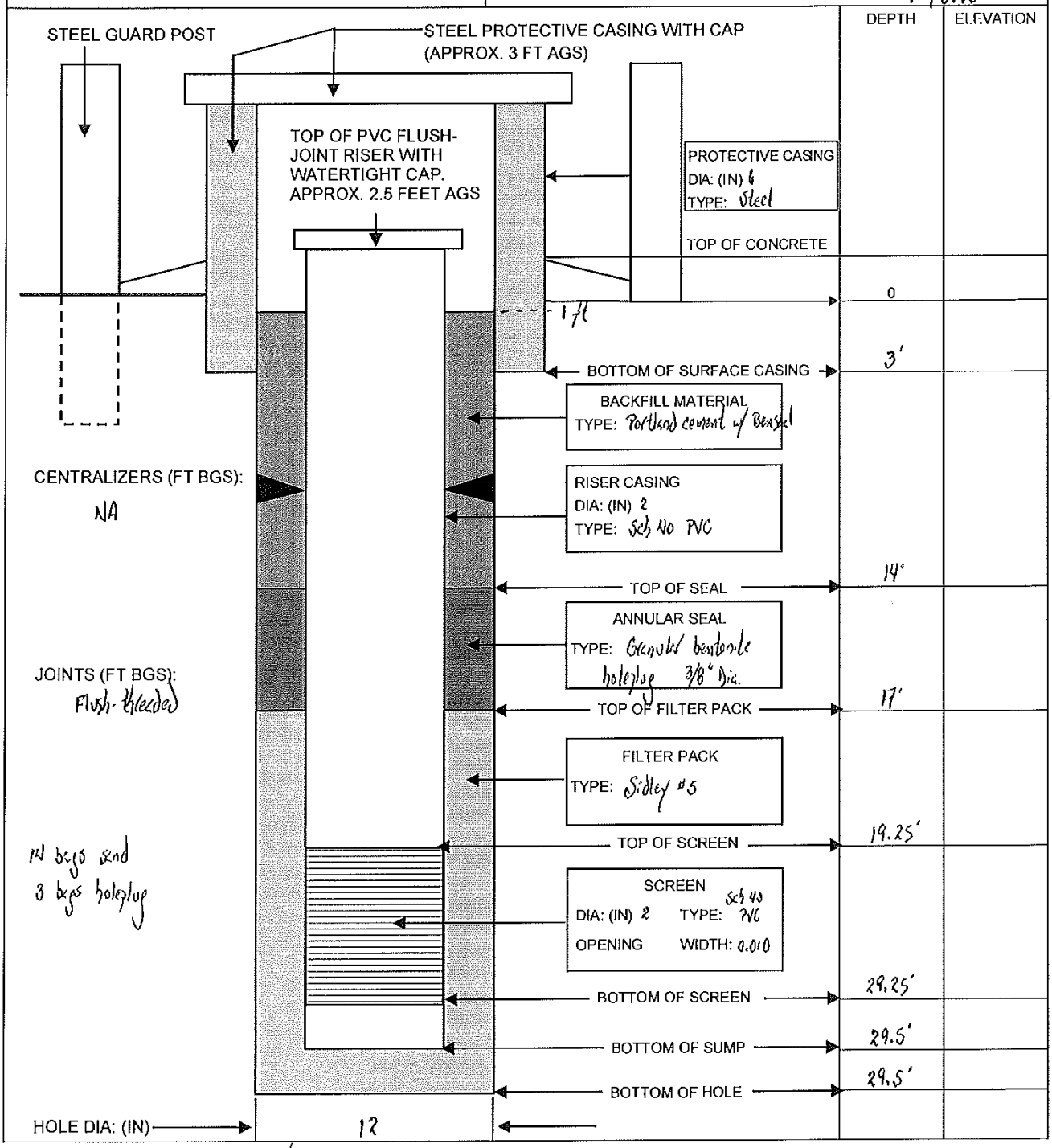
BEGIN: 4/2/12

END: 4/3/12

COORDINATES: N: 558510
E: 2338973

REFERENCE POINT: TOC

ELEVATION: MSL 1170.10



Recorded by: [signature]

QA performed by: _____

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APPENDIX A.3

Upper Sharon Wells – Boring Logs

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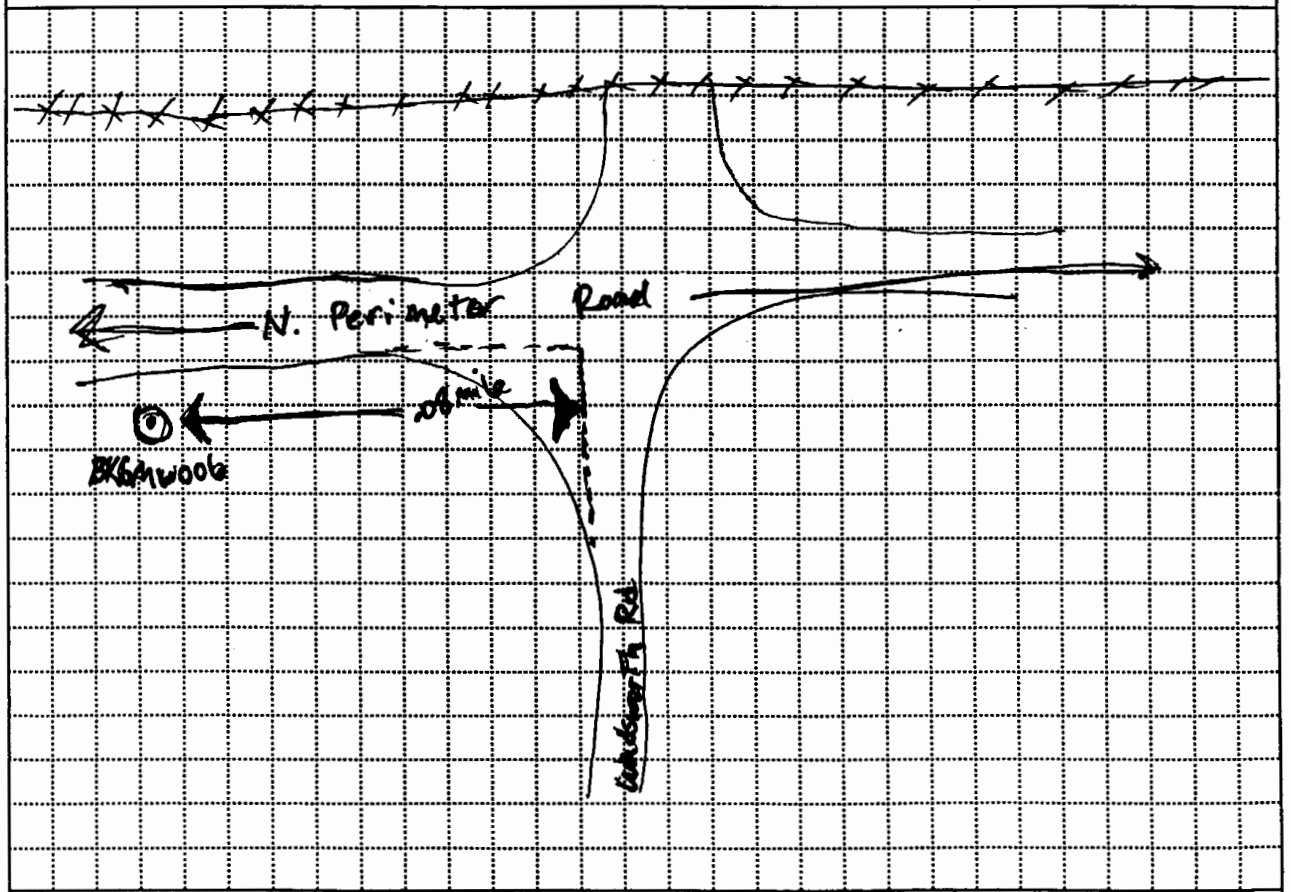
HTRW DRILLING LOG

DISTRICT Louisville Corps		HOLE NUMBER BKGMW-006
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR Bowser-Morner	SHEET 1 OF 7
3. PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation	4. LOCATION Ravenna Arsenal	
5. NAME OF DRILLER John Filburn	6. MANUFACTURERS DESIGNATION OF DRILL Versa Sonic V-100	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 6" and 4" Rotosonic Core Barrels	8. HOLE LOCATION East of N. Perimeter Rd/Industrial Not Industrial/Canalley Intersection Area	
	9. SURFACE ELEVATION 1023.87 ft MSL 9-29-98	
	10. DATE STARTED 4-27-98	11. DATE COMPLETED 4-27-98
12. OVERBURDEN THICKNESS 3.5'	15. DEPTH GROUNDWATER ENCOUNTERED Not uncertain - in Bedrock 25'-35'	
13. DEPTH DRILLED INTO ROCK 32'	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED NA	
14. TOTAL DEPTH OF HOLE 35.5'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY) - 18' BGS, open BH before installing well.	

18. GEOTECHNICAL SAMPLES 1-2, 4-5	DISTURBED X	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES (3)			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY	OTHER (SPECIFY	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
0-1', 1-3', 3-12'		X				
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
		X		Matt Dabney		

LOCATION SKETCH/COMMENTS SCALE: None



PROJECT Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP

HOLE NO. BKGMW006

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

HOLE NUMBER BKG/MW-0006

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR M. OBLOY | SHEET 1 of 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
	0	TOP Soil, Dark Gray, Silt, moist, Roots, etc.				
	1	Clayey SILT (ML), Brown, Moist, soft, low Plasticity	0.0 ppm			
	2	Sandy, gravel w/ silt, and clay (GW-GM), loose, moist, Brown				
	3	↓ increase clay content to clay and sand				
	4	weathered SANDSTONE, Mixed w/ clay/silt paleosoil Top 6".....				
	5	competent SS, Sharon Conglomerate		5'-15' Core Box # MW6-1		25'-33' Core Box # MW6-3
	6	TAN; Very well Sorted F. Sand, 5% - Subr. Predom Quartz Strong Cementation 10-20% Medium Sand				
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					BOB at 35'.
	16			15-25' Core Box # MW6-2		
	17					
	18					
	19					
	20					

PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation | HOLE NO RKGMW0006

N 571910.47 E 2358643.961 ELEV. 1026.380

BKG 7

MONITORING WELL INSTALLATION LOG HOLE NUMBER: BKG MW-6

PROJECT: Phase II RI @ WBG and Background Investigation INSPECTOR: Matt Orr

SHEET 1 OF 1

MKS 29-91

MONITORING WELL ID: BKGMW-6

INSTALLATION START: DATE: 9-27-98 TIME: 1355

INSTALLATION FINISH: DATE: 9-27-98 TIME: 1545

ANNULAR SPACE MATERIALS INVENTORY:

GRANULAR FILTER PACK: TYPE: Global Quartz Sand QUANTITY: 6.5 50 lb bags

BENTONITE SEAL: TYPE: Pel Plug / Pellets Western Bent QUANTITY: 1 - 5 gallon bucket

GROUT: TYPE: portland Cement / Bentonite Powder 5% QUANTITY: 15 gallons

DESCRIPTION OF WELL SCREEN:

SLOT SIZE (inches): .010 SLOT CONFIGURATION: Horizontal

TOTAL OPEN AREA PER FOOT OF SCREEN: —

OUTSIDE DIAMETER: 2" + 5/16" NOMINAL INSIDE DIAMETER: 2"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Global

TYPE OF MATERIAL BETWEEN BOTTOM OF BORING AND SCREEN: —

DESCRIPTION OF WELL CASING:

OUTSIDE DIAMETER: 2" + 5/16" NOMINAL INSIDE DIAMETER: 2"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Global

JOINT DESIGN AND COMPOSITION: Threaded / PVC

CENTRALIZERS DESIGN AND COMPOSITION: —

DESCRIPTION OF PROTECTIVE CASING:

NOMINAL INSIDE DIAMETER: 4" Square COMPOSITION: Steel

SPECIAL PROBLEMS ENCOUNTERED DURING WELL CONSTRUCTION AND THEIR RESOLUTION:

MKS 9-29-98

Was all well screen and casing material used for construction free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.)? YES [X] NO [ ]

Was all well screen and casing material used for construction free of unsecured couplings, ruptures, and other physical breakage and/or defects? YES [X] NO [ ]

Is deformation or bending of the installed well screen and casing minimized to the point of allowing the insertion and retrieval of a 1.0-inch bailer throughout the entire length of the completed well? YES [X] NO [ ]

QUANTITY OF APPROVED WATER USED FOR FILTER PACK ENPLACEMENT: Matt Orr to 4.27.98 0 gallons

RECORDED BY: Matt Orr (Signature & Date)

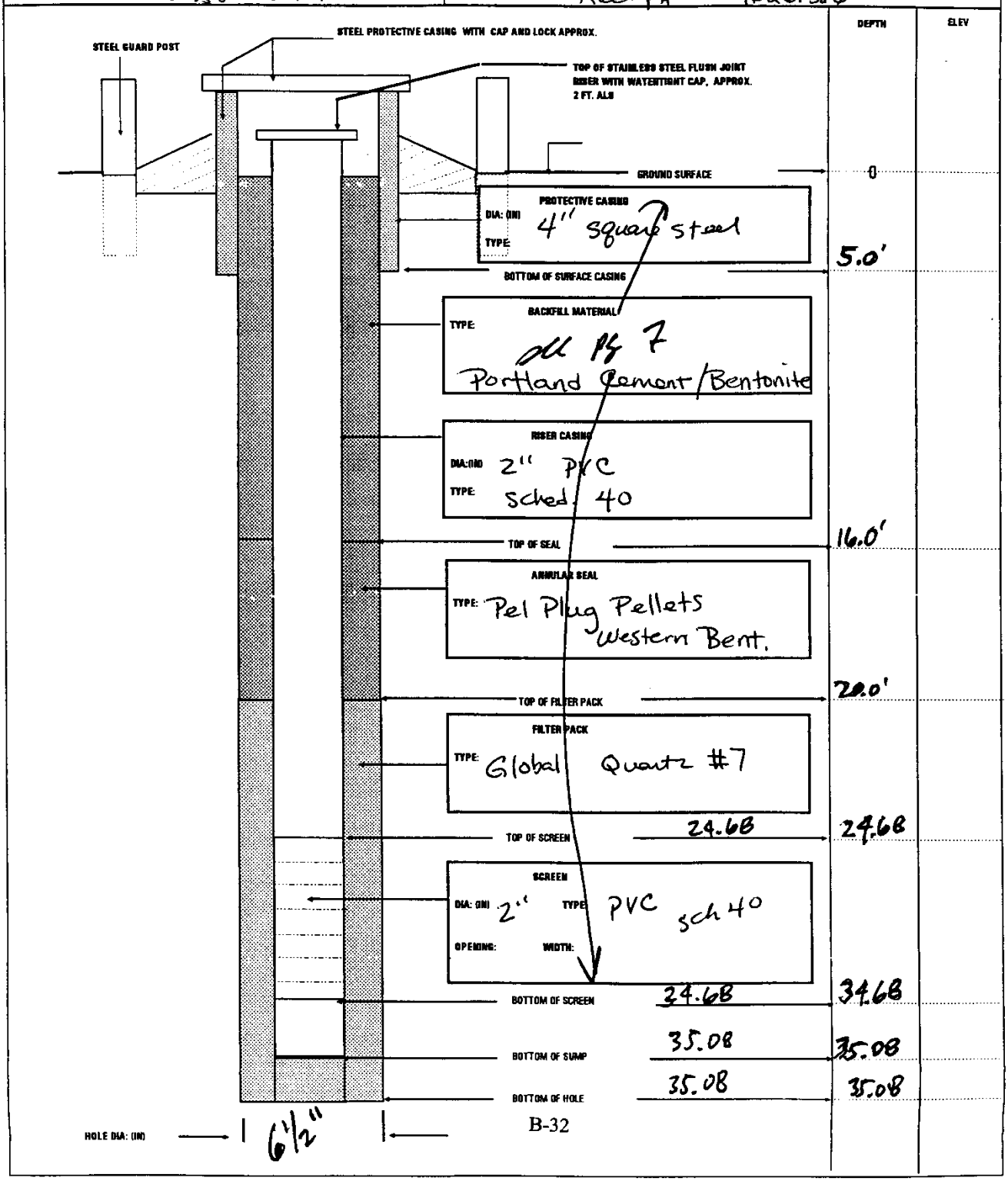
QA CHECK BY: Heather L Smith 9-29-98 (Signature & Date)

B-31

MONITORING WELL

PROJECT NAME: Phase II RI @ WBG and Background Investigation **DELIVERY ORDER NO:** 0080

WELL NUMBER: BKGmw-0006	**BEGIN:** 4-27-98	**END:** 4-27-98
COORDINATES: N: 571910.470 E: 2358643.961	**REFERENCE POINT:** TOP of Riserpipe **ELEVATION:** 1026.380 MSL	



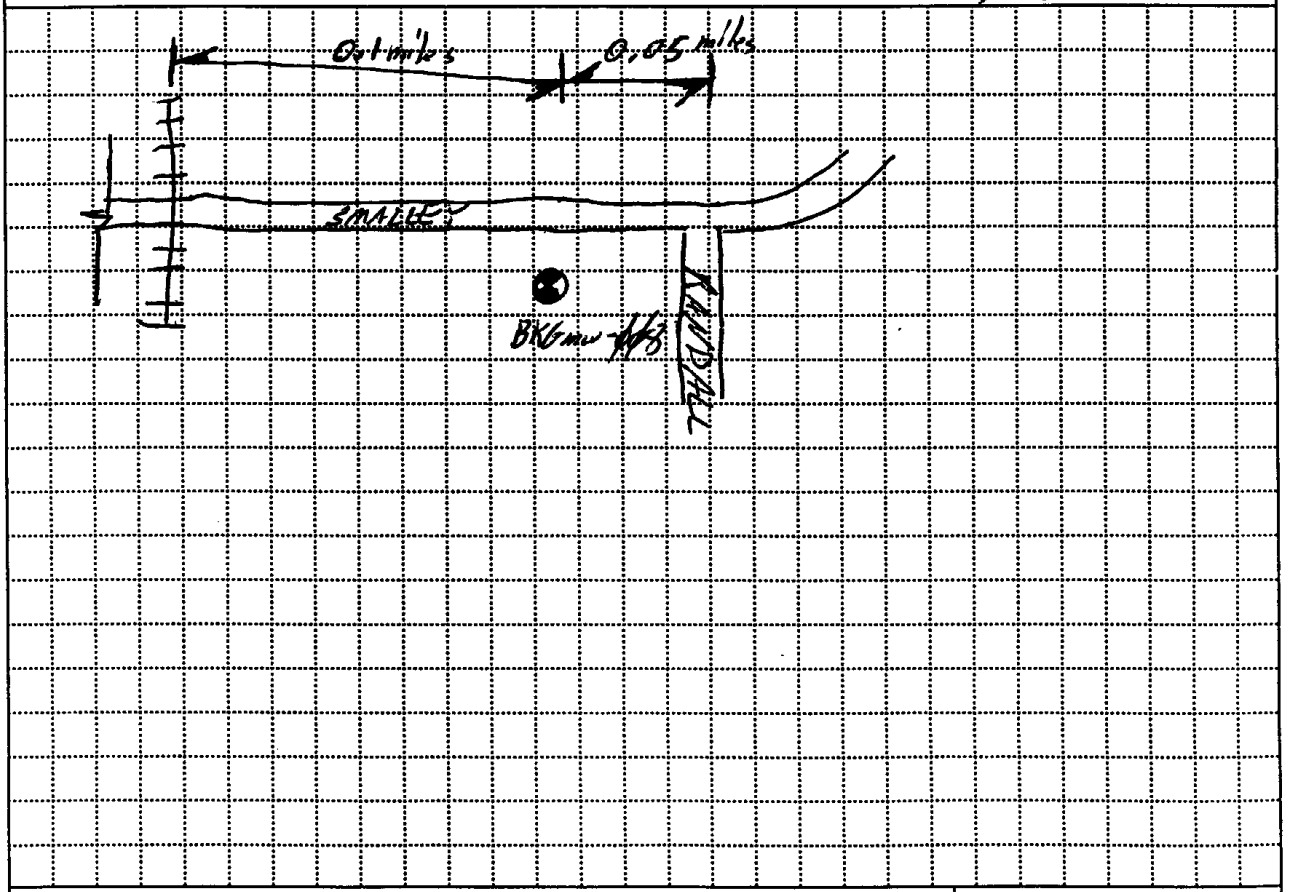
B-32

HTRW DRILLING LOG

DISTRICT Louisville Corps		HOLE NUMBER BKGmw-008
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR Bowser Morner	SHEET 1 SHEETS OF 2
3. PROJECT Phase II RI at WinklepeckBurning Ground and Background Investigation	4. LOCATION RVAAP	
5. NAME OF DRILLER Maynard Lohti	6. MANUFACTURERS DESIGNATION OF DRILL Failing F-7	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 2" ID NX Core barrel 6 1/4" OD HSA's (Cream) 4 1/2" ID HSA's 2 3/4" ID Split Spoon 6" OD Tri-cone Roller Bit 4" ID Continuous split barrel (5ft length)	8. HOLE LOCATION SW of Smalley & Randall Intersection	
	9. SURFACE ELEVATION 968.14	
	10. DATE STARTED 26 Apr 98	11. DATE COMPLETED 27 Apr 98
12. OVERBURDEN THICKNESS 10 ft	15. DEPTH GROUNDWATER ENCOUNTERED 17 ft bg	
13. DEPTH DRILLED INTO ROCK 15 ft	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE 25.0 ft	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED NA	UNDISTURBED NA	19. TOTAL NUMBER OF CORE BOXES NA			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY	OTHER (SPECIFY	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
0-1', 1-3', 3-12'	NA	✓	SVOA's	Explosives		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
		✓				

LOCATION SKETCH/COMMENTS SCALE: NA



PROJECT Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP

HOLE NO. BKG mw-008

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

HOLE NUMBER BKG mw-008

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR Brad Bohn | SHEET 2 of 2

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	1 2 3 4	Silty CLAY; sand: v. fine ~10%, silt ~30%, clay ~60%; Reddish Brown variegated med Gray; subrounded; poorly sorted; med plasticity; soft; moist (CL)	PID-0ppm LEL-0% O_2-21%	NA	1-3 ft BKG820 1825 hrs.	Augered 1.0 ft bls Split spoon 2" Ø from 1-3 ft bls - 100% recovery 3-4 ft sampled above w/ 2" Ø split spoon 100% recovery
	5	Clayey Silt; sand: v. fine, little clay ~40% silt ~50%; Lt brownish yellow w/ variegated gray clay; slightly fissle. Hard; poorly sorted; subrounded; moist low plasticity (ML) 9-9.5 ft SAME AS ABOVE w/ large Dk Reddish Brown Sandstone frag present.	PID-0ppm LEL-0% O_2-21%	NA	6-7 ft BKG821 1920 hrs	4-10 ft sampled w/ 4" Ø direct split barrels 4-9 ft run 100% recovery Attempted 9-12 ft run rock encountered @ 10 ft bls 9-10 ft drilled 0.5 ft recovered, (50%)
	10 16 April 98 16	Cuttings appear as Med Reddish Brown Sandstone	PID-0ppm LEL-0% O_2-21%	NA	NA	Continued drilling w/ 6¼ HSA's, used split barrel but no recovery 26 Apr 98 Competent hard rk. encountered @ 18.5 ft bls. Saturated cuttings present @ 17 ft bls. Ø950 H_2O @ 16.2' bls 1122 H_2O @ 16.5' bls
	18.5 19.2	SANDSTONE; Med Reddish Brown banded light gray; quartz sand & coarse w/ gradational changes ranging from fine to granular grain sizes, hard, mod-well silica cementation; bedding ~105° from vertical; mod-low porosity; subangular; permeability: low-mod primary mod-high secondary, fractured and Fe-stained section @ 21.6-22.0 ft.	PID-0ppm LEL-0% O_2-21%	NA Core Box #1	(Ø830 hrs)	27 Apr 98 H_2O tagged @ 11.0 ft bls TD hole soft tag @ 17.5' bls Converting to 6¼" ID HSA's to ream hole to hard rk. Reamed hole to 19 ft bls. 1390 Tagged H_2O @ 10.10 ft bls Cored from 19.2 ft to 25.0 ft bls. @ 20.0 ft more H_2O present w/ hole and cuttings turned dk. gray. 135Ø Coring complete @ 25.0 ft bls
	25.0	TD = 25.0' bls				

PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation
N 56954.231 E 2372741.876 EL. 970.397 | HOLE NO. BKG mw-008

MONITORING WELL INSTALLATION LOG HOLE NUMBER: BKGmw-008

PROJECT: Phase II RI @ WBG and Background Investigation INSPECTOR: Brad Baker

SHEET 1 OF 1

MONITORING WELL ID: BKGmw-008

INSTALLATION START: DATE: 26 Apr 98 TIME: 0920

INSTALLATION FINISH: DATE: 27 Apr 98 TIME: 1738

ANNULAR SPACE MATERIALS INVENTORY:

GRANULAR FILTER PACK: TYPE: Global #7 Silica Sand QUANTITY: 9.5/50-lb bags

BENTONITE SEAL: TYPE: 3/8" QTK30 Bentonite Pellets QUANTITY: 3 buckets

GROUT: TYPE: Portland (Northwest Type I Cement) QUANTITY: 1.5/94 lb bags lb. Water/Type I Cement ~ 5 lbs bentonite ~ 10 gal H_2O

DESCRIPTION OF WELL SCREEN:

SLOT SIZE (inches): .010 SLOT CONFIGURATION: Horizontal

TOTAL OPEN AREA PER FOOT OF SCREEN: —

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Johnson

TYPE OF MATERIAL BETWEEN BOTTOM OF BORING AND SCREEN: Bottom cap placed on top of rock (bridged bottom)

DESCRIPTION OF WELL CASING:

OUTSIDE DIAMETER: 2.3" NOMINAL INSIDE DIAMETER: 2.0"

SCHEDULE/THICKNESS: PVC Sch 40 COMPOSITION: PVC

MANUFACTURER: Johnson

JOINT DESIGN AND COMPOSITION: Manufactured flush threaded

CENTRALIZERS DESIGN AND COMPOSITION: NA

DESCRIPTION OF PROTECTIVE CASING:

NOMINAL INSIDE DIAMETER: 4"x4" box COMPOSITION: Steel

SPECIAL PROBLEMS ENCOUNTERED DURING WELL CONSTRUCTION AND THEIR RESOLUTION:

NA

Was all well screen and casing material used for construction free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.)? YES [✓] NO [ ]

Was all well screen and casing material used for construction free of unsecured couplings, ruptures, and other physical breakage and/or defects? YES [✓] NO [ ]

Is deformation or bending of the installed well screen and casing minimized to the point of allowing the insertion and retrieval of a 1.0-inch bailer throughout the entire length of the completed well? YES [ ] NO [ ]

QUANTITY OF APPROVED WATER USED FOR FILTER PACK ENPLACEMENT: NA

RECORDED BY: Brad Baker (Signature & Date)

QA CHECK BY: Matt Haley 6-2-98 (Signature & Date)

B-5

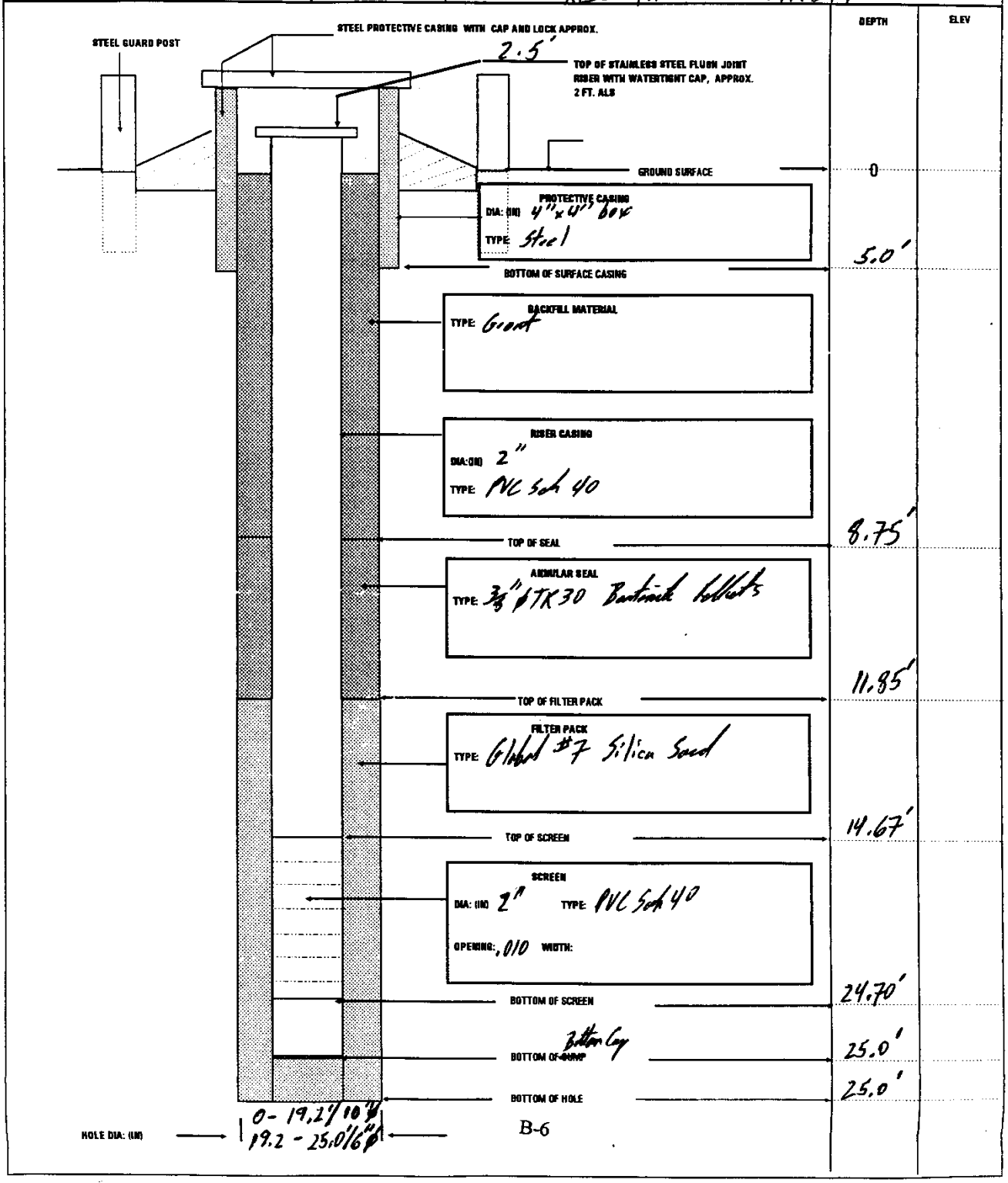
MONITORING WELL

PROJECT NAME: Phase II RI @ WBG and Background Investigation **DELIVERY ORDER NO:** 0060

WELL NUMBER: BKGMW-008 **BEGIN:** 26 Apr 98 **END:** 27 Apr 98

COORDINATES: N: 56954.231 E: 2372741.076

REFERENCE POINT: Top of Riser Pipe **ELEVATION:** 976.397 MSL



B-6

HTRW DRILLING LOG

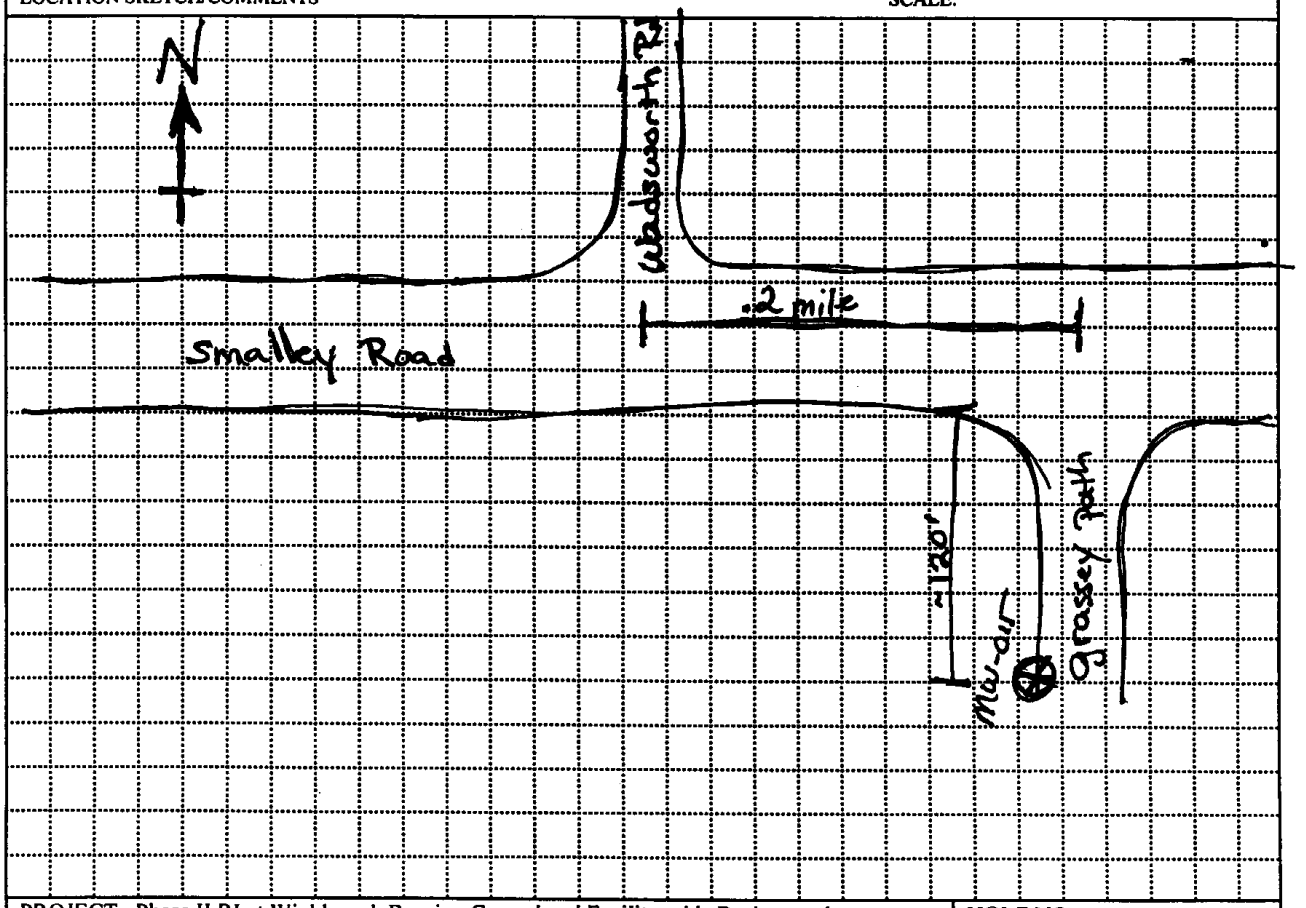
DISTRICT: Louisville Corps		HOLE NUMBER: BX6MW-015
1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: Bowser Morner	SHEET 1 OF 3
3. PROJECT: Phase II RI at WinklepeckBurning Ground and Background Investigation	4. LOCATION: RVAAP	
5. NAME OF DRILLER: John Filburn	6. MANUFACTURERS DESIGNATION OF DRILL: VERSADRILL V100	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 4" & 6" diameter roto sonic drill cores 10' long rock core barrel 2' long bit w/ Carbide Nubs	8. HOLE LOCATION: S. of Smalley Rd ~ 120' (See Map)	
	9. SURFACE ELEVATION: 1035.71	
	10. DATE STARTED: 1300 5-5-98	11. DATE COMPLETED: 1700 5-5-98
12. OVERBURDEN THICKNESS: 10.5'	15. DEPTH GROUNDWATER ENCOUNTERED: in Shale around 30' BGS	
13. DEPTH DRILLED INTO ROCK: 10.5'	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: W.L. @ ~30' BGS after overnight ~15 hrs	
14. TOTAL DEPTH OF HOLE: 55'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): NA	

18. GEOTECHNICAL SAMPLES	DISTRICT	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
2-3' and 9-10'	X		2

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY	OTHER (SPECIFY	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
2-3' and 9-10'		X	Explosives			90

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
		X		

LOCATION SKETCH/COMMENTS — SCALE:



PROJECT: Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP

HOLE NO.: MW-15

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

HOLE NUMBER BKG MW15

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR | SHEET 2 of 3

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0–1	Topsoil; DK gray; SILT w/ Little clay; moist Roots; organic matter; bits of Brick			1'-3' BK0834	
	1–2	Clay, some SILT (CL); Brown; moist; soft; low plasticity				
	2–3					
	3–4	Sandy SILT (ML-CL); well Brn dry; st. stiff; some U.F Sand; SILT; and little clay stratification Apparent				
	4–5					
	5–6				0.0 PPM	25-35' Run comes out powdered and compressed into only ~ 4' of core for 10' Run, not suitable for putting into core Box. Shale very soft to be powdered and compressed like that.
	6–7					
	7–8					
	8–9					DARK GRAY SHALE Thinly Bedded, 1/4" or so
	9–10	9-10' collect Geotech				
	10–11	Weathered Shale Bedrock LT. gray and dry shale with silt/clay stringers very Hard.... Cementation Apparent w/in shale zones	10.8' BGS CONTACT w/weathered shale			
	11–12					
	12–13					
	13–14					
	14–15	Competent Rock				
	15–16	DK gray shale: Pulverized by Rig unable to Box up into core Box Thinly Bedded		35-45 Core Box # MW15-1		
	16–17					
	17–18					
	18–19					
	19–20					

Cont'd on Pg 17

PROJECT Phase II RI at Winkiepeck Burning Ground and Background Investigation
N 569339.868 E 2361482 ELEV. 1037.897

HOLE NO. BKG MW-15

HTRW DRILLING LOG

HOLE NUMBER BKGMW15

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR Matt Odey | SHEET 3 of 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	41					
	42					
	43					
	44					
	45	45-55' Run 12 minutes to core		45-55 Core Box # MW15-2		
	46	SHALE, DK. gray Thinly Bedded.				
	47					
	48					
	49					
	50	V.f. Sand to silt siltstone lt. gray				
	51	↓				
	52					
	53					
	54	grading into ↓				
	55	@55' gray F. grained SS w/ small Interbeds of dk gray Shale				
	56	BOB at 55'				
	57					
	58					
	59					
	60					

61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

A-44

PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation | HOLE NO BKG MW-15

MONITORING WELL INSTALLATION LOG **HOLE NUMBER:** BKG MW15

PROJECT: Phase II RI @ WBG and Background Investigation **INSPECTOR:** Matt Od

SHEET 1 **OF** 1

MONITORING WELL ID: BKGMW15

INSTALLATION START: DATE: 5-6-98 TIME: 10:00

INSTALLATION FINISH: DATE: 5-6-98 TIME: 13:00

ANNULAR SPACE MATERIALS INVENTORY: Global Drilling Suppliers

GRANULAR FILTER PACK: TYPE: Quartz #7 (3/8") QUANTITY: 12- 50lb bags

BENTONITE SEAL: TYPE: Pel-Plug Bentonite Pellets QUANTITY: 1- 5 gallon bucket.

GROUT: TYPE: Cement/Bentonite (5%) QUANTITY: ____

DESCRIPTION OF WELL SCREEN:

SLOT SIZE (inches): .010" SLOT CONFIGURATION: Horizontal

TOTAL OPEN AREA PER FOOT OF SCREEN: ____

OUTSIDE DIAMETER: 2" NOMINAL INSIDE DIAMETER: 2"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Global Drilling Supplies

TYPE OF MATERIAL BETWEEN BOTTOM OF BORING AND SCREEN: #7 Quartz Sand

DESCRIPTION OF WELL CASING: MS 9-29-98

OUTSIDE DIAMETER: 2 5/16" NOMINAL INSIDE DIAMETER: 2"

SCHEDULE/THICKNESS: Sch 40 COMPOSITION: PVC

MANUFACTURER: Global

JOINT DESIGN AND COMPOSITION: Threaded

CENTRALIZERS DESIGN AND COMPOSITION: ____

DESCRIPTION OF PROTECTIVE CASING:

NOMINAL INSIDE DIAMETER: 4" Square COMPOSITION: Steel

SPECIAL PROBLEMS ENCOUNTERED DURING WELL CONSTRUCTION AND THEIR RESOLUTION:

MS 9-29-98

Was all well screen and casing material used for construction free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.)? YES [✓] NO [ ]

Was all well screen and casing material used for construction free of unsecured couplings, ruptures, and other physical breakage and/or defects? YES [✓] NO [ ]

Is deformation or bending of the installed well screen and casing minimized to the point of allowing the insertion and retrieval of a 1.0-inch bailer throughout the entire length of the completed well? YES [✓] NO [ ]

QUANTITY OF APPROVED WATER USED FOR FILTER PACK ENPLACEMENT: ____

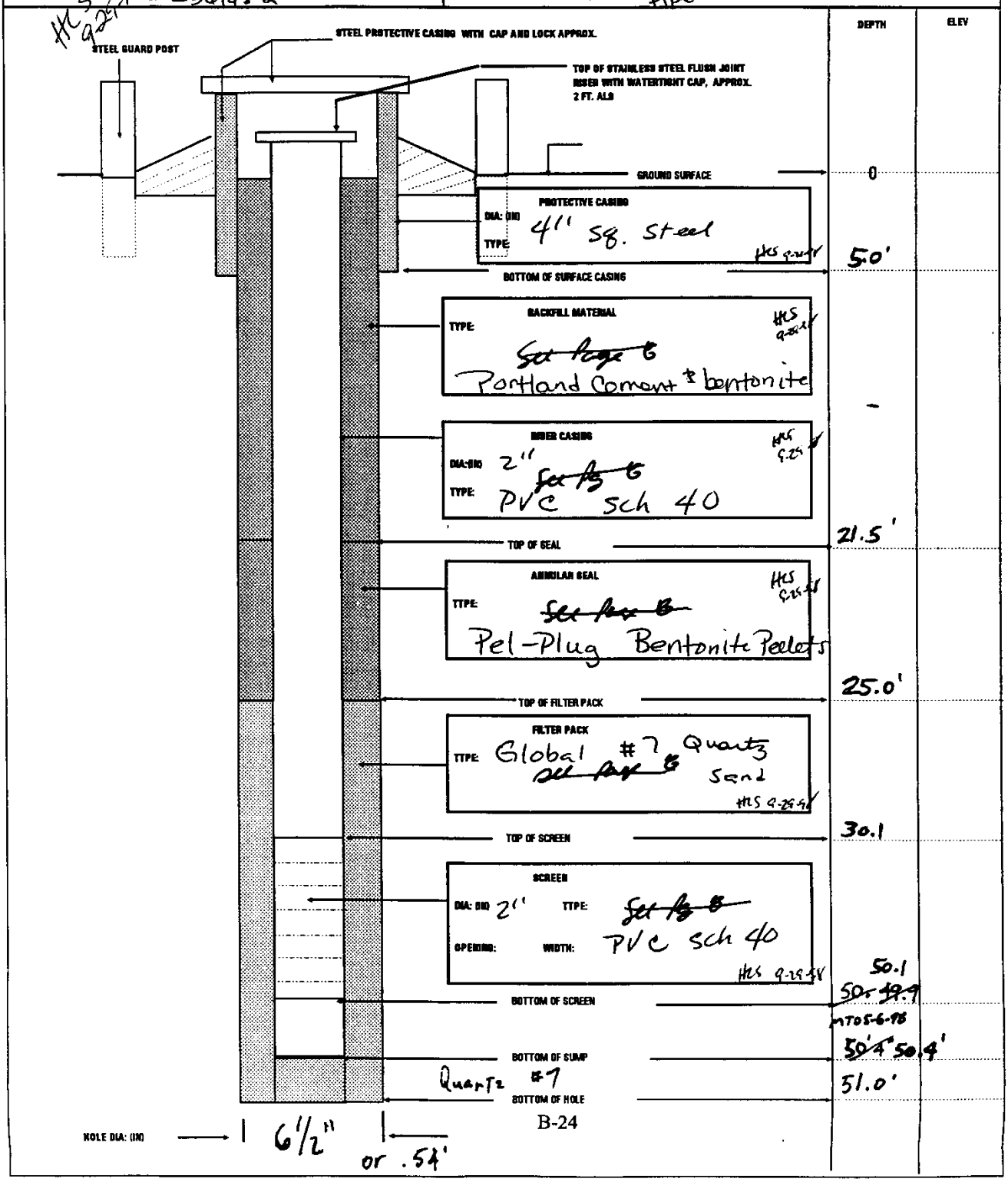
RECORDED BY: Matt Od (Signature & Date) QA CHECK BY: Heather L Smith 9-29-98 (Signature & Date)

B-23

MONITORING WELL

PROJECT NAME: Phase II RI @ WBG and Background Investigation HLS 9-28-98 **DELIVERY ORDER NO:** 0060

WELL NUMBER: BKGmw-15	**BEGIN:** 5-6-98 1000	**END:** 5-6-98 1300	
COORDINATES: N: 569339.868 E: 236148.2 HLS 9-28-98	**REFERENCE POINT:** Top of Riser Pipe	**ELEVATION:** 1037.897 MSL	



HTRW DRILLING LOG

1. COMPANY NAME SAIC	DISTRICT Louisville Corps	HOLE NUMBER BKGMW18
	2. DRILL SUBCONTRACTOR Bowser-Morner	SHEET 1 OF 2

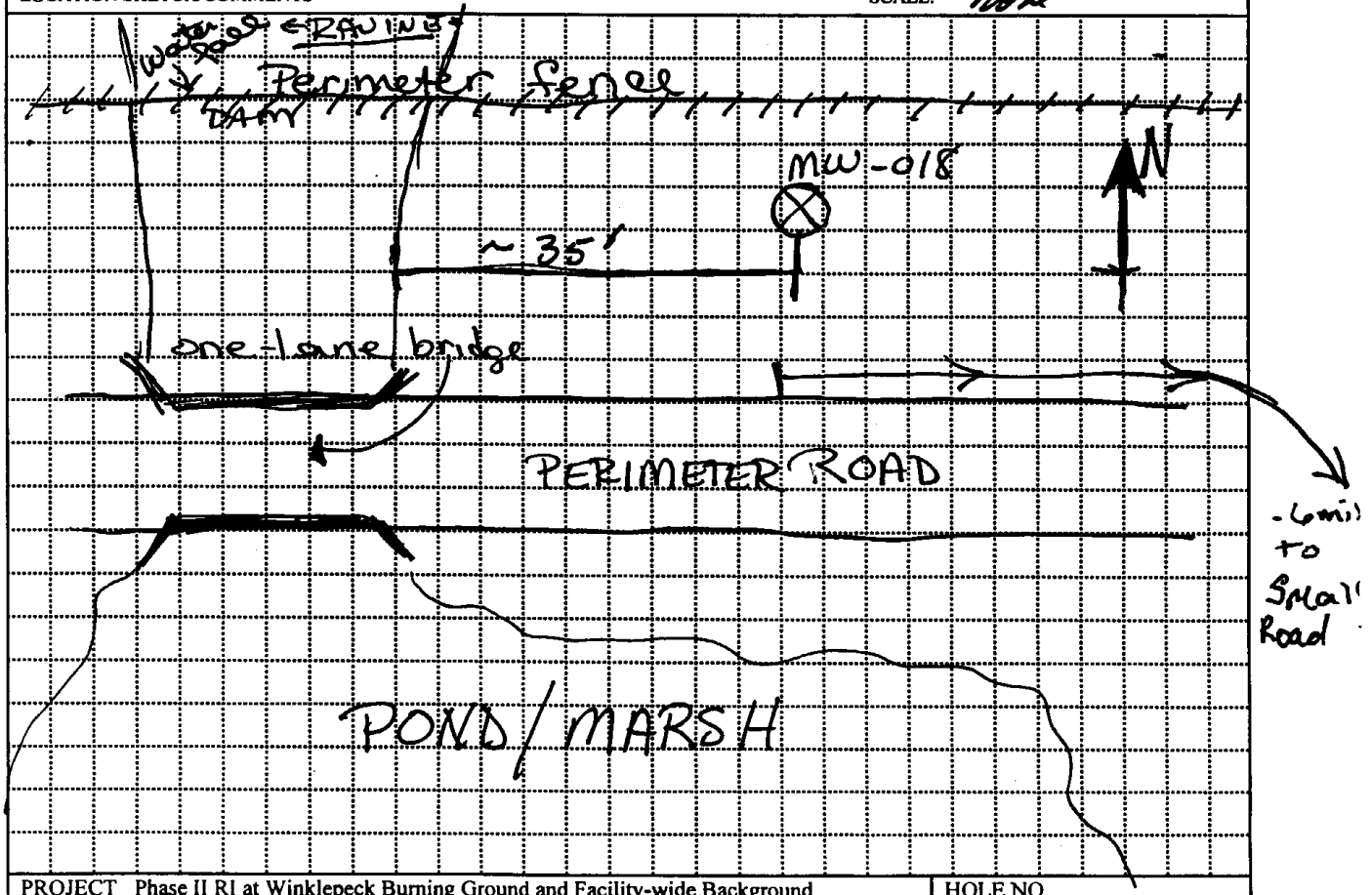
3. PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation	4. LOCATION RVAAP
5. NAME OF DRILLER John Filburn	6. MANUFACTURERS DESIGNATION OF DRILL Versa Drill-100 (V-100)
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 4", 6" Ø Core barrels For Rotasonic Rig, 10' long 2' long bit w/ Carbide nubs.	8. HOLE LOCATION near Perimeter Fence as shown on sketch
	9. SURFACE ELEVATION 1040.82
	10. DATE STARTED 5-6-98 1417 / 11. DATE COMPLETED 5-7-98 0830
12. OVERBURDEN THICKNESS 3'	15. DEPTH GROUNDWATER ENCOUNTERED In Sandstone ~15' BGS based on equilibration
13. DEPTH DRILLED INTO ROCK 3'	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED 15' - one hour
14. TOTAL DEPTH OF HOLE 25'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTRICT	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
1-2' BGS	X		2

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY	OTHER (SPECIFY	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
1-2' BGS		X	Explosives			95%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
				Matt Oxley

LOCATION SKETCH/COMMENTS SCALE: None



PROJECT Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP

HOLE NO. BKGMW-18

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

HOLE NUMBER BKbMW-01B

PROJECT Phase II RI at WBG and Background Investigation | INSPECTOR Matt Olsen | SHEET 2 of 2

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	Topsoil DK gray SANDY SILT Roots, wood, etc	0.0 ppm			SANDSTONE cont'd Tannish gray in color
	1	SANDY SILT (ML): LT. Brown F-V.F Sand; Moist; soft; maybe 5-10% Clay				
	2	SANDY GRAVEL (GW): F-C Sand and F-C Gravel To 3" Subr -R; LT. Brn; Moist-Wet; loose				
	3	Weathered Sandstone reddish Brn; V. well sorted				
	4					
	5	SANDSTONE LT. Brown well sorted; Predom F. Grained - M. grained Predom Quartz Reddish Brn streaks in Top 10' of SS X-Sets X; Horizontal Bedding; Thickly Bedded		5-13.5 Core Box # MW1B-1		5-15 Core Only 5-11.5 lost Bottom 3.5' Drillers Able to Recover another 2' Of 5-13.5' Core Box # MW1B-1
	6					
	7					
	8					BOB at 25' BGS
	9					
	10					
	11					
	12					
	13					
	14					
	15			15-25 Core Box # MW1B-2		
	16					
	17					
	18					
	19					
	20					

PROJECT Phase II RI at Winklepeck Burning Ground and Background Investigation | HOLE NO. BK6 MW01B

N570873.349 E2354993.909 ELEV. 1043.060

MONITORING WELL INSTALLATION LOG HOLE NUMBER: BKG MW-8

PROJECT: Phase II RI @ WBG and Background Investigation INSPECTOR: Matt O'Leary

SHEET 1 OF 1

MONITORING WELL ID: BKG MW-8

INSTALLATION START: DATE: 5-6-98 TIME: 16:00

INSTALLATION FINISH: DATE: 5-7-98 TIME: 0830

ANNULAR SPACE MATERIALS INVENTORY:

GRANULAR FILTER PACK: TYPE: Quartz #7 QUANTITY: 8 - 50 lb. bags

BENTONITE SEAL: TYPE: Pel-Plug 3/8" Bent. Pellets QUANTITY: 1 5 gal bucket

GROUT: TYPE: Cement/Bentonite 5%. Portland Type I QUANTITY: 15 Gallons

DESCRIPTION OF WELL SCREEN:

SLOT SIZE (inches): .010 SLOT CONFIGURATION: Horizontal

TOTAL OPEN AREA PER FOOT OF SCREEN: ———

OUTSIDE DIAMETER: 2" + 5/16" NOMINAL INSIDE DIAMETER: 2"

SCHEDULE/THICKNESS: Sch. 40 COMPOSITION: PVC

MANUFACTURER: Global Drilling Suppliers

TYPE OF MATERIAL BETWEEN BOTTOM OF BORING AND SCREEN: N/A

DESCRIPTION OF WELL CASING:

OUTSIDE DIAMETER: 2" + 5/16" NOMINAL INSIDE DIAMETER: 2"

SCHEDULE/THICKNESS: Scl 40 COMPOSITION: PVC

MANUFACTURER: Global Drilling Suppliers

JOINT DESIGN AND COMPOSITION: Threaded PVC

CENTRALIZERS DESIGN AND COMPOSITION: ———

DESCRIPTION OF PROTECTIVE CASING:

NOMINAL INSIDE DIAMETER: 4" Square COMPOSITION: Steel

SPECIAL PROBLEMS ENCOUNTERED DURING WELL CONSTRUCTION AND THEIR RESOLUTION:

HKS 9-29-98

Was all well screen and casing material used for construction free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.)? YES [X] NO [ ]

Was all well screen and casing material used for construction free of unsecured couplings, ruptures, and other physical breakage and/or defects? YES [X] NO [ ]

Is deformation or bending of the installed well screen and casing minimized to the point of allowing the insertion and retrieval of a 1.0-inch bailer throughout the entire length of the completed well? YES [X] NO [ ]

QUANTITY OF APPROVED WATER USED FOR FILTER PACK ENPLACEMENT: ———

RECORDED BY: Matt O'Leary 5-6-98 (Signature & Date)

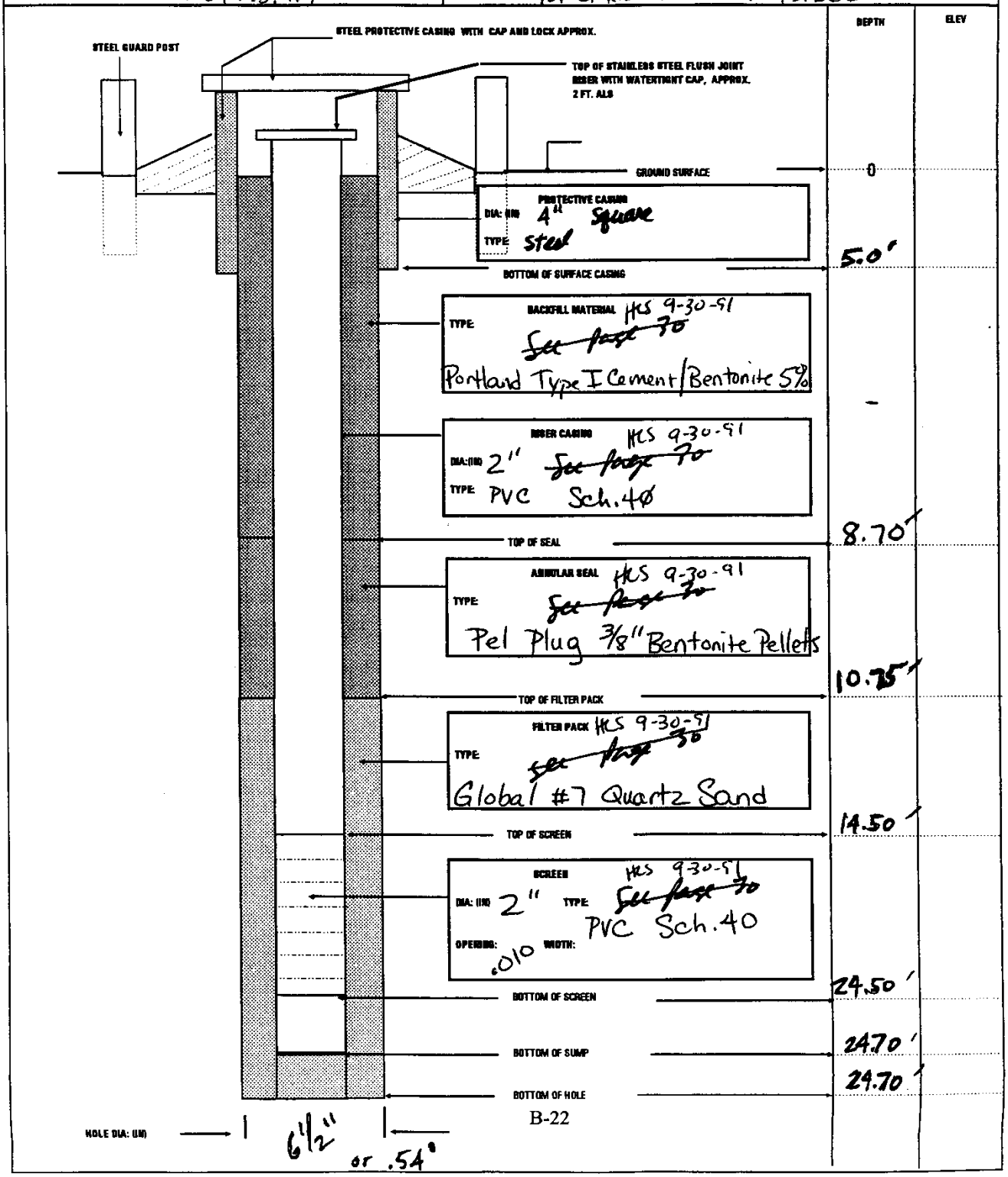
QA CHECK BY: Heather K. Smith 9-29-98 (Signature & Date)

B-21

MONITORING WELL

PROJECT NAME: Phase II RI @ WBG and Background Investigation **DELIVERY ORDER NO:** 0060

WELL NUMBER: BKGMW-18	**BEGIN:** 5-6-98 1600	**END:** 5-7-98 0830
COORDINATES: N: 570873.349 E: 2354993.909	**REFERENCE POINT:** TOP of Riser Pipe **ELEVATION:** 1043.060 MSL	



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APPENDIX A.4

Basal Sharon Conglomerate – Boring Logs

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TEC-Weston Joint Venture

(BKGmw-024)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON1

Company/Project: TEC-Weston Joint Venture/Facility-Wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud	Ground Surface Elevation: —		Datum: —
~~Sampling Device~~: Drill: Versa Sonic Model 1111	Borehole Diameter (inches): 6" bottom 24'		Total Depth (Feet): 164'
Date/Time Drilling Started: 8/2/16 - 13:30	Date/Time Total Depth Reached: 8/10/16 15:00		164'

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/ lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
	100%			0.0 ppm				(0.0-0.85') Topsoil, brown to tan, top 0.4' contains roots and grass, silty to sandy with occasional subangular sandstone boulders, dry	
1.0	100%			0.0 ppm			ML	(0.85'-1.80'): Sandy silt, light brown to slightly orange, dry, occasional angular sandstone boulders	
2.0	100%			0.0 ppm			SM	(1.80'-3.0'): Silty sand, tan to slightly orange, numerous angular/subangular sandstone boulders, micaceous, dry, top of weathered bedrock at 3.0'	Top of weathered and soft sandstone bedrock at 3.0'
3.0									
4.0	0.0%			0.0 ppm (at borehole)			Lost Core (SS)	(3.0'-5.75'): Lost core. Recovered core above and below this zone indicates likely sandstone.	Lost Core
5.0									
6.0									- Began drilling with water at 8.0'
7.0							Sandstone (SS)	(5.75'-10.0'): Sandstone: Tan to light brown with orange streaks (thin green sandstone lense at ~8.0'), weathered, medium to coarse grained, moderately soft, scattered red-brown streaks, becoming more firm and competent downward	- Temporary 10" steel casing installed to 8.0'.
8.0	100%			0.0 ppm					
9.0									
10.0									

TEC-Weston Joint Venture

(BKGMW-024)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON1

Company/Project: TEC-Weston Joint Venture / Facility-Wide Groundwater Monitoring			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cordas)		Drilling Company: Duncan Brother Drilling, Inc.
Drilling Foreman: Mark Michaud	Ground Surface Elevation:		Datum: —
Sampling Device: Drill: Versa Sonic Model 111	Borehole Diameter (inches): 6" bottom 24'		Total Depth (Feet): 164'
Date/Time Drilling Started: 8/2/16 - 13:30	Date/Time Total Depth Reached: 8/10/16 15:00		164'

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/ lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
10.0	70%			0.0 ppm			Sandstone (SS)/ Lost Core	(10.0'-20.0'): Sandstone, tan with scattered orange streaks, medium to coarse grained, friable, moderately hard, gravel and fracture zone at ~12.0'	Lost ~3.0' Core
20.0	100%			0.0 ppm			Sandstone (SS)	(20.0'-30.0'): Sandstone, tan with scattered orange streaks decreasing downward, medium to coarse grained, less friable than above and becoming more competent, micaceous, argillaceous	Drilling stopped at 30' on 8/2/16
30.0	100%			0.0 ppm			Sandstone (SS)	(30.0'-40.0'): Sandstone, tan with rare orange streaks, medium to coarse grained, moderate cementation, slightly friable, very slightly argillaceous and micaceous	1.0' thick claystone from 36.72'-37.72', gray, soft, iron stain at base, massive
40.0	50%			0.0 ppm			Sandstone (SS)/ Lost Core	(40.0'-50.0'): Sandstone, tan with red-orange stains, medium to coarse grained, somewhat friable and weathered, slightly micaceous and argillaceous	Lost 5.0' Core. Material that came out of hole was completely unconsolidated sand (likely from base)
50.0	50%			0.0 ppm			Sandstone (SS)/ Lost Core	(50.0'-60.0') Sandstone. Light brown to red-orange, only ~2.0' of entire run contained consolidated rock (most unconsolidated sand). Some sub-to well rounded quartz pebbles (up to ¾")	Lost 5.0' core. Most was completely unconsolidated sand. Drilling stopped at 60' on 8/3/16
60.0								General Note: The unconsolidated sand discussed above is likely resultant from the sonic drilling, and is not reflective of an actual formation washout zone.	
60.0	70%			0.0 ppm			Sandstone (SS)/ Lost Core	(60.0-70.0') Sandstone. Gray to slightly light brown, very rare orange streaks, massive, hard, competent and well cemented, fine to medium grained, micaceous, argillaceous, mostly unweathered (few slight Fe stains)	Lost ~3.0' Core
70.0	100%			0.0 ppm			Sandstone (SS)	(70.0-80.0') Sandstone, gray with tan lenses, hard, competent and well cemented, fine to medium grained, rare cross bedding, argillaceous, mostly unweathered	Driller set temporary outer 8" steel casing to 80'
80.0	12.5%			0.0 ppm			Sandstone (SS) and Lost Core	(80.0'-90.0'): Sandstone to silty sandstone, dark gray, very fine grained, very hard and well cemented, very rare quartz pebbles, unweathered, some tan coloration in fractures. Some broken pieces within recovered core were tan/light brown	Lost 8.75' Core. Unable to determine where lost core was located within the 10' run, but based on return water color the darker rock was encountered near base of run.
90.0									
9..0									

TEC-Weston Joint Venture

(BKGmw-024)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON1

Company/Project: TEC-Weston Joint Venture / Facility-Wide Groundwater Monitoring			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stanfield (Cordoa)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud	Ground Surface Elevation: —		Datum: —
Sampling Device: Drill: Versa Sonic Model 1111	Borehole Diameter (inches): 6" bottom 24'		Total Depth (Feet): 164'
Date/Time Drilling Started: 8/2/16 - 13:30	Date/Time Total Depth Reached: 8/10/16 15:00		164'

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
90.0									
	N/A			0.0 ppm			Sandstone (SS)	(90.0'-100.0'): Sandstone, light brown, well cemented, slightly conglomeratic, very hard, micaceous. Bottom 7.3' appears to be gray with light brown to tan streaks. This section of core was originally slipped out of the core barrel during extraction from the borehole and driller had to overdrill it to retrieve it.	→ This resulted in almost complete pulverization of this interval. Any small intact pieces were very well cemented. Drilling stopped at 100' on 8/4/16.
100.0									
	12.5			0.0 ppm			Sandstone (SS)/ Lost Core	(100.0'-110.0') Sandstone, gray to slightly light brown, well cemented and hard, some conglomerate in the intact and recovered core. Core recovery issue same as above. Most core lost or	→ pulverized during recovery attempt. Drilling stopped at 110' on 8/5/16.
110.0									
	12.5			0.0 ppm			Sandstone (SS)/ Lost Core	(110.0'-120.0') Sandstone, gray to tan, well cemented and hard, mostly fine to slightly medium grained, some sub-angular quartz pebbles. Core recovery issue same as above.	
120.0									
	0.0			0.0 ppm			Lost Core	(120.0'-130.0') Lost all core. Cutting and water returns indicate likely gray sandstone. Driller reports hard rock.	
130.0									
	0.0			0.0 ppm			Lost Core	(130.0'-140.0') Lost all core. Cutting and water returns indicate likely gray sandstone. Driller reports hard rock.	6" temporary steel casing installed to 140'. Drilling stopped at 140' on 8/9/16
140.0									
	100			0.0 ppm			Sandstone (SS)	(140.0'-142.25'): Sandstone, gray, hard, moderate cemented, rare brown streaks, medium-fine grained, conglomeratic at immediate base	Began conventional core drilling at 140'. Used wireline. No sonic.
142.25									
	100			0.0 ppm			Sandstone (SS)	(142.25'-145.66'): Sandstone, light brown to tan, fractured, medium grained, moderate cementation, subangular quartz pebbles scattered throughout, scattered iron staining	
145.66									
	100			0.0 ppm			Sandstone (SS)	(145.66'-156.53'): Sandstone, gray to light gray, medium grained, hard and well cemented, well rounded quartz pebbles at base, coal spar at 148.6', quartz inclusions increasing downward	
156.53									
	100			0.0 ppm			Conglomerate	(156.53'-159.43'): Conglomerate, light gray, coarse grained, very heavy inclusions of rounded and subangular quartz pebbles (some up to 1/4"), rare coal spars, and pyrite, siderite nodules and bands.	→ sharp basal contact. Base of Sharon Conglomerate
159.43									
	100			0.0 ppm			Claystone	(159.43'-164'): Claystone, gray to dark gray, soft, massive bedding, broken, bottom of hole.	
164.0									

Note: In instances where core loss has occurred and where "lost core" does not have its own entry, it is not possible to determine where the core loss occurred within a respective core run.

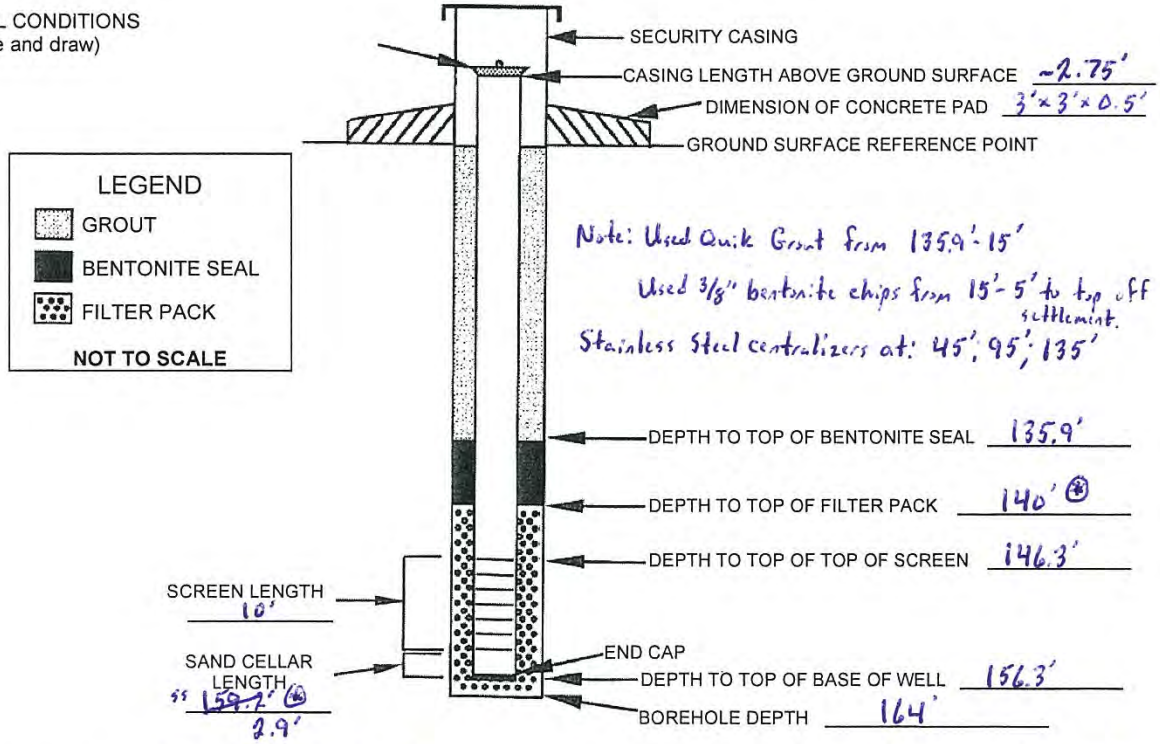
TEC-Weston Joint Venture

Well Construction Details

FIELD REPRESENTATIVE: Steve Stansfield (Cardno)
DRILLING CONTRACTOR: Duncan Brothers Drilling
DRILLING TECHNIQUE: Sonic / Conventional Wireline Core
AUGER SIZE AND TYPE: N/A
BOREHOLE IDENTIFICATION: BKG-SCON1 (BKGmw-024)
BOREHOLE DIAMETER: 6" within screened zone
WELL IDENTIFICATION: BKG-SCON1 (BKGmw-024)
WELL CONSTRUCTION START DATE: 8/11/16
WELL CONSTRUCTION COMPLETE DATE: 8/26/16
SCREEN MATERIAL: 2" Schedule 80 PVC (0.010" slot)
SCREEN DIAMETER: ~~2"~~ 1.94" ID; 2.38" OD
STRATUM-SCREENED INTERVAL (FT): 10' Screen
CASING MATERIAL: 2" Schedule 80 PVC
CASING DIAMETER: ~~2"~~ 1.94" ID; 2.38" O.D.

TYPE OF FILTER PACK: Global #5 Sand
GRADATION: 12 x 20
AMT. OF FILTER PACK USED: 4-50 lb. bags
TYPE OF BENTONITE: 3/4" chips
AMT. OF BENTONITE USED: 1-50 lb. bag (Filter Pack Seal) 23.5 bags Annular Seal
TYPE OF CEMENT: N/A (Used bentonite grout)
AMT. OF CEMENT USED: N/A (Used bentonite grout)
GROUT MATERIAL USED: Baried Quik-Grout 20% High Solids / 3/8" Bentonite Chips
DIMENSIONS OF SECURITY CASING: 8' x 6"
TYPE OF WELL CAP: ~~Cap~~ 2" Torque Well Plug
TYPE OF END CAP: PVC Threaded
COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: Duncan Brothers Drilling
INSTALLATION OBSERVED BY: Steve Stansfield (Cardno)
DISCREPANCIES: (B) From 164-159.2', borehole backfilled with bentonite chips (3/4"). Sand pack interval from 159.2'-140' mixed with formation sand that could not be flushed from borehole.

