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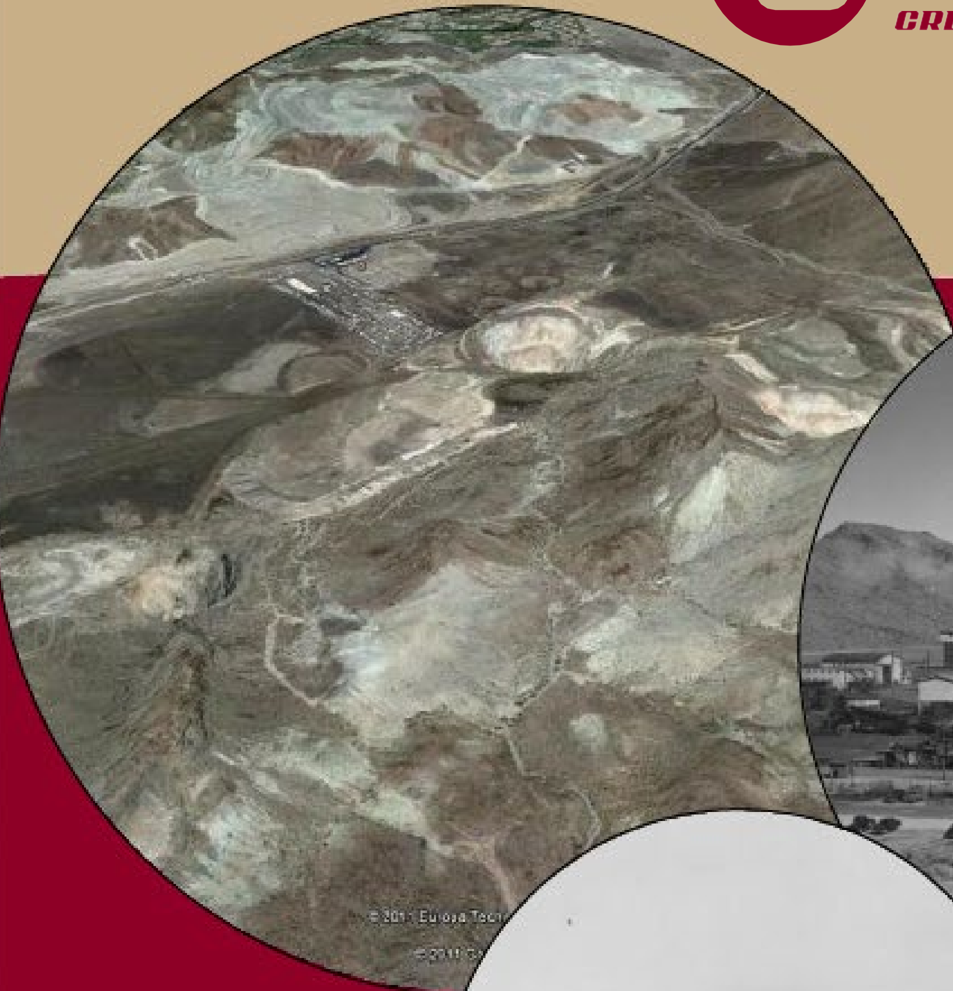

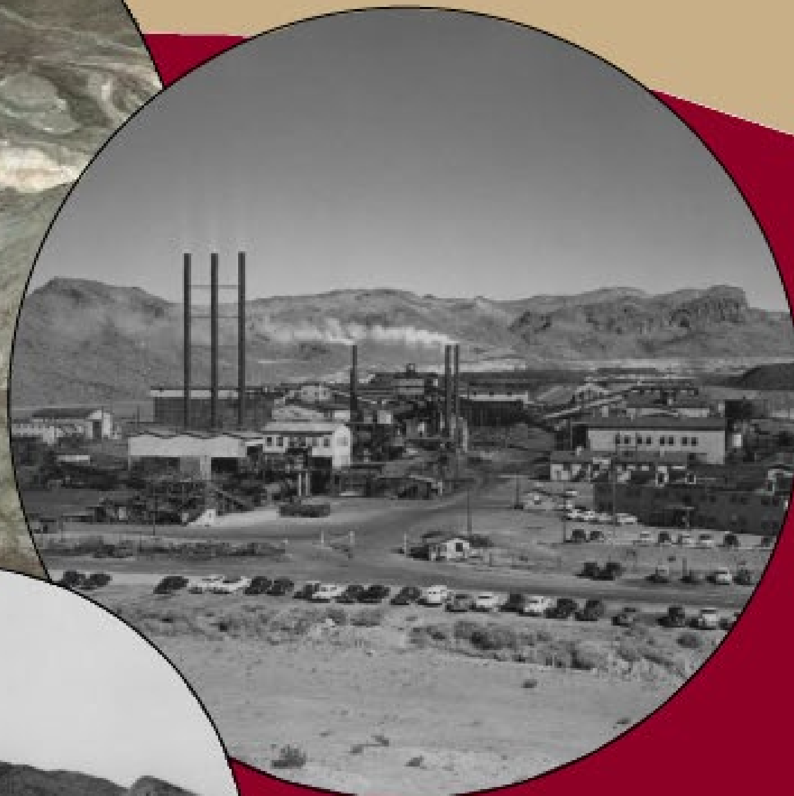

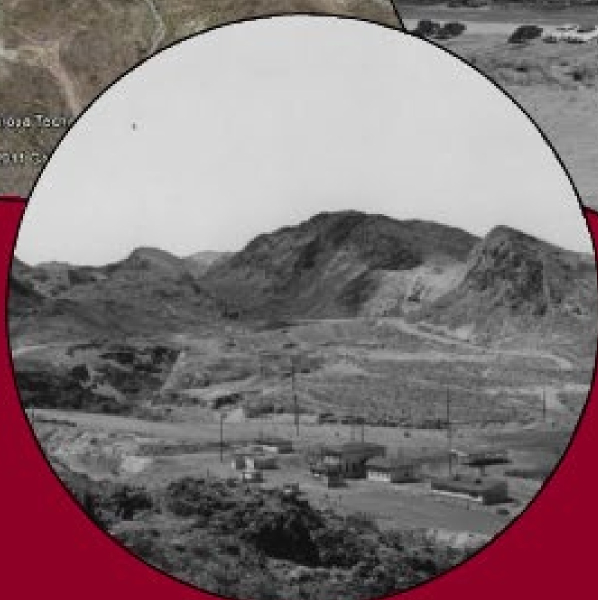

Background Soil Report, Revision 2
Three Kids Mine
Lakemoor Ventures LLC

April 2022

April 5, 2022 Project No. 14-01-156

Alan Pineda, PE
Professional Engineer
Bureau of Industrial Site Cleanup
Nevada Division of Environmental Protection
375 E. Warm Springs Rd., Ste. 200
Las Vegas, NV 89119

Attn: Mr. Pineda

Re: Background Soil Report, Revision 2
Three Kids Mine

Dear Mr. Pineda:

Broadbent & Associates, Inc. (Broadbent) is pleased to submit this *Background Soil Report, Revision 2*.

Please do not hesitate to contact us if you should have any questions or require additional information.

Sincerely,
BROADBENT & ASSOCIATES, INC.

Kirk Stowers, Certified Environmental Manager
Principal Geologist

cc: JD Dotchin, NDEP
James Carlton Parker, NDEP
Joe McGinley, McGinley & Associates, Inc.
Caitlin Jelle, McGinley & Associates, Inc.
Ann Verwiel, ToxStrategies
Robert Unger, Lakemoor Ventures LLC
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Leo Drozdoff, Drozdoff Group, LLC
Karen Gastineau, Broadbent & Associates, Inc.
Cynthia Cheatwood, EA Engineering
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Elizabeth Moody, Bureau of Land Management
Christene Klimek, City of Henderson
Sean Robertson, City of Henderson
Stephanie Garcia-Vause, City of Henderson
Anthony Molloy, City of Henderson

Background Soil Report, Revision 2
Three Kids Mine
Henderson, Nevada

JURAT: I, Karen Gastineau, hereby certify that I am responsible for the services in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulation and ordinances.

______________________________	**April 5, 2022**
Karen Gastineau	**Date**
Senior Hydrogeologist	
Certified Environmental Manager #2468 (4/1/2023)	

NDEP Response to: *Background Soil Report, Revision 2* (April 2022)

1. **Section 1.1.1 Location** – This section indicates that the site includes seven parcels totaling approximately 851 acres under federal administration. It is unclear why the area for the federally-owned land was changed from 952 to 851 acres. The total site area was also changed accordingly. Per the Act, the Three Kids Mine project site consists of approximately 1,262 acres, 948 of which are federally owned. Please explain.

Response: The original Act listed 948 acres of federal land, but this included the 1,400' wide Bureau of Reclamation (BOR) 500kV power corridor. It has since been decided that this area is not needed in open space calculations for Lakemoor and is better kept with BOR. Therefore, the federal acreage for transfer has been reduced to 851 acres. There are other areas with existing easements that will be transferred, but those easements will stay in place and Lakemoor has been coordinating with the entities on development plans to ensure no conflicts will arise.

2. **Section 2.2 Sample Analysis** – The report indicates that "selected samples were analyzed for select polycyclic aromatic hydrocarbons (PAHs) to evaluate impacts to downwind parcels." Although the analytical results for PAHs are presented in Table 1 and Table A.2, the text does not include any discussion of the analytical results (Table 1) or the comparison of their SQLs to the RSLs (Table A.2). It would be helpful for these items to be discussed in the text, or for a statement to be added to the end of Section 2.2 indicating where they will be discussed.

Response: A discussion of the PAH results for the downwind parcels was not included in the Background Soil Report because these analytical results will be evaluated in a risk assessment. A Screening Level Human Health Risk Assessment will be submitted for the Volcanic Units of Downwind Parcels (Strata 122) in the first half of 2022. The text in Section 2.2 has been revised to note these results will be discussed in forthcoming risk assessments.

3. **Section 3.1.2 Exploratory Analyses and Outlier Identification** – When describing the exclusion of outliers, it may be better to use a more descriptive phrase such as "eliminated as an outlier" or "not representative of the data set" instead of "thrown out."

Response: The text has been revised to replace "thrown out" with "eliminated from the dataset as an outlier."

4. **Section 3.1.2 Exploratory Analyses and Outlier Identification** – This section states that "individual metals excluded for River Mountains background samples BG-121-18-01 (anomalous

manganese) and BG-121-26-01 (anomalous lead and manganese) were excluded at the request of NDEP in the meeting held on October 13, 2021." The Background Soil Report was submitted to NDEP on December 23, 2021; NDEP provided draft comments on January 26, 2022; and a meeting to discuss draft comments was held on February 9, 2022. Therefore, it seems more likely that the decision to exclude the individual metals for these two samples was made at the February 9th meeting during discussion regarding General Comment #1.

Response: A meeting was held with NDEP on October 13, 2021 to discuss the preliminary assessment of background results and the risk assessment work plan. A discussion of potential outliers was included and discussed in this meeting.

5. **Section 3.3.3.1 Sedimentary Units of Downwind Parcels versus Muddy Creek Formation** – This section should indicate that based on the limited number of samples for the downwind parcel, there is some uncertainty about the conclusion of this comparison. In fact, the means and medians are much higher in the downwind parcels for several additional metals.
    a. **Table 5a** – The results using ANOVA options in ProUCL provide very different conclusions regarding which metals would be considered from different populations. Although it is possible for SAS to provide different results for these comparisons based on the input statistics, the summary of the comparison should mention the limited data (only five samples for sedimentary units of downwind parcels) and that there may be other metals that have different concentrations based on comparison of medians.

Response: We agree that there is some uncertainty about the conclusion of this comparison due to the limited number of samples. We would note that we are not suggesting that the sedimentary units of the downwind parcels are background. However, some text has been added to the section to provide clarification.

6. **Section 4 Summary and Conclusions** – For additional clarity, it would be helpful for the second paragraph in this section to also mention that individual metals were excluded from the calculation of BTVs for two samples (BG-121-18-01 excluded for manganese, and BG-121-26-01 excluded for lead and manganese).

Response: The additional text has been added to Section 4 to detail the individual metals excluded from two samples within the River Mountain volcanic rocks.

7. **Table 3 Background Summary Statistics** – Units are not identified. The footnote indicating "all concentrations reported in milligrams per kilogram" should have been retained.

Response: The units have been added to Table 3.

8. **Table A.2 Comparison of Sample Quantitation Limits to Risk-Based Screening Levels**
    a. If samples were analyzed for total chromium, it may not be appropriate to compare the corresponding sample quantitation limits to the trivalent chromium RSL of 12,000 mg/kg.
    b. Table A.2 lists an RSL of 180 mg/kg for benzo[g,h,i]perylene, and 1,800 mg/kg for phenanthrene. These PAHs are not listed in the USEPA RSL Summary Table (November 2021). Please add a footnote to Table A.2 with a reference for the listed values.

Response: Table A.2 has been revised to note the surrogate chemicals used in determining RSLs for benzo[g,h,i]perylene and phenanthrene.

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1 INTRODUCTION

This Background Soil Report, Revision 1 was prepared by Broadbent & Associates, Inc. (Broadbent) and EA Engineering, Science, and Technology, Inc. PBC (EA) on behalf of Lakemoor Ventures, LLC (Lakemoor) for the Three Kids Mine site (Site) located in Clark County, Nevada, just east of the City of Henderson (Figure 1). The Site is being remediated and reclaimed by Lakemoor in conjunction with residential development plans in cooperation with the City of Henderson, Clark County, the Nevada Division of Environmental Protection (NDEP) Bureau of Industrial Site Cleanup, the U.S. Bureau of Land Management, and the U.S. Bureau of Reclamation. NDEP is the lead agency overseeing the reclamation of the Site.

Broadbent collected background samples according to the approved *Phase II Sampling and Analysis Plan, Revision 2* (SAP) for site characterization dated November 3, 2021 (Broadbent, 2021). This report discusses geological units present at the Site (Section 1.3), summarizes the background soil investigation (Section 2), discusses statistical methods used on the data gathered during the investigation (Section 3), and provides a summary and conclusions (Section 4). The project objectives, purpose, and Site location and geologic setting are discussed below.

Objectives

This Background Soil Report, Revision 1 was prepared to compile and assess Site sample chemical analyses for development of background datasets in native geologic units that have not been directly disturbed by mining and other operations. The background concentrations of metals will be used for: 1) the assessment of remediation completeness (comparison of contaminant concentrations to Site background), 2) the assessment of whether significant airborne deposition of metals may have occurred in downwind, undisturbed portions of the Site, and 3) evaluating the suitability of borrow materials, if needed.

The primary purpose of this background soil study is to obtain a background soil dataset to establish background concentrations for metals at the Site. Additionally, selected samples were analyzed for select polycyclic aromatic hydrocarbons (PAHs) to evaluate impacts to downwind parcels.

1.1 SITE LOCATION AND GEOLOGIC SETTING

1.1.1 Location

The Site is located approximately five miles northeast of central Henderson, Nevada, along East Lake Mead Parkway (State Road 564). A general location map is provided in Figure 1. The property occupies most of Section 35 and parts of Sections 26, 34, and 36 of Township 21S, Range 63E, Mount Diablo Meridian. The approximate center of the Site is at 36°05'00"N latitude and 114°54'50"W longitude (Figure 2). The Site consists of approximately 1,165 acres in 18 parcels. Seven parcels totaling approximately 851 acres are under federal administration. The remaining 314 acres are distributed across 11 parcels, controlled by three different private entities. Access to most of the Site is gained via a locked gate and unpaved road in the northeast corner of the Site. A small portion of the Site is located north of Lake Mead Parkway and can be accessed by foot.

1.1.2 Geology and Geomorphology

The Site is a part of the Basin and Range province in southern Nevada, near the northern end of the River Mountains Range, which trend northwest – southeast. The Site is surrounded on the south, east, and north by volcanic units of the River Mountains and is open west to a basin. Prior to mining activities, the Site overlaid a gently northwest sloping, thin, alluvial plain deposit within the basin separated from the river mountain bedrock by normal faults. Historical maps show the plain to have been dissected by rills and gullies (Zenitech, 2007). The alluvial plain where the mine and mill were constructed sat on units of the sedimentary Muddy Creek Formation. The regional geology around the Site is provided in Figure 2, the Site-specific geology is presented in Figure 3a, and the geologic key is provided in Figure 3b.

1.1.3 Geological Units

Historical data, geological mapping by Bell and Smith (1980), and prior field inspections indicate that the western half of the Site are sedimentary in origin and are expected to contain low natural arsenic and lead relative to the ore unit or volcanic rocks. By comparison, the volcanics of the east and south portions of the Site have previously demonstrated somewhat higher concentrations of arsenic and lead (CH2M Hill, 2008). The ore body remnants, which can be seen in the pits and commingled with sedimentary overburden, are expected to contain the highest concentrations of arsenic, lead, manganese, and other metals, based on historical data and references (Bureau of Mines, 1945; Hunt et al., 1942; Morris, 1954; NBMG, 1942; Pardee, 1920). Areas sampled as part of the background investigation have been stratified according to geologic subunits and substratified according to upwind/downwind position, based on historical weather patterns (Basic Remediation Company, 2007a; ERM, 2005; WRCC 2006a, 2006b, 2007, and 2021). The following sections detail the geologic subunits identified for investigation in the background investigation.

1.1.3.1 Muddy Creek Formation

The Muddy Creek Formation is a late Miocene/early Pliocene basin fill sedimentary deposit of Lacustrine and subaerial origin (Bell and Smith, 1980). Site geologic units include gypsiferous red siltstones, sandstones, mudstones, tuffs, and beds of massive gypsum. Overall thickness of the Muddy Creek at the Site is estimated at greater than 1,000 feet, except where it thins to meet the River Mountains volcanics along the Extension fault (Hunt et al., 1942). During mining, large portions of the Muddy Creek formation overburden were removed and incorporated onsite to construct dams and control erosion or were deposited as waste rock on the surface. Most of this construction occurred on the west side of the mining properties where large boulders of Muddy Creek gypsum are observable (Zenitech, 2007). Geotechnical and Environmental Services, Inc. (GES, 1998) conducted sampling of overburden and native rock and observed that native rock was not acid generating.

1.1.3.2 Ore Body

The ore body mined at the Site is generally described as a manganiferous- or "wad"-rich, tuffaceous, silty sandstone of 10-80 feet in thickness (Hunt et al., 1942; Pardee and Jones, 1920; Johnson and Trengove, 1956; McKelvey et al., 1949). On-site evidence of hydrothermal activity around faults and manganiferous seep deposits along the exposed Lowney fault wall support a transport and silica and manganese replacement theory, with the Muddy Creek Formation being the primary host. However, Bell and Smith (1980) describe the ore body as tuffaceous or pyroclastic in origin. They believe that the ore body was a separate unit from the Muddy Creek formation, either associated with the River Mountains or independent. Most of the original ore body was mined out in the 1950s making detailed modern study difficult.

1.1.3.3 River Mountain Bedrock

Eleven to twelve million years ago in the mid-Tertiary Period, the River Mountains were formed as part of a strato-volcano complex six miles southeast of the Site (Bell and Smith, 1980). At the location of the subject property, these mountains are composed of lava flows. Bell and Smith (1980) mapped three different units in the locality with the major unit being volcanic lava flows of mainly dacite composition interbedded with epiclastic (local source) sandstones, conglomerates and breccias, and pyroclastic units. The dacite is biotite-, plagioclase-, and hornblende-bearing, and of variable texture. Upper and lower parts of many individual flows are brecciated. Individual flows vary in texture and minor mineral composition. Many flows are vesiculated and some exhibit interbedded breccia, tuff, or agglomerate. The River Mountain volcanics are mainly dacite composition rocks interbedded with epiclastic (local source) sandstones, conglomerates and breccias, and pyroclastic units.

1.1.3.4 Surficial Deposits in Downwind Parcels

The youngest geologic units on the Site are Quaternary surface deposits and soils. These sediments are eroded from and overlie the Muddy Creek Formation as alluvial or pediment deposits up to 20 feet thick. Additional alluvial deposits derived from the River Mountain volcanics were deposited within drainages of the River Mountains. Site soils are derived from weathering of primary bedrock units or secondary alluvial deposits. All Site soils tend to be gypsiferous with clasts of dacite, basalt, and tuff (Zenitech, 2007). Gypsum content is locally highly variable. Winds predominantly blow from the south and west (Zenitech, 2007) and the north (stratum 112) and eastern (stratum 122) parcels of the Site are expected to be the affected by windblown chemicals migrating from Site (Figure 4).

2 SUMMARY OF BACKGROUND INVESTIGATION

2.1 SAMPLING PROCEDURES

A detailed description of the sampling and analysis procedures for the background investigation is provided in the Phase II SAP (Broadbent, 2021). The sampling design used for establishing Site background concentrations for metals is referred to as Element 1. As metals are the primary site-related chemical (SRC) at the Site, reliable background ranges for metals are essential to establishing remediation benchmarks for achieving successful restoration of the Site. As mentioned in Section 1.1, background concentrations of metals will be used for:

1. The assessment of remediation completeness, and
2. The assessment of whether significant airborne deposition of metals may have occurred in downwind, undisturbed portions of the Site.
3. Only if needed, to assess import borrow materials.

The following strata were sampled for Element 1 and are also depicted in Figure 4.

Strata
1.1 Sedimentary Rocks of Muddy Creek Formation and Alluvia
1.1.1 Sedimentary Rocks in Background Areas
1.1.2 Sedimentary Rocks in Downwind Areas
1.2 Volcanic Rocks of Powerline Road (River Mountains)
1.2.1 Volcanic Rocks in Background Areas
1.2.2 Volcanic Rocks in Downwind Areas
1.3 Ore-bearing Rocks (Manganiferous unit)

Samples collected for Element 1 were discrete, independent samples from representative areas. Sample points were the center of randomly selected 20- by 20-foot (ft) sampling units, within a systematically identified 100- by 100-ft numbered grid. Samples of undisturbed soils, sediments, or rock were collected from the near surface (0-1 ft below ground surface, or bgs). Sampling and sample handling procedures were consistent with the standard operating procedures (SOPs) provided in the Phase II SAP (Broadbent, 2021). The following sections detail information specific to each stratum:

Stratum 1.1.1 Sedimentary Unit Background (Muddy Creek Formation)

Sedimentary unit background concentrations will be the basis for comparison to post-remediation soils in most portions of the disturbed area, since the majority of native soils beneath the mill and tailings consist of consolidated Muddy Creek sediments or related alluvial deposits. In addition, soil from this unit will also be used as “clean cover” during future Site development. A total of 23 samples were collected within the Muddy Creek Formation (stratum 111).

Stratum 1.1.2 Sedimentary Unit (Muddy Creek Formation) Downwind of Mill Site

These soil samples were collected for the evaluation of possible windblown deposits and/or tailings in Parcels 6 and 8 downwind of the impacted areas. A total of 5 samples were collected from this area (stratum 112).

Stratum 1.2.1 River Mountain Background

Outcrops of volcanic rocks may be encountered after remediation in some portions of the disturbed area. This unit has not been impacted by Site activities and may be considered an additional background dataset depending upon future Site development. In addition, soil from this unit will also be used as “clean cover” during future Site development. A total of 27 samples were collected for this unit (stratum 121).

Stratum 1.2.2 Volcanic Unit Downwind of Mill Site

Volcanic rock and soil samples were collected for the assessment of possible windblown metal deposits in Parcels 7, 8, and 17. Approximately one-fourth of the volcanic rocks at the Site are in the downwind area. A total of 9 samples were collected within this stratum (stratum 122).

Stratum 1.3 Ore-Bearing Unit

Ore-bearing materials can be found in overburden, mill Site soils, and in associated drainages, in tailings, and perhaps in downwind areas and other parts of the Site. Samples were collected from the ore-bearing unit to provide an indication of SRCs. A total of 13 samples were collected from the Ore Bearing Unit (stratum 13).

2.2 SAMPLE ANALYSIS

As discussed in the Phase II SAP (Broadbent, 2021), the following types of analyses were conducted on samples collected for this background report and were analyzed by Pace-National:

Stratum and Matrix	Analytical Scheme	Number of Samples Collected	Number of Samples in Analysis
1.1.1 Muddy Creek Formation	M1, M3	23	18
1.1.2 Sedimentary Unit of Downwind Parcels 6 & 8	M1, S1	5	5
1.2.1 River Mountain Background	M1, M3	27	22
1.2.2 Volcanic Units of Downwind Parcels 7, 8 & 17	M1, M3, S1	9	9
1.3 Ore Body Background Rocks	M1	13	12

- Analytical Scheme **M1** – U.S. Environmental Protection Agency (EPA) Method 6020A, Analytes: Antimony, arsenic, cadmium, chromium, copper, lead, manganese, selenium, and zinc.
- Analytical Scheme **S1** – EPA Method 8270C/E selected ion monitoring (SIM), Analytes: PAHs.

Although samples were broken out by geologic subunit in the Phase II SAP, for the purposes of statistical analyses presented in this report they are grouped simply by the major geologic unit for two reasons: 1) variation within geologic subunits is expected due to depositional environment, and 2) for practical purposes, it would not be clear which background threshold values (BTVs) to use for comparison to post-remediation samples if calculated by geologic subunit.

In addition, the following types of analyses were conducted on composite samples for some of the strata collected for the background study during 2021 per the Phase II SAP (Broadbent, 2021) identified as analytical scheme **M3**, and analyzed by Pace Wyoming:

- Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure (MWMP) by the American Society for Testing and Materials (ASTM) Method E2242-13 (ASTM, 2013).
- Total metals in MWMP extracts by EPA Methods 200.7, 200.8, and 245.1 (EPA, 1994a,b,c).
- Anions in MWMP extracts by ion chromatography by EPA Method 300.0 (EPA, 1993).

Table 1 presents the analytical results for the metals and SVOCs by stratum. MWMP results will be presented in the forthcoming *Leaching Analysis Report*. Additionally, a discussion of PAH analytical results for the downwind areas will be evaluated in forthcoming risk assessments.

2.3 DATA VALIDATION SUMMARY

Two levels of data validation were conducted by CDFriday, Inc. (2021). Approval of the *Data Validation Summary Report, Reporting of Three Kids Mine Background Study Data* (DVSR) is pending based on responses to NDEP comments. Stage 4 validation was conducted on at least 10 percent of all samples, and the remaining 90 percent were validated to Stage 2B, as specified in the Phase II SAP. Stage 4 verifies and validates the laboratory analytical data through completeness checks of sample receipt conditions, review of sample and laboratory instrument quality control (QC) results, recalculation checks, and review of laboratory instrument outputs (NDEP, 2018). Stage 2B verifies and validates the laboratory analytical data through completeness and compliance checks of sample receipt conditions and an evaluation of QC summary results (both sample-related and laboratory instrument related) (NDEP, 2018). Based on data validation and review, data qualifiers were noted to signify whether the data were acceptable, acceptable with qualification, or rejected. In addition, for every data validation qualifier, a secondary comment code was entered to indicate the primary reason for qualification. The DVSR provides the definitions for the data validation qualifiers and comment codes used in the validation process. Validation qualifiers and definitions are based on those used by EPA in current data validation guidelines (EPA, 2020a,b).

Several sample results were qualified as estimated based on the following issues (corresponding to Tables 4 through 8 in the DVSR:

- Laboratory blank contamination
- Field blank contamination
- Spike sample recovery
- Duplicate precision
- Serial dilution results

The DVSR notes that results qualified as estimated may be used for the purposes of establishing background concentrations and for comparison to Site sample data. No data were qualified as rejected in the dataset. Based on the evaluation of each dataset, 100 percent of the data obtained during the background dataset sampling event are valid; no data was rejected. All validated data is usable for the intended purposes.

2.4 DATA USABILITY

The analytical data were reviewed for applicability and usability following procedures in the *Guidance for Data Usability in Risk Assessment (Part A)* (EPA, 1992) and *Supplemental Guidance for Assessing Data Usability for Environmental Investigations at the BMI Complex and Common Area in Henderson, Nevada* (NDEP, 2010). There are six data useability criteria set forth by EPA and NDEP by which data are judged for usability. The six criteria are:

- Criterion I: Reports to Risk Assessor
- Criterion II: Documentation
- Criterion III: Data Sources
- Criterion IV: Analytical Methods and Detection Limits
- Criterion V: Data Review
- Criterion VI: Data Quality Indicators (DQIs)

2.4.1 Reports to Risk Assessor

This criterion evaluates whether all appropriate data and documentation are available for the risk assessment and other planned uses. The following information components for the determination of data usability are identified:

1. Site description, conceptual Site mode, and objectives for field investigations are provided in the NDEP-approved Phase II SAP (Broadbent, 2021).
2. A Site map with sample locations is provided in Figure 4.
3. Sampling design and procedures, including rationale, are provided in the NDEP-approved Phase II SAP (Broadbent, 2021) and discussed in Sections 2.1 and 2.2.
4. Analytical methods and detection limits are provided in the Phase II SAP (Broadbent, 2021).
5. A complete dataset, including sample quantitation limits (SQLs) and qualifiers, is provided in Appendix A and B of the DVSR.
6. QC results are provided by the laboratory, including blanks, replicates, and spikes. The laboratory QC results are included as part of the DVSR.
7. The laboratory provides a narrative with each analytical data package outlining problems encountered in the laboratory, control limit exceedance, and rationale for deviations from protocol. These narratives are included as part of the DVSR.
8. Data flags used by the laboratory and data validator are provided in the DVSR.
9. Electronic files containing the raw data made available by the laboratory are included as part of the DVSR.
10. Laboratory analytical data packages are provided in the DVSR.

2.4.2 Data Sources

The objective of the data source review is to ensure that the analytical methods used for the investigation are appropriate. The data collection activities were primarily developed to characterize background metals and potential impacts to downwind areas. Analytical methods used were set forth in the Phase II SAP and are analytical methods established by the EPA (Broadbent, 2021). Additionally, the laboratory that performed all analytical methods evaluated in this analysis is accredited by the State of Nevada. Therefore, the analytical methods and data sources for the chemical and physical parameters are appropriate for use.

2.4.3 Documentation

The documentation review ensures that each analytical result can be traced to a sample location, and the procedure(s) used to collect the environmental samples were appropriate. The samples were collected in accordance with the SOPs presented in the NDEP-approved Phase II SAP (Broadbent, 2021). The chain-of-custody forms prepared in the field were reviewed and compared to the analytical data results provided by the laboratory to ensure completeness of the dataset as discussed in the DVSR. Field procedures included documentation of sample times, dates and locations, and other sample-specific information (e.g., sample depth). This sample collection information is part of the project sample database. Figure 4 presents the location of all samples collected as part of the background investigation.

The laboratory reported the analytical data in a format that provides information needed for data evaluation. Each laboratory report describes the analytical method used, provides results and detection limits on a sample-by sample basis, and provides the results of appropriate quality control samples (e.g., laboratory control spike samples, sample surrogates and internal standards [organic analyses only], and matrix spike (MS) samples). Reported sample analysis results were imported into the project database.

2.4.4 Analytical Methods and Detection Limits

For a chemical result to be usable for assessing risks, the analytical method must appropriately identify the chemical, and the sample detection limit must be at or below a concentration that is associated with risk-based benchmark levels. The analytical methods were reviewed in the Phase II SAP to ensure their detection limits were at or below risk-based screening levels (Broadbent, 2021). The laboratory reports detail the EPA analytical methods used to analyze samples and the methods are documented in the laboratory reports. Metals were analyzed via EPA Method 6020A, rather than EPA Method 6020B as specified in the Phase II SAP. Analytical results were reviewed to evaluate laboratory sample quantitation limits (SQLs) to ensure they were sufficient for the intended use. Table A.2 in Appendix A presents summary statistics for both detected and non-detected analytical results. For most of the metals analytical results, the frequency of detection (FOD) was above 75%. For all non-detect results, the SQLs were well below the risk-based screening levels. Additionally, analytical results that were "J" flagged as estimated were primarily due to blank contamination (both laboratory and blank contamination) and not a result of analytical methods or detection limits.

2.4.5 Data Review

The data review portion of the data usability process focuses primarily of the quality of the analytical data performed by a professional knowledgeable in analytical procedures and data application. As noted previously, two levels of validation were conducted. As detailed in the Phase II SAP, 10 percent of samples received Stage 4 validation and the remaining 90 percent received Stage 2B. The DVSR details the aspects of the data review.

2.4.6 Data Quality Indicators

DQIs address field and analytical data quality to ensure it is appropriate for making decisions affecting activities at the Site. The DQIs address the field and analytical data quality aspects as they affect uncertainties in the data collected. The DQIs include precision, accuracy, representativeness, comparability, and completeness (PARCC). The Phase II SAP provides the definitions and specific criteria for assessing DQIs using field and laboratory QC samples. Data validation activities included the evaluation of PARCC parameters, and data not meeting the established PARCC criteria were qualified during the validation process and are noted in the DVSR.

2.4.6.1 Completeness

Completeness for field sampling is measured by the total number of acceptable data points and total number of samples collected by medium and lithology. No data were rejected during the data validation process. Data without qualifiers and data that are qualified as estimated (J, J+, J-) or estimated non-detected (UJ) are considered to be valid and usable. Therefore, completeness for each dataset was 100 percent. The data reported are suitable for their intended use. The percent completeness was acceptable to support the decision-making process and reporting activities of this investigation.

2.4.6.2 Comparability

Comparability of the data is a qualitative parameter that expresses the confidence with which one data set may be compared with another. To ensure comparability, standard EPA analytical methods were used for samples collected as part of this investigation reporting data in standard units, normalizing results to standard conditions, and using standardized reporting formats and data validation procedures. To ensure that data derived from this field effort are comparable, all like-media samples were submitted for analysis by the same analytical method (with like analytical parameters and similar detection/reporting limits); units of measure (e.g., microgram per kilogram) are the same for reporting for each media and analytical method; and like media were sampled, handled, and prepared in the same manner. Additionally, SOPs set forth in the Phase II SAP were followed for sample collection. These ensure that the background soil dataset is comparable to Site datasets for future investigations.

2.4.6.3 Representativeness

Representativeness is a qualitative parameter and is defined by the degree to which data accurately and precisely represent a characteristic of a population. Stratified systematic random design was specified in the Phase II SAP for samples collected for this background report. To ensure representativeness, the areas were stratified according to geologic subunits and substratified according to upwind/downwind position relative to the mine and mill or other areas of human activity, based on historical weather patterns. Only those portions of the Site undisturbed by mining, milling, or other human activities were sampled for background, except the ore body, where discrete locations are accessible in the pits. The sample data collected are representative of background conditions for the lithologies identified.

Additionally, the DVSR evaluated sample collection, including chain of custody (COC) documentation, sample labeling, collection dates, and condition of the samples upon receipt at the laboratory. Laboratory procedures also were examined, including anomalies reported by the laboratory, either upon receipt of the samples at the laboratory or during analytical processes, adherence to recommended holding times of samples prior to analysis, calibration of laboratory instruments, adherence to analytical methods, and completeness of data package documentation. The DVSR analysis did not determine any QC issues that would affect the representativeness of the analytical results.

2.4.6.4 Precision

Precision is a measure of the repeatability of a single measurement and is evaluated from the results of duplicate samples. It is determined by analyzing spike sample pairs [matrix spike (MS)/matrix spike duplicates (MSD)], and matrix duplicate pairs. Precision is expressed as the relative percent difference of a pair of values (or results). The DVSR showed that laboratory duplicate imprecision does occur but is not specific to any one analyte or sample. A total of four results (manganese, lead, antimony, and selenium) were qualified due to precision outliers. For this dataset the MS/MSD pair is the only duplicate analysis provided as there were no field duplicates collected. The qualifications did not result in rejection of data. Data qualified due to precision outliers were accepted as valid results. There are two main reasons for imprecision in regard to MS/MSD pairs: 1) the samples contain particles of different size which makes sample homogenization impossible and 2) elevated concentration of analyte can impact or mask spike amount yielding low or no recovery. There do not appear to be any data usability issues associated with precision.

2.4.6.5 Accuracy

Accuracy is a measure of overestimation or underestimation of reported concentrations and is evaluated from the results of spiked samples. Accuracy is assessed by evaluating instrument calibrations and comparing MS, MSD, laboratory control standard, laboratory control standard duplicate, and surrogate recoveries with associated QC limits. The laboratory control standard measures the accuracy of the method extraction process, and the MS measures the effects the matrix has on accuracy. For metals, additional QC elements such as serial dilutions and post spikes may also be used for determining accuracy. Accuracy is expressed as percent recovery.

Laboratory control standard recoveries were within control limits. A total of five results from MS analyses were qualified due to recoveries outside control limits. MS or MSD recoveries masked by high analyte concentration were not qualified. The outliers are from antimony (three, low recovery), lead (one, high recovery) and manganese (one, high recovery). The high recoveries for lead and manganese are due to high concentration of analyte in sample, not greater than four times the native sample. The low recovery of antimony appears to be matrix related since the laboratory control standard recovery were successful. Table 6 of the DVSR details analytical results that were qualified based upon spike sample accuracy. No samples were rejected based upon accuracy issues.

3 STATISTICAL METHODS

As discussed in Section 2.3, data sets were validated before the data were used in the statistical evaluation. The following sections discuss data preparation, statistical plots, summary statistics and statistical tests, and the types of comparisons conducted.

3.1 DATA PREPARATION

3.1.1 Data Reduction

Within each stratum, it is assumed that soil samples are spatially independent by nature of the random sampling design. Sample results that were estimated between the laboratory reporting limit and the quantitation limit were J-qualified and were treated as detections at their estimated values. Sample results reported as non-detect were treated as less than the SQL. For data sets with non-detects, Kaplan-Meier product limit estimators were used to compute the sample mean and variance.

3.1.2 Exploratory Analyses and Outlier Identification

Normal quantile-quantile (Q-Q) plots (Appendix B) and side-by-side box plots (Appendix C) were used for exploratory data analysis to examine the data distribution and to identify both potential outliers and the presence of multiple data populations. Outliers were identified using an iterative process combining a graphical approach with a formal statistical outlier test as recommended by EPA (EPA, 2015).

A normal Q-Q plot is a probability plot that compares the quantiles (aka, percentiles) of the sample data to the expected quantiles assuming a normal distribution. Q-Q plots were examined for jumps and breaks of significant magnitude suggesting the presence of potential outliers or samples coming from multiple populations (e.g., mixed lithology groups). On a normal Q-Q plot, sample results that follow a straight line suggest a normal distribution. In addition, if one or several observations were well separated from the line, they were identified as possible outliers. In addition, Q-Q plots show potential outliers identified as sample results exceeding 3.5 standard deviations above the median as suggested by Iglewicz and Hoaglin (1993) with the robust bias-corrected scale estimator Q_n used to compute the standard deviation as recommended by Rousseeuw and Croux (1993). As shown in the Q-Q plots the potential outlier threshold was computed as:

$$Potential\ Outlier\ Threshold \geq median + 3.5 \times robust\ standard\ deviation.$$

Both the median and robust standard deviation $S(Q_n) = d_n \times Q_n$ were computed from detected sample results. Details for computing Q_n and the bias correction factor d_n can be found in Croux and Rousseeuw (1993). The Q-Q plot graphs were generated using SAS software, version 9.4 of the SAS System for Windows. The Q_n statistic was computed using SAS PROC UNIVARIATE and Q-Q plots were generated with SAS PROC SGPLOT. Summary statistics including the Qn statistic for the raw data (data with potential outliers) are presented in Appendix A.

Box plots were constructed based on the median and inter-quartile range as well as 1.5 times the inter-quartile range for the whiskers. Observations beyond the whiskers were identified as possible outliers for further testing. Box plots graphs were generated using PROC SGPLOT in SAS software, version 9.4 of the SAS System for Windows.

Fifteen observations identified to be potential outliers were further evaluated to determine if there was sufficient scientific rationale to remove the observations from the background data set. The final disposition of outliers is summarized in Table 2. The locations of removed outliers are shown in Figure 5.

Three samples in the sedimentary background area identified as potential outliers (BG-111-01-01 [anomalous lead and manganese], BG-111-02-01 [anomalous zinc], and BG-111-05-01 [anomalous copper]) were located in or very close to the geologic subunit Qtg, described as older alluvial fan sediments noted as having a significant amount of clasts deriving from the River Mountain volcanics. For this reason, these three samples may represent a mixture between the Muddy Creek Formation/sediments derived from the Muddy Creek Formation and the River Mountain volcanics and are not representative of the sedimentary background units and were thus eliminated for calculation of BTVs.

Arsenic concentrations measured in sample BG-111-07-01 were more than twice the concentrations measured in other samples in the sedimentary units, so this sample eliminated from the dataset as an outlier for calculating the BTVs. Results for chromium, copper, and zinc concentrations in sample BG-111-07-01 were also high relative to other samples collected.

Sample BG-111-23-01, potentially an outlier due to concentrations of antimony, was eliminated from the dataset because it was spatially distinct from other sedimentary background samples and was collected from an alluvial channel surrounded by the River Mountain volcanics. As a result, it may be a mixture between the sedimentary background and volcanic background areas.

Five River Mountain background samples (stratum 1.2.1) identified as potential outliers (BG-121-01-01 [anomalous chromium, copper, and zinc], BG-121-02-01 [anomalous chromium, copper, selenium, and zinc], BG-121-07-01 [anomalous copper], and BG-121-24-01 [anomalous copper]) were located together geographically on the south end of the ridge to the east of the site. Slightly higher metals concentrations measured in these five samples may be the result of windblown sediment on the ridge. As a result, they were excluded from the dataset used to calculate the River Mountain volcanics BTVs. BG-121-06-01 was also removed because of its proximity to BG-121-01-01, BG-121-07-01, and BG-121-24-01.

Individual metals excluded for River Mountains background samples BG-121-18-01 (anomalous manganese) and BG-121-26-01 (anomalous lead and manganese) were excluded at the request of NDEP in the meeting held on October 13, 2021. Results of another River Mountain background sample (BG-121-03-01) indicated anomalous lead concentrations; no rationale was identified to remove this sample so it was retained.

Finally, sample BG-13-13-01 (identified as a potential outlier due to anomalous arsenic concentrations), was excluded because concentrations of arsenic were more than twice as high as other samples collected from the ore body. Another ore body sample (BG-13-02-01) was identified as having anomalous selenium concentrations, but no rationale was identified to remove this sample so it was retained.

3.2 Descriptive Summary Statistics

The following summary statistics were computed as per the NDEP *Guidance on the Development of Summary Statistics* (2008):

- Number of samples
- Number of detected concentrations
- Minimum detected concentration
- Median detected concentration
- Mean of the detected concentrations
- Maximum detected concentration
- 25th percentile of the detected concentrations
- 75th percentile of the detected concentrations
- Standard deviation of the detected concentrations
- Number of non-detected concentrations
- Minimum non-detected value
- Maximum non-detected value
- 25th percentile non-detect
- Median non-detect
- Mean of the non-detects
- 75th percentile non-detect
- Standard deviation of the non-detects

Summary statistics were computed using PROC UNIVARIATE in SAS/STAT software, version 9.4 for Windows. Percentiles were computed using the empirical distribution function with averaging method. (Hyndman and Fan, 1996). Background summary statistics are presented in Table 3.

3.3 Statistical Methods

BTVs representing not-to-exceed values for each metal were calculated for each of the following data sets:

- Muddy Creek Formation (Stratum 111)
- River Mountain (Stratum 121)
- Ore Body (Stratum 13)

In addition to computing the BTVs, statistical comparisons were conducted to compare the distribution of metals among the following stratum:

- Sedimentary Units of Downwind Parcels (112) versus Muddy Creek Formation (111)
- Volcanic Units of Downwind Parcels (122) versus River Mountain Background (121)

The following sections detail the statistical methods used in calculating the BTV and statistical hypothesis tests.

3.3.1 BTV Determination

Combined graphical and formal outlier tests were performed on the data to assure that data used to calculate the BTVs are representative of background. EPA guidance (EPA, 2002 and 2015) specifies that upper limits such as the upper prediction limit (UPL) or upper tolerance limit (UTL) be used for calculating the BTV. These upper limits represent the upper range of background concentrations, such that metals concentrations from unimpacted samples are unlikely to exceed them (i.e., a low rate of false positives is expected). BTVs can be used to screen individual sample results to determine if the sample is likely representative of background. Choosing between the UPL or UTL as the BTV requires balancing false positive and false negative error rates. For a given confidence coefficient (e.g., 95% confidence), the UPL is less than the UTL and therefore has a lower per comparison false negative error rate. However, the false positive error rate for the UPL increases with each comparison to an onsite sample whereas the false positive error rate of the UTL is the same regardless of the number of comparisons. Due to the potentially high false positive error rate, the use of a UPL is not recommended when multiple comparisons are to be made (EPA, 2015). Therefore, the UTL was chosen as the BTV in this study.

3.3.2 Computation of BTVs for Metals

Using the outlier-free data, BTVs were computed as the UTL with 95% confidence coefficient and 95% coverage (UTL95-95). The UTL95-95 represents the 95% upper confidence limit on the 95^{th} percentile of the background samples. The UTL95-95 was computed using EPA's ProUCL version 5.1 software (EPA, 2015). ProUCL conducts goodness-of-fit tests on the detected sample results against normal, gamma, and lognormal distributions at the 95% confidence level and provides a conclusion as to whether or not the data fit the given distribution. This information was used to choose a parametric UTL based on the following order of preference: normal distribution, gamma distribution, or lognormal distribution. ProUCL outputs are attached in Appendix D. Table 4 summarizes the distribution assumed for each data set and the computed BTV.