TEC-Weston Joint Venture

(BKGmw-025)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON2

Page 1 of 6

Company/Project: TEC-Weston Joint Venture/Facility-Wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud / John Keifer	Ground Surface Elevation: —		Datum: —
~~Sampling Device~~: Drill: Versa Sonic Model 150	Borehole Diameter (inches): 6 3/8 (Screened Interv.)		Total Depth (Feet): 282.5
Date/Time Drilling Started: 8/19/16 0905	Date/Time Total Depth Reached: 8/30/16 1410		

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
	100%			0.0			Topsoil	(0.0'-0.5') Topsoil, dark brown, dry, numerous roots	
	100%			0.0			Silty Sand (SM)	(0.5'-1.9'): Silty sand, light brown, dry, crumbly and loose, scattered gray clay inclusions, occasional subrounded sandstone pebbles (1/8")	
2.0									
	100%			0.0			Silty Sand (SM)	(1.9'-4.5'): Silty sand, tan to slight orange, dry, moderately dense, scattered gray clay inclusions, occasional subrounded sandstone sandstone pebbles	
4.0									
6.0							Clayey Sand (SC)	(4.5'-11.5'): Clayey sand, tan with occasional orange sandstone chip inclusions, slightly moist, stiff, some subrounded quartz pebbles (< 1/8")	Driller set temporary 10" outer steel casing to 5'
8.0	100%			0.0					
10.0									
12.0							Silty Clay (CL)	(11.5'-19.0'): Clayey silt, gray, slightly moist, medium stiff to soft, becoming more sandy and loose downward	Driller had to use water to get material out of core barrel
14.0									
16.0	100%			0.0					
18.0									
20.0								see page 2 for 19'-21'	

TEC-Weston Joint Venture

(BKG$_{MW}$-025)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON2

Company/Project: TEC-Weston Joint Venture/Facility-wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud / John Keifer	Ground Surface Elevation: —		Datum: —
Sampling Device: Drill: Versa Sonic Model 150	Borehole Diameter (inches): 6 7/8 (Screened Int.)		Total Depth (Feet): 282.5
Date/Time Drilling Started: 8/19/16 0905	Date/Time Total Depth Reached: 8/30/16 1410		

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
20.0	100%			0.0			SM	(19.0'-21.0'): Silty sand, mostly dry, brown to tan, stiff, occasional orange sandstone inclusions	Began drilling with water at 19'
22.0							Silty Clay (CL)	(21.0'-27.2'): Clayey silt, gray, soft, moderate plasticity	
24.0	100%			0.0					
26.0									
28.0							Clayey Sand (SC) and Lost Core	(27.2'-39.0'): Clayey sand, gray, fine grained, loose, rare subrounded quartz pebbles (some up to 1/2"), crumbly. Comes out of core barrel as soft, unconsolidated clayey sand that can be molded	Driller only recovered 3.8' of this unit (32%)
30.0									
32.0	32%			0.0					
34.0									
36.0									
38.0									
40.0								See page 3 for 39'-49'	

TEC-Weston Joint Venture

(BKGmw-025)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON2

Company/Project: TEC-Weston Joint Venture/Facility-Wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Dunean Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud / John Keifer	Ground Surface Elevation: —		Datum: —
Sampling Device: Drill: Versa Sonic Model 1111	Borehole Diameter (inches): 6 3/4 (Screened Int.)		Total Depth (Feet): 282.5
Date/Time Drilling Started: 8/19/16 0905	Date/Time Total Depth Reached: 8/30/16 1410		

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
40.0	12.5%			0.0 ppm			Conglomerate and Lost Core	(39'-49'): Conglomerate, numerous subangular to rounded quartz pebbles (coarse to 1/2"), matrix is rather loose and rock is semi-consolidated, poor core recovery.	- Recovered 12.5%. - Top of bedrock may be within 39' to 49' core run
50.0	0.0%			0.0 ppm			Lost Core	(49'-60'): Driller lost all core. Cuttings suggest a possible gray sandstone with a possible very thin coal.	- Driller switched from Sonic to Conventional Wireline Core drilling at 60'
60.0	0.0%			0.0 ppm			Lost Core	(60'-65'): Lost core. May possibly be mostly broken shale	- Driller lost core via conventional coring methods
	100%			0.0			Claystone	(65'-66.6'): Claystone, dark gray, soft to very soft, badly broken	
70.0	100% (66.6'-70')			0.0 ppm (67'-70')			Shale and Lost Core	(66.6'-90'): Shale and Lost Core. Gray to dark gray with moderately hard and soft zones; high clay content; fissile; thinly bedded and broken over most of the interval; clay to near mud seams scattered throughout	- Stopped drilling at 70' on 8/19 - Poor core recovery - Difficult to drill; core gets stuck in barrel during drilling and does not advance for additional core to enter barrel. Stopped drilling at 90' on 8/22
80.0	50% (70'-80')			0.0 ppm (70'-80')					
90.0	50% (80'-90')			0.0 ppm (80'-90')					
	12.5%			0.0 ppm			Shale/ Cannel Coal/ Lost Core	(90'-100'): Most of interval lost core. Recovered core consisted of Cannel Coal (broken, blocky) with pyrite. Base of interval was a gray, firm shale	- Driller began Sonic drilling at 90'.
100	0.0%			0.0 ppm			Lost Core	(100'-110'): Driller lost all core returns. Cuttings suggest a firming of rock and becoming slightly sandy.	- Sonic drilling from 100'-110'
110	18%			0.0 ppm			Shale; Silty Shale; Lost Core	(110'-120'): Shale and Silty Shale; dark gray to gray; moderately firm; rare siderite nodules; some sandy/silty laminations; recovered only 1.8'	- Sonic drilling from 110'-120' - Switched to Conventional Core Drilling at 120'
120	42%			0.0 ppm			Shale; Lost Core	(120'-127.75'): Shale, with sandy streaks, gray, moderately firm, broken at top, sand streaks decreasing downward, Poor core recovery	- Driller installed screw drill bit (for soft rock drilling)
130	78%			0.0			Shale/LC	(127.75'-130') Dark gray/near black, moderately soft, somewhat coated.	Stopped drilling at 130' on 8/23
	18%			0.0 ppm			Shale & Lost Core	(130'-136.7') Shale, gray moderately firm, sandstone streaks throughout, thin bedded	- Driller lost ~5.5' - Base of shale at 136.7'
140	100%			0.0 ppm			Sandstone	(136.7'-140'): Sandstone, moderately hard, fine grained, micaceous, argillaceous, rare coal spars, thin shale interbeds, high to near vertical fracture at base.	- Installed temporary 8" Outer casing to 140'

TEC-Weston Joint Venture

(BKGmw-025)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON2

Company/Project: TEC-Weston Joint Venture/Facility-Wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud / John Keifer	Ground Surface Elevation: —		Datum: —
~~Sampling Device~~: Drill: Versa Sonic Model 111	Borehole Diameter (inches): 6" (Screened Int.)		Total Depth (Feet): 282.5
Date/Time Drilling Started: 8/19/16 0905	Date/Time Total Depth Reached: 8/30/16 1410		

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/ lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
140	70%			0.0 ppm			Sandstone/ Lost Core	(140'-150'): Sandstone, gray, hard, well cemented, unweathered, fine grained, slightly micaceous, argillaceous, very rare coal spars, somewhat broken	- Driller installed new "hard-rock" drill bit at 140'. Lost ~3.0'
150	100%			0.0 ppm			Sandstone	(150'-153'): Sandstone, same as above	
	74%			0.0 ppm			Sandstone/ Lost Core	(153'-160'): Sandstone, gray, hard, well cemented, fine grained with medium grained lenses, micaceous, broken near top, siderite nodules near base; argillaceous	- Driller lost ~1.8' - Stopped drilling at 160' on 8/24
160	66%			0.0 ppm			Sandstone/ Lost Core	(160'-170'): Sandstone, gray, hard, well cemented, fine to medium grained downward, unweathered, micaceous, argillaceous, broken near center, high to near vertical fracture near top	- Driller lost ~3.4'
170	100%			0.0 ppm			Sandstone	(170'-180'): Sandstone, hard, well cemented, fine grained, intact and unweathered, micaceous, argillaceous, very rare coal spars in top 3'	
180	82%			0.0 ppm			Sandstone/ Lost Core	(180'-190'): Sandstone, gray, hard, well cemented, fine to medium grained, argillaceous, unweathered	- Driller lost ~1.8'
190	93.5%			0.0 ppm			Sandstone/ Lost Core	(190'-200'): Sandstone, gray, hard, well cemented, fine to medium grained, micaceous, argillaceous, unweathered, very rare coal spars near base	- Driller lost ~0.65'
200	100%			0.0 ppm			Sandstone	(200'-210'): Sandstone, gray, hard, well cemented, mostly medium grained, unweathered, slightly micaceous, argillaceous	- Stopped drilling at 210' on 8/25
210	100%			0.0 ppm			Sandstone	(210'-220'): Sandstone, hard, well cemented, rare coal spars, slightly micaceous, argillaceous, broken at top. Fine grained becoming medium grained and slightly conglomeratic at ~213.8'	
220	100%			0.0 ppm			Sandstone	(220'-230') Sandstone, gray, hard, mostly well cemented, medium grained, rare coal spars at ~223', slightly argillaceous, Conglomeratic from ~223'-223.8' which is coarse grained and fairly poorly cemented	
230	93.5%			0.0 ppm			Sandstone/ Lost Core	(230'-240') Sandstone, gray, hard, bottom 7.8' well cemented and fine grained, rare quartz pebbles, micaceous, argillaceous. Top ~2.2' is coarse and conglomeratic w/poor cementation.	Driller lost ~0.65'
240									

TEC-Weston Joint Venture

(BKGmw-025)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON2

Company/Project: TEC-Weston Joint Venture/Facility-wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Duncan Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud / John Keifer	Ground Surface Elevation: —		Datum: —
~~Sampling Device~~: Drill: Versa Sonic Model 1111	Borehole Diameter (inches): 6 3/8 (Screened Int.)		Total Depth (Feet): 282.5
Date/Time Drilling Started: 8/19/16 0905		Date/Time Total Depth Reached: 8/30/16 1410	

Depth (feet)	Sampling: % Recov	Sampling: Sample Depth	Sampling: Blow Counts	Sampling: PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/ lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
240	66%			0.0 ppm			Sandstone / Lost Core	(240'-250'): Sandstone, gray, hard, well cemented, fine grained becoming medium grained downward, very rare quartz pebbles, slightly micaceous, argillaceous, broken near top	- Driller lost ~3.4'. - Stopped drilling at 250' on 8/29
250	66%			0.0 ppm			Sandstone / Lost Core	(250'-260'): Sandstone, gray, hard, well cemented, matrix, but broken zones, medium grained becoming coarser downward, slightly conglomeratic at base with rare quartz pebbles (up to 1/4"), micaceous, a few high angle fractures	- Driller lost ~3.4'
260	100%			0.0 ppm			Sandstone	(260'-262.85'): Sandstone, gray, hard, medium grained, moderately cemented, some large diameter subrounded quartz pebbles (up to 1/2") at immediate base	
264	41%			0.0 ppm			Conglomerate Lost Core	(262.85'-263.95') Conglomerate, mostly unconsolidated, large quartz pebbles (1/2" and greater), coal spars	- Driller lost ~0.65'
266	100%			0.0 ppm			Sandstone	(263.95'-270'): Sandstone, gray, hard, well cementation, medium grained fining downward, slightly conglomeratic at top, argillaceous [illegible]	
270	100%			0.0 ppm			Sandstone	(270'-274.5'): Sandstone, gray, hard, well cemented, fine grained, scattered quartz pebbles, (most < 1/8")	
274								(274.5'-279.7') See p. 6	
276									

TEC-Weston Joint Venture

(BKGmw-025)

GEOLOGIC BOREHOLE LOG

Borehole (Location) ID: BKG-SCON2

Company/Project: TEC-Weston Joint Venture/Facility-wide Groundwater Monitoring Program			Location Type: —
Location Description: Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio			
Establishing Company: —	Geologist: Steve Stansfield (Cardno)		Drilling Company: Dunsen Brothers Drilling, Inc.
Drilling Foreman: Mark Michaud	Ground Surface Elevation: —		Datum: —
Sampling Device: Drill: Versa Sonic Model 150	Borehole Diameter (inches): 6 7/8 (Screened Int.)		Total Depth (Feet): 282.5
Date/Time Drilling Started: 8/29/16 0905	Date/Time Total Depth Reached: 8/30/16 1410		

Depth (feet)	Sampling: % Recov	Sample Depth	Blow Counts	PID	Graphic	ASTM CODE	Lithologic Codes	Lithology Description: SOIL TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing	Remarks: Drilling Problems, Equipment, Water levels, Time Samples Collected, Weather
276	100%			0.0 ppm			Conglomerate	(274.5-277.75) Conglomerate, gray, hard, fine to medium grained matrix, numerous subrounded quartz pebbles (1/8"-3/4"), unconsolidated thin zone at immediate top, siderite nodules and clay clasts, sharp basal contact, slightly pyritic	- Installed temporary porter 6" casing to 277.5 - Base of Sharon Conglomerate
278									
280	67%			0.0 ppm			Shale and Lost Core	(277.75'-282.5'): Shale, dark gray to near black, moderately soft to soft, slightly rooted, high clay content, bottom of borehole	- Driller lost ~1.55'
282									
284								Note: In instances where core loss has occurred and where "lost core" does not have its own entry, it is not possible to determine where the core loss occurred within a respective core run.	

TEC-Weston Joint Venture

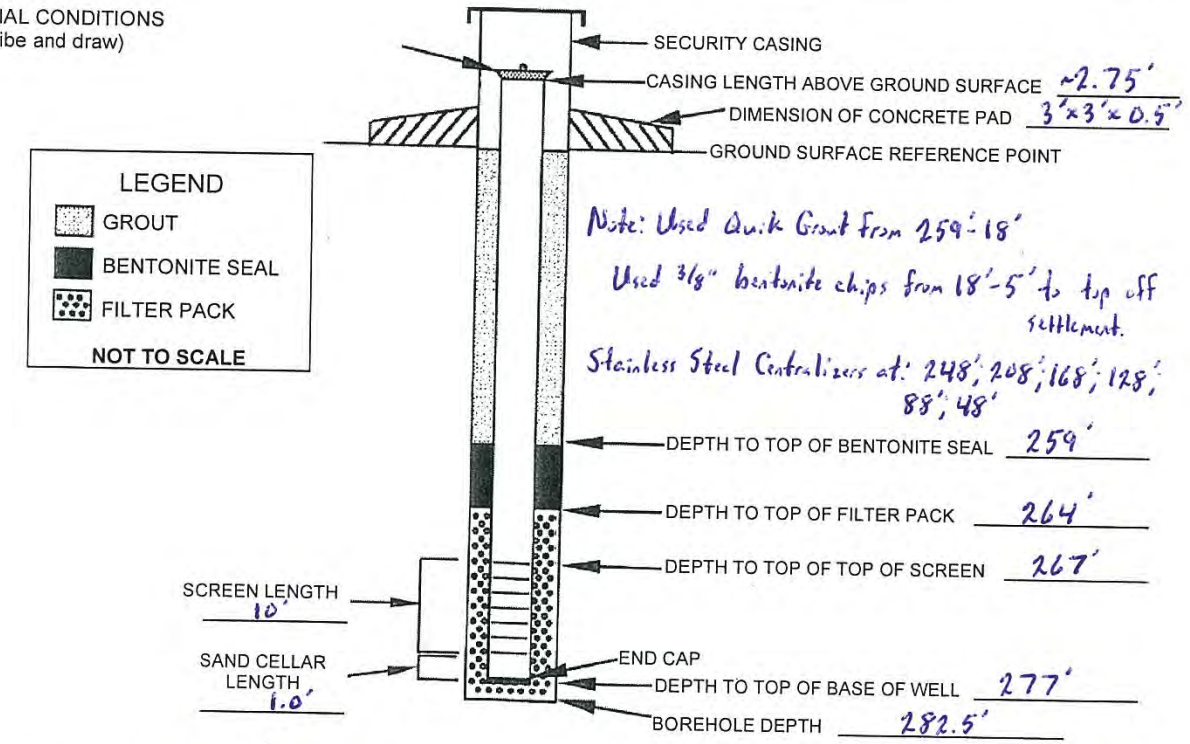
Well Construction Details

FIELD REPRESENTATIVE: Steve Stansfield (Cardno)
DRILLING CONTRACTOR: Duncan Brothers Drilling

DRILLING TECHNIQUE: Sonic/Conventional Wireline Core
AUGER SIZE AND TYPE: N/A
BOREHOLE IDENTIFICATION: BKG-SCON2 (BKGmw-025)
BOREHOLE DIAMETER: 6 7/8" within screened zone
WELL IDENTIFICATION: BKG-SCON2 (BKGmw-025)
WELL CONSTRUCTION START DATE: 9/7/16
WELL CONSTRUCTION COMPLETE DATE: 9/9/16
SCREEN MATERIAL: 2" Schedule 80 PVC (slot 0.010")
SCREEN DIAMETER: 1.94" ID; 2.38" O.D.
STRATUM-SCREENED INTERVAL (FT): 10' Screen
CASING MATERIAL: 2" Schedule 80 PVC
CASING DIAMETER: 1.94" I.D.; 2.38" O.D.

TYPE OF FILTER PACK: Global #5 Sand
GRADATION: 12 x 20
AMT. OF FILTER PACK USED: 7.5 - 50 lb. bags
TYPE OF BENTONITE: 3/8" chips
AMT. OF BENTONITE USED: 2-50 lb. bags (Filter Pack Seal)
TYPE OF CEMENT: N/A (Used bentonite grout)
AMT. OF CEMENT USED: N/A (Used bentonite grout)
GROUT MATERIAL USED: Baroid Quik-Grout 20% High Solids /3/8" Bentonite Chips
DIMENSIONS OF SECURITY CASING: 8' x 6"
TYPE OF WELL CAP: 2" Torque Well Plug
TYPE OF END CAP: PVC Threaded
COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: Duncan Brothers Drilling
INSTALLATION OBSERVED BY: Steve Stansfield (Cardno)
DISCREPANCIES: Borehole backfilled with 3/8" bentonite chips from 282.5'-278'

US Army Corps of Engineers
Louisville District

SAIC From Science to Solutions

Ravenna Army Ammunition Plant
8451 State Route 5
Ravenna, Ohio 44266
Portage County

SCFmw-006

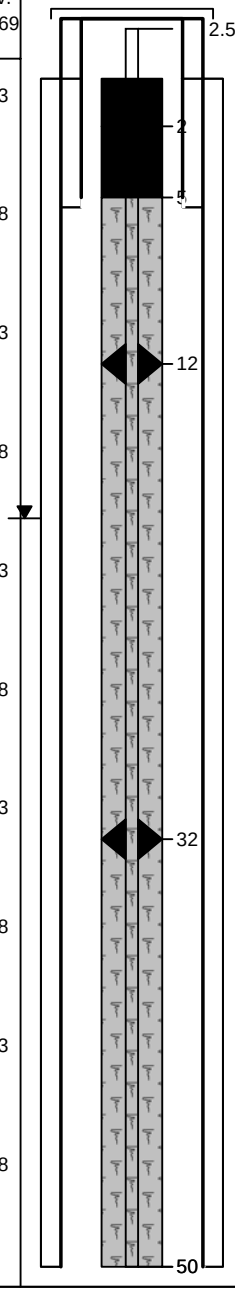
(Page 1 of 2)

Start Date : 02/19/09; 1032
End Date : 03/03/09; 1630

Northing Coord. : 569583.41
Easting Coord. : 2369394.54
Total Depth of Boring : 90 ft

Drilling Company : Frontz Drilling
Driller : Rob Hamilton
Designation of Drill : CME 75/ TH-60
Type of Drill Rig : Auger Rig/Air Rotary
Geologist : Amanda Trenton
Oversight Company : SAIC
Borehole Diameter : 14" Overburden/6" Rock
Sampling Equipment : 12.25" Hollow Stem Augers
: 2" 2' Long Split Spoon
: 6" 10' Long Core Barrel

Depth in feet	USCS Symbol	DESCRIPTION	Surf. Elev. 963.69
0		(0.0' - 6.25') Silty CLAY (CL); dry; soft to stiff; medium plasticity; 10YR5/4 yellow brown, some 10YR5/6 yellow brown and 10YR5/1 gray (1.0' - 2.25'); sand lenses from 3.0' - 6.25'.	963
5		(6.25' - 8.25') Clayey SAND (SC); medium to fine grained; moist; medium dense; 10YR5/3 brown.	958
10		(8.25' - 20.3') SAND (SP); coarsening and fining sequences; pockets of Clay and Silt throughout; little fine 1/4" Gravel; dry; medium dense; 10YR4/3 brown.	953
15			948
20		(20.3' - 33.6') Medium to coarse grained SAND (SW); trace fine Gravel; damp; loose; 10YR4/1 dark gray and 10YR4/2 dark grayish brown.	943
25			938
30			933
35		(33.6' - 46.4') Clayey SILT (ML); little Gravel and Shale fragments; Sand lenses from 44-46.4 ft; dry; stiff; 10YR4/1 dark gray.	928
40			923
45			918
50		(46.4' - 47.6') 1/2" subangular GRAVEL and Clayey SILT (GM); wet to moist; medium dense; 10YR4/1 dark gray.	



Well Constr. Information	Blow Count	Recovery	Collection Interval
Above Grade Completion 6" Protective Casing 3 ft ags - 5 ft bgs Set In Concrete	4/3/2/3	1.7/2.0	
	5/6/7/11	2.0/2.0	
	3/7/5/5	1.6/2.0	
	7/7/9/11	2.0/2.0	
Concrete 0 - 1.0 ft bgs	5/5/6/9	2.0/2.0	
Below Grade Completion 8" Outer Casing set from 0 ft - 60 ft bgs	9/9/8/7	1.5/2.0	
	3/7/7/6	2.0/2.0	
	3/2/4/3	1.3/2.0	
Cement Bentonite Grout 1.0' - 70' bgs	4/3/2/2	2.0/2.0	
	2/2/1/7	2.0/2.0	
Holeplug 3/8 Coarse Grade Bentonite Chips 70 ft - 73 ft bgs & 87 ft - 90 ft bgs	wt/wt/1/2	1.6/2.0	
	wt/wt/wt/1	1.3/2.0	
Riser 2" ID PVC Sch 40 2.5' ags - 76.0 ft bgs	2/1/2/2	2.0/2.0	
	1/1/1/3/	2.0/2.0	
	1/1/1/1	2.0/2.0	
Centralizers: 6" expansion; placed at 2' and 72 ft bgs 8" expansion; placed at 12', 32', & 52' bgs	wt/wt/wt/wt	1.0/2.0	
	3/7/2/2	2.0/2.0	
	8/6/6/10	0.8/2.0	
Sand Pack 73.0 ft - 87 ft bgs Sidley #5 Sand	6/5/3/5	1.5/2.0	
	6/6/9/7	1.5/2.0	
Screen 2" ID PVC Sch 40 76.0 - 86.0 ft bgs 0.010 slot	6/5/9/9	1.3/2.0	
	11/13/9/9	1.5/2.0	
Borehole Dia 6"	4/7/7/11	1.0/2.0	
	6/5/4/9	2.0/2.0	
	7/9/9/10	0.9/2.0	

Elevation:
NGVD 1929

NAVD 1988:
TOC: 965.38
Surface: 963.15

Boring was hand cleared for MEC on 02/09/09
8" outer casing set using 12.25" ID HSAs from 0 ft - 60 ft bgs
3.1 gallons of water injected during drilling; 1,200 gallons of water removed.

SCFmw-006

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05-19-2010 Z:\PUBLIC\RVAAP\RVAAP PBA 2008\Task 3.0 Sharon Conglomerate Wells\3.2 Implementation of WP\Field\Boring Logs\SCFmw-006.bo

US Army Corps of Engineers
Louisville District

SAIC From Science to Solutions

Ravenna Army Ammunition Plant
8451 State Route 5
Ravenna, Ohio 44266
Portage County

SCFmw-006

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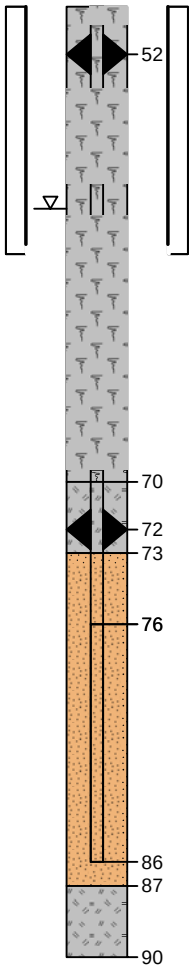
Start Date : 02/19/09; 1032
End Date : 03/03/09; 1630

Northing Coord. : 569583.41
Easting Coord. : 2369394.54
Total Depth of Boring : 90 ft

Drilling Company : Frontz Drilling
Driller : Rob Hamilton
Designation of Drill : CME 75/ TH-60
Type of Drill Rig : Auger Rig/Air Rotary
Geologist : Amanda Trenton
Oversight Company : SAIC
Borehole Diameter : 14" Overburden/6" Rock
Sampling Equipment : 12.25" Hollow Stem Augers
: 2" 2' Long Split Spoon
: 6" 10' Long Core Barrel

Depth in feet	USCS Symbol	DESCRIPTION	Surf. Elev. 963.69
50		(47.6' - 51.75') Clayey SILT (ML); trace 1/4" subangular Gravel; some fine Sand lenses throughout, increased Sand content with depth; dry to damp; 10YR4/1 dark gray.	913
55		(51.75 - 52.6') SAND and SILT (SM); dry; dense; 10YR4/1 dark gray.	908
		(52.6' - 53.7') Fine SAND; trace Silt, Silt content decreases with depth; dry; dense; 10YR4/1 dark gray and 10YR5/3 brown.	
60		(53.7' - 54.0') SANDSTONE (SS); weathered; competent bedrock by 55.0 ft bgs. Augered to 60 ft bgs to set 8" outer casing, no recovery. Drilled using tricone bit to 61' for rock coring, no recovery.	903
65		(61' - 70') Sharon Conglomerate. Medium grained quartzose SANDSTONE (SS); wet; loosely cemented; little fine subrounded quartzose Gravel throughout Sandstone matrix; laminations throughout with trace coal seams (<1/8" thick); some mineral accumulations in voids and fractures; some coarser sequences; 5Y6/1 Gray	898
70		Thin coal seam at 70.0' surrounded by subrounded Gravel	893
75		(74.2') 1/4"-1" Subrounded Gravel	888
80		(81.6' - 87.3') Coarsening downward sandstone; coarser Gravels at 81.6', 82.7', and 83.7'.	883
85		Coarse 1/2" - 1.5" subrounded Gravel at 87.3' bgs.	878
90		(87.3' - 90.0') Cuyahoga Formation. SHALE; interbedded very fine Sandstone laminations; dry; brittle; very dark gray.	873
95		Boring terminated at 90 ft bgs.	868
100			

Well: SCFmw-006
TOC Elev.: 965.92



Well Constr. Information	Blow Count	Recovery	Collection Interval
	7/13/11/19	1.3/2.0	
Above Grade Completion 6" Protective Casing 3 ft ags - 5 ft bgs Set In Concrete	11/13/19/50/3	1.0/2.0	
Concrete 0 - 1.0 ft bgs		NA	
Below Grade Completion 8" Outer Casing set from 0 ft - 60 ft bgs		7.4/9.0	
Cement Bentonite Grout 1.0' - 70' bgs			
Holeplug 3/8 Coarse Grade Bentonite Chips 70 ft - 73 ft bgs & 87 ft - 90 ft bgs		9.3/10.0	
Riser 2" ID PVC Sch 40 2.5' ags - 76.0 ft bgs			
Centralizers: 6" expansion; placed at 2' and 72 ft bgs 8" expansion; placed at 12', 32', & 52' bgs		9.4/10.0	
Sand Pack 73.0 ft - 87 ft bgs Sidley #5 Sand			
Screen 2" ID PVC Sch 40 76.0 - 86.0 ft bgs 0.010 slot			
Borehole Dia 6"			

Comments

Soil Color Chart Munsell 2000 Rev Ed.

Rock Color Chart Munsell 1995, 8th Ed.

Boring was hand cleared for MEC on 02/09/09
8" outer casing set using 12.25" ID HSAs from 0 ft - 60 ft bgs
3.1 gallons of water injected during drilling; 1,200 gallons of water removed.

SCFmw-006
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APPENDIX B

Groundwater Sampling Results

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Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone		Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated
Station		BKGmw-005	BKGmw-005	BKGmw-005	BKGmw-005	BKGmw-005	BKGmw-016	BKGmw-016
Sample Id		BKGmw-005-110916-GW	BKGmw-005-041917-GW	BKGmw-005-050317-GW	BKGmw-005-D-120117-GW	BKGmw-005-120117-GW	BKGmw-016-110916-GW	BKGmw-016-041917-GW
Date		11/09/16	04/19/17	05/03/17	12/01/17	12/01/17	11/09/16	04/19/17
Sample Type		GR	GR	GR	FD	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Aluminum	7429-90-5	0.11 J	0.11 J	NA	0.58	0.75	0.1 J	0.026 J
Antimony	7440-36-0	<0.001 U	<0.001 U	NA	<0.001 U	<0.001 U	<0.001 U	<0.001 U
Arsenic	7440-38-2	<0.001 U	<0.001 U	NA	0.00064 J	0.00049 J	0.0013 J	<0.001 U
Barium	7440-39-3	0.017	0.014	NA	0.019	0.018	0.021	0.012
Beryllium	7440-41-7	<0.0003 U	<0.0003 U	NA	<0.0003 U	<0.001 U	<0.0003 U	<0.0003 U
Cadmium	7440-43-9	<0.001 U	<0.001 U	NA	<0.001 U	<0.001 U	<0.001 U	<0.001 U
Calcium	7440-70-2	75	77	NA	62	63	65	12
Chromium	7440-47-3	0.0015 J	<0.0018 U	NA	0.0012 J	0.00098 J	<0.0018 U	<0.0018 U
Chromium, hexavalent	18540-29-9	NA	<0.004 U	<0.004 U	<0.02 U	<0.02 U	NA	<0.004 U
Cobalt	7440-48-4	0.00011 J	0.00011 J	NA	0.00038 J	0.00039 J	0.00007 J	<0.0002 U
Copper	7440-50-8	0.0031	<0.0018 U	NA	0.0012 J	0.0011 J	0.0025	<0.0018 U
Iron	7439-89-6	0.27	0.23	NA	0.82	1	0.52	<0.085 U
Lead	7439-92-1	0.00039 J	<0.0007 U	NA	0.0007 J	0.00068 J	0.00063 J	<0.0007 U
Magnesium	7439-95-4	18	17	NA	16	17	19	5.2
Manganese	7439-96-5	0.015 J	0.0067	NA	0.052	0.05	0.0062	0.0022 J
Mercury	7439-97-6	<0.00008 U	<0.00008 U	NA	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U
Nickel	7440-02-0	0.00043 J	<0.001 U	NA	0.0011 J	0.00092 J	0.00069 J	0.002 J
Potassium	7440-09-7	2.5 J	<0.94 U	NA	1.7 J	1.8 J	1.6 J	<0.94 U
Selenium	7782-49-2	<0.002 U	<0.002 U	NA	<0.002 U	<0.002 U	<0.002 U	<0.002 U
Silver	7440-22-4	<0.0001 U	<0.0001 U	NA	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
Sodium	7440-23-5	9	2.3 J	NA	7.7	8.2	7.2	3.6 J
Thallium	7440-28-0	<0.0002 U	<0.0002 U	NA	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U
Vanadium	7440-62-2	<0.002 U	<0.002 U	NA	<0.002 U	<0.002 U	0.0005 J	<0.002 U
Zinc	7440-66-6	<0.02 U	<0.008 U	NA	0.0044 J	0.0032 J	<0.02 U	0.0054 J

Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone		Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated
Station		BKGmw-016	BKGmw-016	BKGmw-017	BKGmw-017	BKGmw-017	BKGmw-017	BKGmw-017
Sample Id		BKGmw-016-050117-GW	BKGmw-016-120417-GW	BKGmw-017-110916-GW	BKGmw-017-042017-GF	BKGmw-017-042017-GW	BKGmw-017-120417-GF	BKGmw-017-120417-GW
Date		05/01/17	12/04/17	11/09/16	04/20/17	04/20/17	12/04/17	12/04/17
Sample Type		GR	GR	GR	GR	GR	GR	GR
Filter Status		Total	Total	Total	Dissolved	Total	Dissolved	Total
Analyte (mg/L)	CAS Number							
Aluminum	7429-90-5	NA	0.19 J	0.2 J	0.47	1.3	<0.07 U	0.6
Antimony	7440-36-0	NA	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U
Arsenic	7440-38-2	NA	0.0015 J	0.02	0.017	0.021	0.018	0.019
Barium	7440-39-3	NA	0.02 J	0.041	0.043	0.05	0.033 J	0.033
Beryllium	7440-41-7	NA	<0.0003 U	<0.0003 U	<0.0003 U	<0.001 U	<0.0003 U	<0.0003 U
Cadmium	7440-43-9	NA	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U
Calcium	7440-70-2	NA	69	120	97	100	84	94
Chromium	7440-47-3	NA	<0.0018 U	<0.0018 U	0.0011 J	0.0025 J	<0.0018 U	0.001 J
Chromium, hexavalent	18540-29-9	<0.004 U	<0.02 U	NA	NA	<0.004 U	NA	<0.02 U
Cobalt	7440-48-4	NA	0.00008 J	0.00055 J	0.0011	0.0027	0.0003 J	0.0013
Copper	7440-50-8	NA	<0.0018 U	0.0012 J	0.001 J	0.0027	<0.0018 U	0.0012 J
Iron	7439-89-6	NA	0.9	2.3	2.4	4.3	1.3	3
Lead	7439-92-1	NA	0.00063 J	0.00032 J	0.00095 J	0.0027 J	<0.0007 U	0.0021 J
Magnesium	7439-95-4	NA	22	49	37	39	37	40
Manganese	7439-96-5	NA	0.0072 J	0.23	0.2	0.23	0.2	0.25
Mercury	7439-97-6	NA	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U
Nickel	7440-02-0	NA	0.00042 J	0.00065 J	0.0018 J	0.004	<0.001 U	0.0024 J
Potassium	7440-09-7	NA	<3 U	2.7 J	2.7 J	2.6 J	2 J	2.4 J
Selenium	7782-49-2	NA	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.002 U
Silver	7440-22-4	NA	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
Sodium	7440-23-5	NA	7.8	27	24	23	21	23
Thallium	7440-28-0	NA	<0.0002 U	<0.0002 U	0.0001 J	0.00029 J	<0.0002 U	0.00015 J
Vanadium	7440-62-2	NA	<0.002 U	<0.002 U	<0.006 U	0.0032 J	<0.002 U	0.00077 J
Zinc	7440-66-6	NA	<0.008 U	<0.02 U	0.0054 J	0.013 J	<0.008 U	0.0099 J

Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone		Unconsolidated	Unconsolidated	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone
Station		BKGmw-021	BKGmw-021	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022
Sample Id		BKGmw-021-042117-GW	BKGmw-021-120517-GW	BKGmw-022-111516-GW	BKGmw-510-042117-GW	BKGmw-022-042117-GW	BKGmw-022-080217-GW	BKGmw-022-120117-GW
Date		04/21/17	12/05/17	11/15/16	04/21/17	04/21/17	08/02/17	12/01/17
Sample Type		GR	GR	GR	FD	GR	GR	GR
Filter Status	CAS	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	Number							
Aluminum	7429-90-5	<0.07 U	<0.07 U	0.036 J	<0.07 U	<0.07 U	<0.15 U	<0.07 U
Antimony	7440-36-0	<0.001 U	0.0036 J	<0.001 U	<0.001 U	<0.001 U	<0.009 U	<0.001 U
Arsenic	7440-38-2	<0.001 U	0.00045 J	0.0033 J	0.003 J	0.0031 J	0.0049 J	0.0045 J
Barium	7440-39-3	0.025	0.036	0.092	0.084	0.082	0.089	0.085 J
Beryllium	7440-41-7	<0.0003 U	0.00021 J	<0.0003 U	<0.0003 U	<0.0003 U	<0.0045 U	<0.0003 U
Cadmium	7440-43-9	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.0045 U	<0.001 U
Calcium	7440-70-2	85	69	23	22	23	23 J	21
Chromium	7440-47-3	<0.0018 U	<0.0018 UJ	<0.0018 U	<0.0018 U	0.00075 J	<0.008 U	<0.0018 U
Chromium, hexavalent	18540-29-9	<0.004 UJ	<0.02 U	NA	<0.004 UJ	<0.004 UJ	<0.02 U	<0.02 U
Cobalt	7440-48-4	<0.0002 U	<0.0002 UJ	0.0026	0.0023	0.0022	0.0023	0.0022
Copper	7440-50-8	<0.0018 U	<0.0018 U	<0.0018 U	<0.0018 U	<0.0018 U	0.00096 J	<0.0018 U
Iron	7439-89-6	<0.085 U	<0.085 U	9	9.1	9.7	11	9.3
Lead	7439-92-1	<0.0007 U	0.1	<0.0007 U	<0.0007 U	<0.0007 U	<0.002 U	<0.0007 U
Magnesium	7439-95-4	42	33	7.2	6.3	6.6	6.7	6.7
Manganese	7439-96-5	0.00039 J	<0.0035 U	0.42	0.38	0.37	0.38	0.39
Mercury	7439-97-6	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00015 U	<0.00008 U
Nickel	7440-02-0	<0.001 U	0.00035 J	0.0029 J	0.0024 J	0.0025 J	0.003 J	0.0029 J
Potassium	7440-09-7	<0.94 U	1.2 J	0.95 J	0.25 J	0.28 J	0.85	0.66 J
Selenium	7782-49-2	0.00099 J	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.004 U	<0.002 U
Silver	7440-22-4	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0018 U	<0.0001 U
Sodium	7440-23-5	12	9.3	<5 U	<5 U	3.3 J	2.7	2.7 J
Thallium	7440-28-0	<0.0002 U	0.00008 J	<0.0002 U	<0.0002 U	<0.0002 U	<0.015 U	<0.0002 U
Vanadium	7440-62-2	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.008 U	<0.002 U
Zinc	7440-66-6	<0.008 U	<0.008 U	<0.02 U	0.0033 J	0.0032 J	0.0064 J	0.0042 J

Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone
Station		BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	FWGmw-005	FWGmw-005
Sample Id		BKGmw-023-111516-GW	BKGmw-023-042017-GW	BKGmw-023-080217-GW	BKGmw-023-D-120117-GW	BKGmw-023-120117-GW	FWGmw-005-110916-GW	FWGmw-005-041917-GW
Date		11/15/16	04/20/17	08/02/17	12/01/17	12/01/17	11/09/16	04/19/17
Sample Type		GR	GR	GR	FD	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Aluminum	7429-90-5	<0.07 U	0.022 J	<0.15 U	<0.07 U	<0.07 U	0.085 J	0.047 J
Antimony	7440-36-0	<0.001 U	<0.001 U	<0.009 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U
Arsenic	7440-38-2	0.00038 J	<0.001 U	<0.008 U	<0.001 U	<0.001 U	0.0019 J	0.0012 J
Barium	7440-39-3	0.031	0.023	0.024	0.022	0.02 J	0.062	0.057
Beryllium	7440-41-7	<0.0003 U	<0.0003 U	<0.0045 U	<0.0003 U	<0.0003 U	<0.0003 U	<0.0003 U
Cadmium	7440-43-9	<0.001 U	<0.001 U	<0.0045 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U
Calcium	7440-70-2	75	71	72	68	64	48	47
Chromium	7440-47-3	<0.0018 U	<0.0018 U	<0.008 U	<0.0018 U	<0.0018 U	0.0071 J	<0.0018 U
Chromium, hexavalent	18540-29-9	NA	<0.004 U	<0.02 U	<0.02 U	<0.02 U	NA	<0.004 UJ
Cobalt	7440-48-4	0.0015	0.0011	0.0021	0.0016	0.0017	0.002	0.0016
Copper	7440-50-8	<0.0018 U	<0.0018 U	0.0016 J	<0.0018 U	<0.0018 U	0.0022	<0.0018 U
Iron	7439-89-6	0.49	0.3	0.21	0.15	0.13	4.9	3.6
Lead	7439-92-1	<0.0007 U	<0.0007 U	<0.002 U	<0.0007 U	<0.0007 U	<0.0007 U	<0.0007 U
Magnesium	7439-95-4	20	18	19	19	19	16	15
Manganese	7439-96-5	0.33	0.21	0.36	0.27	0.31	0.28 J	0.24
Mercury	7439-97-6	<0.00008 U	<0.00008 U	<0.00015 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U
Nickel	7440-02-0	0.0012 J	0.0017 J	0.0027 J	0.0014 J	0.0021 J	0.0019 J	0.0015 J
Potassium	7440-09-7	1.2 J	0.43 J	1.1	0.73 J	0.73 J	1.7 J	0.87 J
Selenium	7782-49-2	<0.002 U	<0.002 U	<0.004 U	<0.002 U	<0.002 U	<0.002 U	<0.002 U
Silver	7440-22-4	<0.0001 U	<0.0001 U	<0.0018 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
Sodium	7440-23-5	11	10	11	9.1	9.9	6.6	7.1
Thallium	7440-28-0	<0.0002 U	<0.0002 U	<0.015 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U
Vanadium	7440-62-2	<0.002 U	<0.002 U	<0.008 U	<0.002 U	<0.002 U	0.0007 J	<0.002 U
Zinc	7440-66-6	<0.02 U	<0.008 U	<0.018 U	0.0024 J	<0.008 U	<0.02 U	0.0047 J

Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon
Station		FWGmw-005	FWGmw-005	BKGmw-006	BKGmw-006	BKGmw-006	BKGmw-008	BKGmw-008
Sample Id		FWGmw-005-050317-GW	FWGmw-005-120117-GW	BKGmw-006-110816-GW	BKGmw-006-042417-GW	BKGmw-006-120517-GW	BKGmw-500-110816-GW	BKGmw-008-110816-GW
Date		05/03/17	12/01/17	11/08/16	04/24/17	12/05/17	11/08/16	11/08/16
Sample Type		GR	GR	GR	GR	GR	FD	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Aluminum	7429-90-5	NA	0.43	<0.07 U	<0.07 U	0.032 J	<0.07 U	<0.07 U
Antimony	7440-36-0	NA	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U
Arsenic	7440-38-2	NA	0.0021 J	0.00084 J	0.00093 J	0.0033 J	<0.001 U	<0.001 U
Barium	7440-39-3	NA	0.062 J	0.01	0.0098	0.011	0.004	0.0039
Beryllium	7440-41-7	NA	<0.001 U	<0.0003 U	<0.0003 U	<0.0003 U	<0.0003 U	<0.0003 U
Cadmium	7440-43-9	NA	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U
Calcium	7440-70-2	NA	40	75	68	61	21	21
Chromium	7440-47-3	NA	0.00088 J	<0.0018 U	<0.0018 U	<0.0018 UJ	<0.0018 U	<0.0018 U
Chromium, hexavalent	18540-29-9	<0.004 U	<0.02 U	NA	<0.004 U	<0.02 U	NA	NA
Cobalt	7440-48-4	NA	0.002	0.00029 J	0.00038 J	0.00054 J	0.0017	0.002
Copper	7440-50-8	NA	<0.0018 U	<0.0018 U	<0.0018 U	<0.0018 U	<0.0018 U	<0.0018 U
Iron	7439-89-6	NA	5	0.87	0.85	4	<0.085 U	<0.1 U
Lead	7439-92-1	NA	0.00032 J	<0.0007 U	<0.0007 U	<0.003 U	<0.0007 U	<0.0007 U
Magnesium	7439-95-4	NA	14	23	20	20	8.3	8.3
Manganese	7439-96-5	NA	0.26	0.08 J	0.071	0.14	0.0012 J	<0.0035 U
Mercury	7439-97-6	NA	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U
Nickel	7440-02-0	NA	0.0023 J	0.00092 J	0.00069 J	0.00099 J	0.00072 J	0.0007 J
Potassium	7440-09-7	NA	1.2 J	1.7 J	1.4 J	1.4 J	0.51 J	0.52 J
Selenium	7782-49-2	NA	<0.002 U	<0.002 U	0.00073 J	<0.002 U	<0.002 U	<0.002 U
Silver	7440-22-4	NA	<0.005 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
Sodium	7440-23-5	NA	6.1	57	57	54	6.3	6.2 J
Thallium	7440-28-0	NA	<0.001 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U
Vanadium	7440-62-2	NA	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.002 U
Zinc	7440-66-6	NA	0.009 J	<0.008 U	<0.008 U	<0.008 U	<0.02 U	<0.02 U

Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone		Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon
Station		BKGmw-008	BKGmw-008	BKGmw-008	BKGmw-008	BKGmw-015	BKGmw-015	BKGmw-015
Sample Id		BKGmw-008-041817-GW	BKGmw-008-041917-GW	BKGmw-008-050417-GW	BKGmw-008-120617-GW	BKGmw-015-041917-GW	BKGmw-015-050417-GW	BKGmw-015-120517-GW
Date		04/18/17	04/19/17	05/04/17	12/06/17	04/19/17	05/04/17	12/05/17
Sample Type		GR	GR	GR	GR	GR	GR	GR
Filter Status	CAS	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	Number							
Aluminum	7429-90-5	0.022 J	NA	NA	<0.3 U	0.038 J	NA	<0.07 U
Antimony	7440-36-0	<0.001 U	NA	NA	<0.001 U	<0.001 U	NA	<0.001 U
Arsenic	7440-38-2	<0.001 U	NA	NA	<0.001 U	<0.001 U	NA	<0.001 UJ
Barium	7440-39-3	0.004	NA	NA	0.0073 J	0.25	NA	0.26
Beryllium	7440-41-7	<0.0003 U	NA	NA	<0.0003 U	<0.0003 U	NA	<0.0003 U
Cadmium	7440-43-9	<0.001 U	NA	NA	<0.001 U	<0.001 U	NA	<0.001 U
Calcium	7440-70-2	24	NA	NA	19	32	NA	28
Chromium	7440-47-3	<0.0018 U	NA	NA	<0.0018 U	<0.0018 U	NA	<0.0018 UJ
Chromium, hexavalent	18540-29-9	NA	<0.004 U	<0.004 U	<0.02 U	<0.004 U	<0.004 U	<0.02 U
Cobalt	7440-48-4	0.00006 J	NA	NA	0.015	<0.0002 U	NA	<0.0002 UJ
Copper	7440-50-8	<0.0018 U	NA	NA	<0.0018 U	<0.0018 U	NA	<0.0018 U
Iron	7439-89-6	0.027 J	NA	NA	0.2	0.042 J	NA	<0.085 U
Lead	7439-92-1	<0.0007 U	NA	NA	0.0015 J	<0.0007 U	NA	<0.0007 U
Magnesium	7439-95-4	9.2	NA	NA	7.4	13	NA	12
Manganese	7439-96-5	0.00077 J	NA	NA	0.13 J	0.0011 J	NA	<0.0035 U
Mercury	7439-97-6	<0.00008 U	NA	NA	<0.00008 U	<0.00008 U	NA	<0.00008 U
Nickel	7440-02-0	<0.001 U	NA	NA	0.0016 J	0.00035 J	NA	0.00097 J
Potassium	7440-09-7	<0.94 U	NA	NA	0.58 J	4.7	NA	5
Selenium	7782-49-2	<0.002 U	NA	NA	<0.002 U	<0.002 U	NA	<0.002 U
Silver	7440-22-4	<0.0001 U	NA	NA	<0.0001 U	<0.0001 U	NA	<0.0001 U
Sodium	7440-23-5	7.1	NA	NA	6.2	13	NA	13
Thallium	7440-28-0	<0.0002 U	NA	NA	<0.0002 U	<0.0002 U	NA	<0.0002 U
Vanadium	7440-62-2	<0.002 U	NA	NA	<0.002 UJ	<0.002 U	NA	<0.002 U
Zinc	7440-66-6	<0.008 U	NA	NA	0.0093 J	0.0033 J	NA	0.005 J

Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone		Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-018	BKGmw-018	BKGmw-018	BKGmw-018	BKGmw-024	BKGmw-024	BKGmw-024
Sample Id		BKGmw-018-110816-GW	BKGmw-509-042017-GW	BKGmw-018-042017-GW	BKGmw-018-120517-GW	BKGmw-024-111516-GW	BKGmw-024-042017-GW	BKGmw-024-080717-GW
Date		11/08/16	04/20/17	04/20/17	12/05/17	11/15/16	04/20/17	08/07/17
Sample Type		GR	FD	GR	GR	GR	GR	GR
Filter Status	CAS	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	Number							
Aluminum	7429-90-5	<0.07 U	<0.07 U	<0.07 U	<0.07 U	<0.07 U	<0.07 U	<0.15 U
Antimony	7440-36-0	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U	0.00041 J	<0.009 UJ
Arsenic	7440-38-2	<0.001 U	<0.001 U	<0.001 U	<0.001 UJ	0.0098	0.0075	0.0079 J
Barium	7440-39-3	0.014	0.0067	0.0076	0.018	0.1	0.087	0.096
Beryllium	7440-41-7	<0.0003 U	<0.0003 U	<0.0003 U	<0.0003 U	<0.0003 U	0.00023 J	<0.0045 U
Cadmium	7440-43-9	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.001 U	<0.0045 U
Calcium	7440-70-2	49	23	23	55	77	75	75 J
Chromium	7440-47-3	<0.0018 U	<0.0018 U	<0.0018 U	<0.0018 UJ	<0.0018 U	<0.0018 U	<0.008 U
Chromium, hexavalent	18540-29-9	NA	<0.004 U	<0.004 U	<0.02 U	NA	<0.004 U	<0.02 U
Cobalt	7440-48-4	0.00019 J	<0.0002 U	<0.0002 U	<0.0002 UJ	0.0011	0.00046 J	<0.0018 U
Copper	7440-50-8	0.0012 J	<0.0018 U	0.00099 J	<0.0018 U	<0.0018 U	<0.0018 U	<0.0008 U
Iron	7439-89-6	<0.1 U	<0.085 U	<0.085 U	<0.1 U	1.9	1.4	1.3 J
Lead	7439-92-1	0.00032 J	<0.0007 U	0.00053 J	<0.003 U	<0.003 U	<0.0007 U	<0.002 U
Magnesium	7439-95-4	6.6	2.8	3	8.7	23	21	22 J
Manganese	7439-96-5	0.022 J	0.0007 J	0.0016 J	0.01	0.52	0.45	0.47 J
Mercury	7439-97-6	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00008 U	<0.00015 U
Nickel	7440-02-0	0.00055 J	0.0004 J	0.00033 J	0.00037 J	0.0016 J	0.00086 J	<0.004 U
Potassium	7440-09-7	0.98 J	<0.94 U	<0.94 U	1.1 J	2.2 J	1.4 J	2
Selenium	7782-49-2	0.0012 J	<0.002 U	<0.002 U	0.0011 J	<0.002 U	<0.002 U	<0.004 U
Silver	7440-22-4	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0018 U
Sodium	7440-23-5	<5 U	3.2 J	3.4 J	4.1 J	13	11	11 J
Thallium	7440-28-0	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	0.0001 J	<0.015 UJ
Vanadium	7440-62-2	0.00085 J	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.002 U	<0.008 U
Zinc	7440-66-6	<0.008 U	<0.008 U	0.0042 J	<0.008 U	<0.02 U	<0.008 U	<0.018 U

Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone		Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-024	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025
Sample Id		BKGmw-024-120517-GW	BKGmw-025-111516-GW	BKGmw-025-042617-GW	BKGmw-025-080217-GW	BKGmw-025-D-120117-GW	BKGmw-025-120117-GW
Date		12/05/17	11/15/16	04/26/17	08/02/17	12/01/17	12/01/17
Sample Type		GR	GR	GR	GR	FD	GR
Filter Status		Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number						
Aluminum	7429-90-5	<0.07 U	0.049 J	<0.07 U	<0.15 U	<0.07 U	<0.07 U
Antimony	7440-36-0	<0.001 U	<0.006 U	0.0006 J	<0.009 U	<0.001 U	<0.001 U
Arsenic	7440-38-2	0.0072	0.028	0.048	0.024	0.022	0.022
Barium	7440-39-3	0.094	0.096	0.089 J	0.083	0.084	0.081
Beryllium	7440-41-7	<0.0003 U	<0.0003 U	<0.0003 U	<0.0045 U	<0.0003 U	<0.0003 U
Cadmium	7440-43-9	<0.001 U	<0.001 U	<0.001 U	<0.0045 U	<0.001 U	<0.001 U
Calcium	7440-70-2	69	72	75	69	64	64
Chromium	7440-47-3	<0.0018 U	<0.0018 U	<0.0018 U	<0.008 U	<0.0018 U	<0.0018 U
Chromium, hexavalent	18540-29-9	<0.02 U	NA	<0.004 UJ	<0.02 U	<0.02 U	<0.02 U
Cobalt	7440-48-4	<0.0002 U	0.0066	0.0034	0.002	0.0022	0.0023
Copper	7440-50-8	<0.0018 U	<0.0018 U	<0.0018 U	0.00069 J	<0.0018 U	<0.0018 U
Iron	7439-89-6	1.3	0.34	0.89 J	0.22	0.46	0.54
Lead	7439-92-1	<0.003 U	<0.003 U	<0.0007 U	<0.002 U	<0.0007 U	<0.0007 U
Magnesium	7439-95-4	21	18	18	17	17	17
Manganese	7439-96-5	0.53	0.59	0.33	0.22	0.31	0.3
Mercury	7439-97-6	<0.00008 U	<0.00008 U	<0.00008 U	<0.00015 U	<0.00008 U	<0.00008 U
Nickel	7440-02-0	0.00041 J	0.016	0.0074	0.0057	0.0036 J	0.0037 J
Potassium	7440-09-7	1.9 J	1.9 J	<3 U	1.4	0.92 J	0.95 J
Selenium	7782-49-2	<0.002 U	<0.002 U	<0.002 U	<0.004 U	<0.002 U	<0.002 U
Silver	7440-22-4	<0.0001 U	<0.0001 U	<0.0001 U	<0.0018 U	<0.0001 U	<0.0001 U
Sodium	7440-23-5	12	15	9.8 J	11	9.1	8.8
Thallium	7440-28-0	<0.0002 U	<0.0002 U	<0.0002 U	<0.015 U	<0.0002 U	<0.0002 U
Vanadium	7440-62-2	<0.002 U	<0.002 U	<0.002 U	<0.008 U	<0.002 U	<0.002 U
Zinc	7440-66-6	<0.008 U	<0.02 U	<0.008 U	<0.018 U	<0.008 U	<0.008 U

Table B-1. Concentrations of Metals within the Background Monitoring Well Network

Zone	CAS Number	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		SCFmw-006	SCFmw-006	SCFmw-006	SCFmw-006	SCFmw-006
Sample Id		SCFmw-006-111416	SCFmw-006-041817-GW	SCFmw-006-041917-GW	SCFmw-006-042817-GW	SCFmw-006-120517-GW
Date		11/14/16	04/18/17	04/19/17	04/28/17	12/05/17
Sample Type		GR	GR	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total
Analyte (mg/L)						
Aluminum	7429-90-5	<0.07 U	<0.07 U	NA	NA	0.037 J
Antimony	7440-36-0	<0.001 U	<0.001 U	NA	NA	<0.001 U
Arsenic	7440-38-2	0.012	0.01	NA	NA	0.012 J
Barium	7440-39-3	0.11	0.11	NA	NA	0.11
Beryllium	7440-41-7	<0.0003 U	<0.0003 U	NA	NA	<0.0003 U
Cadmium	7440-43-9	<0.001 U	<0.001 U	NA	NA	<0.001 U
Calcium	7440-70-2	60	63	NA	NA	57
Chromium	7440-47-3	<0.0018 U	0.00074 J	NA	NA	<0.0018 UJ
Chromium, hexavalent	18540-29-9	NA	NA	<0.004 U	<0.004 U	<0.02 U
Cobalt	7440-48-4	0.00013 J	0.00012 J	NA	NA	<0.0002 UJ
Copper	7440-50-8	<0.0018 U	<0.0018 U	NA	NA	<0.0018 U
Iron	7439-89-6	0.58	0.61	NA	NA	0.77
Lead	7439-92-1	0.00022 J	<0.0007 U	NA	NA	<0.003 U
Magnesium	7439-95-4	15	15	NA	NA	15
Manganese	7439-96-5	0.17	0.15	NA	NA	0.18
Mercury	7439-97-6	<0.00008 U	<0.00008 U	NA	NA	<0.00008 U
Nickel	7440-02-0	<0.001 U	<0.001 U	NA	NA	<0.001 U
Potassium	7440-09-7	2.1 J	2 J	NA	NA	1.7 J
Selenium	7782-49-2	<0.002 U	<0.002 U	NA	NA	<0.002 U
Silver	7440-22-4	<0.0001 U	<0.0001 U	NA	NA	<0.0001 U
Sodium	7440-23-5	8.9 J	10	NA	NA	10
Thallium	7440-28-0	<0.0002 U	<0.0002 U	NA	NA	<0.0002 U
Vanadium	7440-62-2	<0.002 U	<0.002 U	NA	NA	<0.002 U
Zinc	7440-66-6	0.0026 J	<0.008 U	NA	NA	<0.008 U

Definition of codes:
Sample Type: GR=Grab sample, FD=Field duplicate
NA=Not analyzed
Result qualifiers:
J—Result is estimated
R-Result was rejected in validation
U-Not detected
UJ-Not detected, reporting limit is estimated

Table B-2. Concentrations of Organic Chemicals within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Upper Sharon	Upper Sharon	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-008	BKGmw-008	BKGmw-024	BKGmw-024
Sample Id		BKGmw-022-111516-GW	BKGmw-510-042117-GW	BKGmw-022-042117-GW	BKGmw-022-080217-GW	BKGmw-022-120117-GW	BKGmw-023-111516-GW	BKGmw-023-042017-GW	BKGmw-023-080217-GW	BKGmw-023-D-120117-GW	BKGmw-023-120117-GW	BKGmw-500-110816-GW	BKGmw-008-110816-GW	BKGmw-024-111516-GW	BKGmw-024-042017-GW
Date		11/15/16	04/21/17	04/21/17	08/02/17	12/01/17	11/15/16	04/20/17	08/02/17	12/01/17	12/01/17	11/08/16	11/08/16	11/15/16	04/20/17
Sample Type		GR	FD	GR	GR	GR	GR	GR	GR	FD	GR	FD	GR	GR	GR
Filter Status	CAS	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	Number														
Explosives/Propellants															
1,3,5-Trinitrobenzene	99-35-4	<0.00041 U	<0.00041 U	<0.00042 U	<0.0002 U	<0.00042 UJ	<0.00042 U	<0.00042 U	<0.0002 U	<0.00043 UJ	<0.00042 U	<0.00042 U	<0.00041 U	<0.00041 U	<0.00041 U
1,3-Dinitrobenzene	99-65-0	<0.00021 U	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U
2,4,6-Trinitrotoluene	118-96-7	<0.00021 U	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U
2,4-Dinitrotoluene	121-14-2	<0.00021 U	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U
2,6-Dinitrotoluene	606-20-2	<0.00021 U	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U
2-Amino-4,6-Dinitrotoluene	35572-78-2	<0.00012 U	<0.00012 U	<0.00013 U	<0.0002 U	<0.00013 UJ	<0.00013 U	<0.00013 U	<0.0002 U	<0.00013 UJ	<0.00013 U	<0.00013 U	<0.00012 U	<0.00012 UJ	<0.00012 U
2-Nitrotoluene	88-72-2	<0.00021 U	<0.00021 U	<0.00021 U	<0.0005 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0005 U	<0.00021 UJ	<0.00021 U	<0.00021 UJ	<0.00021 UJ	<0.00021 U	<0.00021 U
3-Nitrotoluene	99-08-1	<0.00021 U	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U
4-Amino-2,6-Dinitrotoluene	19406-51-0	<0.00012 U	<0.00012 U	<0.00013 U	<0.0002 U	<0.00013 UJ	<0.00013 U	<0.00013 U	<0.0002 U	<0.00013 UJ	<0.00013 U	<0.00013 U	<0.00012 U	<0.00012 U	<0.00012 U
4-Nitrotoluene	99-99-0	<0.00041 U	<0.00041 U	<0.00042 U	<0.0002 U	<0.00042 UJ	<0.00042 U	<0.00042 U	<0.0002 U	<0.00043 UJ	<0.00042 UJ	<0.00042 U	<0.00041 U	<0.00041 U	<0.00041 U
HMX	2691-41-0	<0.00021 U	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U
Nitrobenzene	98-95-3	<0.00021 U	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U
Nitrocellulose	9004-70-0	NA	<1 U	<1 U	<1 U	<1 U	NA	<1 U	<1 U	<1 U	<1 U	NA	NA	NA	<1 U
Nitroglycerin	55-63-0	<0.0021 U	<0.0021 U	<0.0021 U	<0.00099 U	<0.0021 UJ	<0.0021 U	<0.0021 U	<0.001 U	<0.0021 UJ	<0.0021 U	<0.0021 U	<0.0021 U	<0.0021 U	<0.0021 U
Nitroguanidine	556-88-7	NA	<0.006 U	<0.006 U	<0.006 U	<0.006 U	NA	<0.006 U	<0.006 U	<0.006 U	<0.006 U	NA	NA	NA	<0.006 U
PETN	78-11-5	<0.0012 U	<0.0012 U	<0.0013 U	<0.00099 U	<0.0013 UJ	<0.0013 U	<0.0013 U	<0.001 U	<0.0013 UJ	<0.0013 U	<0.0013 U	<0.0012 U	<0.0012 U	<0.0012 U
RDX	121-82-4	<0.00012 U	<0.00012 U	<0.00013 U	<0.0002 U	<0.00013 UJ	<0.00013 U	<0.00013 U	<0.0002 U	<0.00013 UJ	<0.00013 U	<0.00013 U	<0.00012 U	<0.00012 U	<0.00012 U
Tetryl	479-45-8	<0.00021 U	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.00021 UJ	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U	<0.00021 U
SVOCs															
1,2,4-Trichlorobenzene	120-82-1	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.0042 U	<0.00098 U	<0.001 U	<0.0029 R	<0.005 U	<0.0043 U	NA	NA	<0.00096 U	<0.00096 U
1,2-Dichlorobenzene	95-50-1	<0.00049 U	<0.00048 U	<0.00047 U	<0.003 R	<0.0042 U	<0.00049 U	<0.00051 U	<0.0029 R	<0.005 U	<0.0043 U	NA	NA	<0.00048 U	<0.00048 U
1,3-Dichlorobenzene	541-73-1	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.0042 U	<0.00098 U	<0.001 U	<0.0029 R	<0.005 U	<0.0043 U	NA	NA	<0.00096 U	<0.00096 U
1,4-Dichlorobenzene	106-46-7	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.0042 U	<0.00098 U	<0.001 U	<0.0029 R	<0.005 U	<0.0043 U	NA	NA	<0.00096 U	<0.00096 U
1,4-Dioxane	123-91-1	NA	NA	NA	<0.003 R	NA	NA	NA	<0.0029 R	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	95-95-4	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.0019 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.00096 U	<0.00096 U
2,4,6-Trichlorophenol	88-06-2	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.0019 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.00096 U	<0.00096 U
2,4-Dichlorophenol	120-83-2	<0.002 U	<0.0019 U	<0.0019 U	<0.003 R	<0.0019 U	<0.002 U	<0.0021 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0019 U	<0.0019 U
2,4-Dimethylphenol	105-67-9	<0.002 U	<0.0019 U	<0.0019 U	<0.003 R	<0.0038 U	<0.002 U	<0.0021 U	<0.0029 R	<0.0045 U	<0.0039 U	NA	NA	<0.0019 U	<0.0019 U
2,4-Dinitrophenol	51-28-5	<0.029 U	<0.029 U	<0.028 U	<0.01 R	<0.015 U	<0.029 U	<0.031 U	<0.0097 R	<0.018 U	<0.016 U	NA	NA	<0.029 U	<0.029 U
2,4-Dinitrotoluene	121-14-2	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 UJ	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
2,6-Dinitrotoluene	606-20-2	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 UJ	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
2-Chloronaphthalene	91-58-7	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.00096 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00096 U	<0.00096 U
2-Chlorophenol	95-57-8	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.00096 U	<0.0043 U	<0.0045 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.0042 U	<0.0042 U
2-Methyl-4,6-dinitrophenol	534-52-1	<0.0086 U	<0.0084 U	<0.0084 U	<0.003 R	<0.015 U	<0.0086 U	<0.009 U	<0.0029 R	<0.018 U	<0.016 U	NA	NA	<0.0084 U	<0.0085 U
2-Methylnaphthalene	91-57-6	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.00096 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00096 U	<0.00096 U
2-Methylphenol	95-48-7	<0.002 U	<0.0019 U	<0.0019 U	<0.003 R	<0.0019 U	<0.002 U	<0.0021 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0019 U	<0.0019 U
2-Nitrobenzenamine	88-74-4	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 U	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
2-Nitrophenol	88-75-5	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.0019 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.00096 U	<0.00096 U
3+4-Methylphenol	15831-10-4	<0.00049 U	<0.00048 U	<0.00047 U	<0.003 R	<0.00096 U	<0.00049 U	<0.00051 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00048 U	<0.00048 U
3,3'-Dichlorobenzidine	91-94-1	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 U	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
3-Nitrobenzenamine	99-09-2	<0.0043 U	<0.0042 U	<0.0042 U	<0.01 R	<0.0019 U	<0.0043 U	<0.0045 U	<0.0097 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
4-Bromophenyl phenyl ether	101-55-3	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.00096 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00096 U	<0.00096 U

Table B-2. Concentrations of Organic Chemicals within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Upper Sharon	Upper Sharon	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-008	BKGmw-008	BKGmw-024	BKGmw-024
Sample Id		BKGmw-022-111516-GW	BKGmw-510-042117-GW	BKGmw-022-042117-GW	BKGmw-022-080217-GW	BKGmw-022-120117-GW	BKGmw-023-111516-GW	BKGmw-023-042017-GW	BKGmw-023-080217-GW	BKGmw-023-D-120117-GW	BKGmw-023-120117-GW	BKGmw-500-110816-GW	BKGmw-008-110816-GW	BKGmw-024-111516-GW	BKGmw-024-042017-GW
Date		11/15/16	04/21/17	04/21/17	08/02/17	12/01/17	11/15/16	04/20/17	08/02/17	12/01/17	12/01/17	11/08/16	11/08/16	11/15/16	04/20/17
Sample Type		GR	FD	GR	GR	GR	GR	GR	GR	FD	GR	FD	GR	GR	GR
Filter Status	CAS	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	Number														
4-Chloro-3-methylphenol	59-50-7	<0.0049 U	<0.0048 U	<0.0047 U	<0.003 R	<0.00096 U	<0.0049 U	<0.0051 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.0048 U	<0.0048 U
4-Chlorobenzenamine	106-47-8	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 U	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
4-Chlorophenyl phenyl ether	7005-72-3	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 U	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
4-Nitrobenzenamine	100-01-6	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 U	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
4-Nitrophenol	100-02-7	<0.0039 U	<0.0038 U	<0.0038 U	<0.01 R	<0.0038 UJ	<0.0039 U	<0.0041 U	<0.0097 R	<0.0045 UJ	<0.0039 UJ	NA	NA	<0.0038 U	<0.0038 U
Acenaphthene	83-32-9	<0.00004 U	<0.00004 U	<0.00004 U	<0.003 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.0029 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 UJ	<0.00004 U
Acenaphthylene	208-96-8	<0.00004 U	<0.00004 U	<0.00004 U	<0.003 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.0029 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 UJ	<0.00004 U
Anthracene	120-12-7	<0.00004 U	<0.00004 U	<0.00004 U	<0.003 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.0029 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 UJ	<0.00004 U
Benz(a)anthracene	56-55-3	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	7.6E-6 J	0.00002 J	<0.00001 U	<0.0029 R	<0.00001 U	7E-6 J	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U
Benzenemethanol	100-51-6	<0.00049 U	<0.00048 U	<0.00047 U	<0.003 R	<0.00096 U	<0.00049 U	<0.00051 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00048 U	<0.00048 U
Benzo(a)pyrene	50-32-8	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.0029 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U
Benzo(b)fluoranthene	205-99-2	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	4.1E-6 J	0.00002 J	<0.00001 U	<0.0029 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U
Benzo(ghi)perylene	191-24-2	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	<0.00001 U	0.00002 J	<0.00001 U	<0.0029 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U
Benzo(k)fluoranthene	207-08-9	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	<0.00001 U	0.00002 J	<0.00001 U	<0.0029 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U
Benzoic acid	65-85-0	<0.029 U	<0.029 U	<0.028 U	<0.01 R	<0.015 U	<0.029 U	<0.031 U	<0.0097 R	<0.018 U	<0.016 U	NA	NA	<0.029 U	<0.029 U
Bis(2-chloroethoxy)methane	111-91-1	<0.002 U	<0.0019 U	<0.0019 U	<0.003 R	<0.0019 U	<0.002 U	<0.0021 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0019 U	<0.0019 U
Bis(2-chloroethyl) ether	111-44-4	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.00096 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00096 U	<0.00096 U
Bis(2-chloroisopropyl) ether	108-60-1	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.00096 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00096 U	<0.00096 U
Bis(2-ethylhexyl)phthalate	117-81-7	<0.002 U	<0.0019 U	<0.0019 U	<0.003 R	<0.0042 U	<0.002 U	<0.0021 U	<0.0029 R	<0.005 U	<0.0043 U	NA	NA	<0.0019 U	<0.0019 U
Butyl benzyl phthalate	85-68-7	<0.002 U	<0.0019 U	<0.0019 U	<0.003 R	<0.0042 U	<0.002 U	<0.0021 U	<0.0029 R	<0.005 U	<0.0043 U	NA	NA	<0.0019 U	<0.0019 U
Carbazole	86-74-8	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.00096 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00096 U	<0.00096 U
Chrysene	218-01-9	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	<0.00001 U	0.00003 J	<0.00001 U	<0.0029 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U
Di-n-butyl phthalate	84-74-2	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 U	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0042 U	<0.0042 U
Di-n-octylphthalate	117-84-0	<0.00098 U	<0.00096 U	<0.00095 U	<0.01 R	<0.0042 U	<0.00098 U	<0.001 U	<0.0097 R	<0.005 U	<0.0043 U	NA	NA	<0.00096 U	<0.00096 U
Dibenz(a,h)anthracene	53-70-3	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	<0.00001 U	0.00003 J	<0.00001 U	<0.0029 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U
Dibenzofuran	132-64-9	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.00096 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.00096 U	<0.00096 U
Diethyl phthalate	84-66-2	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.0019 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.00096 U	<0.00096 U
Dimethyl phthalate	131-11-3	<0.00049 U	<0.00048 U	<0.00047 U	<0.003 R	<0.0019 U	<0.00049 U	<0.00051 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.00048 U	<0.00048 U
Diphenylamine	122-39-4	NA	NA	NA	<0.003 R	NA	NA	NA	<0.0029 R	NA	NA	NA	NA	NA	NA
Fluoranthene	206-44-0	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.0029 R	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 UJ	<0.00001 U
Fluorene	86-73-7	<0.00004 U	<0.00004 U	<0.00004 U	<0.003 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.0029 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 UJ	<0.00004 U
Hexachlorobenzene	118-74-1	<0.002 U	<0.0019 U	<0.0019 U	<0.003 R	<0.0019 U	<0.002 U	<0.0021 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.0019 U	<0.0019 U
Hexachlorobutadiene	87-68-3	<0.0098 U	<0.0096 U	<0.0095 U	<0.003 R	<0.029 U	<0.0098 U	<0.01 U	<0.0029 R	<0.034 U	<0.03 U	NA	NA	<0.0096 U	<0.0096 U
Hexachlorocyclopentadiene	77-47-4	<0.029 U	<0.029 R	<0.028 R	<0.003 R	<0.024 U	<0.029 U	<0.031 R	<0.0029 R	<0.028 U	<0.025 U	NA	NA	<0.029 U	<0.029 R
Hexachloroethane	67-72-1	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.029 U	<0.0043 U	<0.0045 U	<0.0029 R	<0.034 U	<0.03 U	NA	NA	<0.0042 U	<0.0042 U
Indeno(1,2,3-cd)pyrene	193-39-5	<0.00004 U	<0.00004 U	<0.00004 U	<0.003 R	<0.00004 U	0.00002 J	<0.00004 U	<0.0029 R	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00004 U
Isophorone	78-59-1	<0.00049 U	<0.00048 U	<0.00047 U	<0.003 R	<0.0019 U	<0.00049 U	<0.00051 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.00048 U	<0.00048 U
N-Nitroso-di-n-propylamine	621-64-7	<0.00098 U	<0.00096 U	<0.00095 U	<0.003 R	<0.0019 U	<0.00098 U	<0.001 U	<0.0029 R	<0.0023 U	<0.002 U	NA	NA	<0.00096 U	<0.00096 U
N-Nitrosodiphenylamine	86-30-6	<0.00098 U	<0.00096 U	<0.00095 U	NA	<0.0019 U	<0.00098 U	<0.001 U	NA	<0.0023 U	<0.002 U	NA	NA	<0.00096 U	<0.00096 U
Naphthalene	91-20-3	<0.00001 U	<0.00001 U	<0.00001 U	<0.003 R	8.6E-6 J	<0.00001 U	<0.00001 U	<0.0029 R	0.00001 J	<0.00001 U	<0.00001 U	<0.00001 U	<0.00001 UJ	<0.00001 U
Nitrobenzene	98-95-3	<0.002 U	<0.0019 U	<0.0019 U	<0.003 R	<0.00096 UJ	<0.002 U	<0.0021 U	<0.0029 R	<0.0011 U	<0.00098 U	NA	NA	<0.0019 U	<0.0019 U
Pentachlorophenol	87-86-5	<0.059 U	<0.058 U	<0.057 U	<0.003 R	<0.015 U	<0.059 U	<0.062 U	<0.0029 R	<0.018 U	<0.016 U	NA	NA	<0.057 U	<0.058 U
Phenanthrene	85-01-8	<0.00002 U	<0.00002 U	<0.00002 U	<0.003 R	0.00001 J	<0.00002 U	<0.00002 U	<0.0029 R	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 UJ	<0.00002 U

Table B-2. Concentrations of Organic Chemicals within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Upper Sharon	Upper Sharon	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-008	BKGmw-008	BKGmw-024	BKGmw-024
Sample Id		BKGmw-022-111516-GW	BKGmw-510-042117-GW	BKGmw-022-042117-GW	BKGmw-022-080217-GW	BKGmw-022-120117-GW	BKGmw-023-111516-GW	BKGmw-023-042017-GW	BKGmw-023-080217-GW	BKGmw-023-D-120117-GW	BKGmw-023-120117-GW	BKGmw-500-110816-GW	BKGmw-008-110816-GW	BKGmw-024-111516-GW	BKGmw-024-042017-GW
Date		11/15/16	04/21/17	04/21/17	08/02/17	12/01/17	11/15/16	04/20/17	08/02/17	12/01/17	12/01/17	11/08/16	11/08/16	11/15/16	04/20/17
Sample Type		GR	FD	GR	GR	GR	GR	GR	GR	FD	GR	FD	GR	GR	GR
Filter Status	CAS Number	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)															
Phenol	108-95-2	<0.0043 U	<0.0042 U	<0.0042 U	<0.003 R	<0.0019 UJ	<0.0043 U	<0.0045 U	<0.0029 R	<0.0023 UJ	<0.002 UJ	NA	NA	<0.0042 U	<0.0042 U
Pyrene	129-00-0	<0.00002 U	<0.00002 U	<0.00002 U	<0.003 R	<0.00002 U	<0.00002 U	<0.00002 U	<0.0029 R	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 UJ	<0.00002 U
PCBs															
PCB-1016	12674-11-2	<0.0001 U	<0.0001 U	<0.0001 U	<0.00081 U	<0.0001 U	<0.00009 U	<0.0001 U	<0.00078 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
PCB-1221	11104-28-2	<0.0001 U	<0.0001 U	<0.0001 U	<0.00081 U	<0.0001 U	<0.00009 U	<0.0001 U	<0.00078 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
PCB-1232	11141-16-5	<0.0001 U	<0.0001 U	<0.0001 U	<0.00081 U	<0.0001 U	<0.00009 U	<0.0001 U	<0.00078 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
PCB-1242	53469-21-9	<0.0001 U	<0.0001 U	<0.0001 U	<0.00081 U	<0.0001 U	<0.00009 U	<0.0001 U	<0.00078 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
PCB-1248	12672-29-6	<0.0001 U	<0.0001 U	<0.0001 U	<0.00081 U	<0.0001 U	<0.00009 U	<0.0001 U	<0.00078 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
PCB-1254	11097-69-1	<0.0001 U	<0.0001 U	<0.0001 U	<0.00031 U	<0.0001 U	<0.00009 U	<0.0001 U	<0.00029 U	0.0001 J	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
PCB-1260	11096-82-5	<0.0001 U	<0.0001 U	<0.0001 U	<0.00031 U	<0.0001 U	<0.00009 U	<0.0001 U	<0.00029 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0001 U
Pesticides															
4,4'-DDD	72-54-8	<0.00005 U	<0.00005 U	<0.00005 U	<0.00002 U	<0.00005 U	<0.00005 U	<0.00005 U	<0.00002 U	<0.00005 U	<0.00005 U	NA	NA	<0.00005 U	<0.00005 U
4,4'-DDE	72-55-9	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA	<0.00002 U	<0.00002 U
4,4'-DDT	50-29-3	<0.00001 U	<0.00001 U	<0.00001 U	<0.00002 U	<0.00001 U	<0.00001 U	<0.00001 U	<0.00002 U	<0.00001 U	<0.00001 U	NA	NA	<0.00001 U	<0.00001 U
Aldrin	309-00-2	<0.00002 U	<0.00002 UJ	<0.00002 UJ	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 UJ	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA	<0.00002 U	<0.00002 UJ
Dieldrin	60-57-1	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA	<0.00002 U	<0.00002 U
Endosulfan I	959-98-8	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA	<0.00002 U	<0.00002 U
Endosulfan II	33213-65-9	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA	<0.00004 U	<0.00004 U
Endosulfan sulfate	1031-07-8	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA	<0.00002 U	<0.00002 U
Endrin	72-20-8	<0.00002 U	<0.00002 UJ	<0.00002 UJ	<0.00002 U	<0.00003 U	<0.00002 U	<0.00003 UJ	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA	<0.00002 U	<0.00002 UJ
Endrin aldehyde	7421-93-4	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA	<0.00004 U	<0.00004 U
Endrin ketone	53494-70-5	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA	<0.00004 U	<0.00004 U
Heptachlor	76-44-8	<0.00005 U	<0.00005 U	<0.00005 U	<0.00002 U	<0.00005 U	<0.00005 U	<0.00005 U	<0.00002 U	<0.00005 U	<0.00005 U	NA	NA	<0.00005 U	<0.00005 U
Heptachlor epoxide	1024-57-3	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA	<0.00004 U	<0.00004 U
Lindane	58-89-9	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	NA	NA	<0.00003 U	<0.00003 U
Methoxychlor	72-43-5	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA	<0.00004 U	<0.00004 U
Toxaphene	8001-35-2	<0.0019 U	<0.0019 U	<0.0019 U	<0.0004 U	<0.002 U	<0.0019 U	<0.002 U	<0.00039 U	<0.0019 U	<0.0019 U	NA	NA	<0.0019 U	<0.0019 U
alpha-BHC	319-84-6	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA	<0.00002 U	<0.00002 U
alpha-Chlordane	5103-71-9	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	NA	NA	<0.00003 U	<0.00003 U
beta-BHC	319-85-7	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA	<0.00004 U	<0.00004 U
delta-BHC	319-86-8	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA	<0.00002 U	<0.00002 U
gamma-Chlordane	5103-74-2	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	NA	NA	<0.00003 U	<0.00003 U
VOCs															
1,1,1-Trichloroethane	71-55-6	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
1,1,2,2-Tetrachloroethane	79-34-5	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U
1,1,2-Trichloroethane	79-00-5	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U
1,1-Dichloroethane	75-34-3	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U
1,1-Dichloroethene	75-35-4	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U
1,2-Dibromoethane	106-93-4	<0.0004 U	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
1,2-Dichloroethane	107-06-2	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
1,2-Dichloroethene	540-59-0	<0.0002 U	<0.0002 U	<0.0002 U	NA	<0.0002 U	<0.0002 U	<0.0002 U	NA	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U
1,2-Dichloropropane	78-87-5	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 UJ	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 UJ	<0.0004 U
2-Butanone	78-93-3	<0.004 U	<0.004 U	<0.004 U	<0.001 U	<0.004 U	<0.004 U	<0.004 U	<0.001 U	<0.004 U	<0.004 U	<0.004 U	<0.004 U	<0.004 U	<0.004 U

Table B-2. Concentrations of Organic Chemicals within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Upper Sharon	Upper Sharon	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-008	BKGmw-008	BKGmw-024	BKGmw-024
Sample Id		BKGmw-022-111516-GW	BKGmw-510-042117-GW	BKGmw-022-042117-GW	BKGmw-022-080217-GW	BKGmw-022-120117-GW	BKGmw-023-111516-GW	BKGmw-023-042017-GW	BKGmw-023-080217-GW	BKGmw-023-D-120117-GW	BKGmw-023-120117-GW	BKGmw-500-110816-GW	BKGmw-008-110816-GW	BKGmw-024-111516-GW	BKGmw-024-042017-GW
Date		11/15/16	04/21/17	04/21/17	08/02/17	12/01/17	11/15/16	04/20/17	08/02/17	12/01/17	12/01/17	11/08/16	11/08/16	11/15/16	04/20/17
Sample Type		GR	FD	GR	GR	GR	GR	GR	GR	FD	GR	FD	GR	GR	GR
Filter Status	CAS	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	Number														
2-Hexanone	591-78-6	<0.004 U	<0.004 U	<0.004 U	<0.0005 U	<0.004 U	<0.004 U	<0.004 U	<0.0005 U	<0.004 U	<0.004 U	<0.004 U	<0.004 U	<0.004 U	<0.004 U
4-Methyl-2-pentanone	108-10-1	<0.0032 U	<0.0032 U	<0.0032 U	<0.0005 U	<0.0032 U	<0.0032 U	<0.0032 U	<0.0005 U	<0.0032 U	<0.0032 U	<0.0032 U	<0.0032 U	<0.0032 U	<0.0032 U
Acetone	67-64-1	<0.0064 U	<0.01 U	<0.01 U	0.0021 J	<0.0064 U	<0.0064 U	<0.01 U	0.0021 J	<0.0064 U	<0.0064 U	<0.0064 U	<0.0064 U	<0.0064 U	<0.01 U
Benzene	71-43-2	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Bromochloromethane	74-97-5	<0.0002 U	<0.0002 U	<0.0002 U	<0.0005 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0005 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U
Bromodichloromethane	75-27-4	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Bromoform	75-25-2	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Bromomethane	74-83-9	<0.0008 U	<0.0008 U	<0.0008 U	<0.0005 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0005 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U
Carbon disulfide	75-15-0	<0.0016 U	<0.0016 U	<0.0016 U	<0.00025 U	<0.0016 U	<0.0016 U	<0.0016 U	<0.00025 U	<0.0016 U	<0.0016 U	<0.0016 U	<0.0016 U	<0.0016 U	<0.0016 U
Carbon tetrachloride	56-23-5	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Chlorobenzene	108-90-7	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Chloroethane	75-00-3	<0.0016 U	<0.0016 U	<0.0016 U	<0.00025 U	<0.0016 U	<0.0016 U	<0.0016 U	<0.00025 U	<0.0016 U	<0.0016 U	<0.0016 U	<0.0016 U	<0.0016 U	<0.0016 U
Chloroform	67-66-3	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	0.00033 J	<0.0004 U	0.00013 J	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Chloromethane	74-87-3	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U
Dibromochloromethane	124-48-1	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Ethylbenzene	100-41-4	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Methylene chloride	75-09-2	<0.0008 U	<0.0008 U	<0.0008 U	<0.0005 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0005 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U
Styrene	100-42-5	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Tetrachloroethene	127-18-4	<0.0004 U	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Toluene	108-88-3	<0.0004 U	0.00037 J	0.00038 J	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Trichloroethene	79-01-6	<0.0004 U	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
Vinyl chloride	75-01-4	<0.0002 U	<0.0002 U	<0.0002 U	<0.00025 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.00025 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U	<0.0002 U
Xylenes, total	1330-20-7	<0.0008 U	<0.0008 U	<0.0008 U	<0.0005 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0005 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U	<0.0008 U
cis-1,2-Dichloroethene	156-59-2	NA	NA	NA	<0.00025 U	NA	NA	NA	<0.00025 U	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	10061-01-5	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U
trans-1,2-Dichloroethene	156-60-5	NA	NA	NA	<0.00025 U	NA	NA	NA	<0.00025 U	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	10061-02-6	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U	<0.0004 U

Table B-2. Concentrations of Organic Chemicals within the Background Monitoring Well Network

Zone	CAS Number	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		**BKGmw-024**	**BKGmw-024**	**BKGmw-025**	**BKGmw-025**	**BKGmw-025**	**BKGmw-025**	**BKGmw-025**	**SCFmw-006**	**SCFmw-006**
Sample Id		**BKGmw-024-080717-GW**	**BKGmw-024-120517-GW**	**BKGmw-025-111516-GW**	**BKGmw-025-042617-GW**	**BKGmw-025-080217-GW**	**BKGmw-025-D-120117-GW**	**BKGmw-025-120117-GW**	**SCFmw-006-111416**	**SCFmw-006-111516-GW**
Date		**08/07/17**	**12/05/17**	**11/15/16**	**04/26/17**	**08/02/17**	**12/01/17**	**12/01/17**	**11/14/16**	**11/15/16**
Sample Type		**GR**	**GR**	**GR**	**GR**	**GR**	**FD**	**GR**	**GR**	**GR**
Filter Status		**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Analyte (mg/L)										
Explosives/Propellants										
1,3,5-Trinitrobenzene	99-35-4	<0.0002 U	<0.00044 UJ	<0.00041 U	<0.00042 U	<0.0002 U	<0.00041 U	<0.00041 U	<0.00042 U	NA
1,3-Dinitrobenzene	99-65-0	<0.0002 U	<0.00022 UJ	<0.00021 U	<0.00021 UJ	<0.0002 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
2,4,6-Trinitrotoluene	118-96-7	<0.0002 U	<0.00022 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
2,4-Dinitrotoluene	121-14-2	<0.0002 U	<0.00022 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
2,6-Dinitrotoluene	606-20-2	<0.0002 U	<0.00022 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
2-Amino-4,6-Dinitrotoluene	35572-78-2	<0.0002 U	<0.00013 UJ	<0.00012 U	<0.00013 U	<0.0002 U	<0.00012 U	<0.00012 U	<0.00013 U	NA
2-Nitrotoluene	88-72-2	<0.0005 U	<0.00022 UJ	<0.00021 U	<0.00021 U	<0.0005 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
3-Nitrotoluene	99-08-1	<0.0002 U	<0.00022 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
4-Amino-2,6-Dinitrotoluene	19406-51-0	<0.0002 U	<0.00013 UJ	<0.00012 U	<0.00013 U	<0.0002 U	<0.00012 U	<0.00012 U	<0.00013 U	NA
4-Nitrotoluene	99-99-0	<0.0002 U	<0.00044 UJ	<0.00041 U	<0.00042 U	<0.0002 U	<0.00041 UJ	<0.00041 UJ	<0.00042 U	NA
HMX	2691-41-0	<0.0002 U	<0.00022 UJ	<0.00021 U	<0.00021 UJ	<0.0002 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
Nitrobenzene	98-95-3	<0.0002 U	<0.00022 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
Nitrocellulose	9004-70-0	<1 U	<1 U	NA	<1 U	<1 U	<1 U	<1 U	NA	NA
Nitroglycerin	55-63-0	<0.001 U	<0.0022 UJ	<0.0021 U	<0.0021 U	<0.001 U	<0.002 U	<0.0021 U	<0.0021 U	NA
Nitroguanidine	556-88-7	<0.006 U	<0.006 U	NA	<0.006 U	<0.006 U	<0.006 U	<0.006 U	NA	NA
PETN	78-11-5	<0.001 U	<0.0013 UJ	<0.0012 U	<0.0013 U	<0.001 U	<0.0012 U	<0.0012 U	<0.0013 U	NA
RDX	121-82-4	<0.0002 U	<0.00013 UJ	<0.00012 U	<0.00013 UJ	<0.0002 U	<0.00012 U	<0.00012 U	<0.00013 U	NA
Tetryl	479-45-8	<0.0002 U	<0.00022 UJ	<0.00021 U	<0.00021 U	<0.0002 U	<0.0002 U	<0.00021 U	<0.00021 U	NA
SVOCs										
1,2,4-Trichlorobenzene	120-82-1	<0.003 UJ	<0.0042 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.0042 U	<0.0043 U	NA	NA
1,2-Dichlorobenzene	95-50-1	<0.003 UJ	<0.0042 U	<0.00049 U	<0.00049 U	<0.0029 R	<0.0042 U	<0.0043 U	NA	NA
1,3-Dichlorobenzene	541-73-1	<0.003 UJ	<0.0042 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.0042 U	<0.0043 U	NA	NA
1,4-Dichlorobenzene	106-46-7	<0.003 UJ	<0.0042 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.0042 U	<0.0043 U	NA	NA
1,4-Dioxane	123-91-1	<0.003 U	NA	NA	NA	<0.0029 R	NA	NA	NA	NA
2,4,5-Trichlorophenol	95-95-4	<0.003 U	<0.0019 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
2,4,6-Trichlorophenol	88-06-2	<0.003 U	<0.0019 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
2,4-Dichlorophenol	120-83-2	<0.003 UJ	<0.0019 U	<0.002 U	<0.002 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
2,4-Dimethylphenol	105-67-9	<0.003 U	<0.0038 U	<0.002 U	<0.002 U	<0.0029 R	<0.0038 U	<0.0039 U	NA	NA
2,4-Dinitrophenol	51-28-5	<0.0099 U	<0.015 U	<0.029 U	<0.03 U	<0.0098 R	<0.015 U	<0.016 U	NA	NA
2,4-Dinitrotoluene	121-14-2	<0.003 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
2,6-Dinitrotoluene	606-20-2	<0.003 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
2-Chloronaphthalene	91-58-7	<0.003 U	<0.00095 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
2-Chlorophenol	95-57-8	<0.003 UJ	<0.00095 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
2-Methyl-4,6-dinitrophenol	534-52-1	<0.003 U	<0.015 U	<0.0087 U	<0.0087 U	<0.0029 R	<0.015 U	<0.016 U	NA	NA
2-Methylnaphthalene	91-57-6	<0.003 U	<0.00095 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
2-Methylphenol	95-48-7	<0.003 UJ	<0.0019 U	<0.002 U	<0.002 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
2-Nitrobenzenamine	88-74-4	<0.003 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
2-Nitrophenol	88-75-5	<0.003 UJ	<0.0019 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
3+4-Methylphenol	15831-10-4	<0.003 UJ	<0.00095 U	<0.00049 U	<0.00049 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
3,3'-Dichlorobenzidine	91-94-1	<0.003 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
3-Nitrobenzenamine	99-09-2	<0.0099 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0098 R	<0.0019 U	<0.002 U	NA	NA
4-Bromophenyl phenyl ether	101-55-3	<0.003 U	<0.00095 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA

Table B-2. Concentrations of Organic Chemicals within the Background Monitoring Well Network

Zone		Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-024	BKGmw-024	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	SCFmw-006	SCFmw-006
Sample Id		BKGmw-024-080717-GW	BKGmw-024-120517-GW	BKGmw-025-111516-GW	BKGmw-025-042617-GW	BKGmw-025-080217-GW	BKGmw-025-D-120117-GW	BKGmw-025-120117-GW	SCFmw-006-111416	SCFmw-006-111516-GW
Date		08/07/17	12/05/17	11/15/16	04/26/17	08/02/17	12/01/17	12/01/17	11/14/16	11/15/16
Sample Type		GR	GR	GR	GR	GR	FD	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number									
4-Chloro-3-methylphenol	59-50-7	<0.003 U	<0.00095 U	<0.0049 U	<0.0049 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
4-Chlorobenzenamine	106-47-8	<0.003 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
4-Chlorophenyl phenyl ether	7005-72-3	<0.003 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
4-Nitrobenzenamine	100-01-6	<0.003 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
4-Nitrophenol	100-02-7	<0.0099 U	<0.0038 UJ	<0.0039 U	<0.0039 U	<0.0098 R	<0.0038 UJ	<0.0039 UJ	NA	NA
Acenaphthene	83-32-9	<0.003 U	<0.00004 U	<0.00004 U	<0.00004 UJ	<0.0029 R	<0.00004 U	<0.00004 U	NA	<0.00004 U
Acenaphthylene	208-96-8	<0.003 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.0029 R	<0.00004 U	<0.00004 U	NA	<0.00004 U
Anthracene	120-12-7	<0.003 U	<0.00004 U	<0.00004 U	<0.00004 UJ	<0.0029 R	<0.00004 U	<0.00004 U	NA	<0.00004 U
Benz(a)anthracene	56-55-3	<0.003 U	<0.00011 U	<0.00001 U	<0.00001 UJ	<0.0029 R	6E-6 J	6.6E-6 J	NA	0.00009 J
Benzenemethanol	100-51-6	<0.003 U	<0.00095 U	<0.00049 U	<0.00049 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
Benzo(a)pyrene	50-32-8	<0.003 U	<0.00001 U	<0.00001 U	<0.00001 UJ	<0.0029 R	<0.00001 U	<0.00001 U	NA	0.00008 J
Benzo(b)fluoranthene	205-99-2	<0.003 U	3.8E-6 J	<0.00001 U	<0.00001 UJ	<0.0029 R	<0.00001 U	<0.00001 U	NA	0.00013
Benzo(ghi)perylene	191-24-2	<0.003 U	<0.00001 U	<0.00001 U	<0.00001 UJ	<0.0029 R	<0.00001 U	<0.00001 U	NA	0.00012
Benzo(k)fluoranthene	207-08-9	<0.003 U	<0.00001 U	<0.00001 U	<0.00001 UJ	<0.0029 R	<0.00001 U	<0.00001 U	NA	0.00009 J
Benzoic acid	65-85-0	<0.0099 U	<0.015 UJ	<0.029 U	<0.03 U	<0.0098 R	<0.015 U	<0.016 U	NA	NA
Bis(2-chloroethoxy)methane	111-91-1	<0.003 U	<0.0019 U	<0.002 U	<0.002 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
Bis(2-chloroethyl) ether	111-44-4	<0.003 UJ	<0.00095 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
Bis(2-chloroisopropyl) ether	108-60-1	<0.003 UJ	<0.00095 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
Bis(2-ethylhexyl)phthalate	117-81-7	<0.003 U	<0.0042 U	<0.002 U	<0.002 U	<0.0029 R	<0.0042 U	<0.0043 U	NA	NA
Butyl benzyl phthalate	85-68-7	<0.003 U	<0.0042 U	<0.002 U	<0.002 U	<0.0029 R	<0.0042 U	<0.0043 U	NA	NA
Carbazole	86-74-8	<0.003 U	<0.00095 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
Chrysene	218-01-9	<0.003 U	<0.00011 U	<0.00001 U	<0.00001 UJ	<0.0029 R	<0.00001 U	<0.00001 U	NA	0.00009 J
Di-n-butyl phthalate	84-74-2	<0.003 U	<0.0019 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
Di-n-octylphthalate	117-84-0	<0.0099 U	<0.0042 U	<0.00098 U	<0.00099 U	<0.0098 R	<0.0042 U	<0.0043 U	NA	NA
Dibenz(a,h)anthracene	53-70-3	<0.003 U	<0.00001 U	<0.00001 U	<0.00001 UJ	<0.0029 R	<0.00001 U	<0.00001 U	NA	0.00007 J
Dibenzofuran	132-64-9	<0.003 U	<0.00095 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
Diethyl phthalate	84-66-2	<0.003 U	<0.0019 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
Dimethyl phthalate	131-11-3	<0.003 U	<0.0019 U	<0.00049 U	<0.00049 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
Diphenylamine	122-39-4	<0.003 U	NA	NA	NA	<0.0029 R	NA	NA	NA	NA
Fluoranthene	206-44-0	<0.003 U	<0.00011 U	<0.00001 U	<0.00001 UJ	<0.0029 R	4.9E-6 J	<0.00001 U	NA	0.00012
Fluorene	86-73-7	<0.003 U	<0.00004 U	<0.00004 U	<0.00004 UJ	<0.0029 R	<0.00004 U	<0.00004 U	NA	0.00003 J
Hexachlorobenzene	118-74-1	<0.003 U	<0.0019 U	<0.002 U	<0.002 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
Hexachlorobutadiene	87-68-3	<0.003 UJ	<0.029 U	<0.0098 U	<0.0099 U	<0.0029 R	<0.029 U	<0.029 U	NA	NA
Hexachlorocyclopentadiene	77-47-4	<0.003 UJ	<0.024 UJ	<0.029 U	<0.03 UJ	<0.0029 R	<0.024 U	<0.025 U	NA	NA
Hexachloroethane	67-72-1	<0.003 UJ	<0.029 U	<0.0043 U	<0.0043 U	<0.0029 R	<0.029 U	<0.029 U	NA	NA
Indeno(1,2,3-cd)pyrene	193-39-5	<0.003 U	<0.00004 U	<0.00004 U	<0.00004 UJ	<0.0029 R	<0.00004 U	<0.00004 U	NA	0.00014
Isophorone	78-59-1	<0.003 U	<0.0019 U	<0.00049 U	<0.00049 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
N-Nitroso-di-n-propylamine	621-64-7	<0.003 UJ	<0.0019 U	<0.00098 U	<0.00099 U	<0.0029 R	<0.0019 U	<0.002 U	NA	NA
N-Nitrosodiphenylamine	86-30-6	NA	<0.0019 U	<0.00098 U	<0.00099 U	NA	<0.0019 U	<0.002 U	NA	NA
Naphthalene	91-20-3	<0.003 UJ	0.00002 J	<0.00001 U	0.00005 J	<0.0029 R	0.00005 J	0.00006 J	NA	<0.00001 U
Nitrobenzene	98-95-3	<0.003 UJ	<0.00095 U	<0.002 U	<0.002 U	<0.0029 R	<0.00096 U	<0.00098 U	NA	NA
Pentachlorophenol	87-86-5	<0.003 U	<0.015 U	<0.059 U	<0.059 U	<0.0029 R	<0.015 U	<0.016 U	NA	NA
Phenanthrene	85-01-8	<0.003 U	<0.00011 U	<0.00002 U	<0.00002 UJ	<0.0029 R	0.00001 J	<0.00002 U	NA	0.00008 J

Table B-2. Concentrations of Organic Chemicals within the Background Monitoring Well Network

Zone		Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-024	BKGmw-024	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	SCFmw-006	SCFmw-006
Sample Id		BKGmw-024-080717-GW	BKGmw-024-120517-GW	BKGmw-025-111516-GW	BKGmw-025-042617-GW	BKGmw-025-080217-GW	BKGmw-025-D-120117-GW	BKGmw-025-120117-GW	SCFmw-006-111416	SCFmw-006-111516-GW
Date		08/07/17	12/05/17	11/15/16	04/26/17	08/02/17	12/01/17	12/01/17	11/14/16	11/15/16
Sample Type		GR	GR	GR	GR	GR	FD	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number									
Phenol	108-95-2	<0.003 UJ	<0.0019 UJ	<0.0043 U	<0.0043 U	<0.0029 R	<0.0019 UJ	<0.002 UJ	NA	NA
Pyrene	129-00-0	<0.003 U	<0.00011 U	<0.00002 U	<0.00002 U	<0.0029 R	<0.00002 U	<0.00002 U	NA	0.0001
PCBs										
PCB-1016	12674-11-2	<0.0008 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.00079 U	<0.0001 U	<0.0001 U	<0.0001 U	NA
PCB-1221	11104-28-2	<0.0008 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.00079 U	<0.0001 U	<0.0001 U	<0.0001 U	NA
PCB-1232	11141-16-5	<0.0008 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.00079 U	<0.0001 U	<0.0001 U	<0.0001 U	NA
PCB-1242	53469-21-9	<0.0008 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.00079 U	<0.0001 U	<0.0001 U	<0.0001 U	NA
PCB-1248	12672-29-6	<0.0008 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.00079 U	<0.0001 U	<0.0001 U	<0.0001 U	NA
PCB-1254	11097-69-1	<0.0003 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0003 U	0.00013 J	0.00008 J	<0.0001 U	NA
PCB-1260	11096-82-5	<0.0003 U	<0.0001 U	<0.0001 U	<0.0001 U	<0.0003 U	<0.0001 U	<0.0001 U	<0.0001 U	NA
Pesticides										
4,4'-DDD	72-54-8	<0.00002 U	<0.00006 U	<0.00005 U	<0.00005 U	<0.00002 U	<0.00005 U	<0.00005 U	NA	NA
4,4'-DDE	72-55-9	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA
4,4'-DDT	50-29-3	<0.00002 U	<0.00002 U	<0.00001 U	<0.00001 U	<0.00002 U	<0.00002 U	<0.00001 U	NA	NA
Aldrin	309-00-2	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA
Dieldrin	60-57-1	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA
Endosulfan I	959-98-8	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA
Endosulfan II	33213-65-9	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA
Endosulfan sulfate	1031-07-8	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA
Endrin	72-20-8	<0.00002 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00002 U	<0.00003 U	<0.00003 U	NA	NA
Endrin aldehyde	7421-93-4	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA
Endrin ketone	53494-70-5	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA
Heptachlor	76-44-8	<0.00002 U	<0.00006 U	<0.00005 U	<0.00005 U	<0.00002 U	<0.00005 U	<0.00005 U	NA	NA
Heptachlor epoxide	1024-57-3	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA
Lindane	58-89-9	<0.00002 U	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	NA	NA
Methoxychlor	72-43-5	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA
Toxaphene	8001-35-2	<0.00039 U	<0.0021 U	<0.002 U	<0.0019 U	<0.00041 U	<0.002 U	<0.0019 U	NA	NA
alpha-BHC	319-84-6	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	NA	NA
alpha-Chlordane	5103-71-9	<0.00002 U	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	NA	NA
beta-BHC	319-85-7	<0.00002 U	<0.00004 U	<0.00004 U	<0.00004 U	<0.00002 U	<0.00004 U	<0.00004 U	NA	NA
delta-BHC	319-86-8	<0.00002 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00002 U	<0.00003 U	<0.00003 U	NA	NA
gamma-Chlordane	5103-74-2	<0.00002 U	<0.00003 U	<0.00003 U	<0.00003 U	<0.00002 U	<0.00003 U	<0.00003 U	NA	NA
VOCs										
1,1,1-Trichloroethane	71-55-6	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
1,1,2,2-Tetrachloroethane	79-34-5	<0.00025 U	<0.0008 UJ	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	NA
1,1,2-Trichloroethane	79-00-5	<0.00025 U	<0.0008 UJ	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	NA
1,1-Dichloroethane	75-34-3	<0.00025 U	<0.0008 UJ	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	NA
1,1-Dichloroethene	75-35-4	<0.00025 U	<0.0008 UJ	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	NA
1,2-Dibromoethane	106-93-4	<0.0005 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
1,2-Dichloroethane	107-06-2	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
1,2-Dichloroethene	540-59-0	NA	<0.0002 UJ	<0.0002 U	<0.0002 U	NA	<0.0002 U	<0.0002 U	<0.0002 U	NA
1,2-Dichloropropane	78-87-5	<0.00025 U	<0.0004 UJ	<0.0004 UJ	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
2-Butanone	78-93-3	<0.001 U	<0.004 UJ	<0.004 U	<0.004 U	<0.001 U	<0.004 U	<0.004 U	<0.004 U	NA

Table B-2. Concentrations of Organic Chemicals within the Background Monitoring Well Network

Zone		Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-024	BKGmw-024	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	SCFmw-006	SCFmw-006
Sample Id		BKGmw-024-080717-GW	BKGmw-024-120517-GW	BKGmw-025-111516-GW	BKGmw-025-042617-GW	BKGmw-025-080217-GW	BKGmw-025-D-120117-GW	BKGmw-025-120117-GW	SCFmw-006-111416	SCFmw-006-111516-GW
Date		08/07/17	12/05/17	11/15/16	04/26/17	08/02/17	12/01/17	12/01/17	11/14/16	11/15/16
Sample Type		GR	GR	GR	GR	GR	FD	GR	GR	GR
Filter Status	CAS	Total	Total	Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	Number									
2-Hexanone	591-78-6	<0.0005 U	<0.004 UJ	<0.004 U	<0.004 U	0.00029 J	<0.004 U	<0.004 U	<0.004 U	NA
4-Methyl-2-pentanone	108-10-1	<0.0005 U	<0.0032 UJ	<0.0032 U	<0.0032 U	<0.0005 U	<0.0032 U	<0.0032 U	<0.0032 U	NA
Acetone	67-64-1	0.0021 J	<0.0064 UJ	<0.0064 U	<0.0064 U	0.003 J	<0.0064 U	<0.0064 U	<0.0064 U	NA
Benzene	71-43-2	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Bromochloromethane	74-97-5	<0.0005 U	<0.0002 UJ	<0.0002 U	<0.0002 U	<0.0005 U	<0.0002 U	<0.0002 U	<0.0002 U	NA
Bromodichloromethane	75-27-4	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Bromoform	75-25-2	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Bromomethane	74-83-9	<0.0005 U	<0.0008 UJ	<0.0008 U	<0.0008 U	<0.0005 U	<0.0008 U	<0.0008 U	<0.0008 UJ	NA
Carbon disulfide	75-15-0	<0.00025 U	<0.0016 UJ	<0.0016 U	<0.0016 U	<0.00025 U	<0.0016 U	<0.0016 U	<0.0016 U	NA
Carbon tetrachloride	56-23-5	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Chlorobenzene	108-90-7	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Chloroethane	75-00-3	<0.00025 U	<0.0016 UJ	<0.0016 U	<0.0016 U	<0.00025 U	<0.0016 U	<0.0016 U	<0.0016 U	NA
Chloroform	67-66-3	<0.00025 U	<0.0004 UJ	0.0013	<0.0004 U	0.0002 J	<0.0004 U	<0.0004 U	<0.0004 U	NA
Chloromethane	74-87-3	<0.00025 U	<0.0008 UJ	<0.0008 U	<0.0008 U	<0.00025 U	<0.0008 U	<0.0008 U	<0.0008 U	NA
Dibromochloromethane	124-48-1	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Ethylbenzene	100-41-4	<0.00025 U	<0.0004 UJ	0.0016	<0.0004 U	0.00029 J	<0.0004 U	<0.0004 U	<0.0004 U	NA
Methylene chloride	75-09-2	<0.0005 U	<0.0008 UJ	<0.0008 U	<0.0008 U	<0.0005 U	<0.0008 U	<0.0008 U	<0.0008 U	NA
Styrene	100-42-5	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Tetrachloroethene	127-18-4	<0.0005 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Toluene	108-88-3	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Trichloroethene	79-01-6	<0.0005 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.0005 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
Vinyl chloride	75-01-4	<0.00025 U	<0.0002 UJ	<0.0002 U	<0.0002 U	<0.00025 U	<0.0002 U	<0.0002 U	<0.0002 U	NA
Xylenes, total	1330-20-7	<0.0005 U	<0.0008 UJ	0.0064	<0.0008 U	0.0009 J	<0.0008 U	<0.0008 U	<0.0008 U	NA
cis-1,2-Dichloroethene	156-59-2	<0.00025 U	NA	NA	NA	<0.00025 U	NA	NA	NA	NA
cis-1,3-Dichloropropene	10061-01-5	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA
trans-1,2-Dichloroethene	156-60-5	<0.00025 U	NA	NA	NA	<0.00025 U	NA	NA	NA	NA
trans-1,3-Dichloropropene	10061-02-6	<0.00025 U	<0.0004 UJ	<0.0004 U	<0.0004 U	<0.00025 U	<0.0004 U	<0.0004 U	<0.0004 U	NA

Definition of codes:
Sample Type: GR=Grab sample, FD=Field duplicate
NA=Not analyzed
Result qualifiers:
J—Result is estimated
R-Result was rejected in validation
U-Not detected
UJ-Not detected, reporting limit is estimated

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Table B-3. Concentrations of Miscellaneous Chemicals within the Background Monitoring Well Network

Zone		Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated
Station		BKGmw-005	BKGmw-005	BKGmw-005	BKGmw-005	BKGmw-016	BKGmw-016	BKGmw-016
Sample Id		BKGmw-005-110916-GW	BKGmw-005-041917-GW	BKGmw-005-D-120117-GW	BKGmw-005-120117-GW	BKGmw-016-110916-GW	BKGmw-016-041917-GW	BKGmw-016-120417-GW
Date		11/09/16	04/19/17	12/01/17	12/01/17	11/09/16	04/19/17	12/04/17
Sample Type		GR	GR	FD	GR	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Chloride	16887-00-6	2.5 J	0.59 J	2.3 J	2.3 J	6.2	1.6 J	5 J
Nitrite	14797-65-0	<0.1 U	<0.1 U	NA	NA	<0.1 U	<0.1 U	NA
Sulfate	14808-79-8	52	37	50	50	44	36	39
Sulfide	18496-25-8	<1.9 U	<1.9 U	NA	NA	<1.9 U	<1.9 U	NA
Alkalinity	N33	200	230	200	200	210	17	210
Cyanide	57-12-5	NA	NA	NA	NA	NA	NA	NA
Perchlorate	14797-73-0	NA	NA	NA	NA	NA	NA	NA

Table B-3. Concentrations of Miscellaneous Chemicals within the Background Monitoring Well Network

Zone		Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Homewood Sandstone	Homewood Sandstone
Station		BKGmw-017	BKGmw-017	BKGmw-017	BKGmw-021	BKGmw-021	BKGmw-022	BKGmw-022
Sample Id		BKGmw-017-110916-GW	BKGmw-017-042017-GW	BKGmw-017-120417-GW	BKGmw-021-042117-GW	BKGmw-021-120517-GW	BKGmw-022-111516-GW	BKGmw-510-042117-GW
Date		11/09/16	04/20/17	12/04/17	04/21/17	12/05/17	11/15/16	04/21/17
Sample Type		GR	GR	GR	GR	GR	GR	FD
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Chloride	16887-00-6	1.9 J	<3 U	1.7 J	3.6	2.1 J	NA	<3 U
Nitrite	14797-65-0	<0.1 U	<0.1 UJ	NA	<0.1 U	NA	NA	<0.1 U
Sulfate	14808-79-8	150	140	130	50	32	NA	25
Sulfide	18496-25-8	<1.9 U	<1.9 U	NA	<1.9 U	NA	NA	NA
Alkalinity	N33	350	350	340	350	300	NA	63
Cyanide	57-12-5	NA	NA	NA	NA	NA	0.0028 J	<0.005 U
Perchlorate	14797-73-0	NA	NA	NA	NA	NA	NA	<0.00001 U

Table B-3. Concentrations of Miscellaneous Chemicals within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone
Station		BKGmw-022	BKGmw-022	BKGmw-022	BKGmw-023	BKGmw-023	BKGmw-023	BKGmw-023
Sample Id		BKGmw-022-042117-GW	BKGmw-022-080217-GW	BKGmw-022-120117-GW	BKGmw-023-111516-GW	BKGmw-023-042017-GW	BKGmw-023-080217-GW	BKGmw-023-D-120117-GW
Date		04/21/17	08/02/17	12/01/17	11/15/16	04/20/17	08/02/17	12/01/17
Sample Type		GR	GR	GR	GR	GR	GR	FD
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Chloride	16887-00-6	<3 U	NA	2.5 J	NA	11	NA	12
Nitrite	14797-65-0	<0.1 U	NA	NA	NA	<0.1 UJ	NA	NA
Sulfate	14808-79-8	25	NA	27	NA	63	NA	60
Sulfide	18496-25-8	<1.9 U	NA	NA	NA	<1.9 U	NA	NA
Alkalinity	N33	67	NA	69	NA	210	NA	190
Cyanide	57-12-5	0.0055 J	<0.005 U	<0.005 U	<0.005 U	<0.005 U	<0.005 U	<0.01 U
Perchlorate	14797-73-0	<0.00001 U	<0.00001 U	<0.00001 U	NA	0.00003 J	<0.00001 U	0.00004 J

Table B-3. Concentrations of Miscellaneous Chemicals within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Upper Sharon	Upper Sharon	Upper Sharon
Station		BKGmw-023	FWGmw-005	FWGmw-005	FWGmw-005	BKGmw-006	BKGmw-006	BKGmw-006
Sample Id		BKGmw-023-120117-GW	FWGmw-005-110916-GW	FWGmw-005-041917-GW	FWGmw-005-120117-GW	BKGmw-006-110816-GW	BKGmw-006-042417-GW	BKGmw-006-120517-GW
Date		12/01/17	11/09/16	04/19/17	12/01/17	11/08/16	04/24/17	12/05/17
Sample Type		GR	GR	GR	GR	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Chloride	16887-00-6	12	3.2	3.2	3	110	110 J	94
Nitrite	14797-65-0	NA	NA	<0.1 U	NA	<0.1 U	<0.1 U	NA
Sulfate	14808-79-8	61	52	49	52	55	55 J	53
Sulfide	18496-25-8	NA	<1.9 U	<1.9 U	NA	<1.9 U	<1.9 U	NA
Alkalinity	N33	200	120	140	130	190	190	190
Cyanide	57-12-5	<0.01 U	NA	NA	NA	NA	NA	NA
Perchlorate	14797-73-0	0.00003 J	NA	NA	NA	NA	NA	NA

Table B-3. Concentrations of Miscellaneous Chemicals within the Background Monitoring Well Network

Zone		Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon
Station		BKGmw-008	BKGmw-008	BKGmw-008	BKGmw-008	BKGmw-015	BKGmw-015	BKGmw-018
Sample Id		BKGmw-500-110816-GW	BKGmw-008-110816-GW	BKGmw-008-041817-GW	BKGmw-008-120617-GW	BKGmw-015-041917-GW	BKGmw-015-120517-GW	BKGmw-018-110816-GW
Date		11/08/16	11/08/16	04/18/17	12/06/17	04/19/17	12/05/17	11/08/16
Sample Type		FD	GR	GR	GR	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Chloride	16887-00-6	2.7 J	2.7 J	3.8	3.2 J	0.79 J	0.92 J	3.3
Nitrite	14797-65-0	<0.1 U	<0.1 U	<0.1 U	NA	<0.1 U	NA	<0.1 U
Sulfate	14808-79-8	28	28	32	28	6.9	4.4 J	37
Sulfide	18496-25-8	<1.9 U	<1.9 U	<1.9 U	NA	<1.9 U	NA	<1.9 U
Alkalinity	N33	NA	68	78	62	140	150	110
Cyanide	57-12-5	0.019 J	<0.005 UJ	0.002 J	<0.01 U	NA	NA	NA
Perchlorate	14797-73-0	NA	NA	NA	NA	NA	NA	NA

Table B-3. Concentrations of Miscellaneous Chemicals within the Background Monitoring Well Network

Zone		Upper Sharon	Upper Sharon	Upper Sharon	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-018	BKGmw-018	BKGmw-018	BKGmw-024	BKGmw-024	BKGmw-024	BKGmw-024
Sample Id		BKGmw-509-042017-GW	BKGmw-018-042017-GW	BKGmw-018-120517-GW	BKGmw-024-111516-GW	BKGmw-024-042017-GW	BKGmw-024-050317-GW	BKGmw-024-080717-GW
Date		04/20/17	04/20/17	12/05/17	11/15/16	04/20/17	05/03/17	08/07/17
Sample Type		FD	GR	GR	GR	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Chloride	16887-00-6	NA	3.3	4.7	NA	6.8	NA	NA
Nitrite	14797-65-0	NA	<0.1 UJ	NA	NA	<0.1 UJ	NA	NA
Sulfate	14808-79-8	NA	14	32	NA	34	NA	NA
Sulfide	18496-25-8	NA	<1.9 U	NA	NA	<1.9 U	NA	NA
Alkalinity	N33	57 J	94 J	160	NA	260	NA	NA
Cyanide	57-12-5	NA	NA	NA	0.0026 J	<0.005 U	NA	0.0046 J
Perchlorate	14797-73-0	NA	NA	NA	NA	NA	<0.00001 U	<0.00001 U

Table B-3. Concentrations of Miscellaneous Chemicals within the Background Monitoring Well Network

Zone		Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		BKGmw-024	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	BKGmw-025	SCFmw-006
Sample Id		BKGmw-024-120517-GW	BKGmw-025-111516-GW	BKGmw-025-042617-GW	BKGmw-025-080217-GW	BKGmw-025-D-120117-GW	BKGmw-025-120117-GW	SCFmw-006-111416
Date		12/05/17	11/15/16	04/26/17	08/02/17	12/01/17	12/01/17	11/14/16
Sample Type		GR	GR	GR	GR	FD	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total	Total
Analyte (mg/L)	CAS Number							
Chloride	16887-00-6	6.2	NA	3	NA	3.5	3.3	NA
Nitrite	14797-65-0	NA	NA	<0.1 U	NA	NA	NA	<0.1 U
Sulfate	14808-79-8	32	NA	23	NA	22	22	NA
Sulfide	18496-25-8	NA	NA	<1.9 U	NA	NA	NA	NA
Alkalinity	N33	270	NA	240	NA	240	230	200
Cyanide	57-12-5	<0.005 U	0.0029 J	0.0024 J	<0.005 U	<0.005 U	0.0026 J	0.0044 J
Perchlorate	14797-73-0	<0.00001 U	NA	<0.00001 U	<0.00001 U	<0.00001 U	0.00003 J	NA

Table B-3. Concentrations of Miscellaneous Chemicals within the Background Monitoring Well Network

Zone		Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		SCFmw-006	SCFmw-006
Sample Id		SCFmw-006-041817-GW	SCFmw-006-120517-GW
Date		04/18/17	12/05/17
Sample Type		GR	GR
Filter Status		Total	Total
Analyte (mg/L)	CAS Number		
Chloride	16887-00-6	3.9	2.7 J
Nitrite	14797-65-0	<0.1 UJ	NA
Sulfate	14808-79-8	28	21
Sulfide	18496-25-8	<1.9 U	NA
Alkalinity	N33	210	210
Cyanide	57-12-5	NA	NA
Perchlorate	14797-73-0	NA	NA

Definition of codes:
Sample Type: GR=Grab sample, FD=Field duplicate
NA=Not analyzed
Result qualifiers:
J—Result is estimated
R-Result was rejected in validation
U-Not detected
UJ-Not detected, reporting limit is estimated

Table B-4. Field Parameters within the Background Monitoring Well Network

Zone		Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated
Station		BKGmw-005	BKGmw-005	BKGmw-005	BKGmw-005	BKGmw-016	BKGmw-016
Sample Id		BKGmw-005-110916-GW	BKGmw-005-041917-GW	BKGmw-005-050317-GW	BKGmw-005-120117-GW	BKGmw-016-110916-GW	BKGmw-016-041917-GW
Date		11/09/16	04/19/17	05/03/17	12/01/17	11/09/16	04/19/17
Sample Type		GR	GR	GR	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total
Parameter	Units						
Conductivity	mS/cm	0.508	3.641	0.806	0.499	0.514	0.491
Oxidation/Reduction Potential	mV	185.6	-16	149	65	71.5	45.8
Oxygen	mg/L	3.79	7.69	6.39	0.78	3.38	7.93
Turbidity	NTU	7.15	5.96	3.83	0	3.46	0.52
Water Temperature	C	12.28	8.98	10.61	11.18	13.24	9.16
pH	pH	6.75	6.56	7.24	6.81	7.26	4.93

Table B-4. Field Parameters within the Background Monitoring Well Network

Zone		Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated	Unconsolidated
Station		BKGmw-016	BKGmw-016	BKGmw-017	BKGmw-017	BKGmw-017	BKGmw-021
Sample Id		BKGmw-016-050117-GW	BKGmw-016-120417-GW	BKGmw-017-110916-GW	BKGmw-017-042017-GW	BKGmw-017-120417-GW	BKGmw-021-042117-GW
Date		05/01/17	12/04/17	11/09/16	04/20/17	12/04/17	04/21/17
Sample Type		GR	GR	GR	GR	GR	GR
Filter Status		Total	Total	Total	Total	Total	Total
Parameter	Units						
Conductivity	mS/cm	0.101	0.445	0.514	0.819	0.942	0.589
Oxidation/Reduction Potential	mV	166.3	121.2	-41.8	-74	-97	102
Oxygen	mg/L	6.73	3.98	3.13	0.22	0	6.39
Turbidity	NTU	0.75	10	9.26	158	57.4	0.52
Water Temperature	C	11.57	11.61	10.64	12.5	11.53	10.34
pH	pH	5.71	7.22	7.16	6.91	7.1	6.76

Table B-4. Field Parameters within the Background Monitoring Well Network

Zone		Unconsolidated	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone
Station		**BKGmw-021**	**BKGmw-022**	**BKGmw-022**	**BKGmw-022**	**BKGmw-022**	**BKGmw-023**	**BKGmw-023**
Sample Id		**BKGmw-021-120517-GW**	**BKGmw-022-111516-GW**	**BKGmw-022-042117-GW**	**BKGmw-022-080217-GW**	**BKGmw-022-120117-GW**	**BKGmw-023-111516-GW**	**BKGmw-023-080217-GW**
Date		**12/05/17**	**11/15/16**	**04/21/17**	**08/02/17**	**12/01/17**	**11/15/16**	**08/02/17**
Sample Type		**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**
Filter Status		**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Parameter	**Units**							
Conductivity	mS/cm	0.629	0.216	0.174	0.22	0.223	0.55	0.531
Oxidation/Reduction Potential	mV	228.3	-49.2	-20.7	-50	-58	-5.1	55
Oxygen	mg/L	7.56	0.18	0.17	0	2.43	0.18	0
Turbidity	NTU	6.3	3.71	5.62	9.6	0	5.91	0
Water Temperature	C	12.25	11.43	10.49	13.32	10.51	11.55	13.75
pH	pH	6.83	6.12	6.73	6.5	6.9	6.46	6.85

Table B-4. Field Parameters within the Background Monitoring Well Network

Zone		Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Homewood Sandstone	Upper Sharon	Upper Sharon
Station		**BKGmw-023**	**FWGmw-005**	**FWGmw-005**	**FWGmw-005**	**FWGmw-005**	**BKGmw-006**	**BKGmw-006**
Sample Id		**BKGmw-023-120117-GW**	**FWGmw-005-110916-GW**	**FWGmw-005-041917-GW**	**FWGmw-005-050317-GW**	**FWGmw-005-120117-GW**	**BKGmw-006-110816-GW**	**BKGmw-006-042417-GW**
Date		**12/01/17**	**11/09/16**	**04/19/17**	**05/03/17**	**12/01/17**	**11/08/16**	**04/24/17**
Sample Type		**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**
Filter Status		**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Parameter	**Units**							
Conductivity	mS/cm	0.551	0.371	0.833	0.661	0.384	0.795	0.752
Oxidation/Reduction Potential	mV	37	21.2	-28.3	4.3	-19	224.8	119.4
Oxygen	mg/L	0	0.14	0.91	0.61	9.64	3.56	2.2
Turbidity	NTU	0	11	6.22	8.84	8.9	6.65	6.59
Water Temperature	C	9.99	11.08	10.15	10.02	9.18	11.58	11.73
pH	pH	6.99	6.22	6.28	7.05	6.74	6.36	6.32

Table B-4. Field Parameters within the Background Monitoring Well Network

Zone		Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon
Station		**BKGmw-006**	**BKGmw-008**	**BKGmw-008**	**BKGmw-008**	**BKGmw-008**	**BKGmw-008**	**BKGmw-015**
Sample Id		**BKGmw-006-120517-GW**	**BKGmw-500-110816-GW**	**BKGmw-008-110816-GW**	**BKGmw-008-041817-GW**	**BKGmw-008-050417-GW**	**BKGmw-008-120617-GW**	**BKGmw-015-041917-GW**
Date		**12/05/17**	**11/08/16**	**11/08/16**	**04/18/17**	**05/04/17**	**12/06/17**	**04/19/17**
Sample Type		**GR**	**FD**	**GR**	**GR**	**GR**	**GR**	**GR**
Filter Status		**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Parameter	**Units**							
Conductivity	mS/cm	0.783	NA	0.187	0.219	0.375	0.228	0.283
Oxidation/Reduction Potential	mV	54	NA	231.5	14.9	70.5	203	158.6
Oxygen	mg/L	0.42	NA	4.89	8.28	7.91	11.58	2.02
Turbidity	NTU	0	0.8	0.8	0.2	1.03	8.4	0.45
Water Temperature	C	10.87	NA	12.56	10.68	9.29	8.77	11.74
pH	pH	6.66	6.07	6.07	6.34	6.56	6.41	6.75

Table B-4. Field Parameters within the Background Monitoring Well Network

Zone		Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Upper Sharon	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		**BKGmw-015**	**BKGmw-015**	**BKGmw-018**	**BKGmw-018**	**BKGmw-018**	**BKGmw-024**	**BKGmw-024**
Sample Id		**BKGmw-015-050417-GW**	**BKGmw-015-120517-GW**	**BKGmw-018-110816-GW**	**BKGmw-018-042017-GW**	**BKGmw-018-120517-GW**	**BKGmw-024-111516-GW**	**BKGmw-024-042017-GW**
Date		**05/04/17**	**12/05/17**	**11/08/16**	**04/20/17**	**12/05/17**	**11/15/16**	**04/20/17**
Sample Type		**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**
Filter Status		**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Parameter	**Units**							
Conductivity	mS/cm	0.516	0.325	0.308	0.125	0.404	0.519	0.496
Oxidation/Reduction Potential	mV	169.8	149	309.8	-210.2	126	-68.8	-109.2
Oxygen	mg/L	3.82	2.3	6.39	8.23	2.97	13.41	0.73
Turbidity	NTU	4.1	0	0.49	0.04	0	1	1.2
Water Temperature	C	10.57	10.89	13.38	10.68	11.49	10.72	11.35
pH	pH	6.68	6.56	6.11	6.22	6.53	7.21	6.99

Table B-4. Field Parameters within the Background Monitoring Well Network

Zone		Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		**BKGmw-024**	**BKGmw-024**	**BKGmw-024**	**BKGmw-025**	**BKGmw-025**	**BKGmw-025**	**BKGmw-025**
Sample Id		**BKGmw-024-050317-GW**	**BKGmw-024-080717-GW**	**BKGmw-024-120517-GW**	**BKGmw-025-111516-GW**	**BKGmw-025-042617-GW**	**BKGmw-025-080217-GW**	**BKGmw-025-120117-GW**
Date		**05/03/17**	**08/07/17**	**12/05/17**	**11/15/16**	**04/26/17**	**08/02/17**	**12/01/17**
Sample Type		**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**
Filter Status		**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Parameter	**Units**							
Conductivity	mS/cm	0.672	0.579	0.589	0.479	0.449	0.509	0.512
Oxidation/Reduction Potential	mV	-94.8	-76	-132	-25.2	-103.4	-83	-71
Oxygen	mg/L	0.39	0	0	7.19	0.14	0	9.69
Turbidity	NTU	0.53	0	0	4.07	0.28	0	0
Water Temperature	C	10.02	12.64	11.02	11.68	11.67	13.27	9.22
pH	pH	7.23	7.16	7.24	7.47	7.35	7.28	7.37

Table B-4. Field Parameters within the Background Monitoring Well Network

Zone		Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate	Basal Sharon Conglomerate
Station		**SCFmw-006**	**SCFmw-006**	**SCFmw-006**	**SCFmw-006**	**SCFmw-006**
Sample Id		**SCFmw-006-111416**	**SCFmw-006-111516-GW**	**SCFmw-006-041817-GW**	**SCFmw-006-042817-GW**	**SCFmw-006-120517-GW**
Date		**11/14/16**	**11/15/16**	**04/18/17**	**04/28/17**	**12/05/17**
Sample Type		**GR**	**GR**	**GR**	**GR**	**GR**
Filter Status		**Total**	**Total**	**Total**	**Total**	**Total**
Parameter	**Units**					
Conductivity	mS/cm	0.43	NA	0.472	0.353	0.449
Oxidation/Reduction Potential	mV	-101.4	NA	-72.1	-248.7	-40.7
Oxygen	mg/L	0.66	NA	1.01	0.72	1.17
Turbidity	NTU	5.96	10.4	1.1	0.5	0.4
Water Temperature	C	10.36	NA	11.65	10.88	10.35
pH	pH	7.39	NA	7.46	7.22	7.53

Definition of codes:
Sample Type: GR=Grab sample, FD=Field duplicate
NA=Not analyzed
Result qualifiers:
J—Result is estimated
R-Result was rejected in validation
U-Not detected
UJ-Not detected, reporting limit is estimated

APPENDIX C

Probability and Box Plots

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APPENDIX C.1

Probability and Box Plots with Outliers

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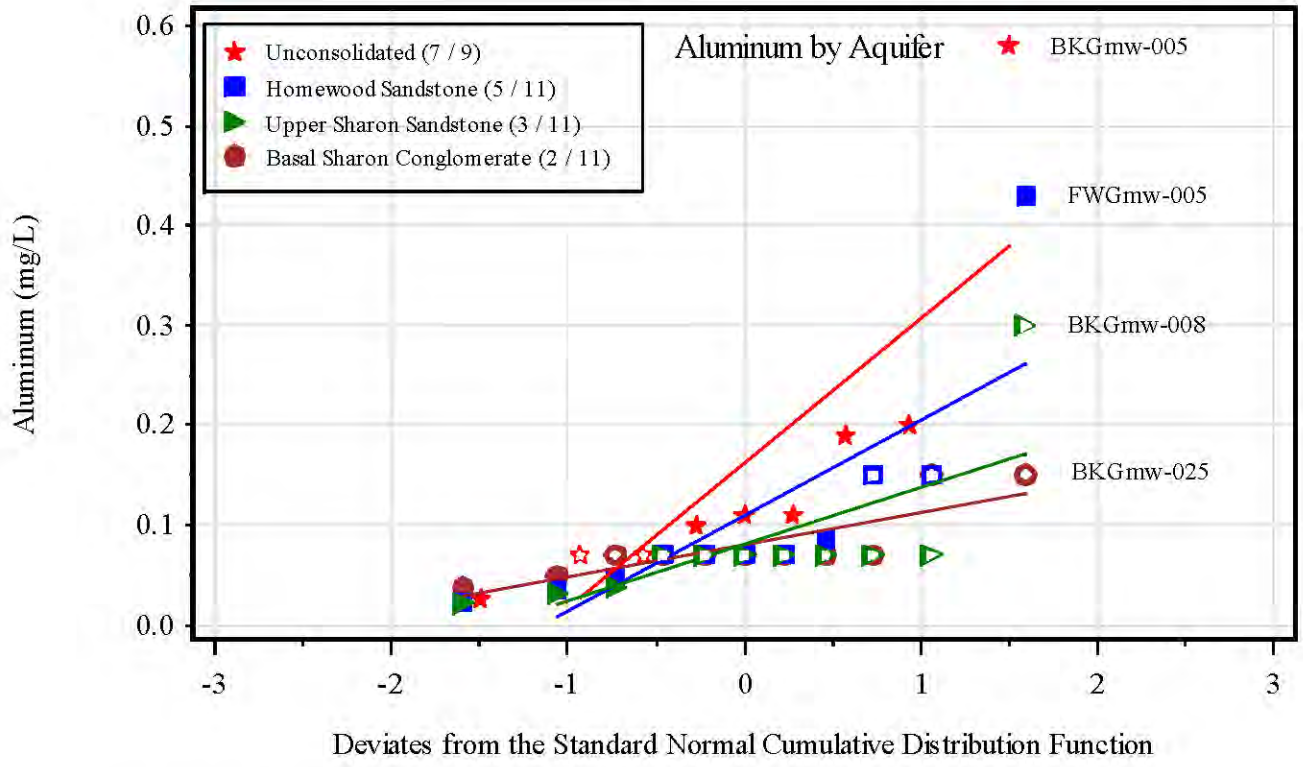
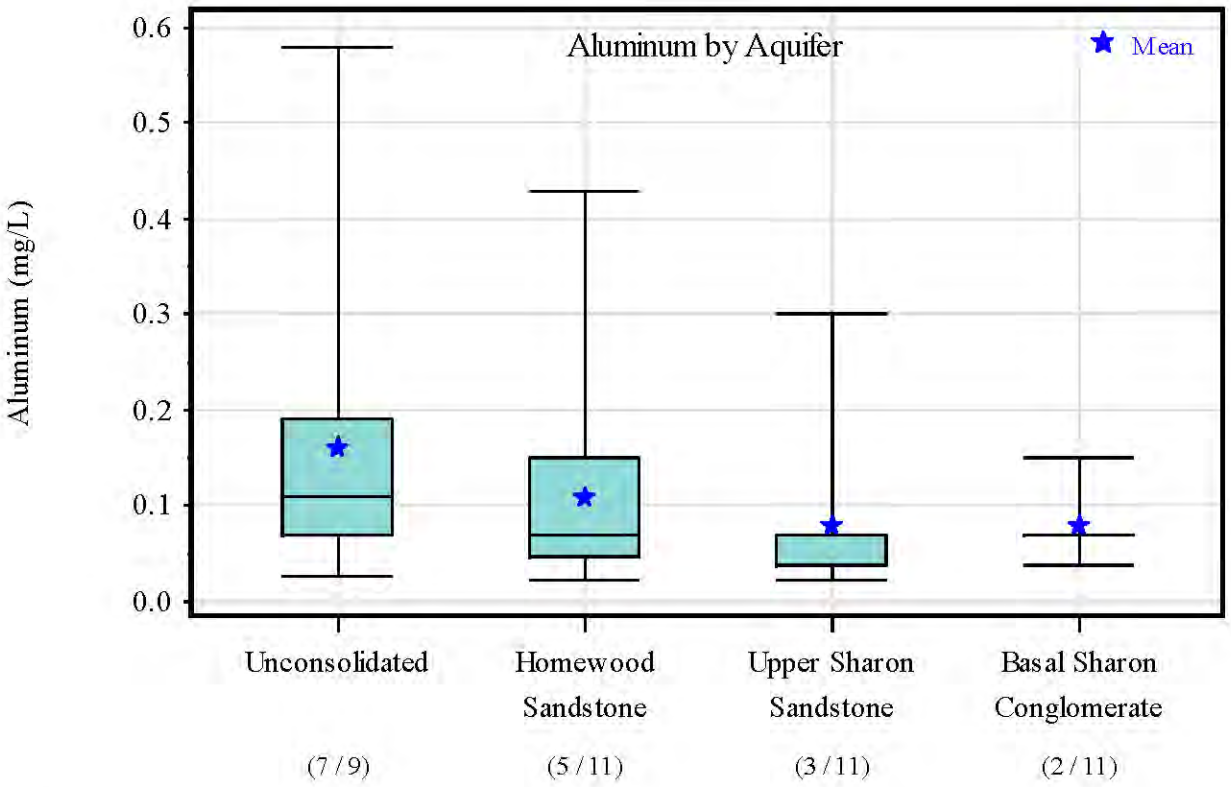
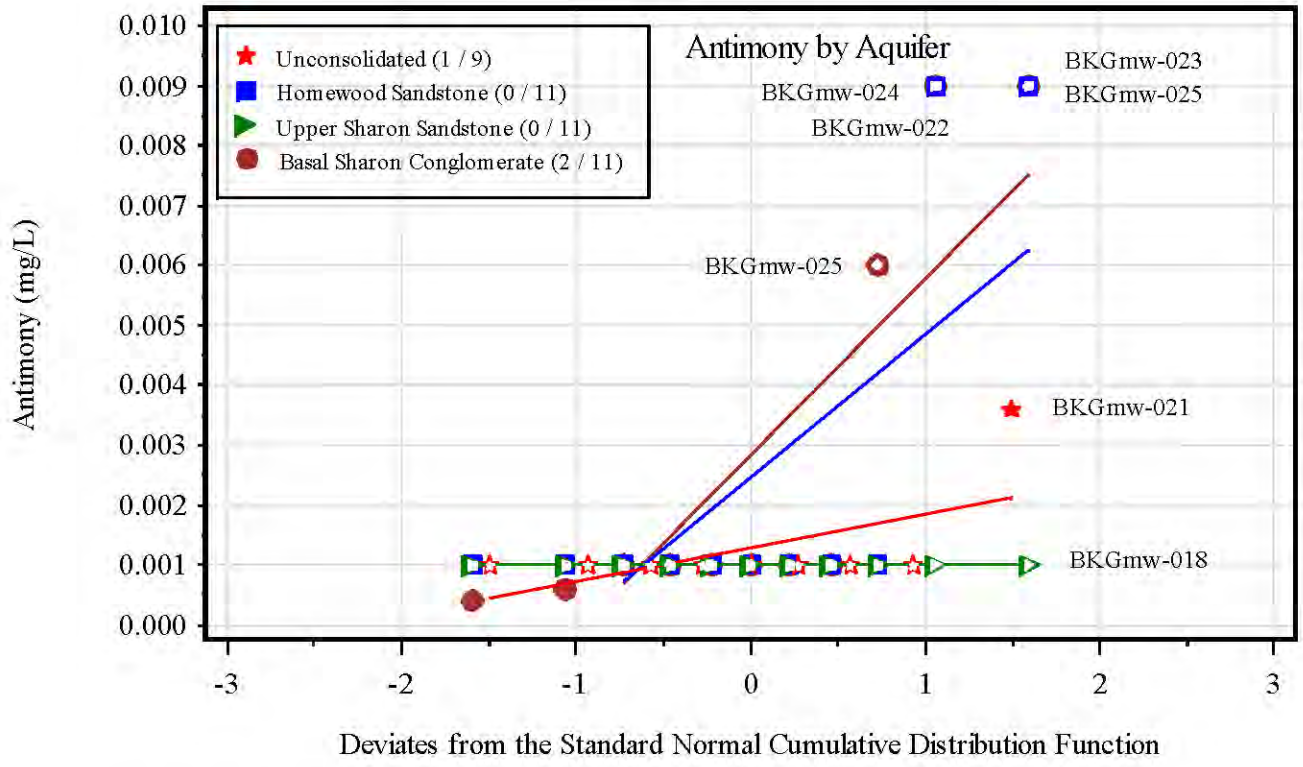


Hollow symbols denote the reporting limit was used for non-detects.

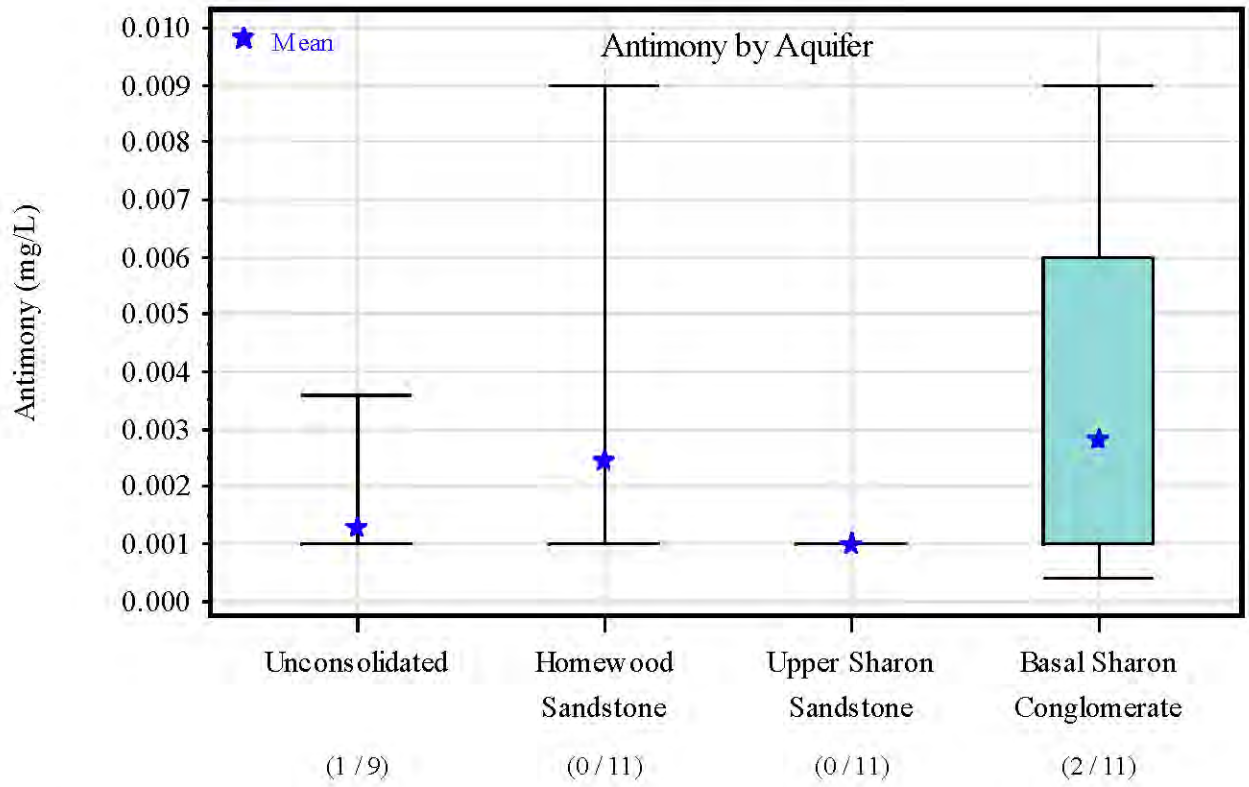


Reporting limits were plotted for non-detects.