3.3.3 Comparison of Strata

Statistical analyses were conducted to infer whether background datasets are comparable and whether there exist relationships between concentrations of some of the metals. Comparisons between strata were conducted using the generalized Wilcoxon test. The generalized Wilcoxon test is an extension of the nonparametric Wilcoxon rank-sum test that uses Gehan rankings to compare the empirical distribution function (EDF) among two or more groups. The EDF is an empirical estimate of the data population's cumulative distribution function and can represent non-detect results without arbitrary substitution (e.g., ½ SQL). The generalized Wilcoxon test can be used to compare multiple groups when many of the observations are non-detect with multiple SQLs. The null hypothesis is that the EDFs among the groups are the same versus the alternative hypothesis that there are differences among the group EDFs. Appendix E shows the EDFs for each SRC by lithology group. Tables 5a and 5b summarize the results of the generalized Wilcoxon test at the 95% confidence level. The generalized Wilcoxon test was conducted using PROC LIFETEST in SAS/STAT software, version 9.4 for Windows.

3.3.3.1 Sedimentary Units of Downwind Parcels versus Muddy Creek Formation

Although concentrations of both selenium and zinc were significantly higher in the Sedimentary Units of Downwind Parcels stratum (112) than in the Muddy Creek Formation stratum (111) ($p < 0.05$), we are not implying that the sedimentary units of the downwind parcels represent background concentrations.

3.3.3.2 Volcanic Units of Downwind Parcels versus River Mountain Background

Concentrations of chromium, copper, lead, and zinc were significantly higher in the Volcanic Units of Downwind Parcels stratum (Unit 122) than in the River Mountain Background stratum (Unit 121) ($p < 0.05$).

4 SUMMARY AND CONCLUSIONS

The purpose of the background study was to collect and analyze soil samples to determine background concentrations of metals that will be used in three decisions: 1) the assessment of remediation completeness, 2) the assessment of whether significant airborne deposition of metals may have occurred in downwind, undisturbed portions of the Site, and 3) the evaluation of potential borrow materials.

Samples were collected from three geologic units: sedimentary rocks of Muddy Creek Formation, River Mountain volcanic rocks, and Ore-bearing rocks. Based upon the geologic units, five sample stratum were identified: Muddy Creek Formation background area (stratum 111), sedimentary units in downwind areas (stratum 112), River Mountain volcanic rocks in background areas (stratum 121), River Mountain volcanic rocks in downwind areas (stratum 122), and ore-body rocks (stratum 13). A total of 77 soil samples were collected for analysis, and BTVs were calculated from 66 samples after the identification and exclusion of 11 outliers. Additionally, individual metals for two samples were excluded from the calculation of BTVs for the River Mountain volcanic rocks (stratum 121). Sample BG-121-18-01 was excluded for manganese, and sample BG-121-26-01 was excluded for lead and manganese.

Data validation included 10 percent Stage 4 validation and 90 percent Stage 2B validation. Results qualified as estimated based on the data validation are usable for the purposes of establishing background concentrations and for comparison to Site sample data. No sample results were rejected based upon the data validation.

The primary goal of the determination of a background dataset has been met. The dataset generated from the Muddy Creek Formation (stratum 111) and the River Mountain volcanic rocks (stratum 121) will be used as the background dataset for comparison to post-remediation samples. Additional details on which BTVs will be used for comparison to post-remediation samples will be provided in future work plans that detail area-specific risk assessments. Additionally, soil from these areas will be used as "clean cover" during future Site development. Finally, a comparison of downwind parcels of the Muddy Creek Formation and River Mountain volcanic rocks reveals these areas are not consistent with background. Potential impacts to these downwind parcels will be reviewed during Site remediation and closure activities.

ACRONYMS

ASTM	American Society for Testing and Materials
bgs	Below Ground Surface
Broadbent	Broadbent & Associates, Inc.
BTV	Background Threshold Values
COC	Chain of custody
DQI	Data Quality Indicator
DVSR	Data Validation and Summary Report
EA	EA Engineering, Science, and Technology, Inc. PBC
EDF	Empirical Distribution Function
EPA	U.S Environmental Protection Agency
ft	Foot/feet
GES	Geotechnical and Environmental Services, Inc.
Lakemoor	Lakemoor Development, LLC
MWMP	Meteoric Water Mobility Procedure
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NDEP	Nevada Division of Environmental Protection
PAH	Polycyclic Aromatic Hydrocarbons
PARCC	Precision, Accuracy/bias, Representativeness, Comparability, and Completeness
Q-Q	Quantile-Quantile
QC	Quality Control
Q_n	Robust scale estimator used to estimate the standard deviation in data sets that may contain one or more outliers.
SAP	Sampling and Analysis Plan
SIM	Selected Ion Monitoring
Site	Three Kids Mine, Clark County, Nevada
SOP	Standard Operating Procedure
SQL	Sample Quantitation Limit
SRC	Site-related chemical
UPL	Upper Prediction Limit
UTL	Upper Tolerance Limit

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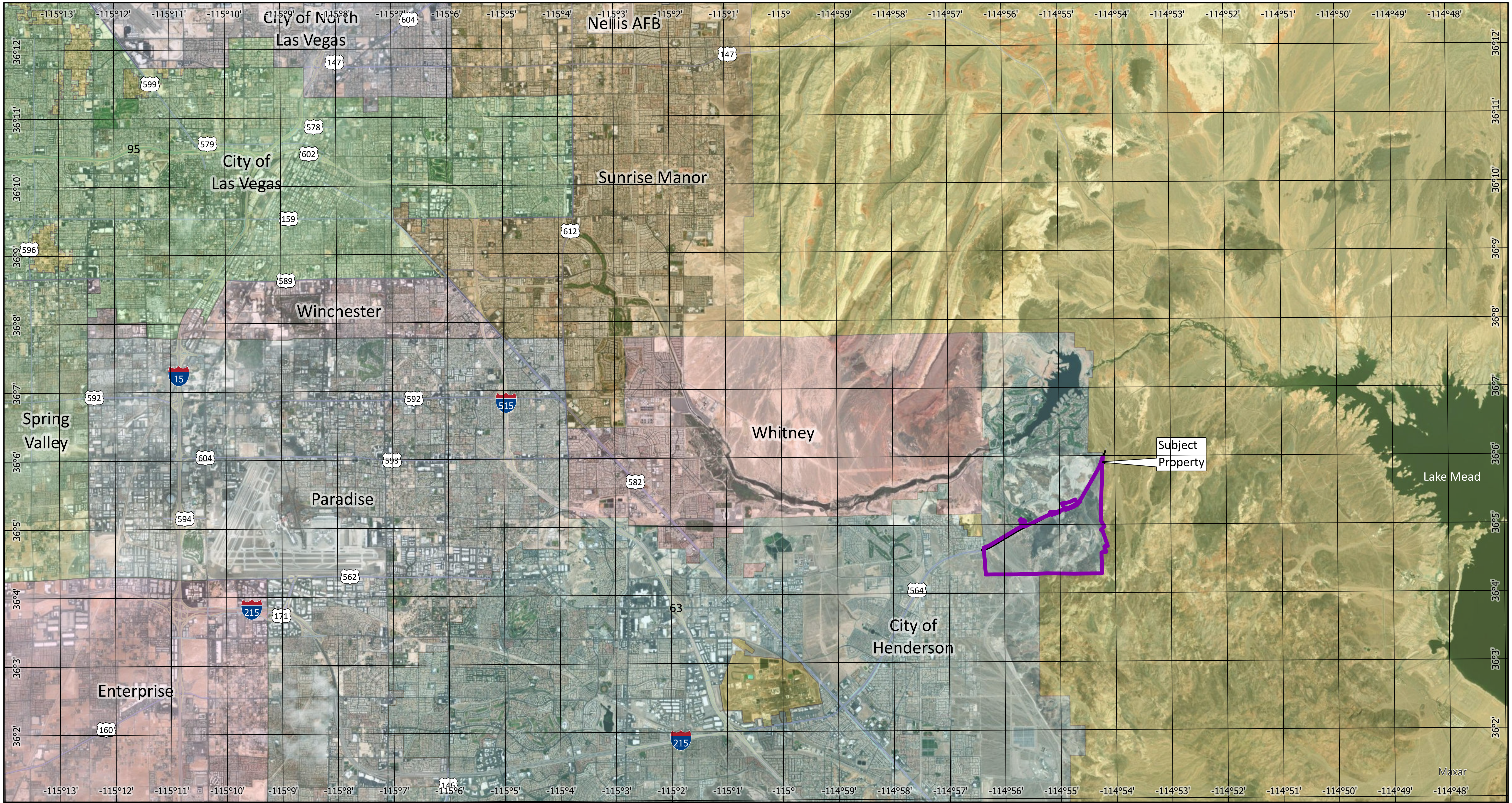
FIGURES



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 10/7/2021

Legend:

- Subject Property
- City of Henderson
- City of Las Vegas
- City of North Las Vegas
- Unincorporated Clark County
- Enterprise
- Nellis AFB
- Paradise
- Spring Valley
- Sunrise Manor
- Whitney
- Winchester

Notes:
1. Imagery Source: Esri World Imagery
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Political Boundary Source: Clark County GIS Management Office.
4. Parcel Boundary Source: Clark County Assessor.
5. Roads Source: Nevada DOT GeoHub.
6. Geographic grid divided at every minute of latitude and longitude.

Nevada

N

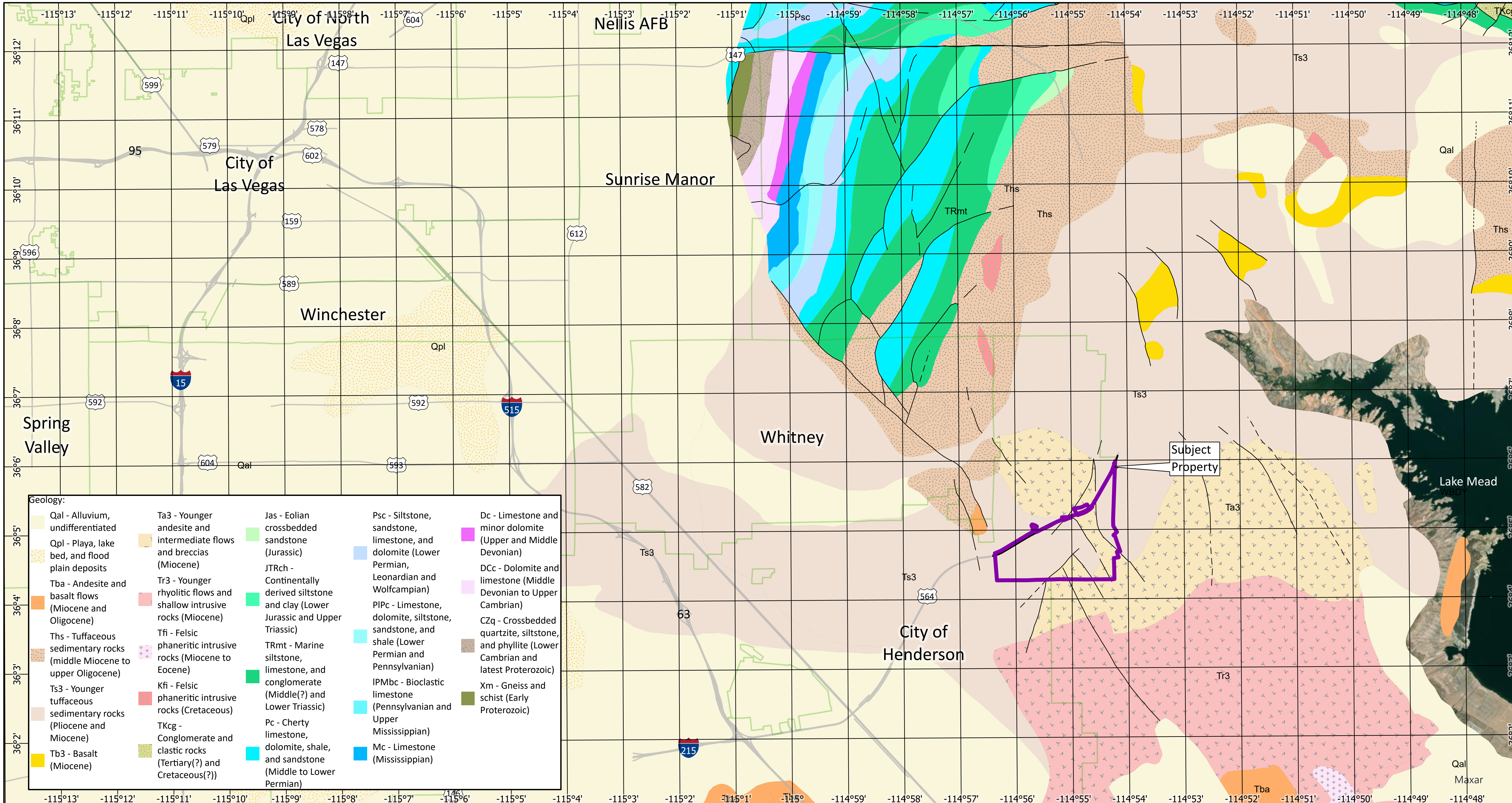
1 0.5 0 1 Miles

Figure 1

Site Location

Former Three Kids Mine

Designed	
Drawn	JCM
Approved	



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 9/9/2021

Legend:
- Subject Property
- Political_Boundaries

Faults
- Known fault
- Inferred fault
- Concealed fault

Notes:
1. Imagery Source: Esri World Imagery
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Political Boundary Source: Clark County GIS Management Office.
4. Parcel Boundary Source: Clark County Assessor.
5. Roads Source: Nevada DOT GeoHub.
6. Geology Source: Crafford, A.E.J., 2007, Geologic Map of Nevada: U.S. Geological Survey Data Series 249, 1 CD-ROM, 46 p., 1 plate.
7. Geographic grid on map divided at every minute of latitude and longitude.

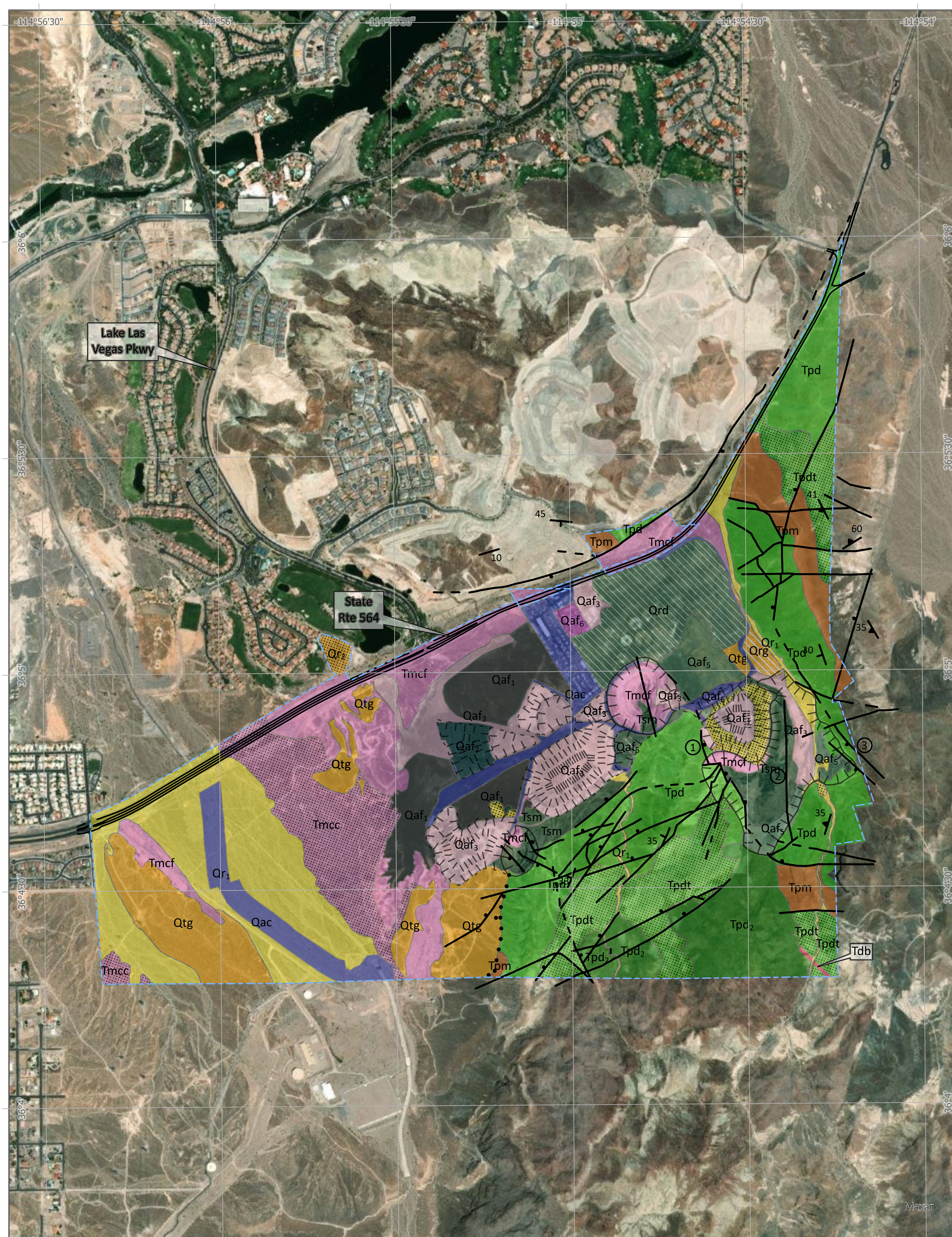
Nevada
N
1 0.5 0 1 Miles

Figure 2

Regional Geology

Former Three Kids Mine

Designed	
Drawn	JCM
Approved	



Legend:

Project Area

Lithology

Qac	Qaf_3	Qrd	Tpd
Qaf_1	Qaf_4	Qrg	Tpd_2
Qaf_2	Qaf_5	Qtg	Tpdt
	Qaf_6	Tdb	Tpm
	Qr_1	Tmcc	Tsm
	Qr_2	Tmcf	

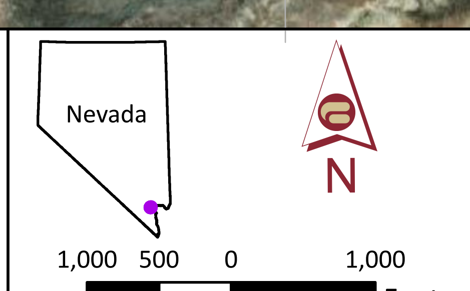


Figure 3A

Site Geology

Former Three Kids Mine

Designed	
Drawn	JCM
Approved	

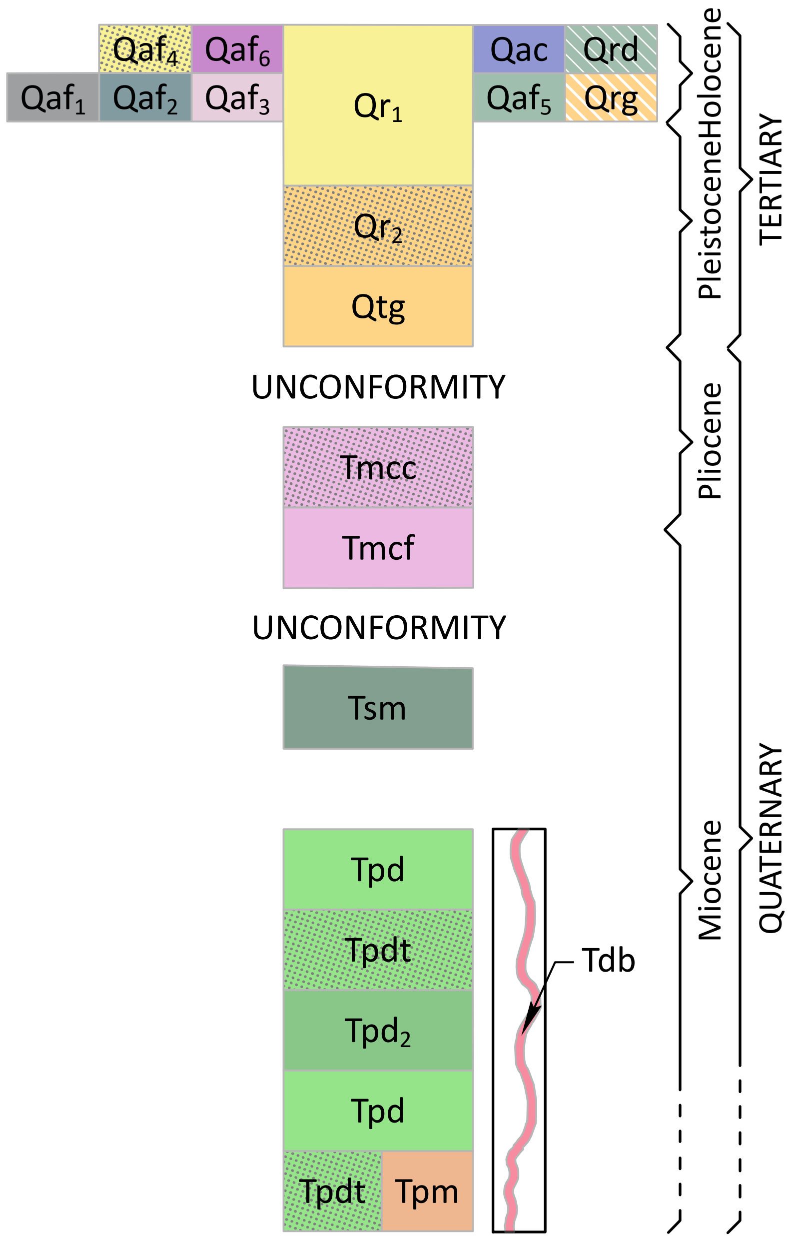
BROADBENT

8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 9/9/2021

Notes:
1. Imagery Source: Esri World Imagery
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Not a survey. Grid origin at southwest corner of Section 34, Township 21 S., Range 63 E. Mount Diablo Meridian, Index grids on 500 foot intervals. Sample grid size is 100 feet.
4. Geographic grid on map divided at 30 seconds of latitude and longitude.

LITHOLOGIC KEY



DETAILED LITHOLOGY

LATE HOLOCENE AND MINE RELATED DEPOSITS (LATE QUATERNARY)

Qac – Compacted alluvium. Roads and reworked alluvium or overburden. Compacted roadways (paved and unpaved) or graded and currently developed/occupied properties. In the west of the Three Kids Mine area, a large swath is a former ultra light landing strip. Comparative topography from 1917 data suggests many of these roads are "built up" or elevated above natural topography.

Qrg – Graded pediment / alluvial plain deposit. Alluvial deposits typically composed of decomposing Powerline Road volcanic materials from the River Mountains. Locally graded or compacted based on the presence of building foundations, but not commingled with other material from the area.

Qrd – Disturbed, graded, commingled, alluvial deposits. Former alluvial deposits of Powerline Road volcanics and Muddy Creek materials which have been graded, transported, and commingled or covered with product, and/or Tsm material. This is typical of the former mill site in the Three Kids Mine area, where dark sediments produced by mill activities cover the area from a few inches to feet thick and large area grading is evident. Mining debris and modern refuse are common.

Qaf$_1$ – Tailings. Tailings of the former Three Kids Mine and Mill Site. Unit composed of dark colored clay, silt, and sand sized particles. Materials were flow deposited into artificial ponds created by damming drainages. Tails are lead and arsenic laden residues containing diesel-range petroleum constituents, polar organic compounds (Oronite-S, linoleic acid, oleic acid, and wood tannin), water, iron, other metals, silica, and alumina. The upper portion of the tailings material is dry and silty and prone to eolian deflation and transport. Within ponds, approximately five feet below ground surface, the material is a highly viscous semi-solid prone to liquefaction when agitated.

Qaf$_2$ – Wind blown tailings. Suspect eolian deposits of tailings creating a dune field within an area mottled with overburden from various sources. Tailings particles are well sorted and sand sized. Overburden material up to boulder size are somewhat evenly scattered in the area and eolian deposits sit between the boulders. Unit occurs in only one, well demarcated area, leading to some question as to actual deposition origin of the sandy material. Windblown deposits typically do not follow demarked boundaries; however, the overburden may be acting as dune anchors and windbreaks.

Qaf$_3$ – Muddy Creek overburden. Gypsum, sandstone, and other sedimentary units derived from the Muddy Creek formation. Material was overburden to the mining operation and is typically found in the form of terraced overburden piles or as a construction material in tailings pond damns and dikes. Contains plentiful massive gypsum boulders with clasts of red siltstone and sandstones. May contain minor amounts of manganiferous sedimentary rock (source: Tsm) and River Mountains (source: Tpd) materials.

Qaf$_4$ – River Mountains alluvium / overburden. Alluvium and rock from Powerline Road volcanic units similar in origin to Qrg. May be remnants of the original alluvial plain in place or relocated alluvial plain overburden from mining operations. Largest deposit forms the base terrace of a multi-terraced overburden pile north of the A/B Pit. Surface in this location is covered with Tsm fines or tailings 1-6 inches thick. Particle sizes typically no larger than cobble and dominantly sand and silt sized.

Qaf$_5$ – Manganiferous sedimentary fill. Pyroclastics, sandstones and other material derived from Tertiary manganiferous sedimentary units (Tsm). Material may have been low-grade ore, overburden, or stockpile. Found in the form of dams, ramps, and unterraced overburden piles. Most significant deposit is thought to have been used to create the ore stockpile yards just south of, and overlooking, the former mill area.

Qaf$_6$ – Artificial fill. Transported, compacted, and graded fill of fine sand to gravel sized particles. Material is composed of commingled Qaf$_3$, Qaf$_4$, and Qaf$_5$ that have been used to "build up" an area along Lake Mead Parkway within a developed property. Distinguished from Qac by its high manganiferous fill content (Qaf$_5$).

EARLIER QUATERNARY DEPOSITS

Qr$_1$ – Wash Deposits. Alluvial deposits derived mainly from the River Mountains (Powerline road volcanics). Dominantly sand and silt sized particles with minor contributions of up to boulder sized volcanics. Deposits become more gypsiferous and contain Muddy Creek formation material within the drainage on the east side of the Three Kids Mine and Mill Site where the drainage intersects with Highway 564.

Qr$_2$ – Pediment and fan deposits of River Mountains material. Undisturbed pediment or fan deposits derived from Powerline Road host material. Dominantly sand and silt sized particles. May be gypsiferous from contributions of Muddy Creek material, especially further from the drainage mouth.

Qtg – Older alluvial fan deposits and pediments. Sandy pebble to boulder gravels with desert pavement surfaces. Generally gypsiferous with dacite and other volcanic clasts originating from the River Mountains. Pediment former. Surface typically unconformably overlying Tmcc of Tmcf. Units range from 1-30 feet thick (Bell and Smith, 1980).

LATE TERTIARY DEPOSITS

Tmcc – Muddy Creek fanglomerate. Coarse gypsiferous reddish to yellow fanglomerate. Well cemented coarse sandy, pebble to cobble gravels. Upper portion is well bedded with volcanic pebble clasts (River Mountains in origin). Locally may contain gypsiferous siltstone interbedding. Lower portion is poorly to moderately bedded with igneous and reworked sedimentary clasts.

Tmcf – Muddy Creek Formation. Sedimentary beds of red siltstone, sandy siltstone, and claystone, with dominate white to light pink, massive gypsum occurring in the upper portion. Claystone interbedding locally occurring. Locally manganiferous within gypsum according to Bell and Smith, 1980. Badland and bluff former in the region although, at Three Kids Mine, the unit is mainly buried or has been distributed through mining activity. These units unconformably overlie Tsm and Tpd in the Three Kids area. They are thought to have been "lapped" into a graben structure of the River Mountains that is the location of the Three Kids Mine and Mill Site.

Tsm – Manganiferous sedimentary rocks of the Three Kids Mine. Top of unit is well defined beds of light gray, red, and black manganese rich tuff, tuffaceous sandstone, and siltstones. Forms a "bacon rind" appearance many tens of feet thick feet where exposed. A basal sub-unit of Tsm as exposed at the Hulin pit is comprised of a thick (up to 100 feet), poorly bedded, unsorted breccia with clasts from <1 inch to >3 feet in diameter and of volcanic origin. Sub-unit probably deposited as mud or debris flow(s) and appears to represent a single large, or limited series of large deposition events.

Tsm was originally mapped as part of the Muddy Creek formation (McKelvey et al., 1949; Longwell et al., 1965). Bell and Smith, 1980, present that the Tsm may be closer associated to the Powerline Road units that comprise the River Mountains in the area. It may also be a remnant of an interstitial unit that has been mostly eroded away. Hydrothermal transport and deposition from, and within, this unit into faults and fractures may have been the petrogenetic mechanism of high-grade manganese ore (wad) formation. Chemical data from fault gauge within the Tsm at the Hulin pit indicates high arsenic and lead. Tsm, where present, underlies and unconformably contacts the Muddy Creek formation, observable in the Hulin pit. This contact appears to be gradiated at the Hulin pit and some fluvial reworking may have occurred during Muddy Creek deposition.

MID TERTIARY ROCKS

Tpd – Resistant volcanic units of Powerline Road. Numerous dacite flows. Units are texturally variable, plagioclase, biotite, and hornblende bearing. Flows are commonly banded. Bell and Smith noted large amplitude flow folds. Unit as mapped is a ridge former in the River Mountains. Dacite varies in color from gray on fresh surfaces to reddish black on well weathered surfaces. Upper and lower parts of many flows, and at the contact between Tpd and Tpdt, are brecciated.

Tpdt – Saddle forming volcanic units of Powerline Road. Tuffaceous interbedded units in the River Mountains. Units consist of interbedded pyroclastic, breccia, dacite, zeolitized, and perlitic flows. Breccias often contain purple/red andesite xenoliths. Rock units are dark grey, buff or tan. Previously mapped by Bell and Smith (1980) as part of the Tpd, the units are separately mapped here due to their fissle/less resistant qualities. These units are easily decomposed and are saddle formers in the River Mountains.

Tpd$_2$ – Resistant volcanic units of Powerline Road. Grayish red to red dacite flows. Contain numerous clasts/xenoliths of grey andesite. Bell and Smith (1980) noted vertical thickness of 150-200 feet. The unit is a resistant ridge former in the River Mountains and considered a marker horizon for the northern part of the mountain range. At the Three Kids Mine the unit outcrops exclusively in the southeastern area of the site within the "House" region.

Tpm – Resistant volcanic units of Powerline Road. Interbedded basalt and andesite flows of the River Mountains. Basalts are typically vesicular and mafic containing phenocrysts of augite and olivine. Andesites are reddish purple with plagioclase, hornblende, and augite phenocrysts. These are ridge formers in the River Mountains and occur mainly on the eastern boundary of the Three Kids Mine and Mill Site.

Tdb – Dikes. Basalt/Andesite composition dikes of Miocene age. Associated with Tpd and Tpdt in the Three Kids Mine area. Thickness variable. Only dikes >10 feet thick are mapped.

KEY TO MAP SYMBOLS

Contact. Dashed where approximate or concealed.

Fault. Dashed where approximate or inferred, dotted where concealed, ball on downthrown side.

45
Strike and dip of beds

45
Strike and dip of foliation

Mine Waste

Pit

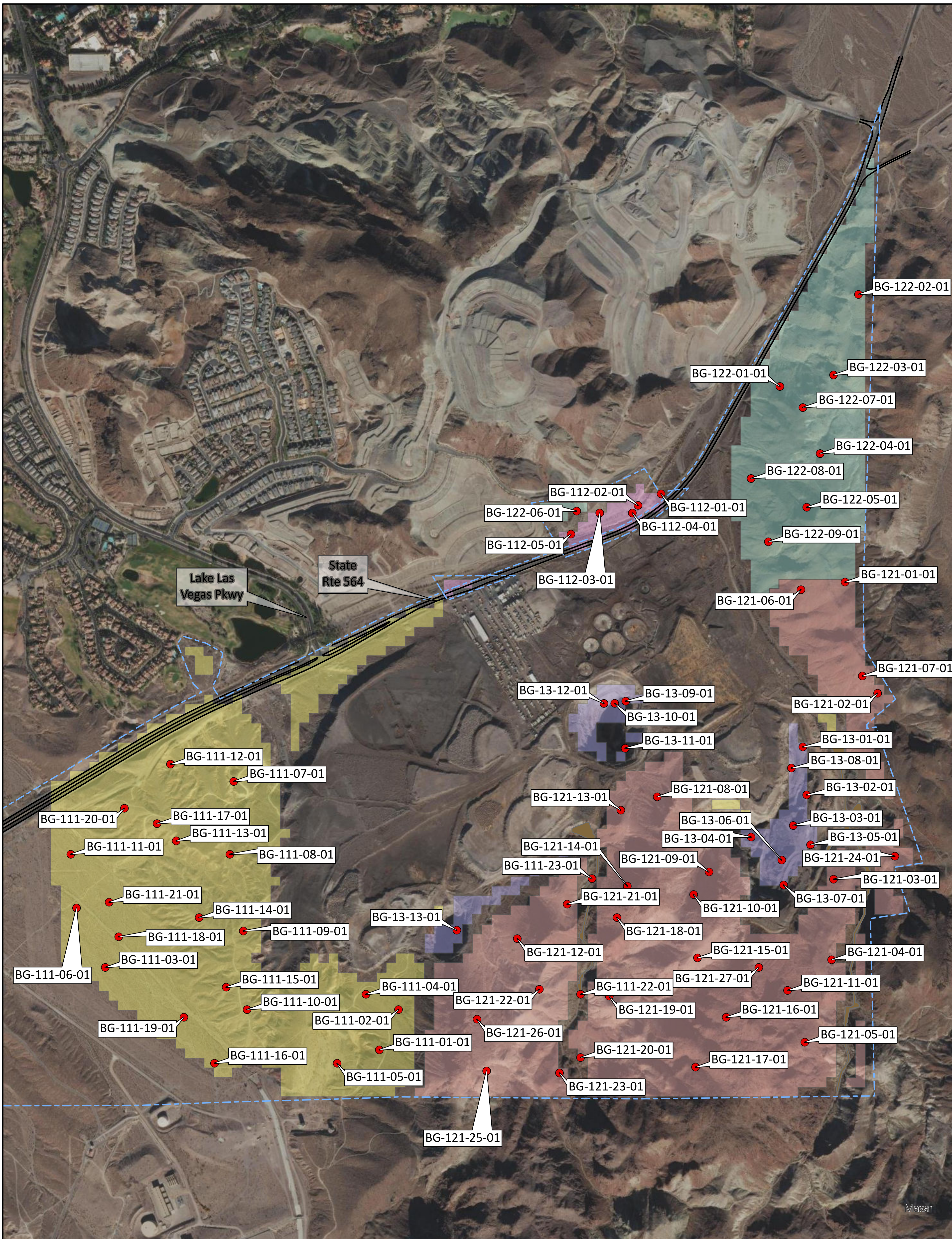
BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 9/9/2021

Legend:
As shown above.

Notes:
1. Source: 2005-2008 Field and Aerial data combined with data from Bell and Smith, 1980, *Geologic map of the Henderson Quadrangle, Nevada*, Nevada Bureau of Mines and Geology, Map 67, and Hunt, et. al., 1942, *Three Kids Manganese District Clark County, Nevada*, United States Department of the Interior, Bulletin 936-L.

Figure 3B	
Detailed Geologic Map Key	
Former Three Kids Mine	
Designed	
Drawn	JCM
Approved	



Legend:

- Element 1, Background Sample Location
- Project Area

Stratum

- Muddy Creek formation and natural sediments background (sedimentary rocks), Stratum 1.1.1
- Sedimentary units of downwind parcels no. 6 & 8, Stratum 1.1.2
- Volcanic Rocks of Powerline Rd., a.k.a. River Mountain background (Igneous Rocks), Stratum 1.2.1
- Volcanic Units of downwind parcels No. 7, 8, & 9, Stratum 1.2.2
- Rocks of the Three Kids Mine, a.k.a. Ore body background (Manganiferous Rocks), Stratum 1.3

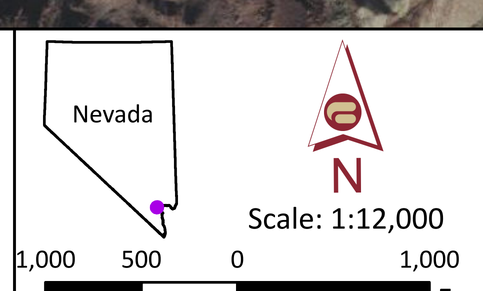


Figure 4

Sample Locations: Element 1

Three Kids Mine

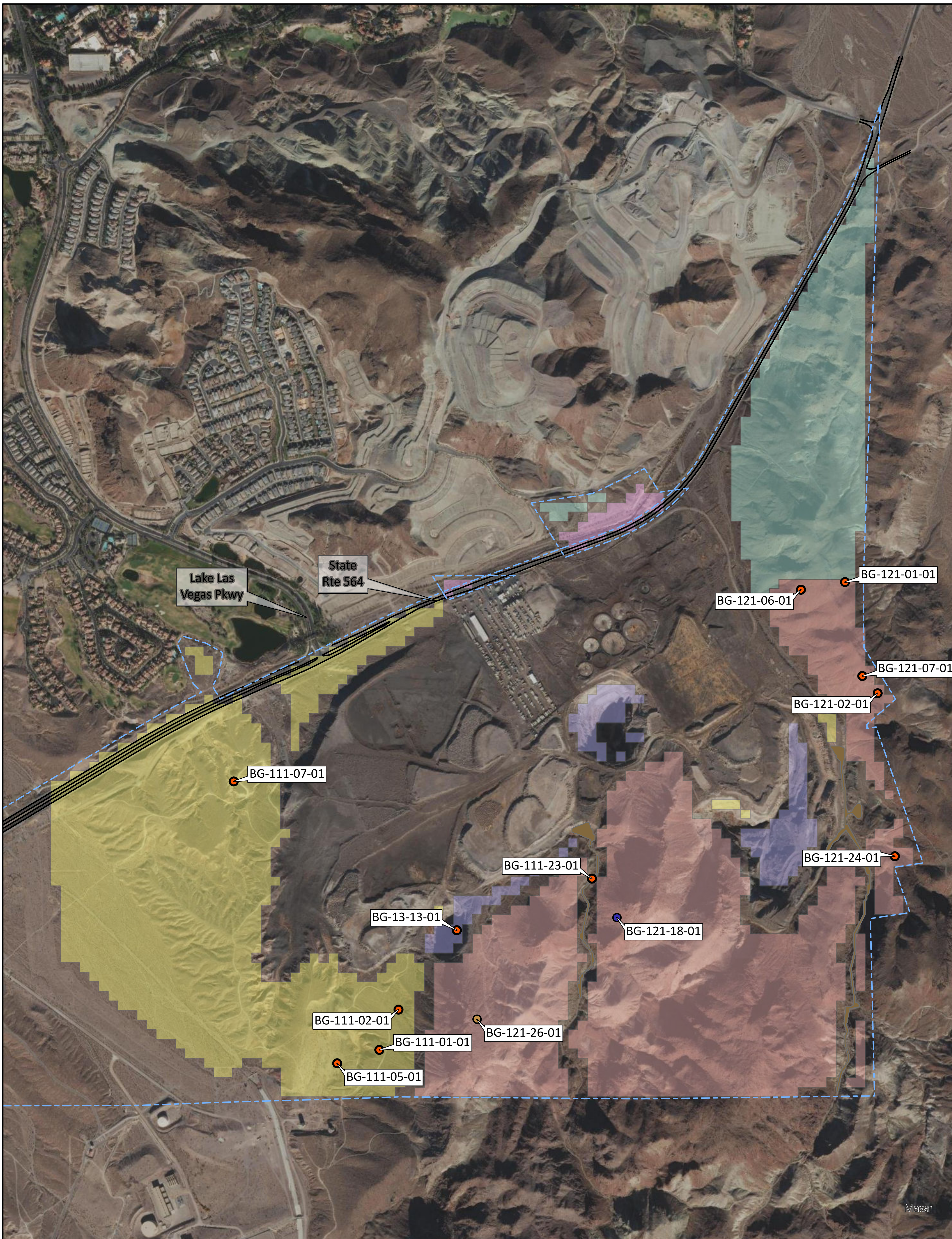
Designed	
Drawn	JCM
Approved	

BROADBENT

8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 12/16/2021

Notes:
1. Imagery Source: Esri World Imagery
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Not a survey.



Legend:

Element 1, Background Sample Outlier

Excluded Outlier

- Excluded

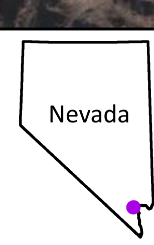
Partially Excluded Outlier

- Excluded for lead and manganese
- Excluded for manganese

Project Area

Stratum

- Muddy Creek formation and natural sediments background (sedimentary rocks), Stratum 1.1.1
- Sedimentary units of downwind parcels no. 6 & 8, Stratum 1.1.2
- Volcanic Rocks of Powerline Rd., a.k.a. River Mountain background (Igneous Rocks), Stratum 1.2.1
- Volcanic Units of downwind parcels No. 7, 8, & 9, Stratum 1.2.2
- Rocks of the Three Kids Mine, a.k.a. Ore body background (Manganiferous Rocks), Stratum 1.3



N

Scale: 1:12,000

1,000 500 0 1,000 Feet

Figure 5

Locations of Outliers Removed

Three Kids Mine

Designed	
Drawn	JCM
Approved	

BROADBENT

8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 12/16/2021

Notes:
1. Imagery Source: Esri World Imagery
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Not a survey.
4. Potential outliers identified from Normal Q-Q Plots.

TABLES

TABLE 1
ANALYTICAL RESULTS

	Location ID	BG-111-01-01	BG-111-02-01	BG-111-03-01	BG-111-04-01	BG-111-05-01	BG-111-06-01	BG-111-07-01	BG-111-08-01	BG-111-09-01	BG-111-10-01	BG-111-11-01
	Sample Name	BG-111-01-01	BG-111-02-01	BG-111-03-01	BG-111-04-01	BG-111-05-01	BG-111-06-01	BG-111-07-01	BG-111-08-01	BG-111-09-01	BG-111-10-01	BG-111-11-01
	Sample Date	5/19/2021	5/19/2021	5/18/2021	5/19/2021	5/19/2021	5/17/2021	5/19/2021	5/19/2021	5/20/2021	5/18/2021	5/18/2021
	Sample Depth	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs
Analyte	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals (SW6020A)												
Antimony	mg/kg	0.287 J	0.224 J	0.177 J	0.324 J	0.171 J	0.228 J	0.315 J	< 0.168 U	0.202 J-	< 0.169 U	0.382 J
Arsenic	mg/kg	11.9	11 J+	4.38	6.26	9.02	7.64	48.8	7.62	3.69 J	8.02	16.4
Cadmium	mg/kg	0.127 J	0.133 J	0.1 J	0.116 J	< 0.0864 U	0.142 J	< 0.0907 U	< 0.0867 U	< 0.0873 U	0.0971 J	0.122 J
Chromium	mg/kg	16.6	12.6	8.19	12.8	3.06 J	11.1	20.7	7.1	3.28 J	5.5	11.2
Copper	mg/kg	23.5	23.3	8.57	15.3	37.2	13.2	38.6	7.98	7.17 J	9.21	11.3
Lead	mg/kg	88.2	79.1	11.4	34.6	23.3	33.2	23.4 J	12.8	3.25 J	11.2	21.9
Manganese	mg/kg	1670	1350	449	625	434	602	518	593 J	137 J	277	451
Selenium	mg/kg	0.478 J	0.318 J	0.268 J	0.388 J	0.226 J	0.335 J	0.363 J	< 0.183 U	0.187 J	< 0.184 U	0.401 J
Zinc	mg/kg	139	165	57.2	74.1	29.5	81.5	123	23.4 J	18.5 J	26.6	58.7
PAHS (SW8270C/E SIM)												
Benzo[a]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[a]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[b]fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[g,h,i]perylene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Chrysene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzo[a,h]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--

-- = not analyzed
ft bgs = feet below ground surface
J = Estimated value.
J+ = Estimated value, biased high.
J- = Estimated value, biased low.
mg/kg = milligram(s) per kilogram
PAH = polycyclic aromatic hydrocarbons
U = Analyte not detected.