Fig. C.1-1. Normal Probability and Box Plots of All Background Data-Aluminum

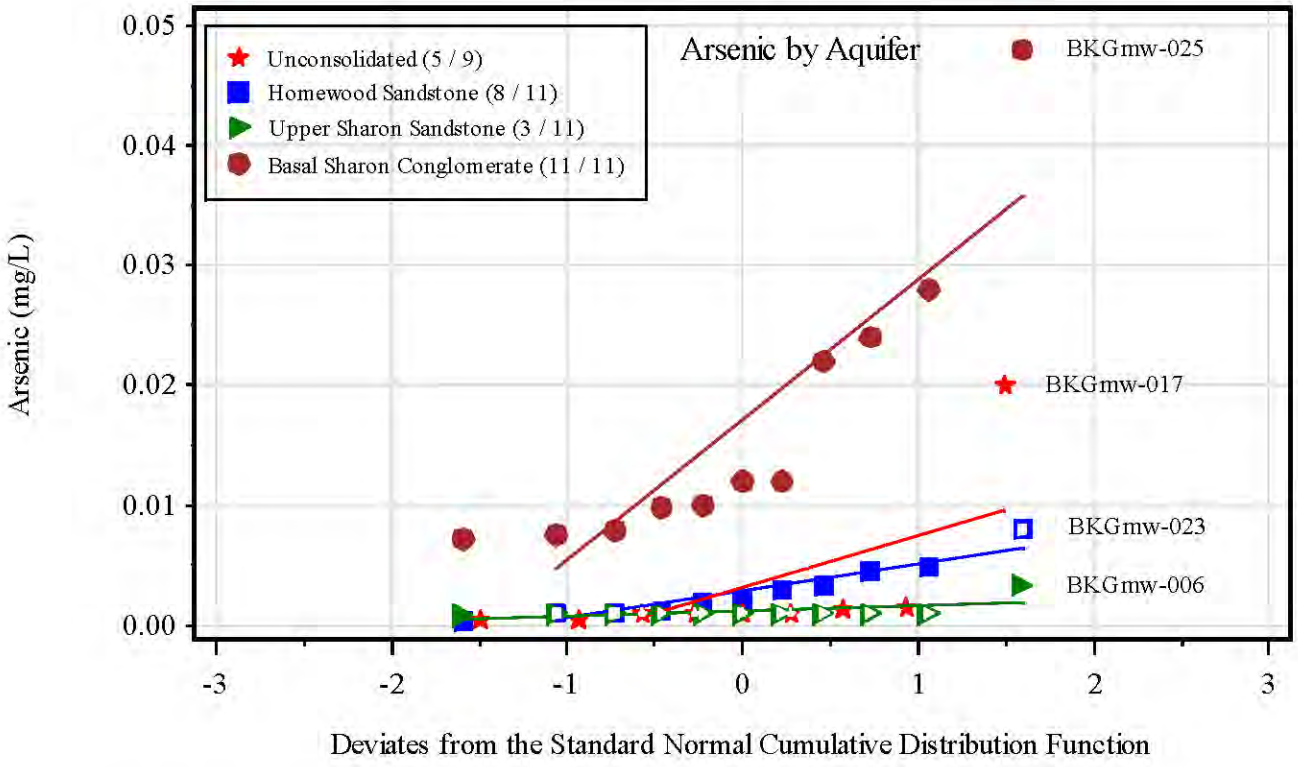


Hollow symbols denote the reporting limit was used for non-detects.

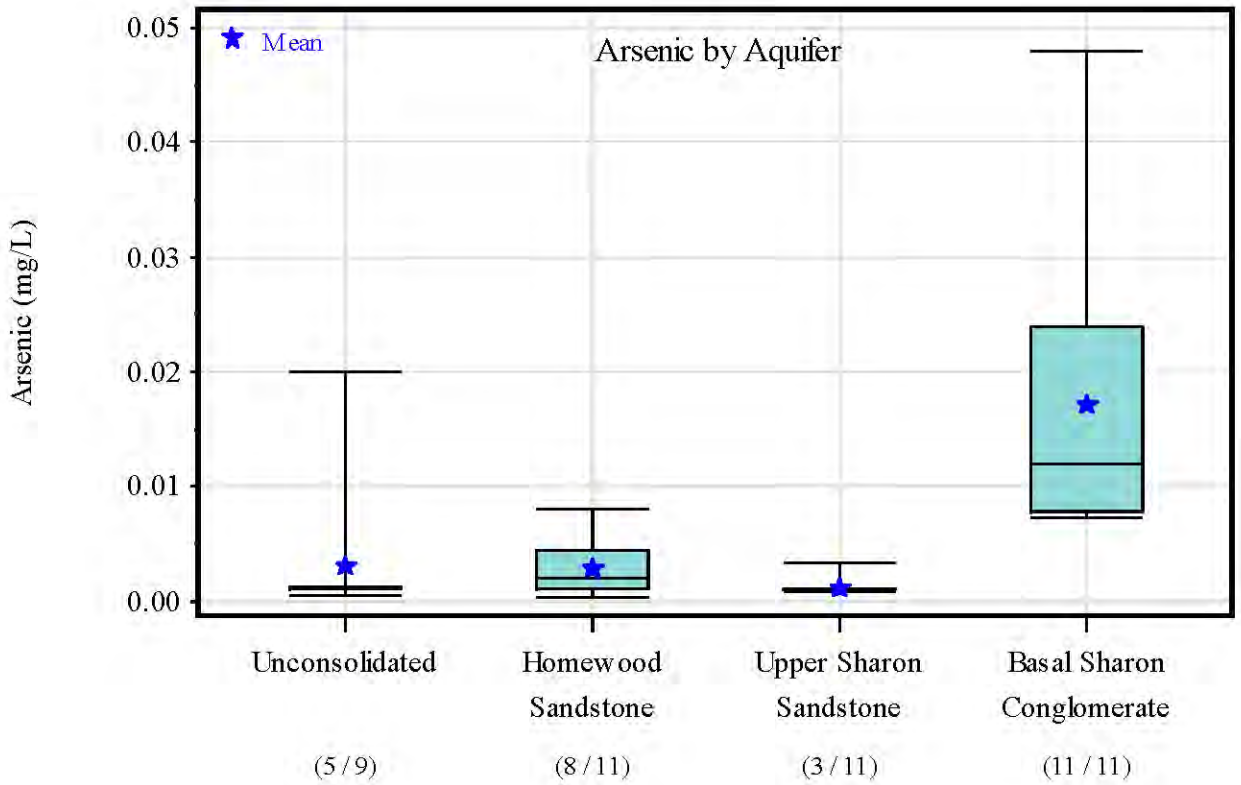


Reporting limits were plotted for non-detects.

Fig. C.1-2. Normal Probability and Box Plots of All Background Data-Antimony

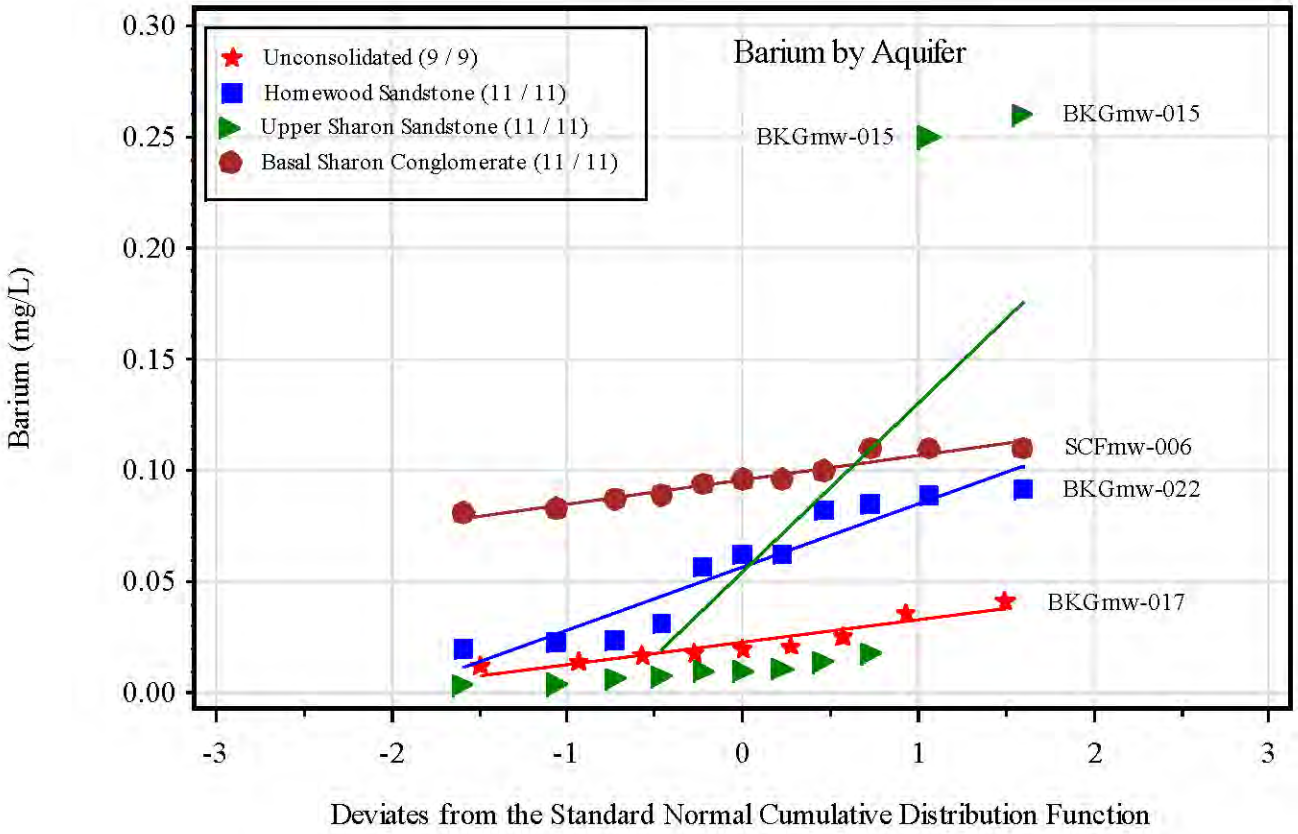


Hollow symbols denote the reporting limit was used for non-detects.



Reporting limits were plotted for non-detects.

Fig. C.1-3. Normal Probability and Box Plots of All Background Data-Arsenic



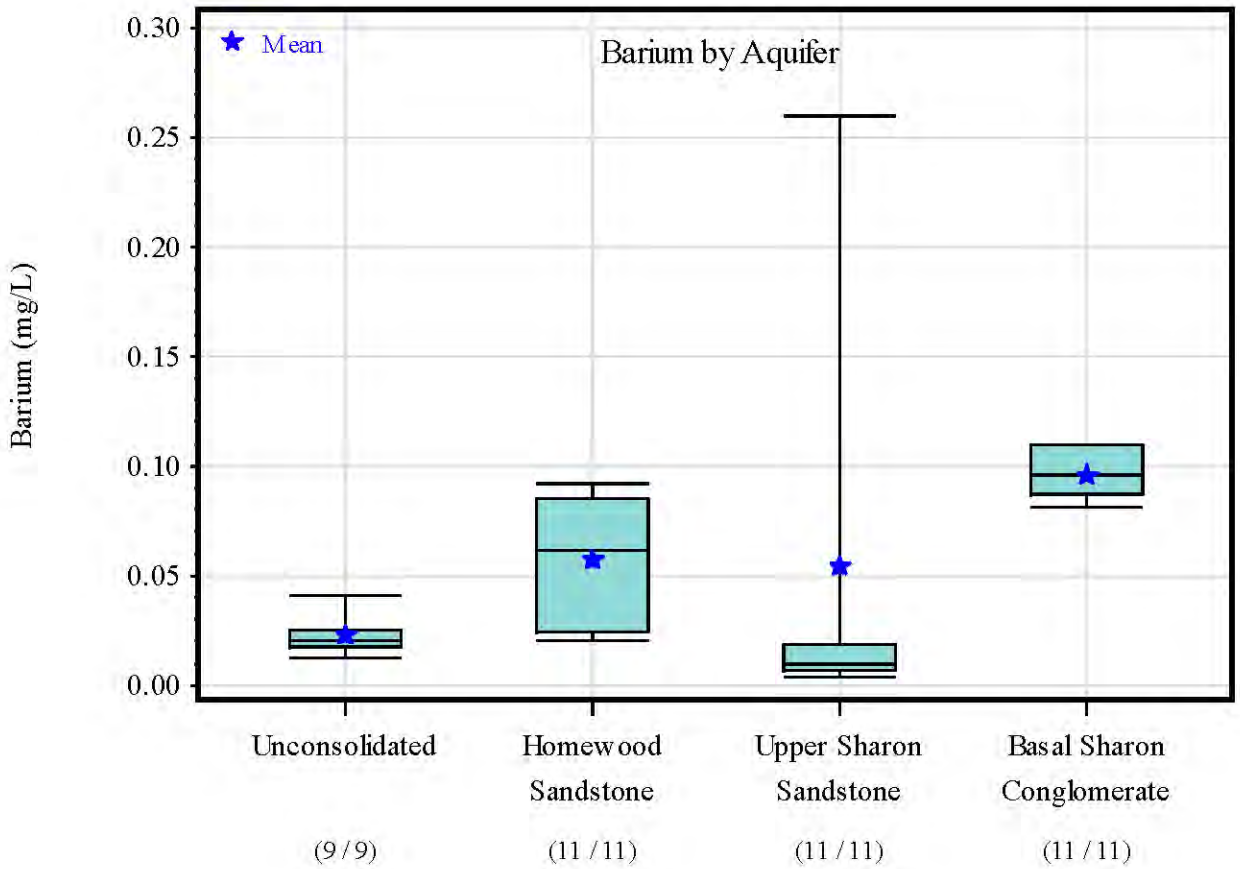
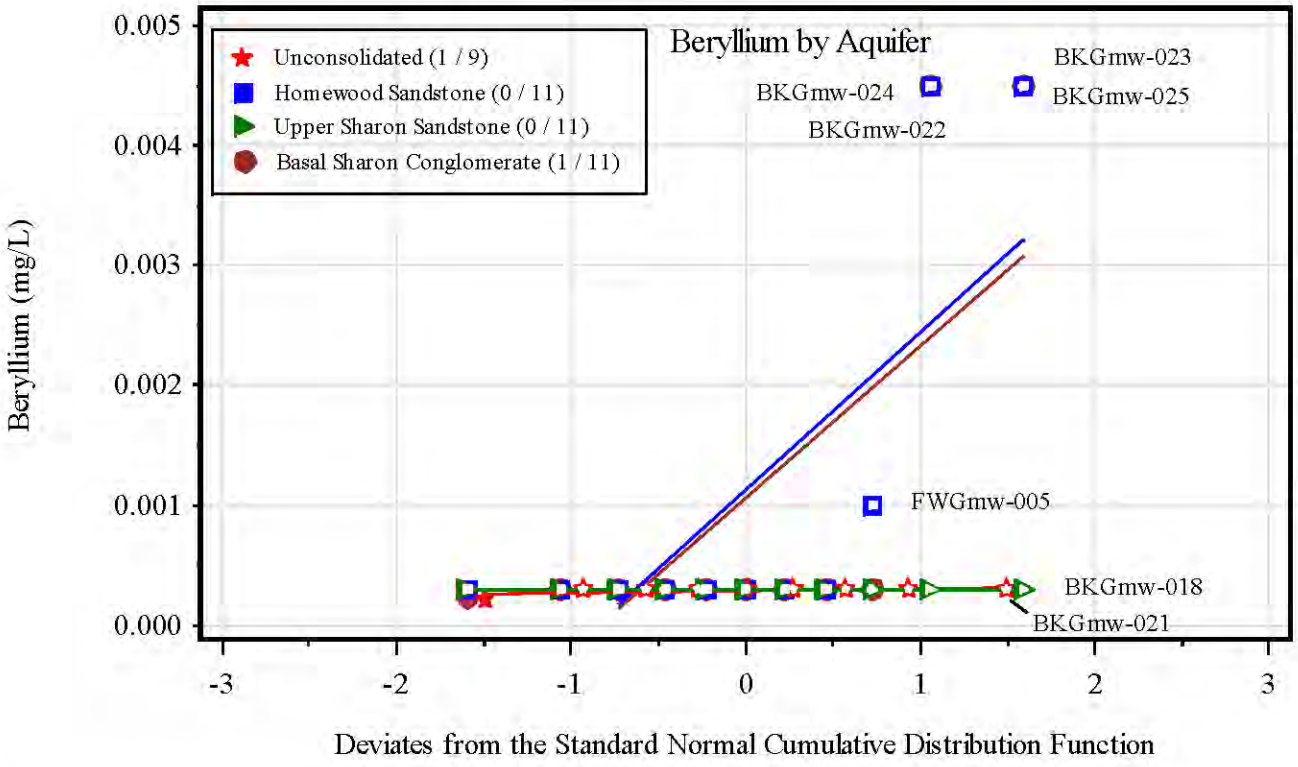
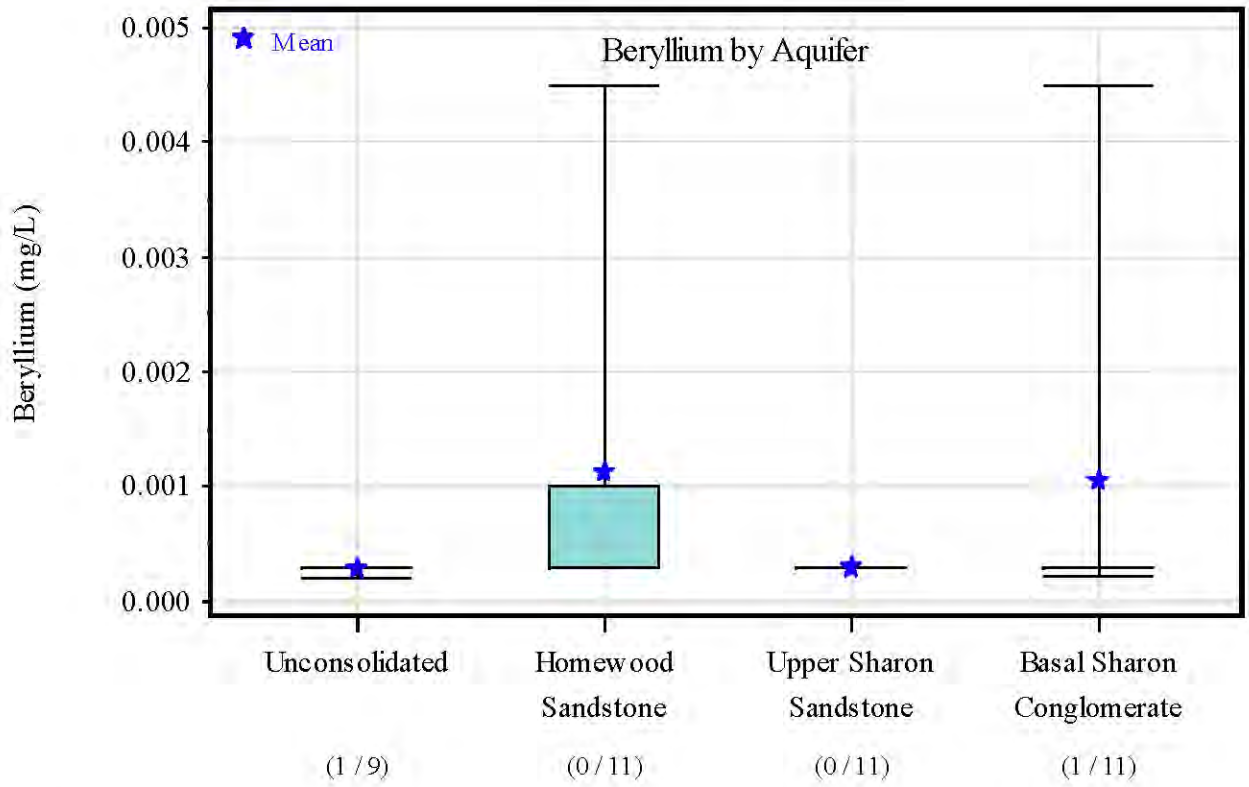


Fig. C.1-4. Normal Probability and Box Plots of All Background Data-Barium

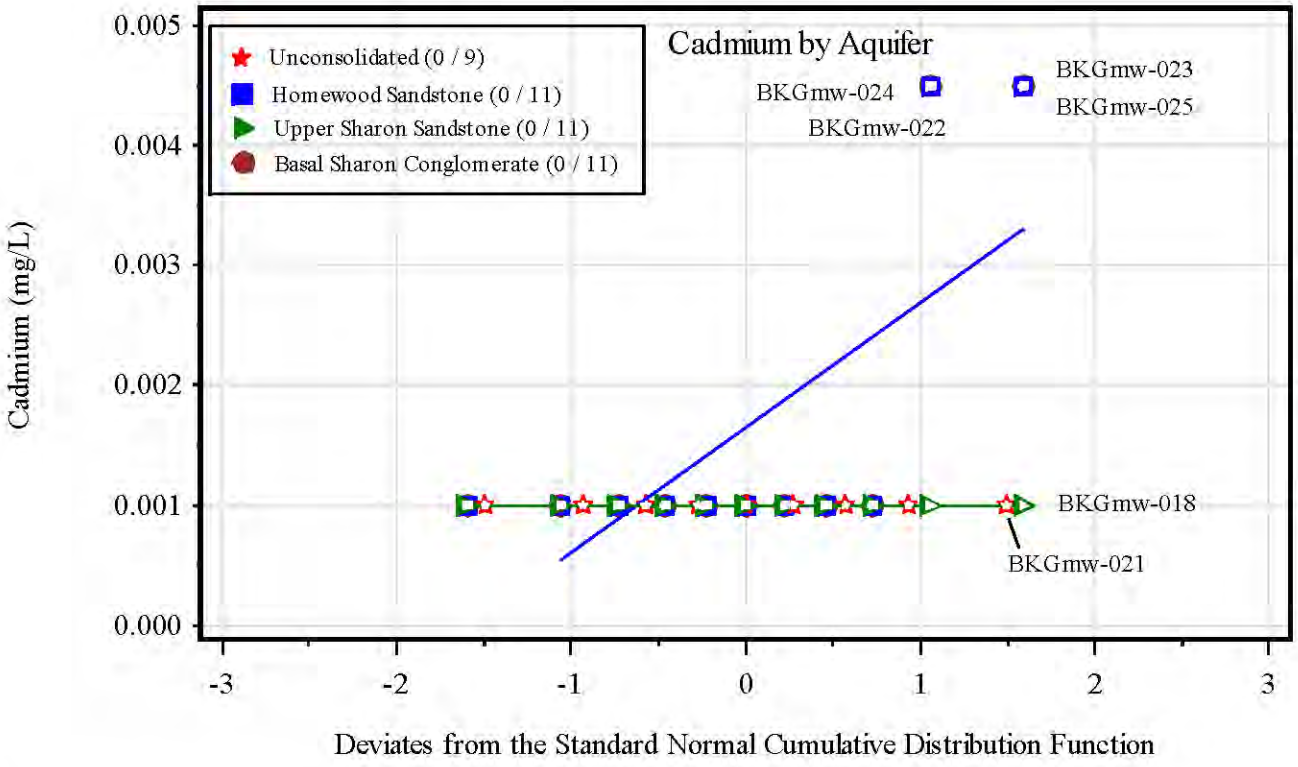


Hollow symbols denote the reporting limit was used for non-detects.

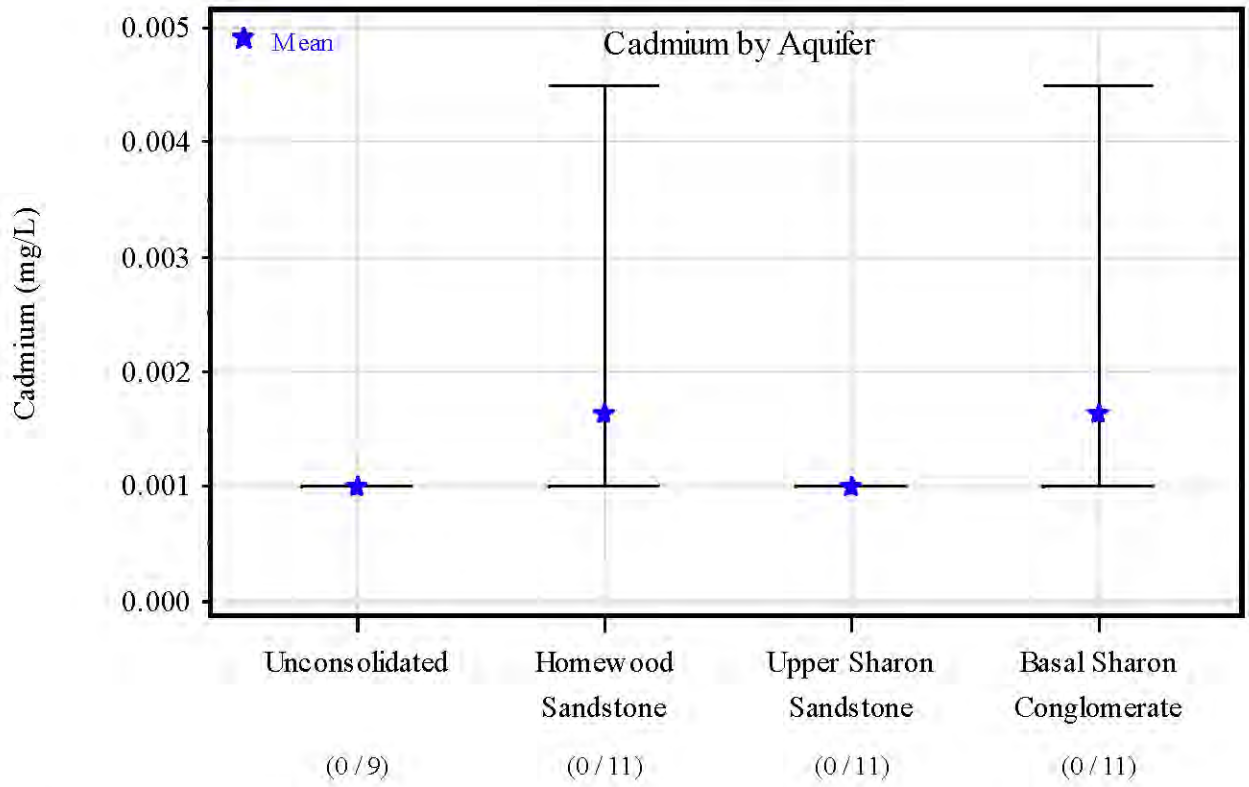


Reporting limits were plotted for non-detects.

Fig. C.1-5. Normal Probability and Box Plots of All Background Data-Beryllium

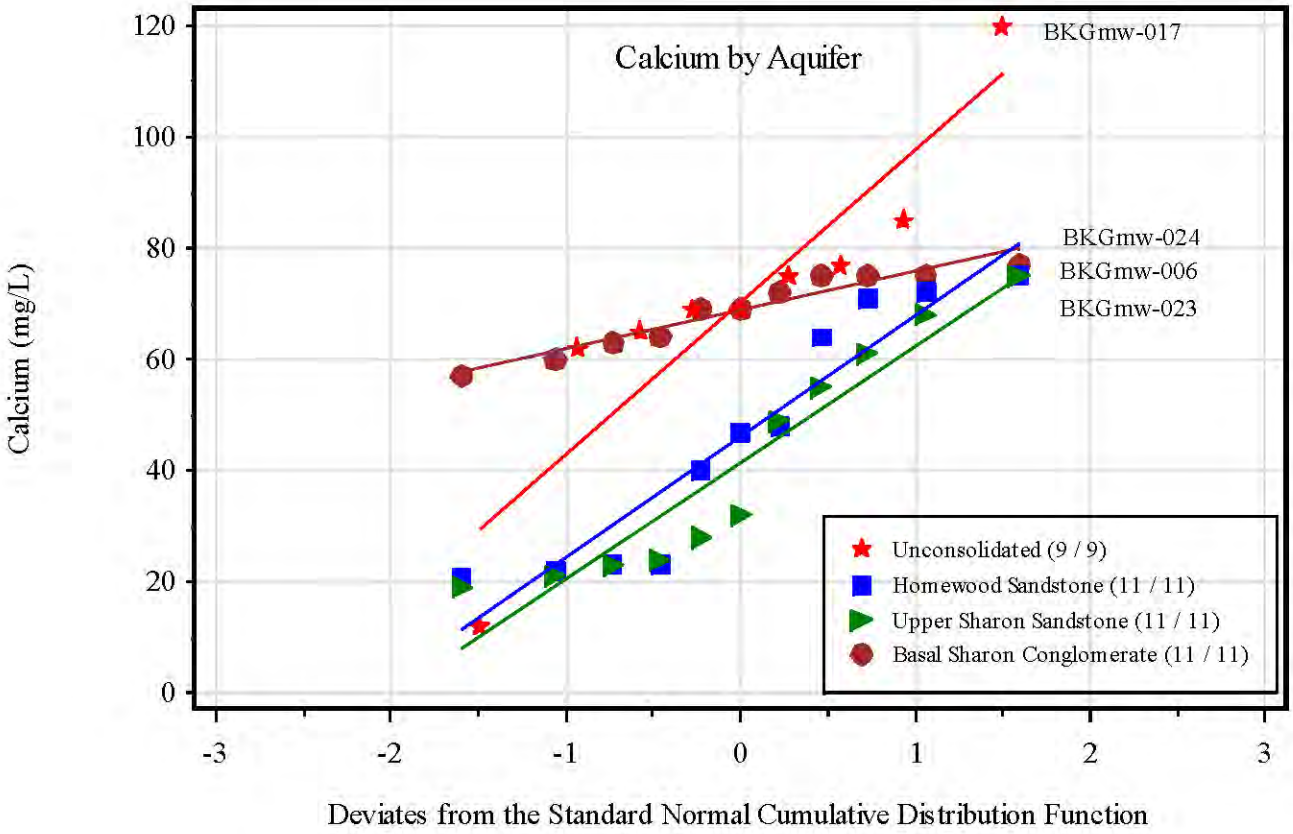


Hollow symbols denote the reporting limit was used for non-detects.



Reporting limits were plotted for non-detects.

Fig. C.1-6. Normal Probability and Box Plots of All Background Data-Cadmium



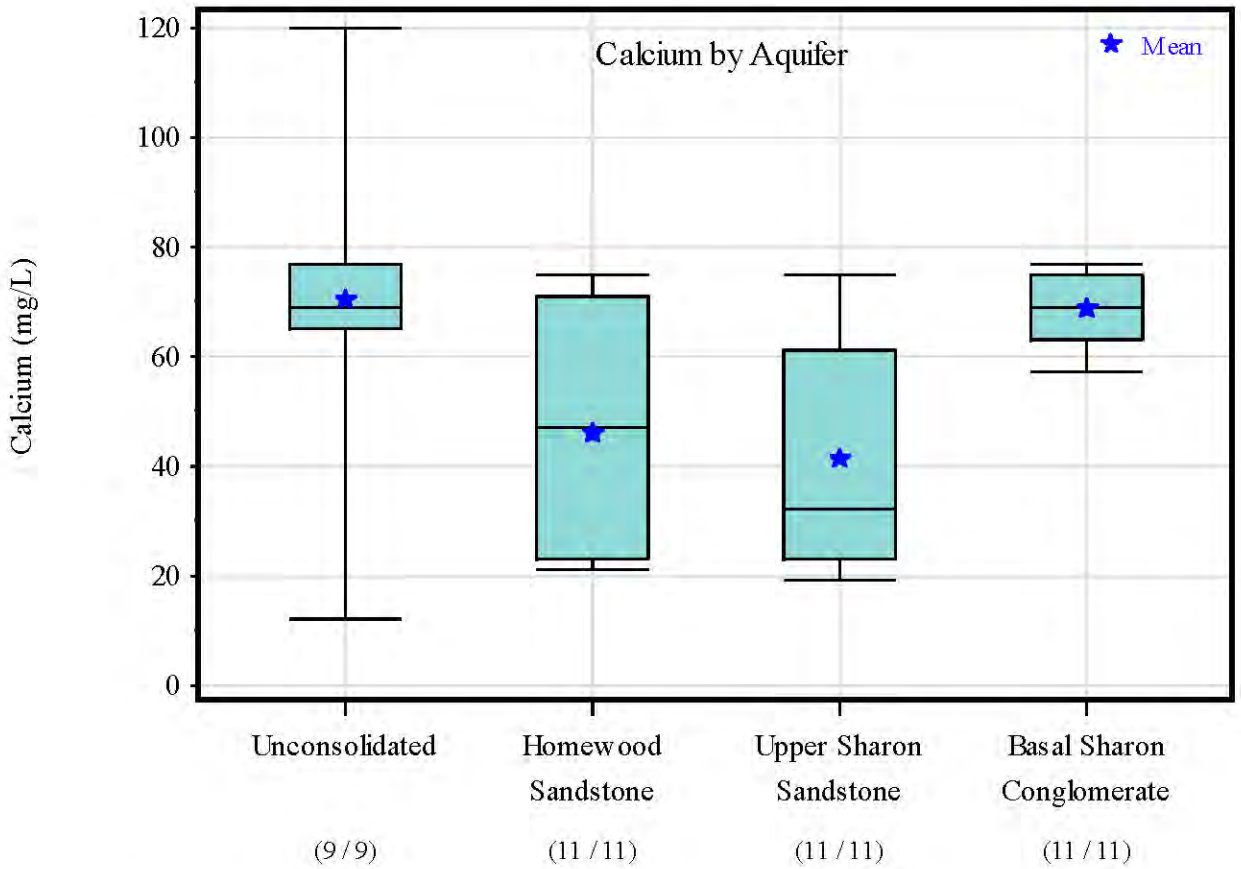
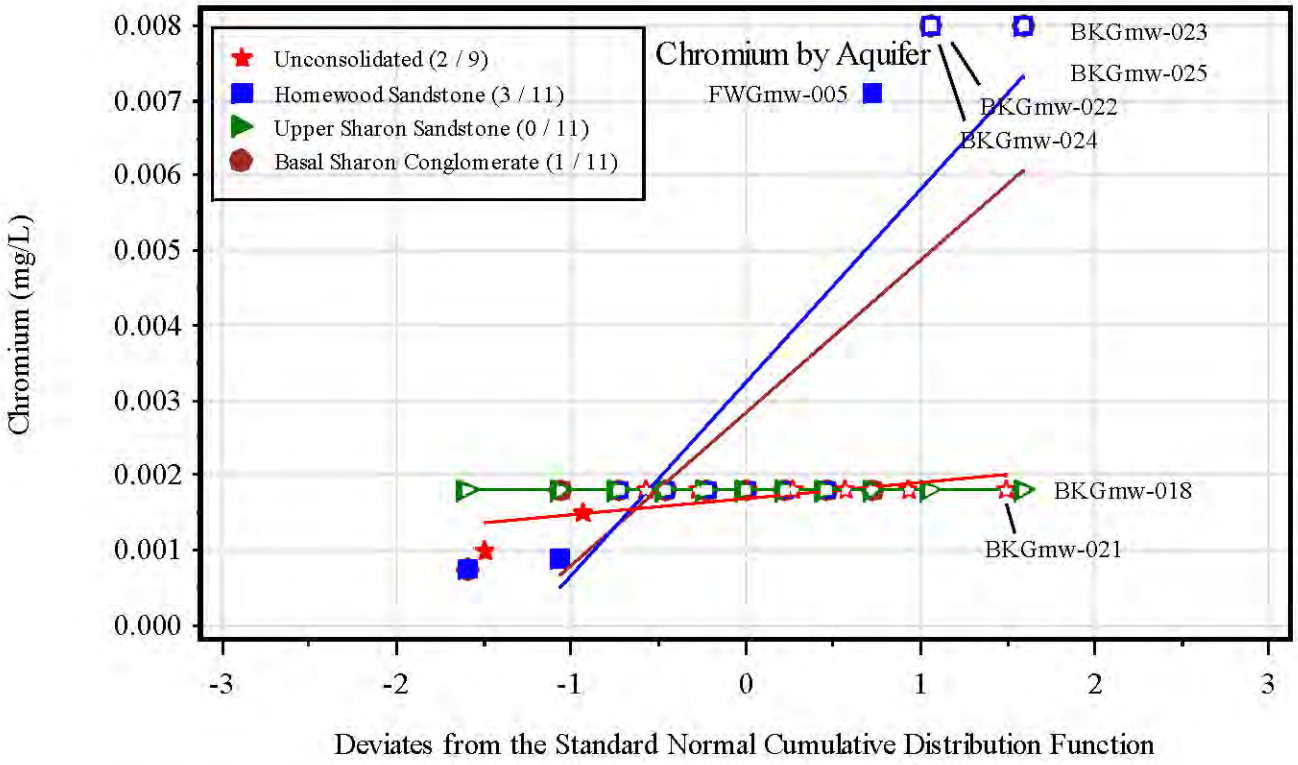
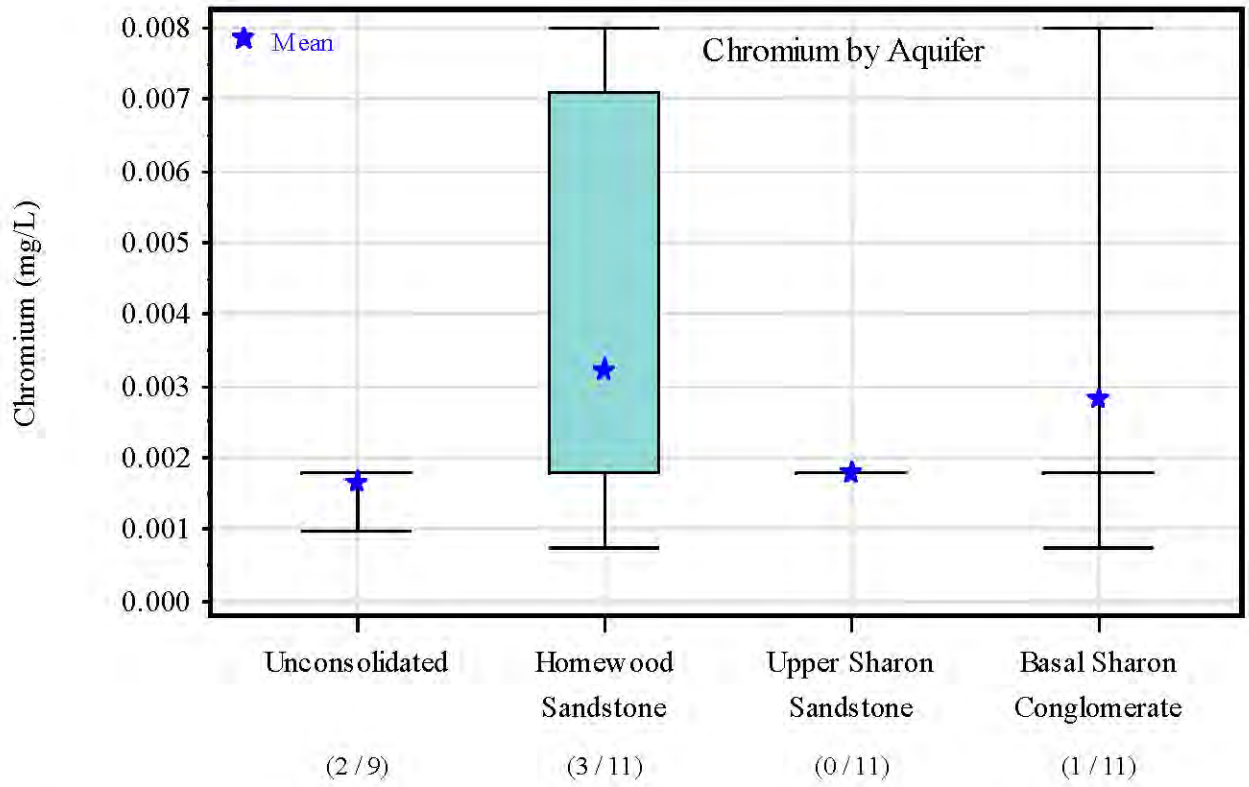


Fig. C.1-7. Normal Probability and Box Plots of All Background Data-Calcium

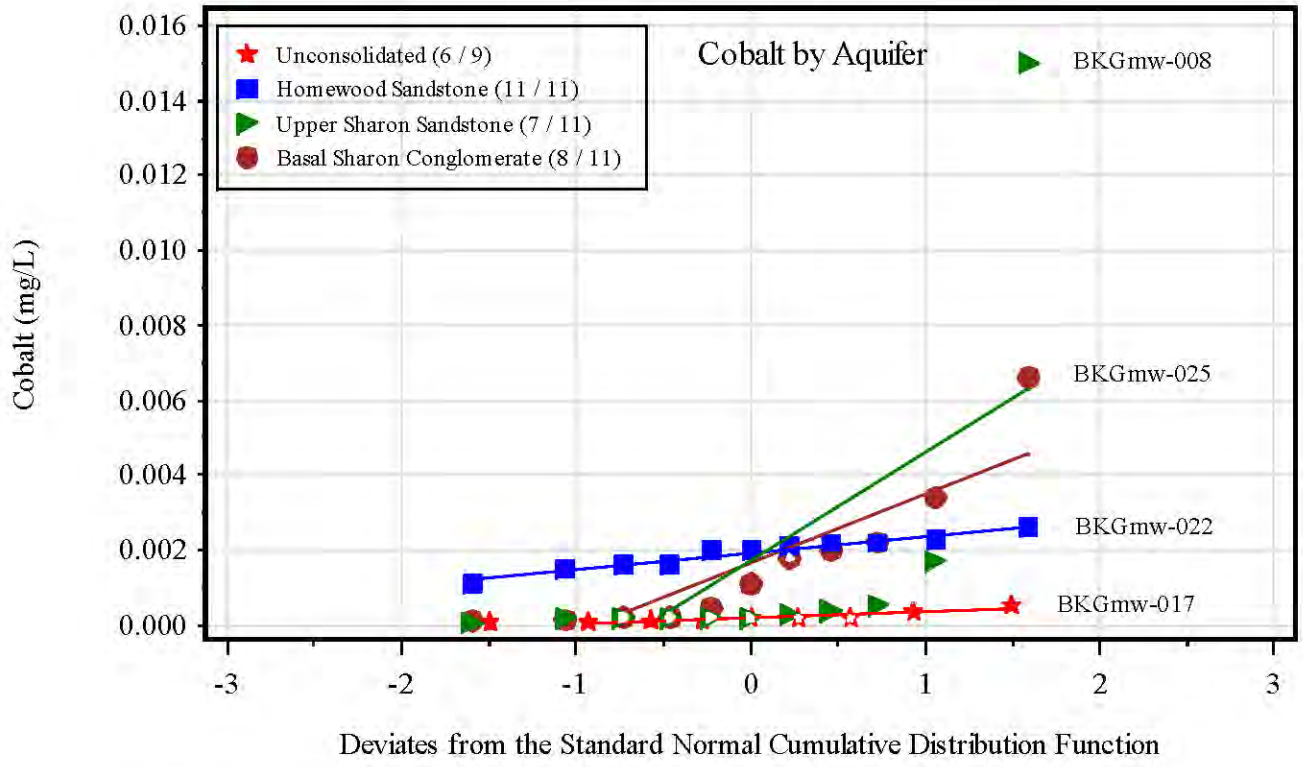


Hollow symbols denote the reporting limit was used for non-detects.

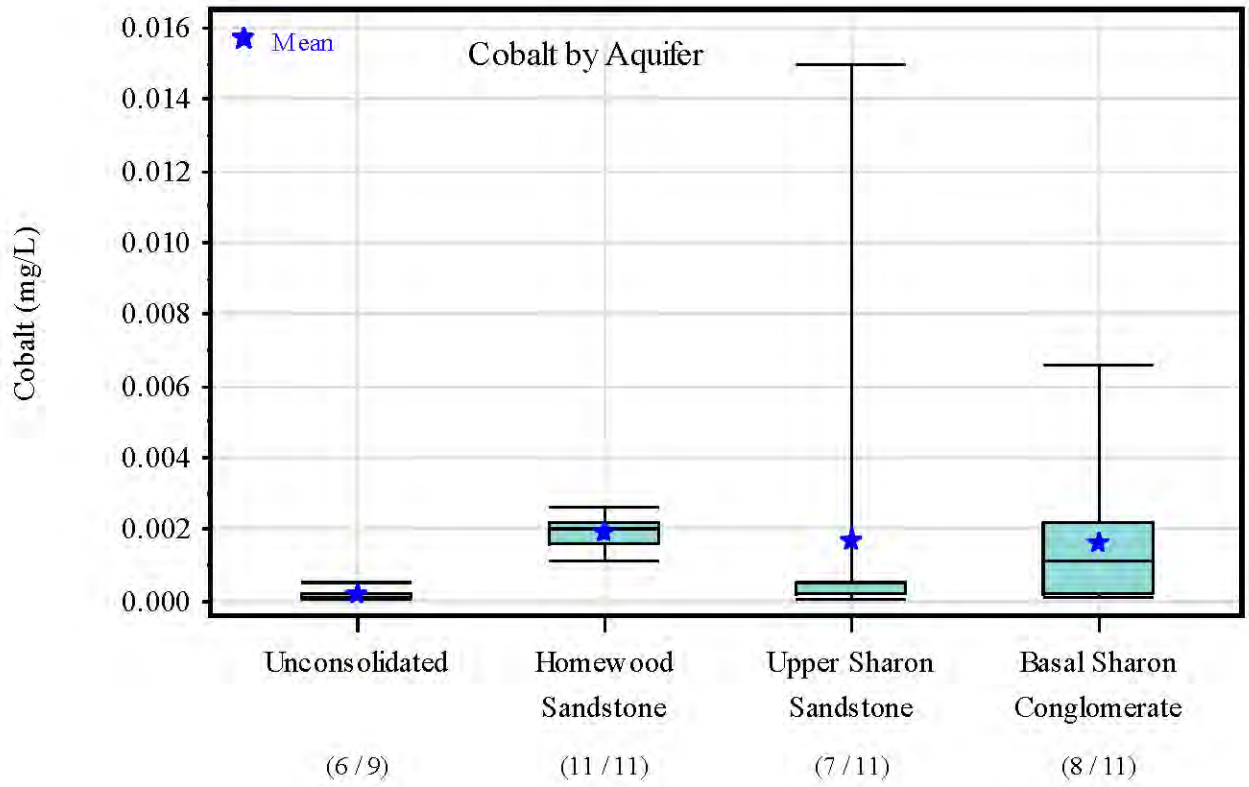


Reporting limits were plotted for non-detects.

Fig. C.1-8. Normal Probability and Box Plots of All Background Data-Chromium

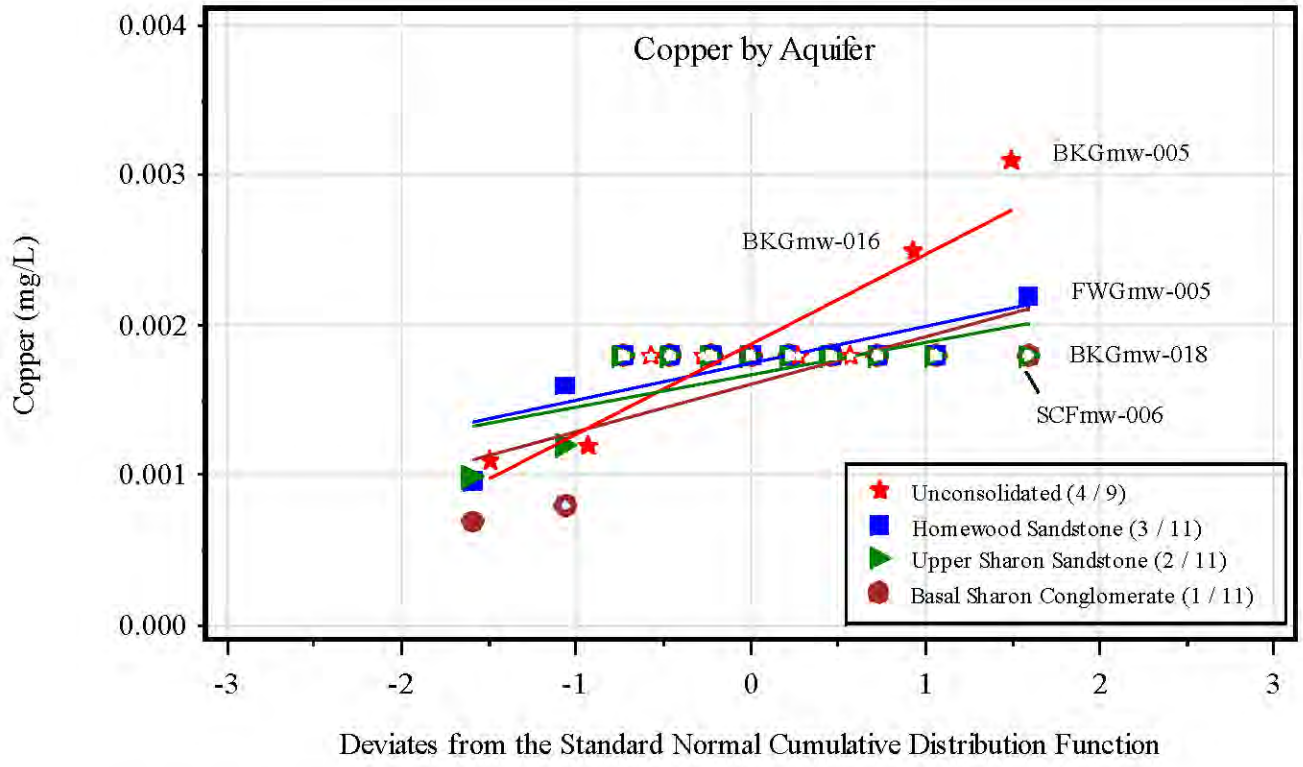


Hollow symbols denote the reporting limit was used for non-detects.

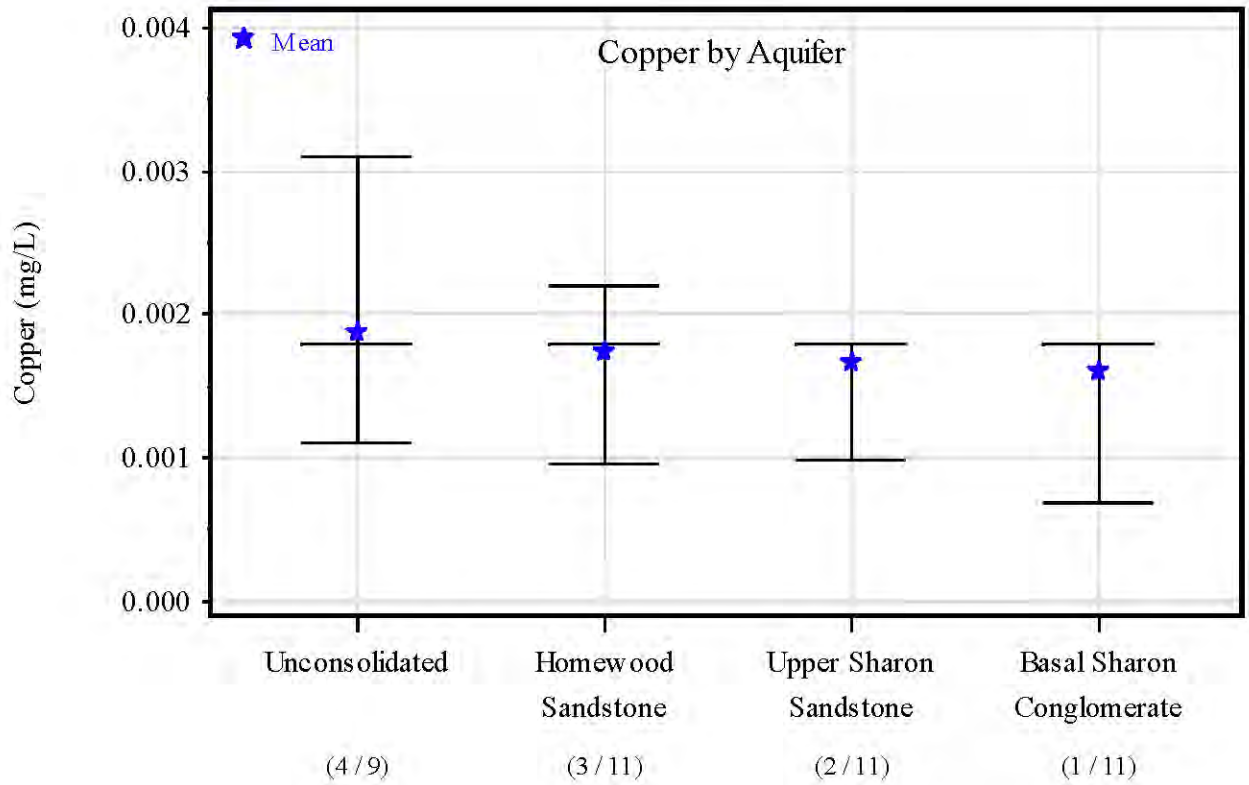


Reporting limits were plotted for non-detects.

Fig. C.1-9. Normal Probability and Box Plots of All Background Data-Cobalt

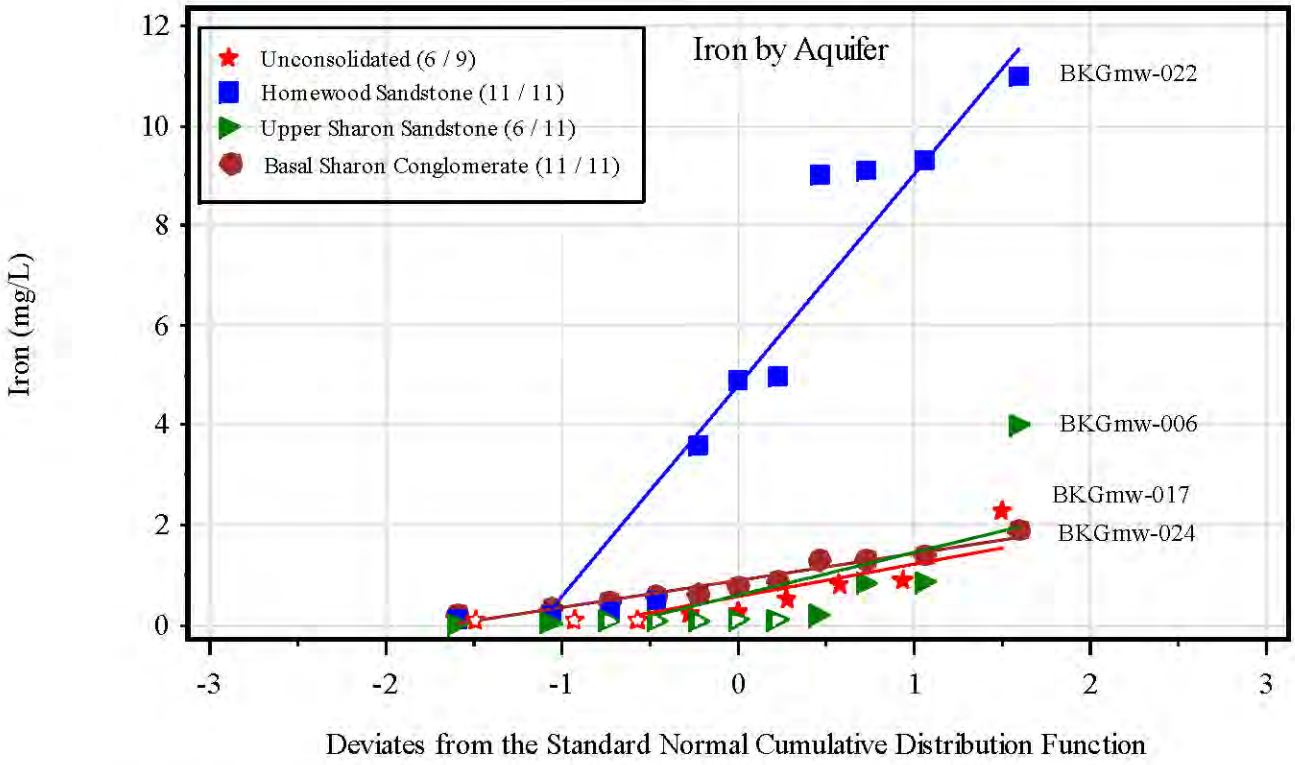


Hollow symbols denote the reporting limit was used for non-detects.

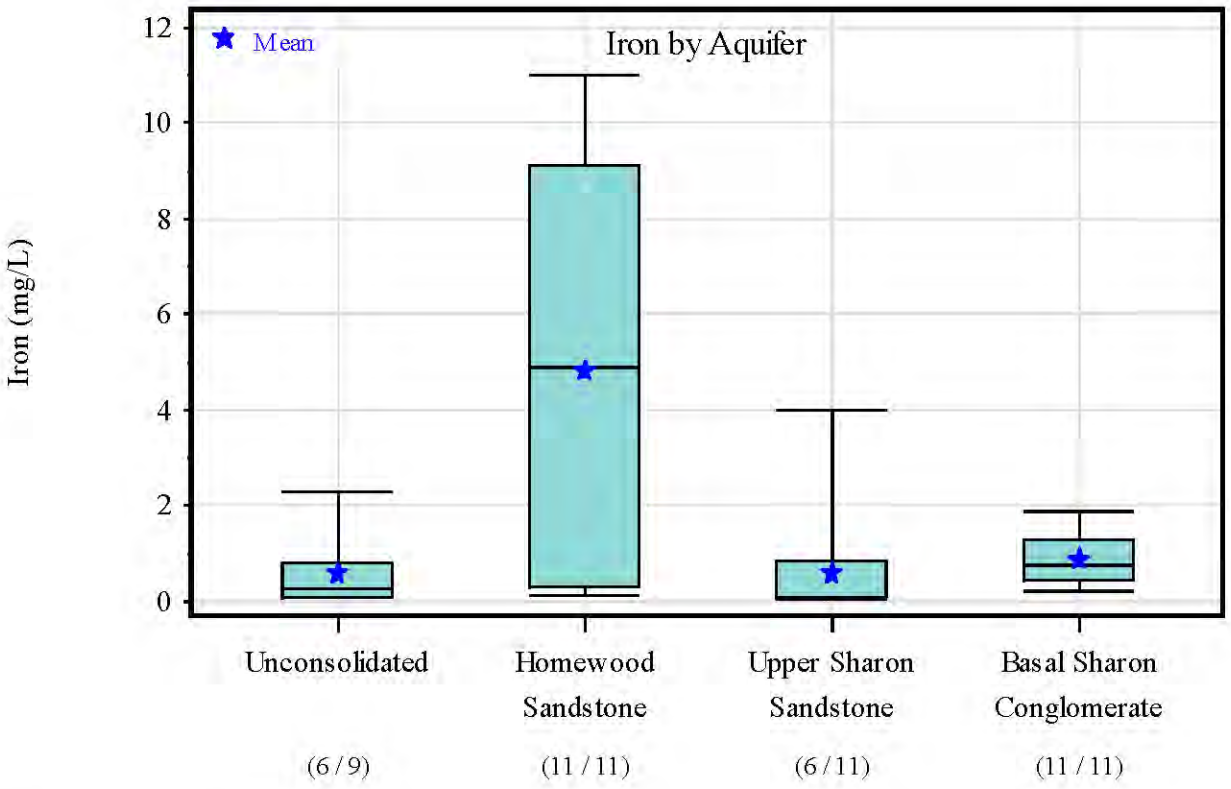


Reporting limits were plotted for non-detects.

Fig. C.1-10. Normal Probability and Box Plots of All Background Data-Copper

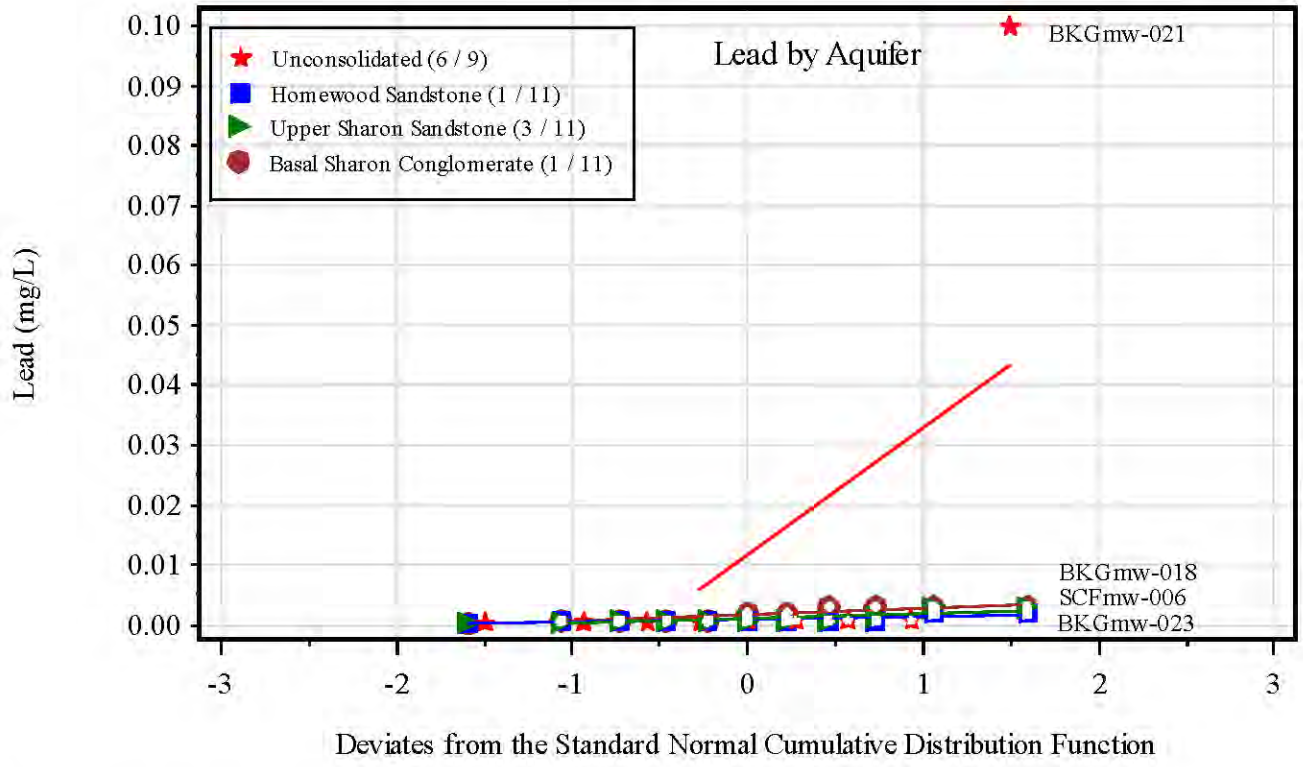


Hollow symbols denote the reporting limit was used for non-detects.

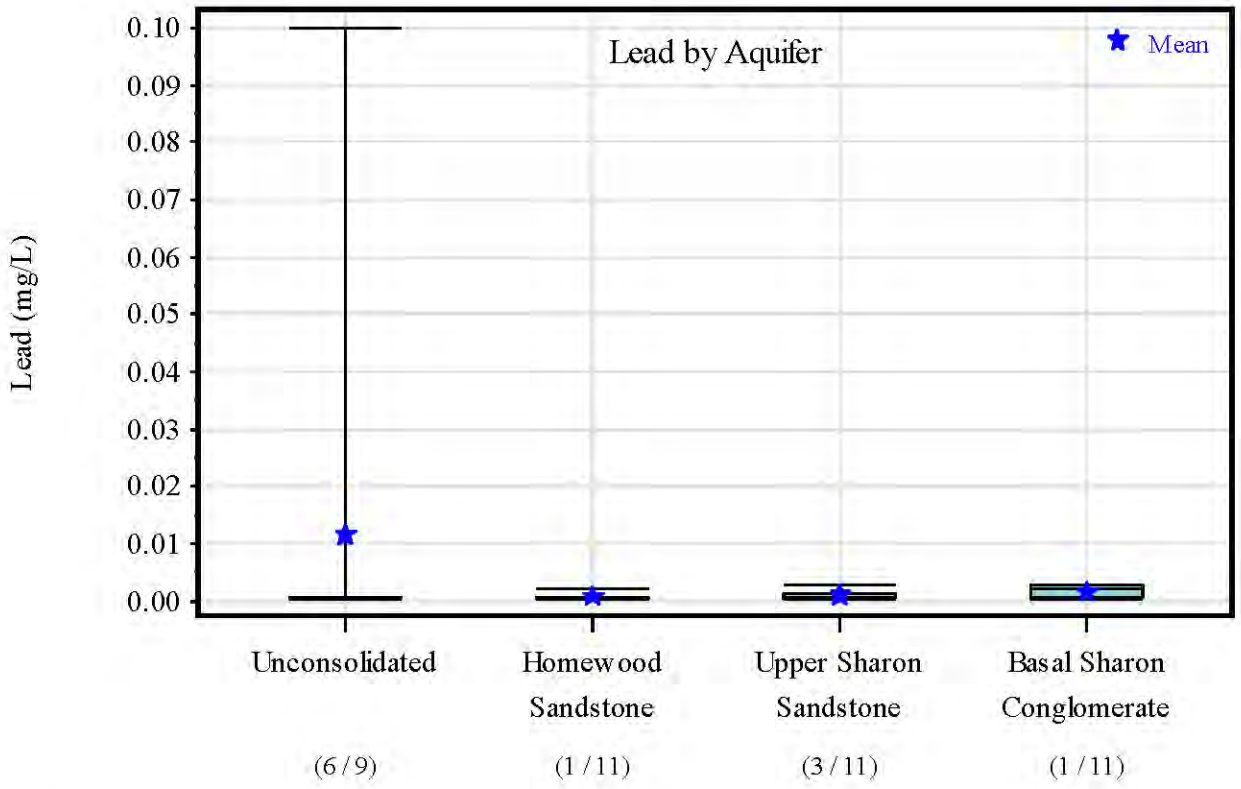


Reporting limits were plotted for non-detects.

Fig. C.1-11. Normal Probability and Box Plots of All Background Data-Iron

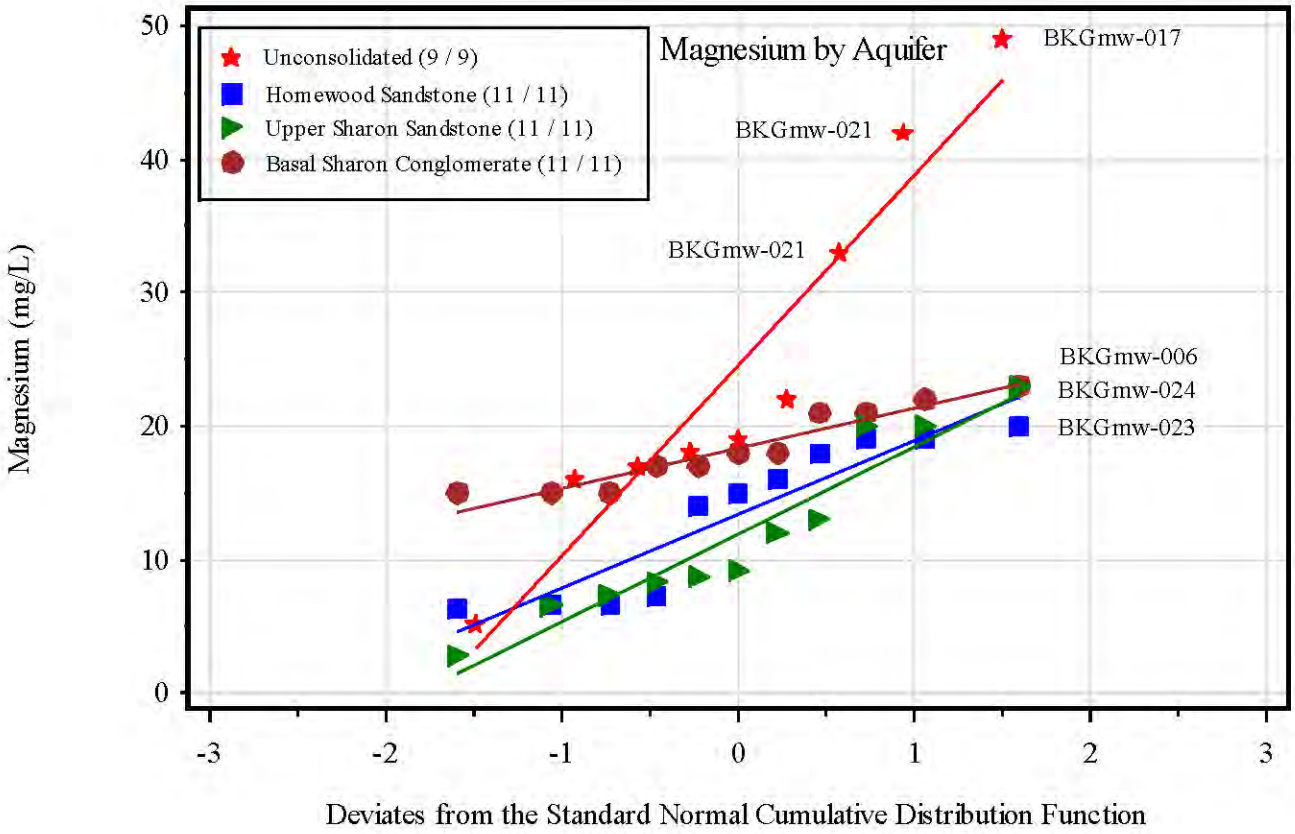


Hollow symbols denote the reporting limit was used for non-detects.



Reporting limits were plotted for non-detects.