TABLE 1
ANALYTICAL RESULTS

	Location ID	BG-111-12-01	BG-111-13-01	BG-111-14-01	BG-111-15-01	BG-111-16-01	BG-111-17-01	BG-111-18-01	BG-111-19-01	BG-111-20-01	BG-111-21-01	BG-111-22-01
	Sample Name	BG-111-12-01	BG-111-13-01	BG-111-14-01	BG-111-15-01	BG-111-16-01	BG-111-17-01	BG-111-18-01	BG-111-19-01	BG-111-20-01	BG-111-21-01	BG-111-22-01
	Sample Date	5/19/2021	5/18/2021	5/20/2021	5/20/2021	5/18/2021	5/18/2021	5/17/2021	5/18/2021	5/18/2021	5/17/2021	5/20/2021
	Sample Depth	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs
Analyte	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals (SW6020A)												
Antimony	mg/kg	< 0.17 U	0.255 J	0.23 J	0.3 J	0.456 J	< 0.169 U	0.205 J	0.334 J	0.187 J	0.177 J	0.197 J
Arsenic	mg/kg	16.4	14.9	9.26 J	7.79 J	6.43	6.9	7.18	8.29	7.83	6.6	4.9 J
Cadmium	mg/kg	0.0952 J	0.151 J	< 0.0897 U	0.137 J	0.203 J	< 0.0873 U	0.104 J	0.106 J	< 0.0874 U	0.14 J	< 0.0874 U
Chromium	mg/kg	12.4	12.5	8.21	7.14	8.04	6.03	10.7	11.7	9.17	10.3	3.34 J
Copper	mg/kg	13.5	16.1	11.8 J	11.4 J	12	10.5	13.7	12.7	10.8	13.4	8.92 J
Lead	mg/kg	10.6	24.7	13 J	17.4 J	34.8	7.94	25.1	41.9 J	9.7	31.7	25.8 J
Manganese	mg/kg	406	637	597 J	372	981	196 J	896 J	747 J	250	495	331
Selenium	mg/kg	0.486 J	0.395 J	0.432 J	0.44 J	0.355 J	< 0.184 U	0.363 J	0.436 J	0.375 J	0.321 J	0.25 J
Zinc	mg/kg	34	74.8	34.6 J	35.7 J	49.4	18.4 J	65.8	68.1	33.9	65.4	29.4 J
PAHS (SW8270C/E SIM)												
Benzo[a]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[a]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[b]fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[g,h,i]perylene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Chrysene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzo[a,h]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--

-- = not analyzed
ft bgs = feet below ground surface
J = Estimated value.
J+ = Estimated value, biased high.
J- = Estimated value, biased low.
mg/kg = milligram(s) per kilogram
PAH = polycyclic aromatic hydrocarbons
U = Analyte not detected.

TABLE 1
ANALYTICAL RESULTS

	Location ID	BG-111-23-01	BG-112-01-01	BG-112-02-01	BG-112-03-01	BG-112-04-01	BG-112-05-01	BG-121-01-01	BG-121-02-01	BG-121-03-01	BG-121-04-01	BG-121-05-01
	Sample Name	BG-111-23-01	BG-112-01-01	BG-112-02-01	BG-112-03-01	BG-112-04-01	BG-112-05-01	BG-121-01-01	BG-121-02-01	BG-121-03-01	BG-121-04-01	BG-121-05-01
	Sample Date	5/20/2021	5/20/2021	5/21/2021	5/21/2021	5/21/2021	5/21/2021	5/19/2021	5/19/2021	5/18/2021	5/18/2021	5/17/2021
	Sample Depth	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs
Analyte	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals (SW6020A)												
Antimony	mg/kg	0.75 J	0.369 J	0.285 J	< 0.173 UJ	0.225 J	< 0.169 U	0.286 J	0.178 J	0.194 J	< 0.166 U	0.494 J
Arsenic	mg/kg	7.7 J	156 J	50.7 J	13.6 J	46 J	8.51 J	7.48 J	6.35 J	7.85 J	9.07 J	6.13 J
Cadmium	mg/kg	< 0.0877 U	0.533 J	0.588 J	0.537 J	0.467 J	< 0.0872 U	0.11 J	0.106 J	0.0959 J	< 0.0857 U	0.184 J
Chromium	mg/kg	5.91	14.4	9.14	10.2	10.6	13	17.9 J	16.6 J	4.97 J	7.78 J	4.52 J
Copper	mg/kg	25.2 J	40.8 J	12.6 J	9.51 J	17.8 J	13.4 J	28.2	38.9	19	22	5.29 J
Lead	mg/kg	41.9 J	1060 J	274 J	72.5 J	244 J	18 J	18.6	24.5	30.9	18.9	12.6
Manganese	mg/kg	1230	13300	2630	330	2980	697	337 J	369 J	312 J	253 J	254 J
Selenium	mg/kg	0.221 J	0.786 J	0.34 J	0.382 J	0.68 J	0.397 J	1.21 J	1.43 J	0.603 J	0.57 J	0.692 J
Zinc	mg/kg	33.9 J	182 J	262 J	148 J	324 J	140 J	147 J	230 J	35.2 J	48.8 J	14.8 J
PAHS (SW8270C/E SIM)												
Benzo[a]anthracene	mg/kg	--	0.013	0.0192	< 0.0018 U	0.0153	< 0.00177 U	--	--	--	--	--
Benzo[a]pyrene	mg/kg	--	0.0131	0.0198	< 0.00187 U	0.0147	< 0.00183 U	--	--	--	--	--
Benzo[b]fluoranthene	mg/kg	--	0.0284	0.0322	< 0.0016 U	0.0179	< 0.00156 U	--	--	--	--	--
Benzo[g,h,i]perylene	mg/kg	--	0.0215	0.0212	< 0.00185 U	0.0159	< 0.00181 U	--	--	--	--	--
Chrysene	mg/kg	--	0.0476	0.0359	< 0.00242 U	0.0364	< 0.00237 U	--	--	--	--	--
Dibenzo[a,h]anthracene	mg/kg	--	0.00781	0.0068 J	< 0.00179 U	0.00659 J	< 0.00175 U	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	mg/kg	--	0.0143	0.0169	< 0.00189 U	0.0101	< 0.00185 U	--	--	--	--	--
Phenanthrene	mg/kg	--	0.00692	0.00594 J	< 0.00241 U	0.0053 J	< 0.00236 U	--	--	--	--	--
Pyrene	mg/kg	--	0.0172	0.0285	< 0.00209 U	0.0148	< 0.00204 U	--	--	--	--	--

-- = not analyzed
ft bgs = feet below ground surface
J = Estimated value.
J+ = Estimated value, biased high.
J- = Estimated value, biased low.
mg/kg = milligram(s) per kilogram
PAH = polycyclic aromatic hydrocarbons
U = Analyte not detected.

TABLE 1
ANALYTICAL RESULTS

	Location ID	BG-121-06-01	BG-121-07-01	BG-121-08-01	BG-121-09-01	BG-121-10-01	BG-121-11-01	BG-121-12-01	BG-121-13-01	BG-121-14-01	BG-121-15-01	BG-121-16-01
	Sample Name	BG-121-06-01	BG-121-07-01	BG-121-08-01	BG-121-09-01	BG-121-10-01	BG-121-11-01	BG-121-12-01	BG-121-13-01	BG-121-14-01	BG-121-15-01	BG-121-16-01
	Sample Date	5/19/2021	5/19/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/19/2021	5/18/2021	5/20/2021	5/20/2021	5/17/2021
	Sample Depth	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs
Analyte	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals (SW6020A)												
Antimony	mg/kg	< 0.166 U	< 0.167 U	< 0.166 U	< 0.167 UJ	< 0.167 U	0.324 J	0.371 J	< 0.166 U	< 0.166 U	< 0.167 U	0.427 J
Arsenic	mg/kg	4.09 J	7.89 J	2.57 J	9.39 J	9.88 J	7.39 J	5.6 J+	4.36 J	5.09	3.65 J+	8.41 J
Cadmium	mg/kg	0.101 J	< 0.0858 U	< 0.0857 U	< 0.0861 U	< 0.0858 U	0.124 J	< 0.0857 U	< 0.0857 U	< 0.0857 U	< 0.0859 U	0.13 J
Chromium	mg/kg	7.12 J	10.4 J	3 J	3.25 J	4.31 J	3.91 J	4.88 J	2.7 J	4.18 J	3.95 J	3.73 J
Copper	mg/kg	20.1	27.1	4.31 J	5.73	3.65 J	5.46	4.26 J	3.76 J	2.72 J	5.68 J	7.05
Lead	mg/kg	12.3	8.74	5.11	8.55	8.17	22.1	7.77 J+	7.08	9.03 J	7.03 J	8.64
Manganese	mg/kg	245 J	201 J	111 J	174 J	200 J	306 J	232 J	170 J	265 J	195 J	406 J
Selenium	mg/kg	0.735 J	0.802 J	0.278 J	0.414 J	0.488 J	0.508 J	0.374 J	0.214 J	0.346 J	0.317 J	0.659 J
Zinc	mg/kg	54.2 J	59.5 J	14.5 J	38.1 J	23.5 J	12.4 J	22.6 J+	14.7 J	19.7 J	28.7 J	17.7 J
PAHS (SW8270C/E SIM)												
Benzo[a]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[a]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[b]fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[g,h,i]perylene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Chrysene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzo[a,h]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--

-- = not analyzed
ft bgs = feet below ground surface
J = Estimated value.
J+ = Estimated value, biased high.
J- = Estimated value, biased low.
mg/kg = milligram(s) per kilogram
PAH = polycyclic aromatic hydrocarbons
U = Analyte not detected.

TABLE 1
ANALYTICAL RESULTS

	Location ID	BG-121-17-01	BG-121-18-01	BG-121-19-01	BG-121-20-01	BG-121-21-01	BG-121-22-01	BG-121-23-01	BG-121-24-01	BG-121-25-01	BG-121-26-01	BG-121-27-01
	Sample Name	BG-121-17-01	BG-121-18-01	BG-121-19-01	BG-121-20-01	BG-121-21-01	BG-121-22-01	BG-121-23-01	BG-121-24-01	BG-121-25-01	BG-121-26-01	BG-121-27-01
	Sample Date	5/17/2021	5/18/2021	5/19/2021	5/19/2021	5/20/2021	5/19/2021	5/19/2021	5/18/2021	5/19/2021	5/19/2021	5/18/2021
	Sample Depth	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs
Analyte	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals (SW6020A)												
Antimony	mg/kg	0.574 J	< 0.166 U	< 0.17 U	0.624 J	< 0.166 U	< 0.169 U	0.512 J	< 0.166 UJ	< 0.17 U	< 0.166 U	< 0.168 U
Arsenic	mg/kg	7.48 J	4.71 J	14.2	12.3	1.51	6.19	9.21 J	2.94 J	13.6 J	2.84 J	6.67 J
Cadmium	mg/kg	0.157 J	< 0.0857 U	< 0.0874 U	0.166 J	< 0.0858 U	< 0.0868 U	0.095 J	< 0.0857 U	< 0.0873 U	< 0.0857 U	< 0.0863 U
Chromium	mg/kg	4.66 J	3.01 J	2.25 J	8	1.8 J	2.29 J	9.13 J	7.18 J	1.37 J	2.99 J	3.38 J
Copper	mg/kg	8.18	2.46 J	5.39	14.4	2.59 J	3.32 J	13.8	42.1	6.05	11.9	9.82
Lead	mg/kg	9.91	8.69	11.4	13	5.73 J	8.36	9.29	14.3	16	42.8	13.8
Manganese	mg/kg	474 J	802 J	174 J	309 J	127 J	263 J	251 J	182 J	405 J	721 J	186 J
Selenium	mg/kg	0.877 J	0.321 J	0.542 J	0.771 J	0.23 J	0.524 J	0.597 J	0.544 J	0.598 J	0.227 J	0.832 J
Zinc	mg/kg	20.2 J	16 J	32.5	44.8	11.3 J	32.6	41.4 J	40 J	36.4 J	15.5 J	32.8 J
PAHS (SW8270C/E SIM)												
Benzo[a]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[a]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[b]fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[g,h,i]perylene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Chrysene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzo[a,h]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--

-- = not analyzed
ft bgs = feet below ground surface
J = Estimated value.
J+ = Estimated value, biased high.
J- = Estimated value, biased low.
mg/kg = milligram(s) per kilogram
PAH = polycyclic aromatic hydrocarbons
U = Analyte not detected.

TABLE 1
ANALYTICAL RESULTS

	Location ID	BG-122-01-01	BG-122-02-01	BG-122-03-01	BG-122-04-01	BG-122-05-01	BG-122-06-01	BG-122-07-01	BG-122-08-01	BG-122-09-01	BG-13-01-01	BG-13-02-01
	Sample Name	BG-122-01-01	BG-122-02-01	BG-122-03-01	BG-122-04-01	BG-122-05-01	BG-122-06-01	BG-122-07-01	BG-122-08-01	BG-122-09-01	BG-13-01-01	BG-13-02-01
	Sample Date	5/20/2021	5/20/2021	5/20/2021	5/20/2021	5/20/2021	5/21/2021	5/20/2021	5/20/2021	5/21/2021	5/20/2021	5/21/2021
	Sample Depth	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs
Analyte	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals (SW6020A)												
Antimony	mg/kg	< 0.168 U	< 0.166 U	< 0.167 U	0.167 J	< 0.168 U	0.177 J	< 0.17 U	< 0.167 U	< 0.166 UJ	5.29	16.5
Arsenic	mg/kg	3.53 J+	3.56	3.67	10.2	13.1	13.6	3.79 J+	11.2	4.59	1430	1210
Cadmium	mg/kg	< 0.0864 U	< 0.0856 U	< 0.0862 U	0.136 J	0.15 J	0.171 J	< 0.0874 U	0.0872 J	< 0.0857 U	0.81 J	0.765 J
Chromium	mg/kg	1.23 J	4.33 J	1.63 J	18.1	22.3	18.4	0.994 J	18.1	8.62	8.46	2.25 J
Copper	mg/kg	4.88 J	2.25 J	2.87 J	28.9	33.3	12.8	3.11 J	35.5	18.3	162	690
Lead	mg/kg	11.5 J	18.6 J	12.3	63.7	56.8	28.6	7.39 J+	85.4	18.9	9410 J+	27000
Manganese	mg/kg	190 J	234 J	129 J	477 J	558 J	286 J	109 J	637 J	231 J	207000 J	341000 J
Selenium	mg/kg	0.257 J	0.216 J	0.202 J	1.41 J	1.37 J	1.28 J	0.23 J	1.25 J	0.827 J	0.386 J	1.07 J
Zinc	mg/kg	106 J	11.4 J	51.2	136	481	90	80.4 J+	101	59.4	646 J+	398
PAHS (SW8270C/E SIM)												
Benzo[a]anthracene	mg/kg	0.00513 J+	< 0.00175 U	0.00323 J	< 0.00174 U	< 0.00174 U	< 0.00174 U	< 0.00175 U	0.00973	< 0.00174 U	--	--
Benzo[a]pyrene	mg/kg	0.00202 J+	< 0.00181 U	0.00313 J	< 0.0018 U	< 0.00181 U	< 0.0018 U	< 0.00181 U	0.00474 J	< 0.0018 U	--	--
Benzo[b]fluoranthene	mg/kg	0.0098 J+	< 0.00154 U	0.0111	0.00205 J	0.00392 J	< 0.00154 U	< 0.00155 U	0.0241	< 0.00154 U	--	--
Benzo[g,h,i]perylene	mg/kg	0.00884 J+	0.00294 J	0.0108	0.00201 J	< 0.00179 U	< 0.00178 U	0.0019 J+	0.0186	< 0.00178 U	--	--
Chrysene	mg/kg	0.0166 J+	0.00361 J	0.0111	0.00394 J	0.00868	< 0.00233 U	0.00443 J+	0.0331	< 0.00234 U	--	--
Dibenzo[a,h]anthracene	mg/kg	0.00367 J+	< 0.00174 U	0.00238 J	< 0.00173 U	< 0.00173 U	< 0.00173 U	< 0.00174 U	0.0068	< 0.00173 U	--	--
Indeno[1,2,3-cd]pyrene	mg/kg	0.00644 J+	0.00196 J	0.00843	< 0.00182 U	< 0.00183 U	< 0.00182 U	< 0.00183 U	0.0144	< 0.00182 U	--	--
Phenanthrene	mg/kg	0.00406 J+	< 0.00233 U	0.00258 J	< 0.00232 U	< 0.00233 U	< 0.00232 U	< 0.00234 U	0.00598 J	< 0.00233 U	--	--
Pyrene	mg/kg	0.0106 J+	0.00223 J	0.00661	0.00223 J	0.00251 J	< 0.00201 U	0.00208 J+	0.0164	< 0.00201 U	--	--

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J- = Estimated value, biased low.
mg/kg = milligram(s) per kilogram
PAH = polycyclic aromatic hydrocarbons
U = Analyte not detected.

TABLE 1
ANALYTICAL RESULTS

	Location ID	BG-13-03-01	BG-13-04-01	BG-13-05-01	BG-13-06-01	BG-13-07-01	BG-13-08-01	BG-13-09-01	BG-13-10-01	BG-13-11-01	BG-13-12-01	BG-13-13-01
	Sample Name	BG-13-03-01	BG-13-04-01	BG-13-05-01	BG-13-06-01	BG-13-07-01	BG-13-08-01	BG-13-09-01	BG-13-10-01	BG-13-11-01	BG-13-12-01	BG-13-13-01
	Sample Date	5/21/2021	5/21/2021	5/21/2021	5/21/2021	5/21/2021	5/21/2021	5/19/2021	5/19/2021	5/19/2021	5/19/2021	5/19/2021
	Sample Depth	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs	0-1 ft bgs
Analyte	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals (SW6020A)												
Antimony	mg/kg	0.226 J	2.56 J	**33.7**	0.664 J	0.424 J	6.72	10.2	20.3	12.3 J	15.1	20.9
Arsenic	mg/kg	31.3	790	2510	142	94.6	1110	3460	6440	4460	7100	20000
Cadmium	mg/kg	< 0.0873 U	0.131 J	0.274 J	< 0.0871 U	0.625 J	0.551 J	0.397 J	0.383 J	0.437 J	0.397 J	0.222 J
Chromium	mg/kg	10.5 J	6.37	4.65 J	8.68 J	5.01 J	11.9	6.93	4.42 J	7.86 J	5.83	4.63 J
Copper	mg/kg	16.5 J	213	633 J	178 J	95.3 J	66.7	117	331 J	498 J	292 J	483 J
Lead	mg/kg	57.5 J	12800	24900 J	2650 J	1800 J	7780	7570	3470	4760	3640	14000
Manganese	mg/kg	765 J	207000 J	299000 J	30500 J	19800 J	117000 J	204000 J	313000 J	193000 J	242000 J	205000 J
Selenium	mg/kg	0.635 J	0.294 J	0.264 J	0.316 J	0.418 J	0.446 J	0.474 J	0.355 J	0.919 J	0.465 J	0.392 J
Zinc	mg/kg	179 J	251	340 J	154 J	109 J	675	865	1310	824	1190	728
PAHS (SW8270C/E SIM)												
Benzo[a]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[a]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[b]fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo[g,h,i]perylene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Chrysene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzo[a,h]anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--

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ft bgs = feet below ground surface
J = Estimated value.
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J- = Estimated value, biased low.
mg/kg = milligram(s) per kilogram
PAH = polycyclic aromatic hydrocarbons
U = Analyte not detected.

TABLE 2
DISPOSITION OF POTENTIAL OUTLIERS IDENTIFIED FROM NORMAL Q-Q PLOTS

Stratum	Location	latitude_wgs84	longitude_wgs84	Removed from Background Data	COMMENT
111	BG-111-01-01	36.07295677	-114.9215859	Yes (anomalous concentrations of lead and manganese)	Mixture of Muddy Creek (111) and River Mountain (121) zones
111	BG-111-02-01	36.07410678	-114.9208995	Yes (anomalous concentrations of zinc)	Mixture of Muddy Creek (111) and River Mountain (121) zones
111	BG-111-05-01	36.0725804	-114.923078	Yes (anomalous concentrations of copper)	Mixture of Muddy Creek (111) and River Mountain (121) zones
111	BG-111-07-01	36.08067673	-114.9266653	Yes (anomalous concentrations of arsenic and copper)	Not representative of Muddy Creek (111)
111	BG-111-23-01	36.0778221	-114.9140366	Yes (anomalous concentrations of antimony)	Spatially remote and not representative of Muddy Creek (111)
121	BG-121-01-01	36.08627026	-114.9050257	Yes (anomalous concentrations of chromium, copper, and zinc)	Not representative of River Mountain Background (121)
121	BG-121-02-01	36.08307721	-114.9039025	Yes (anomalous concentrations of chromium, copper, selenium, and zinc)	Not representative of River Mountain Background (121)
121	BG-121-03-01	36.07775683	-114.905505	No (anomalous concentrations of lead)	No other rationale to remove
121	BG-121-06-01	36.0860593	-114.9065844	Yes (located near BG-121-01-01)	Not representative of River Mountain Background (121)
121	BG-121-07-01	36.08357474	-114.9044397	Yes (anomalous concentrations of copper)	Not representative of River Mountain Background (121)
121	BG-121-24-01	36.07840384	-114.9033336	Yes (anomalous concentrations of copper)	Not representative of River Mountain Background (121)
121	BG-121-18-01	36.07670103	-114.913162	Excluded for manganese	
121	BG-121-26-01	36.07381671	-114.9181271	Excluded for lead and manganese	
13	BG-13-02-01	36.08017955	-114.9064317	No (anomalous concentrations of selenium)	No other rationale to remove
13	BG-13-13-01	36.07637	-114.91882	Yes (anomalous concentrations of arsenic)	Not representative of Ore Body Background (13)

TABLE 3
BACKGROUND SUMMARY STATISTICS

			Detected Data								Non-Detected Data							
Lithology	Parameter	No. Samples	N	Min	25th Percentile [1]	Median	Mean	75th Percentile [1]	Max	Standard Deviation	N	Min	25th Percentile [1]	Median	Mean	75th Percentile [1]	Max	Standard Deviation
Muddy Creek Formation (111)	Antimony	18	14	0.177	0.197	0.229	0.261	0.324	0.456	0.0859	4	0.168	0.169	0.169	0.169	0.17	0.17	0.000816
	Arsenic	18	18	3.69	6.43	7.63	8.36	8.29	16.4	3.75	0							
	Cadmium	18	12	0.0952	0.102	0.119	0.126	0.141	0.203	0.031	6	0.0867	0.0873	0.0874	0.0876	0.0874	0.0897	0.00105
	Chromium	18	18	3.28	7.1	8.69	8.82	11.2	12.8	3.01	0							
	Copper	18	18	7.17	9.21	11.6	11.5	13.4	16.1	2.5	0							
	Lead	18	18	3.25	11.2	19.7	20.6	31.7	41.9	11.3	0							
	Manganese	18	18	137	331	473	502	625	981	231	0							
	Selenium	18	15	0.187	0.321	0.375	0.362	0.432	0.486	0.0801	3	0.183	0.183	0.184	0.184	0.184	0.184	0.000577
	Zinc	18	18	18.4	29.4	42.6	47.2	65.8	81.5	21.2	0							
Sedimentary Units of Downwind Parcels (112)	Antimony	5	3	0.225	0.225	0.285	0.293	0.369	0.369	0.0723	2	0.169	0.169	0.171	0.171	0.173	0.173	0.00283
	Arsenic	5	5	8.51	13.6	46	55	50.7	156	59.5	0							
	Cadmium	5	4	0.467	0.5	0.535	0.531	0.563	0.588	0.0496	1	0.0872	0.0872	0.0872	0.0872	0.0872	0.0872	
	Chromium	5	5	9.14	10.2	10.6	11.5	13	14.4	2.16	0							
	Copper	5	5	9.51	12.6	13.4	18.8	17.8	40.8	12.6	0							
	Lead	5	5	18	72.5	244	334	274	1060	420	0							
	Manganese	5	5	330	697	2630	3990	2980	13300	5330	0							
	Selenium	5	5	0.34	0.382	0.397	0.517	0.68	0.786	0.202	0							
	Zinc	5	5	140	148	182	211	262	324	79.4	0							
River Mountain Background (121)	Antimony	22	8	0.194	0.348	0.461	0.44	0.543	0.624	0.141	14	0.166	0.166	0.167	0.167	0.168	0.17	0.00151
	Arsenic	22	22	1.51	4.71	7.03	7.19	9.21	14.2	3.43	0							
	Cadmium	22	7	0.095	0.0959	0.13	0.136	0.166	0.184	0.0344	15	0.0857	0.0857	0.0858	0.0861	0.0863	0.0874	0.000597
	Chromium	22	22	1.37	2.99	3.82	4.09	4.66	9.13	1.98	0							
	Copper	22	22	2.46	3.76	5.57	7.58	9.82	22	5.42	0							
	Lead	21	21	5.11	8.17	9.03	11.5	13	30.9	6.16	0							
	Manganese	20	20	111	180	252	253	308	474	95	0							
	Selenium	22	22	0.214	0.321	0.516	0.499	0.603	0.877	0.197	0							
	Zinc	22	22	11.3	15.5	23.1	26.1	35.2	48.8	11.4	0							
Volcanic Units of Downwind Parcels (122)	Antimony	9	2	0.167	0.167	0.172	0.172	0.177	0.177	0.00707	7	0.166	0.166	0.167	0.167	0.168	0.17	0.0014
	Arsenic	9	9	3.53	3.67	4.59	7.47	11.2	13.6	4.44	0							
	Cadmium	9	4	0.0872	0.112	0.143	0.136	0.161	0.171	0.0356	5	0.0856	0.0857	0.0862	0.0863	0.0864	0.0874	0.00072
	Chromium	9	9	0.994	1.63	8.62	10.4	18.1	22.3	8.76	0							
	Copper	9	9	2.25	3.11	12.8	15.8	28.9	35.5	13.7	0							
	Lead	9	9	7.39	12.3	18.9	33.7	56.8	85.4	27.9	0							
	Manganese	9	9	109	190	234	317	477	637	192	0							
	Selenium	9	9	0.202	0.23	0.827	0.782	1.28	1.41	0.553	0							
	Zinc	9	9	11.4	59.4	90	124	106	481	139	0							
Ore Body Background (13)	Antimony	12	12	0.226	1.61	8.46	10.3	15.8	33.7	10	0							
	Arsenic	12	12	31.3	466	1320	2400	3960	7100	2460	0							
	Cadmium	12	10	0.131	0.383	0.417	0.477	0.625	0.81	0.212	2	0.0871	0.0871	0.0872	0.0872	0.0873	0.0873	0.000141
	Chromium	12	12	2.25	4.83	6.65	6.91	8.57	11.9	2.74	0							
	Copper	12	12	16.5	106	196	274	415	690	223	0							
	Lead	12	12	57.5	3060	6170	8820	11100	27000	8760	0							
	Manganese	12	12	765	73800	206000	181000	271000	341000	116000	0							
	Selenium	12	12	0.264	0.336	0.432	0.504	0.555	1.07	0.252	0							
	Zinc	12	12	109	215	522	578	845	1310	407	0							

1. Percentiles computed using empirical distribution function with averaging (Hyndman Definition #2).
Note that ProUCL computes quartiles for fully detected data sets using linear interpolation of the modes for the order statistics on the uniform distribution [0,1] (Hyndman Definition #7).
All concentrations reported in milligrams per kilogram.

TABLE 4
BACKGROUND THRESHOLD VALUES (BTVs)

Lithology	Parameter	No. Samples	No. Detects	No. Non-Detects	Max Detect (mg/kg)	Distribution of Detected Data	BTV [1] (mg/kg)
Muddy Creek Formation (111)	Antimony	18	14	4	0.456	Normal	0.443
	Arsenic	18	18	0	16.4	Lognormal [2]	20.85
	Cadmium	18	12	6	0.203	Normal	0.188
	Chromium	18	18	0	12.8	Normal	16.2
	Copper	18	18	0	16.1	Normal	17.65
	Lead	18	18	0	41.9	Normal	48.4
	Manganese	18	18	0	981	Normal	1069
	Selenium	18	15	3	0.486	Normal	0.571
	Zinc	18	18	0	81.5	Normal	99.11
River Mountain Background (121)	Antimony	22	8	14	0.624	Normal	0.627
	Arsenic	22	22	0	14.2	Normal	15.24
	Cadmium	22	7	15	0.184	Normal	0.171
	Chromium	22	22	0	9.13	Gamma (WH)	9.727
	Copper	22	22	0	22	Gamma (WH)	23.24
	Lead	21	21	0	30.9	Lognormal [2]	29.83
	Manganese	20	20	0	474	Normal	481
	Selenium	22	22	0	0.877	Normal	0.962
	Zinc	22	22	0	48.8	Normal	52.96
Ore Body (13)	Antimony	12	12	0	33.7	Normal	37.73
	Arsenic	12	12	0	7100	Normal	9122
	Cadmium	12	10	2	0.81	Normal	1.053
	Chromium	12	12	0	11.9	Normal	14.39
	Copper	12	12	0	690	Normal	884.5
	Lead	12	12	0	27000	Normal	32785
	Manganese	12	12	0	341000	Normal	498434
	Selenium	12	12	0	1.07	Gamma (WH)	0.999
	Zinc	12	12	0	1310	Normal	1692

1 For parametric distributions, the BTV is the 95% Upper Tolerance Limit (UTL) with 95% coverage.
2 Skewness (standard deviation of logged data) < 1, so use of lognormal distribution is appropriate as per ProUCL version 5.1 recommendations.
UTLs computed using ProUCL (version 5.1) with Kaplan-Meier estimation for data sets with non-detect results.
mg/kg = milligrams per kilogram.

TABLE 5a
STRATUM COMPARISONS - SEDIMENTARY UNITS OF DOWNWIND PARCELS VERSUS MUDDY CREEK FORMATION

Metal	Sedimentary Units of Downwind Parcels (112)				Muddy Creek Formation (111)				Generalized Wilcoxon Test			
	n	No. Detects	Mean [a]	Median [a]	n	No. Detects	Mean [a]	Median [a]	Chi-Square	Pr > Chi-Square	Adjusted Pr > Chi-Square [b]	Conclusion [c]
Antimony	5	3	0.243	0.225	18	14	0.24	0.204	0.05	0.8280	0.9555	
Arsenic	5	5	55	46	18	18	8.36	7.63	4.15	0.0417	0.0834	
Cadmium	5	4	0.442	0.533	18	12	0.113	0.102	2.18	0.1402	0.1402	
Chromium	5	5	11.5	10.6	18	18	8.82	8.69	0.93	0.3342	0.3342	
Copper	5	5	18.8	13.4	18	18	11.5	11.6	0.38	0.5355	0.5355	
Lead	5	5	334	244	18	18	20.6	19.7	2.68	0.1018	0.1018	
Manganese	5	5	3990	2630	18	18	502	473	0.25	0.6143	0.6143	
Selenium	***5***	***5***	***0.517***	***0.397***	***18***	***15***	***0.332***	***0.359***	***6.02***	***0.0141***	***0.0423***	*
Zinc	***5***	***5***	***211***	***182***	***18***	***18***	***47.2***	***42.6***	***5.00***	***0.0254***	***0.0254***	*

(a) Kaplan-Meier product limit estimator used to compute the mean/median of data sets with non-detect.
(b) P-Value adjusted using the Benjamini-Hochberg procedure for controlling the false discovery rate.
(c) * = Data distributions are different at 95% significance level using adjusted P-value.
All concentrations reported in milligrams per kilogram.

TABLE 5b
STRATUM COMPARISONS - VOLCANIC UNITS OF DOWNWIND PARCELS VERSUS RIVER MOUNTAIN BACKGROUND

	Volcanic Units of Downwind Parcels (122)				River Mountain Background (121)				Generalized Wilcoxon Test			
Metal	**n**	**No. Detects**	**Mean [(a)]**	**Median [(a)]**	**n**	**No. Detects**	**Mean [(a)]**	**Median [(a)]**	**Chi-Square**	**Pr > Chi-Square**	**Adjusted Pr > Chi-Square [(b)]**	**Conclusion [(c)]**
Antimony	9	2	0.167		22	8	0.266		0.00	0.9555	0.9555	
Arsenic	9	9	7.47	4.59	22	22	7.19	7.03	1.10	0.2942	0.2942	
Cadmium	9	4	0.108		22	7	0.102		2.19	0.1388	0.1402	
Chromium	***9***	***9***	***10.4***	***8.62***	***22***	***22***	***4.09***	***3.82***	***11.70***	***0.0006***	***0.0019***	*
Copper	***9***	***9***	***15.8***	***12.8***	***22***	***22***	***7.58***	***5.57***	***6.13***	***0.0133***	***0.0265***	*
Lead	***9***	***9***	***33.7***	***18.9***	***21***	***21***	***11.5***	***9.03***	***10.20***	***0.0014***	***0.0028***	*
Manganese	9	9	317	234	20	20	253	252	3.21	0.0732	0.1465	
Selenium	9	9	0.782	0.827	22	22	0.499	0.516	0.17	0.6785	0.9475	
Zinc	***9***	***9***	***124***	***90***	***22***	***22***	***26.1***	***23***	***18.30***	***0.0000***	***0.0001***	*

(a) Kaplan-Meier Product limit estimator used to compute the mean/median of data sets with non-detect.
(b) P-Value adjusted using Benjamini-Hochberg procedure for controlling the false discovery rate.
(c) * = Data distributions are different at 95% significance level using adjusted P-value.
All concentrations reported in milligrams per kilogram.

APPENDICES

APPENDIX A

Summary Statistics for Raw Data and Comparison of Sample Quantitation Limits

TABLE A.1
SUMMARY STATISTICS FOR RAW DATA

Lithology	Stratum	Analyte	Unit	N	No. Detects	Min	Max	Median	Q_n [1]	$S(Q_n)$ [1]	Potential Outlier Threshold [1]
					Analysis of Detected Results						
Muddy Creek Formation	111	Antimony	mg/kg	23	19	0.171	0.75	0.23	0.075545	0.07036	0.47626
	111	Arsenic	mg/kg	23	23	3.69	48.8	7.79	3.0218	2.8484	17.759
	111	Cadmium	mg/kg	23	14	0.0952	0.203	0.1245	0.031107	0.024466	0.21013
	111	Chromium	mg/kg	23	23	3.06	20.7	9.17	4.666	4.3983	24.564
	111	Copper	mg/kg	23	23	7.17	38.6	12.7	4.666	4.3983	28.094
	111	Lead	mg/kg	23	23	3.25	88.2	23.4	17.664	16.651	81.677
	111	Manganese	mg/kg	23	23	137	1670	518	324.4	305.78	1588.2
	111	Selenium	mg/kg	23	20	0.187	0.486	0.363	0.10221	0.085889	0.66361
	111	Zinc	mg/kg	23	23	18.4	165	49.4	27.329	25.761	139.56
Ore Body Background	13	Antimony	mg/kg	13	13	0.226	33.7	10.2	10.91	9.8489	44.671
	13	Arsenic	mg/kg	13	13	31.3	20000	1430	2478.3	2237.4	9260.8
	13	Cadmium	mg/kg	13	11	0.131	0.81	0.397	0.31107	0.27595	1.3628
	13	Chromium	mg/kg	13	13	2.25	11.9	6.37	3.3995	3.069	17.111
	13	Copper	mg/kg	13	13	16.5	690	213	253.3	228.67	1013.3
	13	Lead	mg/kg	13	13	57.5	27000	7570	7582.2	6845.1	31528
	13	Manganese	mg/kg	13	13	765	341000	205000	108870	98288	549010
	13	Selenium	mg/kg	13	13	0.264	1.07	0.418	0.1622	0.14643	0.9305
	13	Zinc	mg/kg	13	13	109	1310	646	422.16	381.12	1979.9
River Mountain Background	121	Antimony	mg/kg	27	10	0.178	0.624	0.399	0.24885	0.18033	1.0301
	121	Arsenic	mg/kg	27	27	1.51	14.2	6.67	3.4217	3.253	18.056
	121	Cadmium	mg/kg	27	10	0.095	0.184	0.117	0.039994	0.028981	0.21843
	121	Chromium	mg/kg	27	27	1.37	17.9	4.18	2.3552	2.2391	12.017
	121	Copper	mg/kg	27	27	2.46	42.1	6.05	5.7103	5.4288	25.051
	121	Lead	mg/kg	27	27	5.11	42.8	9.91	5.3326	5.0697	27.654
	121	Manganese	mg/kg	27	27	111	802	253	126.65	120.41	674.42
	121	Selenium	mg/kg	27	27	0.214	1.43	0.544	0.25996	0.24715	1.409
	121	Zinc	mg/kg	27	27	11.3	230	32.5	17.109	16.265	89.428
Sedimentary Units of Downwind Parcels	112	Antimony	mg/kg	5	3	0.225	0.369	0.285	0.13331	0.13251	0.7488
	112	Arsenic	mg/kg	5	5	8.51	156	46	71.99	60.759	258.66
	112	Cadmium	mg/kg	5	4	0.467	0.588	0.535	0.1222	0.062569	0.75399
	112	Chromium	mg/kg	5	5	9.14	14.4	10.6	3.1107	2.6254	19.789
	112	Copper	mg/kg	5	5	9.51	40.8	13.4	8.6432	7.2949	38.932
	112	Lead	mg/kg	5	5	18	1060	244	381.06	321.61	1369.6
	112	Manganese	mg/kg	5	5	330	13300	2630	4294.9	3624.9	15317
	112	Selenium	mg/kg	5	5	0.34	0.786	0.397	0.12665	0.10689	0.77112
	112	Zinc	mg/kg	5	5	140	324	182	93.32	78.762	457.67
Volcanic Units of Downwind Parcels	122	Antimony	mg/kg	9	2	0.167	0.177	0.172	0.022219	0.0088654	0.20303
	122	Arsenic	mg/kg	9	9	3.53	13.6	4.59	2.2219	1.9375	11.371
	122	Cadmium	mg/kg	9	4	0.0872	0.171	0.143	0.077767	0.039816	0.28236
	122	Chromium	mg/kg	9	9	0.994	22.3	8.62	8.6654	7.5562	35.067
	122	Copper	mg/kg	9	9	2.25	35.5	12.8	14.665	12.787	57.556
	122	Lead	mg/kg	9	9	7.39	85.4	18.9	21.552	18.794	84.678
	122	Manganese	mg/kg	9	9	109	637	234	179.97	156.94	783.28
	122	Selenium	mg/kg	9	9	0.202	1.41	0.827	0.26663	0.2325	1.6407
	122	Zinc	mg/kg	9	9	11.4	481	90	66.657	58.125	293.44

1. Potential outliers defined as detected concentrations exceeding the median + 3.5*$S(Q_n)$.
The statistic Qn is a robust bias-corrected estimate of the sample standard deviation (Rousseeuw and Croux, 1993).

TABLE A.2
COMPARISON OF SAMPLE QUANTITATION LIMITS TO RISK-BASED SCREENING LEVELS

			Detected Data					Non-Detected Data			
Lithology	**Parameter**	**No. Samples**	**FOD**	**Min**	**Max**	**Median**	**Mean**	**Min**	**Mean**	**Max**	**Residential Soil RSL[1]**
Muddy Creek Formation (111)	Antimony	23	19/23	0.171	0.75		0.284	0.168	0.169	0.17	3.1
	Arsenic	23	23/23	3.69	48.8		10.4				0.68
	Cadmium	23	14/23	0.0952	0.203		0.127	0.0864	0.0878	0.0907	0.71
	Chromium	23	23/23	3.06	20.7		9.46				12,000
	Copper	23	23/23	7.17	38.6		15.5				310
	Lead	23	23/23	3.25	88.2		27.3				400
	Manganese	23	23/23	137	1670		619				180
	Selenium	23	20/23	0.187	0.486		0.352	0.183	0.184	0.184	39
	Zinc	23	23/23	18.4	165		58.3				2,300
Sedimentary Units of Downwind Parcels (112)	Antimony	5	3/5	0.225	0.369		0.293	0.169	0.171	0.173	3.1
	Arsenic	5	5/5	8.51	156		55				0.68
	Cadmium	5	4/5	0.467	0.588		0.531	0.0872	0.0872	0.0872	0.71
	Chromium	5	5/5	9.14	14.4		11.5				12,000
	Copper	5	5/5	9.51	40.8		18.8				310
	Lead	5	5/5	18	1060		334				400
	Manganese	5	5/5	330	13300		3990				180
	Selenium	5	5/5	0.34	0.786		0.517				39
	Zinc	5	5/5	140	324		211				2,300
	Benzo[a]anthracene	5	3/5	0.013	0.0192		0.0158	0.00177	0.001785	0.0018	1.1
	Benzo[a]pyrene	5	3/5	0.0131	0.0198		0.0159	0.00183	0.00185	0.00187	0.11
	Benzo[b]fluoranthene	5	3/5	0.0179	0.0322		0.0262	0.00156	0.00158	0.0016	1.1
	Benzo[g,h,i]perylene	5	3/5	0.0159	0.0215		0.0195	0.00181	0.00183	0.00185	180
	Chrysene	5	3/5	0.0359	0.0476		0.0400	0.00237	0.002395	0.00242	110
	Dibenzo[a,h]anthracene	5	3/5	0.00659	0.00781		0.00707	0.00175	0.00177	0.00179	0.11
	Indeno[1,2,3-cd]pyrene	5	3/5	0.0101	0.0169		0.0138	0.00185	0.00187	0.00189	1.1
	Phenanthrene	5	3/5	0.0053	0.00692		0.0061	0.00236	0.002385	0.00241	1,800
	Pyrene	5	3/5	0.0148	0.0285		0.0202	0.00204	0.002065	0.00209	180
River Mountain Background (121)	Antimony	27	10/27	0.178	0.624		0.398	0.166	0.167	0.17	3.1
	Arsenic	27	27/27	1.51	14.2		6.92				0.68
	Cadmium	27	10/27	0.095	0.184		0.127	0.0857	0.086	0.0874	0.71
	Chromium	27	27/27	1.37	17.9		5.53				12,000
	Copper	27	27/27	2.46	42.1		12.0				310
	Lead	27	27/27	5.11	42.8		13.5				400
	Manganese	27	27/27	111	802		293				180
	Selenium	27	27/27	0.214	1.43		0.582				39
	Zinc	27	27/27	11.3	230		40.9				2,300
Volcanic Units of Downwind Parcels (122)	Antimony	9	2/9	0.167	0.177		0.172	0.166	0.167	0.17	3.1
	Arsenic	9	9/9	3.53	13.6		7.47				0.68
	Cadmium	9	4/9	0.0872	0.171		0.136	0.0856	0.0863	0.0874	0.71
	Chromium	9	9/9	0.994	22.3		10.4				12,000
	Copper	9	9/9	2.25	35.5		15.8				310
	Lead	9	9/9	7.39	85.4		33.7				400
	Manganese	9	9/9	109	637		317				180
	Selenium	9	9/9	0.202	1.41		0.782				39
	Zinc	9	9/9	11.4	481		124				2,300
	Benzo[a]anthracene	9	3/9	0.00323	0.00973		0.00603	0.00174	0.001743	0.00175	1.1
	Benzo[a]pyrene	9	3/9	0.00202	0.00474		0.00330	0.0018	0.001805	0.00181	0.11
	Benzo[b]fluoranthene	9	5/9	0.00205	0.0241		0.0102	0.00154	0.001543	0.00155	1.1
	Benzo[g,h,i]perylene	9	6/9	0.0019	0.0186		0.0075	0.00178	0.001783	0.00179	180
	Chrysene	9	7/9	0.00361	0.0331		0.0116	0.0023	0.00232	0.00234	110
	Dibenzo[a,h]anthracene	9	3/9	0.00238	0.0068		0.00428	0.00173	0.001733	0.00174	0.11
	Indeno[1,2,3-cd]pyrene	9	4/9	0.00196	0.0144		0.00781	0.00182	0.001824	0.00183	1.1
	Phenanthrene	9	3/9	0.00258	0.00598		0.00421	0.00232	0.002328	0.00234	1,800
	Pyrene	9	7/9	0.00208	0.0164		0.00609	0.00201	0.00201	0.00201	180
Ore Body Background (13)	Antimony	13	13/13	0.226	33.7		11.1				3.1
	Arsenic	13	13/13	31.3	20000		3752				0.68
	Cadmium	13	11/13	0.131	0.81		0.454	0.0871	0.0872	0.0873	0.71
	Chromium	13	13/13	2.25	11.9		6.73				12,000
	Copper	13	13/13	16.5	690		290				310
	Lead	13	13/13	57.5	27000		9218				400
	Manganese	13	13/13	765	341000		183005				180
	Selenium	13	13/13	0.264	1.07		0.495				39
	Zinc	13	13/13	109	1310		590				2,300

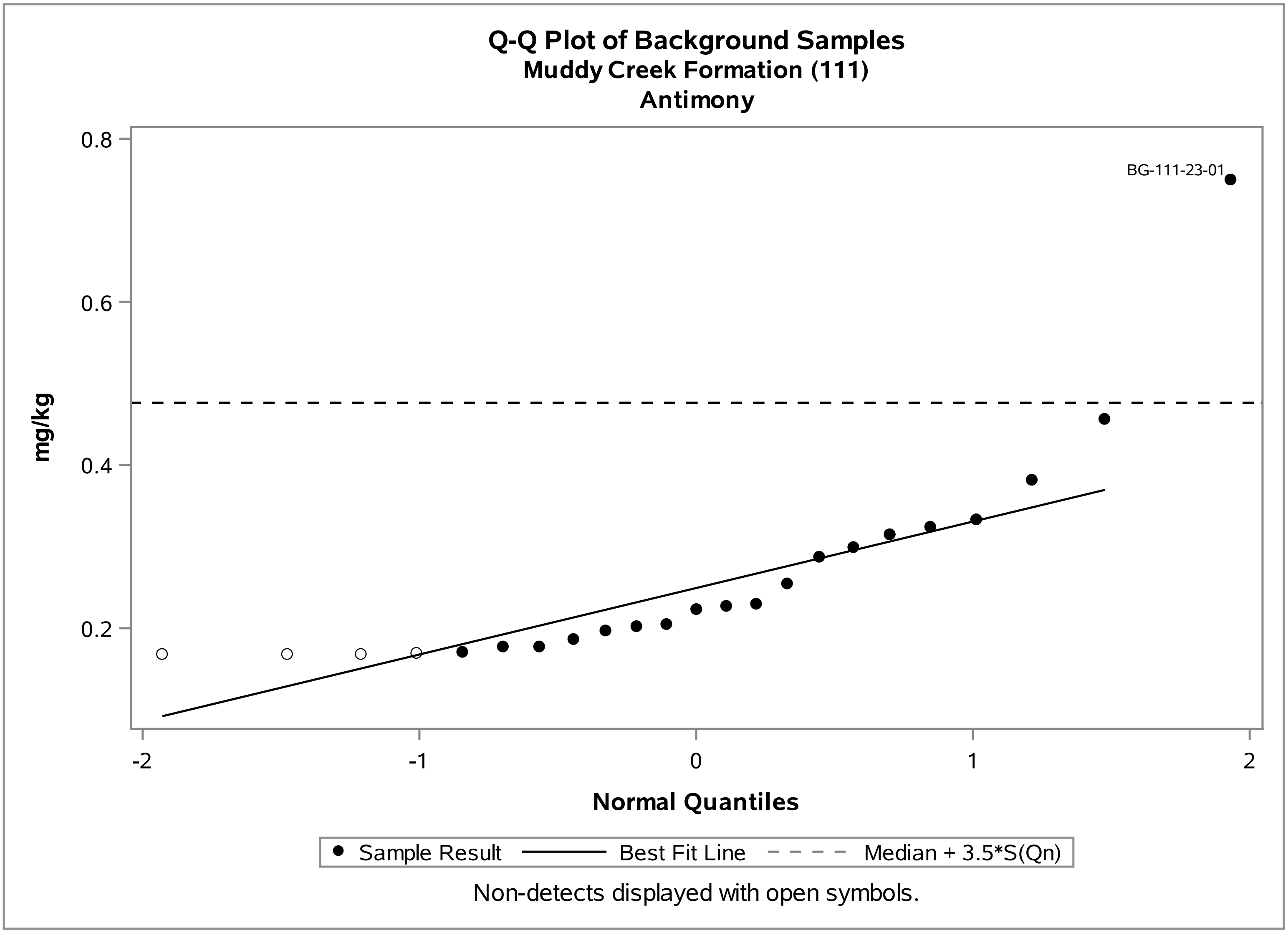
All concentrations reported in milligrams per kilogram.

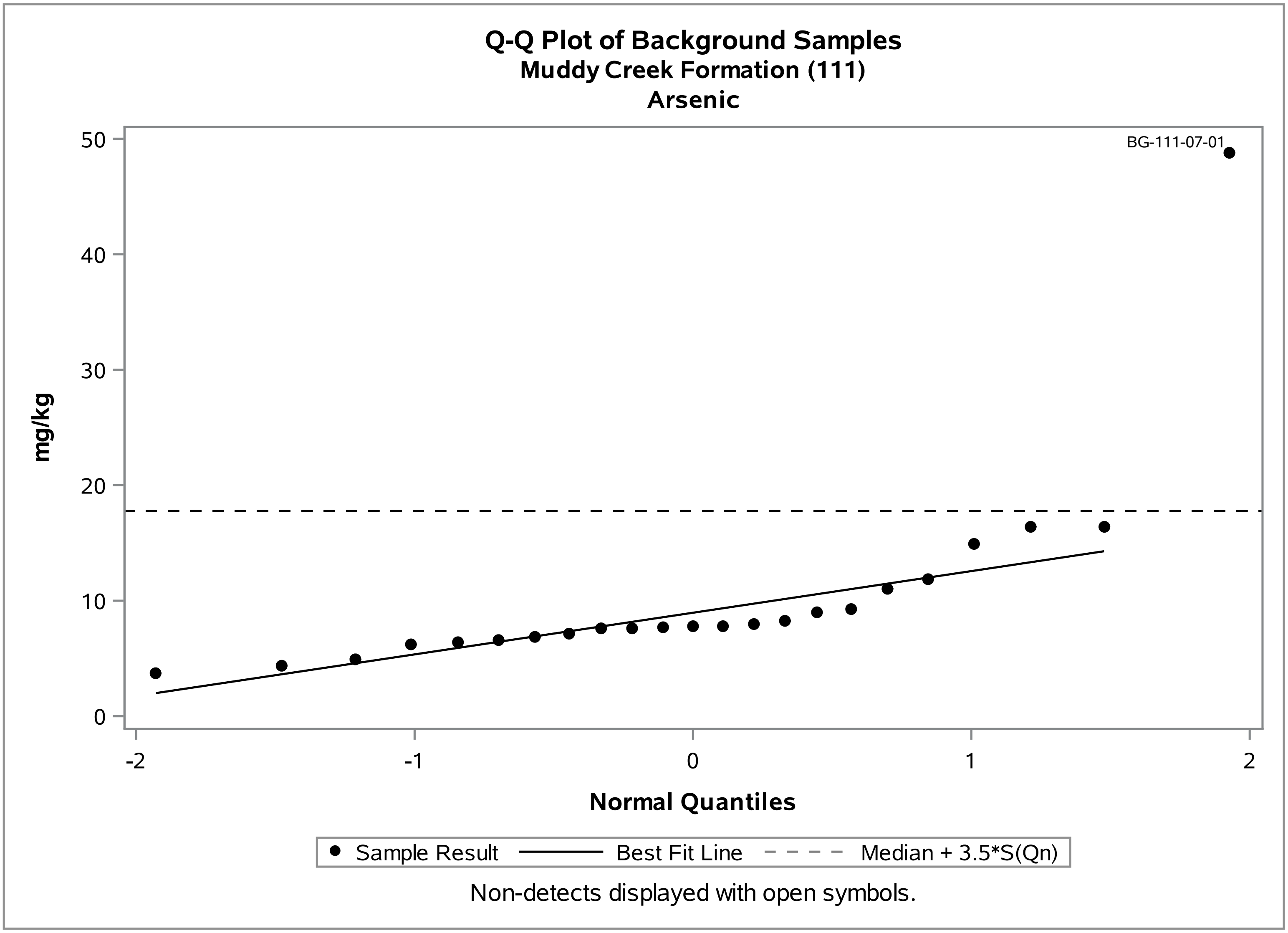
[1] USEPA Regional Screening Level (RSL) for Residential Soil (TR=1E-06, HQ=0.1), November 2021.

Surrogates used: chromium III for chromium, pyrene for benzo(g,h,i)perylene, and anthracene for phenanthrene.

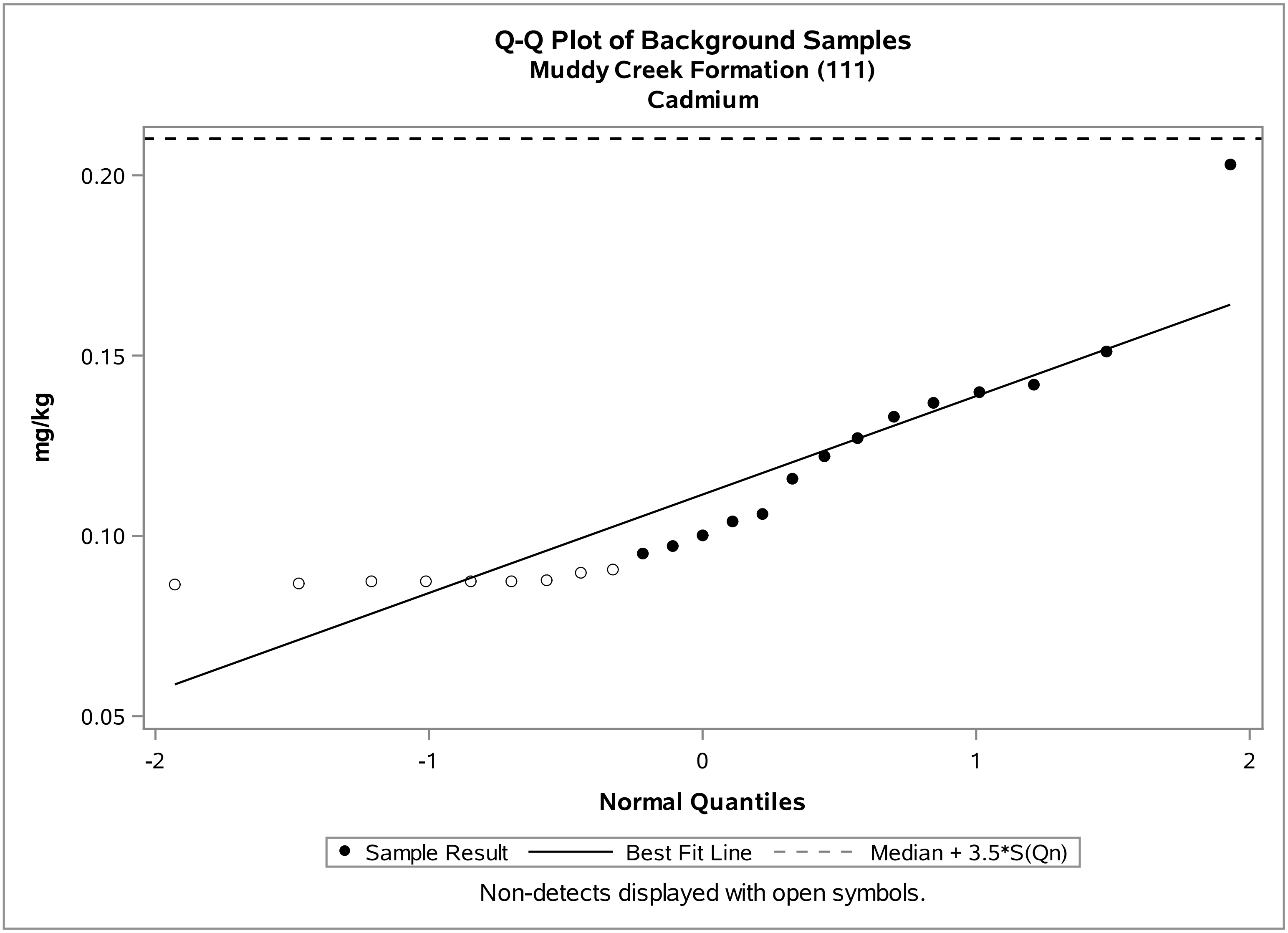
APPENDIX B

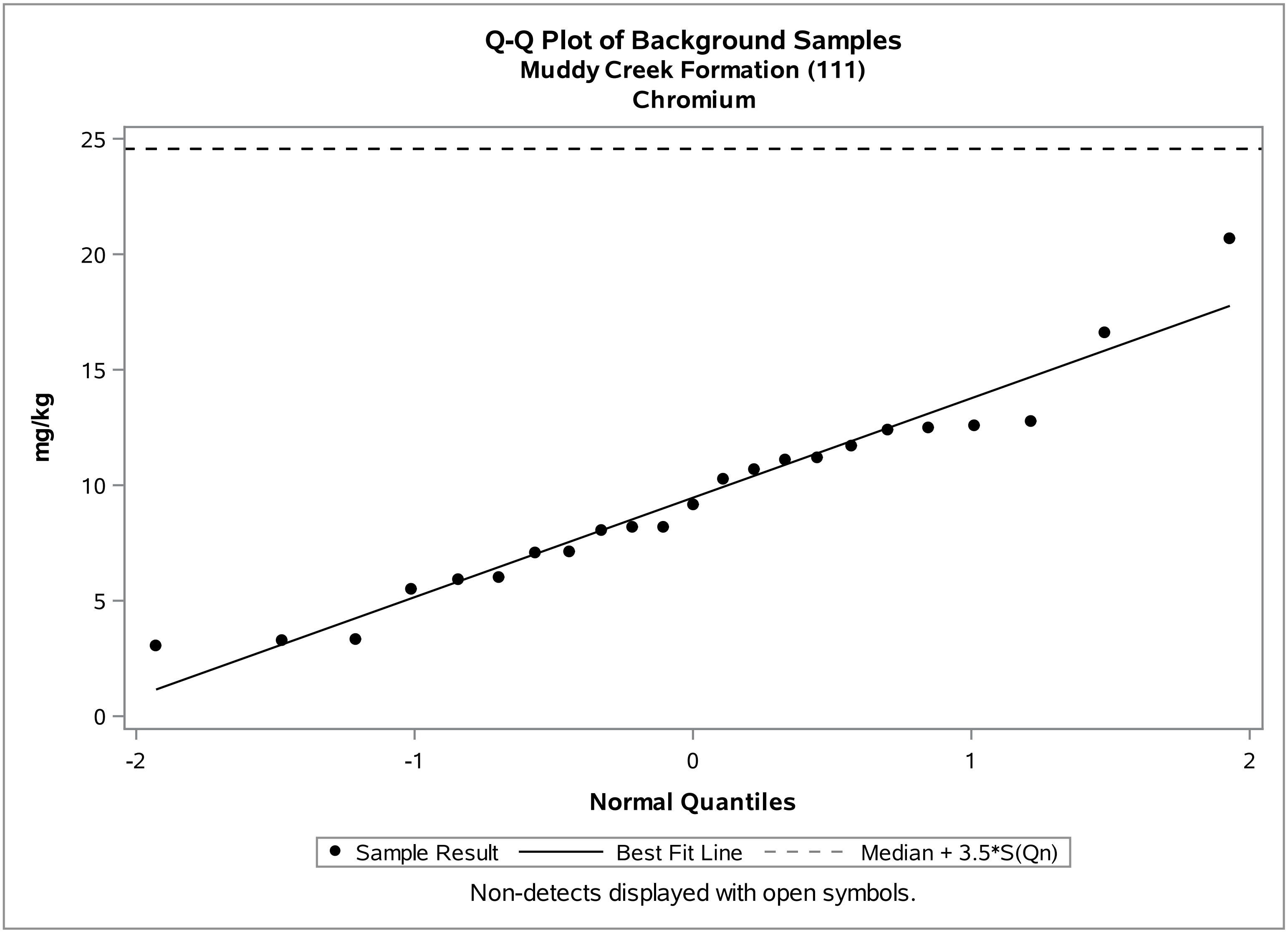
Q-Q Plots


Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Antimony
mg/kg
0.8
0.6
0.4
0.2
BG-111-23-01
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

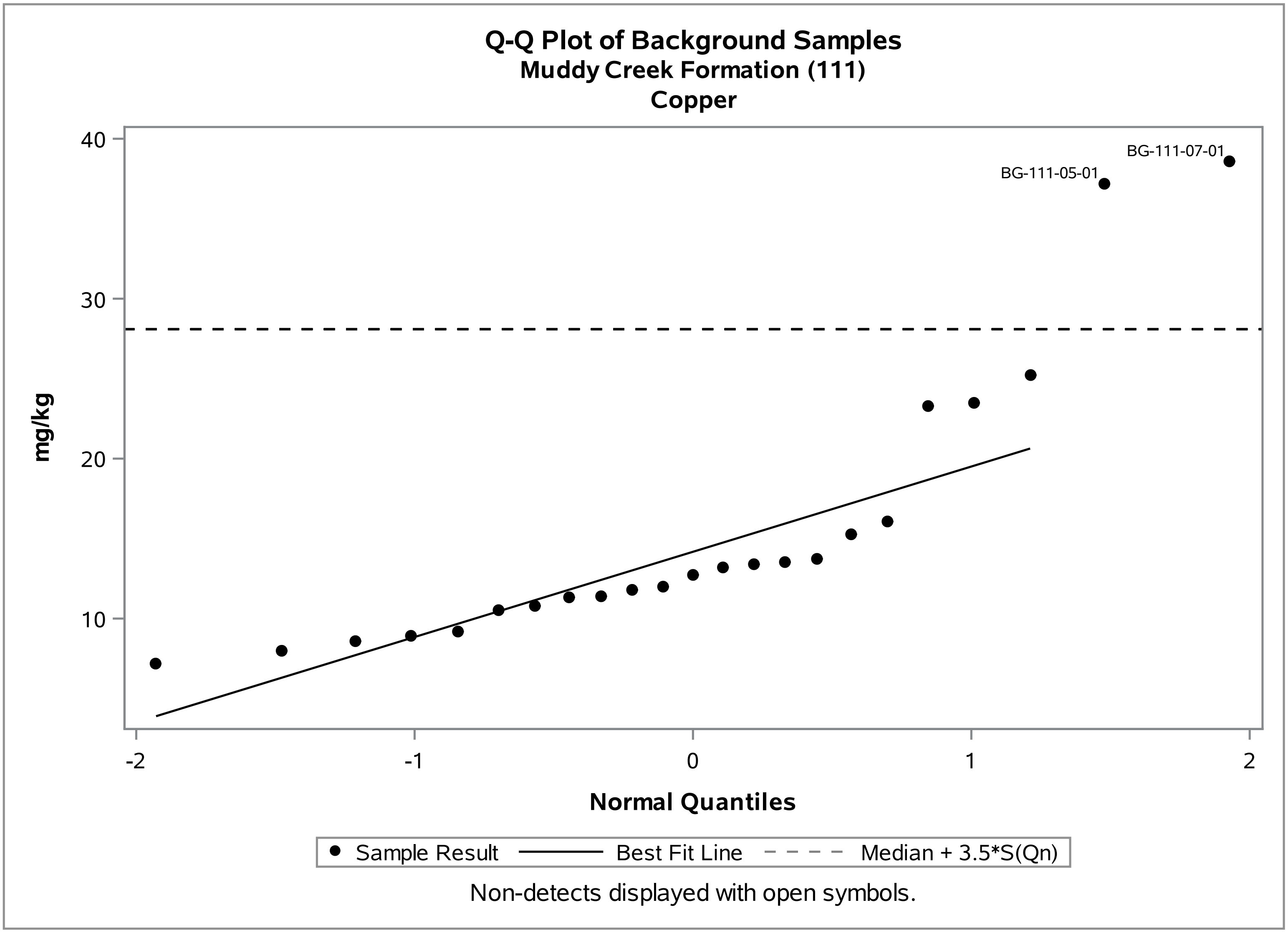


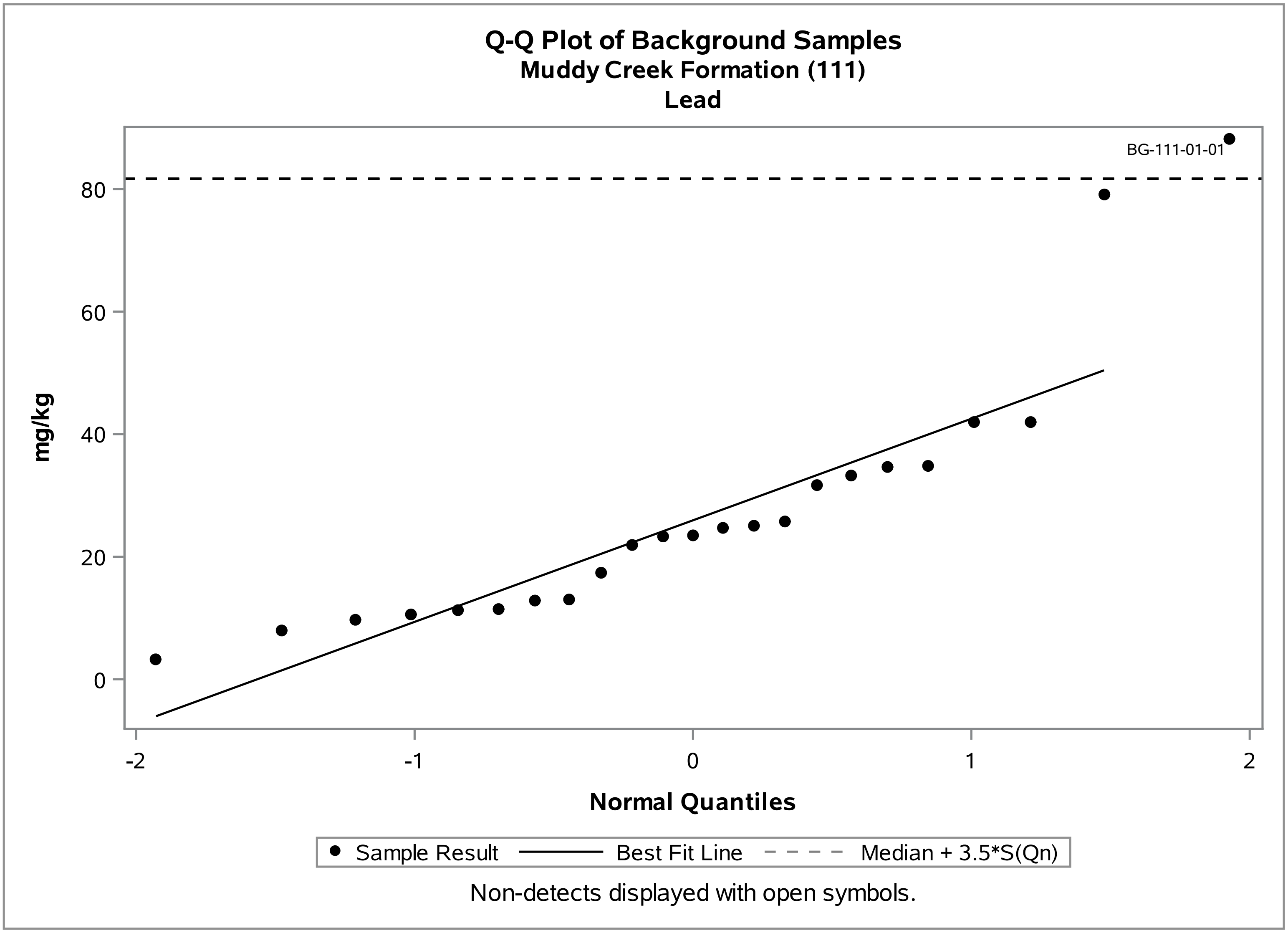
Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Arsenic
mg/kg
50
40
30
20
10
0
-2
-1
0
1
2
Normal Quantiles
BG-111-07-01
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

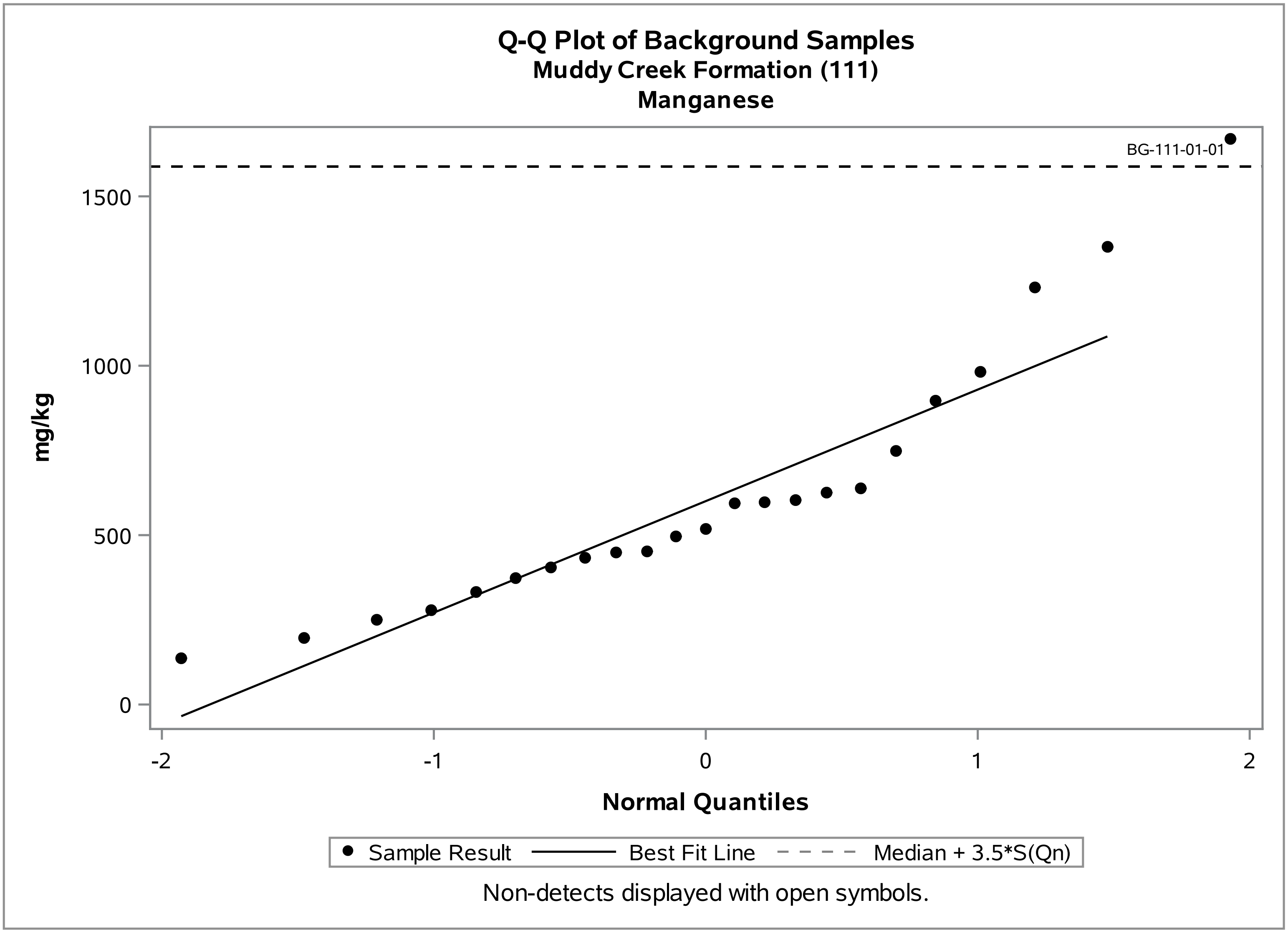

Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Cadmium
mg/kg
0.20
0.15
0.10
0.05
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

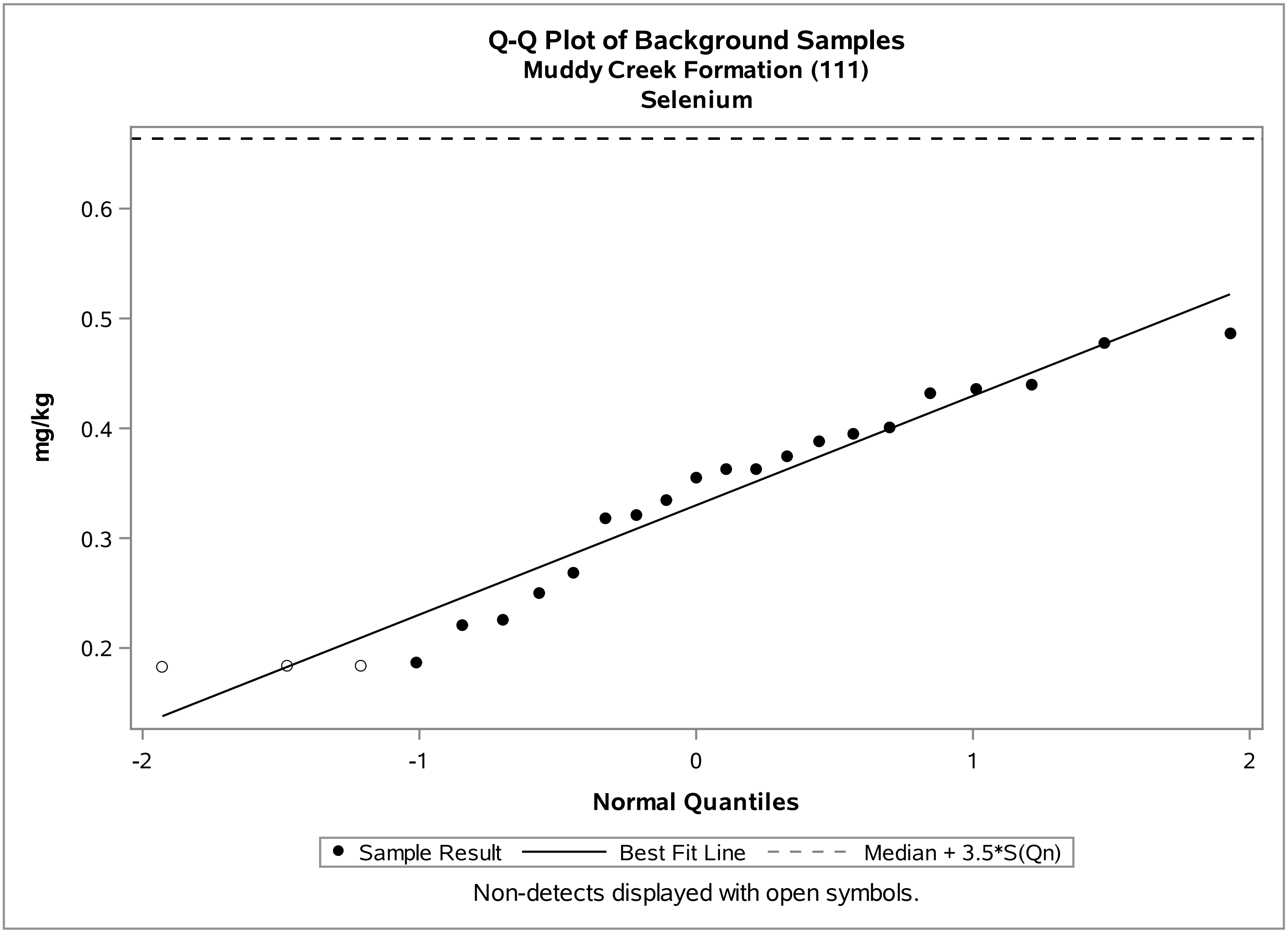


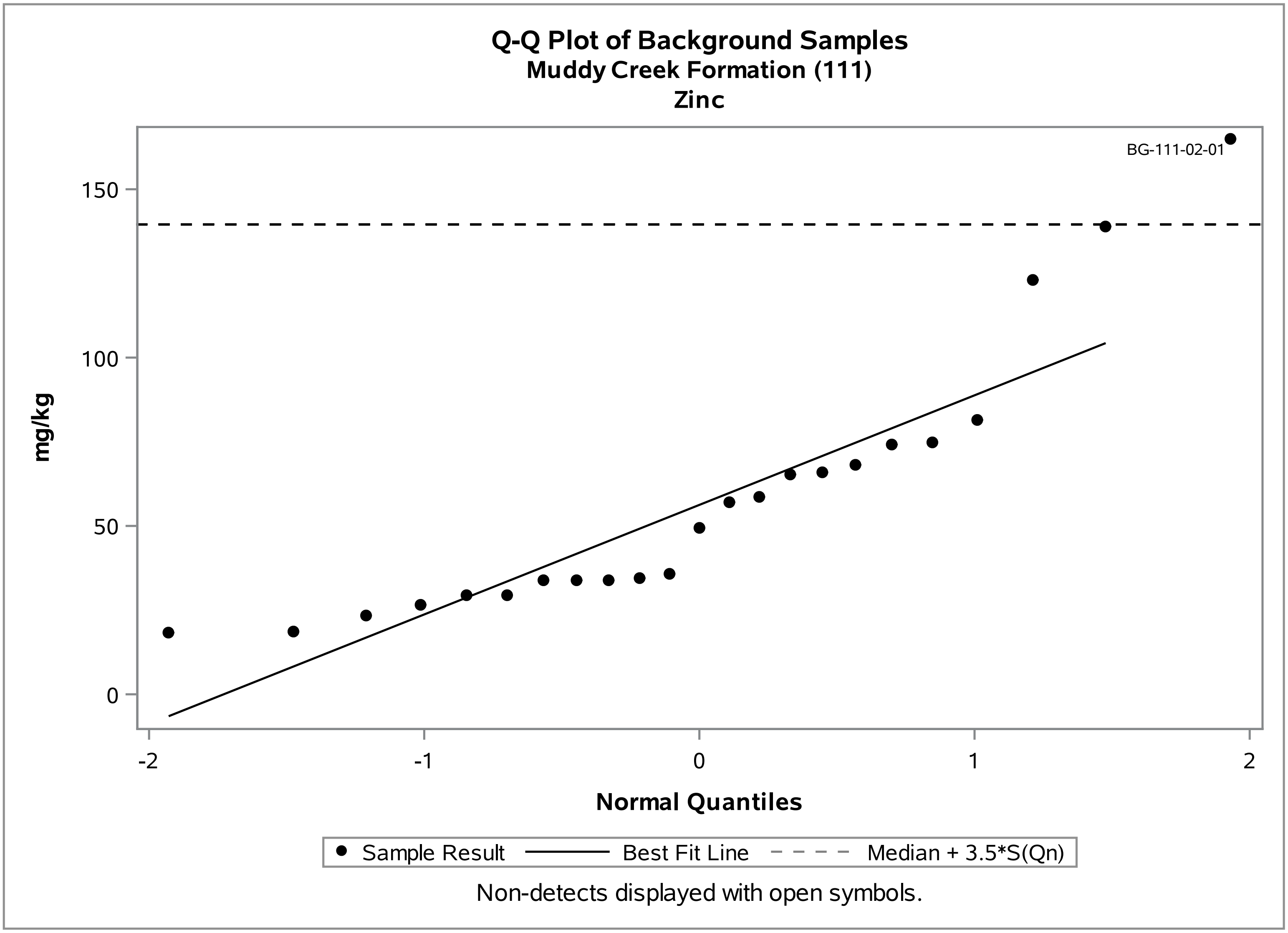
Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Chromium
mg/kg
25
20
15
10
5
0
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

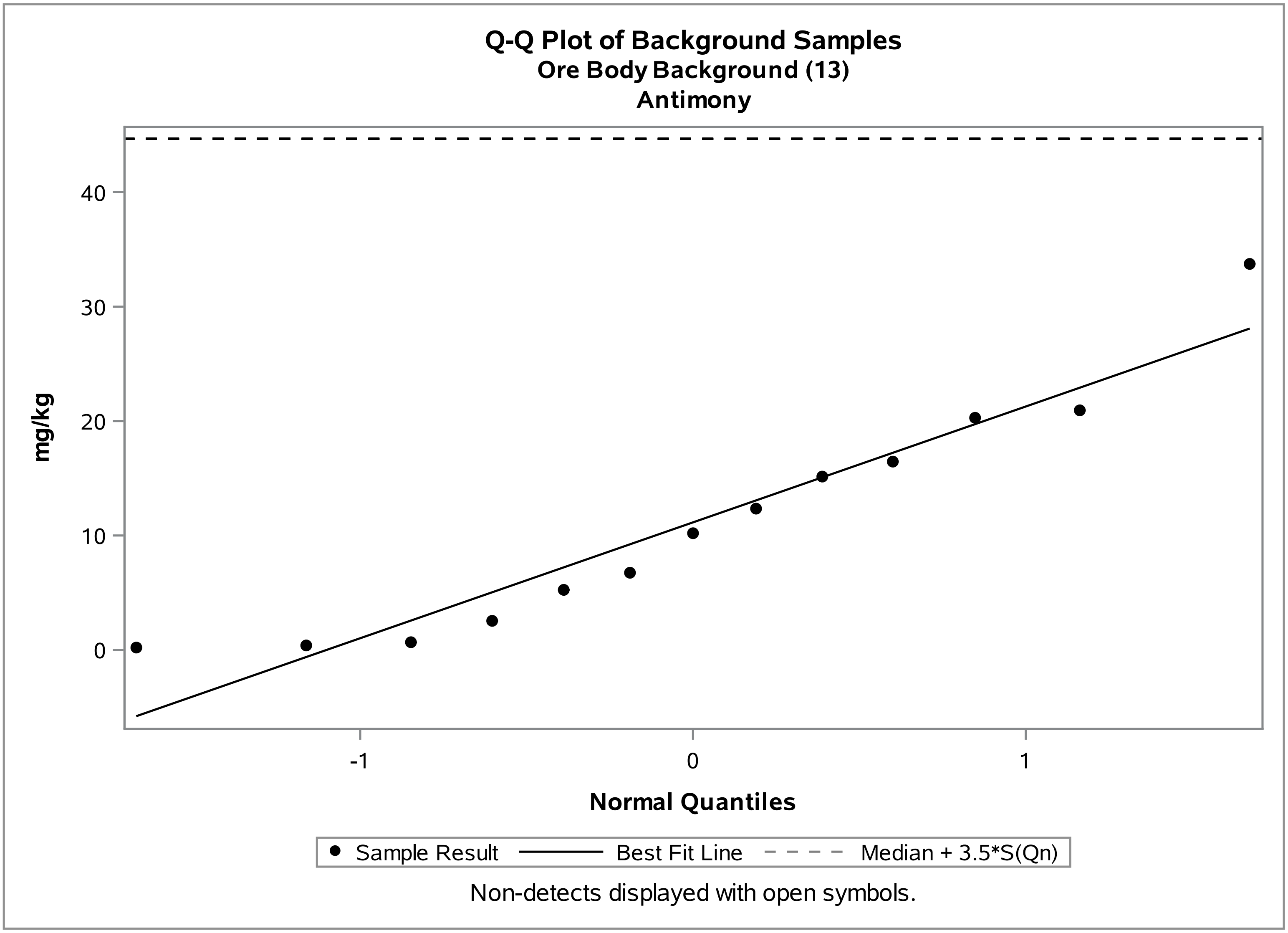

Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Copper
BG-111-07-01
BG-111-05-01
40
30
20
10
mg/kg
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

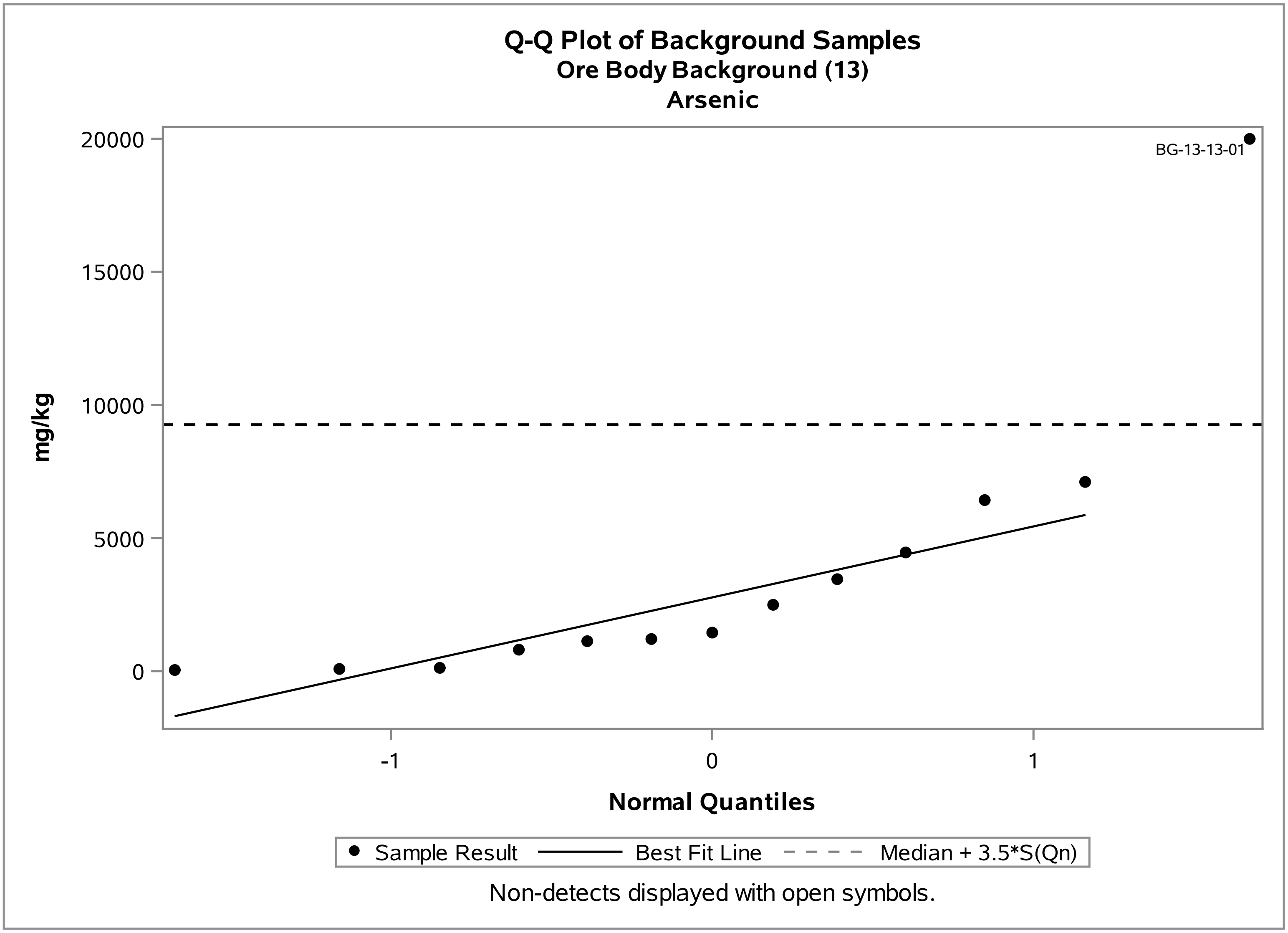

Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Lead
mg/kg
80
60
40
20
0
-2
-1
0
1
2
Normal Quantiles
BG-111-01-01
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

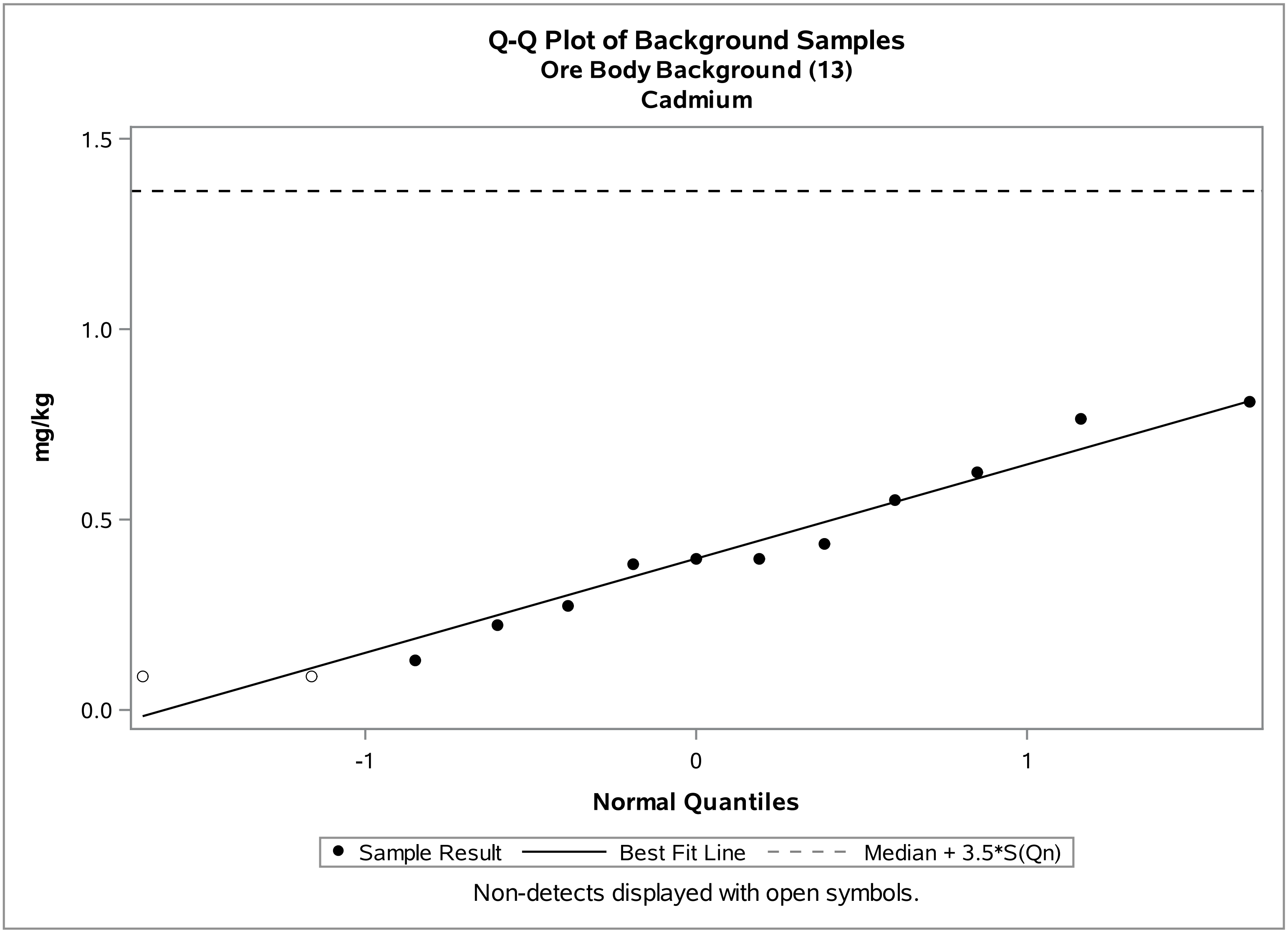

Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Manganese
BG-111-01-01
1500
1000
500
0
mg/kg
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