Fig. C.1-12. Normal Probability and Box Plots of All Background Data-Lead



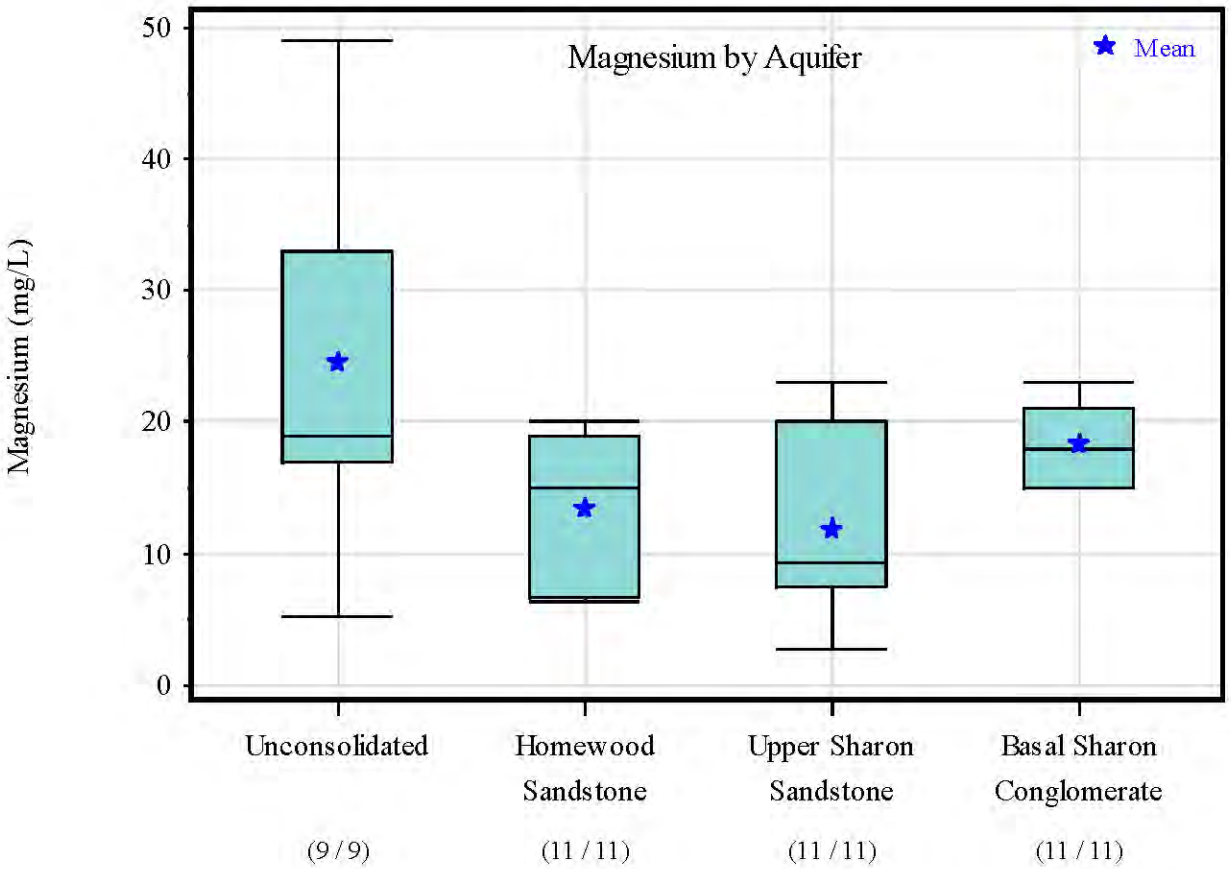
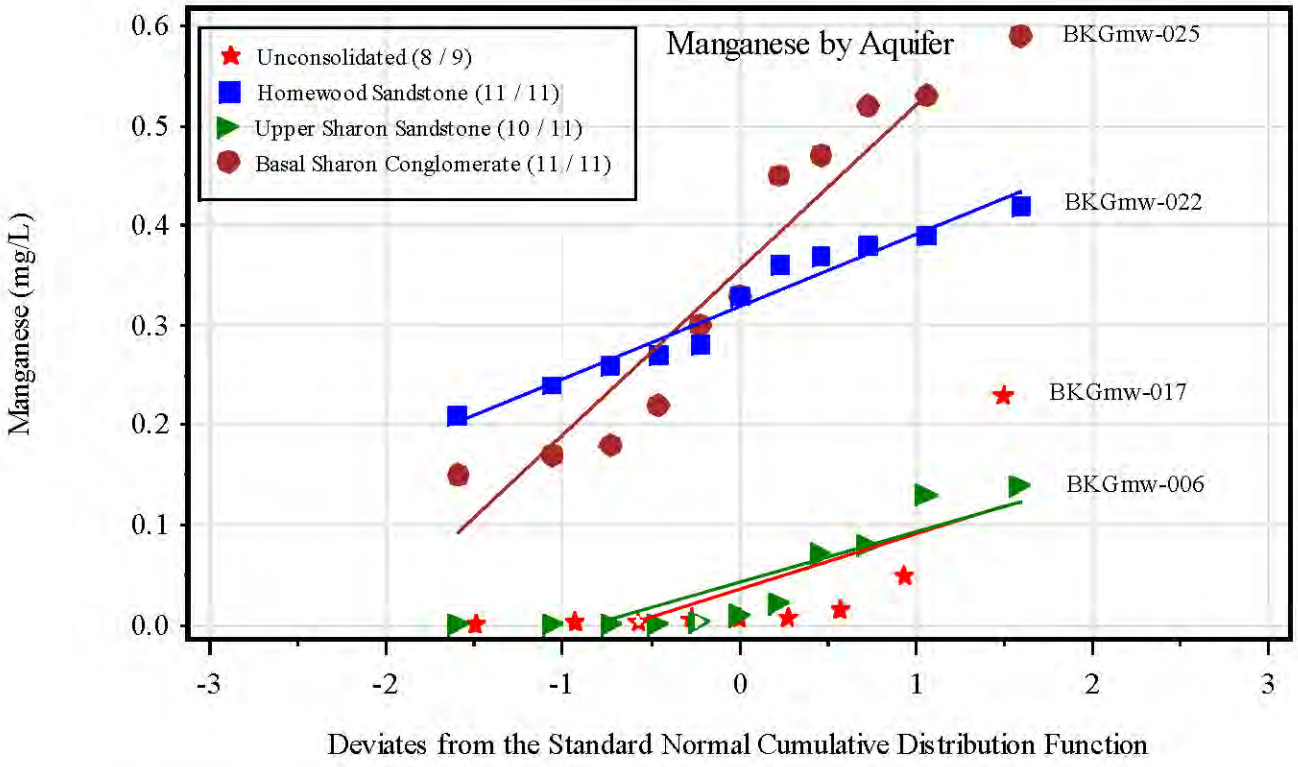
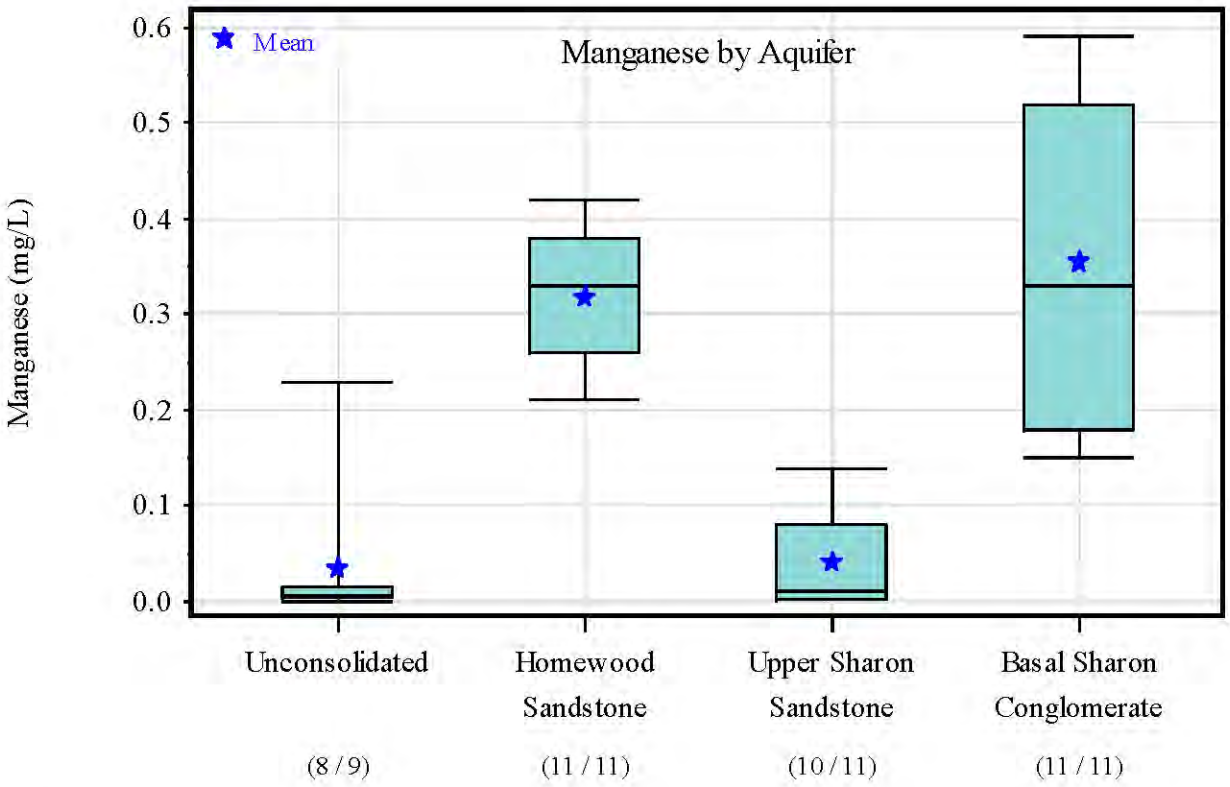


Fig. C.1-13. Normal Probability and Box Plots of All Background Data-Magnesium

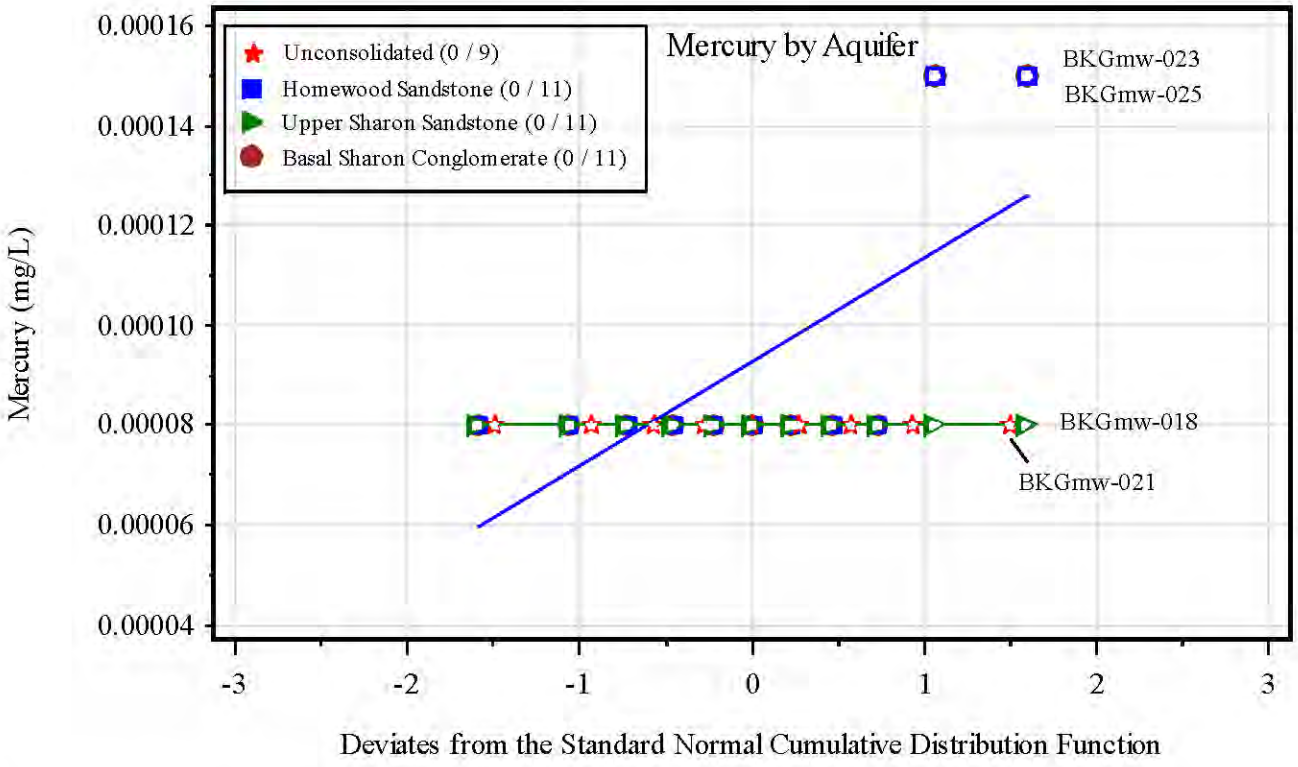


Hollow symbols denote the reporting limit was used for non-detects.

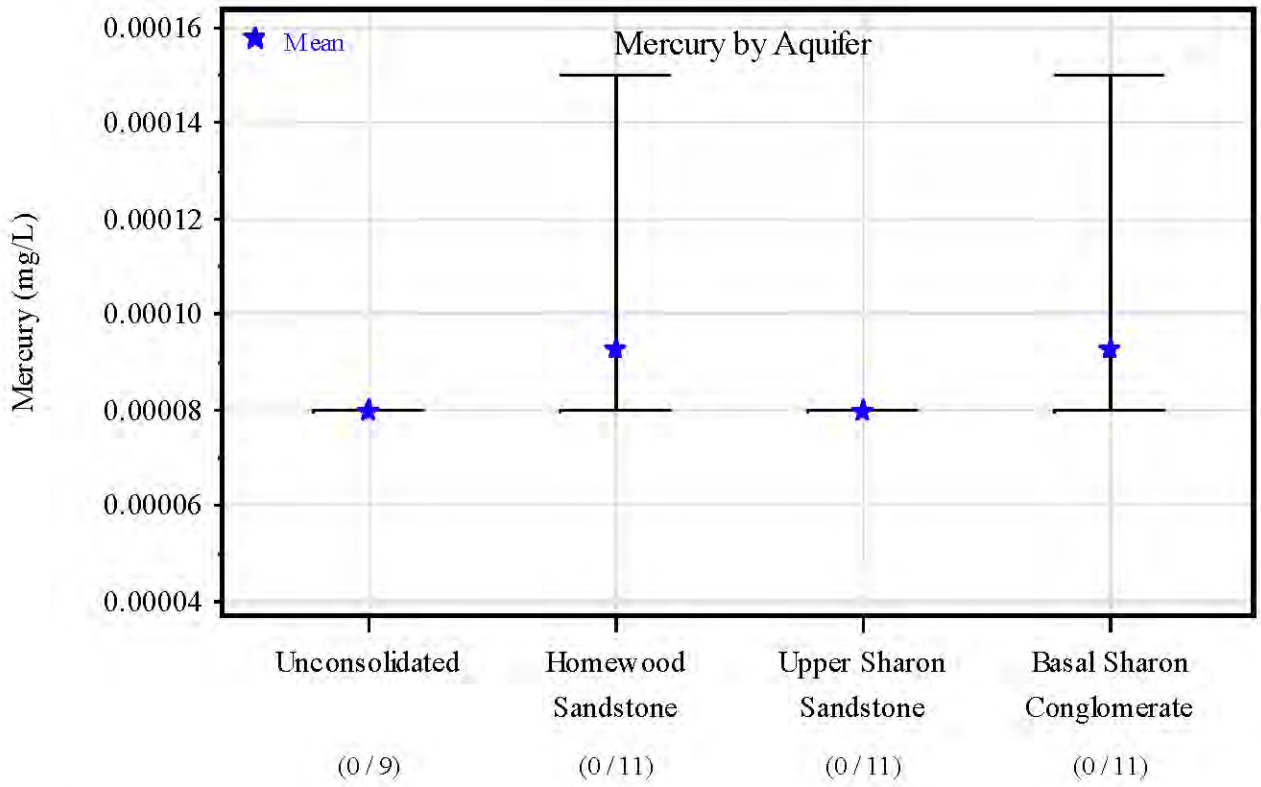


Reporting limits were plotted for non-detects.

Fig. C.1-14. Normal Probability and Box Plots of All Background Data-Manganese

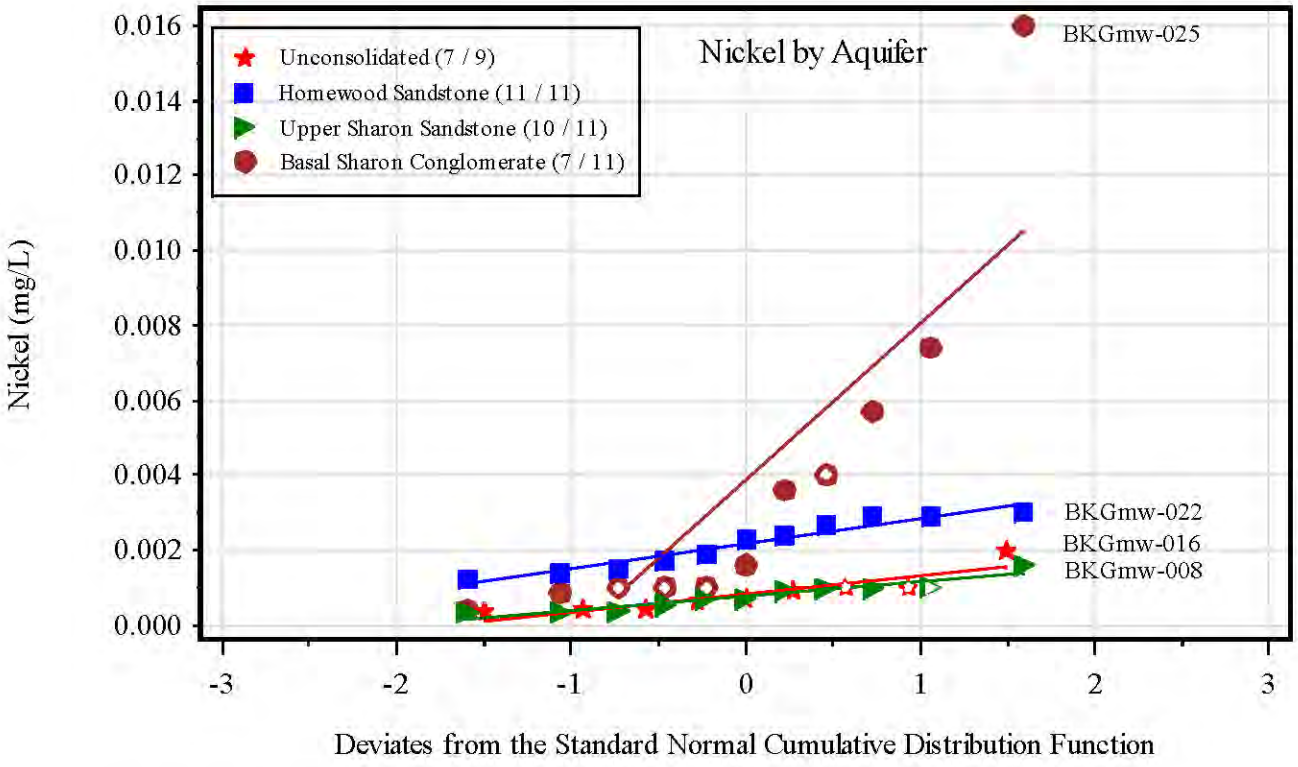


Hollow symbols denote the reporting limit was used for non-detects.

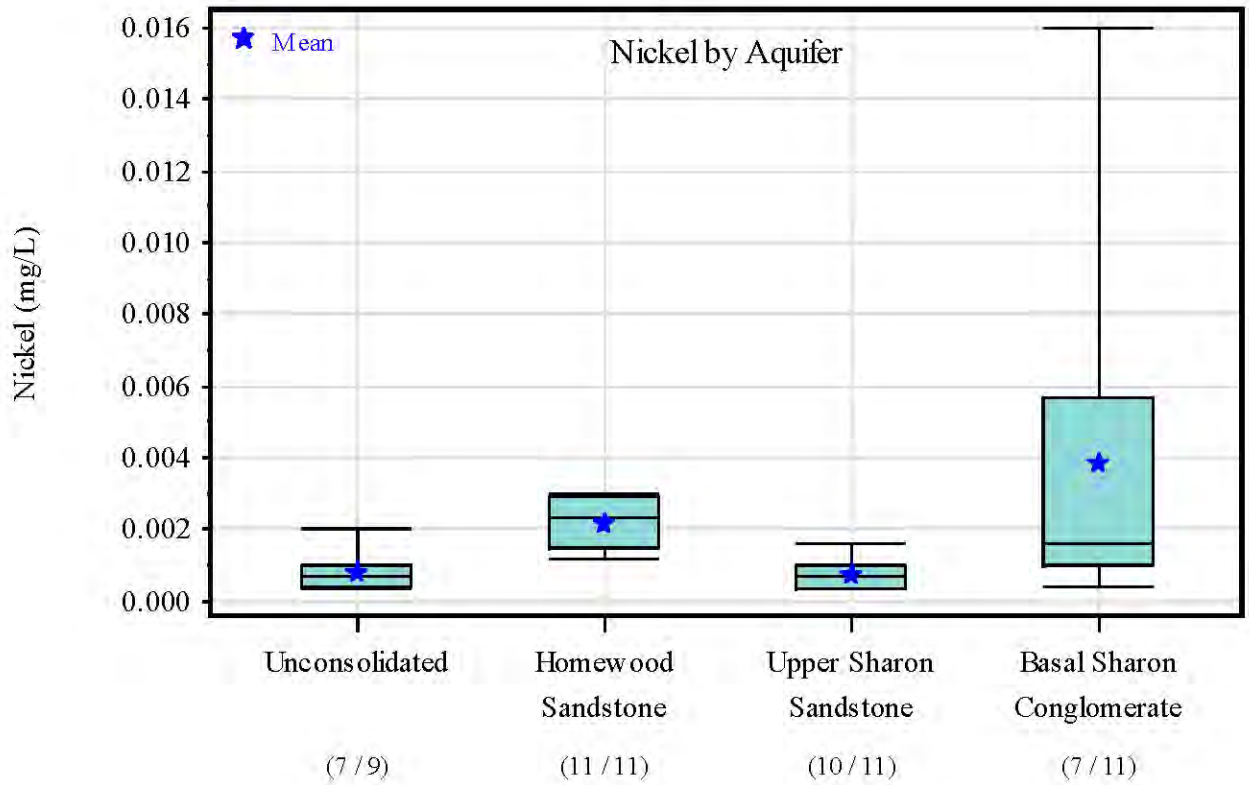


Reporting limits were plotted for non-detects.

Fig. C.1-15. Normal Probability and Box Plots of All Background Data-Mercury

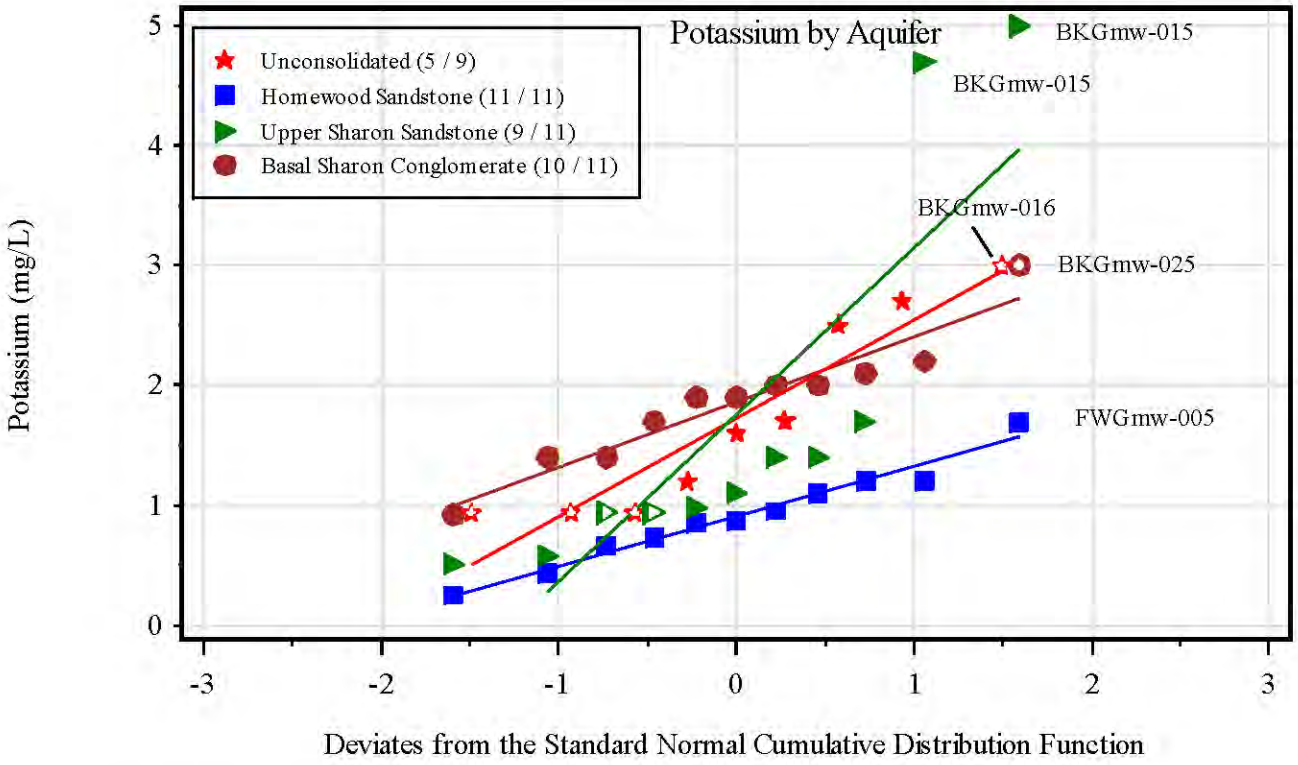


Hollow symbols denote the reporting limit was used for non-detects.

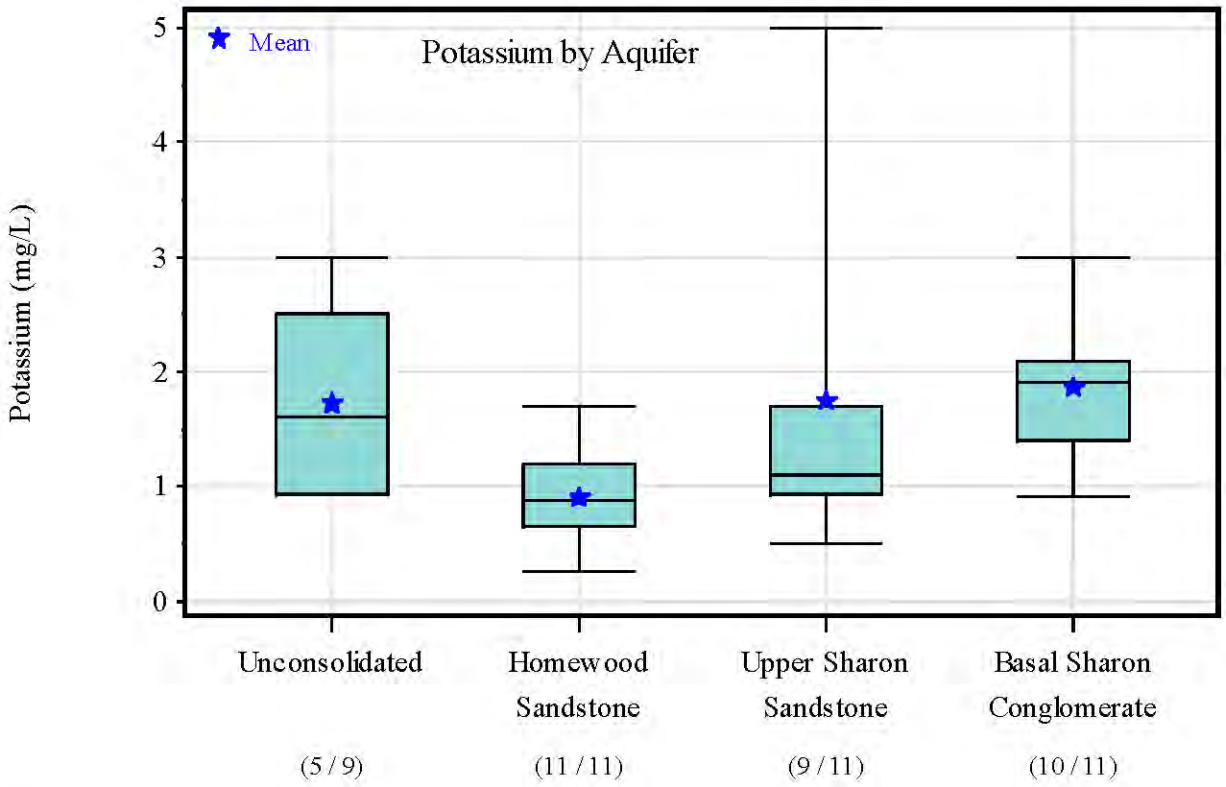


Reporting limits were plotted for non-detects.

Fig. C.1-16. Normal Probability and Box Plots of All Background Data-Nickel

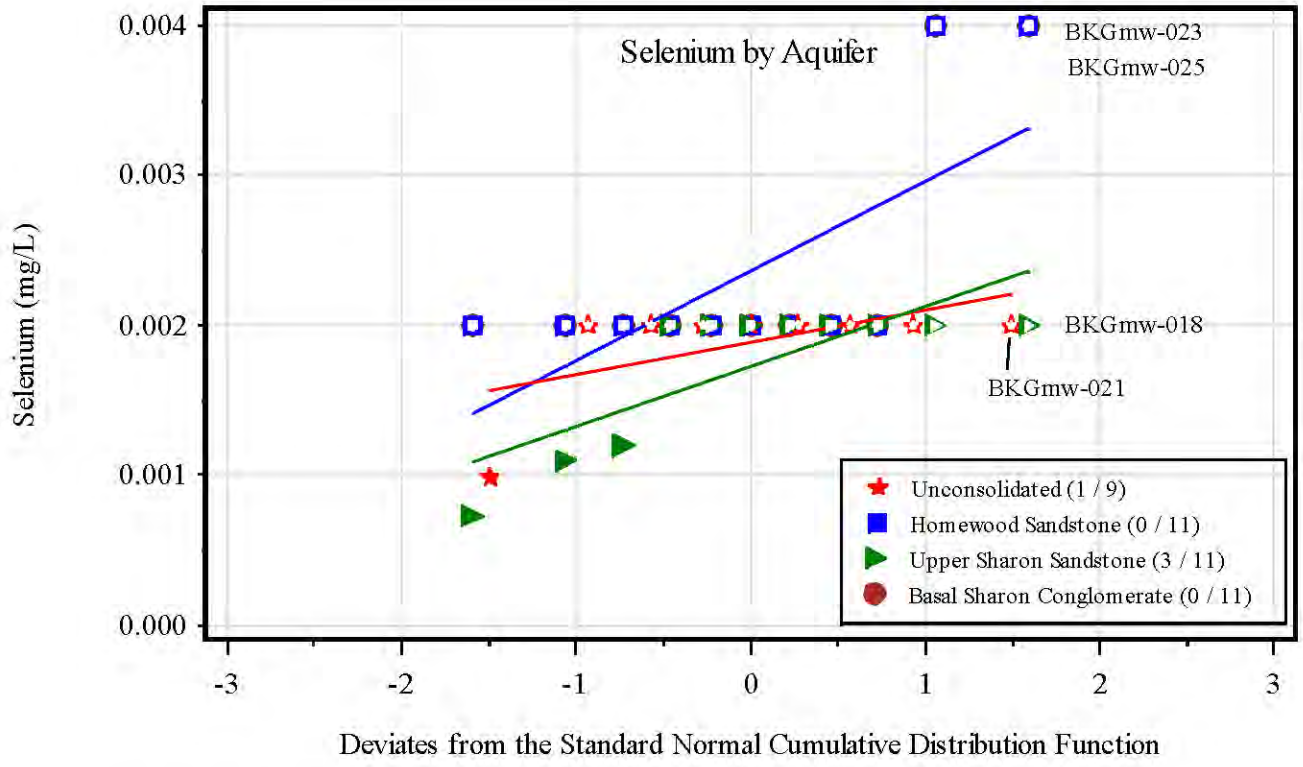


Hollow symbols denote the reporting limit was used for non-detects.

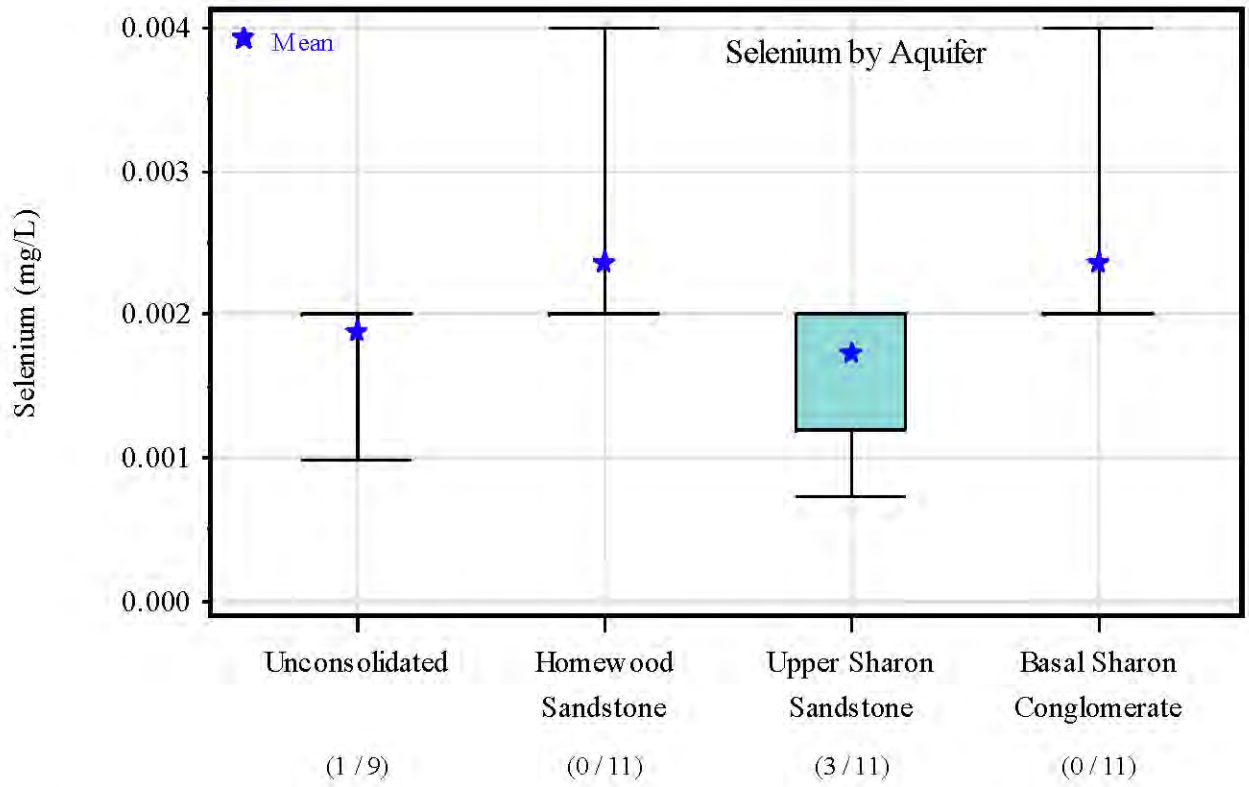


Reporting limits were plotted for non-detects.

Fig. C.1-17. Normal Probability and Box Plots of All Background Data-Potassium

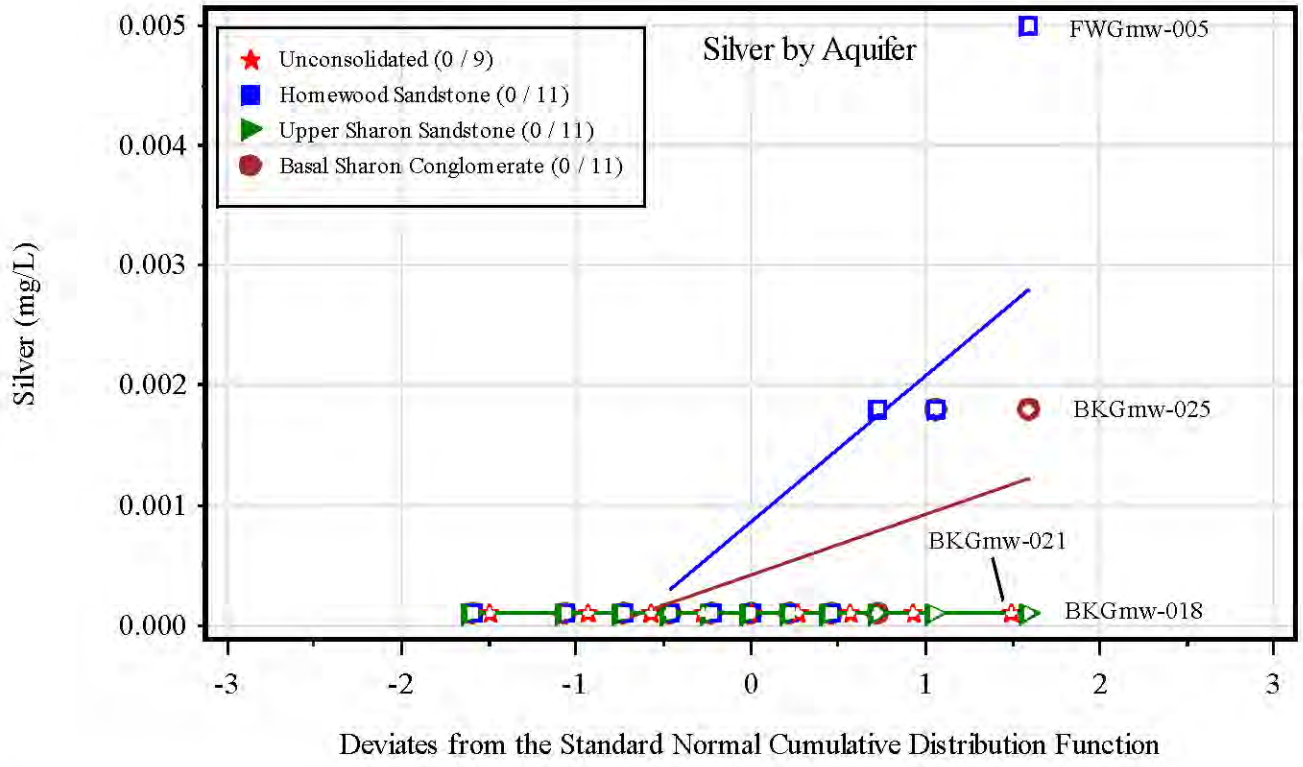


Hollow symbols denote the reporting limit was used for non-detects.

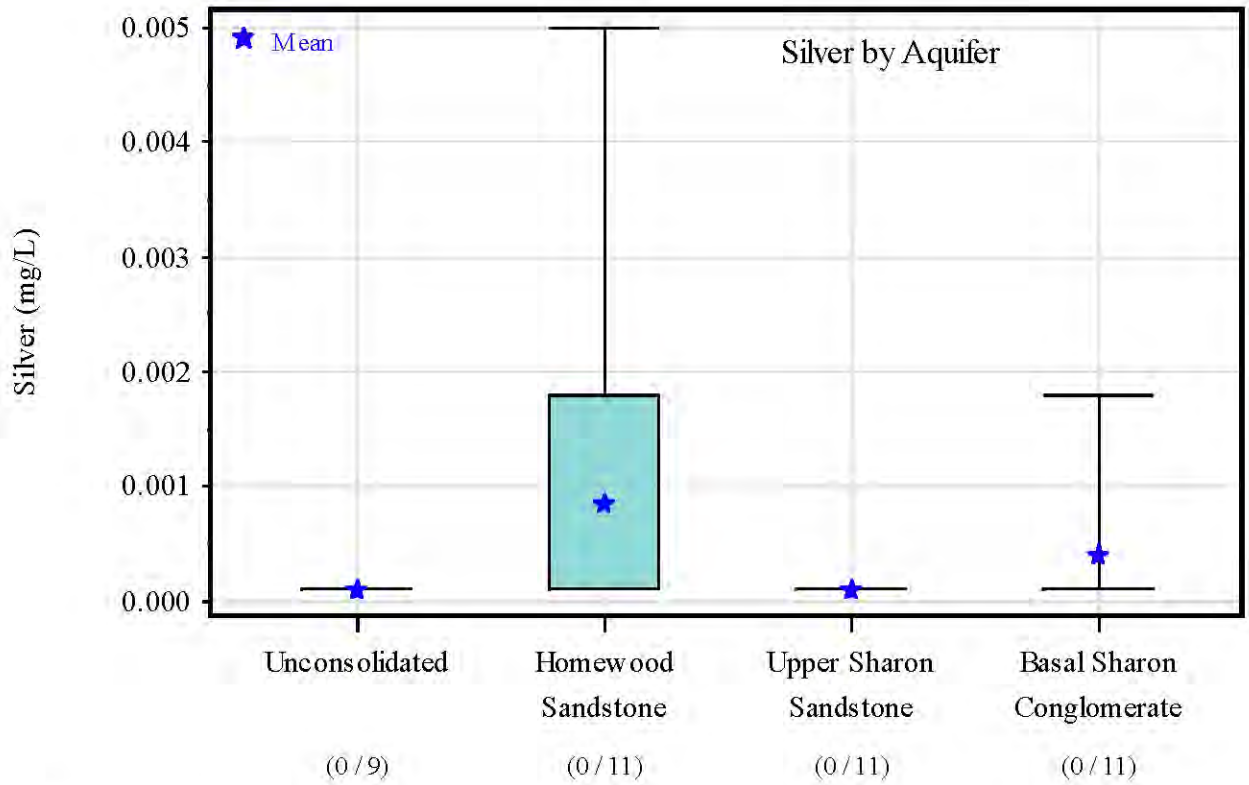


Reporting limits were plotted for non-detects.

Fig. C.1-18. Normal Probability and Box Plots of All Background Data-Selenium

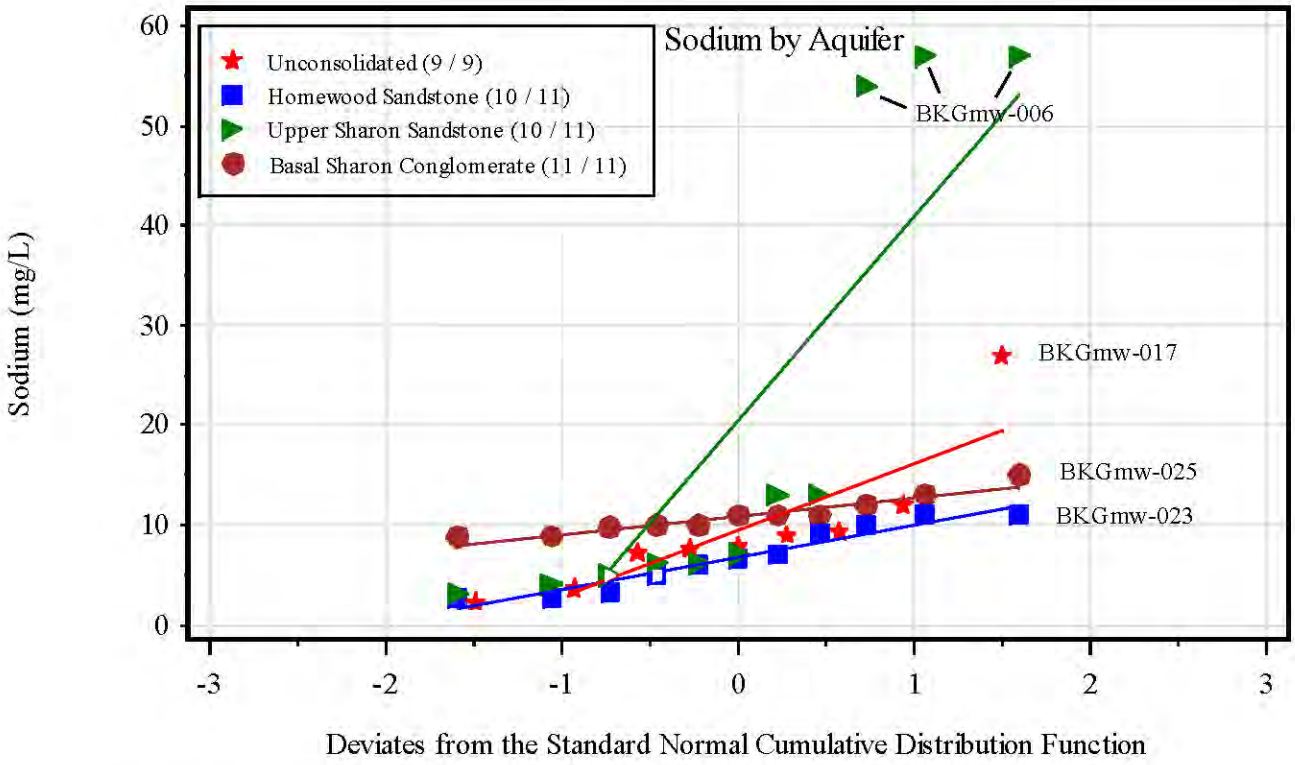


Hollow symbols denote the reporting limit was used for non-detects.

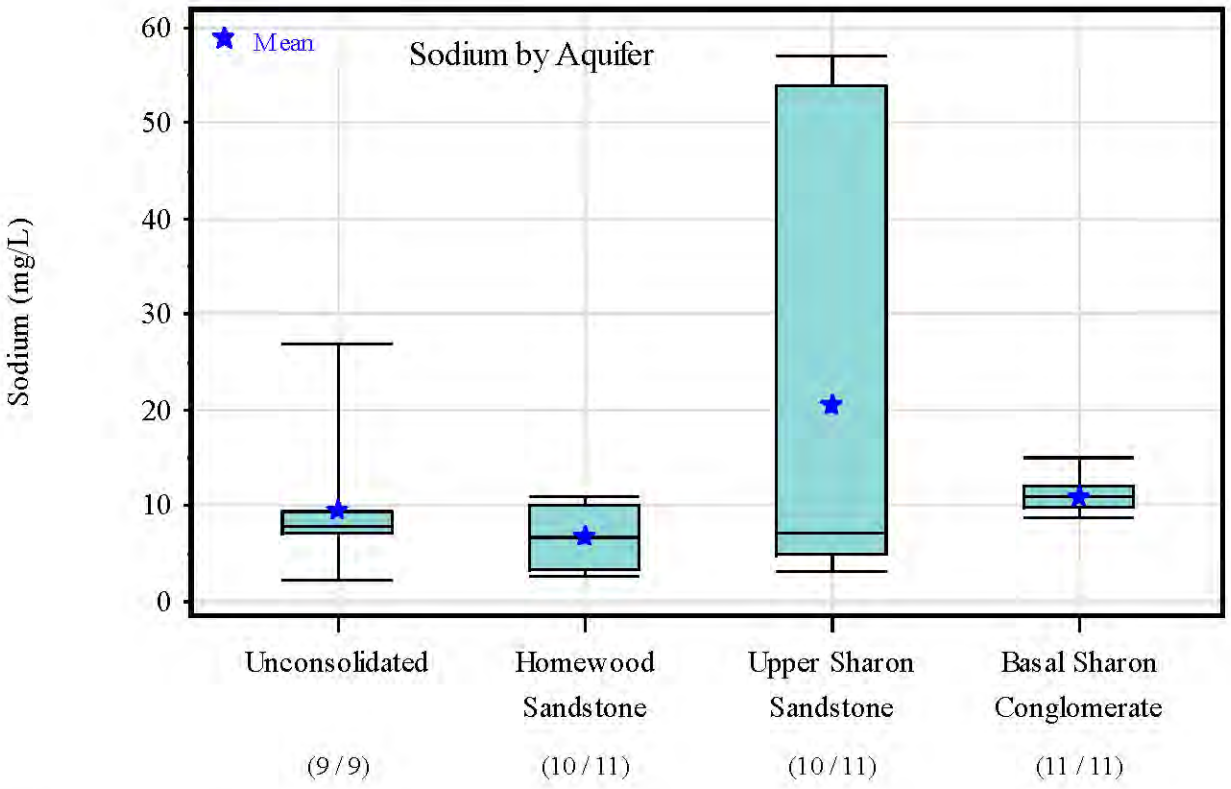


Reporting limits were plotted for non-detects.

Fig. C.1-19. Normal Probability and Box Plots of All Background Data-Silver

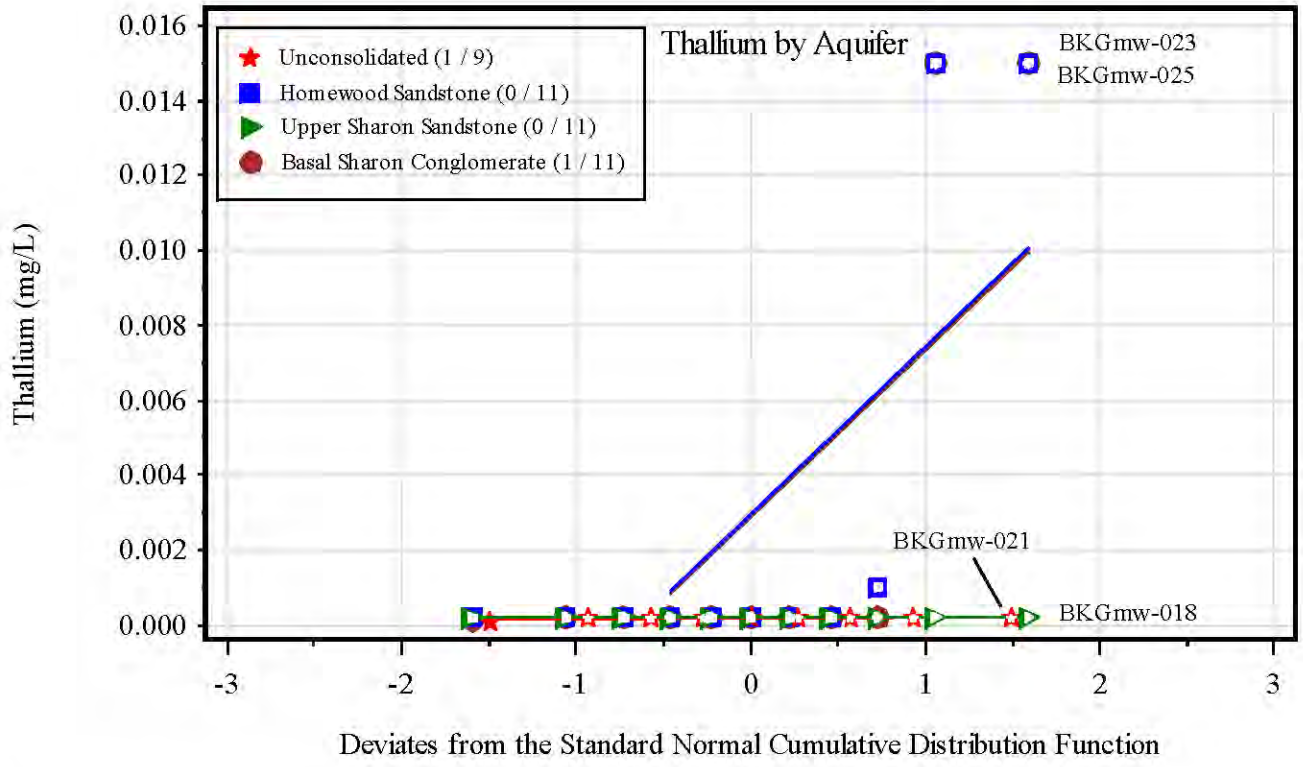


Hollow symbols denote the reporting limit was used for non-detects.

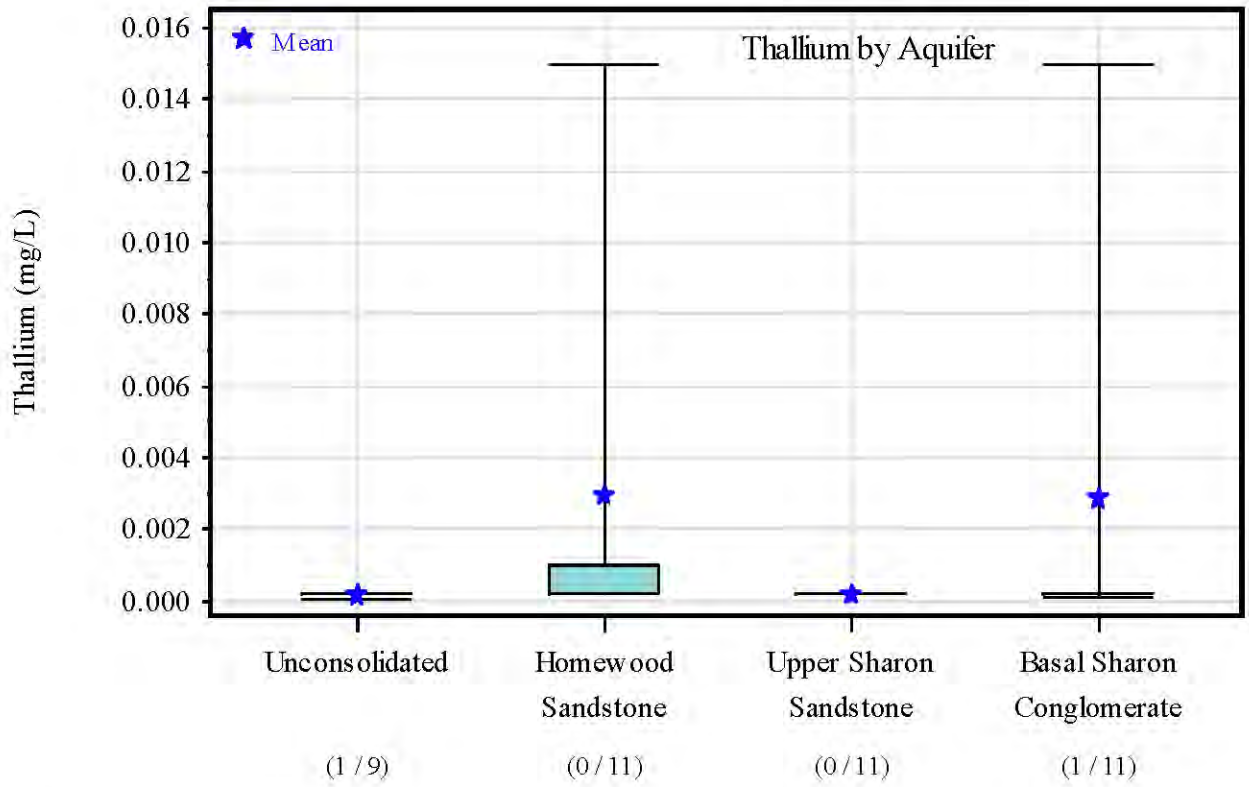


Reporting limits were plotted for non-detects.

Fig. C.1-20. Normal Probability and Box Plots of All Background Data-Sodium

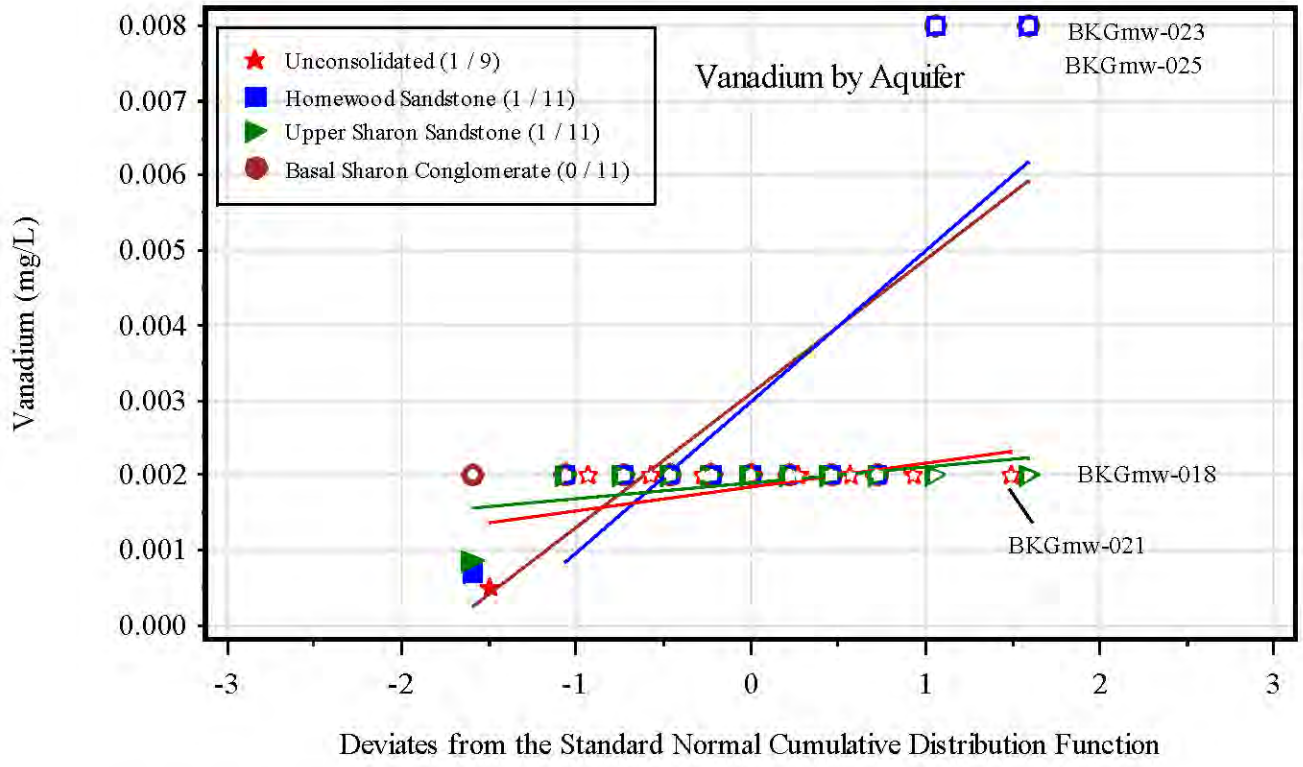


Hollow symbols denote the reporting limit was used for non-detects.

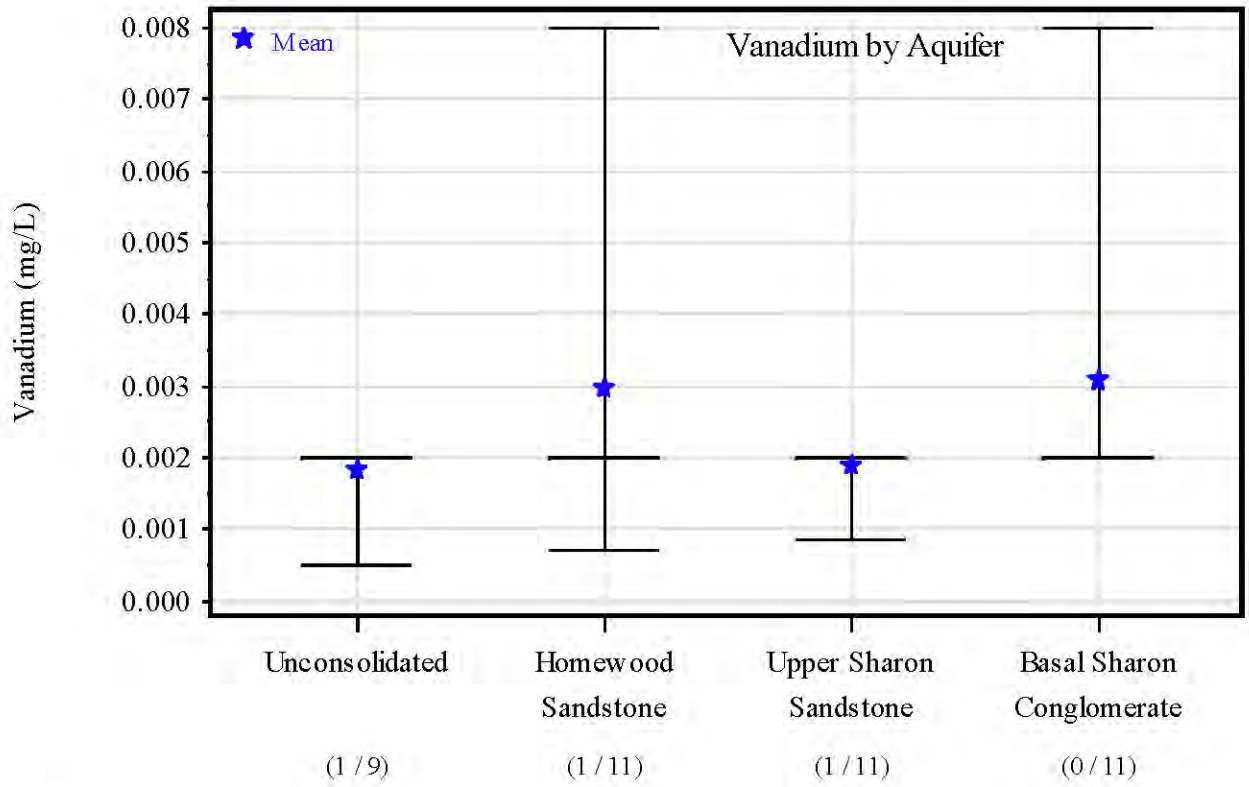


Reporting limits were plotted for non-detects.

Fig. C.1-21. Normal Probability and Box Plots of All Background Data-Thallium

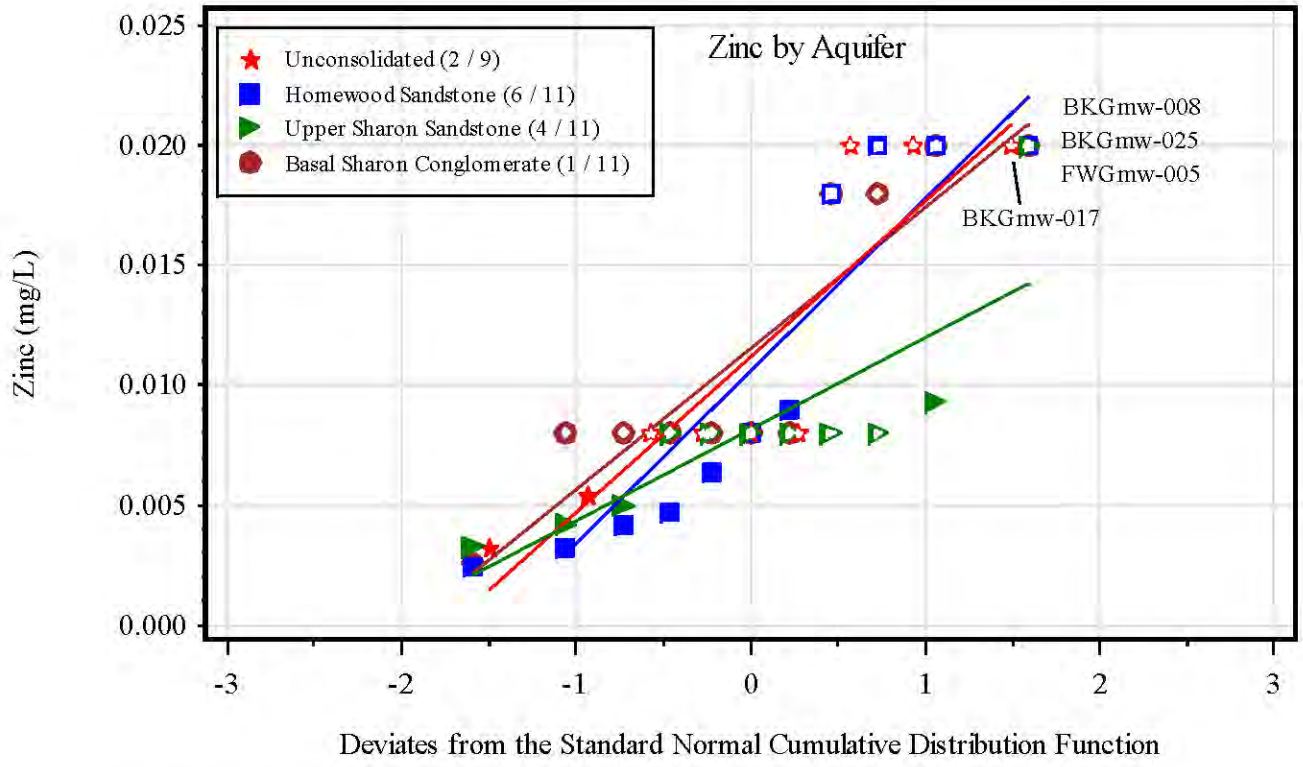


Hollow symbols denote the reporting limit was used for non-detects.

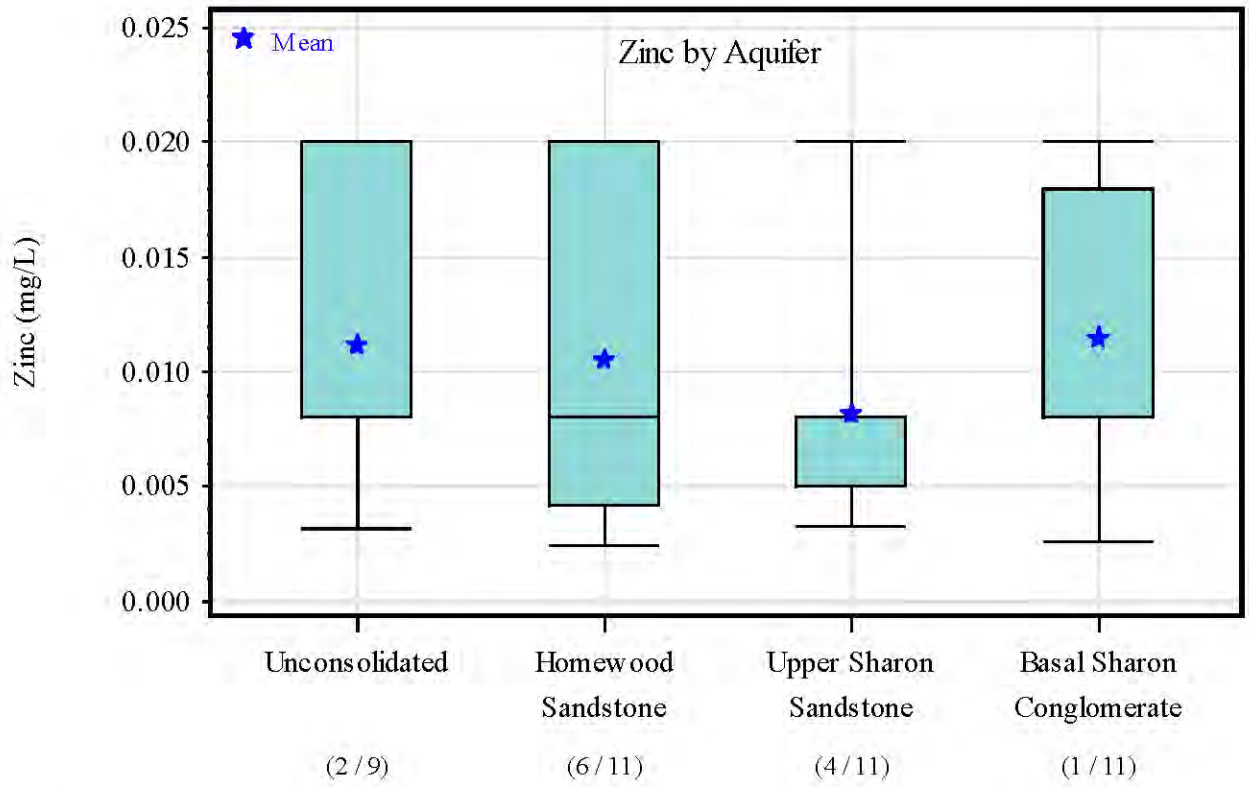


Reporting limits were plotted for non-detects.

Fig. C.1-22. Normal Probability and Box Plots of All Background Data-Vanadium

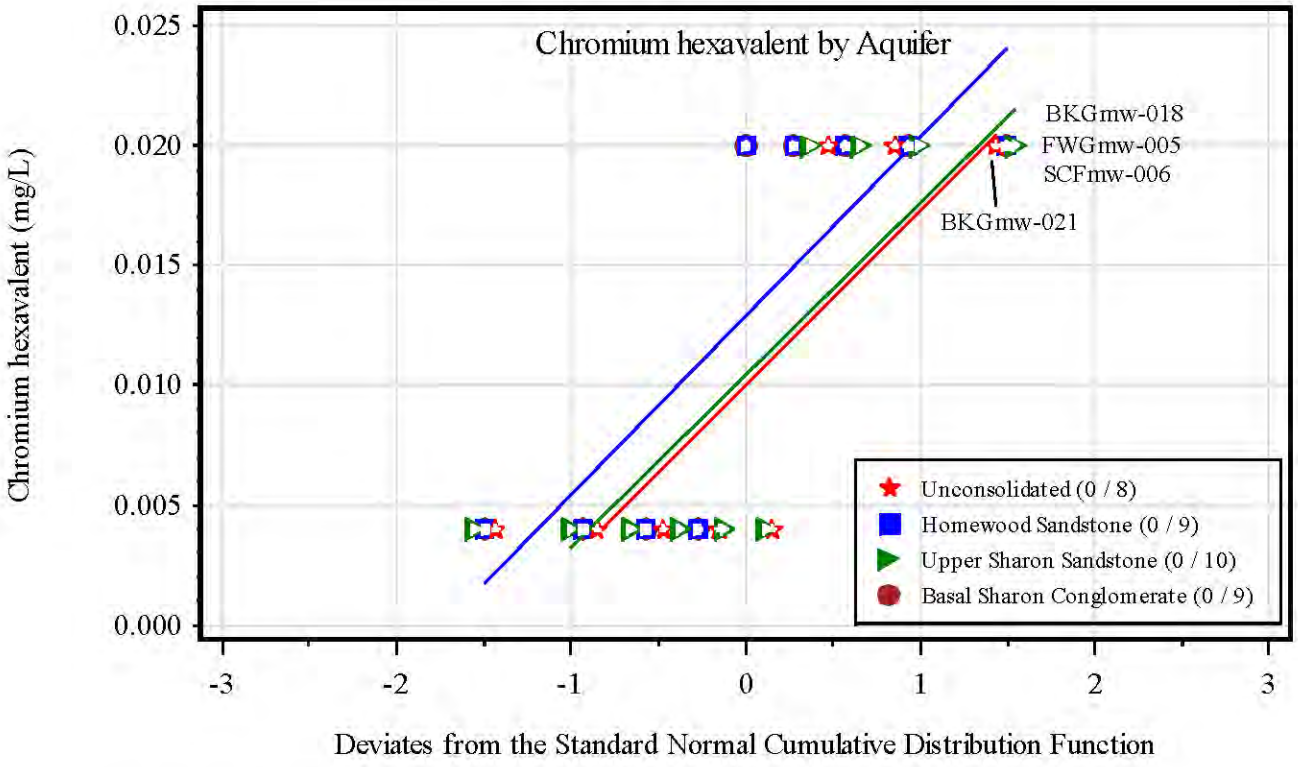


Hollow symbols denote the reporting limit was used for non-detects.

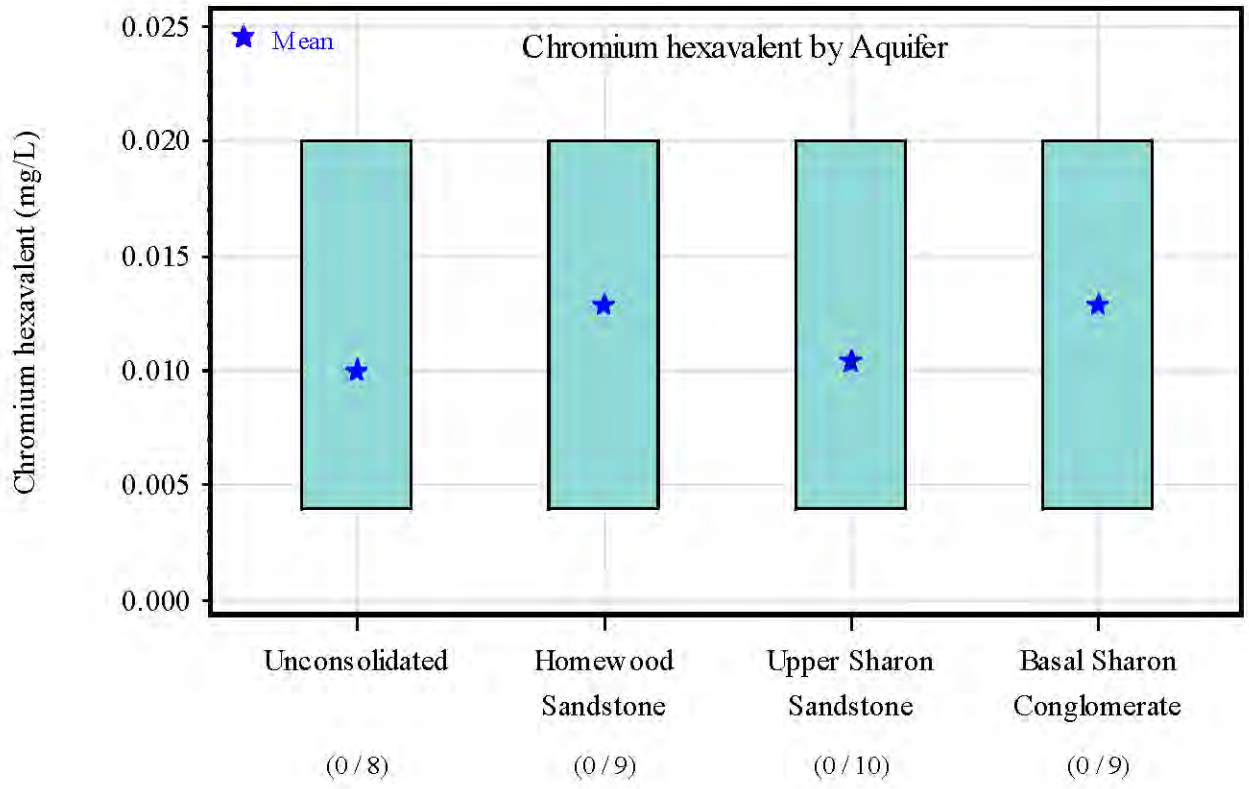


Reporting limits were plotted for non-detects.

Fig. C.1-23. Normal Probability and Box Plots of All Background Data-Zinc



Hollow symbols denote the reporting limit was used for non-detects.



Reporting limits were plotted for non-detects.