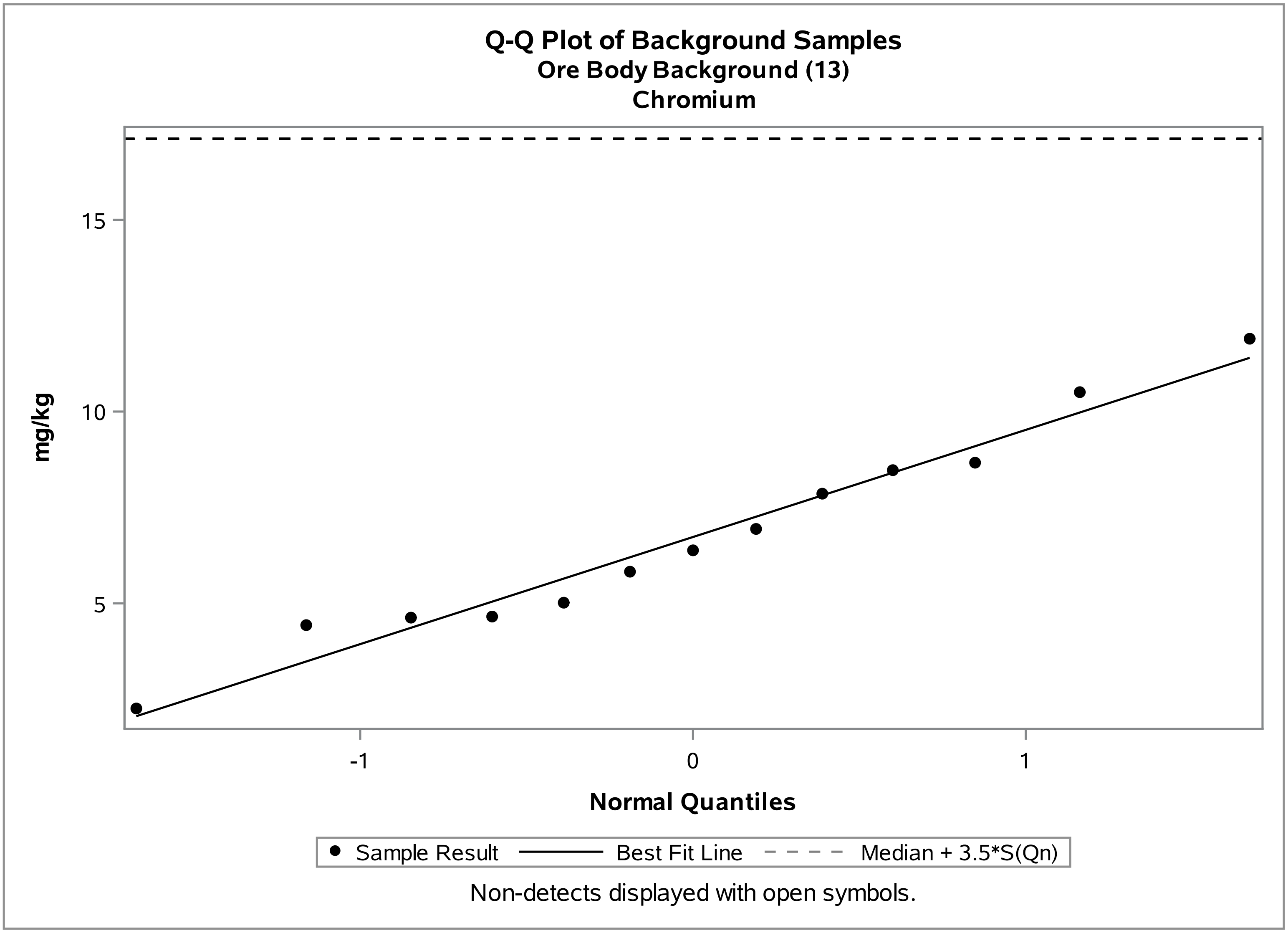

Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Selenium
mg/kg
0.6
0.5
0.4
0.3
0.2
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
Muddy Creek Formation (111)
Zinc
BG-111-02-01
150
100
50
0
mg/kg
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

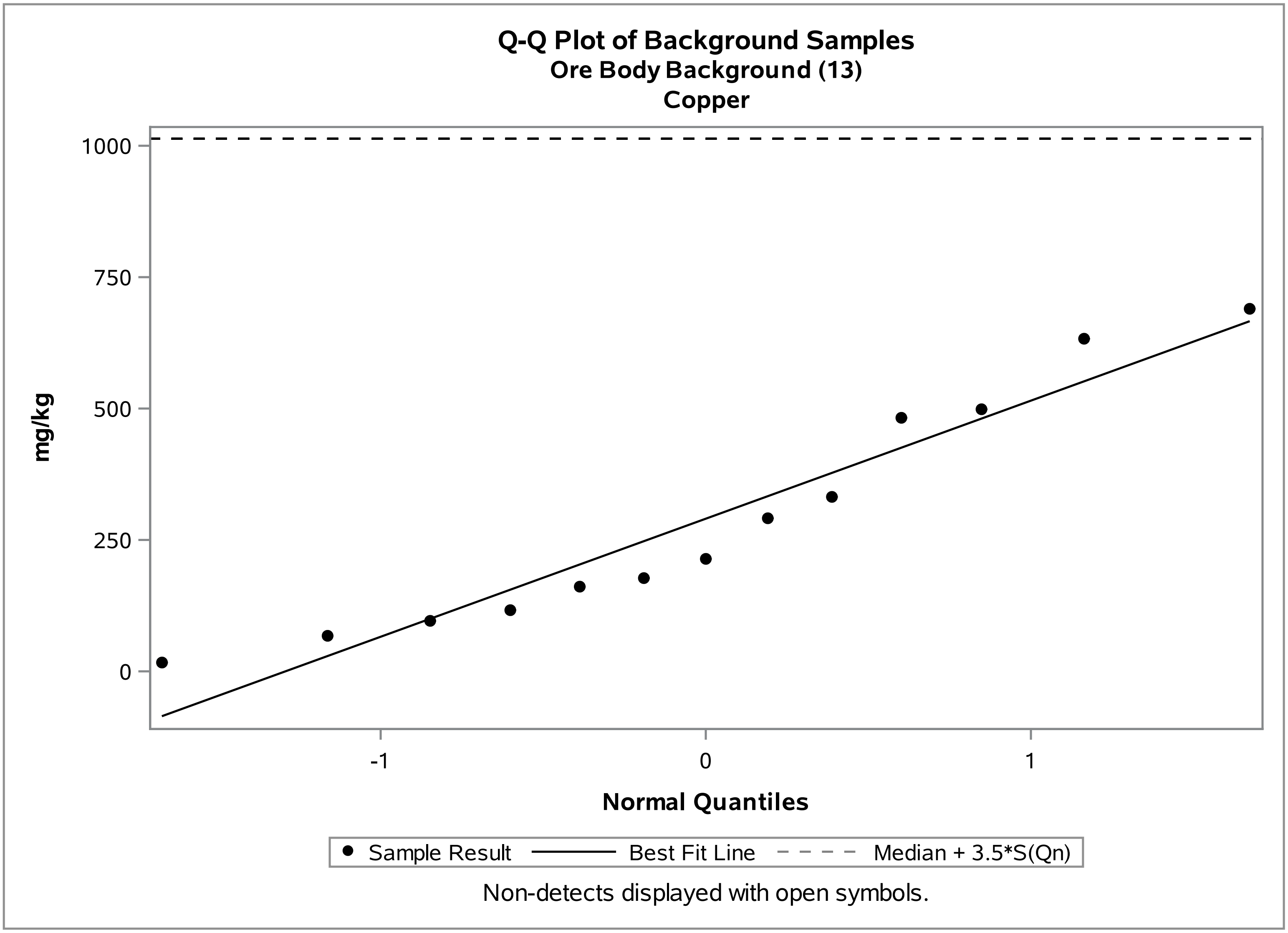

Q-Q Plot of Background Samples
Ore Body Background (13)
Antimony
mg/kg
40
30
20
10
0
-1
0
1
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

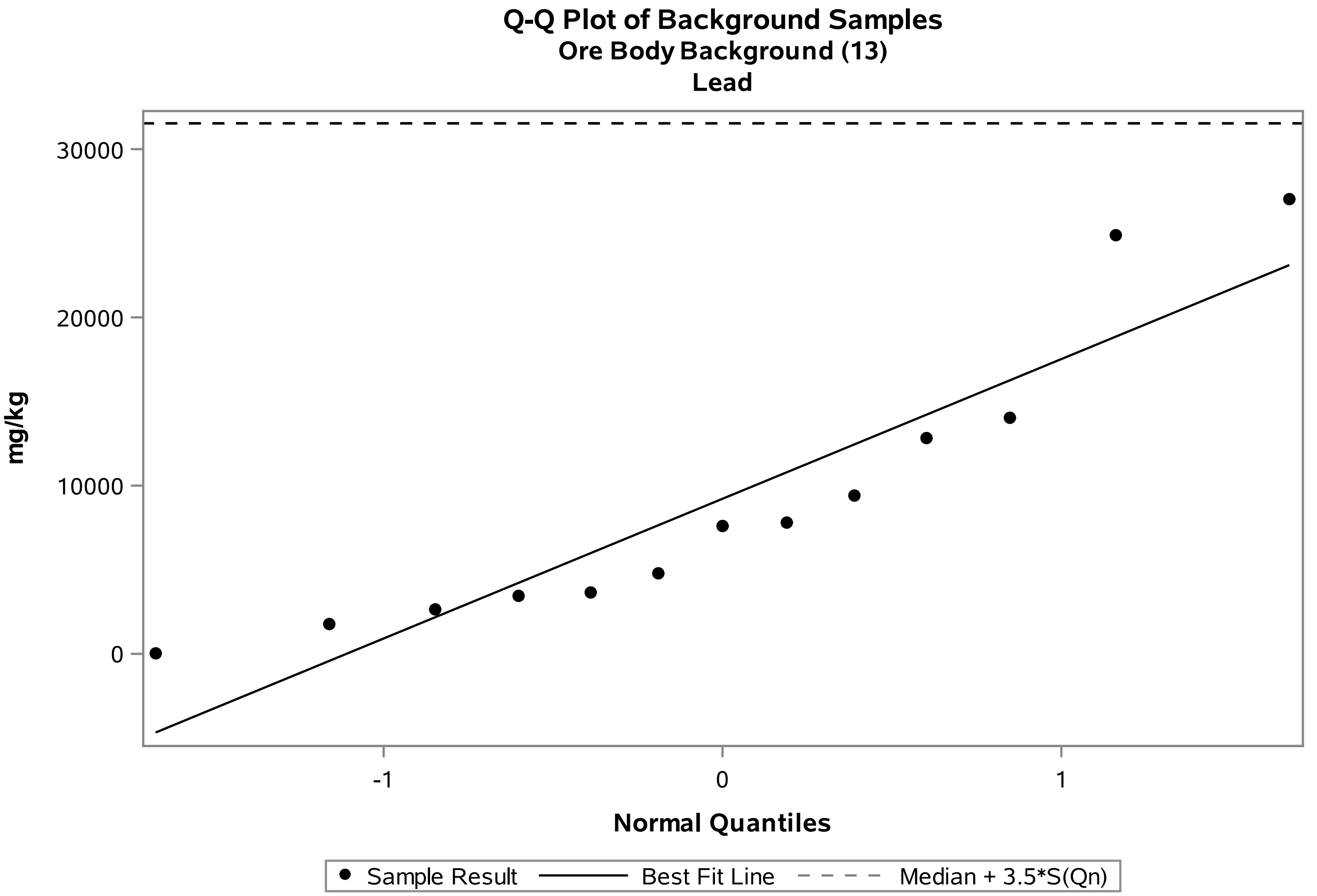

Q-Q Plot of Background Samples
Ore Body Background (13)
Arsenic
mg/kg
20000
15000
10000
5000
0
BG-13-13-01
-1
0
1
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
Ore Body Background (13)
Cadmium
1.5
1.0
0.5
0.0
mg/kg
-1
0
1
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

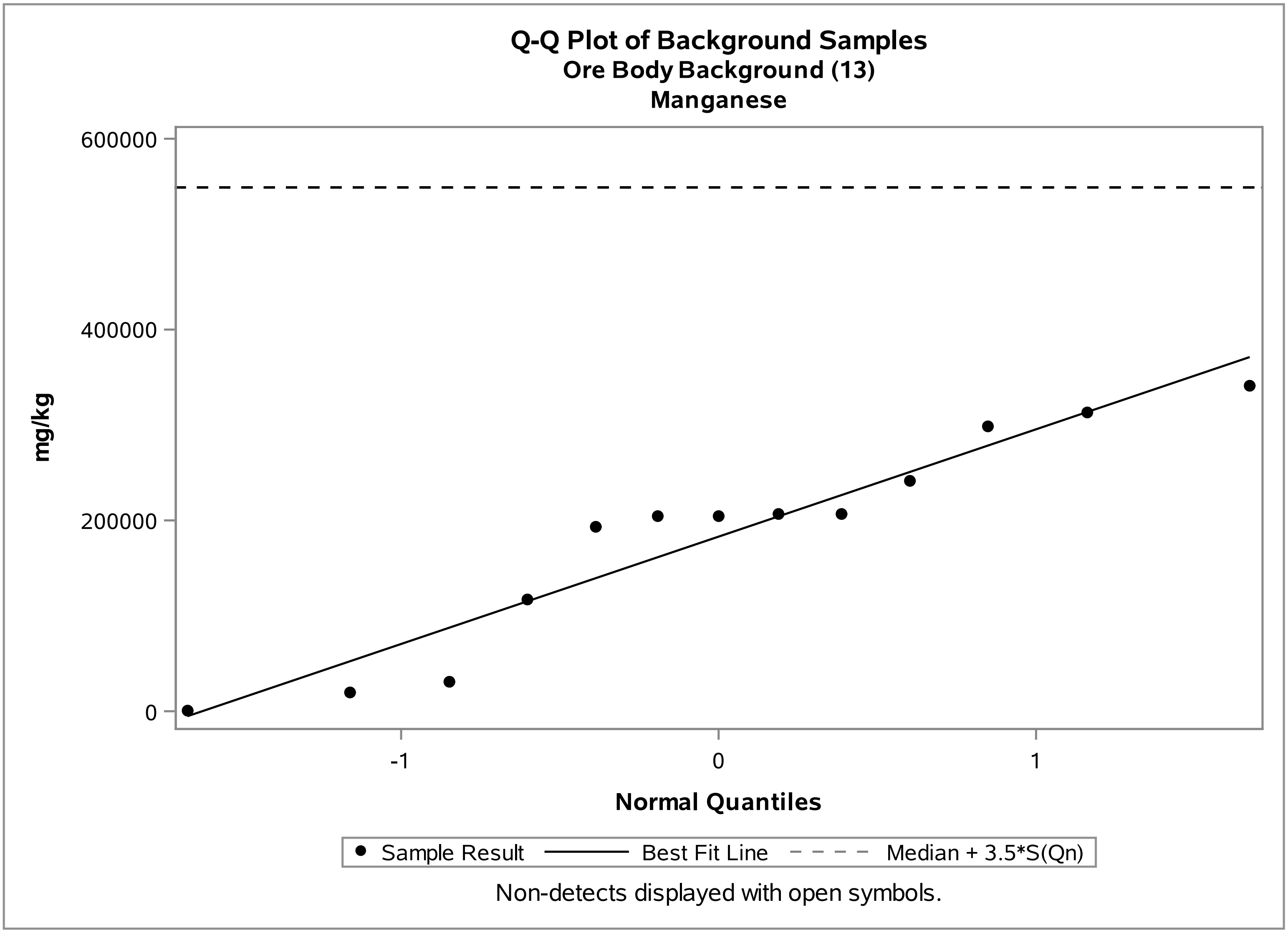


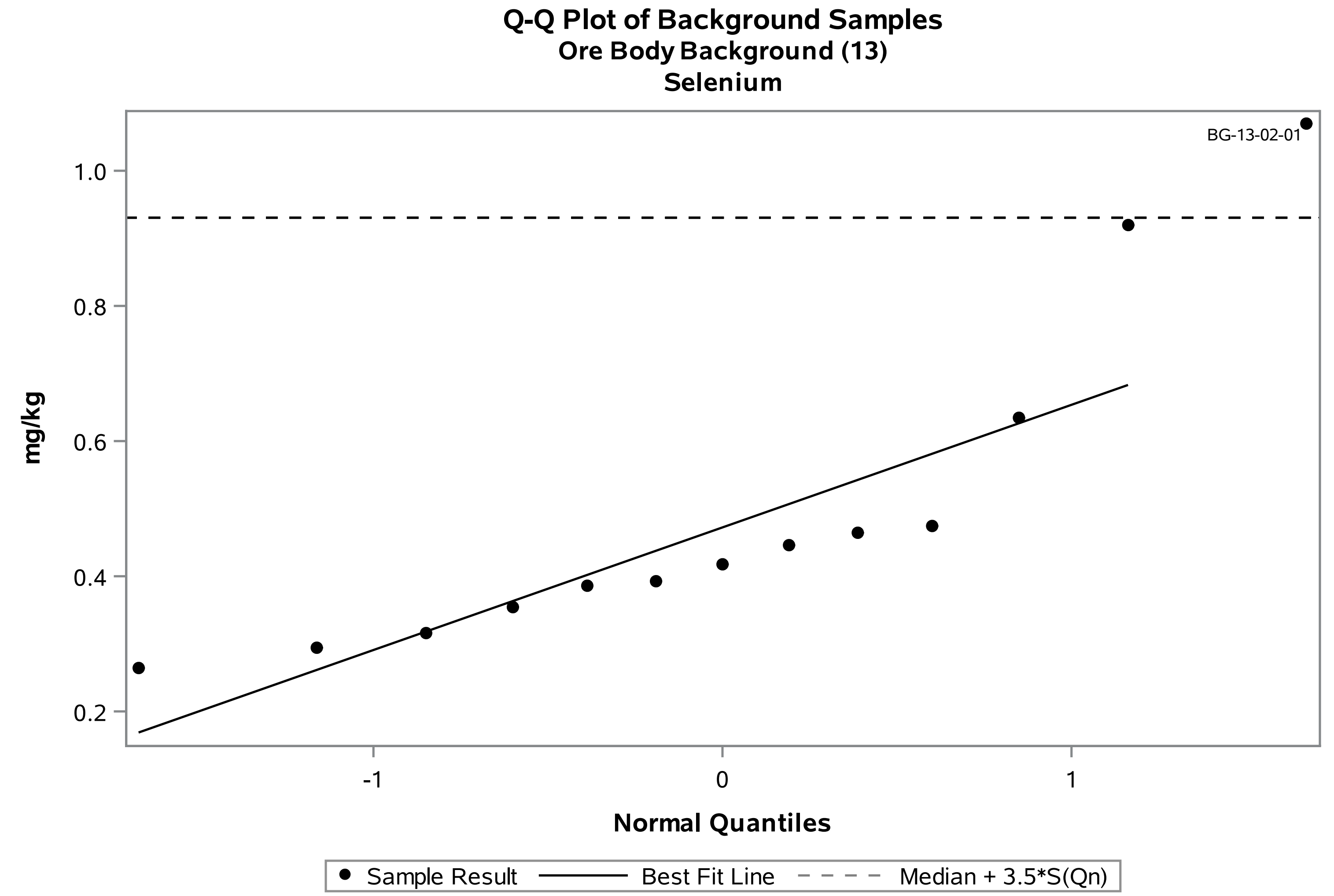
Q-Q Plot of Background Samples
Ore Body Background (13)
Chromium
mg/kg
15
10
5
-1
0
1
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
Ore Body Background (13)
Copper
1000
750
500
250
0
mg/kg
-1
0
1
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

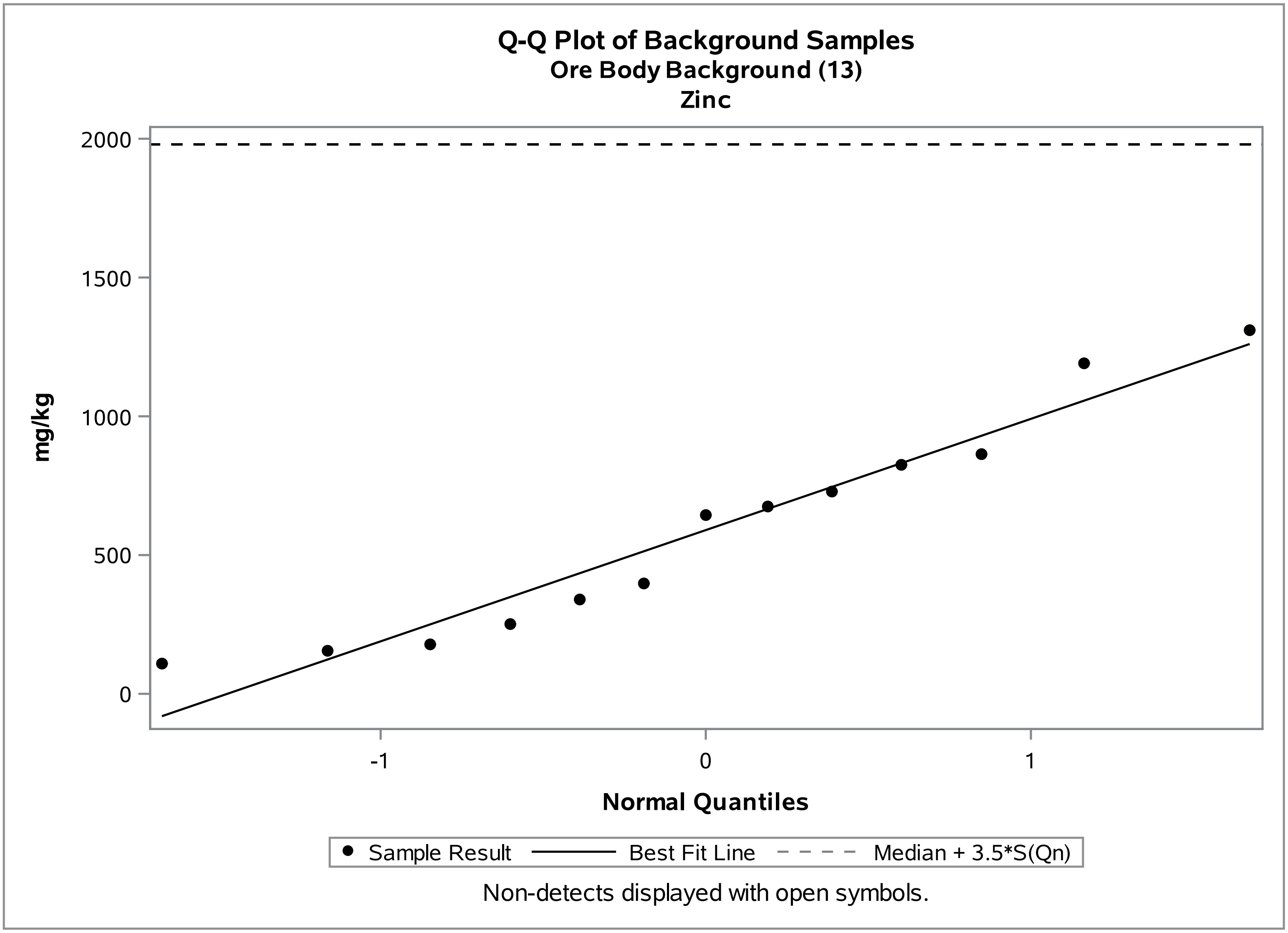


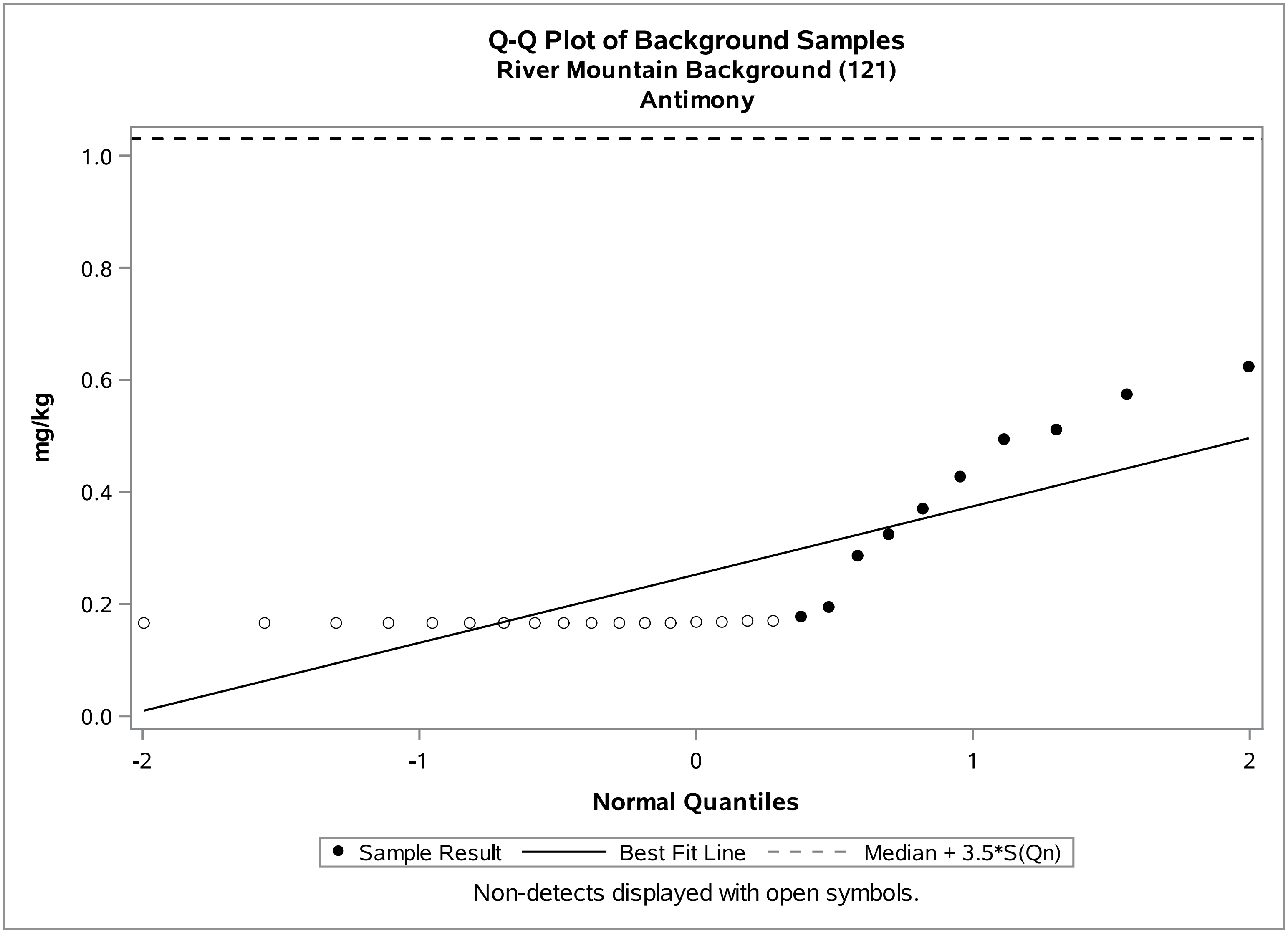
Non-detects displayed with open symbols.

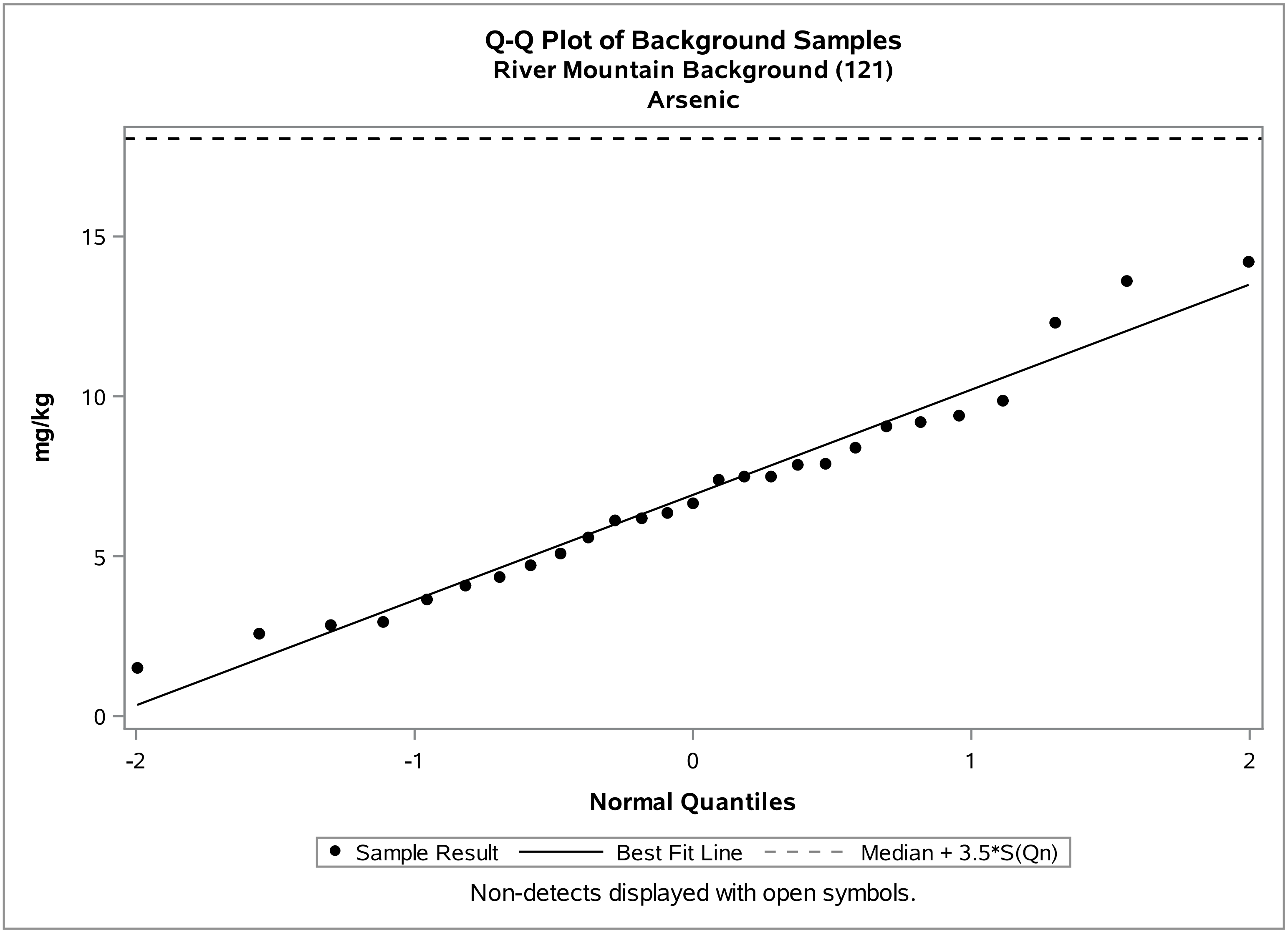

Q-Q Plot of Background Samples
Ore Body Background (13)
Manganese
mg/kg
600000
400000
200000
0
-1
0
1
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

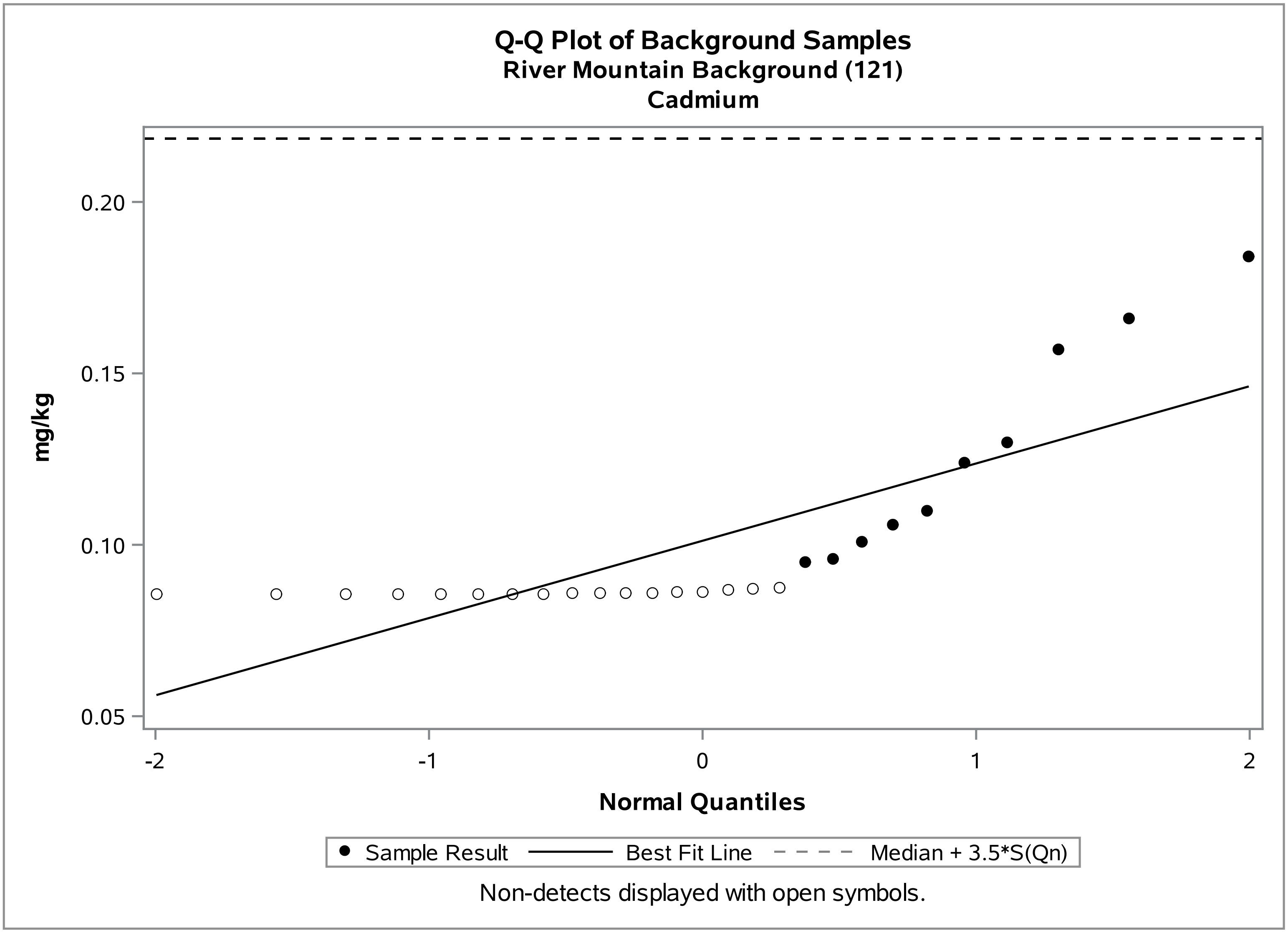


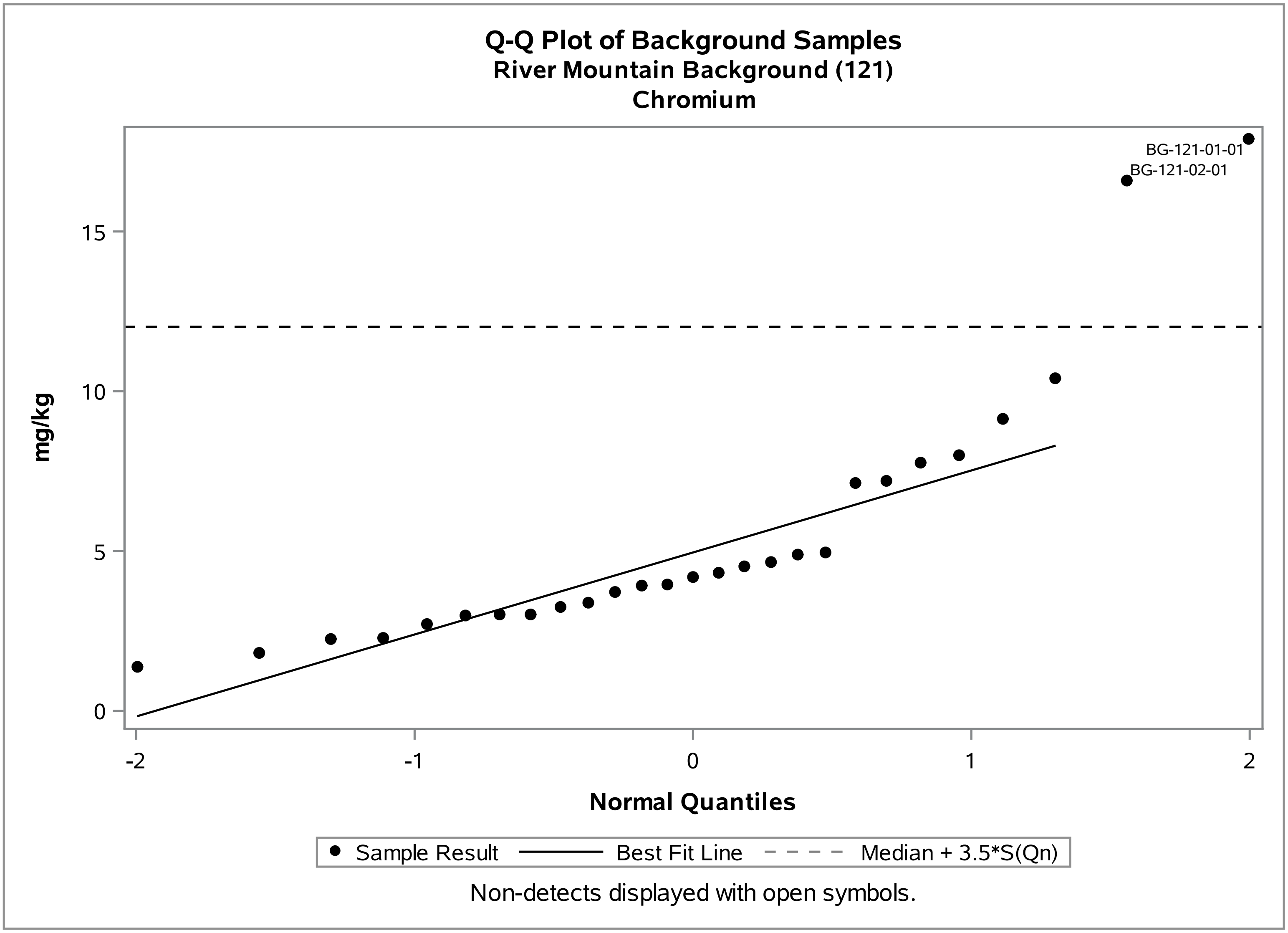
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
Ore Body Background (13)
Zinc
2000
1500
1000
500
0
mg/kg
-1
0
1
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

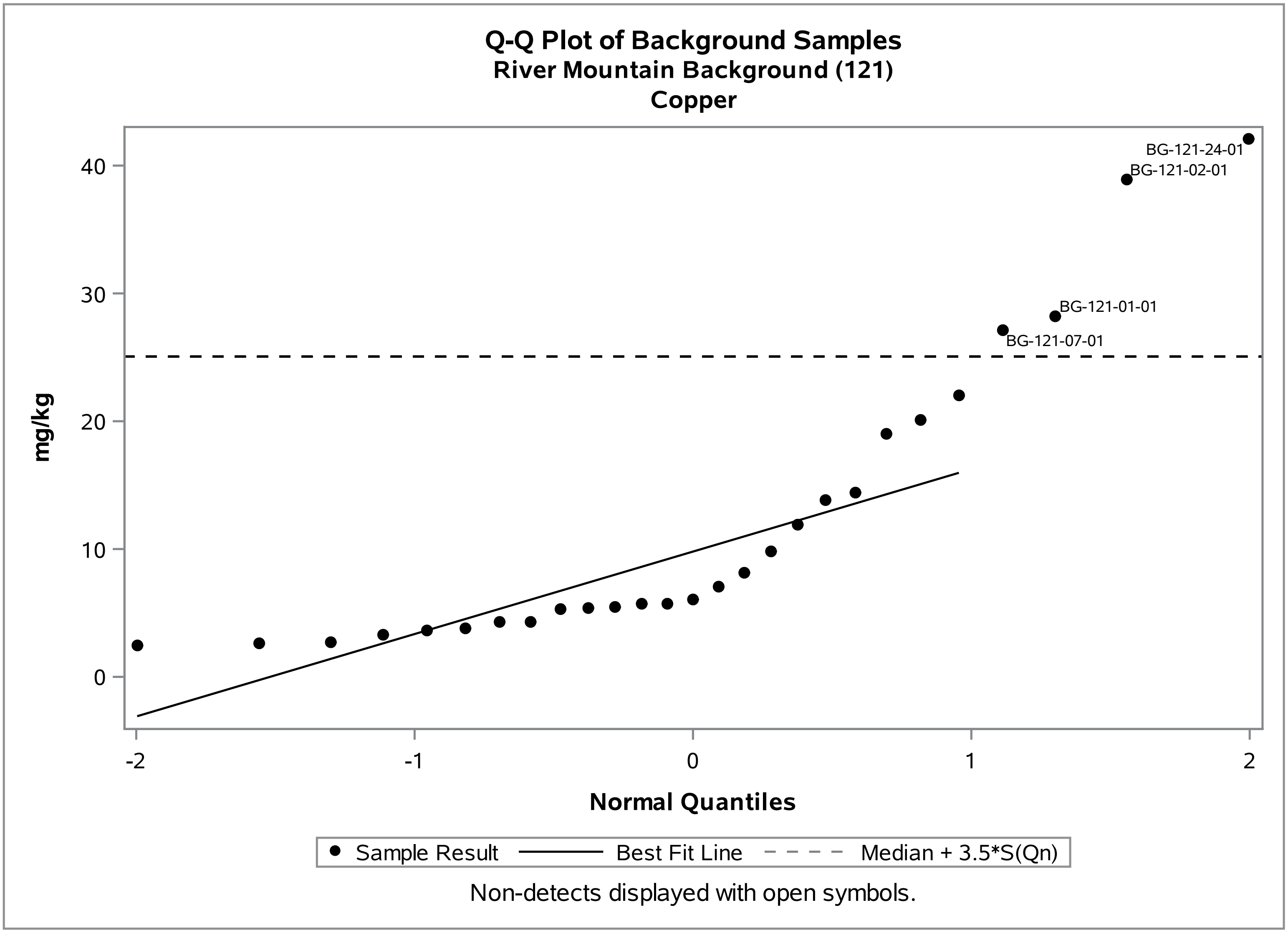

Q-Q Plot of Background Samples
River Mountain Background (121)
Antimony
mg/kg
1.0
0.8
0.6
0.4
0.2
0.0
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

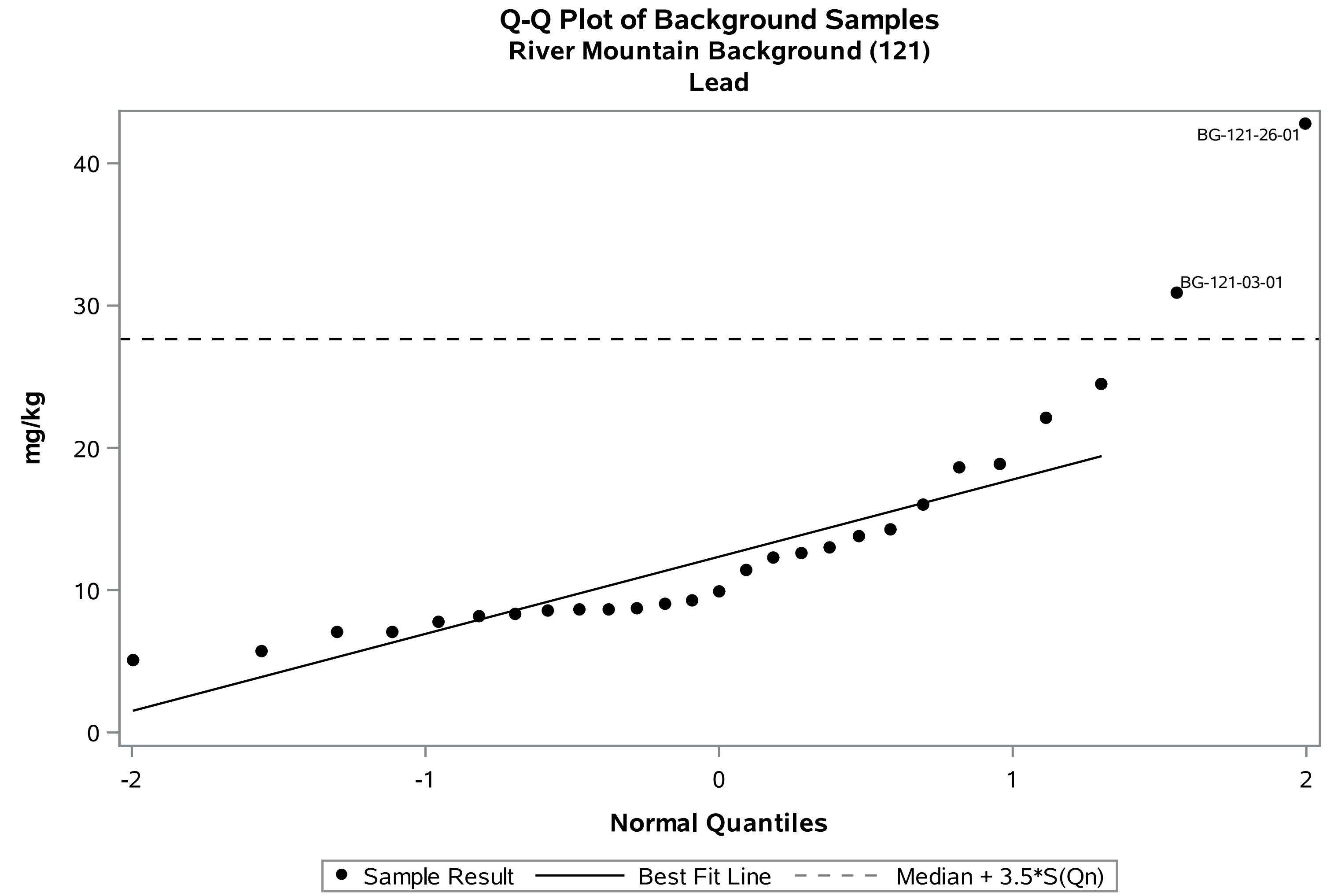

Q-Q Plot of Background Samples
River Mountain Background (121)
Arsenic
mg/kg
0
5
10
15
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
River Mountain Background (121)
Cadmium
mg/kg
0.20
0.15
0.10
0.05
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