Fig. C.1-24. Normal Probability and Box Plots of All Background Data-Hexavalent Chromium

APPENDIX C.2

Probability and Box Plots without Outliers

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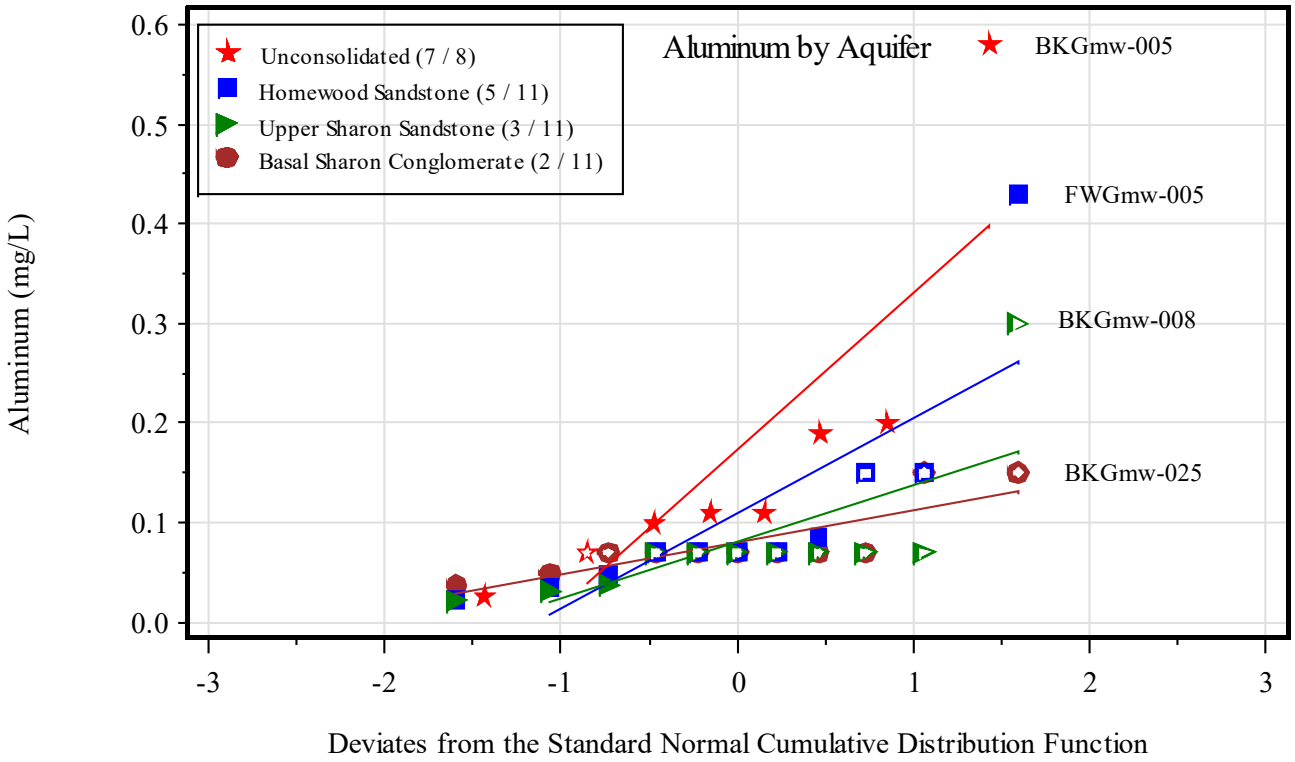
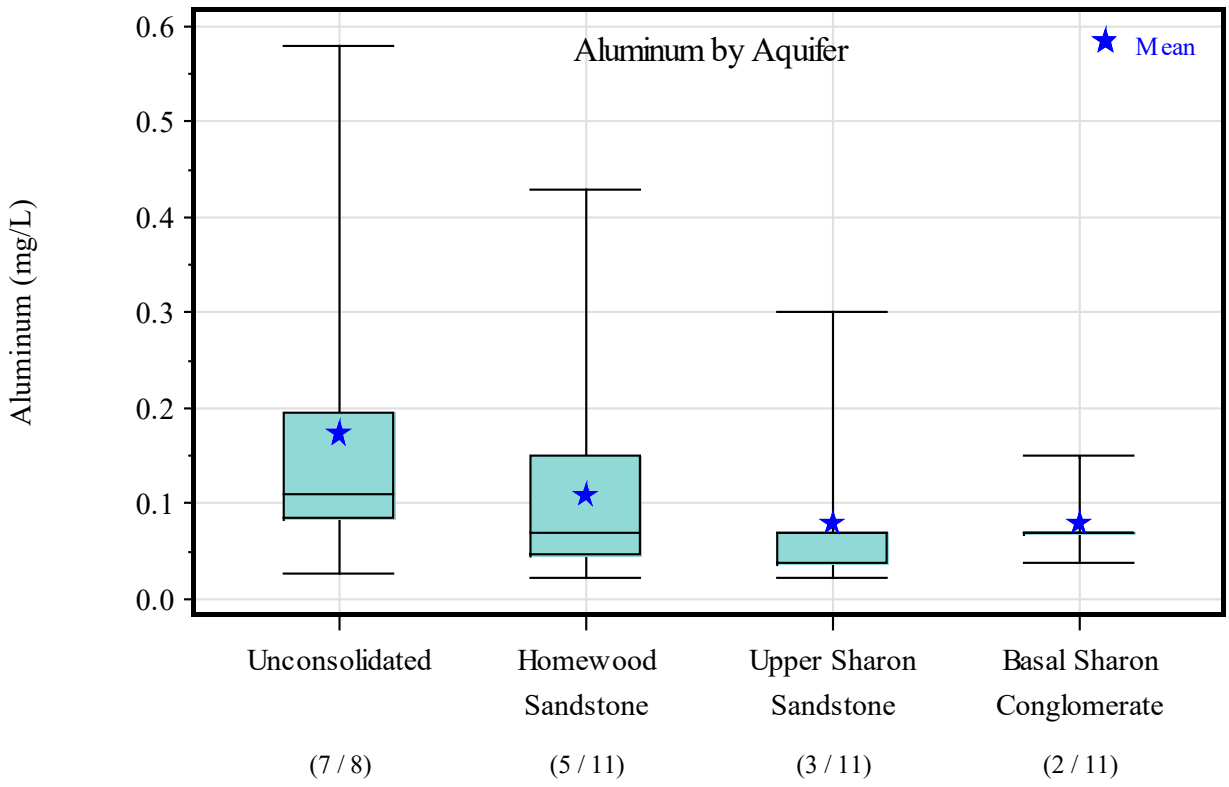
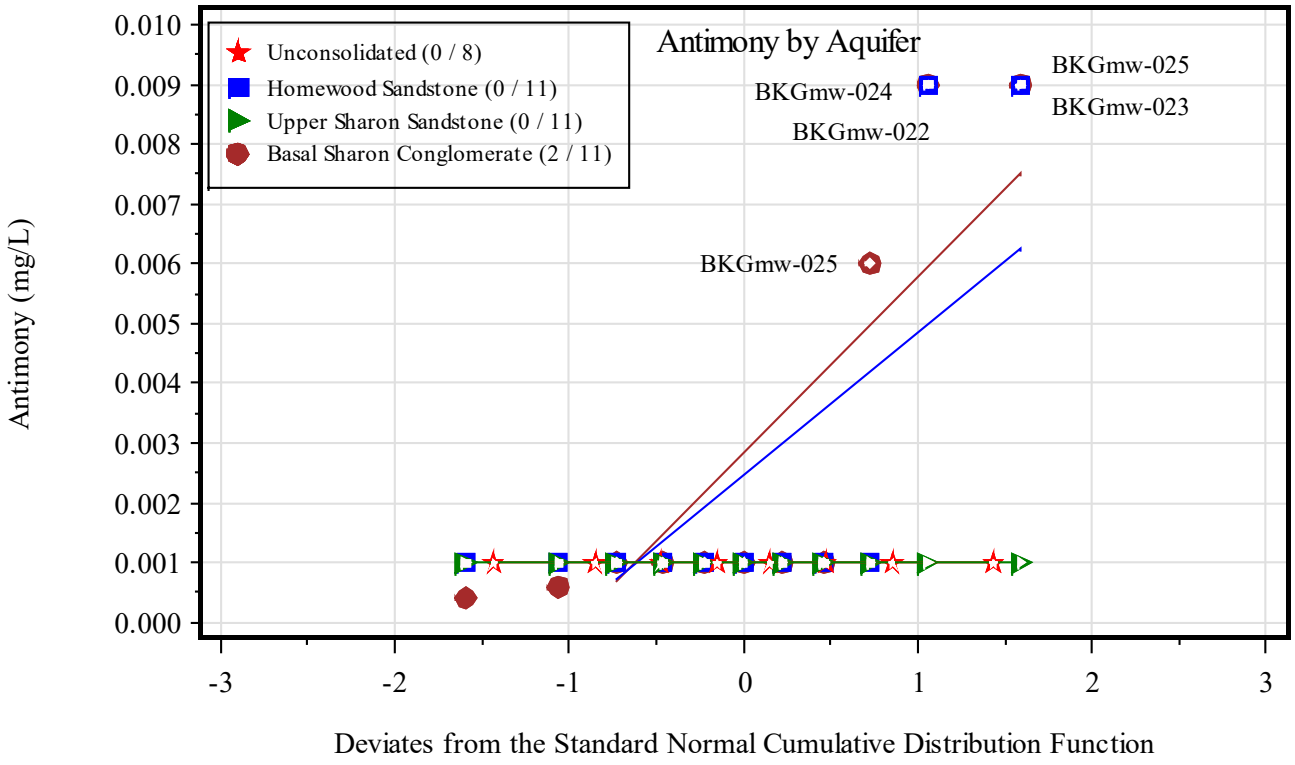


Hollow symbols denote the reporting limit was used for non-detects.

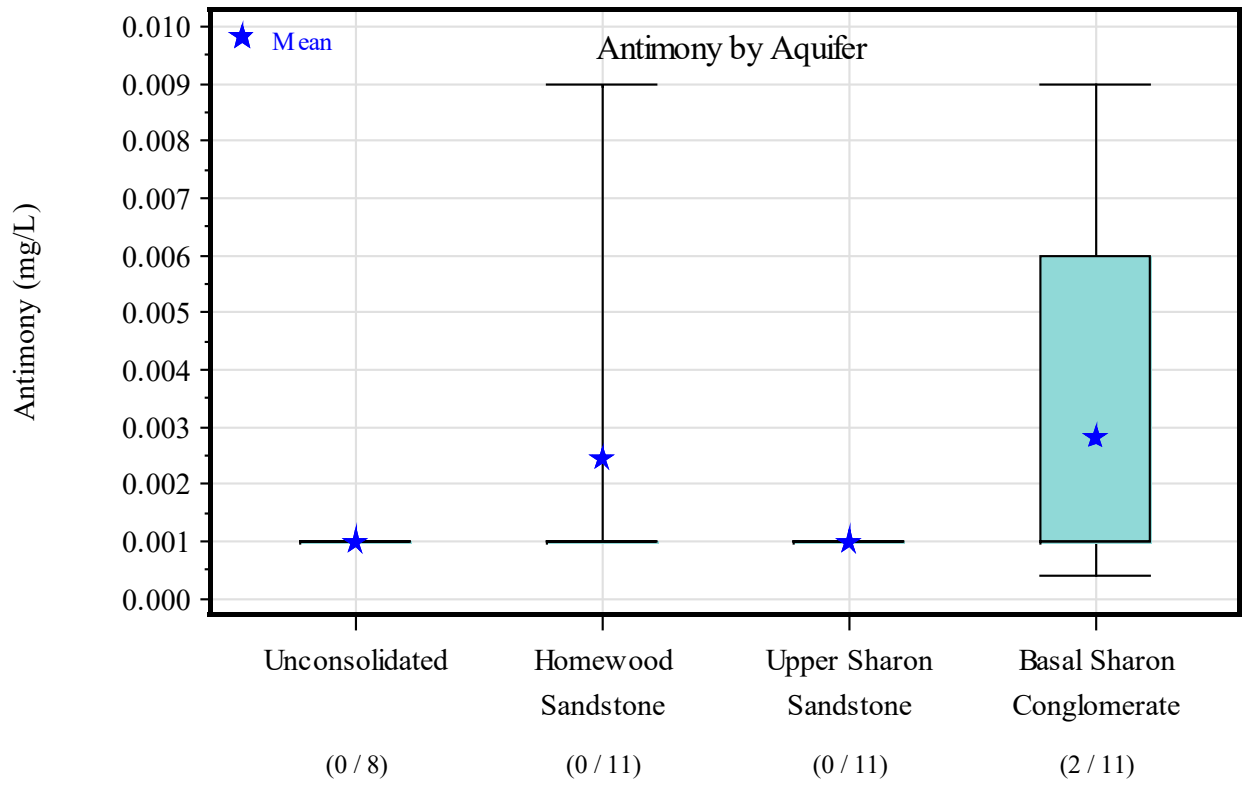


Reporting limits were plotted for non-detects.

Figure C.2-1. Normal Probability and Box Plots with Outliers Removed– Aluminum

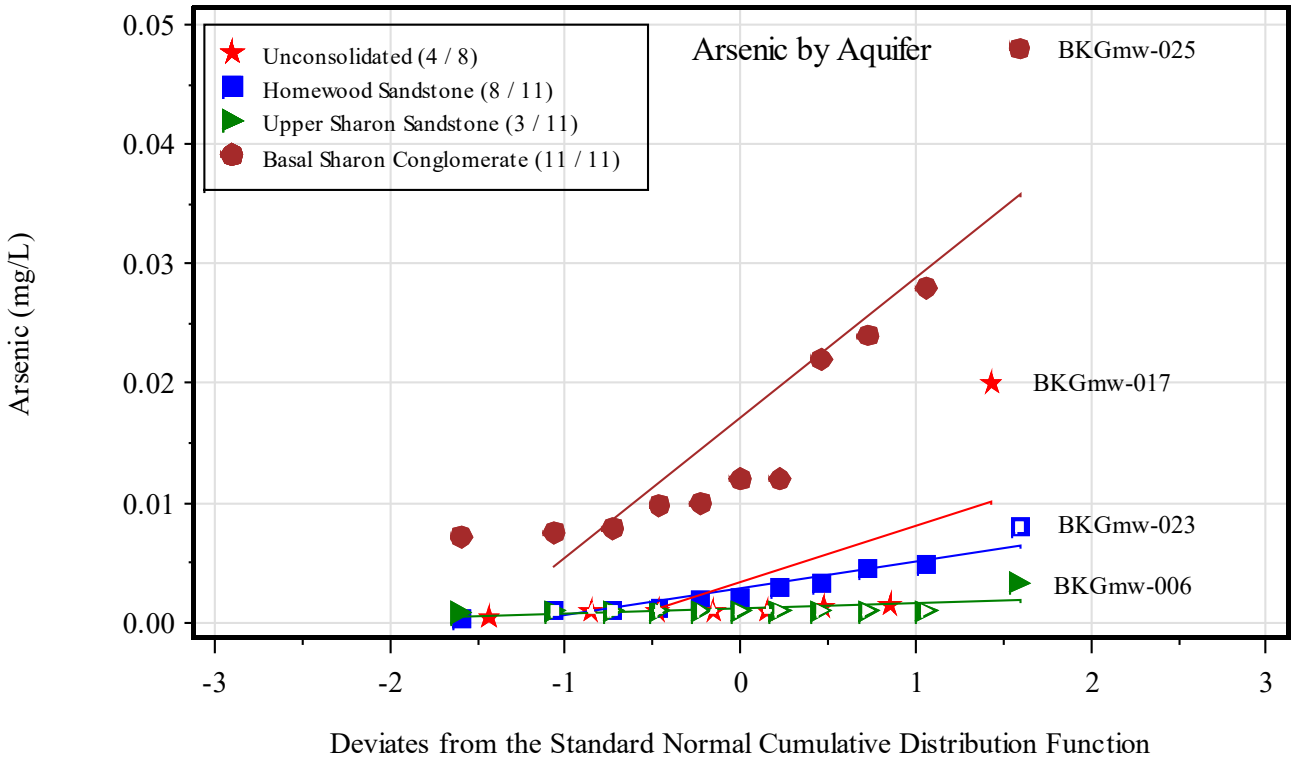


Hollow symbols denote the reporting limit was used for non-detects.

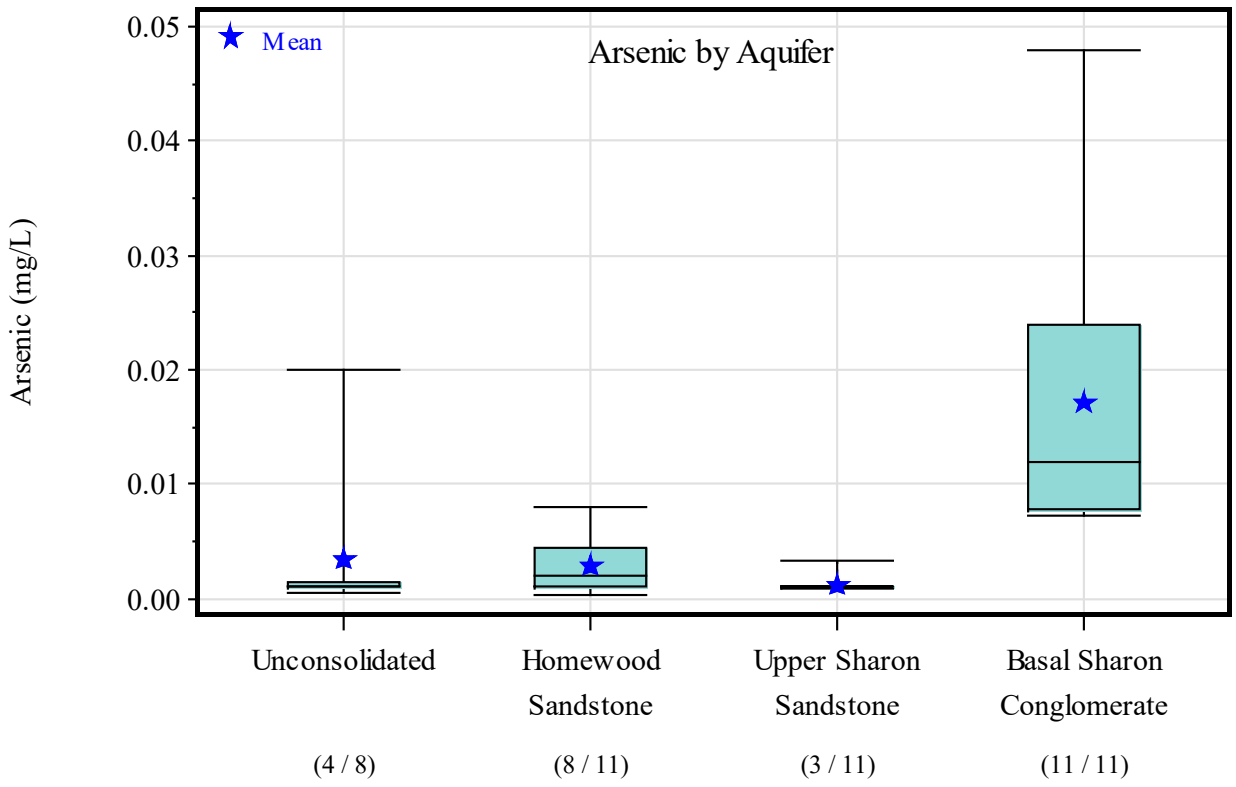


Reporting limits were plotted for non-detects.

Figure C.2-2. Normal Probability and Box Plots – Antimony

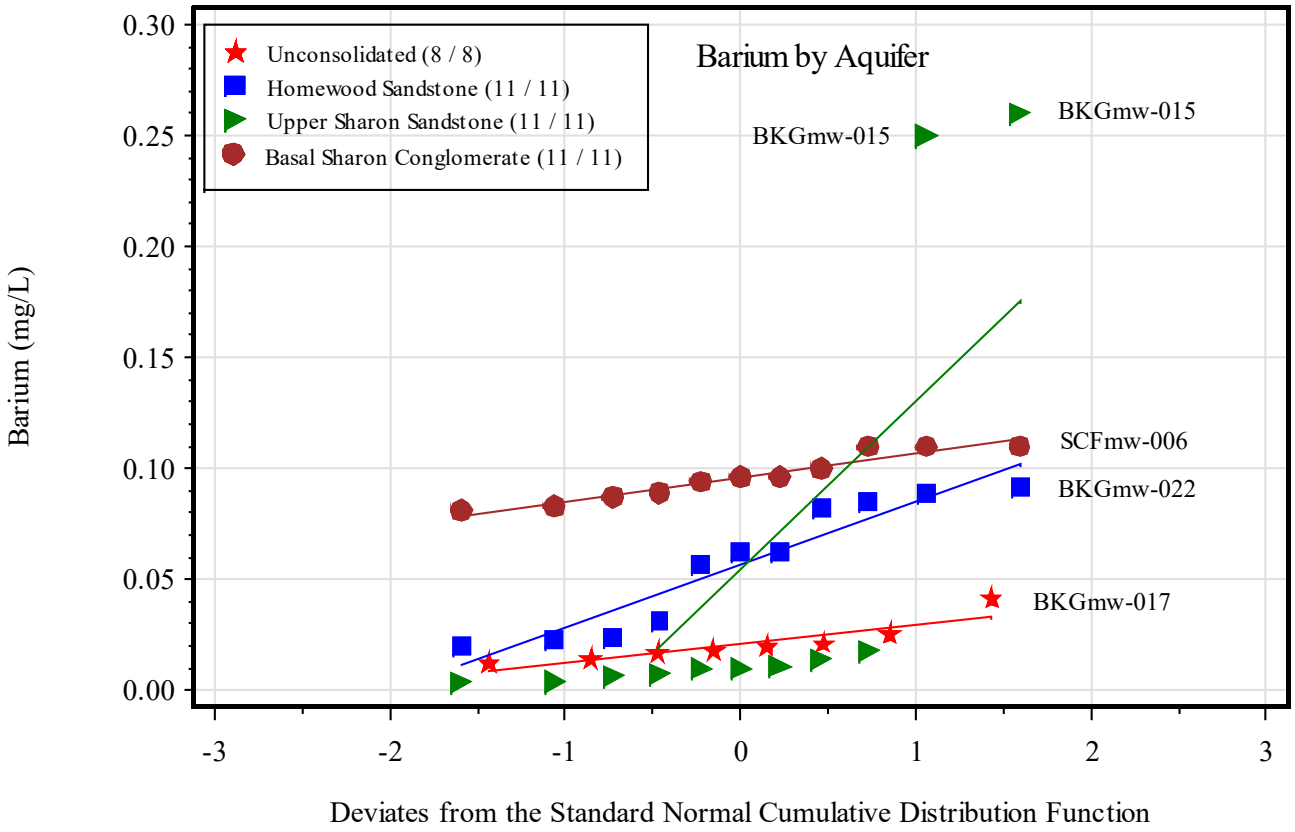


Hollow symbols denote the reporting limit was used for non-detects.



Reporting limits were plotted for non-detects.

Figure C.2-3. Normal Probability and Box Plots with Outliers Removed– Arsenic



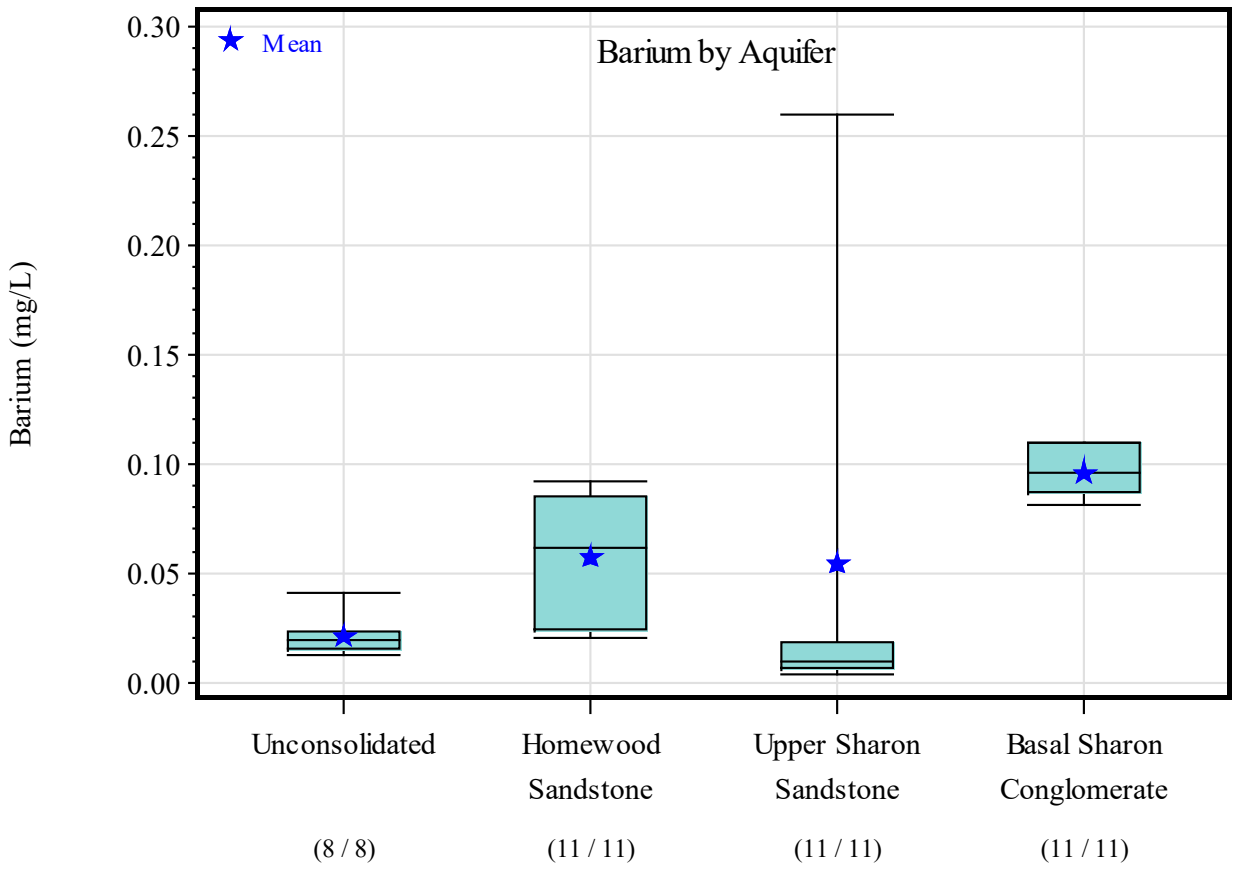
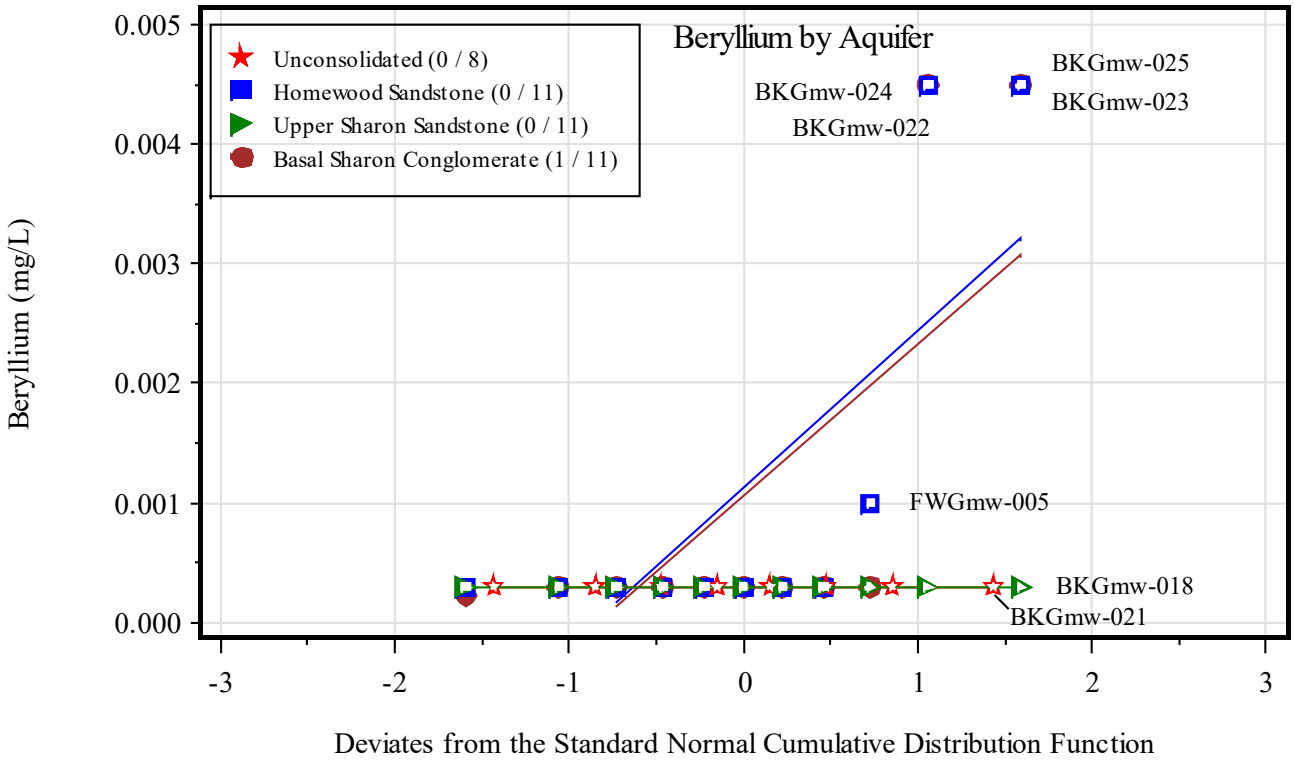
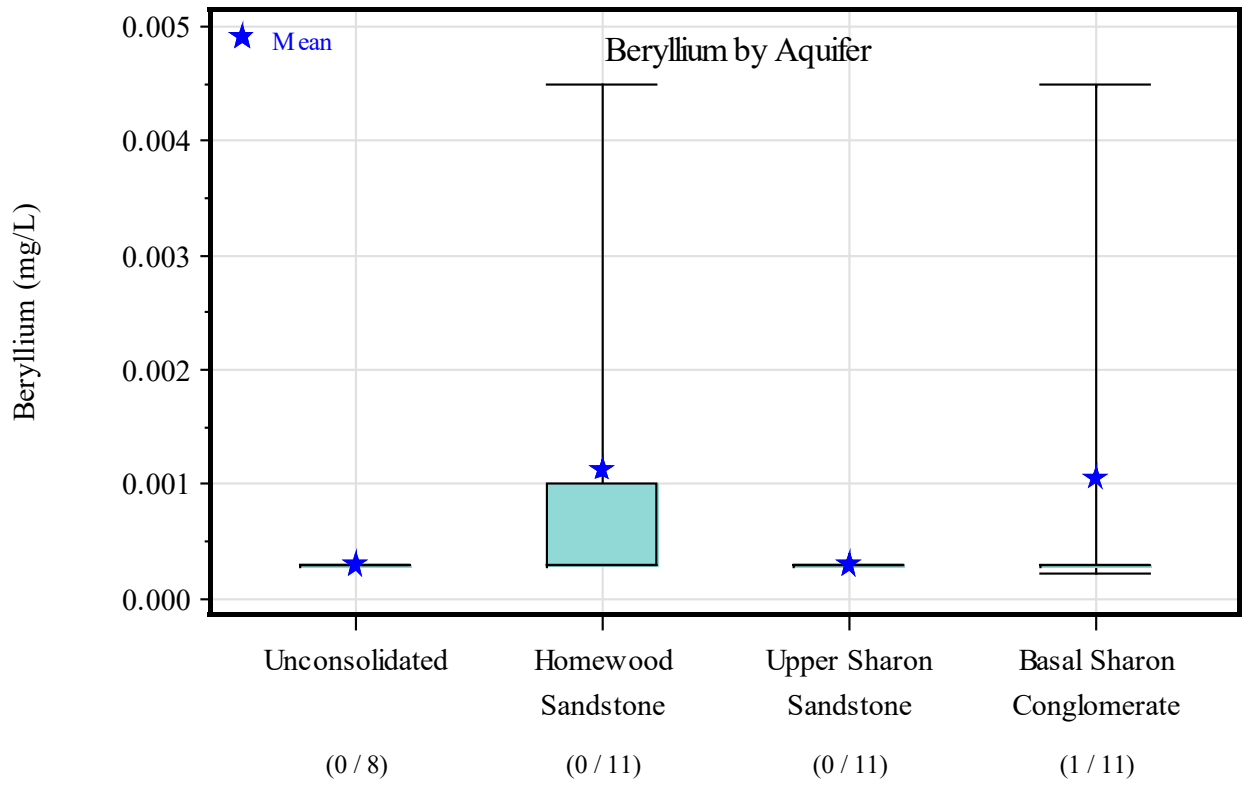


Figure C.2-4. Normal Probability and Box Plots with Outliers Removed– Barium

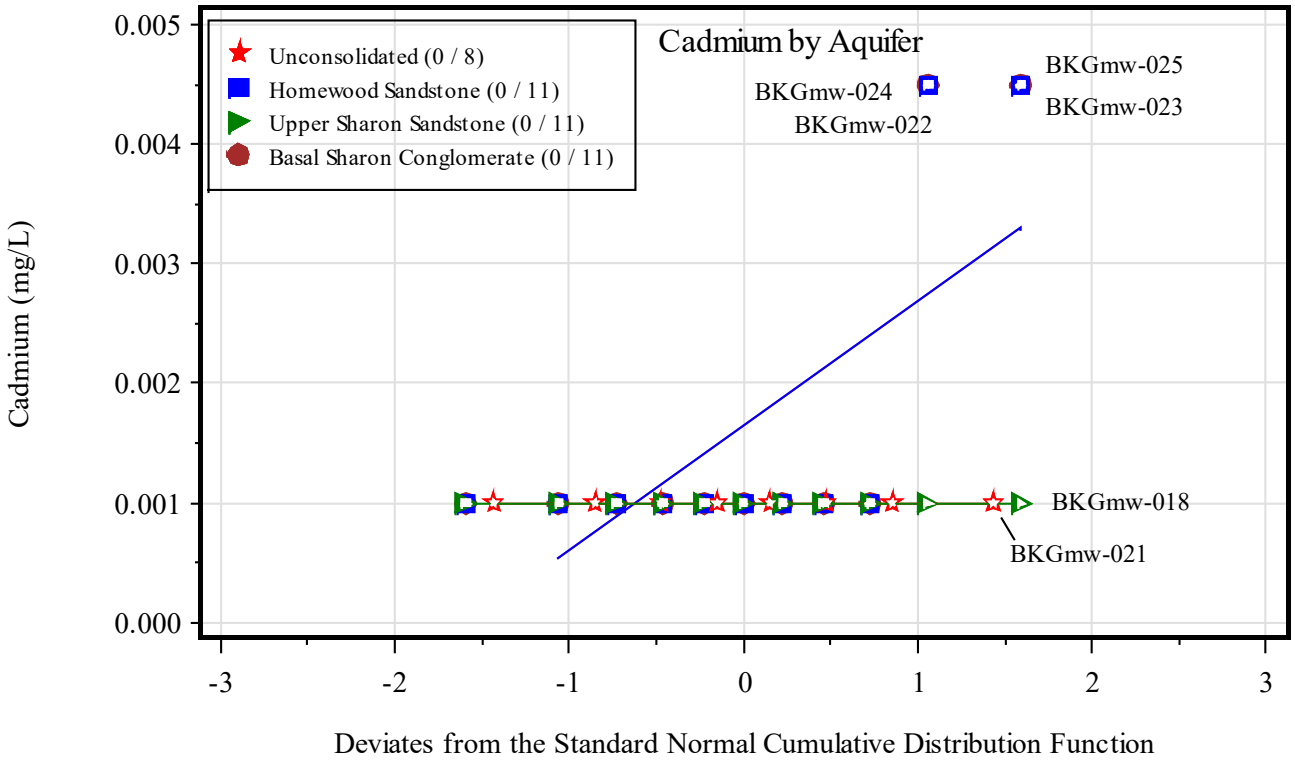


Hollow symbols denote the reporting limit was used for non-detects.

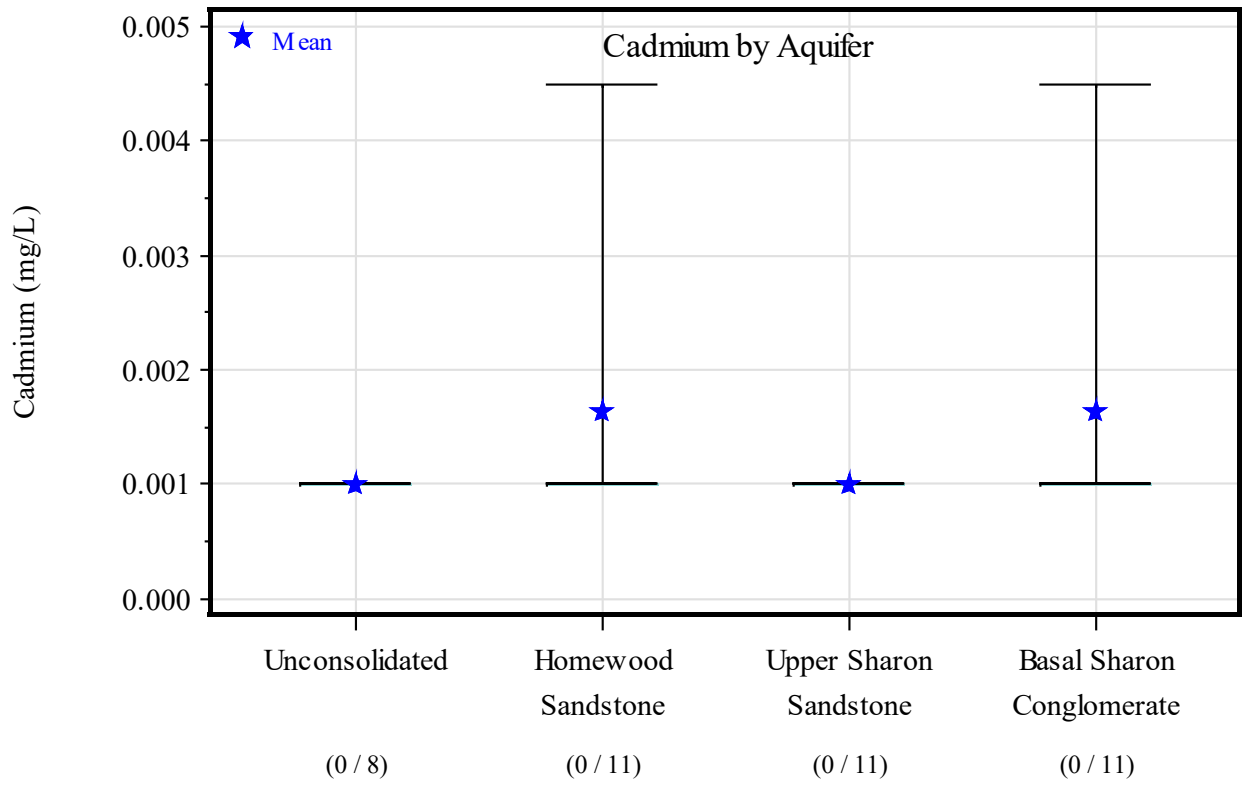


Reporting limits were plotted for non-detects.

Figure C.2-5. Normal Probability and Box Plots with Outliers Removed– Beryllium

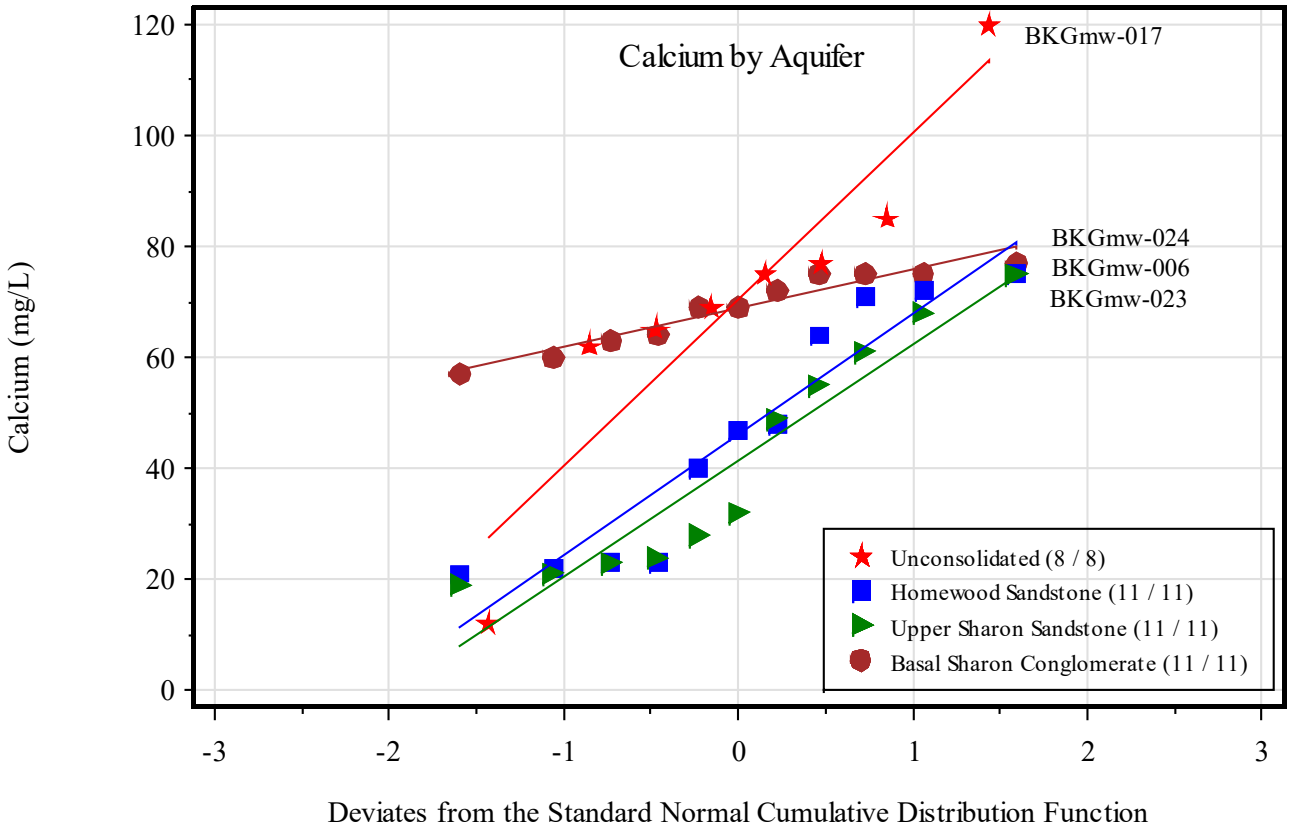


Hollow symbols denote the reporting limit was used for non-detects.



Reporting limits were plotted for non-detects.

Figure C.2-6. Normal Probability and Box Plots with Outliers Removed– Cadmium



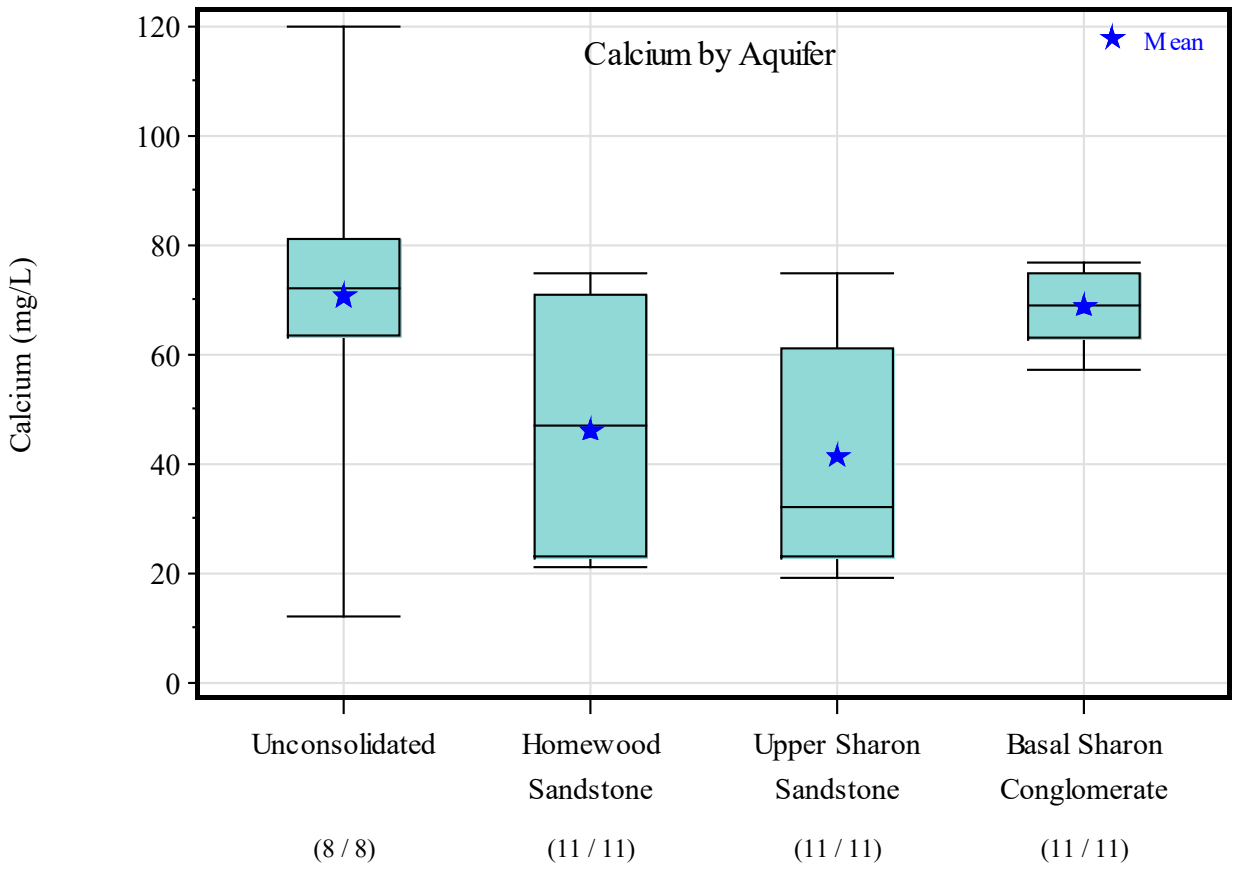
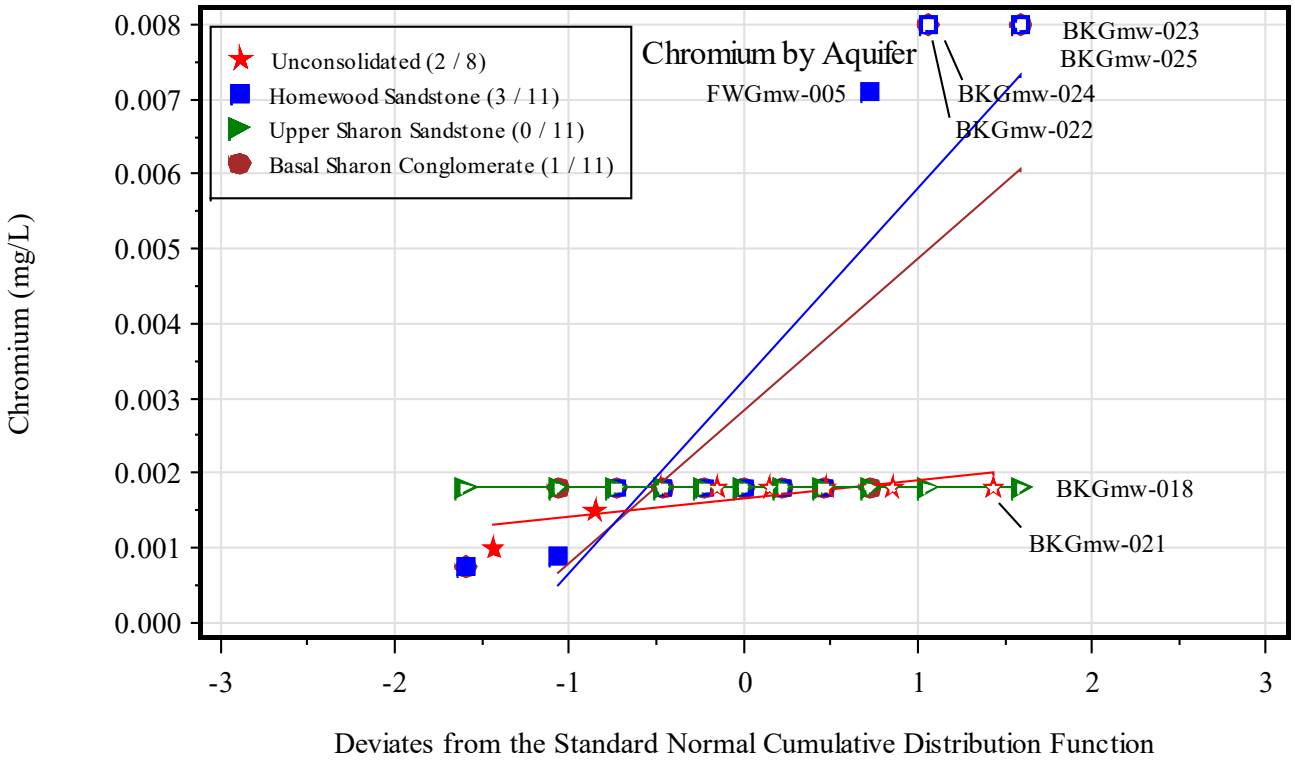
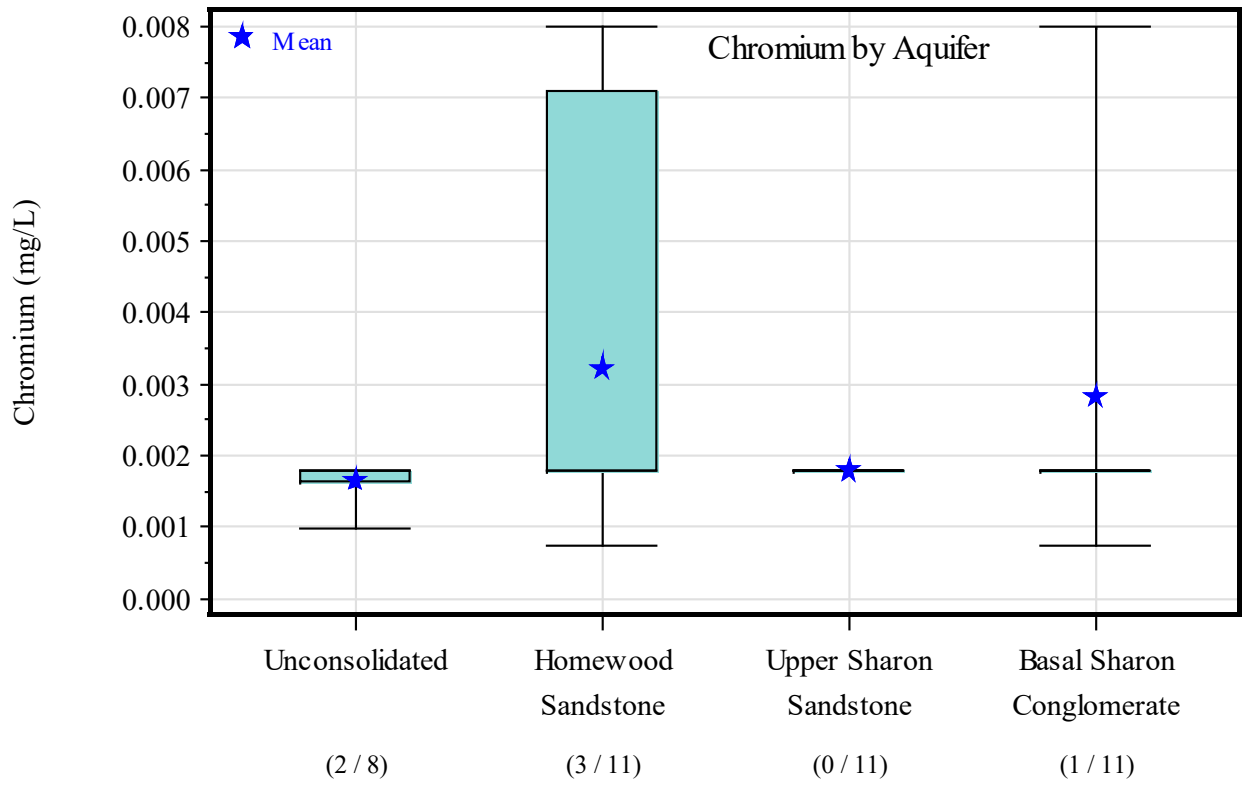


Figure C.2-7. Normal Probability and Box Plots with Outliers Removed– Calcium

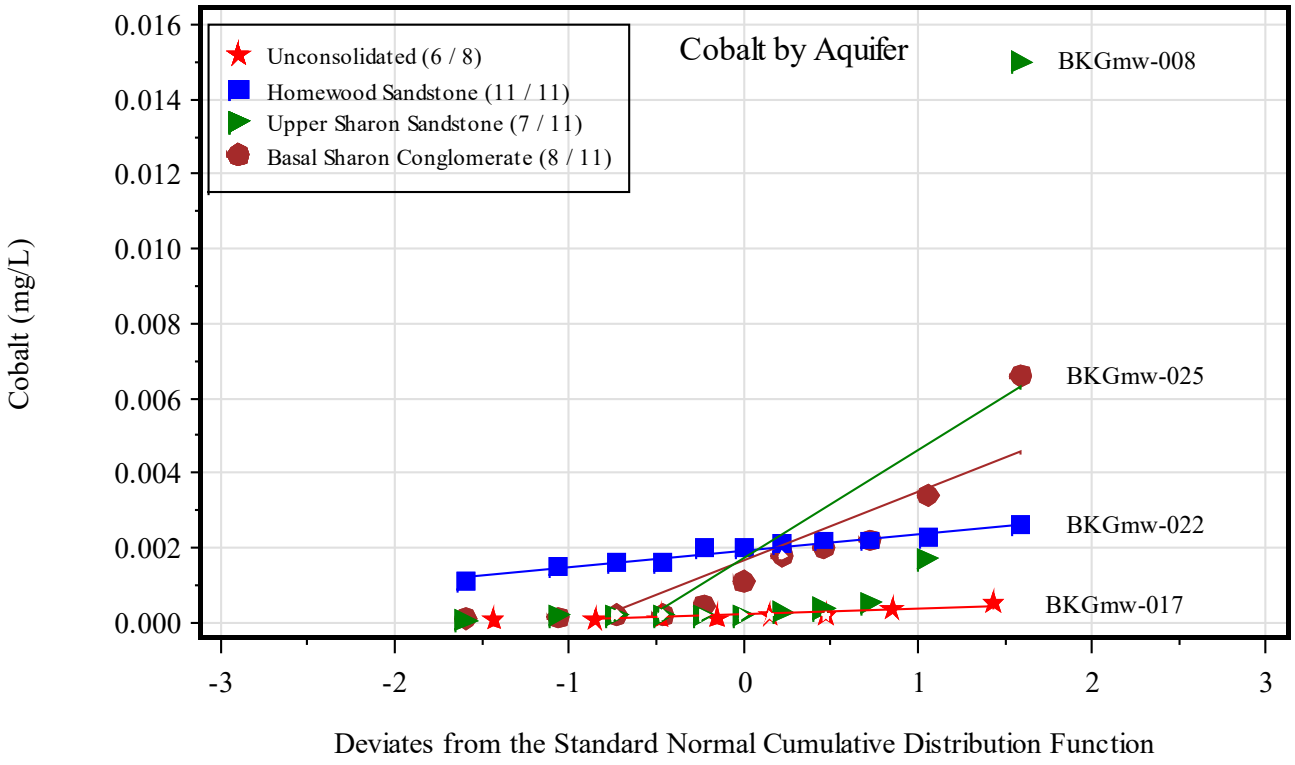


Hollow symbols denote the reporting limit was used for non-detects.

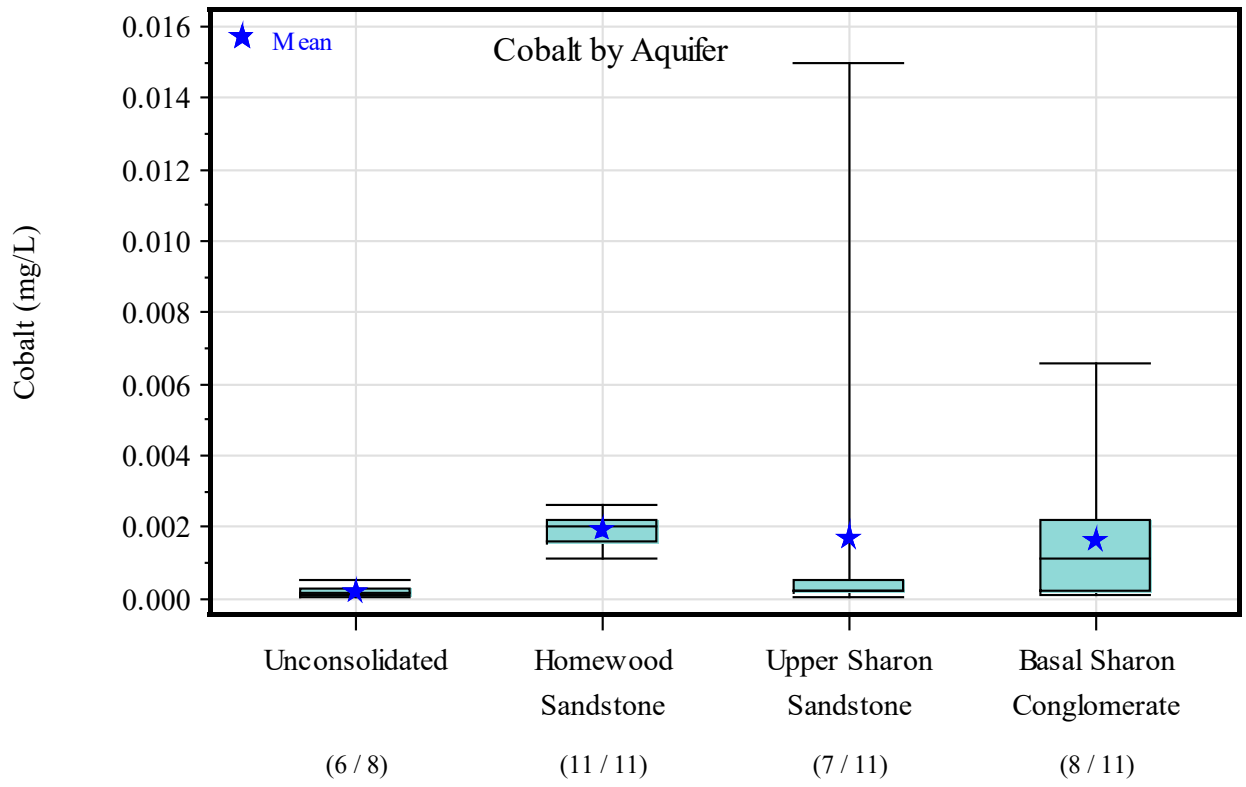


Reporting limits were plotted for non-detects.

Figure C.2-8. Normal Probability and Box Plots with Outliers Removed– Chromium

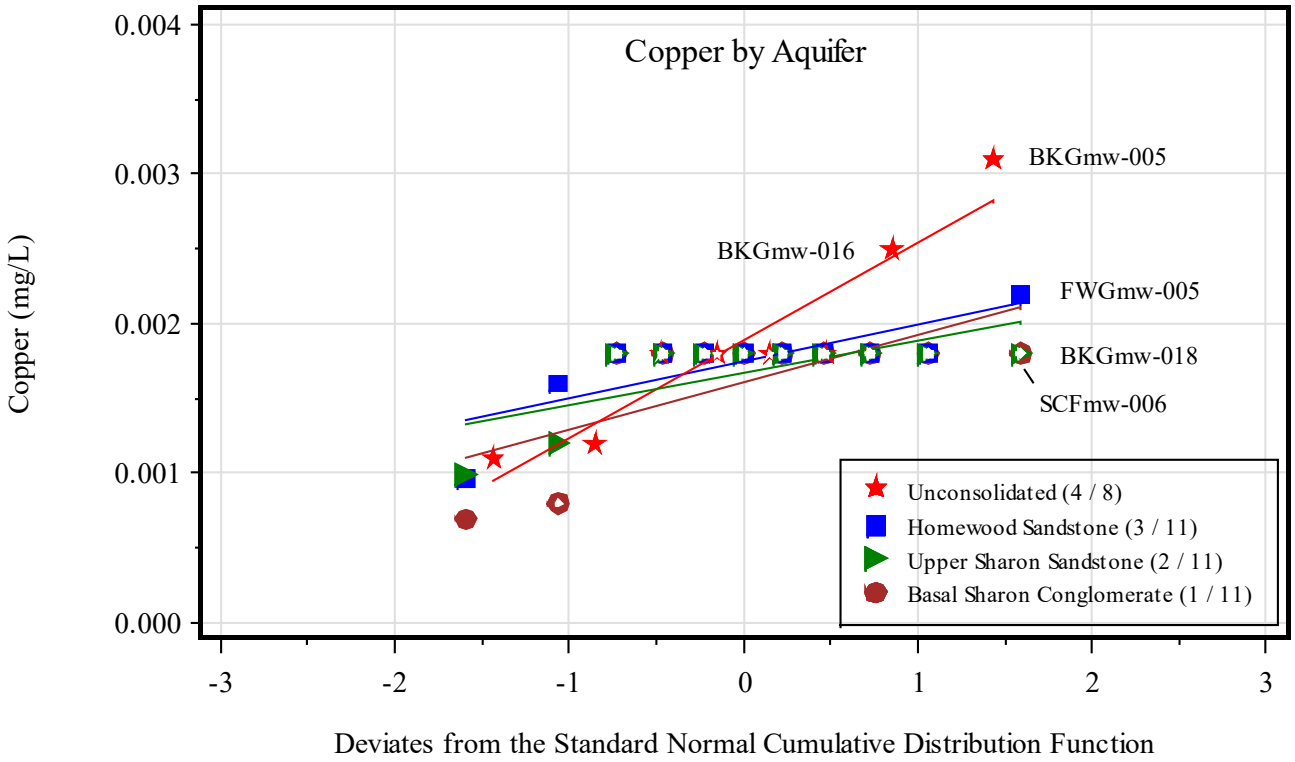


Hollow symbols denote the reporting limit was used for non-detects.

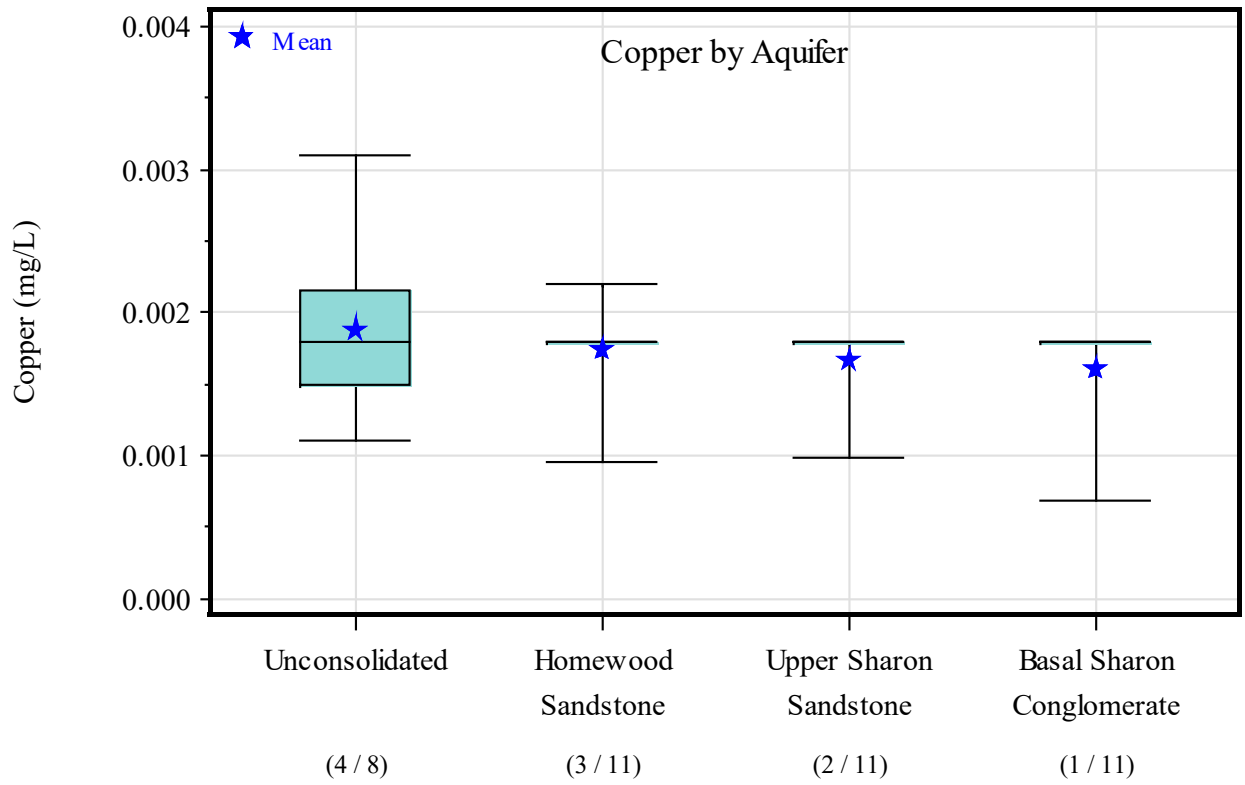


Reporting limits were plotted for non-detects.

Figure C.2-9. Normal Probability and Box Plots with Outliers Removed– Cobalt

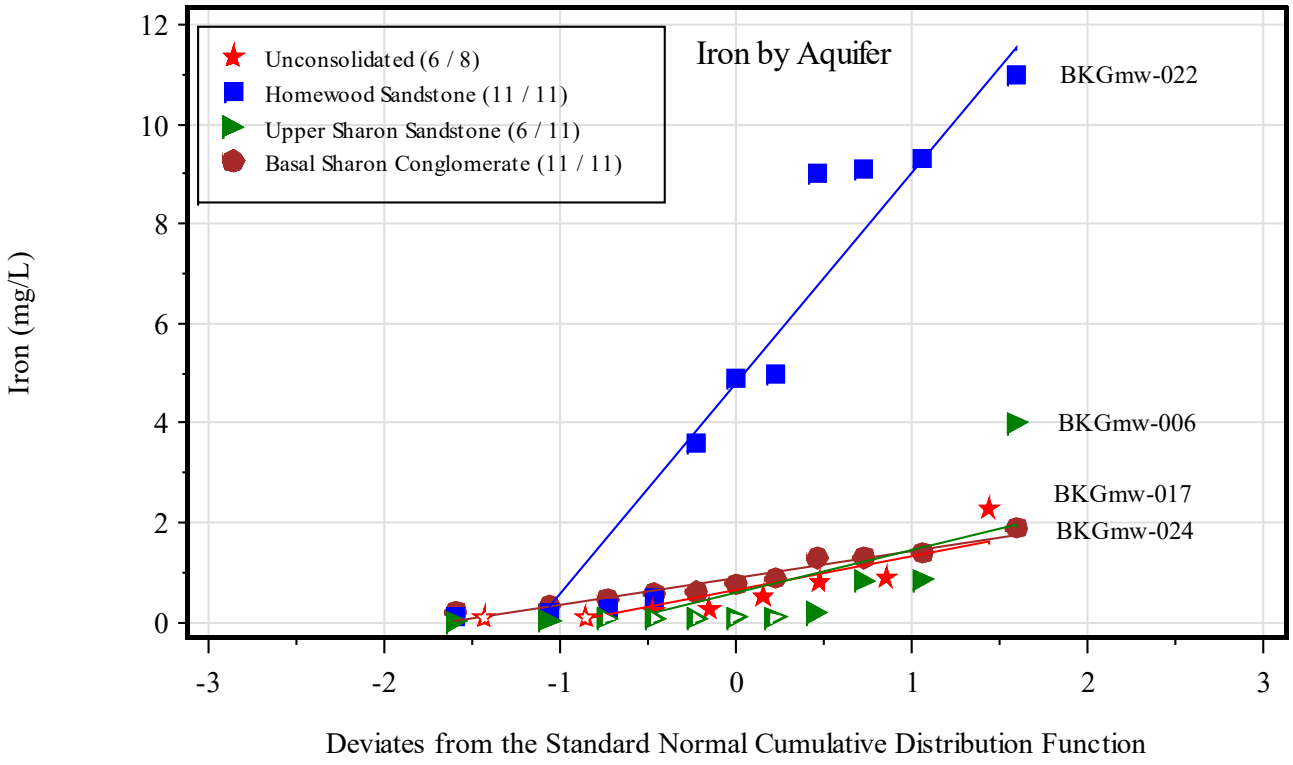


Hollow symbols denote the reporting limit was used for non-detects.

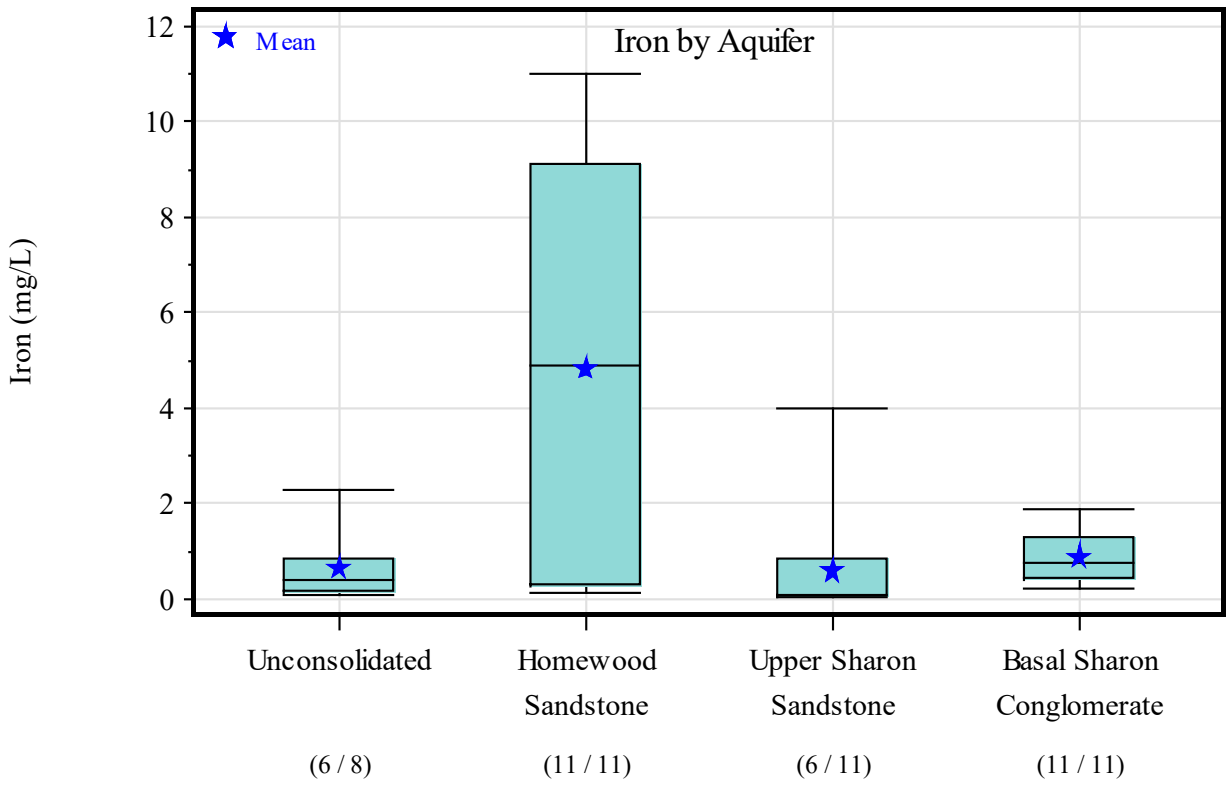


Reporting limits were plotted for non-detects.