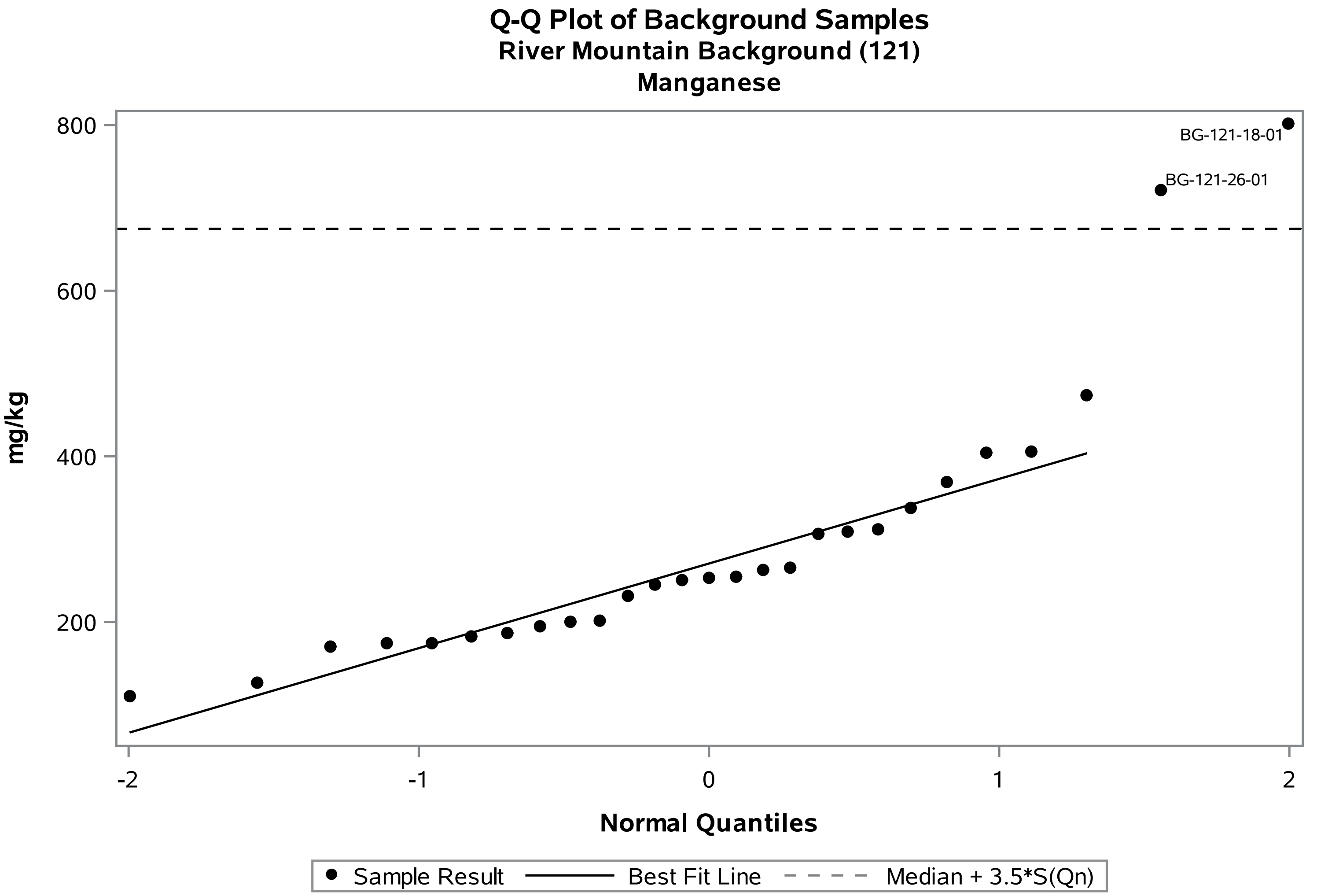


Q-Q Plot of Background Samples
River Mountain Background (121)
Chromium
mg/kg
0
5
10
15
BG-121-01-01
BG-121-02-01
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

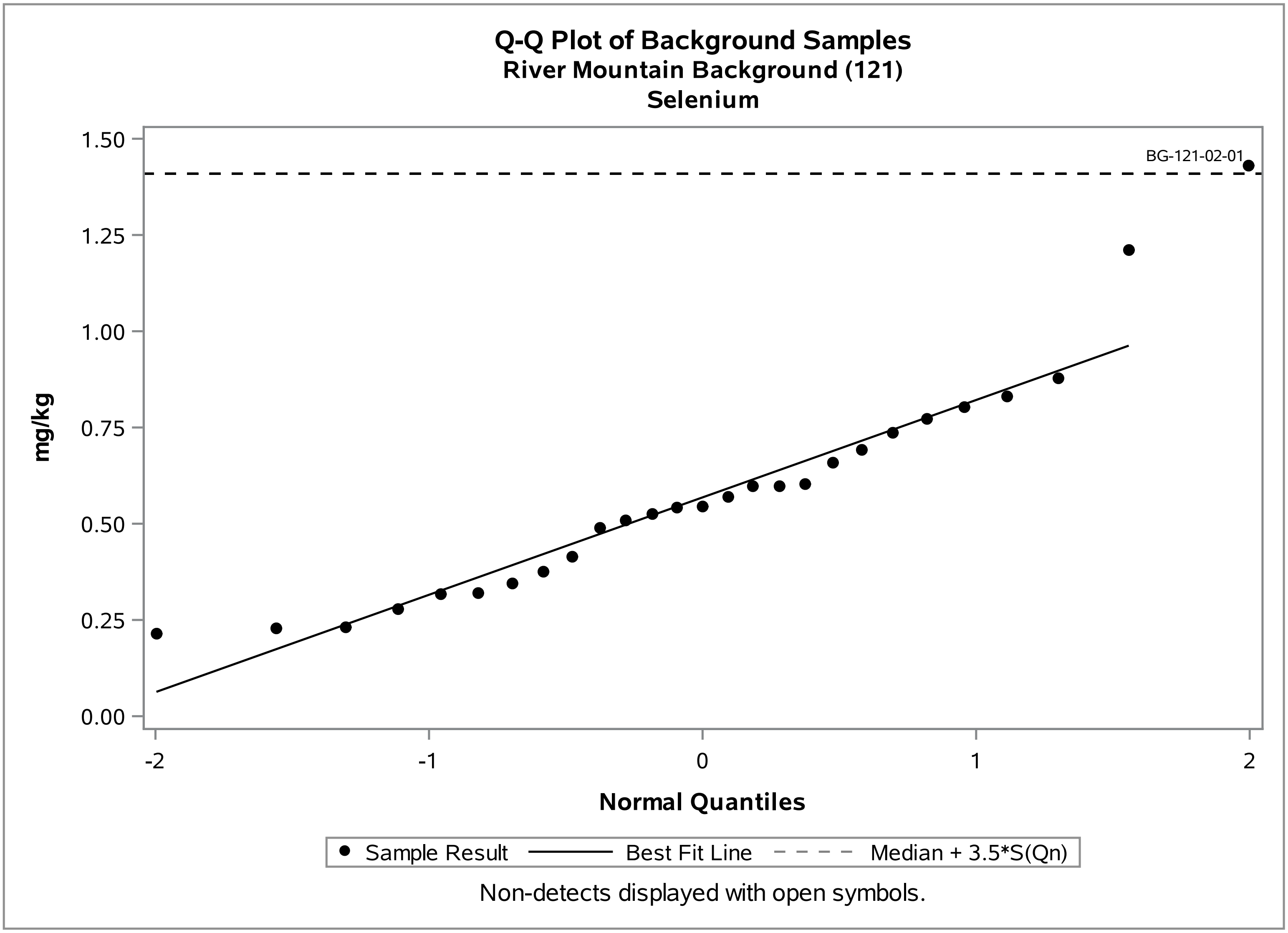

Q-Q Plot of Background Samples
River Mountain Background (121)
Copper
BG-121-24-01
BG-121-02-01
BG-121-01-01
BG-121-07-01
mg/kg
40
30
20
10
0
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

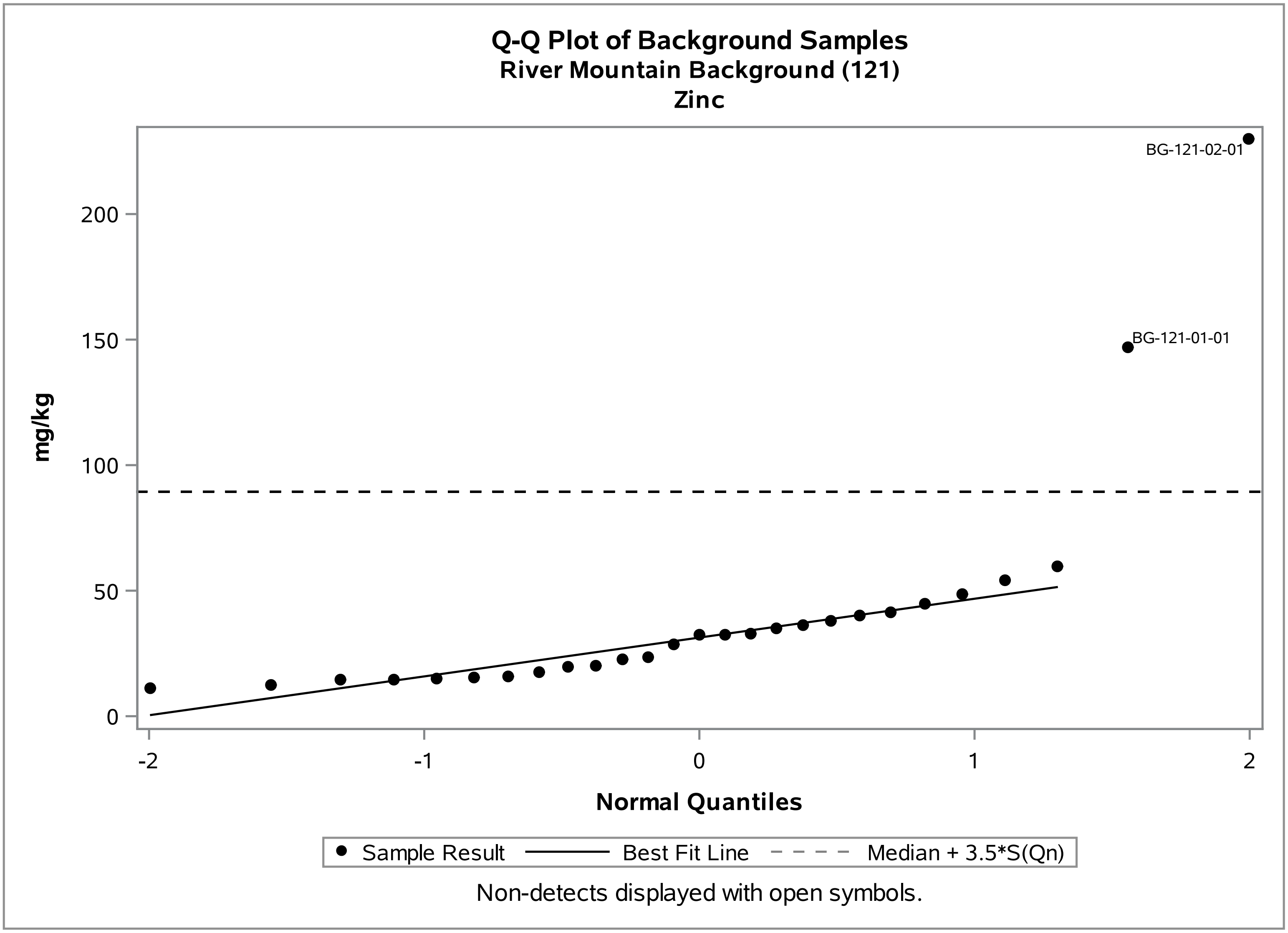


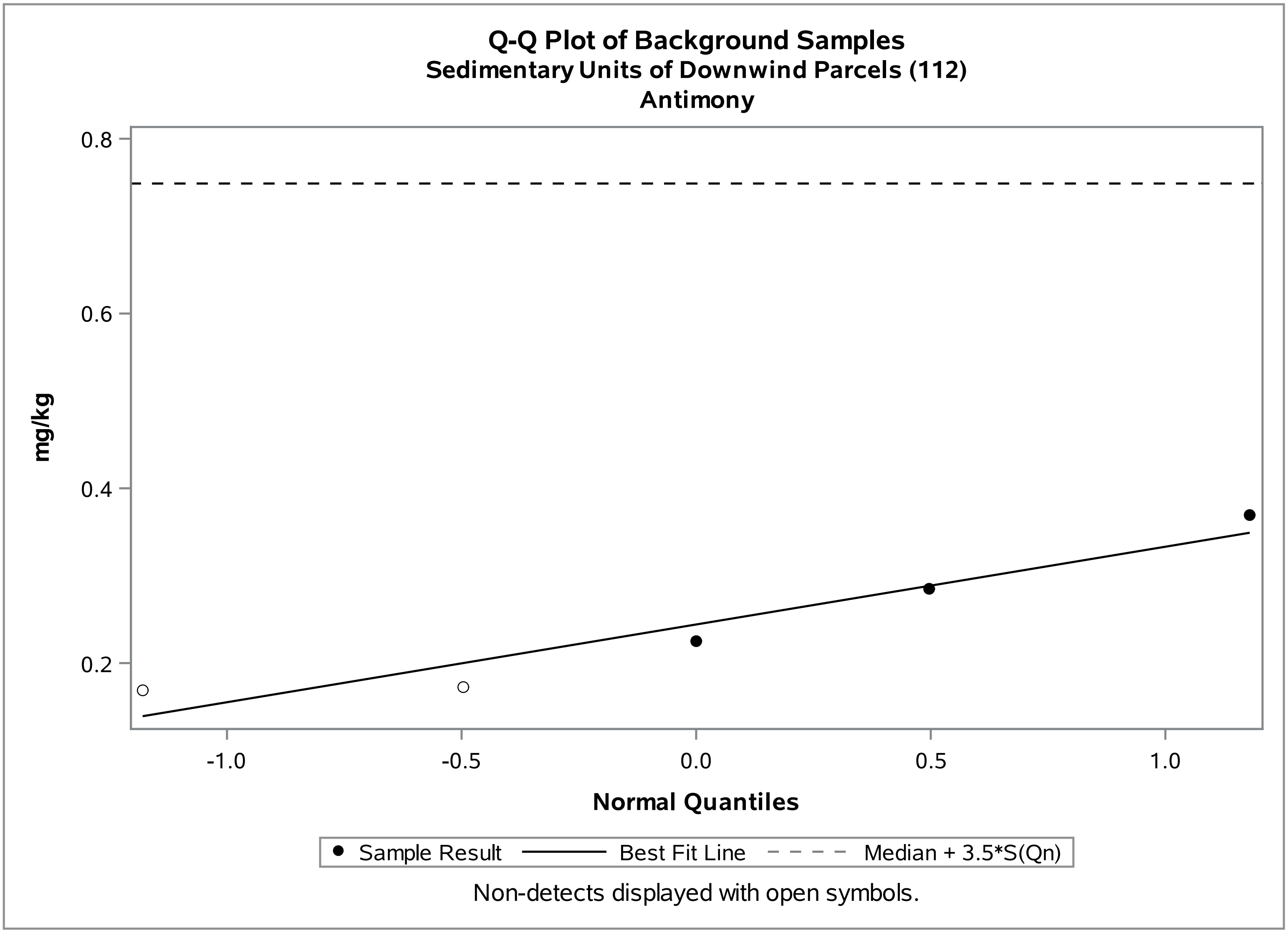
Non-detects displayed with open symbols.

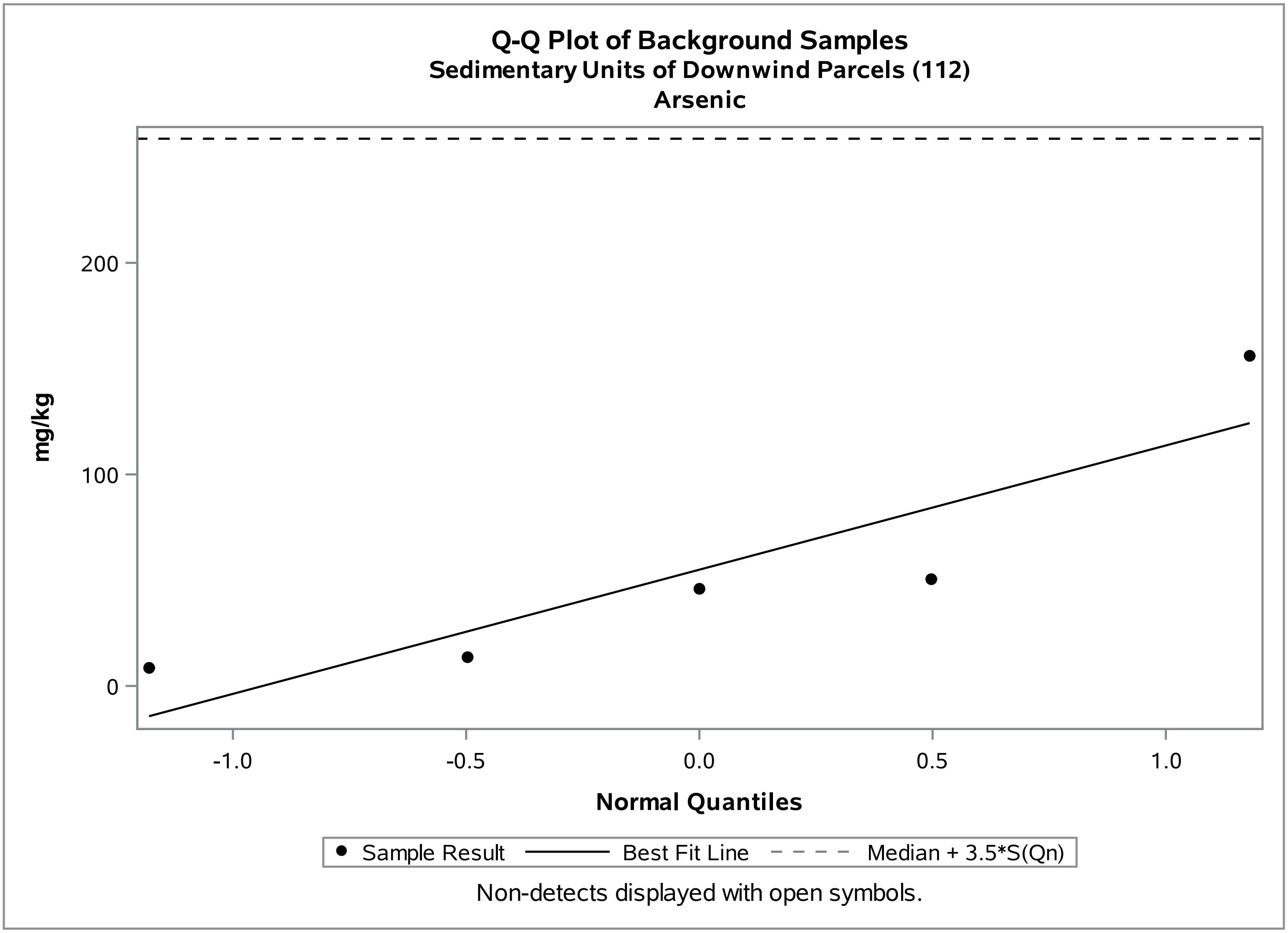


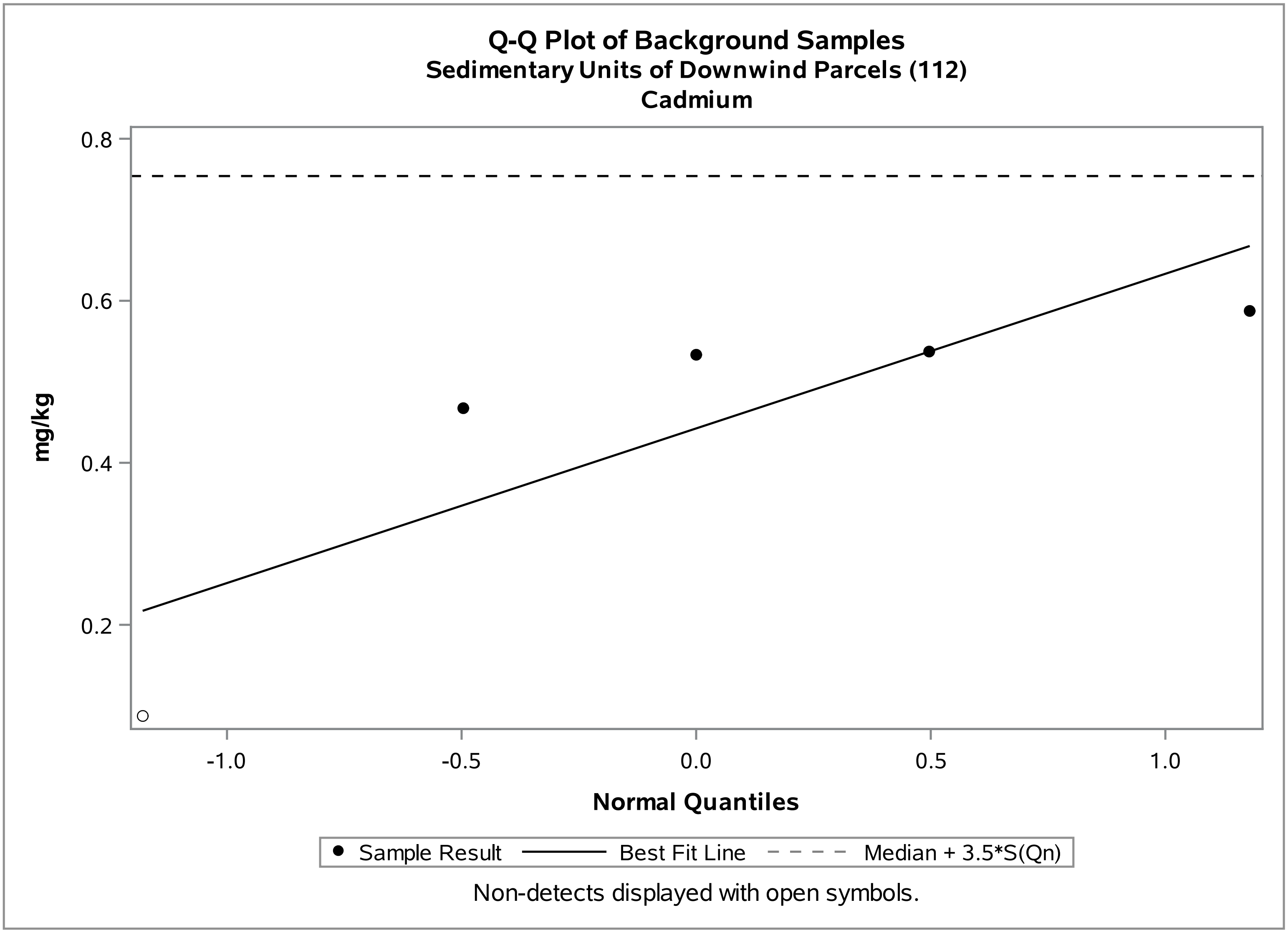
Non-detects displayed with open symbols.

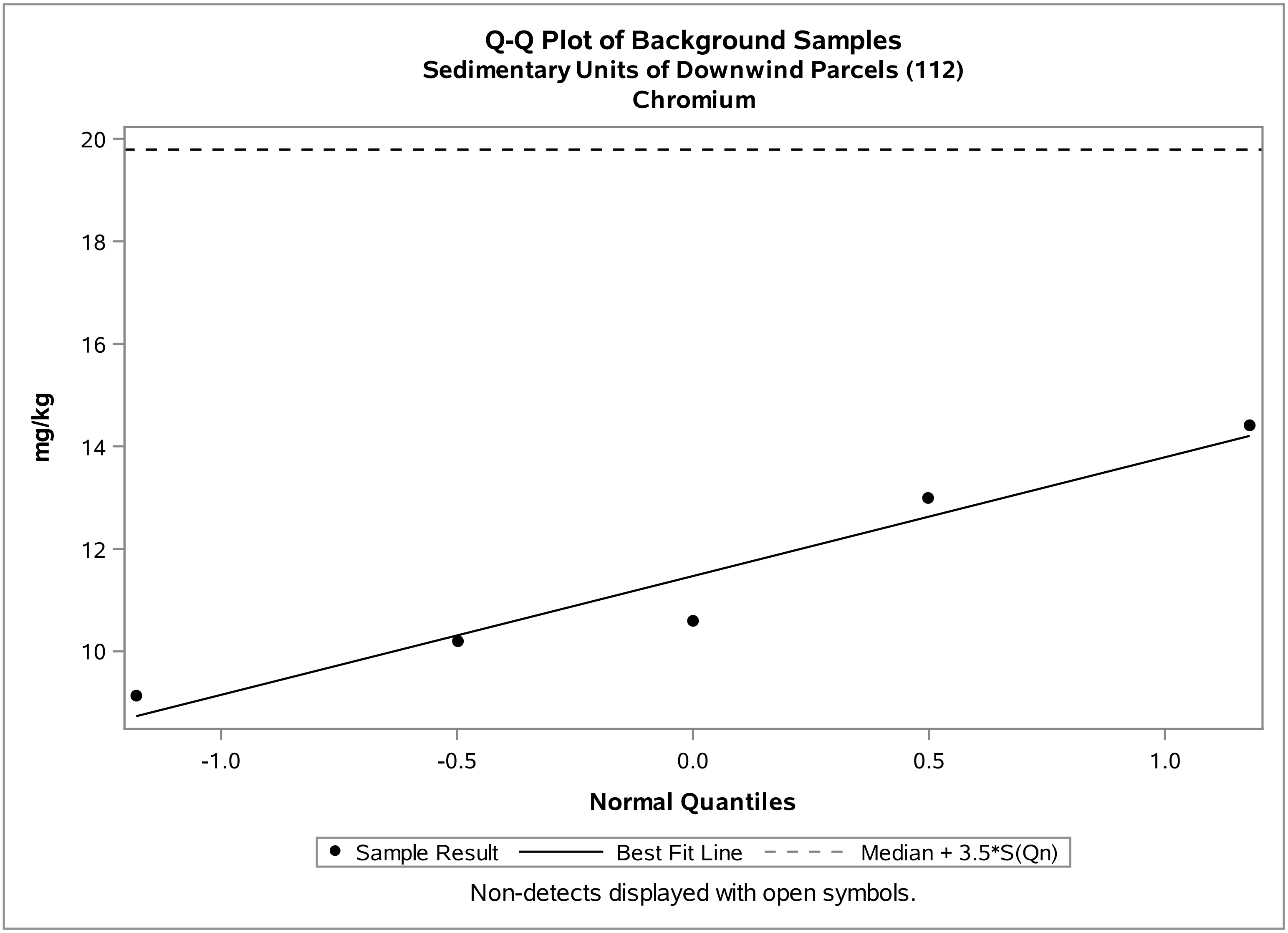

Q-Q Plot of Background Samples
River Mountain Background (121)
Selenium
BG-121-02-01
1.50
1.25
1.00
0.75
0.50
0.25
0.00
mg/kg
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

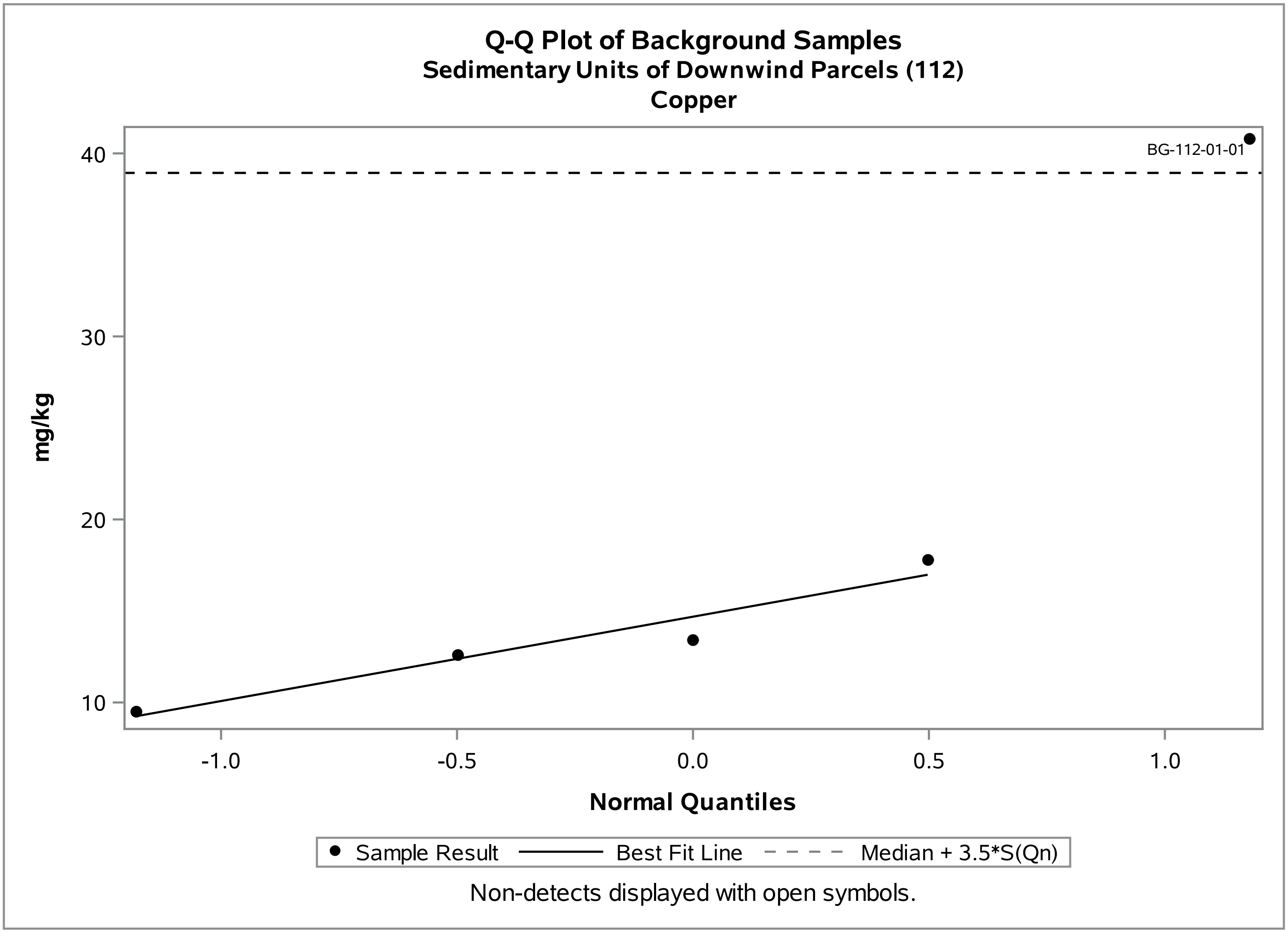

Q-Q Plot of Background Samples
River Mountain Background (121)
Zinc
mg/kg
200
150
100
50
0
BG-121-02-01
BG-121-01-01
-2
-1
0
1
2
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

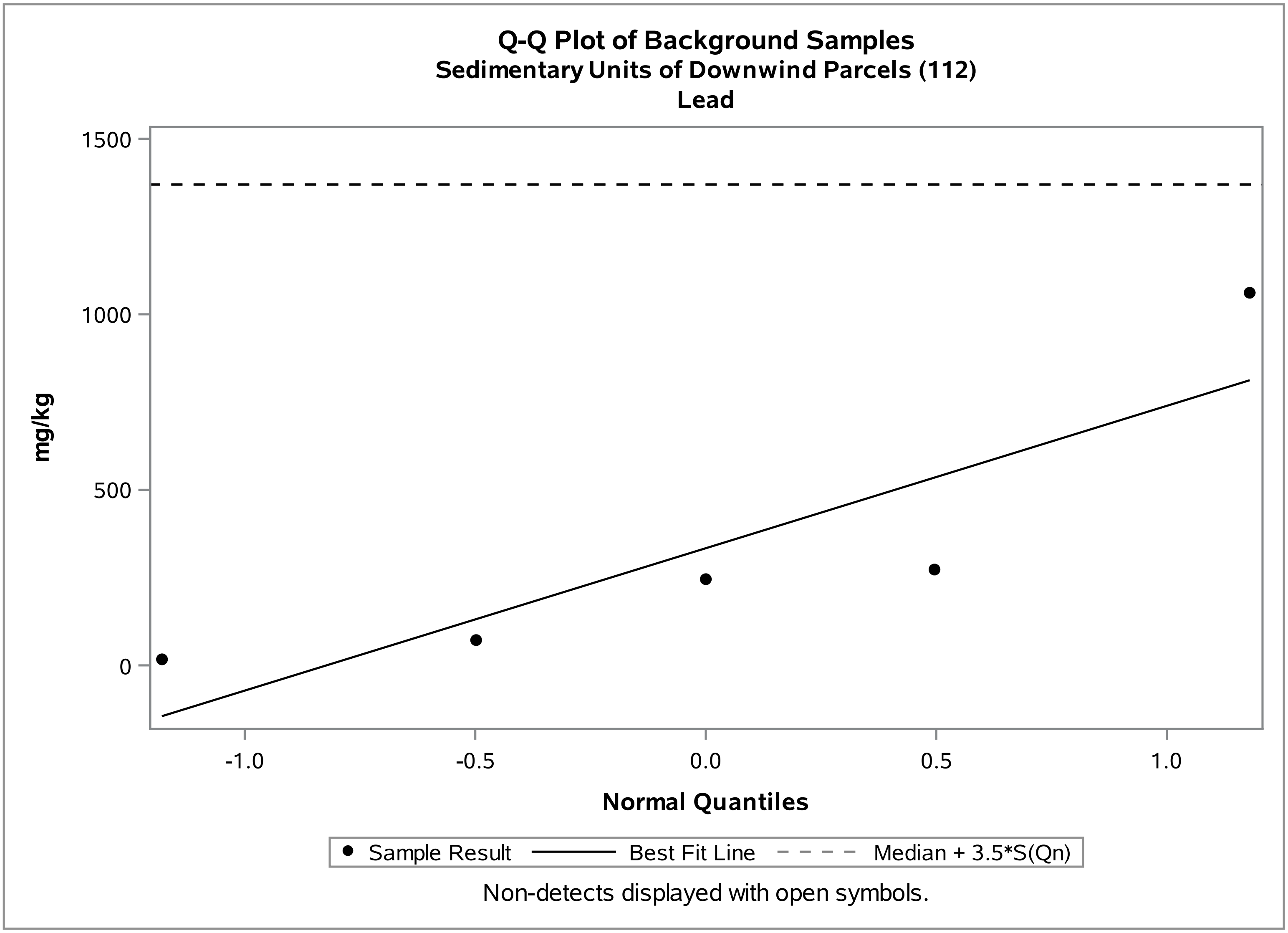

Q-Q Plot of Background Samples
Sedimentary Units of Downwind Parcels (112)
Antimony
mg/kg
0.8
0.6
0.4
0.2
-1.0
-0.5
0.0
0.5
1.0
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

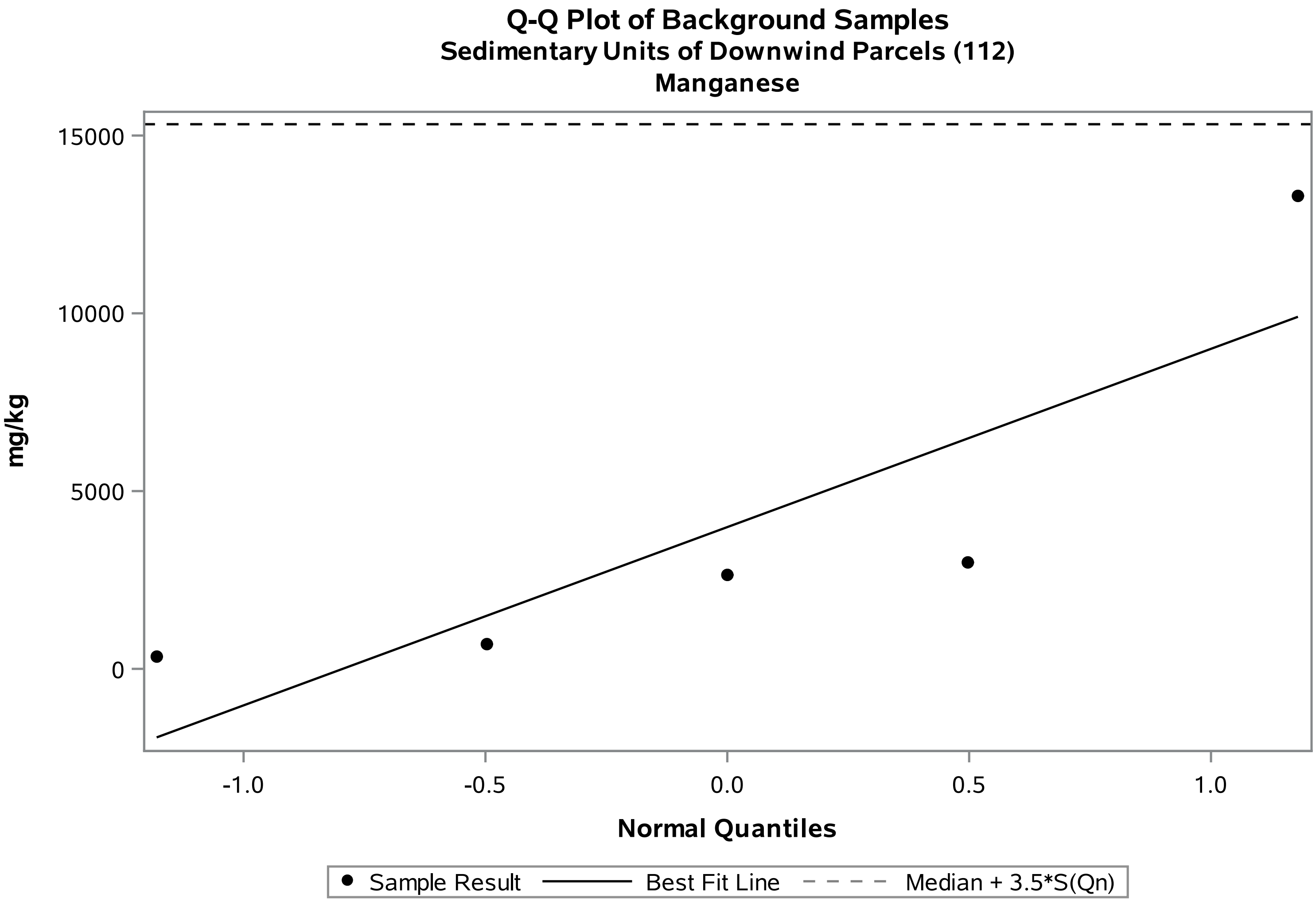

Q-Q Plot of Background Samples
Sedimentary Units of Downwind Parcels (112)
Arsenic
mg/kg
200
100
0
-1.0
-0.5
0.0
0.5
1.0
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
Sedimentary Units of Downwind Parcels (112)
Cadmium
mg/kg
0.8
0.6
0.4
0.2
-1.0
-0.5
0.0
0.5
1.0
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

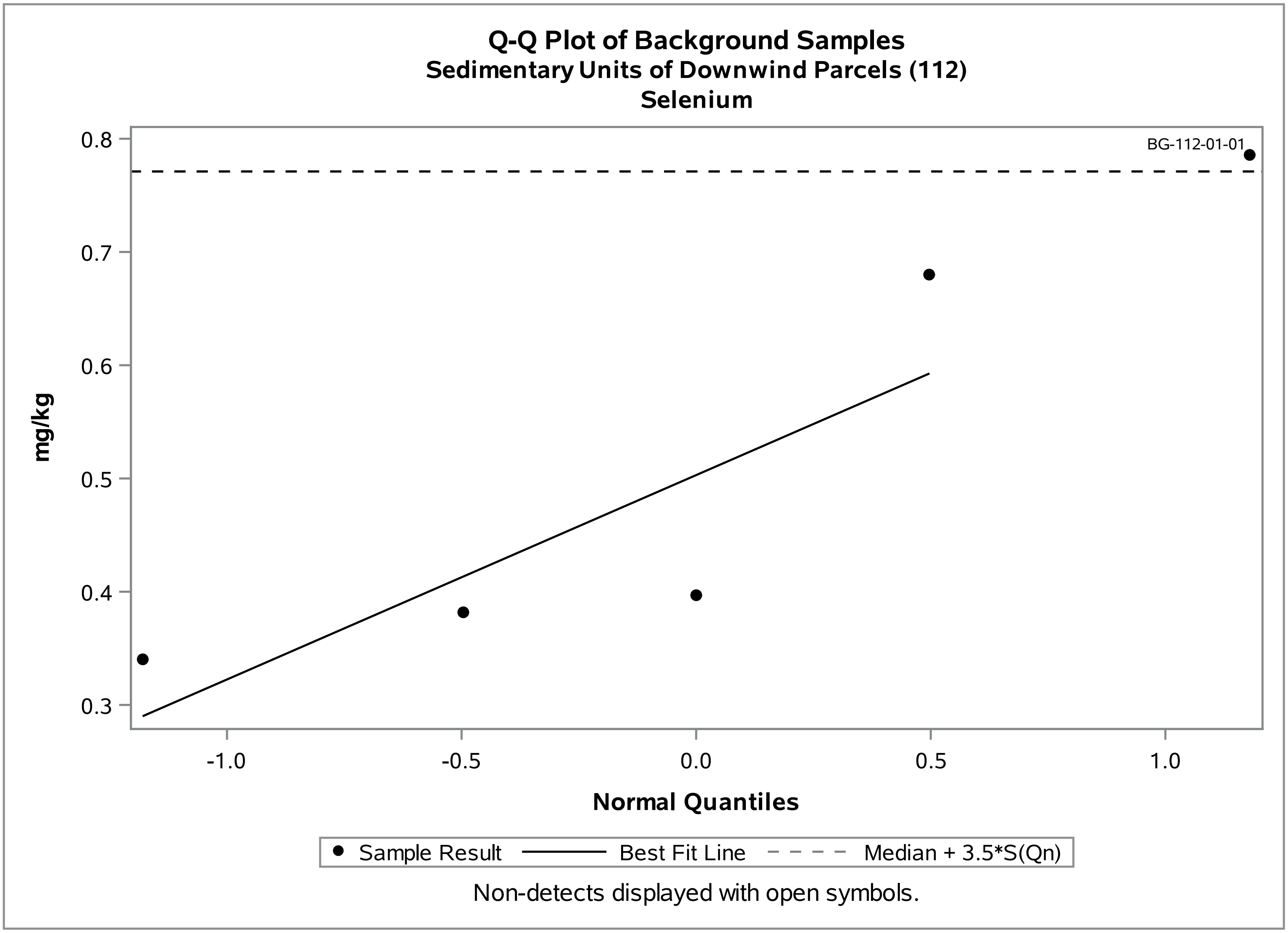

Q-Q Plot of Background Samples
Sedimentary Units of Downwind Parcels (112)
Chromium
mg/kg
20
18
16
14
12
10
-1.0
-0.5
0.0
0.5
1.0
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