Figure C.2-10. Normal Probability and Box Plots with Outliers Removed– Copper

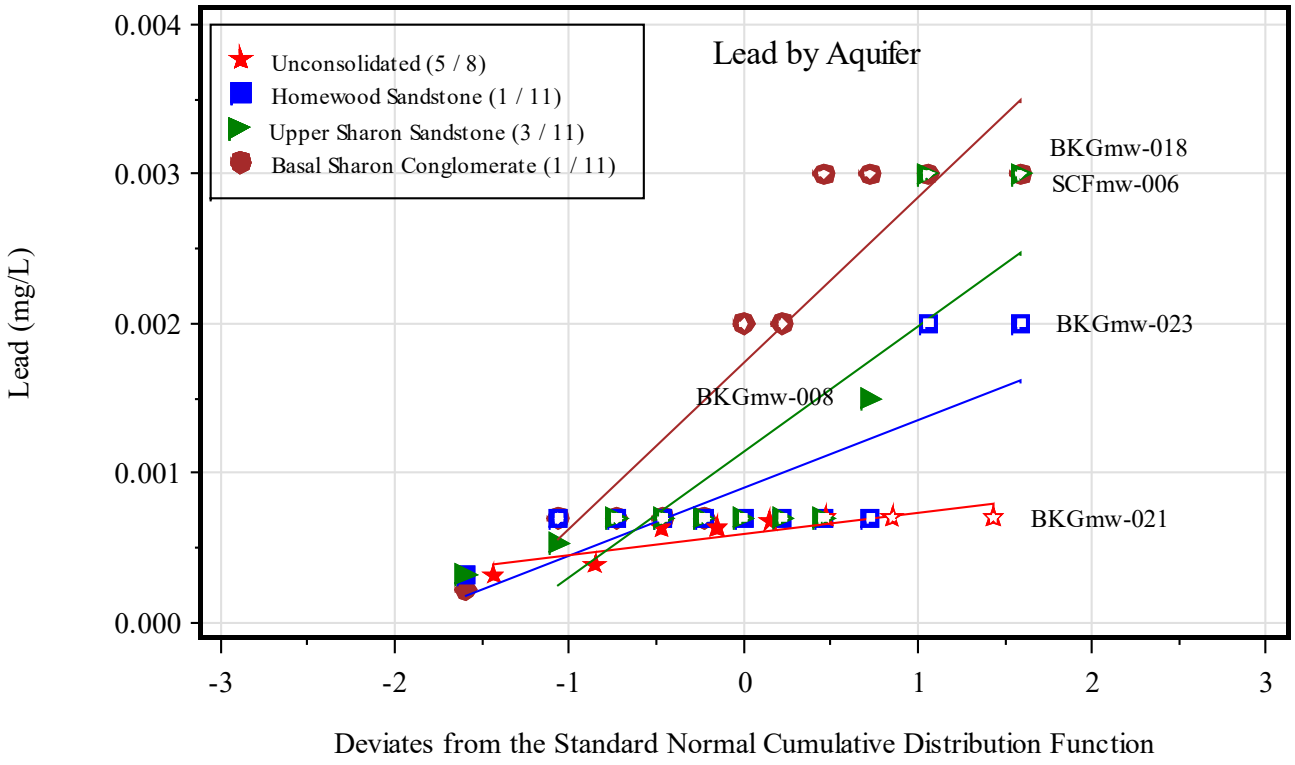


Hollow symbols denote the reporting limit was used for non-detects.

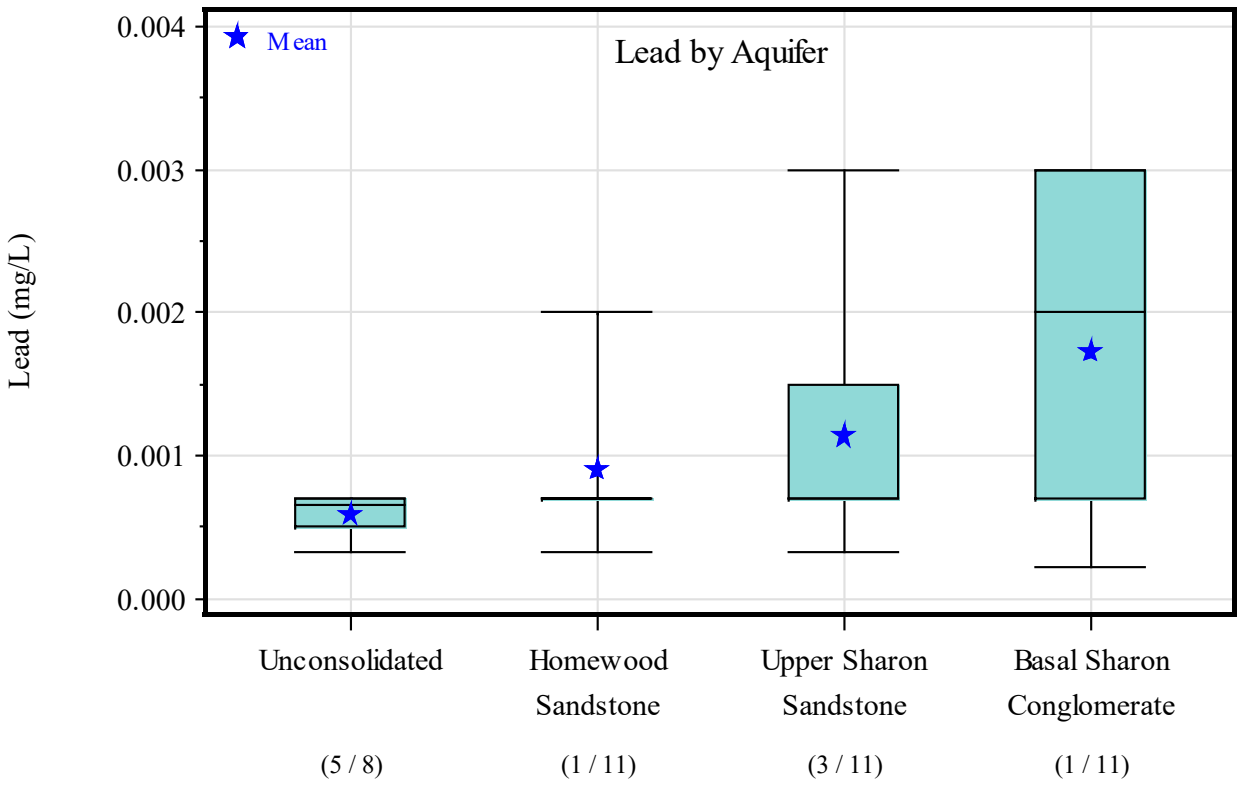


Reporting limits were plotted for non-detects.

Figure C.2-11. Normal Probability and Box Plots with Outliers Removed– Iron

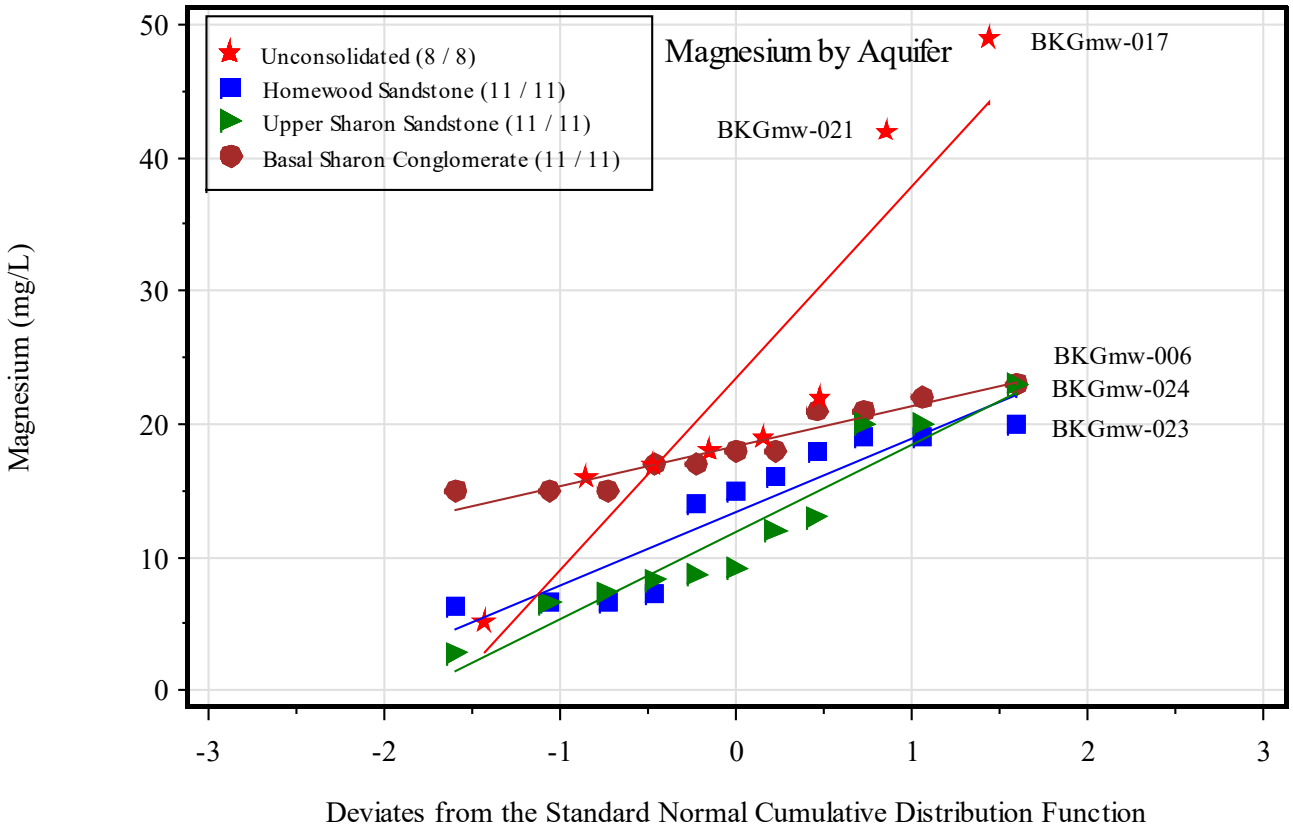


Hollow symbols denote the reporting limit was used for non-detects.



Reporting limits were plotted for non-detects.

Figure C.2-12. Normal Probability and Box Plots with Outliers Removed– Lead



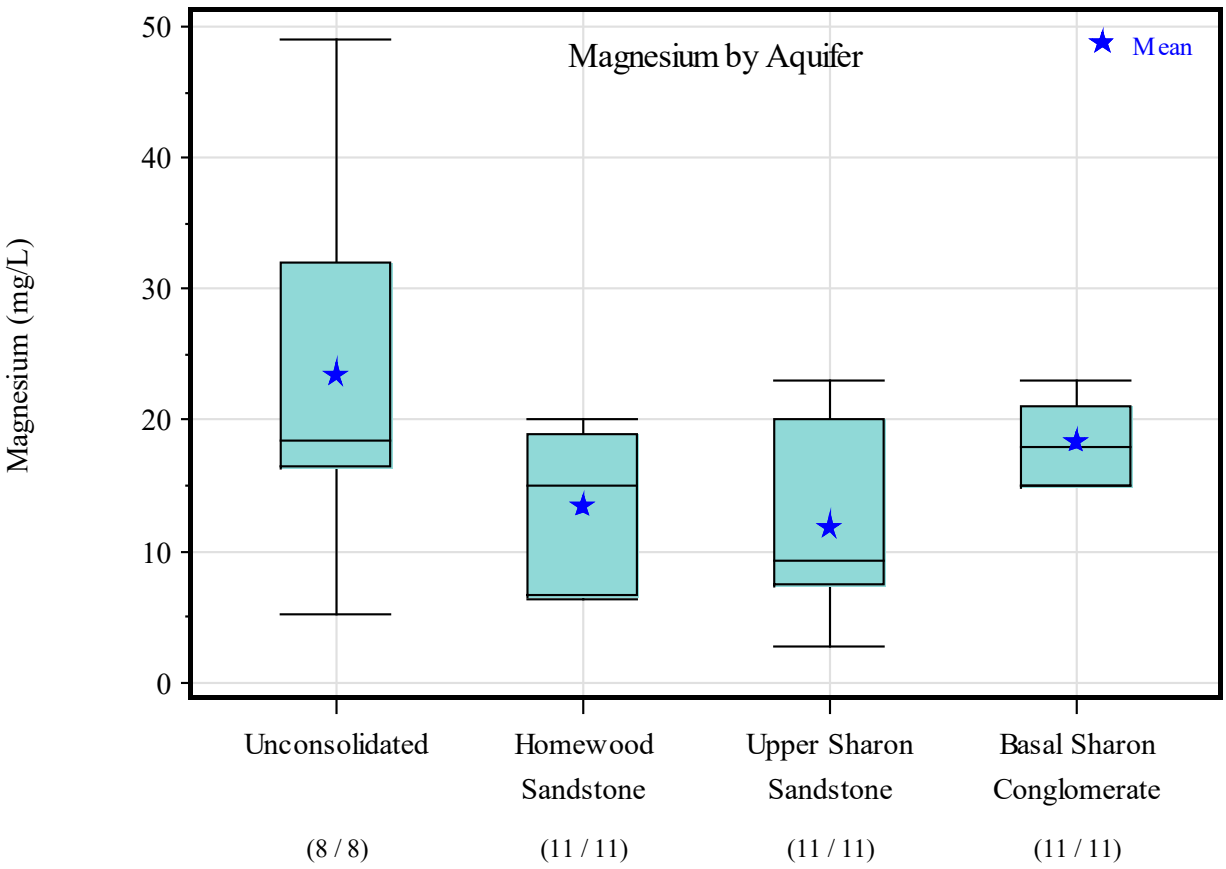
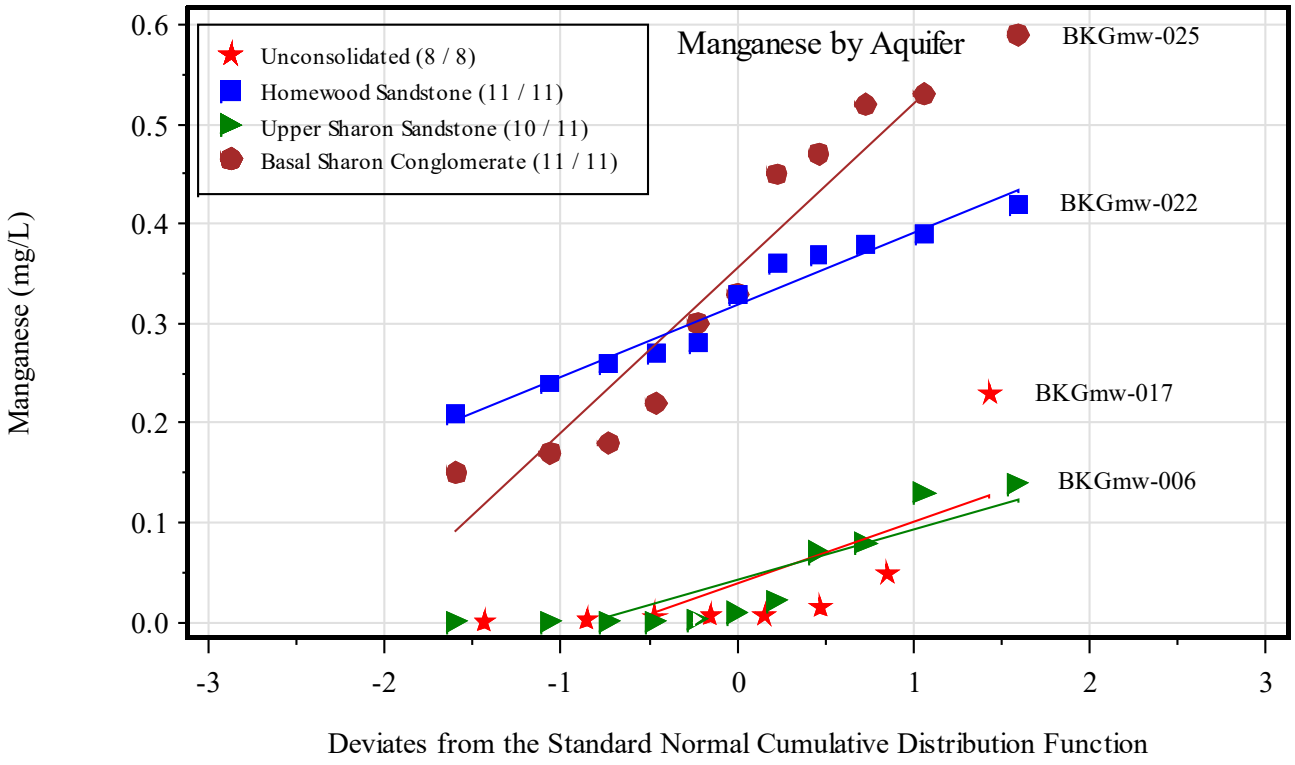
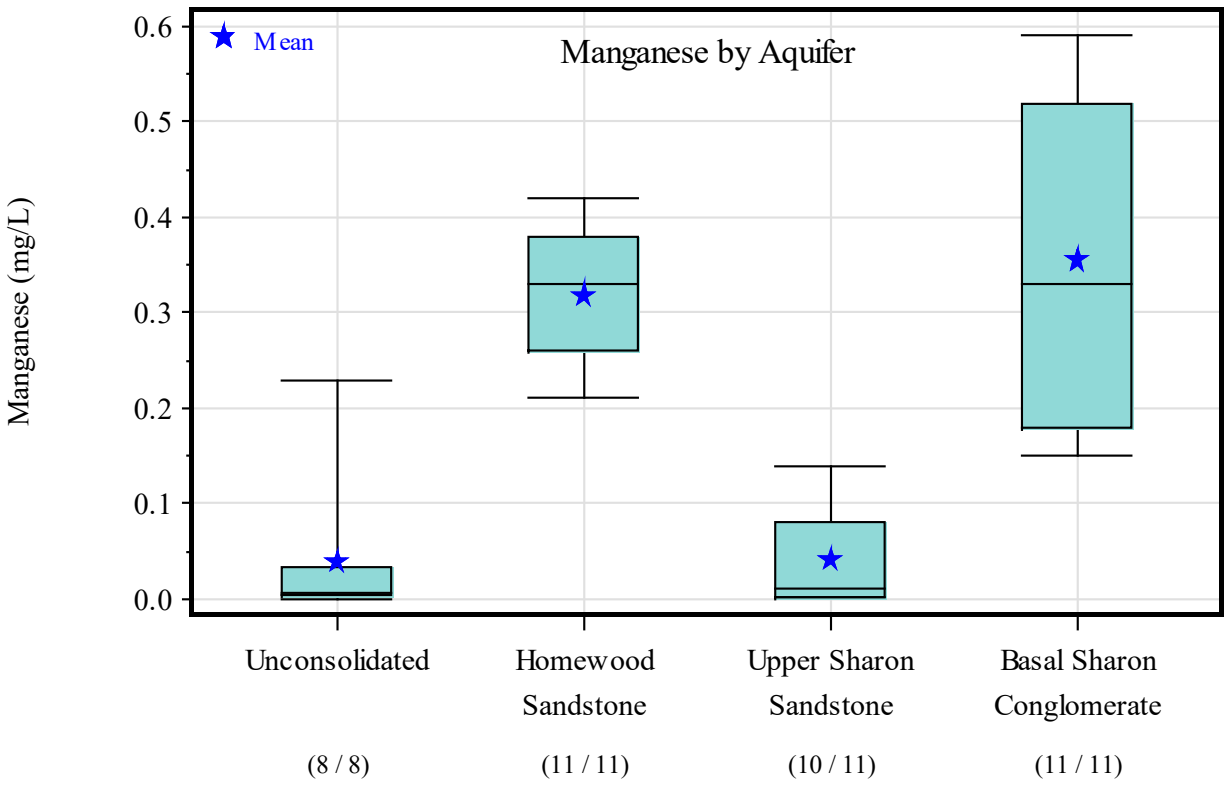


Figure C.2-13. Normal Probability and Box Plots with Outliers Removed– Magnesium

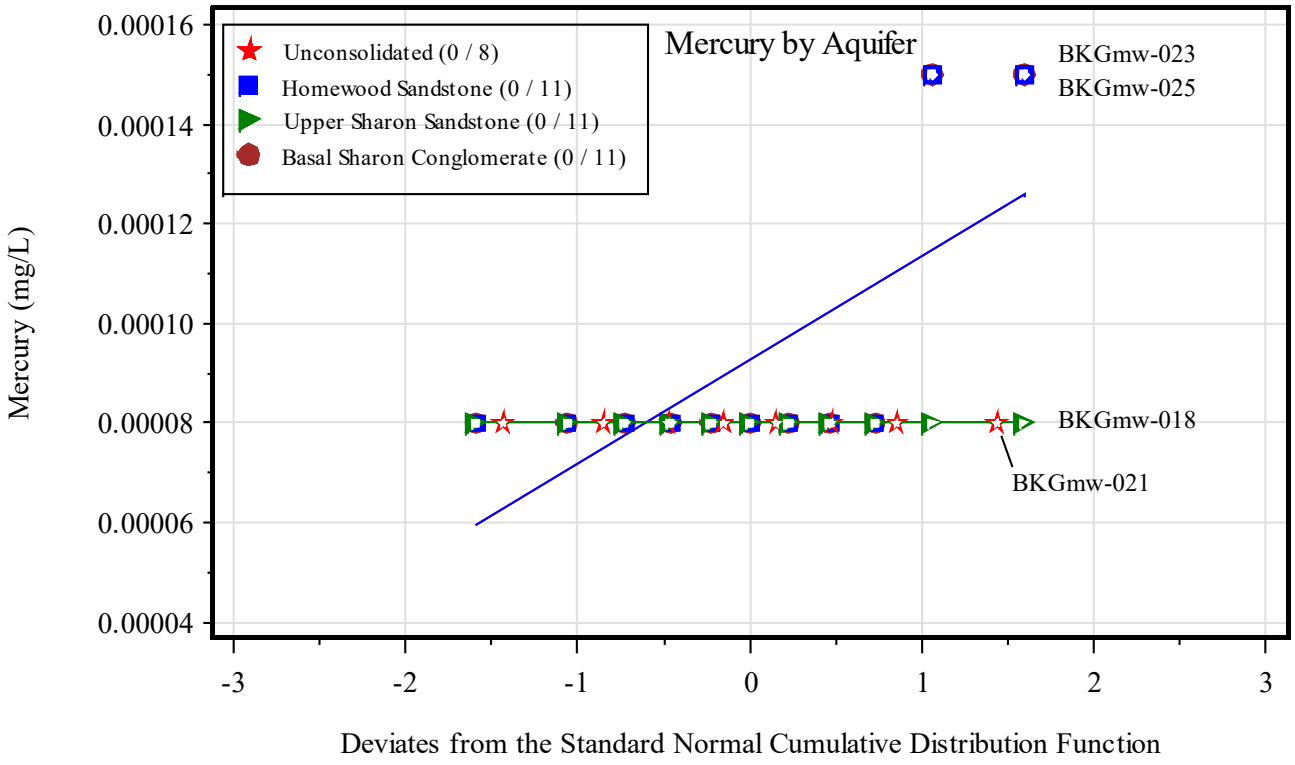


Hollow symbols denote the reporting limit was used for non-detects.

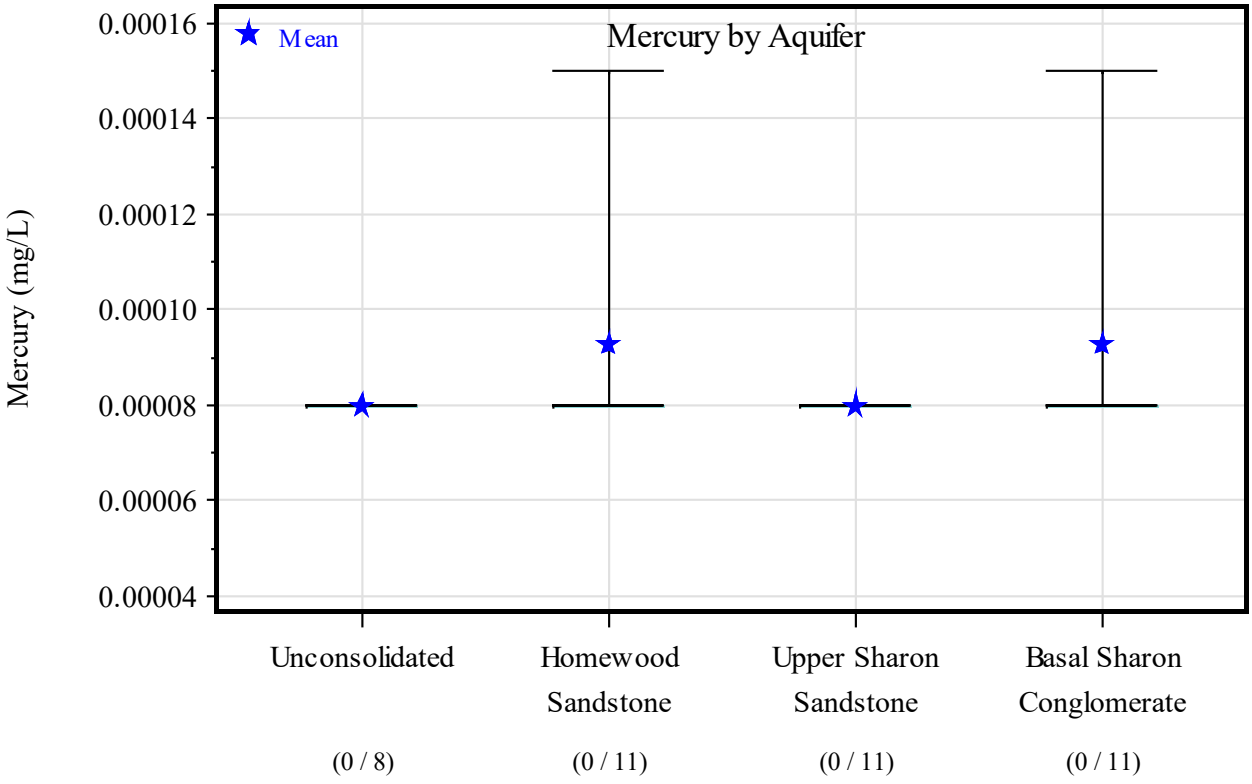


Reporting limits were plotted for non-detects.

Figure C.2-14. Normal Probability and Box Plots with Outliers Removed– Manganese

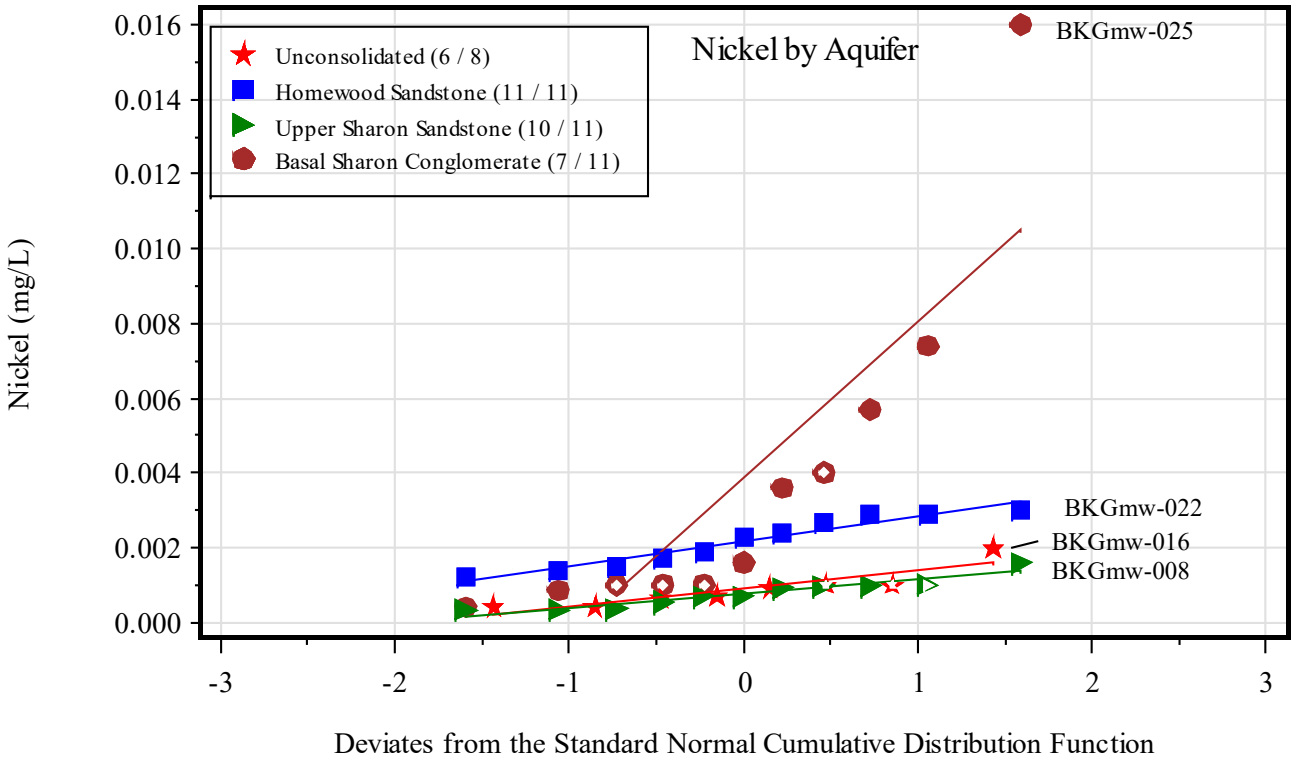


Hollow symbols denote the reporting limit was used for non-detects.

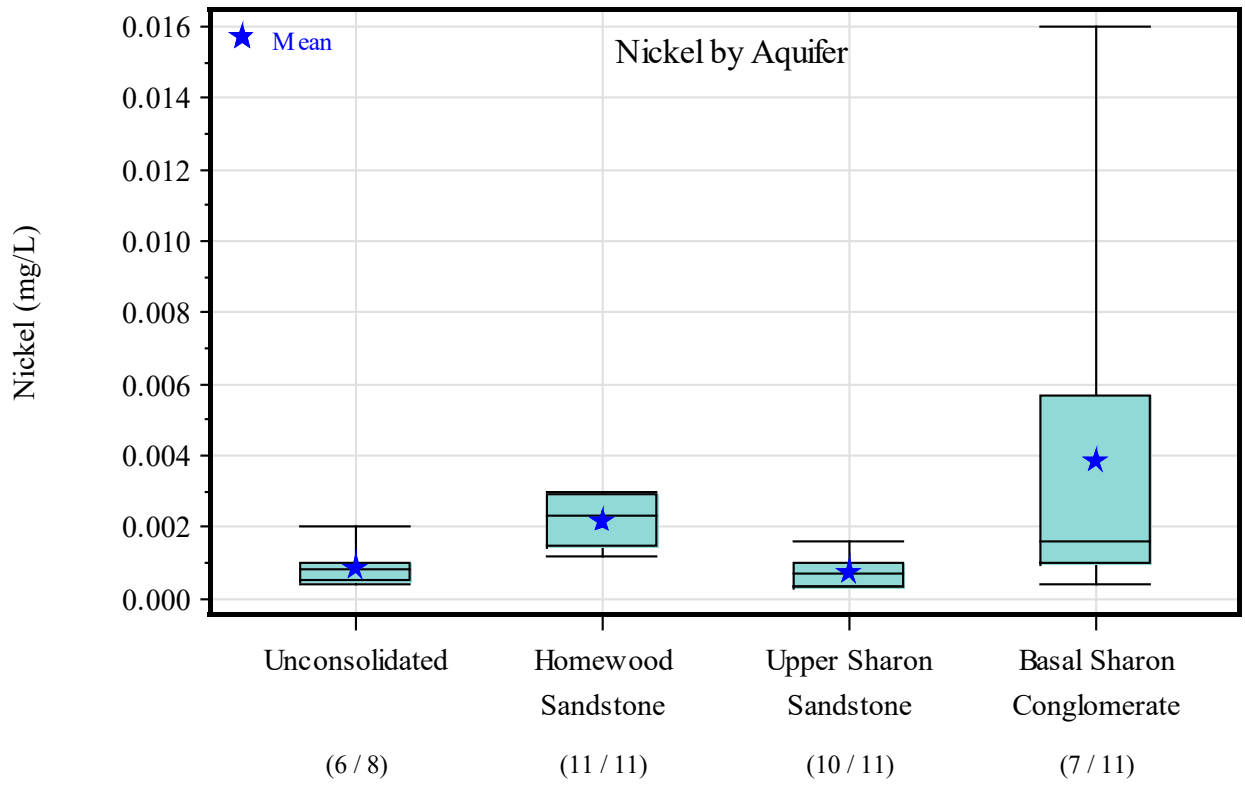


Reporting limits were plotted for non-detects.

Figure C.2-15. Normal Probability and Box Plots with Outliers Removed– Mercury

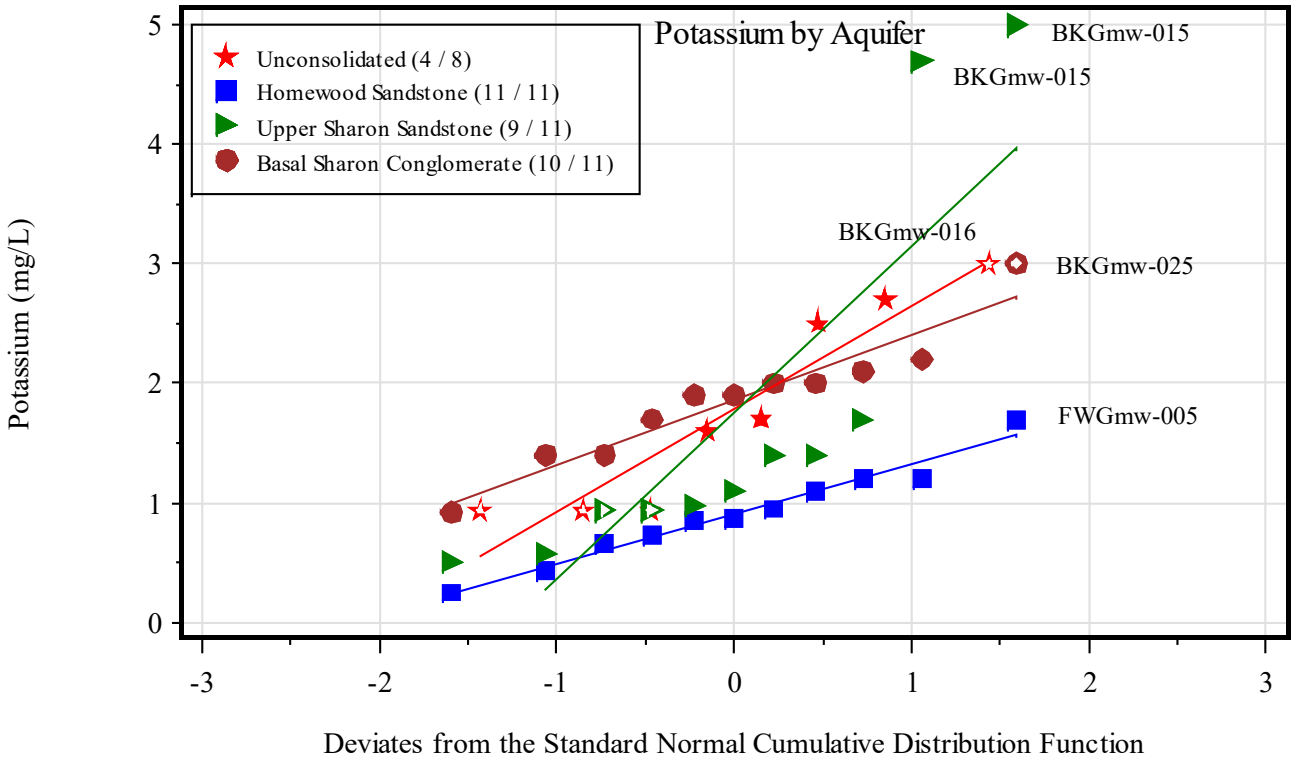


Hollow symbols denote the reporting limit was used for non-detects.

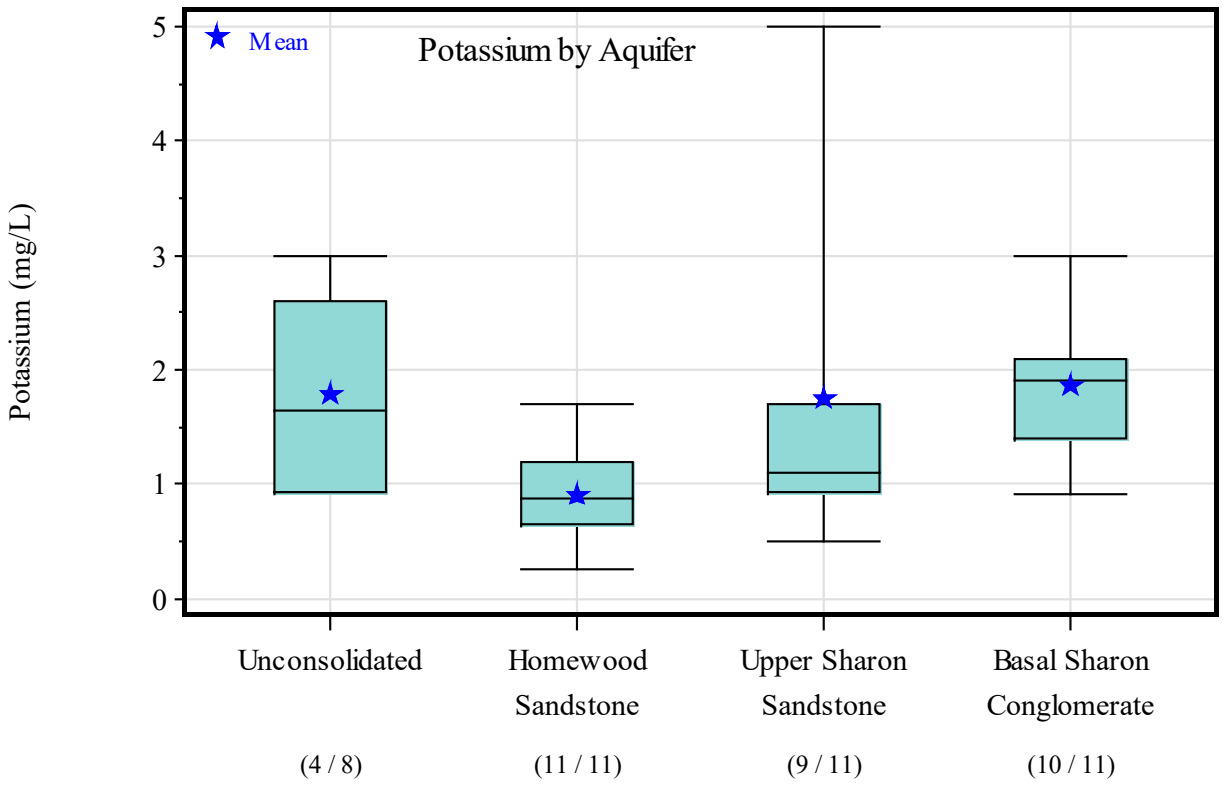


Reporting limits were plotted for non-detects.

Figure C.2-16. Normal Probability and Box Plots with Outliers Removed– Nickel

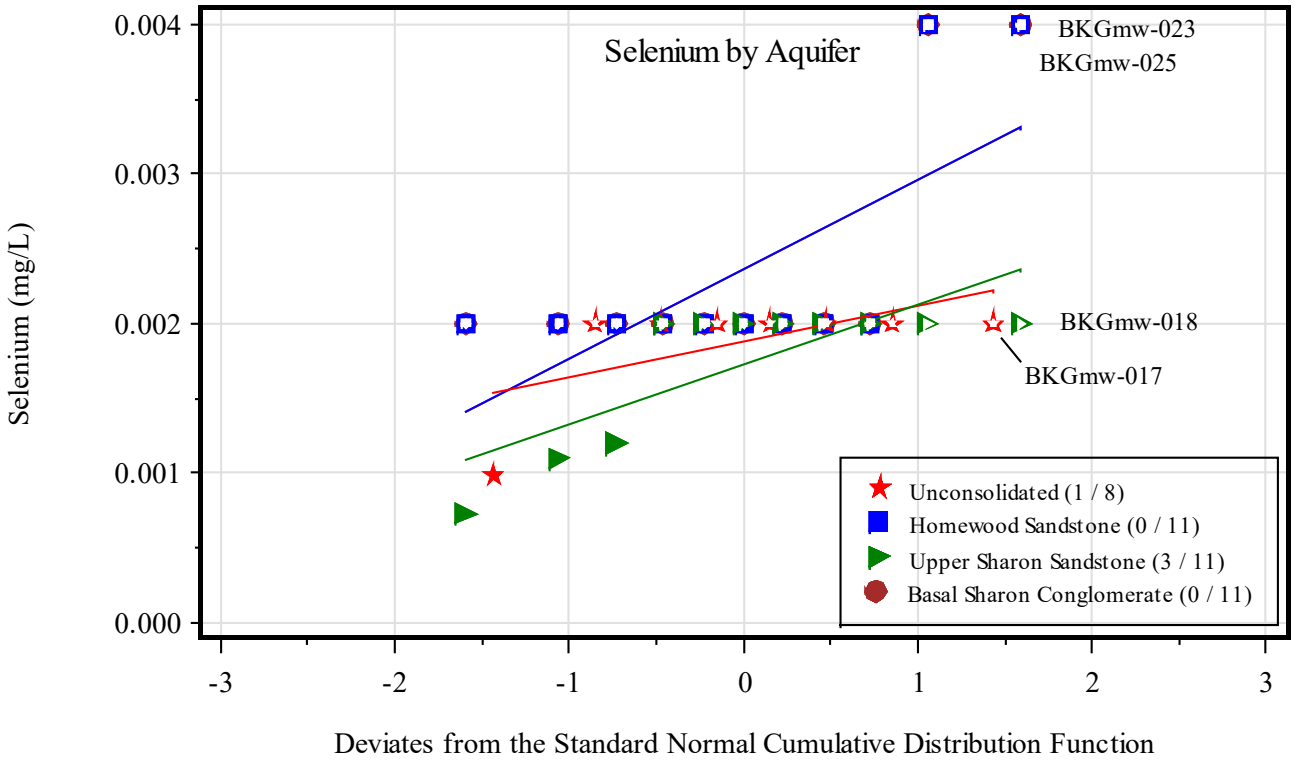


Hollow symbols denote the reporting limit was used for non-detects.

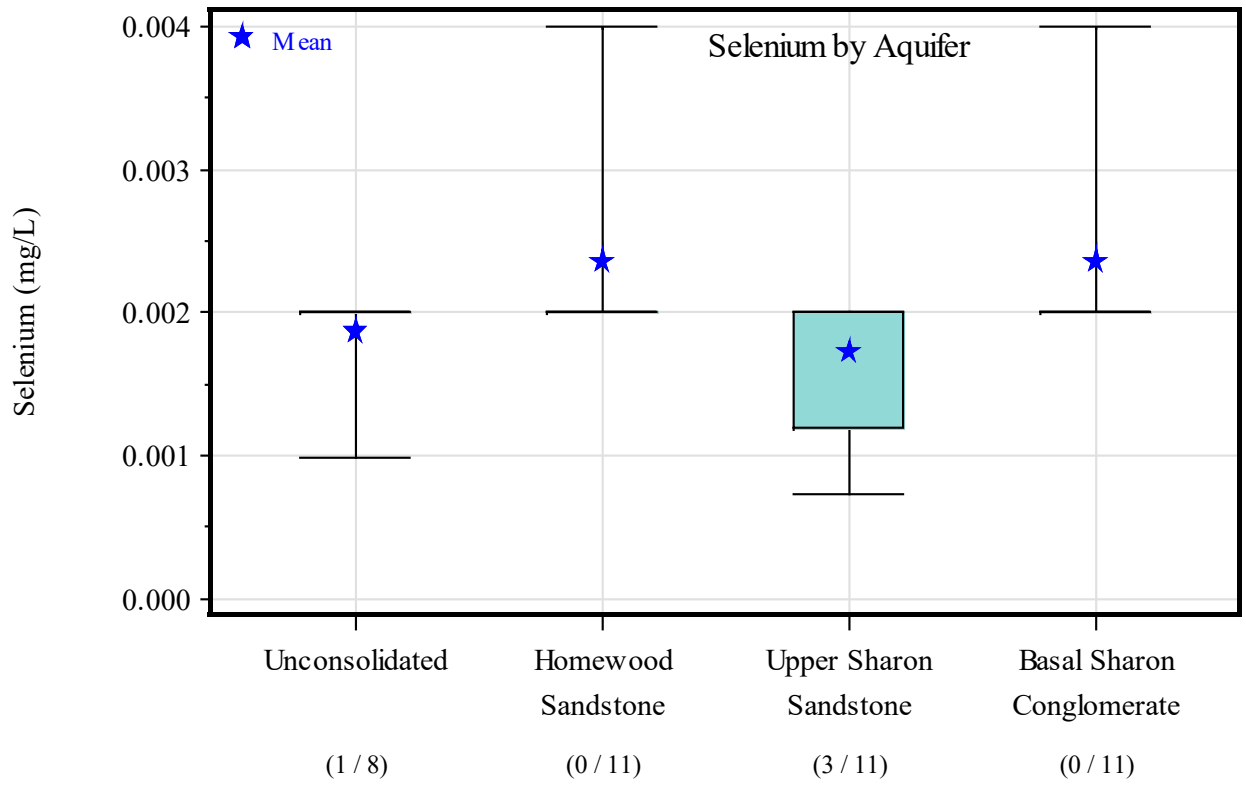


Reporting limits were plotted for non-detects.

Figure C.2-17. Normal Probability and Box Plots with Outliers Removed– Potassium

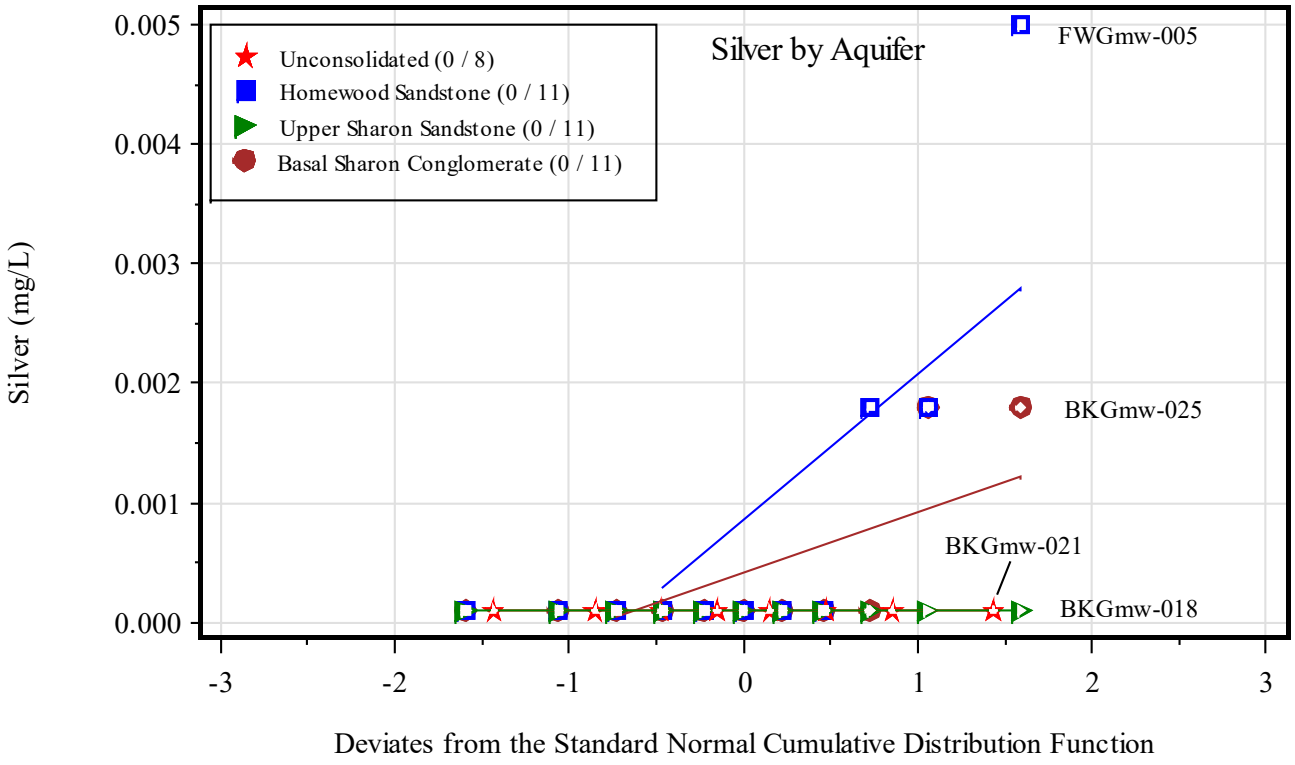


Hollow symbols denote the reporting limit was used for non-detects.

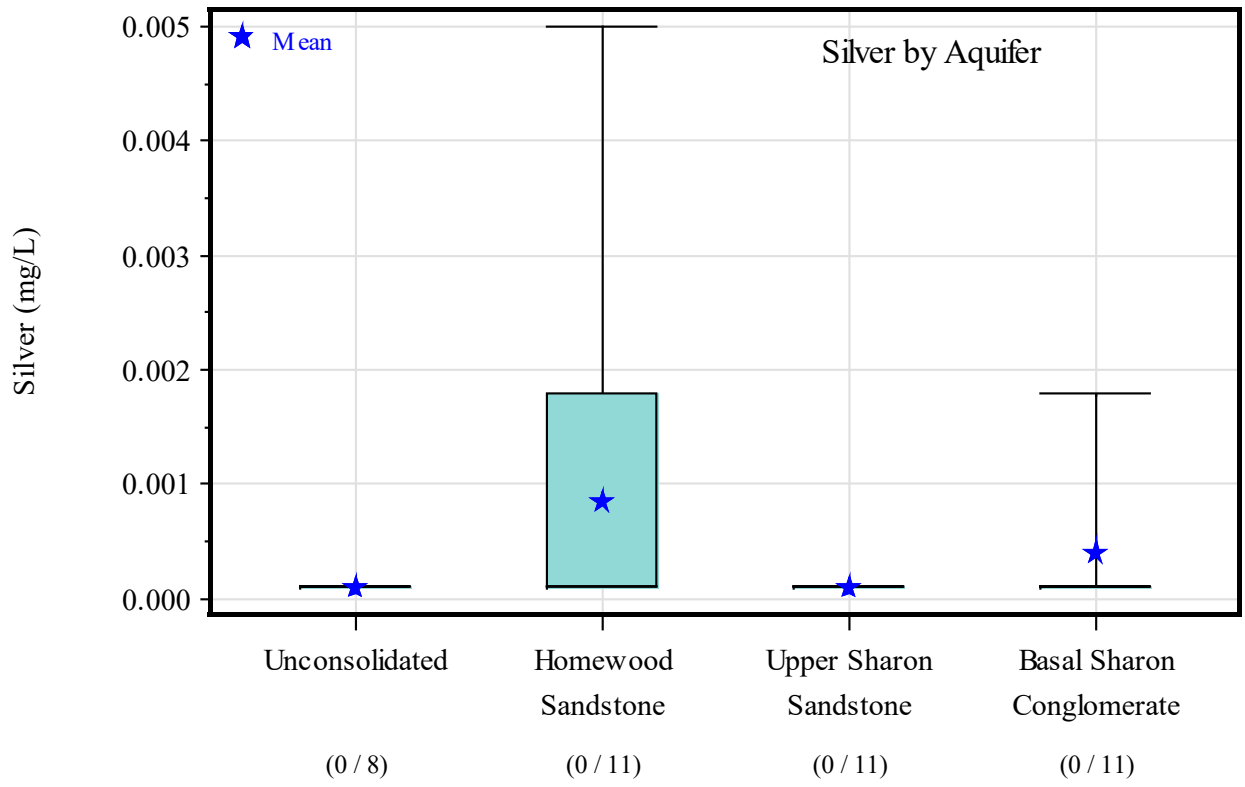


Reporting limits were plotted for non-detects.

Figure C.2-18. Normal Probability and Box Plots with Outliers Removed– Selenium

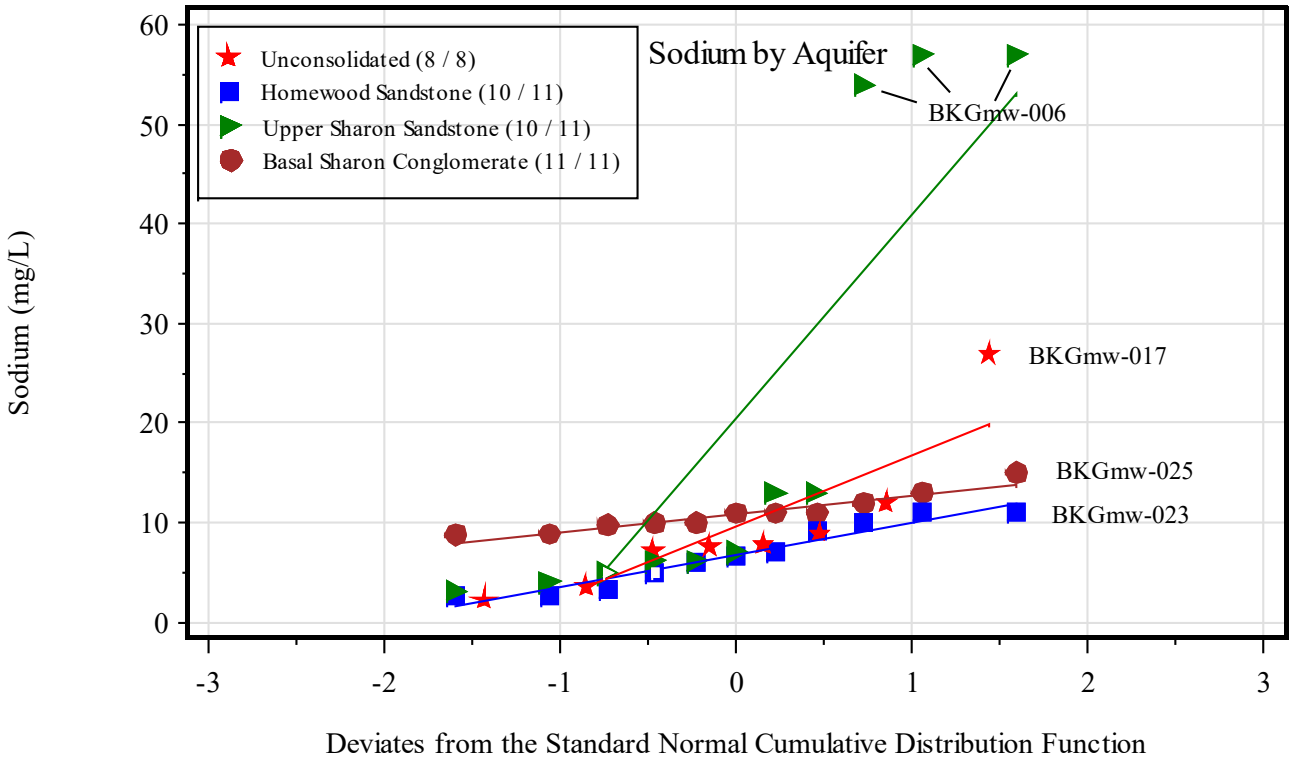


Hollow symbols denote the reporting limit was used for non-detects.

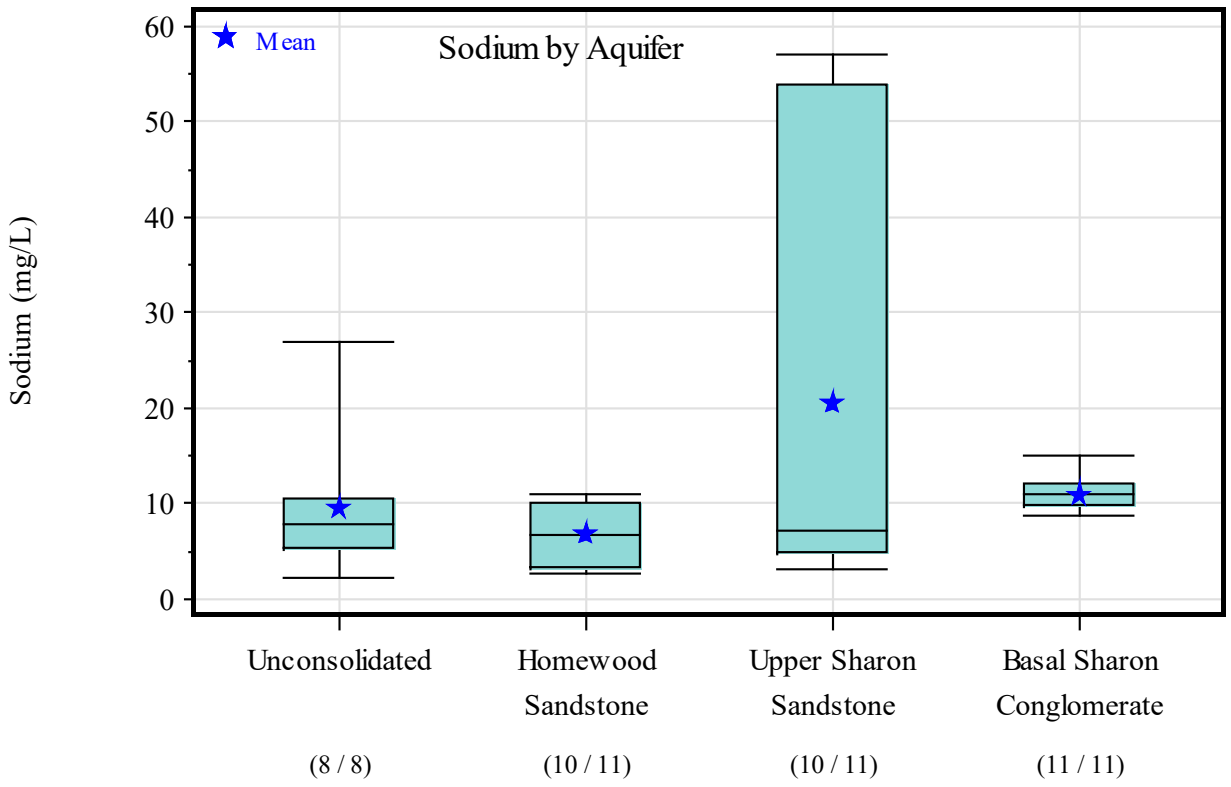


Reporting limits were plotted for non-detects.

Figure C.2-19. Normal Probability and Box Plots with Outliers Removed– Silver

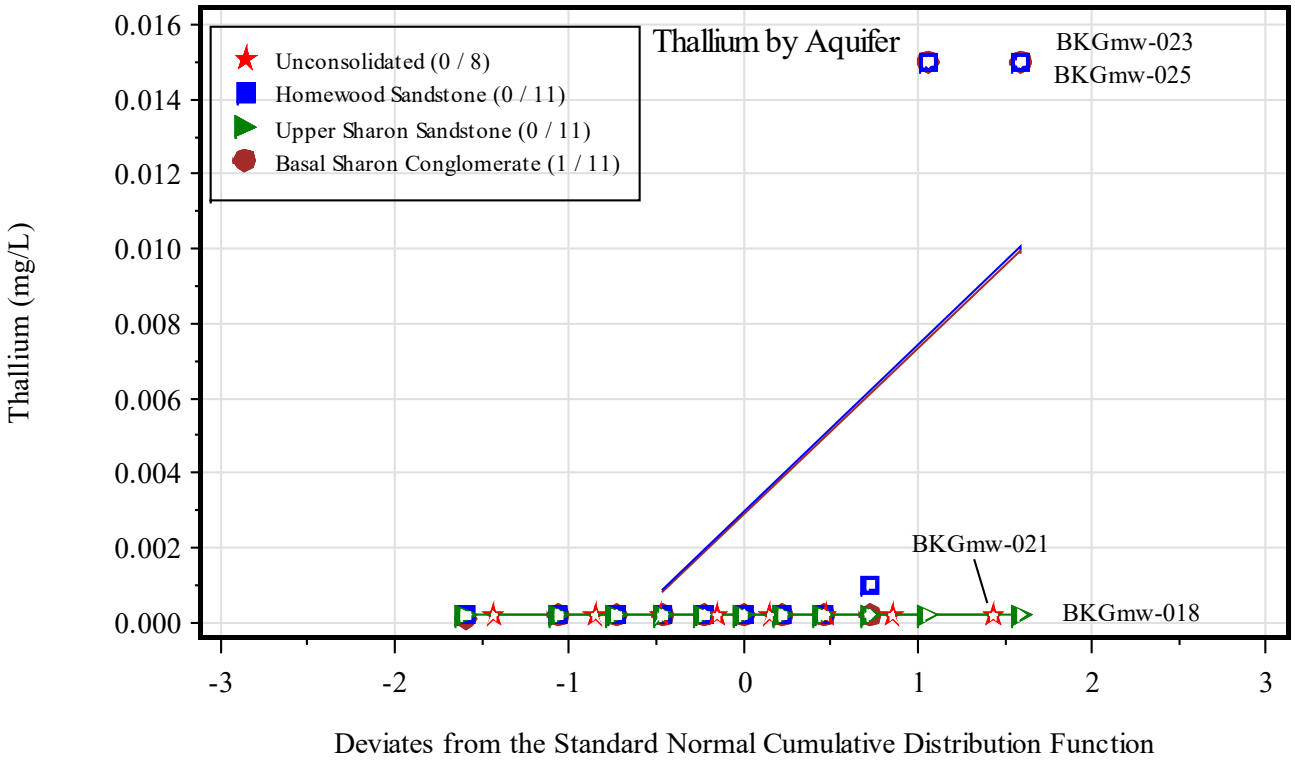


Hollow symbols denote the reporting limit was used for non-detects.

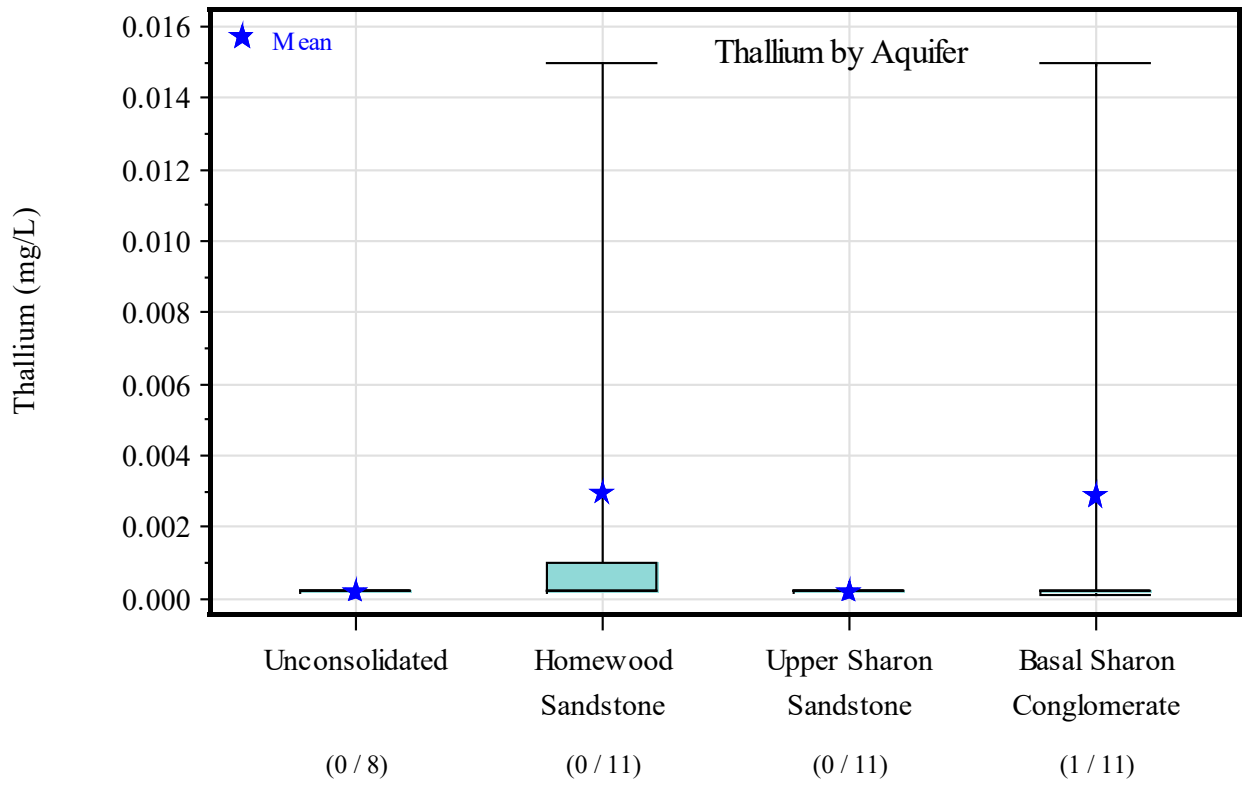


Reporting limits were plotted for non-detects.

Figure C.2-20. Normal Probability and Box Plots with Outliers Removed– Sodium

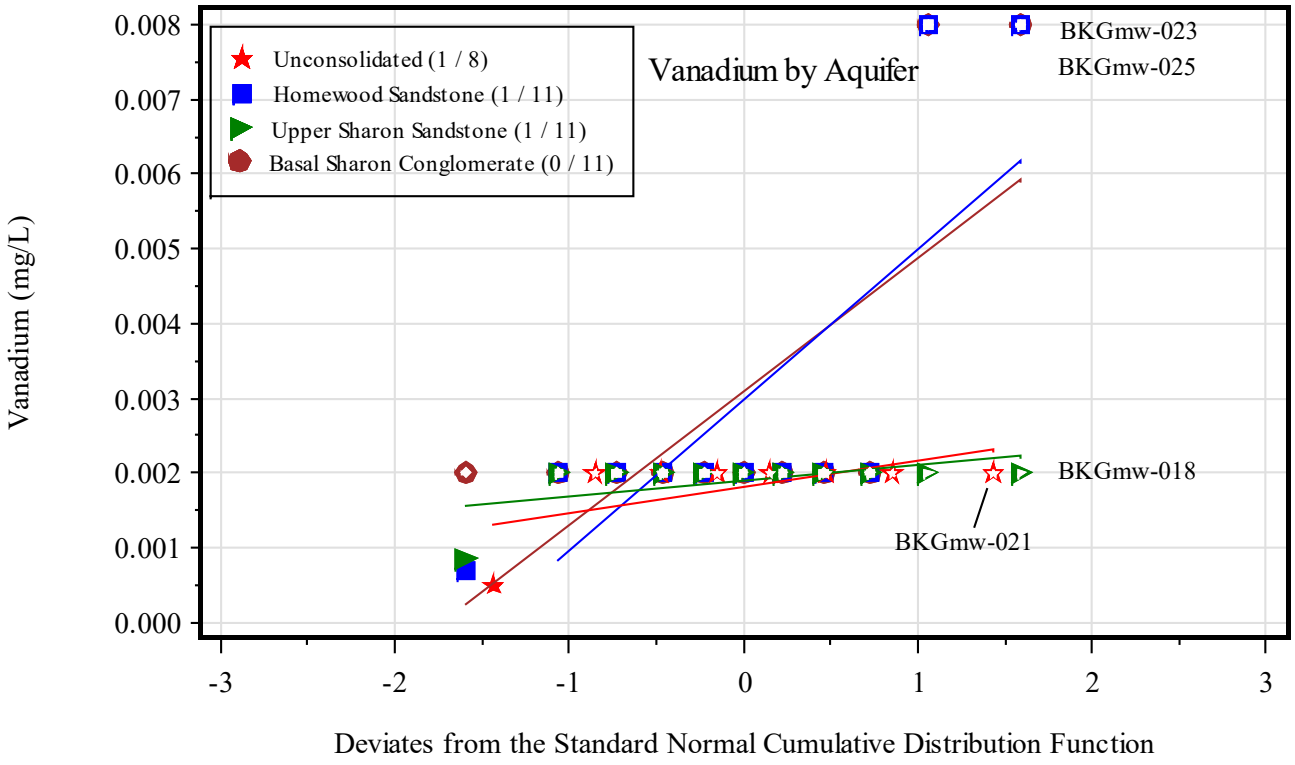


Hollow symbols denote the reporting limit was used for non-detects.

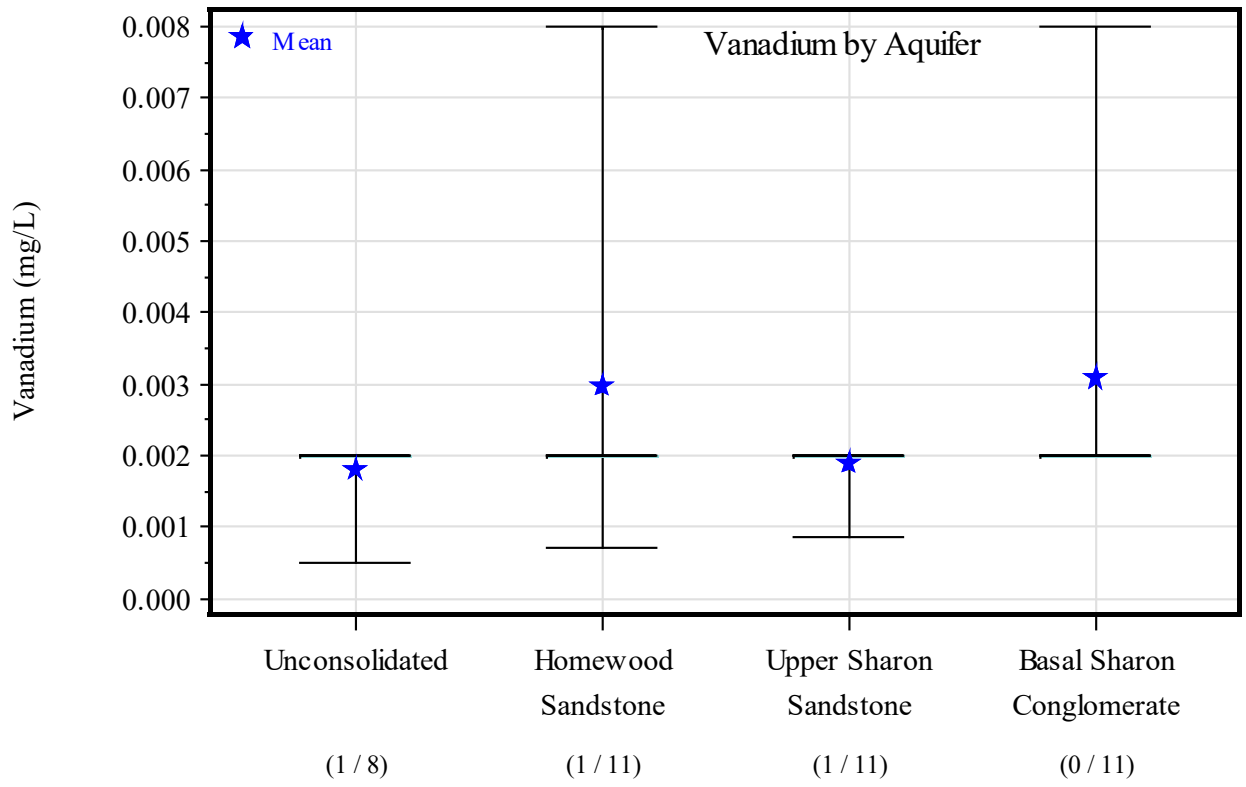


Reporting limits were plotted for non-detects.

Figure C.2-21. Normal Probability and Box Plots with Outliers Removed– Thallium

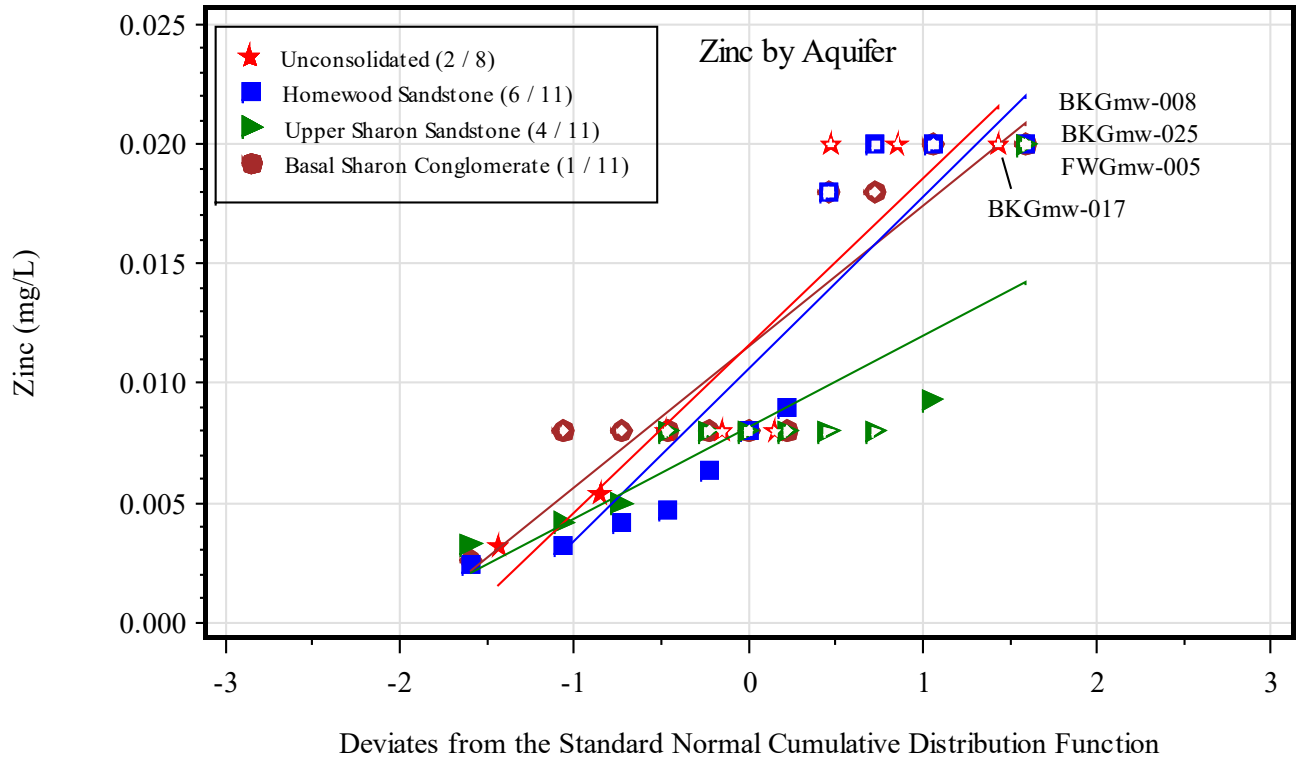


Hollow symbols denote the reporting limit was used for non-detects.

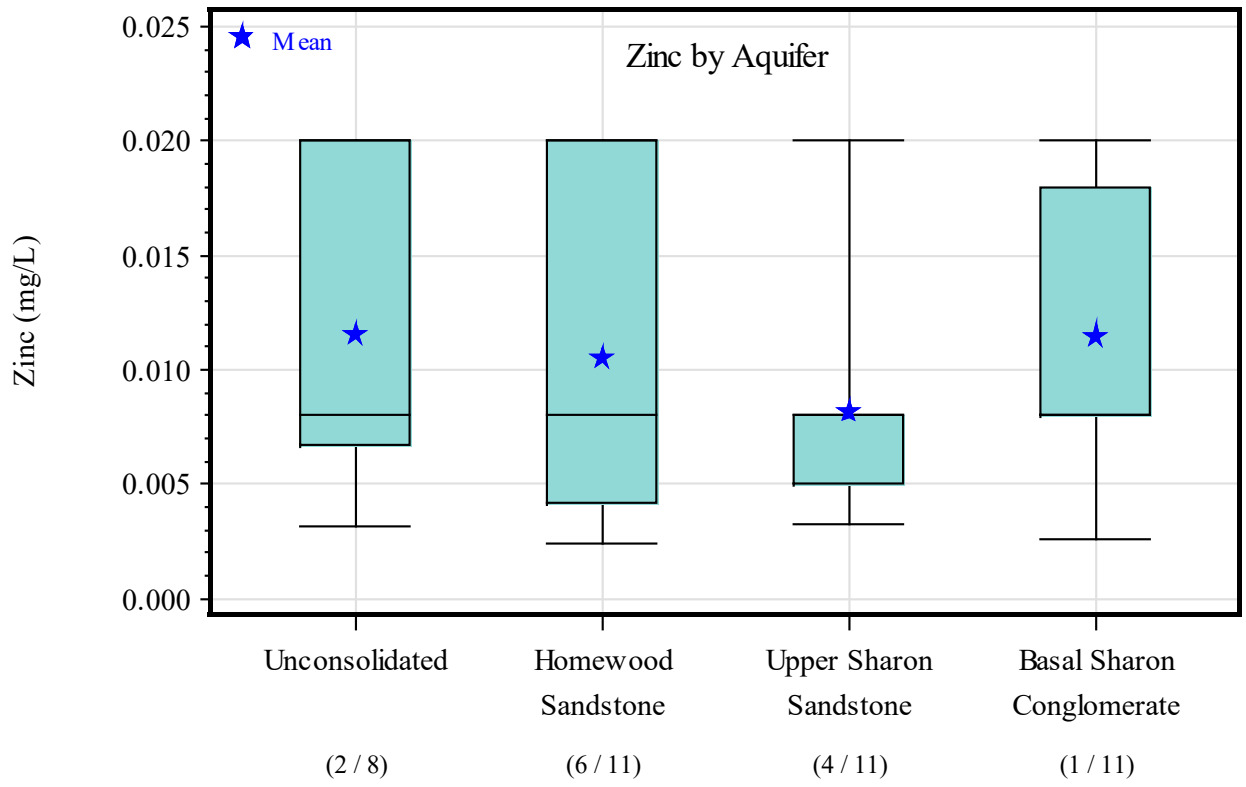


Reporting limits were plotted for non-detects.

Figure C.2-22. Normal Probability and Box Plots with Outliers Removed– Vanadium

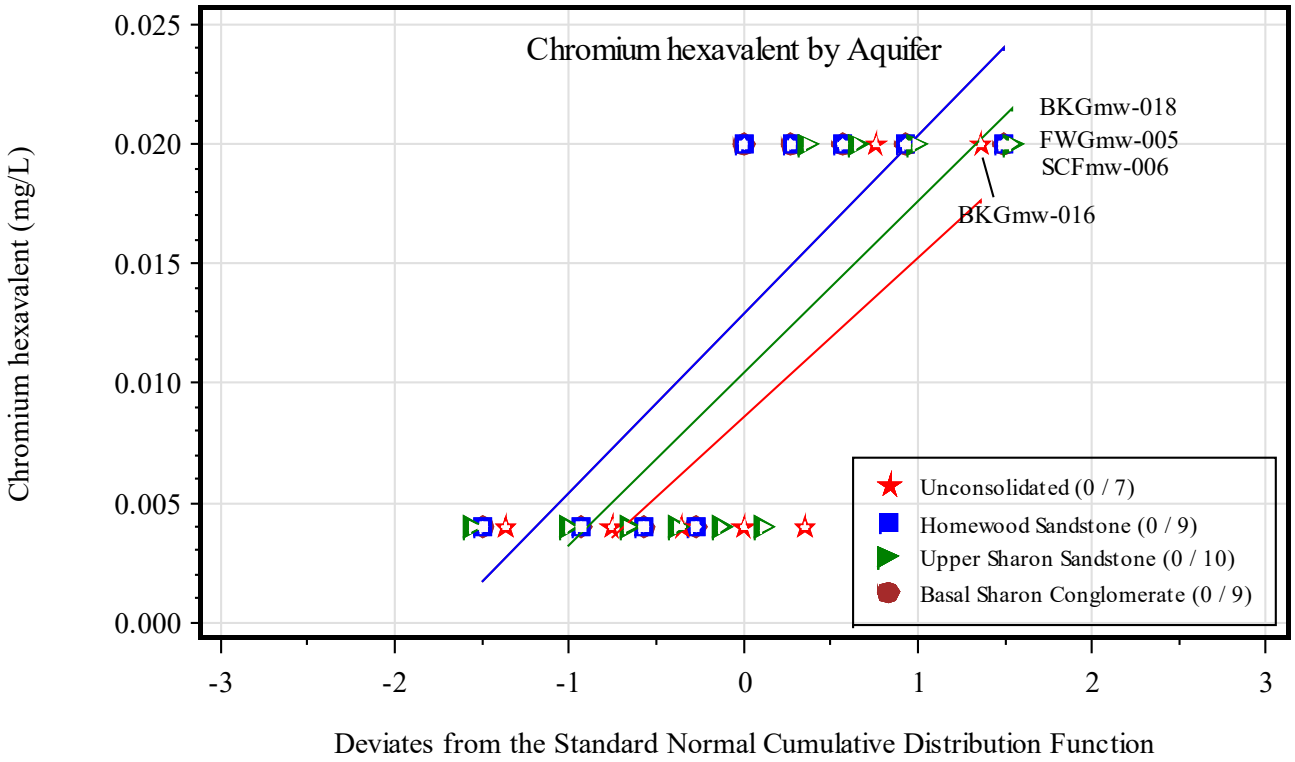


Hollow symbols denote the reporting limit was used for non-detects.

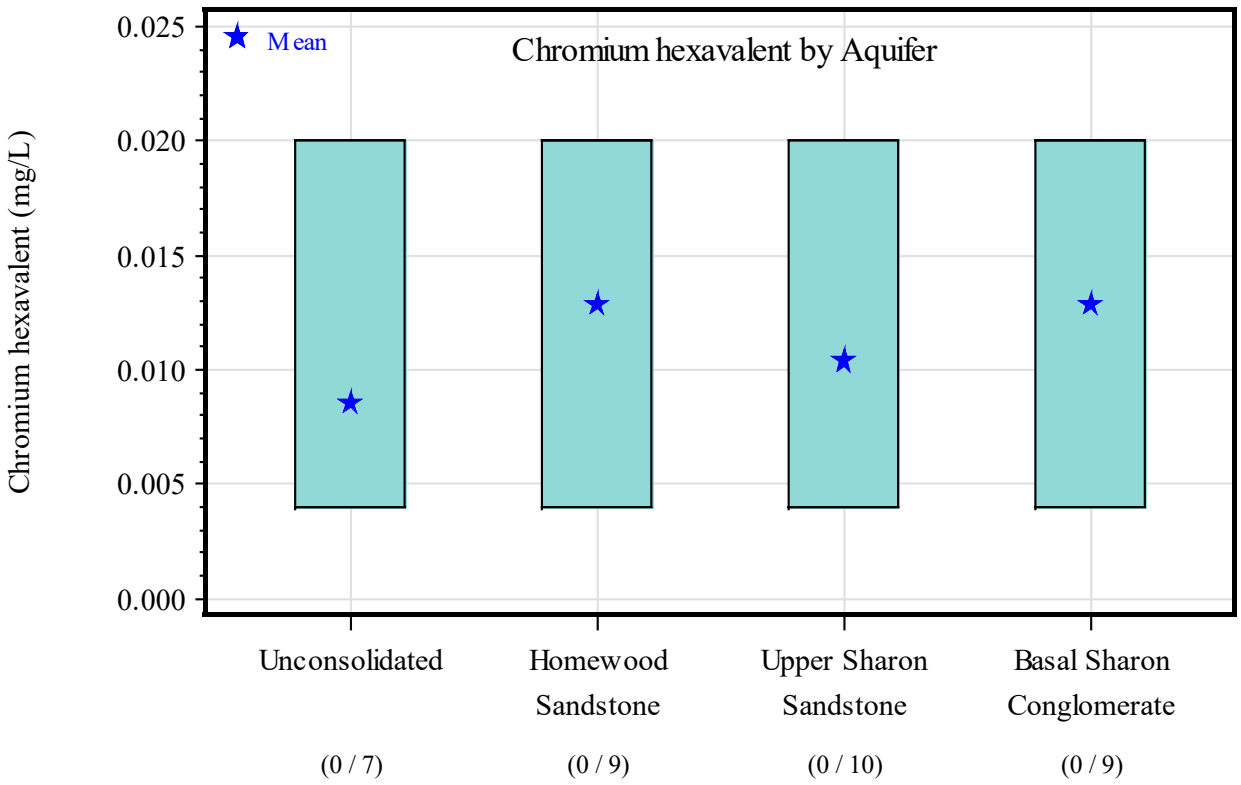


Reporting limits were plotted for non-detects.

Figure C.2-23. Normal Probability and Box Plots with Outliers Removed– Zinc



Hollow symbols denote the reporting limit was used for non-detects.



Reporting limits were plotted for non-detects.

Figure C.2-24. Normal Probability and Box Plots with Outliers Removed– Hexavalent Chromium

APPENDIX D

Piper Diagrams

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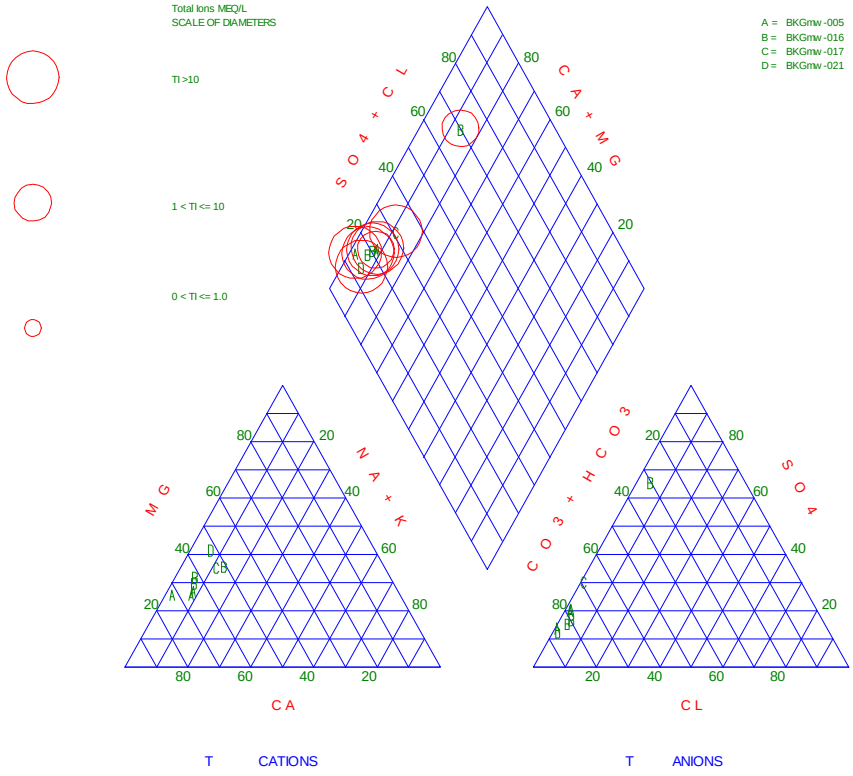

Figure D-1. Piper Diagram for the Unconsolidated Aquifer

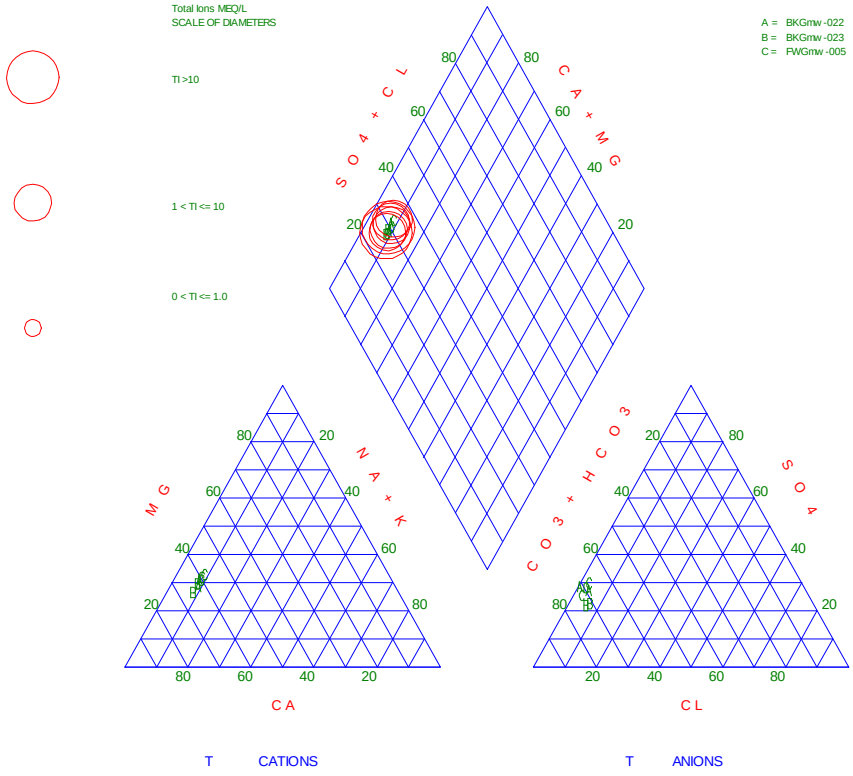

Figure D-2. Piper Diagram for the Homewood Sandstone Aquifer

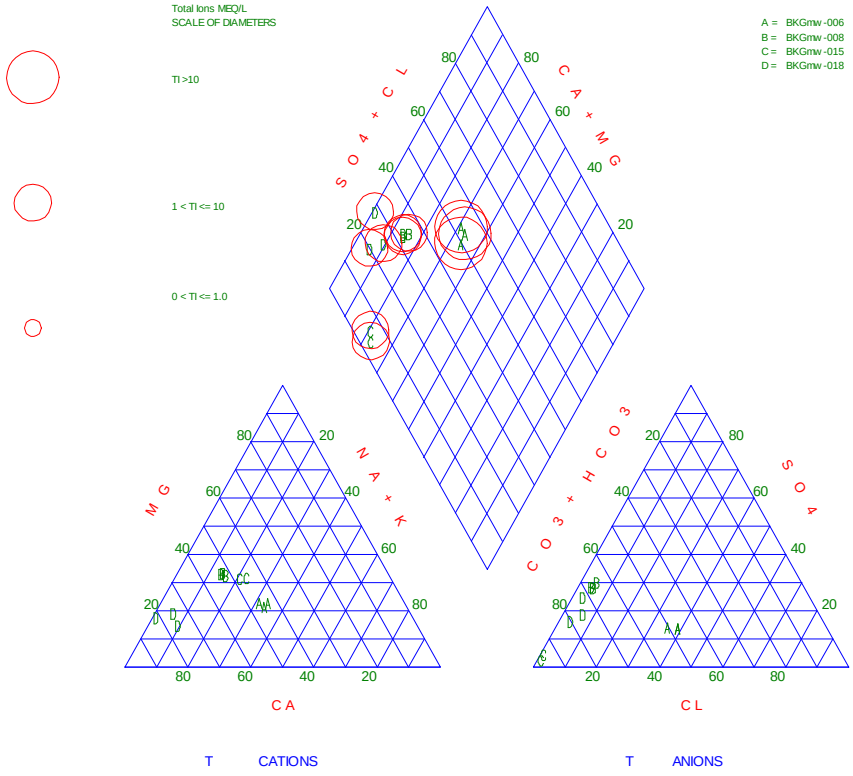

Figure D-3. Piper Diagram for the Upper Sharon Sandstone Aquifer

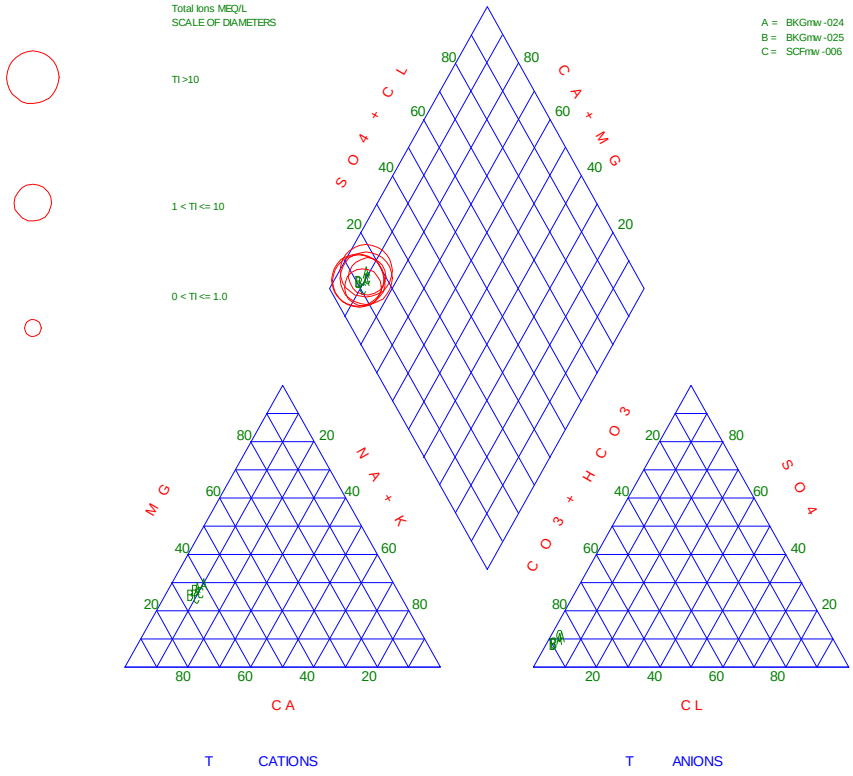

Figure D-4. Piper Diagram for the Basal Sharon Conglomerate Aquifer

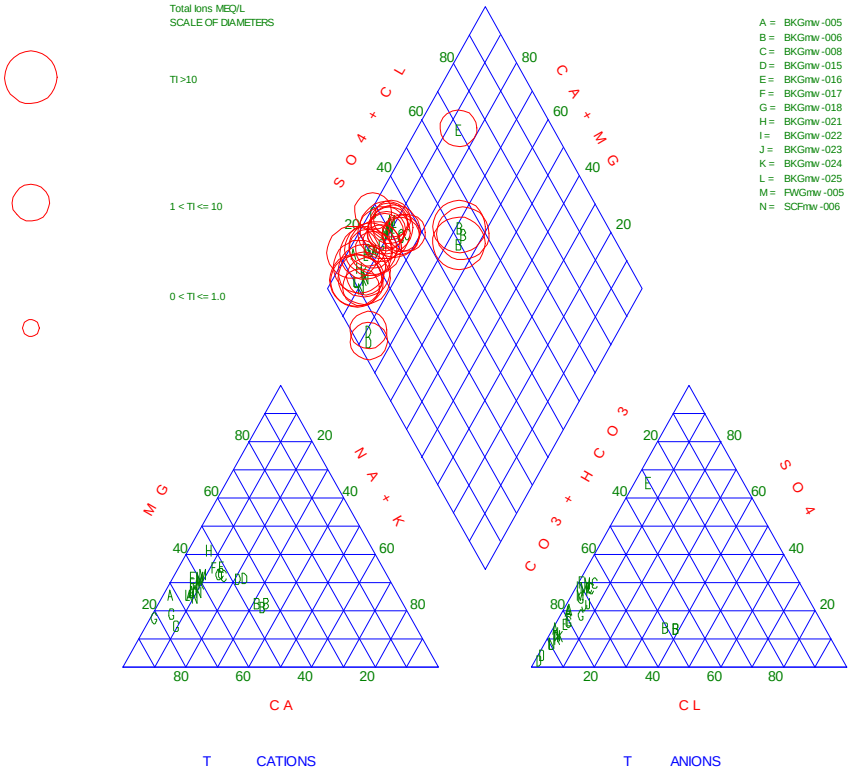

Figure D-5. Piper Diagram for All Background Aquifers.

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APPENDIX E

Background Groundwater Summary Statistics

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Table E-1. Background Groundwater Summary Statistics - Unconsolidated

Chemical	Freq. of Detection	Percent Non-Detects	Units	Non-detect Reporting Limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Skewness[b]	Detected				Dist.	UCL 95[b]	UTL 95/95[b]	Background
				Min	Max							Min	Mean	Max	S.D.				
Unconsolidated																			
Metals																			
Aluminum	7 / 8	12.5	mg/L	0.07	0.07	0.026	0.169	0.11	0.58	0.177	2.16	0.026	0.188	0.58	0.183	L	0.596	2.6	0.386
Antimony	0 / 8	100	mg/L	0.001	0.001	5.0E-04	5.0E-04	5.0E-04	5.0E-04	0	--	--	--	--	--	O	--	--	0
Arsenic	4 / 8	50	mg/L	0.001	0.001	4.9E-04	0.003	4.9E-04	0.02	0.006	2.81	4.9E-04	0.006	0.02	0.009	X*	0.015	--	0.003
Barium	8 / 8	0	mg/L	--	--	0.012	0.021	0.019	0.041	0.009	1.78	0.012	0.021	0.041	0.009	N	0.027	0.05	0.034
Beryllium	0 / 8	100	mg/L	3.0E-04	3.0E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	0	--	--	--	--	--	O	--	--	0
Cadmium	0 / 8	100	mg/L	0.001	0.001	5.0E-04	5.0E-04	5.0E-04	5.0E-04	0	--	--	--	--	--	O	--	--	0
Calcium	8 / 8	0	mg/L	--	--	12	70.6	72	120	29.9	-0.561	12	70.6	120	29.9	N	90.6	166	107
Chromium	2 / 8	75	mg/L	0.002	0.002	9.0E-04	9.9E-04	9.0E-04	0.002	2.1E-04	2.73	9.8E-04	0.001	0.002	3.7E-04	X	0.002	--	0.002
Chromium, hexavalent	0 / 7	100	mg/L	0.004	0.02	0.002	0.004	0.002	0.01	0.004	1.23	--	--	--	--	O	--	--	0
Cobalt	6 / 8	25	mg/L	2.0E-04	2.0E-04	6.6E-05	1.9E-04	1.1E-04	5.5E-04	1.7E-04	1.68	6.6E-05	2.2E-04	5.5E-04	2.0E-04	X*	4.7E-04	--	8.3E-04
Copper	4 / 8	50	mg/L	0.002	0.002	9.0E-04	0.002	0.001	0.003	7.3E-04	1.52	0.001	0.002	0.003	9.8E-04	X*	0.003	--	0.005
Iron	6 / 8	25	mg/L	0.085	0.085	0.043	0.651	0.52	2.3	0.688	1.86	0.23	0.84	2.3	0.766	L*	3.08	30.4	1.91
Lead	5 / 8	37.5	mg/L	7.0E-04	7.0E-04	3.2E-04	5.3E-04	6.3E-04	6.8E-04	1.5E-04	0.628	3.2E-04	5.3E-04	6.8E-04	1.6E-04	X*	8.5E-04	--	9.9E-04
Magnesium	8 / 8	0	mg/L	--	--	5.2	23.5	18.5	49	14.5	0.975	5.2	23.5	49	14.5	N	33.3	69.8	55.3
Manganese	8 / 8	0	mg/L	--	--	3.9E-04	0.04	0.007	0.23	0.079	2.62	3.9E-04	0.04	0.23	0.079	L	0.142	4.11	0.075
Mercury	0 / 8	100	mg/L	8.0E-05	8.0E-05	4.0E-05	4.0E-05	4.0E-05	4.0E-05	0	--	--	--	--	--	O	--	--	0
Nickel	6 / 8	25	mg/L	0.001	0.001	4.2E-04	7.9E-04	6.5E-04	0.002	4.9E-04	2.32	4.2E-04	8.5E-04	0.002	5.9E-04	L*	0.001	0.003	0.002
Potassium	4 / 8	50	mg/L	0.94	3	0.47	1.62	1.6	2.7	0.69	0.187	1.6	2.13	2.7	0.556	N*	2.19	3.82	4.84
Selenium	1 / 8	87.5	mg/L	0.002	0.002	9.9E-04	1.0E-03	0.001	0.001	3.5E-06	-2.83	9.9E-04	9.9E-04	9.9E-04	--	X	0.001	--	9.9E-04
Silver	0 / 8	100	mg/L	1.0E-04	1.0E-04	5.0E-05	5.0E-05	5.0E-05	5.0E-05	0	--	--	--	--	--	O	--	--	0
Sodium	8 / 8	0	mg/L	--	--	2.3	9.58	7.75	27	7.66	1.98	2.3	9.58	27	7.66	L	21.8	79.8	18.2
Thallium	0 / 8	100	mg/L	2.0E-04	2.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	0	--	--	--	--	--	O	--	--	0
Vanadium	1 / 8	87.5	mg/L	0.002	0.002	5.0E-04	9.4E-04	0.001	0.001	1.8E-04	-2.83	5.0E-04	5.0E-04	5.0E-04	--	X	0.001	--	5.0E-04
Zinc	2 / 8	75	mg/L	0.008	0.02	0.003	0.006	0.005	0.01	0.003	0.51	0.003	0.004	0.005	0.002	X	0.009	--	0.005

[a] One half of the reporting limits shown are used as proxy values for non-detects except where the Kaplan-Meier summary statistics are calculated with between 15% and 50% non-detects.
[b] This summary statistic is calculated using both detects and non-detects.
Dist. = distribution. Distribution flags are defined as:
D = The distribution could not be determined with fewer than 6 samples. The UCL95 was calculated using the nonparametric Chebyshev inequality method with at least 2 samples.
G = gamma. UCL95 was calculated using either the adjusted or unadjusted gamma.
L = lognormal. UCL95 was calculated using Land's statistic, Chebyshev minimum variance unbiased estimator, or nonparametric Chebyshev inequality method.
N = normal. UCL95 was calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal nor gamma. UCL95 was calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
Background = Q3 + 1.5(Q3 - Q1) as described in the RVAAP Final Remedial Investigation Work Plan p. 1-26.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
UTL95/95 = upper tolerance limit on individual concentrations with 95% confidence and 95% coverage. A nonparametric UTL95/95 requires at least 59 samples.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* The mean, median, standard deviation and UCL95 were calculated using Kaplan-Meier if the percent non-detects is more than 15% but no more than 50%.

Table E-2. Background Groundwater Summary Statistics - Homewood Sandstone

Chemical	Freq. of Detection	Percent Non-Detects	Units	Non-detect Reporting Limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Skewness[b]	Detected				Dist.	UCL 95[b]	UTL 95/95[b]	Background
				Min	Max							Min	Mean	Max	S.D.				
Homewood Sandstone																			
Metals																			
Aluminum	5 / 11	54.5	mg/L	0.07	0.15	0.022	0.083	0.036	0.43	0.117	3.13	0.022	0.124	0.43	0.173	X	0.244	--	0.43
Antimony	0 / 11	100	mg/L	0.001	0.009	5.0E-04	0.001	5.0E-04	0.005	0.002	1.92	--	--	--	--	O	--	--	0
Arsenic	8 / 11	27.3	mg/L	0.001	0.008	3.8E-04	0.002	0.002	0.005	0.002	0.188	3.8E-04	0.003	0.005	0.002	N*	0.003	0.007	0.008
Barium	11 / 11	0	mg/L	--	--	0.02	0.057	0.062	0.092	0.028	-0.162	0.02	0.057	0.092	0.028	N	0.072	0.137	0.177
Beryllium	0 / 11	100	mg/L	3.0E-04	0.005	1.5E-04	5.6E-04	1.5E-04	0.002	8.4E-04	1.86	--	--	--	--	O	--	--	0
Cadmium	0 / 11	100	mg/L	0.001	0.005	5.0E-04	8.2E-04	5.0E-04	0.002	7.1E-04	1.92	--	--	--	--	O	--	--	0
Calcium	11 / 11	0	mg/L	--	--	21	46	47	75	21.8	0.111	21	46	75	21.8	N	57.9	107	143
Chromium	3 / 11	72.7	mg/L	0.002	0.008	7.5E-04	0.002	9.0E-04	0.007	0.002	1.79	7.5E-04	0.003	0.007	0.004	X	0.005	--	0.007
Chromium, hexavalent	0 / 9	100	mg/L	0.004	0.02	0.002	0.006	0.01	0.01	0.004	-0.271	--	--	--	--	O	--	--	0
Cobalt	11 / 11	0	mg/L	--	--	0.001	0.002	0.002	0.003	4.3E-04	-0.474	0.001	0.002	0.003	4.3E-04	N	0.002	0.003	0.003
Copper	3 / 11	72.7	mg/L	0.002	0.002	9.0E-04	0.001	9.0E-04	0.002	4.2E-04	2.34	9.6E-04	0.002	0.002	6.2E-04	X	0.003	--	0.002
Iron	11 / 11	0	mg/L	--	--	0.13	4.82	4.9	11	4.22	0.163	0.13	4.82	11	4.22	N	7.13	16.7	22.3
Lead	1 / 11	90.9	mg/L	7.0E-04	0.002	3.2E-04	4.7E-04	3.5E-04	0.001	2.6E-04	1.92	3.2E-04	3.2E-04	3.2E-04	--	X	8.1E-04	--	3.2E-04
Magnesium	11 / 11	0	mg/L	--	--	6.3	13.4	15	20	5.62	-0.333	6.3	13.4	20	5.62	G	18.4	39.4	37.5
Manganese	11 / 11	0	mg/L	--	--	0.21	0.319	0.33	0.42	0.07	-0.131	0.21	0.319	0.42	0.07	N	0.357	0.516	0.56
Mercury	0 / 11	100	mg/L	8.0E-05	1.5E-04	4.0E-05	4.6E-05	4.0E-05	7.5E-05	1.4E-05	1.92	--	--	--	--	O	--	--	0
Nickel	11 / 11	0	mg/L	--	--	0.001	0.002	0.002	0.003	6.6E-04	-0.133	0.001	0.002	0.003	6.6E-04	N	0.003	0.004	0.005
Potassium	11 / 11	0	mg/L	--	--	0.25	0.904	0.87	1.7	0.399	0.306	0.25	0.904	1.7	0.399	N	1.12	2.03	2.01
Selenium	0 / 11	100	mg/L	0.002	0.004	0.001	0.001	0.001	0.002	4.0E-04	1.92	--	--	--	--	O	--	--	0
Silver	0 / 11	100	mg/L	1.0E-04	0.005	5.0E-05	4.3E-04	5.0E-05	0.003	7.7E-04	2.35	--	--	--	--	O	--	--	0
Sodium	10 / 11	9.09	mg/L	5	5	2.5	6.55	6.6	11	3.39	0.055	2.7	6.96	11	3.28	N	8.43	15.6	21.0
Thallium	0 / 11	100	mg/L	2.0E-04	0.015	1.0E-04	0.001	1.0E-04	0.008	0.003	1.92	--	--	--	--	O	--	--	0
Vanadium	1 / 11	90.9	mg/L	0.002	0.008	7.0E-04	0.002	0.001	0.004	0.001	1.9	7.0E-04	7.0E-04	7.0E-04	--	X	0.003	--	7.0E-04
Zinc	6 / 11	45.5	mg/L	0.008	0.02	0.002	0.005	0.004	0.01	0.002	-0.06	0.002	0.005	0.009	0.002	N*	0.007	0.011	0.011

[a] One half of the reporting limits shown are used as proxy values for non-detects except where the Kaplan-Meier summary statistics are calculated with between 15% and 50% non-detects.
[b] This summary statistic is calculated using both detects and non-detects.
Dist. = distribution. Distribution flags are defined as:
D = The distribution could not be determined with fewer than 6 samples. The UCL95 was calculated using the nonparametric Chebyshev inequality method with at least 2 samples.
G = gamma. UCL95 was calculated using either the adjusted or unadjusted gamma.
L = lognormal. UCL95 was calculated using Land's statistic, Chebyshev minimum variance unbiased estimator, or nonparametric Chebyshev inequality method.
N = normal. UCL95 was calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal nor gamma. UCL95 was calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
Background = Q3 + 1.5(Q3 - Q1) as described in the RVAAP Final Remedial Investigation Work Plan p. 1-26.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
UTL95/95 = upper tolerance limit on individual concentrations with 95% confidence and 95% coverage. A nonparametric UTL95/95 requires at least 59 samples.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* The mean, median, standard deviation and UCL95 were calculated using Kaplan-Meier if the percent non-detects is more than 15% but no more than 50%.

Table E-3. Background Groundwater Summary Statistics - Upper Sharon

Chemical	Freq. of Detection	Percent Non-Detects	Units	Non-detect Reporting Limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Skewness[b]	Detected				Dist.	UCL 95[b]	UTL 95/95[b]	Background
				Min	Max							Min	Mean	Max	S.D.				
Upper Sharon																			
Metals																			
Aluminum	3 / 11	72.7	mg/L	0.07	0.3	0.022	0.044	0.035	0.15	0.035	3.23	0.022	0.031	0.038	0.008	X	0.051	--	0.038
Antimony	0 / 11	100	mg/L	0.001	0.001	5.0E-04	5.0E-04	5.0E-04	5.0E-04	0	--	--	--	--	--	O	--	--	0
Arsenic	3 / 11	72.7	mg/L	0.001	0.001	5.0E-04	8.2E-04	5.0E-04	0.003	8.4E-04	3.12	8.4E-04	0.002	0.003	0.001	X	0.002	--	0.003
Barium	11 / 11	0	mg/L	--	--	0.004	0.054	0.01	0.26	0.099	1.92	0.004	0.054	0.26	0.099	G	0.168	0.525	0.035
Beryllium	0 / 11	100	mg/L	3.0E-04	3.0E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	0	--	--	--	--	--	O	--	--	0
Cadmium	0 / 11	100	mg/L	0.001	0.001	5.0E-04	5.0E-04	5.0E-04	5.0E-04	0	--	--	--	--	--	O	--	--	0
Calcium	11 / 11	0	mg/L	--	--	19	41.4	32	75	20.7	0.457	19	41.4	75	20.7	N	52.7	99.7	118
Chromium	0 / 11	100	mg/L	0.002	0.002	9.0E-04	9.0E-04	9.0E-04	9.0E-04	0	--	--	--	--	--	O	--	--	0
Chromium, hexavalent	0 / 10	100	mg/L	0.004	0.02	0.002	0.005	0.002	0.01	0.004	0.484	--	--	--	--	O	--	--	0
Cobalt	7 / 11	36.4	mg/L	2.0E-04	2.0E-04	5.9E-05	0.002	1.9E-04	0.015	0.004	3.25	5.9E-05	0.003	0.015	0.005	G*	0.016	0.016	0.001
Copper	2 / 11	81.8	mg/L	0.002	0.002	9.0E-04	9.4E-04	9.0E-04	0.001	9.2E-05	2.89	9.9E-04	0.001	0.001	1.5E-04	X	0.002	--	0.001
Iron	6 / 11	45.5	mg/L	0.085	0.1	0.027	0.56	0.042	4	1.13	2.91	0.027	0.998	4	1.52	X*	2.19	--	2.08
Lead	3 / 11	72.7	mg/L	7.0E-04	0.003	3.2E-04	6.8E-04	3.5E-04	0.002	5.3E-04	1.15	3.2E-04	7.8E-04	0.002	6.3E-04	X	0.001	--	0.002
Magnesium	11 / 11	0	mg/L	--	--	2.8	11.9	9.2	23	6.46	0.602	2.8	11.9	23	6.46	N	15.4	30.1	38.9
Manganese	10 / 11	9.09	mg/L	0.004	0.004	7.0E-04	0.042	0.01	0.14	0.054	1.03	7.0E-04	0.046	0.14	0.055	X	0.113	--	0.198
Mercury	0 / 11	100	mg/L	8.0E-05	8.0E-05	4.0E-05	4.0E-05	4.0E-05	4.0E-05	0	--	--	--	--	--	O	--	--	0
Nickel	10 / 11	9.09	mg/L	0.001	0.001	3.3E-04	7.2E-04	6.9E-04	0.002	3.8E-04	1.2	3.3E-04	7.5E-04	0.002	3.9E-04	N	9.5E-04	0.002	0.002
Potassium	9 / 11	18.2	mg/L	0.94	0.94	0.47	1.68	1.1	5	1.55	1.64	0.51	1.93	5	1.7	L*	3.07	12.6	3.38
Selenium	3 / 11	72.7	mg/L	0.002	0.002	7.3E-04	0.001	0.001	0.001	1.1E-04	-1.05	7.3E-04	0.001	0.001	2.5E-04	X	0.002	--	0.001
Silver	0 / 11	100	mg/L	1.0E-04	1.0E-04	5.0E-05	5.0E-05	5.0E-05	5.0E-05	0	--	--	--	--	--	O	--	--	0
Sodium	10 / 11	9.09	mg/L	5	5	2.5	20.3	7.1	57	23.2	1.11	3.2	22.1	57	23.6	L	57.9	289	129
Thallium	0 / 11	100	mg/L	2.0E-04	2.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	0	--	--	--	--	--	O	--	--	0
Vanadium	1 / 11	90.9	mg/L	0.002	0.002	8.5E-04	9.9E-04	0.001	0.001	4.5E-05	-3.32	8.5E-04	8.5E-04	8.5E-04	--	X	0.001	--	8.5E-04
Zinc	4 / 11	63.6	mg/L	0.008	0.02	0.003	0.005	0.004	0.01	0.002	1.82	0.003	0.005	0.009	0.003	X	0.008	--	0.009

[a] One half of the reporting limits shown are used as proxy values for non-detects except where the Kaplan-Meier summary statistics are calculated with between 15% and 50% non-detects.
[b] This summary statistic is calculated using both detects and non-detects.
Dist. = distribution. Distribution flags are defined as:
D = The distribution could not be determined with fewer than 6 samples. The UCL95 was calculated using the nonparametric Chebyshev inequality method with at least 2 samples.
G = gamma. UCL95 was calculated using either the adjusted or unadjusted gamma.
L = lognormal. UCL95 was calculated using Land's statistic, Chebyshev minimum variance unbiased estimator, or nonparametric Chebyshev inequality method.
N = normal. UCL95 was calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal nor gamma. UCL95 was calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
Background = Q3 + 1.5(Q3 - Q1) as described in the RVAAP Final Remedial Investigation Work Plan p. 1-26.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
UTL95/95 = upper tolerance limit on individual concentrations with 95% confidence and 95% coverage. A nonparametric UTL95/95 requires at least 59 samples.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* The mean, median, standard deviation and UCL95 were calculated using Kaplan-Meier if the percent non-detects is more than 15% but no more than 50%.

Table E-4. Background Groundwater Summary Statistics - Basal Sharon Conglomerate

Chemical	Freq. of Detection	Percent Non-Detects	Units	Non-detect Reporting Limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Skewness[b]	Detected				Dist.	UCL 95[b]	UTL 95/95[b]	Background
				Min	Max							Min	Mean	Max	S.D.				
Basal Sharon Conglomerate																			
Metals																			
Aluminum	2 / 11	81.8	mg/L	0.07	0.15	0.035	0.044	0.035	0.075	0.016	1.68	0.037	0.043	0.049	0.008	X	0.069	--	0.049
Antimony	2 / 11	81.8	mg/L	0.001	0.009	4.1E-04	0.001	5.0E-04	0.005	0.002	1.37	4.1E-04	5.1E-04	6.0E-04	1.3E-04	X	9.2E-04	--	6.0E-04
Arsenic	11 / 11	0	mg/L	--	--	0.007	0.017	0.012	0.048	0.013	1.7	0.007	0.017	0.048	0.013	L	0.027	0.082	0.048
Barium	11 / 11	0	mg/L	--	--	0.081	0.096	0.096	0.11	0.011	0.167	0.081	0.096	0.11	0.011	N	0.102	0.126	0.145
Beryllium	1 / 11	90.9	mg/L	3.0E-04	0.005	1.5E-04	5.4E-04	1.5E-04	0.002	8.5E-04	1.92	2.3E-04	2.3E-04	2.3E-04	--	X	0.002	--	2.3E-04
Cadmium	0 / 11	100	mg/L	0.001	0.005	5.0E-04	8.2E-04	5.0E-04	0.002	7.1E-04	1.92	--	--	--	--	O	--	--	0
Calcium	11 / 11	0	mg/L	--	--	57	68.7	69	77	6.83	-0.472	57	68.7	77	6.83	N	72.5	87.9	93
Chromium	1 / 11	90.9	mg/L	0.002	0.008	7.4E-04	0.001	9.0E-04	0.004	0.001	1.92	7.4E-04	7.4E-04	7.4E-04	--	X	0.003	--	7.4E-04
Chromium, hexavalent	0 / 9	100	mg/L	0.004	0.02	0.002	0.006	0.01	0.01	0.004	-0.271	--	--	--	--	O	--	--	0
Cobalt	8 / 11	27.3	mg/L	2.0E-04	0.002	1.0E-04	0.002	4.6E-04	0.007	0.002	1.88	1.2E-04	0.002	0.007	0.002	L*	0.011	0.049	0.005
Copper	1 / 11	90.9	mg/L	8.0E-04	0.002	4.0E-04	8.4E-04	9.0E-04	9.0E-04	1.6E-04	-2.6	6.9E-04	6.9E-04	6.9E-04	--	X	0.001	--	6.9E-04
Iron	11 / 11	0	mg/L	--	--	0.22	0.888	0.77	1.9	0.524	0.609	0.22	0.888	1.9	0.524	N	1.17	2.36	2.56
Lead	1 / 11	90.9	mg/L	7.0E-04	0.003	2.2E-04	8.7E-04	0.001	0.002	5.6E-04	0.087	2.2E-04	2.2E-04	2.2E-04	--	X	0.002	--	2.2E-04
Magnesium	11 / 11	0	mg/L	--	--	15	18.4	18	23	2.94	0.312	15	18.4	23	2.94	N	20.0	26.6	30
Manganese	11 / 11	0	mg/L	--	--	0.15	0.355	0.33	0.59	0.163	0.054	0.15	0.355	0.59	0.163	N	0.444	0.813	1.03
Mercury	0 / 11	100	mg/L	8.0E-05	1.5E-04	4.0E-05	4.6E-05	4.0E-05	7.5E-05	1.4E-05	1.92	--	--	--	--	O	--	--	0
Nickel	7 / 11	36.4	mg/L	0.001	0.004	4.1E-04	0.004	8.6E-04	0.016	0.005	2.11	4.1E-04	0.005	0.016	0.005	L*	0.013	0.061	0.014
Potassium	10 / 11	9.09	mg/L	3	3	0.92	1.73	1.9	2.2	0.386	-0.867	0.92	1.75	2.2	0.399	N	1.98	2.82	2.9
Selenium	0 / 11	100	mg/L	0.002	0.004	0.001	0.001	0.001	0.002	4.0E-04	1.92	--	--	--	--	O	--	--	0
Silver	0 / 11	100	mg/L	1.0E-04	0.002	5.0E-05	2.0E-04	5.0E-05	9.0E-04	3.4E-04	1.92	--	--	--	--	O	--	--	0
Sodium	11 / 11	0	mg/L	--	--	8.8	11.0	11	15	1.83	1.07	8.8	11.0	15	1.83	N	12.0	16.1	15.3
Thallium	1 / 11	90.9	mg/L	2.0E-04	0.015	9.7E-05	0.001	1.0E-04	0.008	0.003	1.92	9.7E-05	9.7E-05	9.7E-05	--	X	0.005	--	9.7E-05
Vanadium	0 / 11	100	mg/L	0.002	0.008	0.001	0.002	0.001	0.004	0.001	1.92	--	--	--	--	O	--	--	0
Zinc	1 / 11	90.9	mg/L	0.008	0.02	0.003	0.006	0.004	0.01	0.003	0.624	0.003	0.003	0.003	--	X	0.01	--	0.003

[a] One half of the reporting limits shown are used as proxy values for non-detects except where the Kaplan-Meier summary statistics are calculated with between 15% and 50% non-detects.

[b] This summary statistic is calculated using both detects and non-detects.

Dist. = distribution. Distribution flags are defined as:

D = The distribution could not be determined with fewer than 6 samples. The UCL95 was calculated using the nonparametric Chebyshev inequality method with at least 2 samples.

L = lognormal. UCL95 was calculated using Land's statistic, Chebyshev minimum variance unbiased estimator, or nonparametric Chebyshev inequality method.

N = normal. UCL95 was calculated using t statistic.

O = no detected results to calculate some summary statistics.

X = neither normal, lognormal nor gamma. UCL95 was calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.

Background = Q3 + 1.5(Q3 - Q1) as described in the RVAAP Final Remedial Investigation Work Plan p. 1-26.

S.D. = standard deviation.

UCL95 = upper confidence limit on the mean concentration with 95% confidence.

UTL95/95 = upper tolerance limit on individual concentrations with 95% confidence and 95% coverage. A nonparametric UTL95/95 requires at least 59 samples.

-- = Not applicable, not available or insufficient data to calculate the statistic.

* The mean, median, standard deviation and UCL95 were calculated using Kaplan-Meier if the percent non-detects is more than 15% but no more than 50%.

APPENDIX F

Ohio EPA Comments

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Ohio Environmental Protection Agency

Mike DeWine, Governor
Jon Husted, Lt. Governor
Laurie A. Stevenson, Director

July 23, 2019

RE: US Army Ammunition Plt RVAAP
Remediation Response
Project Records
Remedial Response
Portage County
ID # 267000859036

Mr. David Connolly
Army National Guard Directorate
Environmental Programs Division
ARNGD-ILE-CR
111 South George Mason Drive
Arlington, VA 22204

Subject: Response to Ohio EPA Comments on the "Draft Background Study for Metals for RVAAP-66 Facility-wide Groundwater"

Dear Mr. Connolly:

The Ohio Environmental Protection Agency (Ohio EPA) has received and reviewed the response to Ohio EPA comments on the "Draft Background Study for Metals for RVAAP-66 Facility-wide Groundwater." This document was received via email at Ohio EPA's Northeast District Office (NEDO), Division of Environmental Response and Revitalization (DERR), on June 10, 2019. The report was prepared by Leidos for the United States Army Corps of Engineers (USACE) on behalf of the Army National Guard Bureau (ARNG).

Ohio EPA finds that all comments have been adequately addressed and are resolved. Please finalize the document with the changes agreed to according to this correspondence. If you have questions, please call me at (330) 963-1292.

Sincerely,

Kevin M. Palombo
Environmental Specialist
Division of Environmental Response and Revitalization

KP/sc

ec: David Connolly, ARNG
Kevin Sedlak, ARNG, Camp James A. Garfield
Katie Tait, OHARNG, Camp James A. Garfield
Craig Coombs, USACE Louisville
Nathaniel Peters, USACE Louisville
Rebecca Shreffler, Chenega Tri-Services, LLC
Mark S. Johnson, Jr., Ohio EPA, DERR, NEDO
Bob Princic, Ohio EPA, DERR, NEDO
Liam McEvoy, Ohio EPA, DERR, NEDO
Thomas Schneider, Ohio EPA, DERR, SWDO
Carrie Rasik, Ohio EPA, DERR, CO

NATIONAL GUARD BUREAU
111 SOUTH GEORGE MASON DRIVE
ARLINGTON VA 22204-1373

June 10, 2019

Ohio Environmental Protection Agency
DERR-NEDO
Attn: Mr. Kevin Palombo
2110 East Aurora Road
Twinsburg, OH 44087-1924

Subject: Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, RVAAP-66 Facility-Wide Groundwater, Responses to Comments on the Background Study for Metals (Work Activity No. 267-000-859-036)

Dear Mr. Palombo:

The Army appreciates your time and comments (dated and received May 29, 2019) on the *Draft Background Study for Metals for RVAAP-66 Facility-wide Groundwater*. Enclosed for your review are responses to your comments. Upon resolution of these comments, the Army will provide a Final version of the study for Ohio EPA concurrence.

This comment response table was prepared for the Army National Guard in support of the RVAAP restoration program. Please contact the undersigned at (703) 607-7589 or david.m.connolly8.civ@mail.mil if there are issues or concerns with this submission.

Sincerely,

David Connolly
RVAAP Restoration Program Manager
Army National Guard Directorate

cc: Bob Princic, Ohio EPA, NEDO, DERR
Mark Johnson, Ohio EPA, NEDO, DERR
Liam Envoy, Ohio EPA, NEDO, DERR
Albert Muller, Ohio EPA, NEDO, DMWM
Thomas Schneider, Ohio EPA, SWDO, DERR
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Kevin Sedlak, ARNG, Camp James A. Garfield
Katie Tait, OHARNG, Camp James A. Garfield
Craig Coombs, USACE Louisville
Jay Trumble, USACE Louisville
Vasu Peterson, Leidos
Jed Thomas, Leidos
Gail Harris, Vista Sciences Corporation

Subject: Former Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, Facility-Wide Groundwater Responses to Comments on Background Study for Metals (Work Activity No. 267-000-859-036)

Comments

Ohio EPA Comment 1: Section 4.2.1.5 states that while the December 2017 results from well BKGmw-021 indicated that lead was an outlier, it appears that the entire December 2017 sampling event results from well BKGmw-021 were also removed from the Unconsolidated Aquifer data sets, so the parameters other than lead were not included in statistical evaluations. It should be clarified as to why the entire sampling event data set was excluded from statistical analysis, when only lead was found to be an outlier.

Army Response: Clarification. Upon identification that the lead concentration for sample the BKGmw-021 collected in December 2017 was a potential outlier, the laboratory report and any available sample-specific information was reviewed. This review could not identify the reason in which the lead concentration was high in this sample. Since it was unable to be determined why this sample had an elevated concentration of lead, all the results from this sample were conservatively excluded from the background concentrations. Even while excluding these sample results, there was still an adequate amount of samples to statistically calculate the background concentrations in the Unconsolidated aquifer.

Ohio EPA Comment 2: The final data sets used for background calculations appear to consist of eight sets of sampling results for the Unconsolidated Aquifer and eleven sets of sample results for each the Homewood, Upper Sharon, and Basal Sharon Conglomerate Aquifers. However, different tables within the report indicate up to 14 sets of sampling events for the Unconsolidated, 13 events for the Homewood, 13 events for the Upper Sharon, and 12 events for the Basal Sharon (minus obvious confirmation duplicate sampling events). While some Unconsolidated Aquifer samples discussed in Comment 1 are identified as being absent from the final data sets, it should be clarified as to what sampling events, and subsequently what data were selected for statistical analyses.

Army Response: Clarification. Table 4-1 presents the complete list of background wells and sample events that are used in the final background data set and also notes which of these sample events were excluded from the final background data set. As noted in Table 4-1, 11 samples were collected from each of the 4 aquifers. Three of the samples collected from the Unconsolidated zone were excluded from the background calculations based on the assessment of turbidity (2 samples as described in Section 4.2.1.4) and outliers (1 sample as described in Section 4.2.1.5) leaving 8 samples for the Unconsolidated zone and 11 samples for each of the other 3 aquifers.

Ohio EPA Comment 3: The presented background data tables and box plot data were compared to "Ohio's Integrated Water Quality Monitoring and Assessment Report" (Ohio EPA, 2016, Section M) which compiles Ohio EPA's Ambient Ground Water program raw ground water samples taken from public drinking water wells. In general, background ground water results and the calculated background upper cutoff values for Unconsolidated, Homewood, Upper Sharon, and Basal Sharon Aquifers underlying the site are within an order of magnitude of ranges (for sand and gravel aquifers and sandstone aquifers) found throughout Ohio and appear to be acceptable calculations of reasonably anticipated natural concentrations.

Army Response: Comment noted.

Ohio EPA Comment 4: The upper cutoff values for metals parameters barium, copper, hexavalent chromium, lead, nickel, selenium, and zinc were found to be below applicable Ohio EPA's ambient program data (Ohio EPA, 2016), while upper cutoff values for metals parameters calcium, iron, and magnesium were found to be higher than ambient program data. Remaining metals were varied as to ranging below or above ambient program data, but generally within acceptable margins.

Army Response: Comment noted.

Ohio EPA Comment 5: The Piper diagrams showing the background ground water quality/chemistry in the Upper Sharon and Basal Sharon Conglomerate beneath Camp Garfield are consistent with what is published in Foos et al., 2003 (Ohio Department of Natural Resources Guidebook No. 18, 2003) for ground water quality in the Sharon Aquifer in Portage County.

Army Response: Comment noted.

Ohio EPA Comment 6: The upper cutoff values for the parameters calcium, magnesium, sodium, potassium, and magnesium for background ground water quality in the Upper Sharon and Basal Sharon Conglomerate Aquifers beneath Camp Garfield are within the range of 127 analyses of ground water chemistry in the Sharon Aquifer published in Foos et al., 2003.

Army Response: Comment noted.

Ohio EPA Comment 7: Elevated levels of arsenic in background samples in the Basal Sharon Conglomerate are likely naturally occurring and can be attributed to the dissolution of arsenic from arsenopyrite and iron oxide cements in the Basal Sharon Conglomerate and Harrison Ore (Matisoff et al., 1980).

Army Response: Comment noted.

Ohio EPA Comment 8: Background ground water results and the calculated background upper cutoff value for arsenic (0.048 mg/L) in the Basal Sharon Conglomerate Aquifer beneath Camp Garfield exceed the Drinking Water Maximum Contaminant Level (MCL) for arsenic of 0.01 mg/L.

Army Response: Comment noted. The drinking water MCL will be considered as part of the human health risk assessment in the remedial investigation report.

Ohio EPA Comment 9: According to the 2018 Edition of the "Drinking Water Standards and Heath Advisory Tables," (United States EPA, 2018), background ground water results and the calculated background upper cutoff value for manganese in the Homewood (0.56 mg/L) and Basal Sharon Aquifers (1.03 mg/L) beneath Camp Garfield exceed the 2018 U.S. EPA Life-Time Health Advisory Level (HAL) for manganese of 0.30 mg/L.

Army Response: Comment noted.

Ohio EPA Comment 10: The calculated background upper cutoff value for sodium in the Homewood (21 mg/L) exceeds the 2018 U.S. EPA HAL for sodium of 20 mg/L for individuals on a 500 mg/day restricted sodium diet. However, the individual data results for sodium in the Homewood do not exceed the sodium HAL.

Army Response: Comment noted.

Ohio EPA Comment 11: Background ground water results and the calculated background upper cutoff value for sodium (129 mg/L) in the Upper Sharon Aquifer beneath Camp Garfield exceed the 2018 U.S. EPA HAL for sodium of 20 mg/L for individuals on a 500 mg/day restricted sodium diet.

Army Response: Comment noted.

Ohio EPA Comment 12: Additionally, it was noted that Figure 3.3 shows lithologic sequences out of geologic/chronological order and includes the Berea Sandstone and Cuyahoga Group shale/sandstone in the legend when these units are not present on the Figure. The Berea Sandstone and Cuyahoga Group shale/sandstone do not outcrop on site and are not the bedrock first encountered underlying the Unconsolidated Aquifer at the site. For clarification, on Figure 3.3 please remove references to lithologic groups that are not present as bedrock outcrops or bedrock beneath the Unconsolidated Aquifer on the site and re-sort the remaining lithologic groups in chronological order.

Army Response: Agree. Revised Figure 3-3 is attached and has been modified per comments on the 2018 Annual Report. This reflects what was in Figure 1-3 of the RI Work Plan. Please note that the color scheme has been revised to closely mirror what is in the cross sections in Figures 3-4 and 3-5, and the order in the legend has been revised from youngest to oldest.

Subject: Former Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, Facility-Wide Groundwater Responses to Comments on Background Study for Metals (Work Activity No. 267-000-859-036)

Revied Figure 3-3:

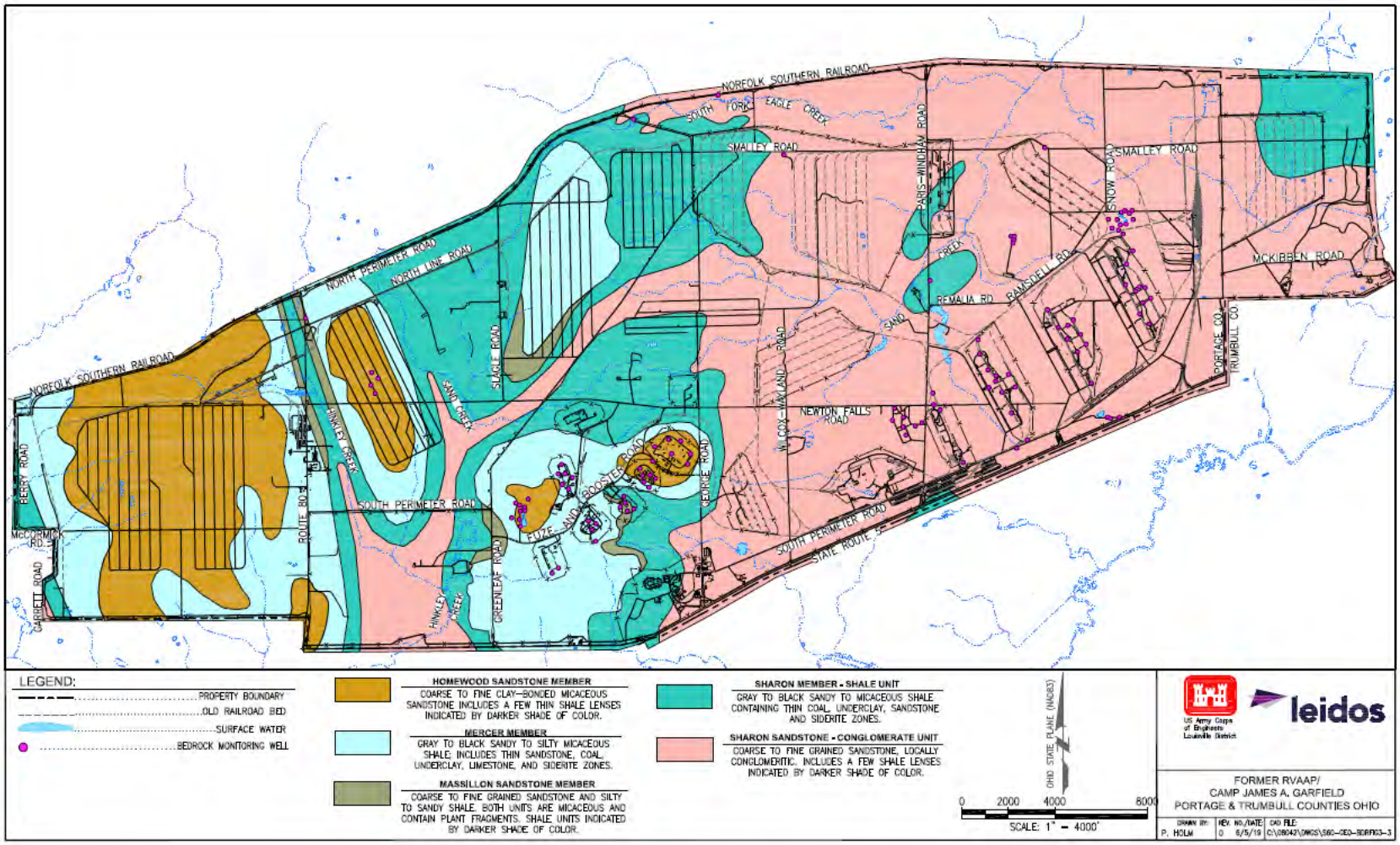

Figure 3-3. Geologic Bedrock Map and Stratigraphic Description of Units at Camp James A. Garfield

Ohio Environmental Protection Agency

Mike DeWine, Governor
Jon Husted, Lt. Governor
Laurie A. Stevenson, Director

May 29, 2019

RE: US Army Ammunition Plt RVAAP
Remediation Response
Project Records
Remedial Response
Portage County
ID # 267000859036

Mr. David Connolly
Army National Guard Directorate
Environmental Programs Division
ARNGD-ILE-CR
111 South George Mason Drive
Arlington, VA 22204

Subject: Ohio EPA Comments on the "Draft Background Study for Metals for RVAAP-66 Facility-wide Groundwater," Dated March 21, 2019

Dear Mr. Connolly:

The Ohio Environmental Protection Agency (Ohio EPA) has received and reviewed the "Draft Background Study for Metals for RVAAP-66 Facility-wide Groundwater" at the Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio (Camp Garfield). This document was received at Ohio EPA's Northeast District Office (NEDO), Division of Environmental Response and Revitalization (DERR) on March 26, 2019. The report was prepared for the United States Army Corps of Engineers on behalf of the National Guard Bureau by Leidos under Contract Number W912QR-16-D-0003.

Comments on the document based on Ohio EPA review are provided below. Please provide responses to the enclosed comments in accordance with the Directors Findings and Orders.

STATEMENT

The "Draft Background Study for Metals for RVAAP-66 Facility-wide Ground Water" summarizes findings of the background ground water sampling conducted for purposes of establishing background concentrations for metals in ground water at the former RVAAP. Background calculations were determined in accordance with the methodology specified in the "Remedial Investigation Work Plan for Ground Water and Environmental Investigation Services for RVAAP-66 Facility-wide Ground Water" (2016 RI Work Plan) and were calculated for all four different geologic aquifers on-site: the Unconsolidated, Homewood, Upper Sharon, and Basal Sharon Conglomerate.

In accordance with the 2016 RI Work Plan, background concentrations were calculated using the method outlined in "Use of Background for Remedial Response Sites" found in Ohio EPA, DERR's "2009 Technical Decision Compendium" (TDC). This method determines upper cutoff value (U) for the background concentration of a given metal as being equal to the sum of the upper quartile of the data (Q3) with the product of a constant (K) times the interquartile range of the data (Q3- Q1). The Ohio EPA 2009

document recommends a multiplicative value for K of 1.5. The referenced equation used for these calculations is as follows:

$$U = Q3 + k (Q3- Q1)$$

A total of 14 monitoring wells were used for background data, based on the apparent upgradient locations of these wells and/or the determination that these wells were most likely not impacted by historical activities at the facility. These wells included: four Unconsolidated (Hiram and Lavery Tills) Aquifer wells (BKGmw-005, BkGmw-016, BKGmw-017, and BKGmw-021), three Homewood Aquifer wells (BKGmw-022, BKGmw-023, and BKGmw-005), four Upper Sharon Aquifers (BKGmw-006, BKGmw-008, BKGmw-015, BKGmw-018) and three Basal Sharon Conglomerate Wells (BKGmw-024, BKGmw-025, and SCFmw-006).

The data from these background wells were collected during sampling events conducted between November 2016 and December 2017.

COMMENTS

1. Section 4.2.1.5 states that while the December 2017 results from well BKGmw-021 indicated that lead was an outlier, it appears that the entire December 2017 sampling event results from well BKGmw-021 were also removed from the Unconsolidated Aquifer data sets, so the parameters other than lead were not included in statistical evaluations. It should be clarified as to why the entire sampling event data set was excluded from statistical analysis, when only lead was found to be an outlier.

2. The final data sets used for background calculations appear to consist of eight sets of sampling results for the Unconsolidated Aquifer and eleven sets of sample results for each the Homewood, Upper Sharon, and Basal Sharon Conglomerate Aquifers. However, different tables within the report indicate up to 14 sets of sampling events for the Unconsolidated, 13 events for the Homewood, 13 events for the Upper Sharon, and 12 events for the Basal Sharon (minus obvious confirmation duplicate sampling events). While some Unconsolidated Aquifer samples discussed in Comment 1 are identified as being absent from the final data sets, it should be clarified as to what sampling events, and subsequently what data were selected for statistical analyses.

3. The presented background data tables and box plot data were compared to "Ohio's Integrated Water Quality Monitoring and Assessment Report" (Ohio EPA, 2016, Section M) which compiles Ohio EPA's Ambient Ground Water program raw ground water samples taken from public drinking water wells. In general, background ground water results and the calculated background upper cutoff values for Unconsolidated, Homewood, Upper Sharon, and Basal Sharon

Aquifers underlying the site are within an order of magnitude of ranges (for sand and gravel aquifers and sandstone aquifers) found throughout Ohio and appear to be acceptable calculations of reasonably anticipated natural concentrations.

4. The upper cutoff values for metals parameters barium, copper, hexavalent chromium, lead, nickel, selenium, and zinc were found to be below applicable Ohio EPA's ambient program data (Ohio EPA, 2016), while upper cutoff values for metals parameters calcium, iron, and magnesium were found to be higher than ambient program data. Remaining metals were varied as to ranging below or above ambient program data, but generally within acceptable margins.

5. The Piper diagrams showing the background ground water quality/chemistry in the Upper Sharon and Basal Sharon Conglomerate beneath Camp Garfield are consistent with what is published in Foos et al., 2003 (Ohio Department of Natural Resources Guidebook No. 18, 2003) for ground water quality in the Sharon Aquifer in Portage County.

6. The upper cutoff values for the parameters calcium, magnesium, sodium, potassium, and magnesium for background ground water quality in the Upper Sharon and Basal Sharon Conglomerate Aquifers beneath Camp Garfield are within the range of 127 analyses of ground water chemistry in the Sharon Aquifer published in Foos et al., 2003.

7. Elevated levels of arsenic in background samples in the Basal Sharon Conglomerate are likely naturally occurring and can be attributed to the dissolution of arsenic from arsenopyrite and iron oxide cements in the Basal Sharon Conglomerate and Harrison Ore (Matisoff et al., 1980).

8. Background ground water results and the calculated background upper cutoff value for arsenic (0.048 mg/L) in the Basal Sharon Conglomerate Aquifer beneath Camp Garfield exceed the Drinking Water Maximum Contaminant Level (MCL) for arsenic of 0.01 mg/L.

9. According to the 2018 Edition of the "Drinking Water Standards and Heath Advisory Tables," (United States EPA, 2018), background ground water results and the calculated background upper cutoff value for manganese in the Homewood (0.56 mg/L) and Basal Sharon Aquifers (1.03 mg/L) beneath Camp Garfield exceed the 2018 U.S. EPA Life-Time Health Advisory Level (HAL) for manganese of 0.30 mg/L.

10. The calculated background upper cutoff value for sodium in the Homewood (21 mg/L) exceeds the 2018 U.S. EPA HAL for sodium of 20 mg/L for individuals on a 500 mg/day restricted sodium diet. However, the individual data results for sodium in the Homewood do not exceed the sodium HAL.

11. Background ground water results and the calculated background upper cutoff value for sodium (129 mg/L) in the Upper Sharon Aquifer beneath Camp Garfield exceed the 2018 U.S. EPA HAL for sodium of 20 mg/L for individuals on a 500 mg/day restricted sodium diet.

12. Additionally, it was noted that Figure 3.3 shows lithologic sequences out of geologic/chronological order and includes the Berea Sandstone and Cuyahoga Group shale/sandstone in the legend when these units are not present on the Figure. The Berea Sandstone and Cuyahoga Group shale/sandstone do not outcrop on site and are not the bedrock first encountered underlying the Unconsolidated Aquifer at the site. For clarification, on Figure 3.3 please remove references to lithologic groups that are not present as bedrock outcrops or bedrock beneath the Unconsolidated Aquifer on the site and re-sort the remaining lithologic groups in chronological order.

This "Draft Background Study for Metals for RVAAP-66 Facility-wide Groundwater" was reviewed by personnel from Ohio EPA, DERR, DERR Risk, and Division of Materials and Waste Management (DMWM). Additional information is necessary to approve the document. If you have questions or would like to set up a meeting to discuss these comments, please call me at (330) 963-1292.

Sincerely,

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