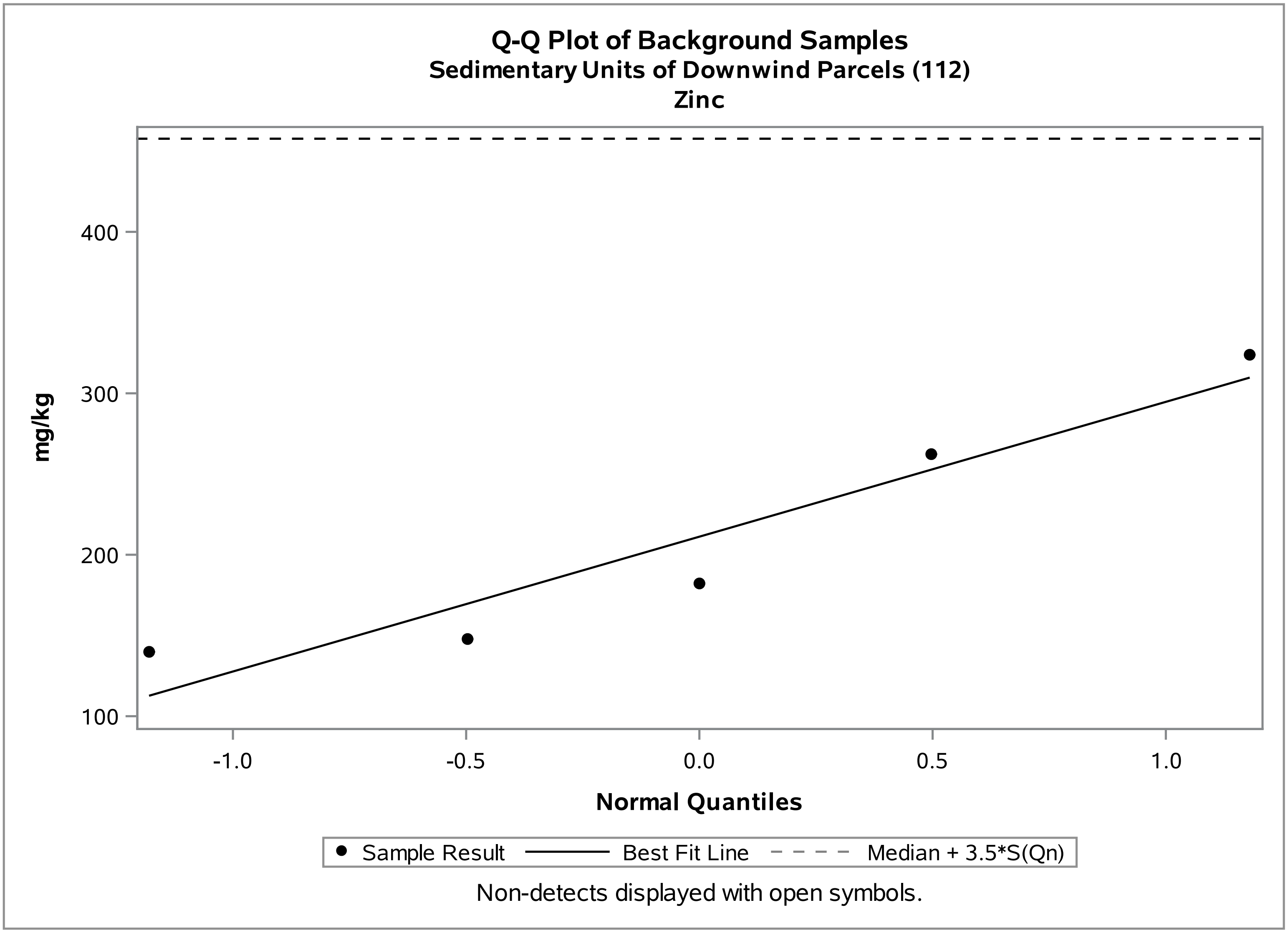

Q-Q Plot of Background Samples
Sedimentary Units of Downwind Parcels (112)
Copper
mg/kg
40
30
20
10
-1.0
-0.5
0.0
0.5
1.0
Normal Quantiles
BG-112-01-01
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

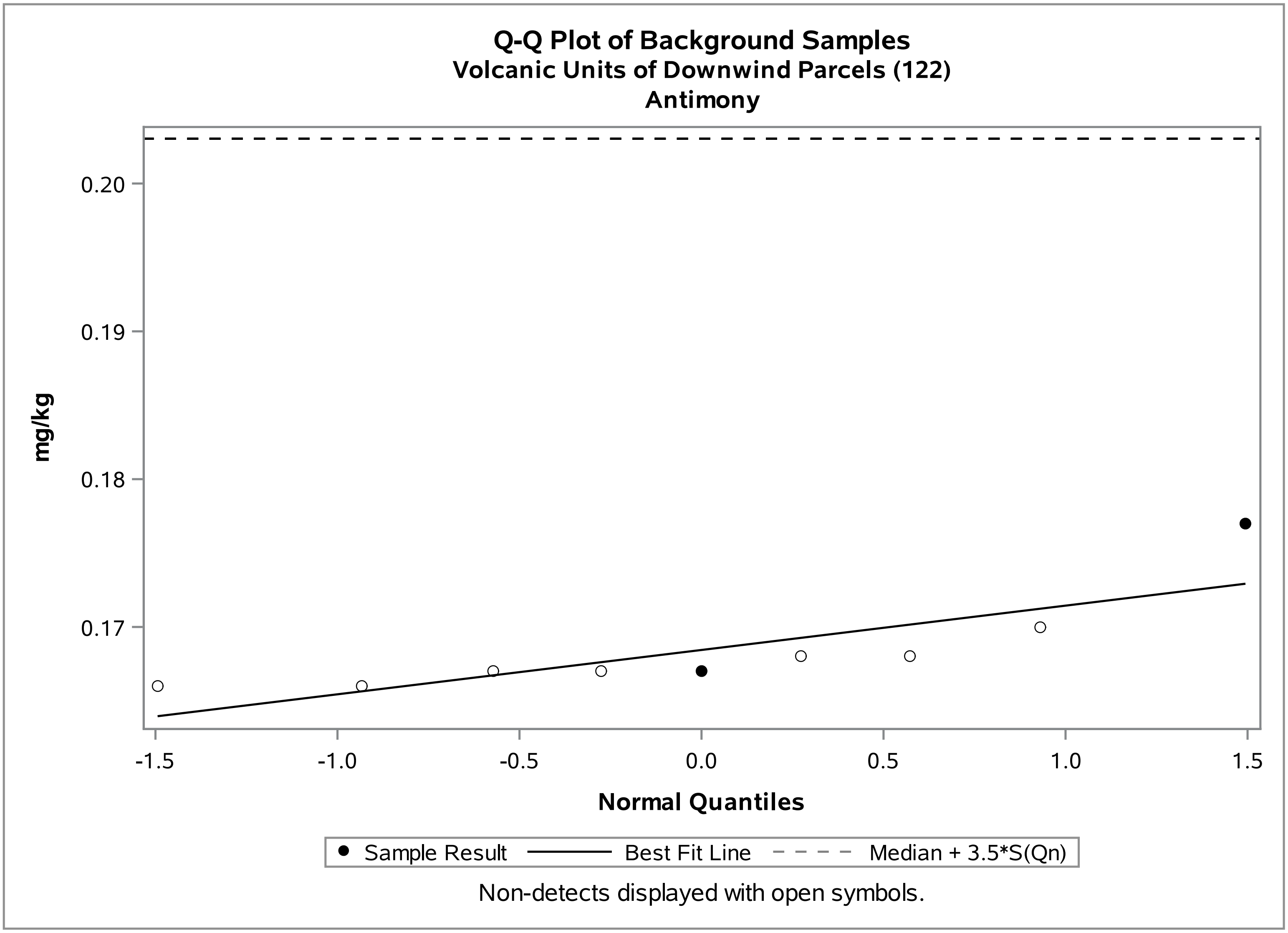

Q-Q Plot of Background Samples
Sedimentary Units of Downwind Parcels (112)
Lead
mg/kg
1500
1000
500
0
-1.0
-0.5
0.0
0.5
1.0
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

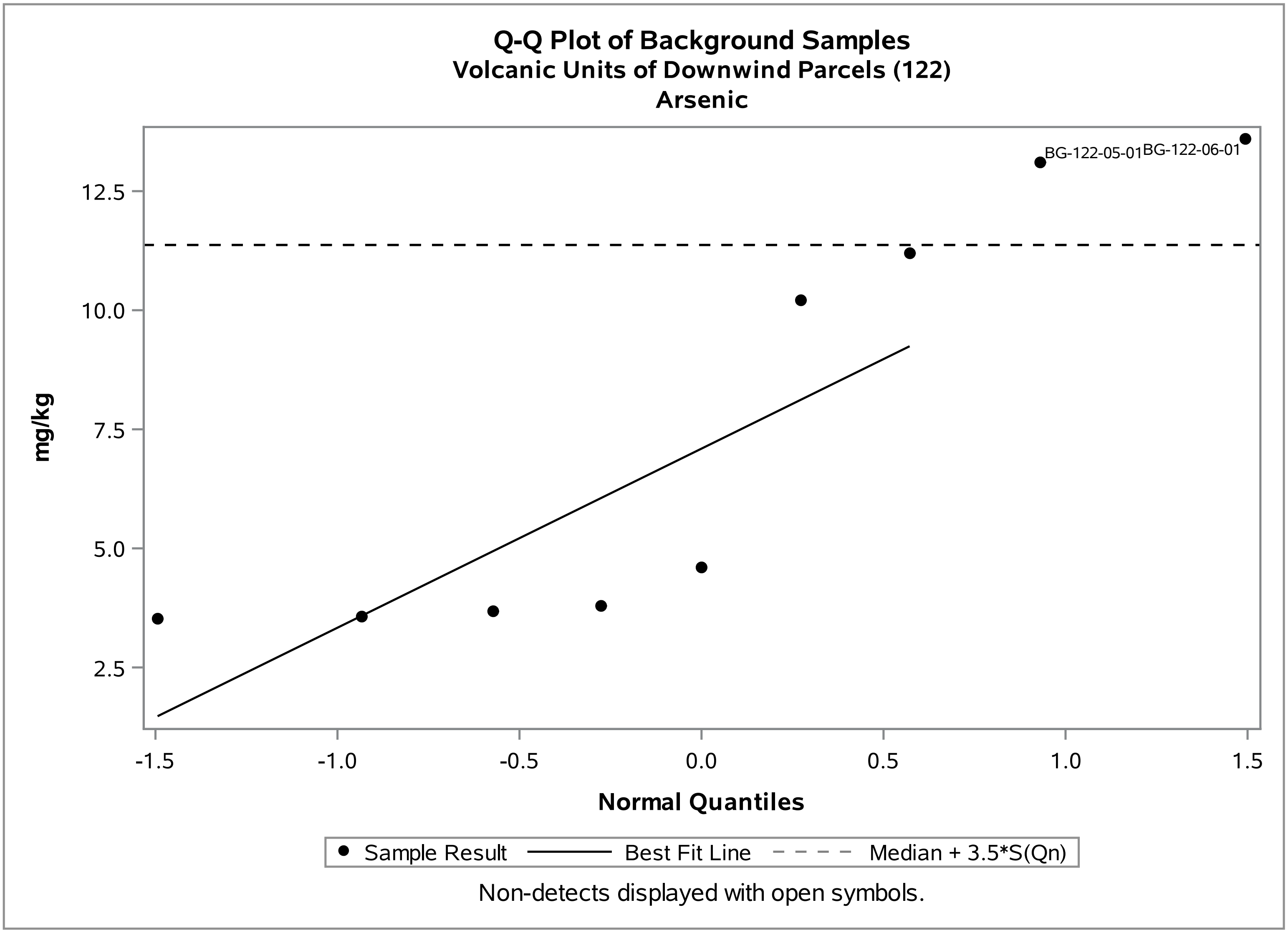


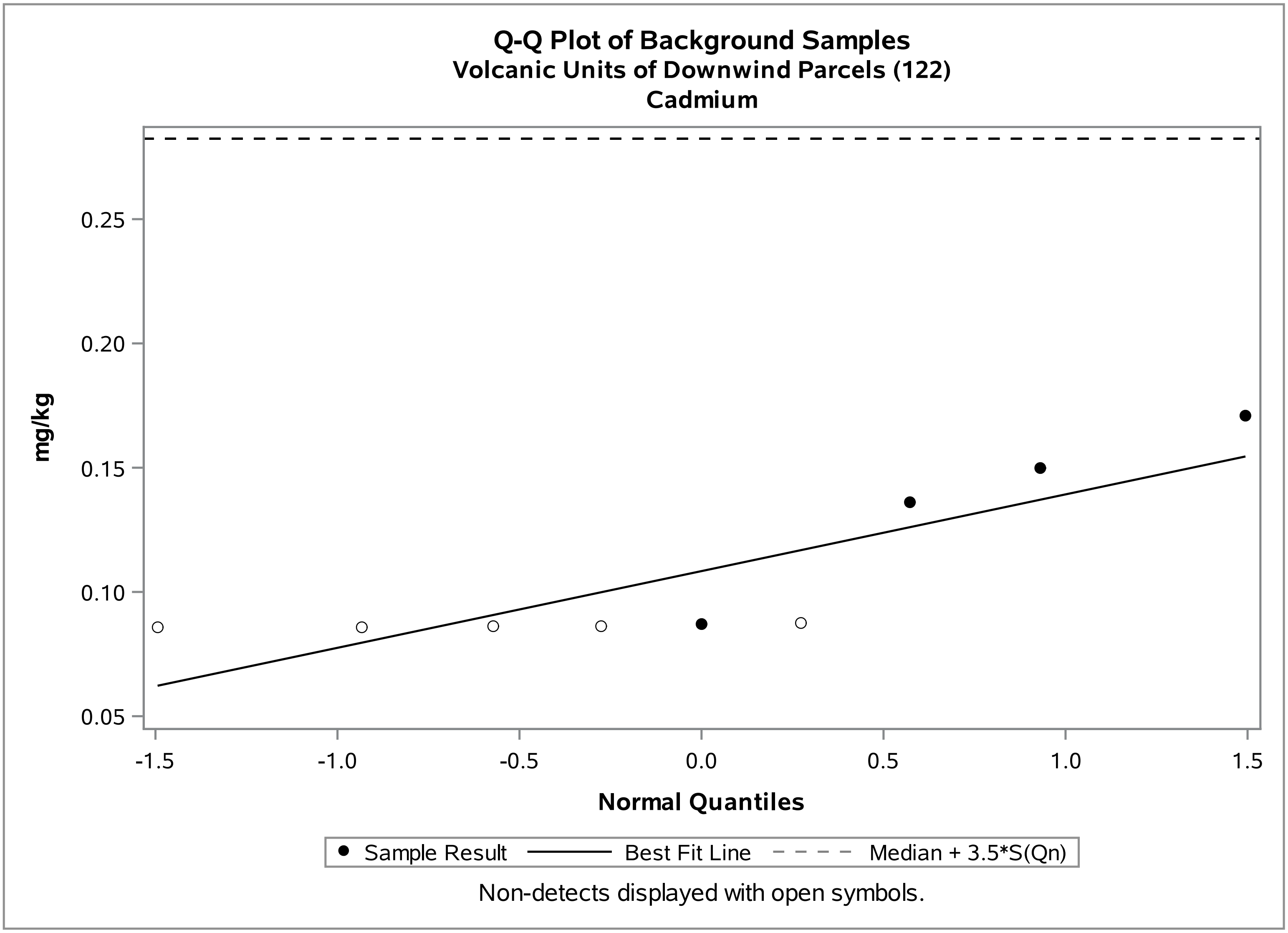
Non-detects displayed with open symbols.

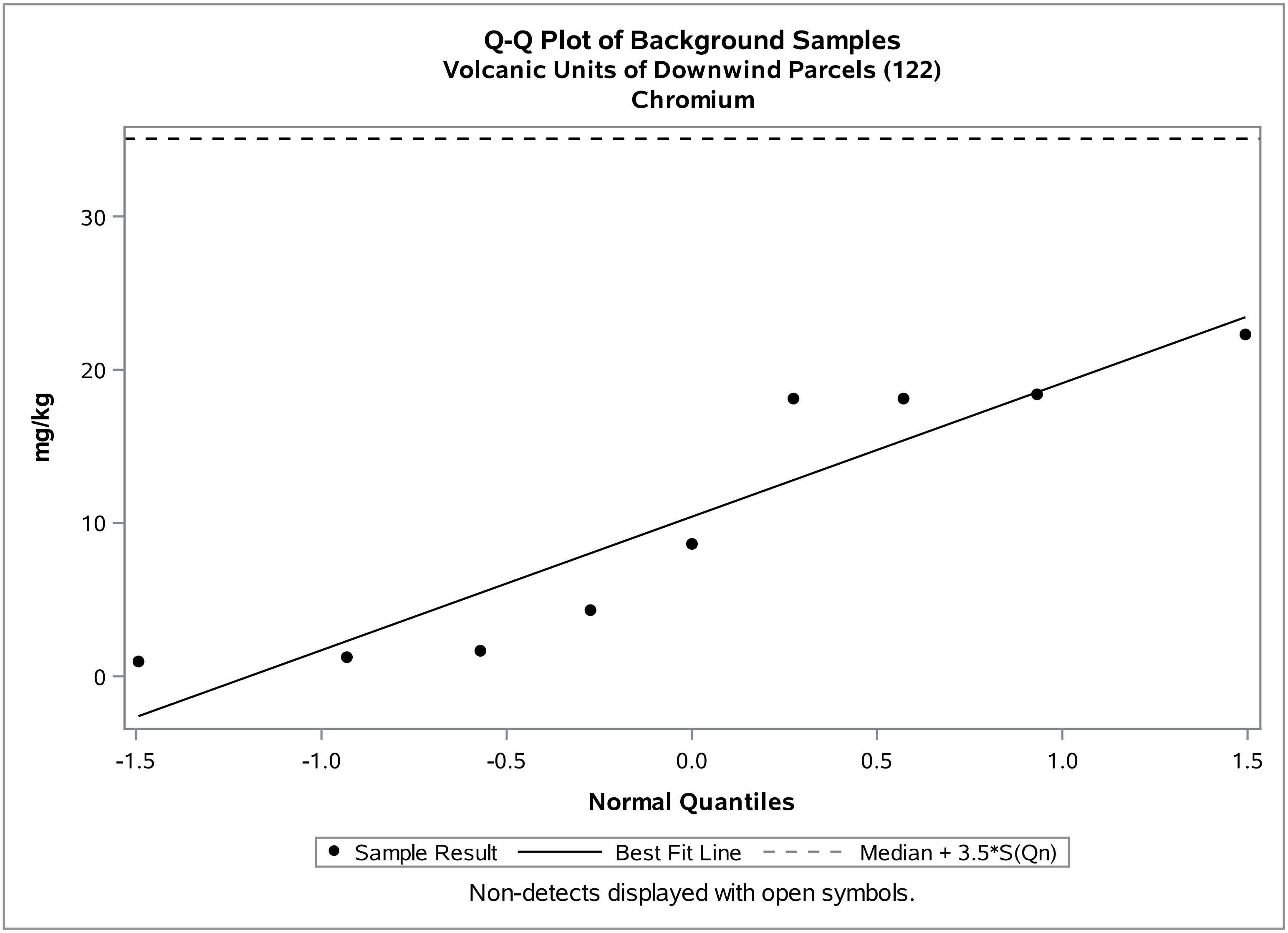

Q-Q Plot of Background Samples
Sedimentary Units of Downwind Parcels (112)
Selenium
mg/kg
0.8
0.7
0.6
0.5
0.4
0.3
BG-112-01-01
-1.0
-0.5
0.0
0.5
1.0
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

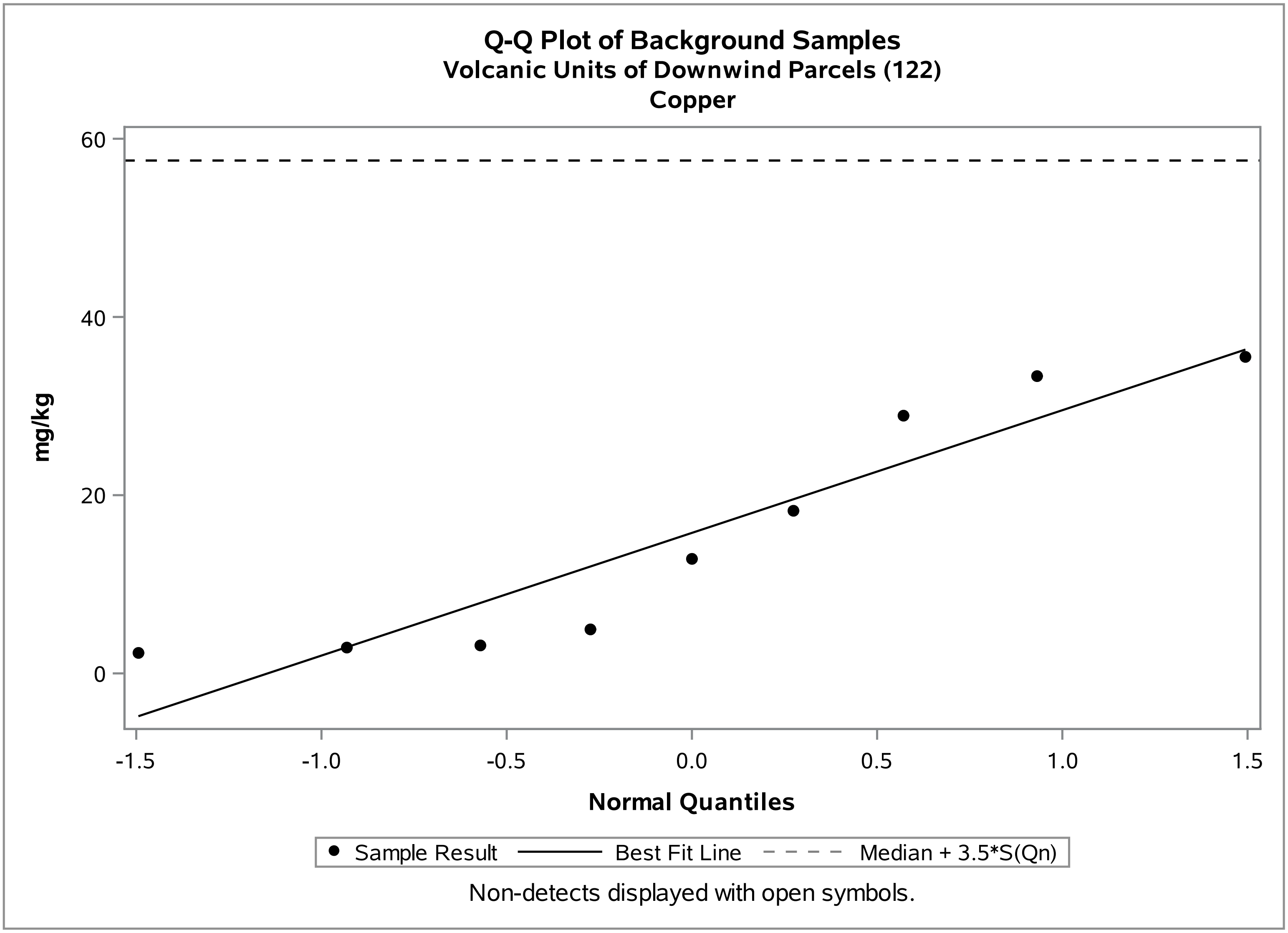

Q-Q Plot of Background Samples
Sedimentary Units of Downwind Parcels (112)
Zinc
mg/kg
400
300
200
100
-1.0
-0.5
0.0
0.5
1.0
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

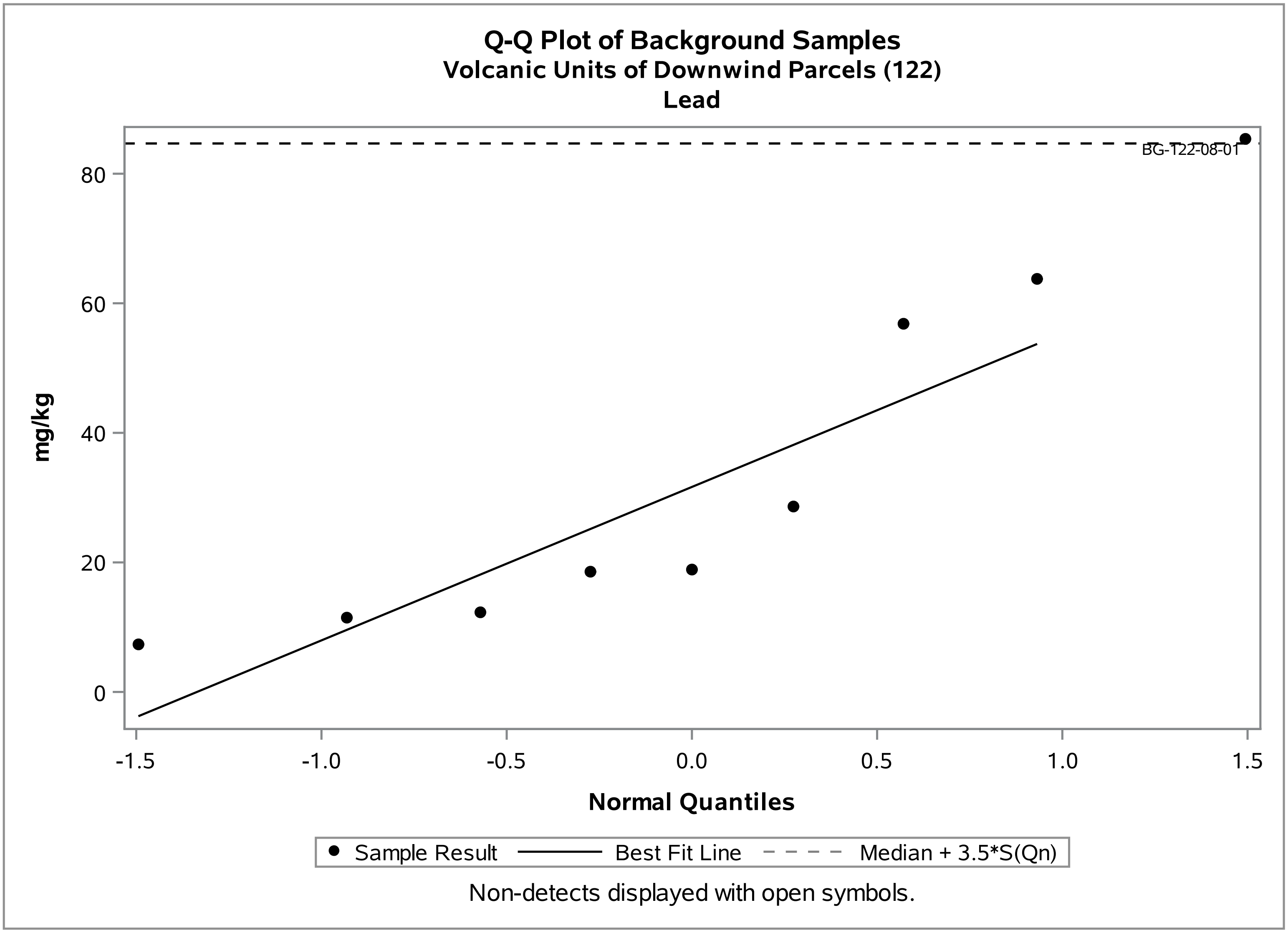

Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Antimony
mg/kg
0.20
0.19
0.18
0.17
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

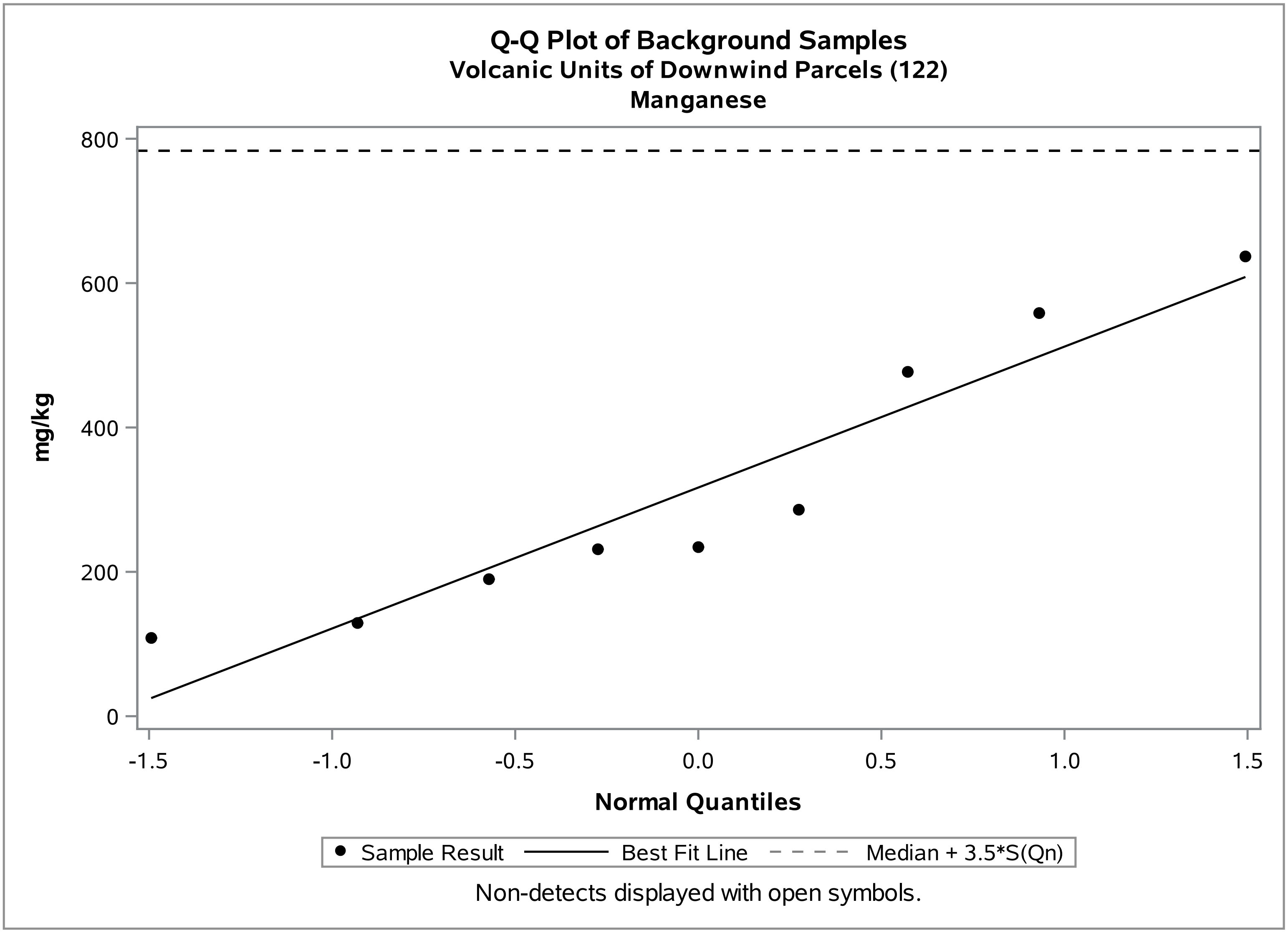

Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Arsenic
BG-122-05-01
BG-122-06-01
12.5
10.0
7.5
5.0
2.5
mg/kg
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

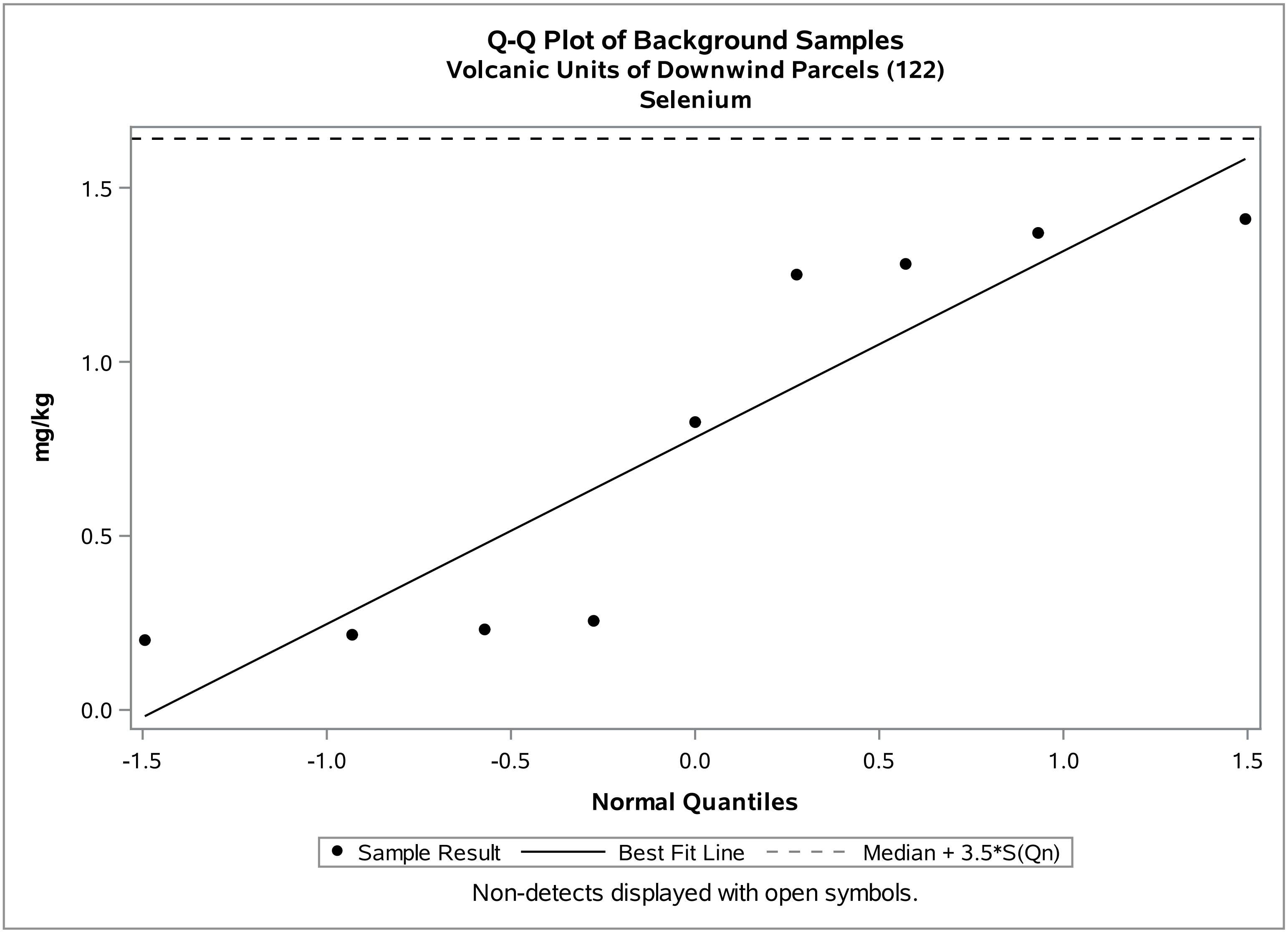

Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Cadmium
mg/kg
0.25
0.20
0.15
0.10
0.05
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

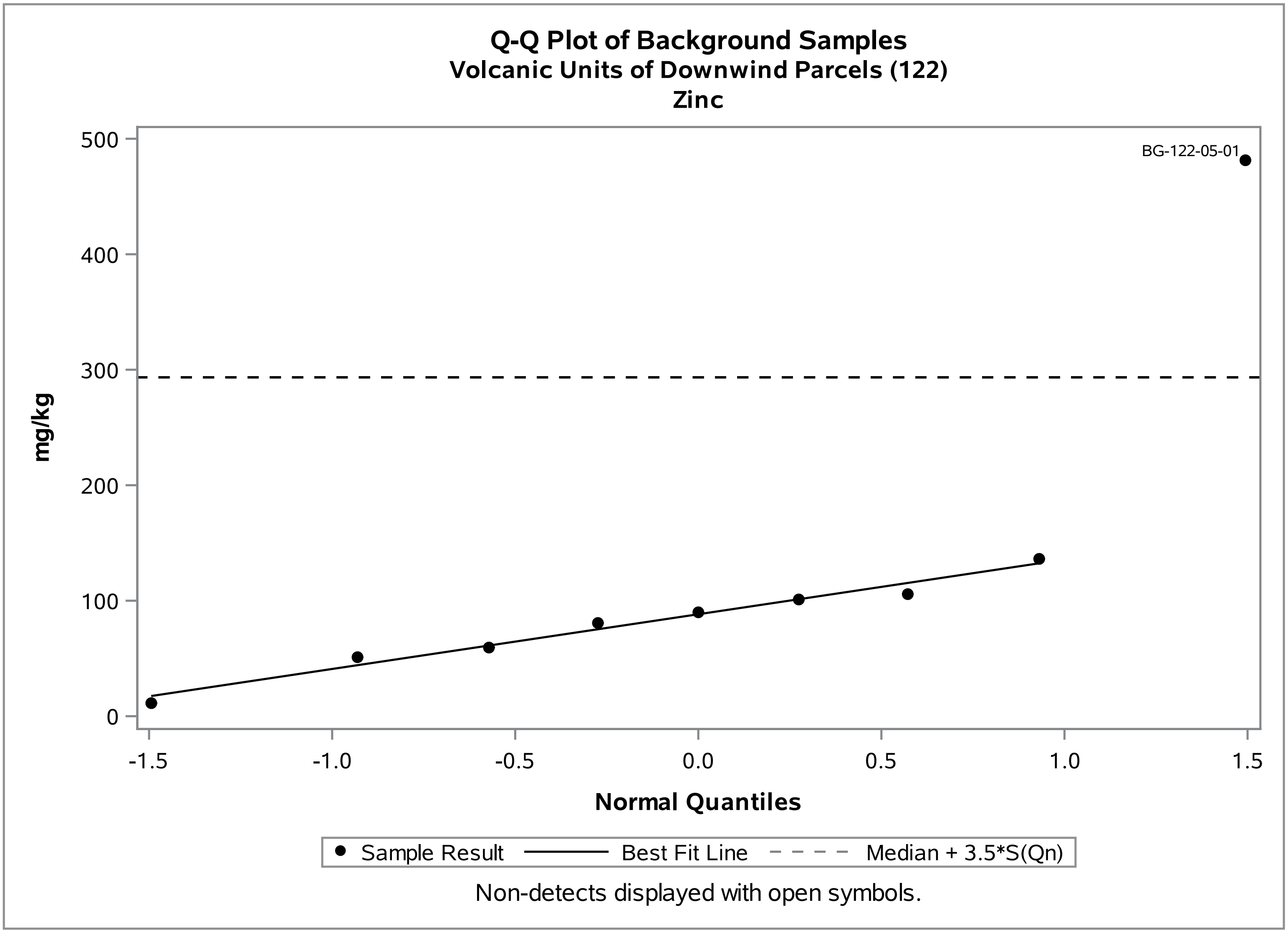

Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Chromium
mg/kg
30
20
10
0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Copper
mg/kg
60
40
20
0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Lead
BG-T22-08-01
mg/kg
0
20
40
60
80
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

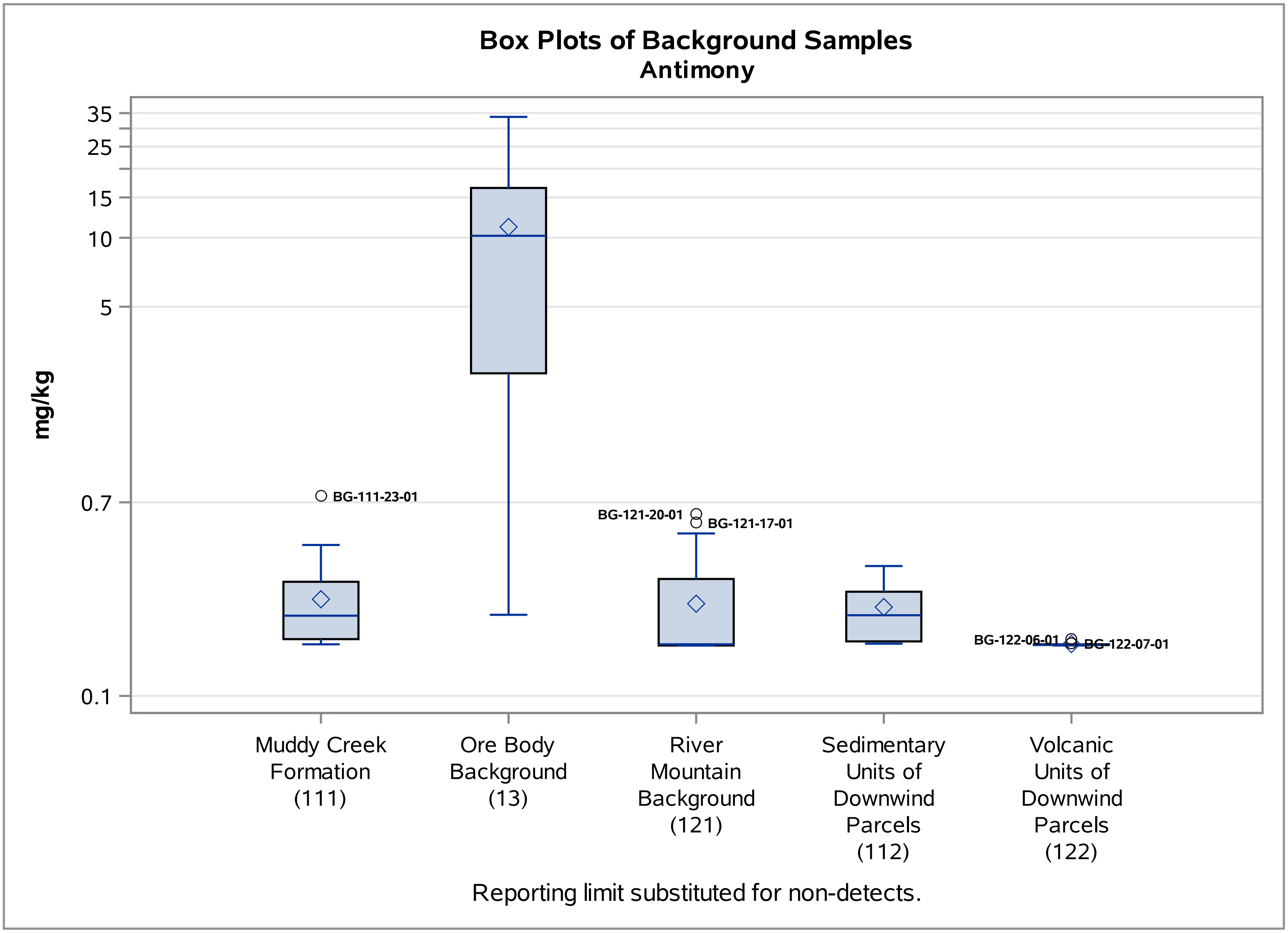

Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Manganese
mg/kg
800
600
400
200
0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

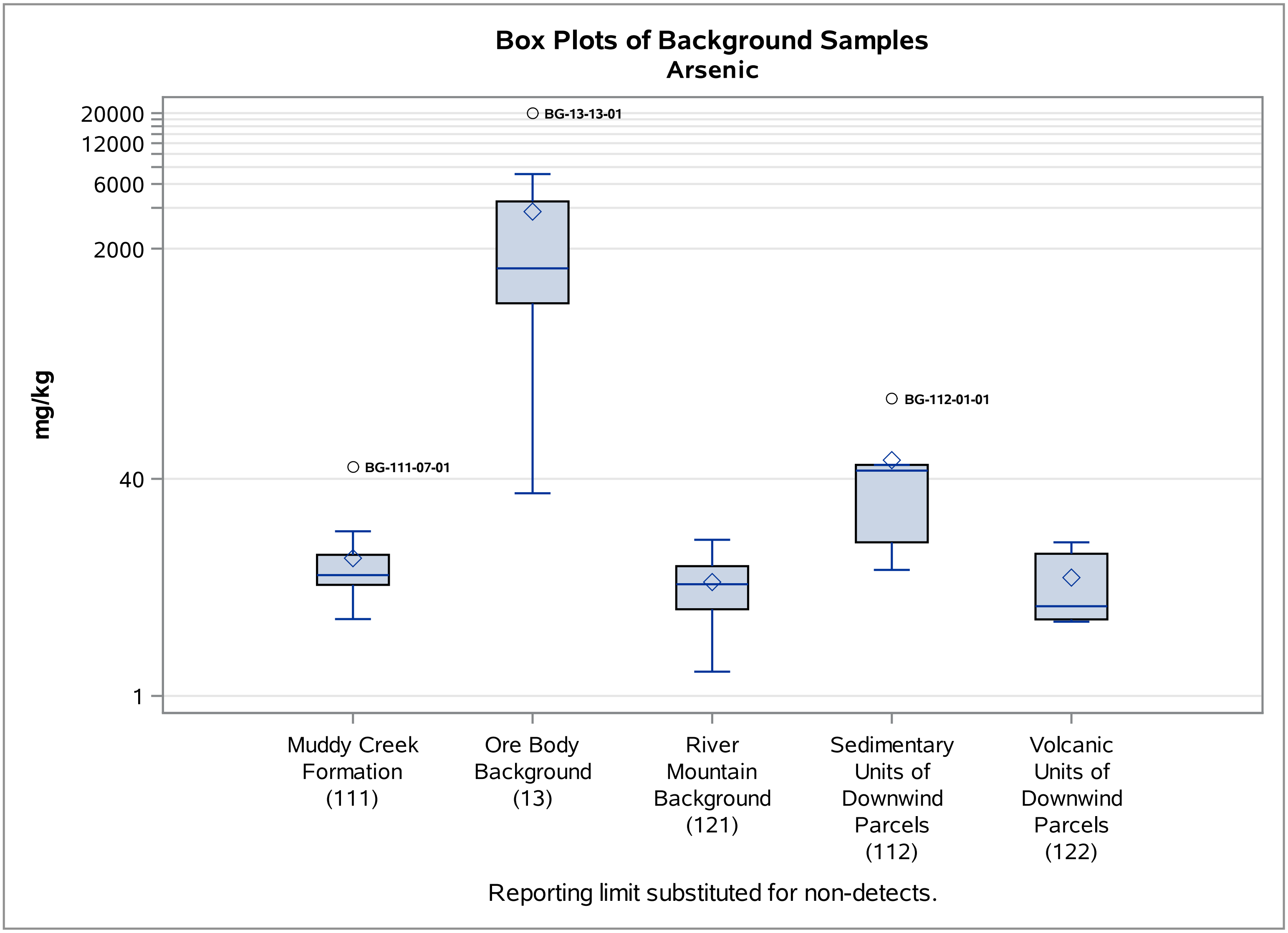

Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Selenium
mg/kg
1.5
1.0
0.5
0.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.


Q-Q Plot of Background Samples
Volcanic Units of Downwind Parcels (122)
Zinc
mg/kg
500
400
300
200
100
0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Normal Quantiles
BG-122-05-01
Sample Result
Best Fit Line
Median + 3.5*S(Qn)
Non-detects displayed with open symbols.

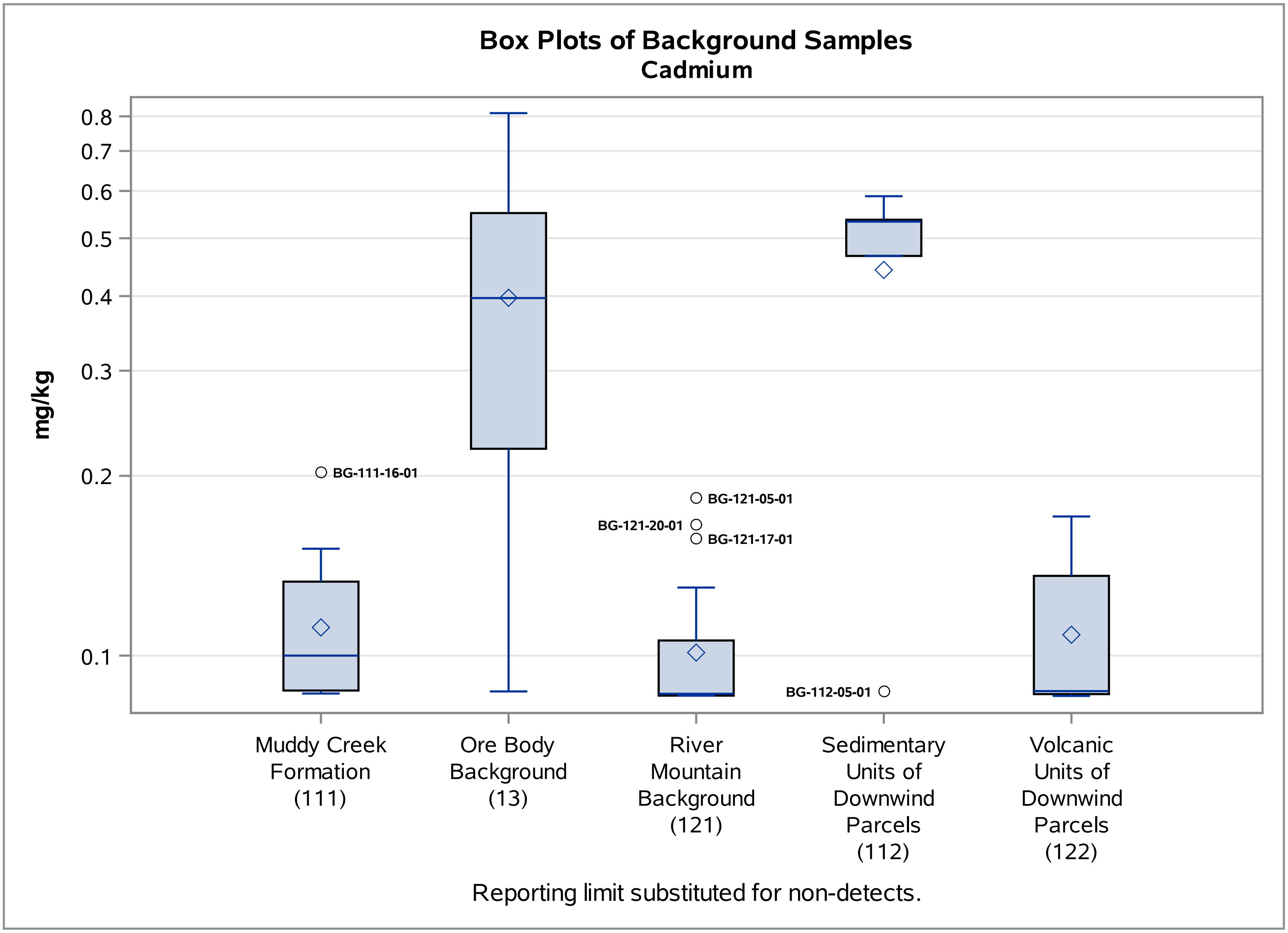
APPENDIX C

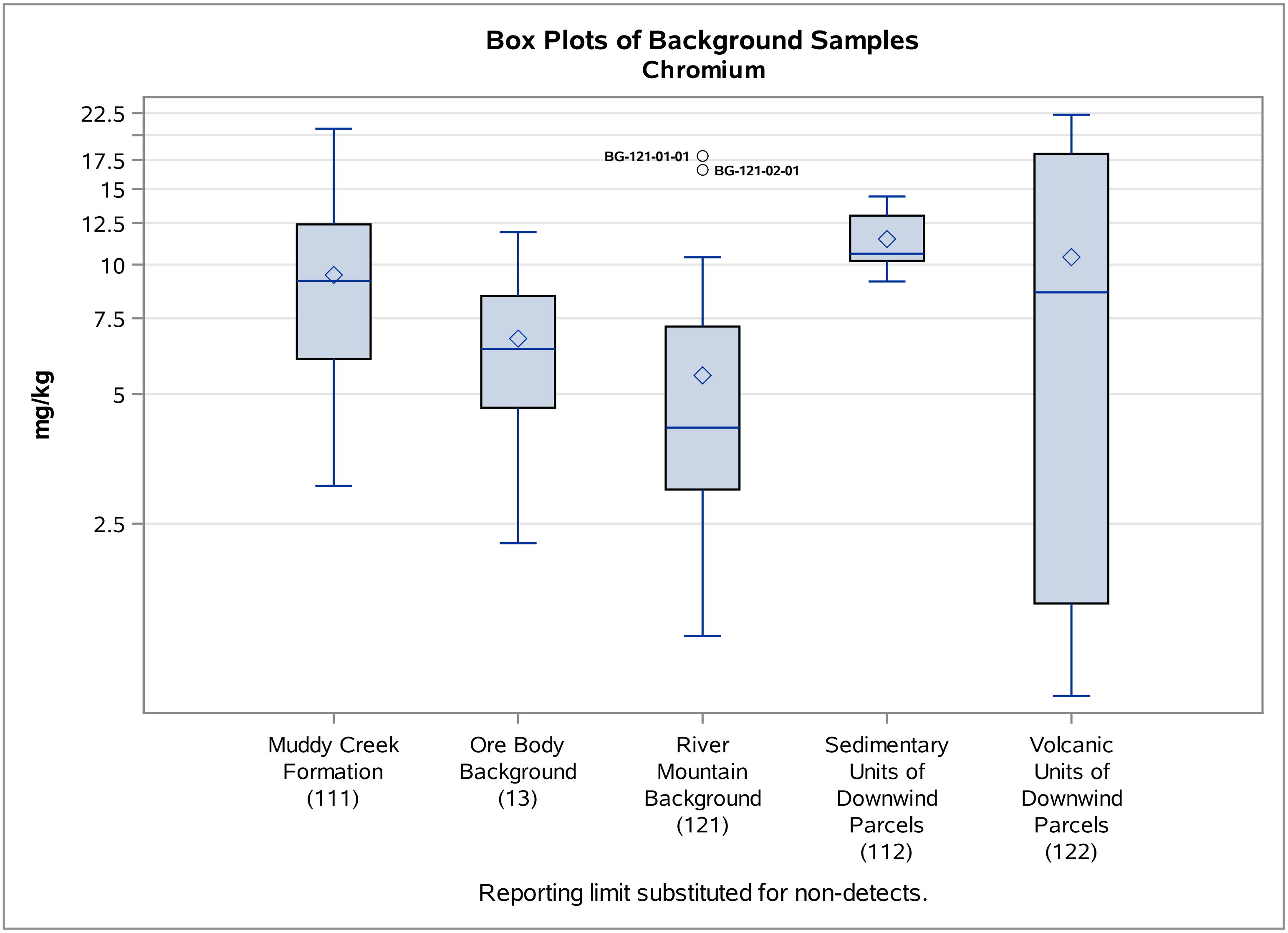
Side by Side Box Plots


Box Plots of Background Samples
Antimony
mg/kg
35
25
15
10
5
0.7
0.1
BG-111-23-01
BG-121-20-01
BG-121-17-01
BG-122-06-01
BG-122-07-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.

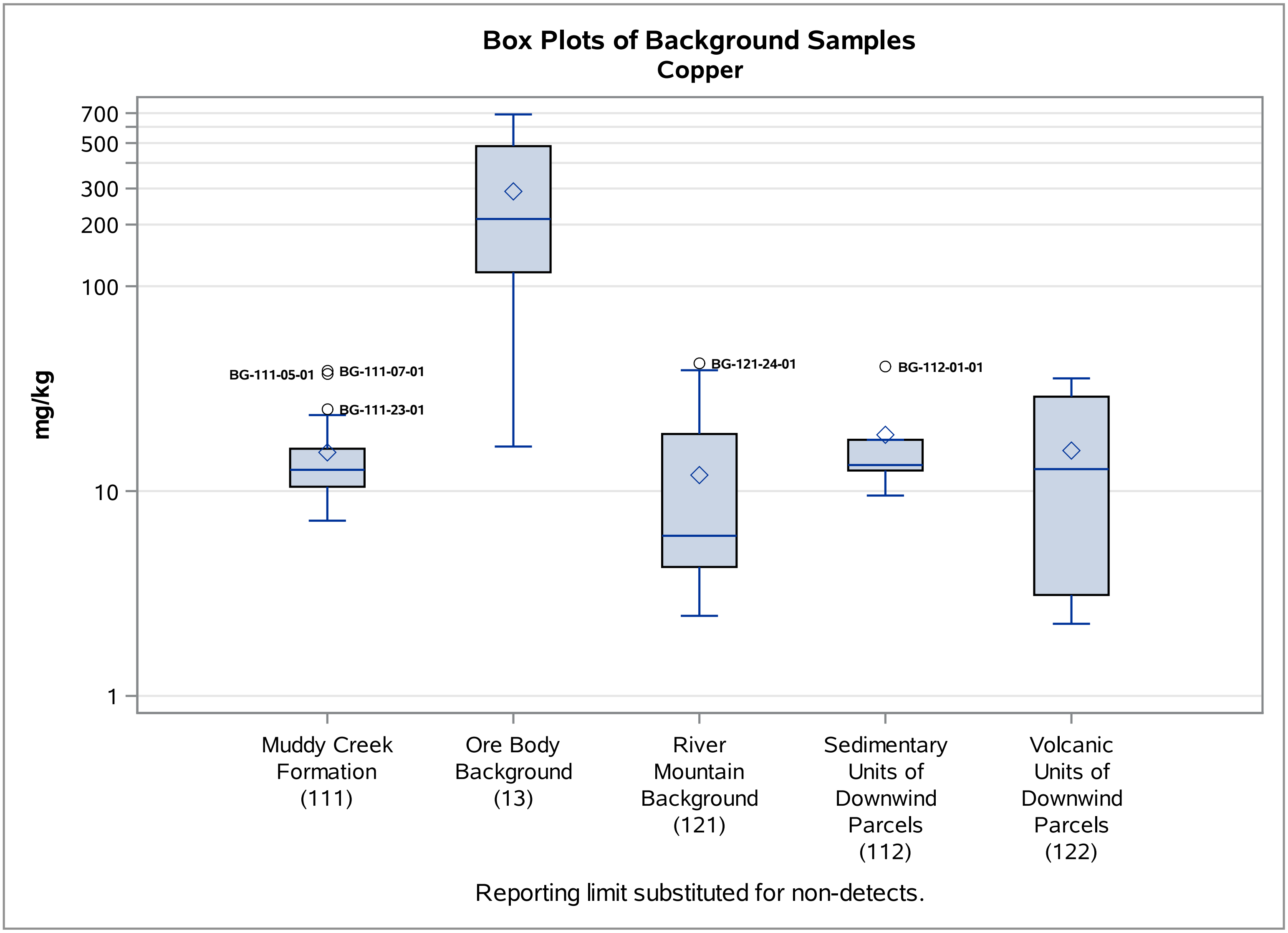


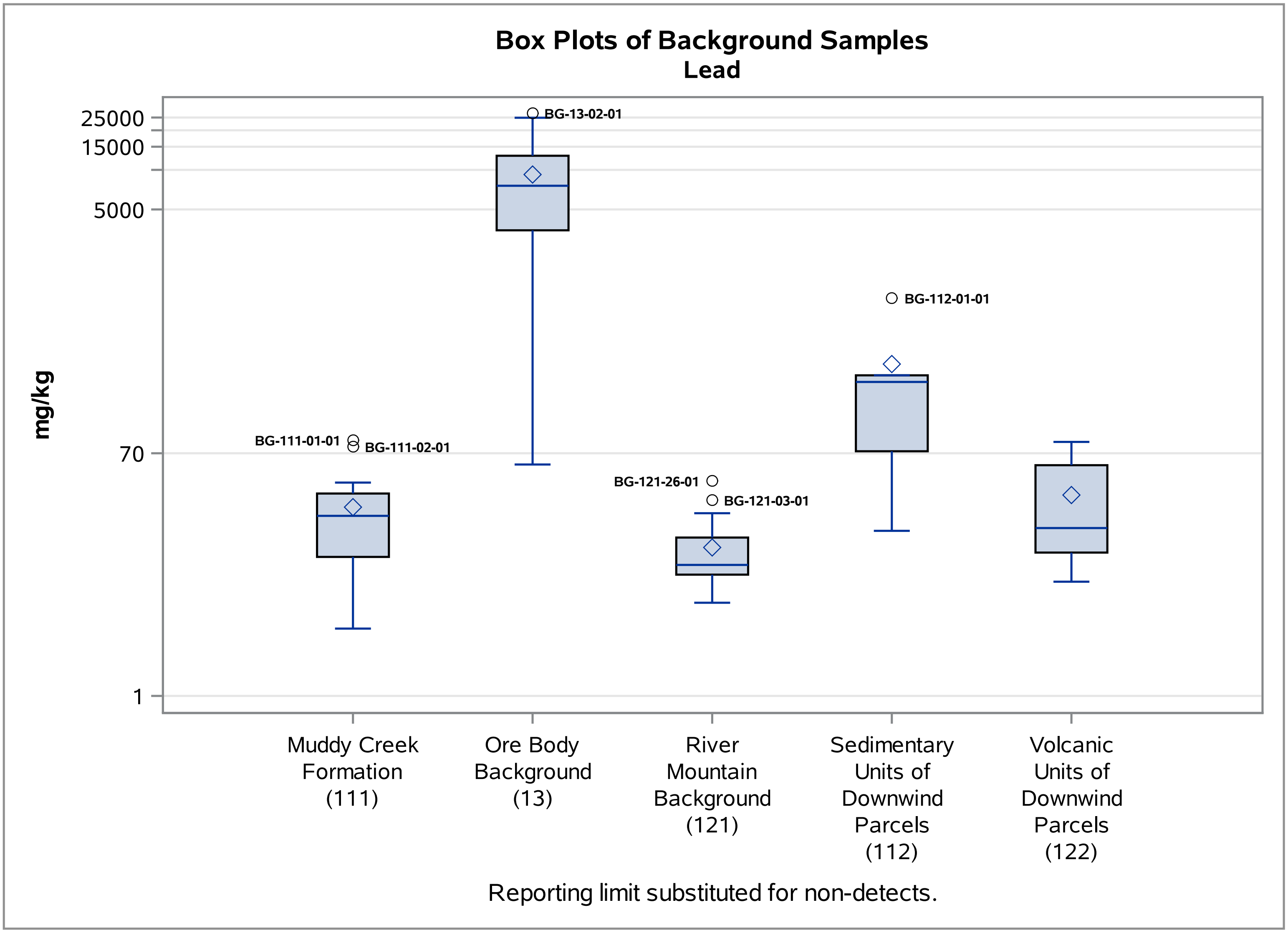
Box Plots of Background Samples
Arsenic
mg/kg
20000
12000
6000
2000
40
1
BG-13-13-01
BG-112-01-01
BG-111-07-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.

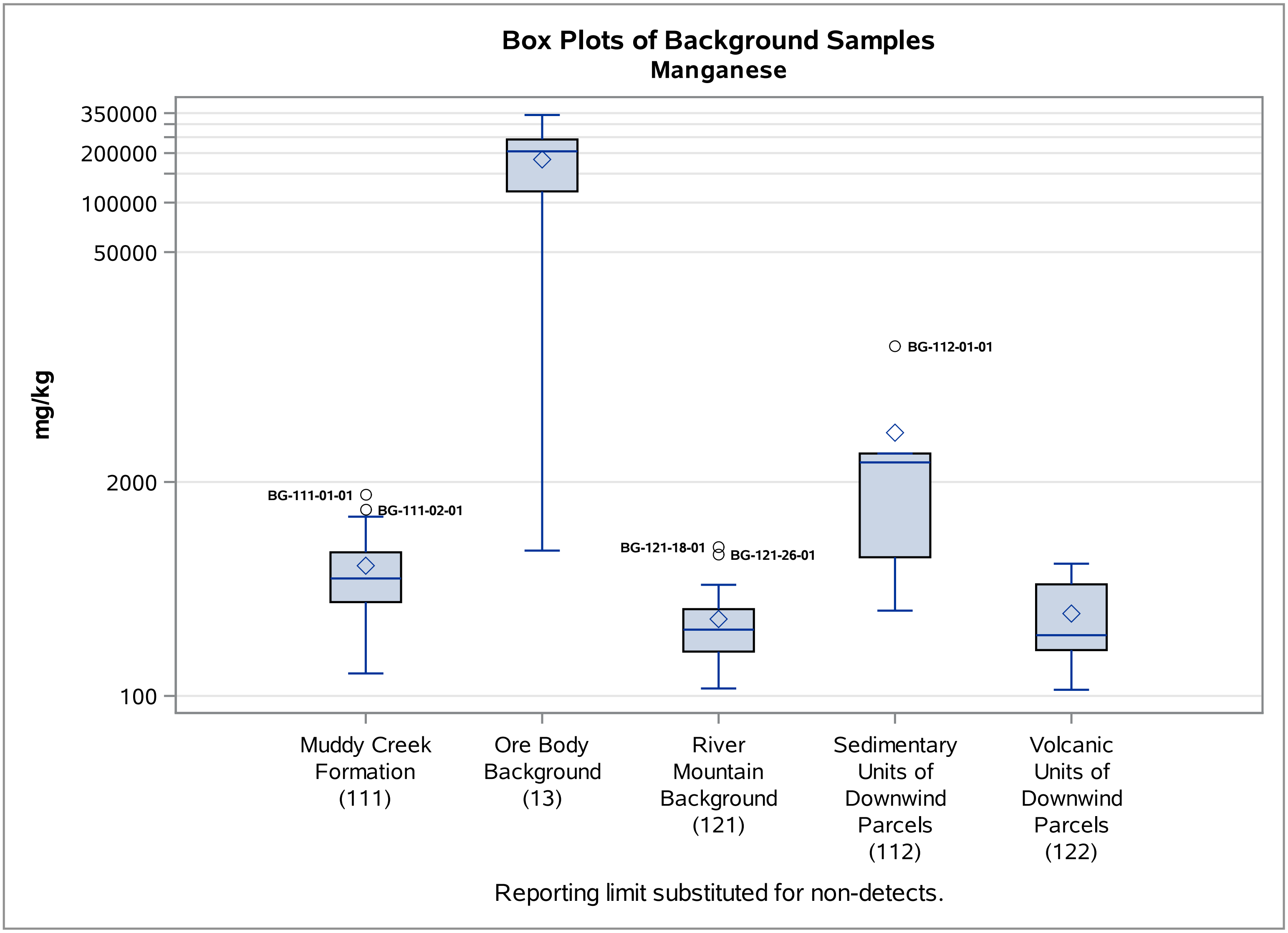

Box Plots of Background Samples
Cadmium
mg/kg
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
BG-111-16-01
BG-121-05-01
BG-121-20-01
BG-121-17-01
BG-112-05-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.

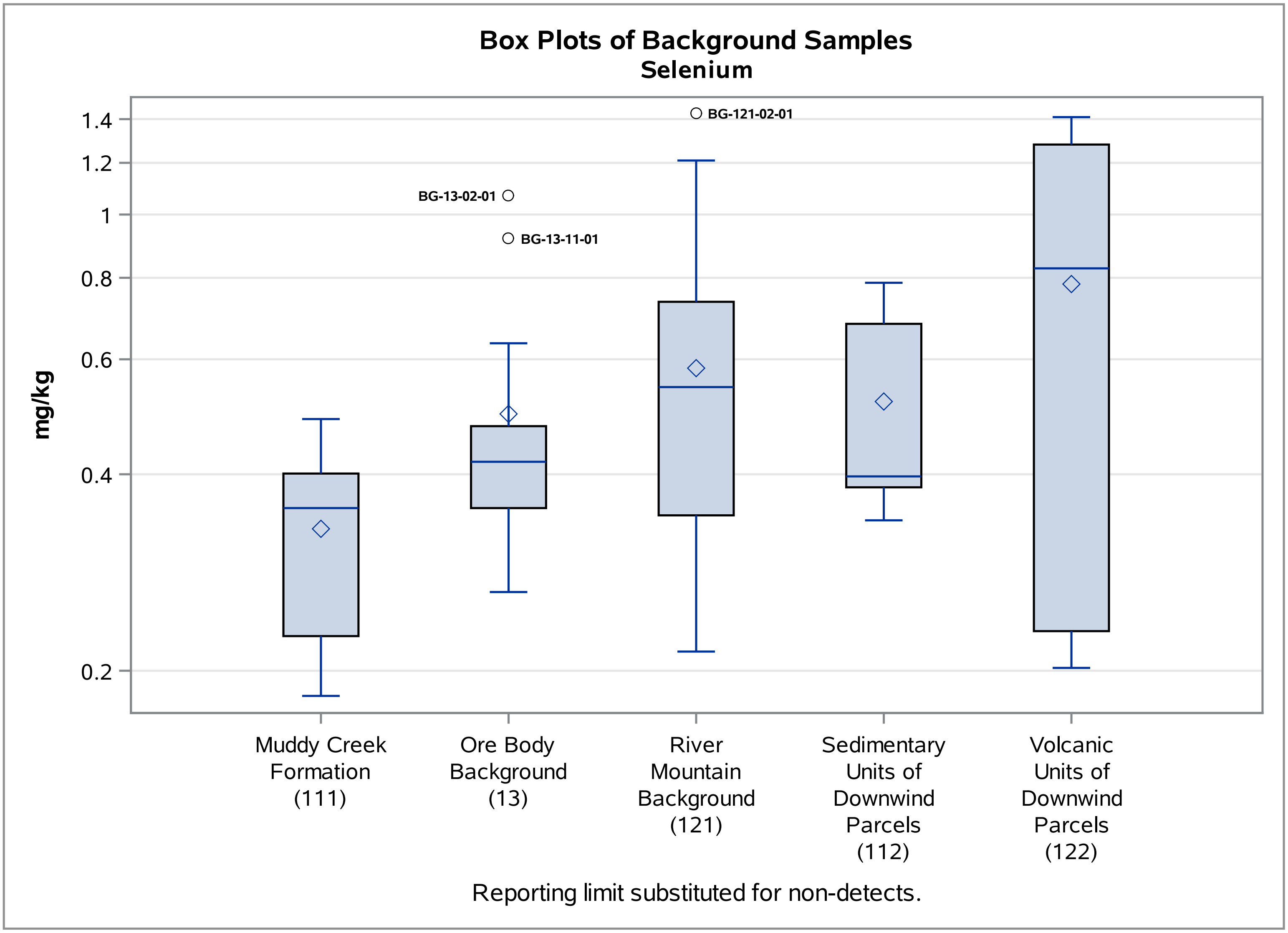


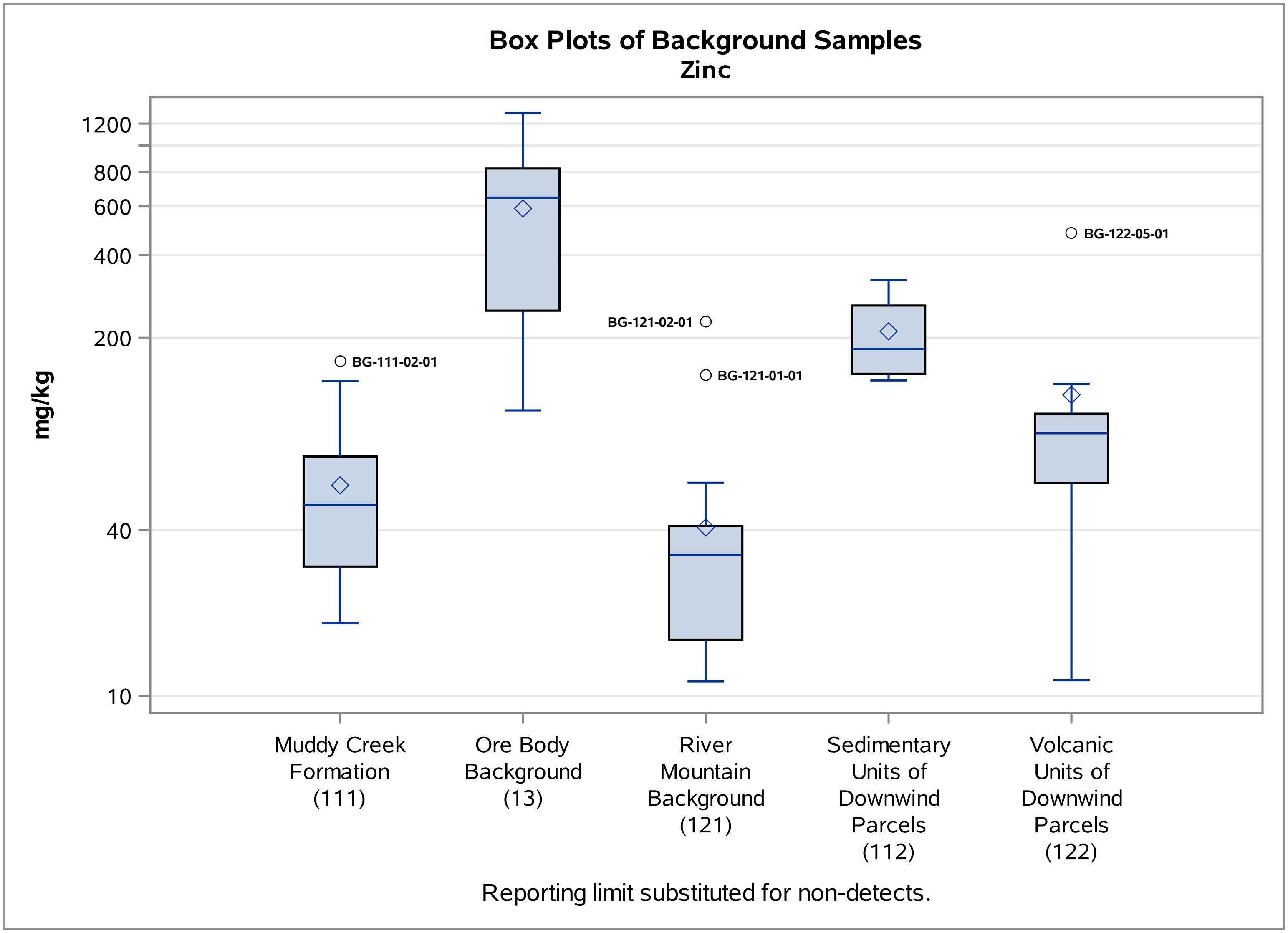
Box Plots of Background Samples
Chromium
mg/kg
22.5
17.5
15
12.5
10
7.5
5
2.5
BG-121-01-01
BG-121-02-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.


Box Plots of Background Samples
Copper
mg/kg
700
500
300
200
100
10
1
BG-111-05-01
BG-111-07-01
BG-111-23-01
BG-121-24-01
BG-112-01-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.


Box Plots of Background Samples
Lead
mg/kg
25000
15000
5000
70
1
BG-13-02-01
BG-112-01-01
BG-111-01-01
BG-111-02-01
BG-121-26-01
BG-121-03-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.


Box Plots of Background Samples
Manganese
mg/kg
350000
200000
100000
50000
2000
100
BG-111-01-01
BG-111-02-01
BG-121-18-01
BG-121-26-01
BG-112-01-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.


Box Plots of Background Samples
Selenium
mg/kg
1.4
1.2
1
0.8
0.6
0.4
0.2
BG-121-02-01
BG-13-02-01
BG-13-11-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.



Box Plots of Background Samples
Zinc
mg/kg
1200
800
600
400
200
40
10
BG-111-02-01
BG-121-02-01
BG-121-01-01
BG-122-05-01
Muddy Creek Formation (111)
Ore Body Background (13)
River Mountain Background (121)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)
Reporting limit substituted for non-detects.

APPENDIX D

ProUCL Outputs

Background Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.110/21/2021 8:37:24 PM
From File	proucl_data.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
rent or Future K Observations	1
ımber of Bootstrap Operations	2000

Result (antimony)

General Statistics

Total Number of Observations	18	Number of Missing Observations	0
Number of Distinct Observations	16		
Number of Detects	14	Number of Non-Detects	4
Number of Distinct Detects	13	Number of Distinct Non-Detects	3
Minimum Detect	0.177	Minimum Non-Detect	0.168
Maximum Detect	0.456	Maximum Non-Detect	0.17
Variance Detected	0.00737	Percent Non-Detects	22.22%
Mean Detected	0.261	SD Detected	0.0859
Mean of Detected Logged Data	-1.388	SD of Detected Logged Data	0.305

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.874	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.24	KM SD	0.0826
95% UTL95% Coverage	0.443	95% KM UPL (t)	0.388
90% KM Percentile (z)	0.346	95% KM Percentile (z)	0.376
99% KM Percentile (z)	0.432	95% KM USL	0.447

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.222	SD	0.106
95% UTL95% Coverage	0.483	95% UPL (t)	0.412
90% Percentile (z)	0.358	95% Percentile (z)	0.397
99% Percentile (z)	0.47	95% USL	0.488

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.562	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.734	›etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.195	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.229	›etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	11.22	k star (bias corrected MLE)	8.864
Theta hat (MLE)	0.0233	Theta star (bias corrected MLE)	0.0294
nu hat (MLE)	314.2	nu star (bias corrected)	248.2
MLE Mean (bias corrected)	0.261		
MLE Sd (bias corrected)	0.0877	95% Percentile of Chisquare (2kstar)	28.52

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0705	Mean	0.223

Maximum	0.456	Median	0.204
SD	0.105	CV	0.473
k hat (MLE)	4.39	k star (bias corrected MLE)	3.696
Theta hat (MLE)	0.0507	Theta star (bias corrected MLE)	0.0603
nu hat (MLE)	158.1	nu star (bias corrected)	133
MLE Mean (bias corrected)	0.223	MLE Sd (bias corrected)	0.116
95% Percentile of Chisquare (2kstar)	14.63	90% Percentile	0.378
95% Percentile	0.441	99% Percentile	0.576

The following statistics are computed using Gamma ROS Statistics on Imputed Data

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
Approx. Gamma UTL with 95% Coverage	0.581	0.605	95% Approx. Gamma UPL	0.454	0.463
95% Gamma USL	0.592	0.617			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.24	SD (KM)	0.0826
Variance (KM)	0.00682	SE of Mean (KM)	0.0202
k hat (KM)	8.468	k star (KM)	7.094
nu hat (KM)	304.8	nu star (KM)	255.4
theta hat (KM)	0.0284	theta star (KM)	0.0339
80% gamma percentile (KM)	0.311	90% gamma percentile (KM)	0.361
95% gamma percentile (KM)	0.405	99% gamma percentile (KM)	0.498

The following statistics are computed using gamma distribution and KM estimates

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
Approx. Gamma UTL with 95% Coverage	0.466	0.47	95% Approx. Gamma UPL	0.391	0.392
95% KM Gamma Percentile	0.377	0.377	95% Gamma USL	0.472	0.476

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.177	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.23	Mean in Log Scale	-1.548
SD in Original Scale	0.0959	SD in Log Scale	0.408
95% UTL95% Coverage	0.578	95% BCA UTL95% Coverage	0.456
95% Bootstrap (%) UTL95% Coverage	0.456	95% UPL (t)	0.441
90% Percentile (z)	0.359	95% Percentile (z)	0.416
99% Percentile (z)	0.549	95% USL	0.59

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-1.476	95% KM UTL (Lognormal)95% Coverage	0.485
KM SD of Logged Data	0.307	95% KM UPL (Lognormal)	0.395
95% KM Percentile Lognormal (z)	0.378	95% KM USL (Lognormal)	0.492

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.222	Mean in Log Scale	-1.629
SD in Original Scale	0.106	SD in Log Scale	0.534
95% UTL95% Coverage	0.727	95% UPL (t)	0.51
90% Percentile (z)	0.389	95% Percentile (z)	0.472
99% Percentile (z)	0.68	95% USL	0.747

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	18	95% UTL with95% Coverage	0.456
Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
ximate Sample Size needed to achieve specified CC	59	95% UPL	0.456
95% USL	0.456	95% KM Chebyshev UPL	0.61

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.

Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

Result (arsenic)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	17
Minimum	3.69	First Quartile	6.473
Second Largest	16.4	Median	7.63
Maximum	16.4	Third Quartile	8.223
Mean	8.361	SD	3.75
Coefficient of Variation	0.449	Skewness	1.362
Mean of logged Data	2.042	SD of logged Data	0.406

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test

Shapiro Wilk Test Statistic	0.803	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.285	Lilliefors GOF Test
5% Lilliefors Critical Value	0.202	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	17.56	90% Percentile (z)	13.17
95% UPL (t)	15.06	95% Percentile (z)	14.53
95% USL	17.75	99% Percentile (z)	17.08

Gamma GOF Test

A-D Test Statistic	0.964	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.742	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.233	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.204	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.272	k star (bias corrected MLE)	5.264
Theta hat (MLE)	1.333	Theta star (bias corrected MLE)	1.588
nu hat (MLE)	225.8	nu star (bias corrected)	189.5
MLE Mean (bias corrected)	8.361	MLE Sd (bias corrected)	3.644

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	15.42	90% Percentile	13.24
95% Hawkins Wixley (HW) Approx. Gamma UPL	15.52	95% Percentile	15.11
95% WH Approx. Gamma UTL with 95% Coverage	19.12	99% Percentile	19.07
95% HW Approx. Gamma UTL with 95% Coverage	19.46		
95% WH USL	19.43	95% HW USL	19.79

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.914	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.206	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.202	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	20.85	90% Percentile (z)	12.96
95% UPL (t)	15.91	95% Percentile (z)	15.02
95% USL	21.29	99% Percentile (z)	19.8

Nonparametric Distribution Free Background Statistics

Data appear Approximate Lognormal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	18	95% UTL with 95% Coverage	16.4
Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
		ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	16.4	95% BCA Bootstrap UTL with 95% Coverage	16.4
95% UPL	16.4	90% Percentile	15.35
90% Chebyshev UPL	19.92	95% Percentile	16.4
95% Chebyshev UPL	25.15	99% Percentile	16.4
95% USL	16.4		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (cadmium)

General Statistics

Total Number of Observations	18	Number of Missing Observations	0
Number of Distinct Observations	16		
Number of Detects	12	Number of Non-Detects	6
Number of Distinct Detects	12	Number of Distinct Non-Detects	4
Minimum Detect	0.0952	Minimum Non-Detect	0.0867
Maximum Detect	0.203	Maximum Non-Detect	0.0897
Variance Detected	9.6243E-4	Percent Non-Detects	33.33%
Mean Detected	0.126	SD Detected	0.031
Mean of Detected Logged Data	-2.095	SD of Detected Logged Data	0.226

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.862	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.113	KM SD	0.0305
95% UTL95% Coverage	0.188	95% KM UPL (t)	0.168
90% KM Percentile (z)	0.152	95% KM Percentile (z)	0.163
99% KM Percentile (z)	0.184	95% KM USL	0.189

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.0987	SD	0.0471
95% UTL95% Coverage	0.214	95% UPL (t)	0.183
90% Percentile (z)	0.159	95% Percentile (z)	0.176
99% Percentile (z)	0.208	95% USL	0.217

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.442	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.732	etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.171	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.245	etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	20.47	k star (bias corrected MLE)	15.41
Theta hat (MLE)	0.00616	Theta star (bias corrected MLE)	0.00818
nu hat (MLE)	491.4	nu star (bias corrected)	369.9
MLE Mean (bias corrected)	0.126		
MLE Sd (bias corrected)	0.0321	95% Percentile of Chisquare (2kstar)	44.77

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0496	Mean	0.104
Maximum	0.203	Median	0.102
SD	0.0413	CV	0.398
k hat (MLE)	6.621	k star (bias corrected MLE)	5.554
Theta hat (MLE)	0.0157	Theta star (bias corrected MLE)	0.0187
nu hat (MLE)	238.3	nu star (bias corrected)	199.9
MLE Mean (bias corrected)	0.104	MLE Sd (bias corrected)	0.044
95% Percentile of Chisquare (2kstar)	19.82	90% Percentile	0.163
95% Percentile	0.185	99% Percentile	0.232

The following statistics are computed using Gamma ROS Statistics on Imputed Data
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
Approx. Gamma UTL with 95% Coverage	0.233	0.239	95% Approx. Gamma UPL	0.189	0.191
95% Gamma USL	0.237	0.243			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.113	SD (KM)	0.0305
Variance (KM)	9.3327E-4	SE of Mean (KM)	0.00752
k hat (KM)	13.68	k star (KM)	11.43
nu hat (KM)	492.3	nu star (KM)	411.6
theta hat (KM)	0.00826	theta star (KM)	0.00988
80% gamma percentile (KM)	0.14	90% gamma percentile (KM)	0.157
95% gamma percentile (KM)	0.173	99% gamma percentile (KM)	0.205

The following statistics are computed using gamma distribution and KM estimates
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
Approx. Gamma UTL with 95% Coverage	0.193	0.194	95% Approx. Gamma UPL	0.168	0.168
95% KM Gamma Percentile	0.163	0.163	95% Gamma USL	0.196	0.197

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.162	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.108	Mean in Log Scale	-2.281
SD in Original Scale	0.0368	SD in Log Scale	0.328
95% UTL95% Coverage	0.228	95% BCA UTL95% Coverage	0.203
95% Bootstrap (%) UTL95% Coverage	0.203	95% UPL (t)	0.184
90% Percentile (z)	0.156	95% Percentile (z)	0.175
99% Percentile (z)	0.219	95% USL	0.232

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-2.212	95% KM UTL (Lognormal)95% Coverage	0.198
KM SD of Logged Data	0.242	95% KM UPL (Lognormal)	0.169
95% KM Percentile Lognormal (z)	0.163	95% KM USL (Lognormal)	0.2

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.0987	Mean in Log Scale	-2.439
SD in Original Scale	0.0471	SD in Log Scale	0.533
95% UTL95% Coverage	0.322	95% UPL (t)	0.226
90% Percentile (z)	0.173	95% Percentile (z)	0.209
99% Percentile (z)	0.301	95% USL	0.331

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	18	95% UTL with95% Coverage	0.203

Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
›ximate Sample Size needed to achieve specified CC	59	95% UPL	0.203
95% USL	0.203	95% KM Chebyshev UPL	0.25

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (chromium)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
Minimum	3.28	First Quartile	7.11
Second Largest	12.5	Median	8.69
Maximum	12.8	Third Quartile	11.18
Mean	8.817	SD	3.009
Coefficient of Variation	0.341	Skewness	-0.448
Mean of logged Data	2.106	SD of logged Data	0.416

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test

Shapiro Wilk Test Statistic	0.937	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.133	Lilliefors GOF Test
5% Lilliefors Critical Value	0.202	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	16.2	90% Percentile (z)	12.67
95% UPL (t)	14.19	95% Percentile (z)	13.77
95% USL	16.35	99% Percentile (z)	15.82

Gamma GOF Test

A-D Test Statistic	0.596	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.741	›etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.154	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.204	›etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.237	k star (bias corrected MLE)	6.068
Theta hat (MLE)	1.218	Theta star (bias corrected MLE)	1.453
nu hat (MLE)	260.5	nu star (bias corrected)	218.5
MLE Mean (bias corrected)	8.817	MLE Sd (bias corrected)	3.579

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	15.73	90% Percentile	13.6
95% Hawkins Wixley (HW) Approx. Gamma UPL	16.04	95% Percentile	15.41
95% WH Approx. Gamma UTL with 95% Coverage	19.27	99% Percentile	19.19
95% HW Approx. Gamma UTL with 95% Coverage	19.94		
95% WH USL	19.56	95% HW USL	20.26

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.87	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.897	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.151	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	22.78	90% Percentile (z)	14
95% UPL (t)	17.27	95% Percentile (z)	16.28
95% USL	23.27	99% Percentile (z)	21.61

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	18	95% UTL with 95% Coverage	12.8
Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	12.8	95% BCA Bootstrap UTL with 95% Coverage	12.8
95% UPL	12.8	90% Percentile	12.43
90% Chebyshev UPL	18.09	95% Percentile	12.55
95% Chebyshev UPL	22.29	99% Percentile	12.75
95% USL	12.8		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (copper)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
Minimum	7.17	First Quartile	9.533
Second Largest	15.3	Median	11.6
Maximum	16.1	Third Quartile	13.35
Mean	11.53	SD	2.496
Coefficient of Variation	0.216	Skewness	-0.0242
Mean of logged Data	2.422	SD of logged Data	0.226

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.102	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	17.65	90% Percentile (z)	14.73
95% UPL (t)	15.99	95% Percentile (z)	15.64
95% USL	17.78	99% Percentile (z)	17.34

Gamma GOF Test

A-D Test Statistic	0.253	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.739	›etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.103	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.203	›etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	21.59	k star (bias corrected MLE)	18.03
Theta hat (MLE)	0.534	Theta star (bias corrected MLE)	0.64
nu hat (MLE)	777.1	nu star (bias corrected)	648.9
MLE Mean (bias corrected)	11.53	MLE Sd (bias corrected)	2.716

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	16.5	90% Percentile	15.12
95% Hawkins Wixley (HW) Approx. Gamma UPL	16.58	95% Percentile	16.33
95% WH Approx. Gamma UTL with 95% Coverage	18.75	99% Percentile	18.77
95% HW Approx. Gamma UTL with 95% Coverage	18.94		
95% WH USL	18.93	95% HW USL	19.13

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.117	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	19.61	90% Percentile (z)	15.05
95% UPL (t)	16.87	95% Percentile (z)	16.33
95% USL	19.83	99% Percentile (z)	19.05

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	18	95% UTL with 95% Coverage	16.1
Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
		ɔximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	16.1	95% BCA Bootstrap UTL with 95% Coverage	16.1
95% UPL	16.1	90% Percentile	14.18
90% Chebyshev UPL	19.22	95% Percentile	15.42
95% Chebyshev UPL	22.71	99% Percentile	15.96
95% USL	16.1		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (lead)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
Minimum	3.25	First Quartile	11.25
Second Largest	34.8	Median	19.65
Maximum	41.9	Third Quartile	30.23
Mean	20.61	SD	11.33
Coefficient of Variation	0.55	Skewness	0.308
Mean of logged Data	2.848	SD of logged Data	0.666

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.194	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	48.4	90% Percentile (z)	35.13
95% UPL (t)	40.85	95% Percentile (z)	39.24
95% USL	48.97	99% Percentile (z)	46.96

Gamma GOF Test

A-D Test Statistic	0.424	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.746	ɔetected data appear Gamma Distributed at 5% Significance Leve	
K-S Test Statistic	0.148	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.205	ɔetected data appear Gamma Distributed at 5% Significance Leve	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.963	k star (bias corrected MLE)	2.506
Theta hat (MLE)	6.956	Theta star (bias corrected MLE)	8.224
nu hat (MLE)	106.7	nu star (bias corrected)	90.23

MLE Mean (bias corrected)	20.61	MLE Sd (bias corrected)	13.02

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	47.28	90% Percentile	38.05
95% Hawkins Wixley (HW) Approx. Gamma UPL	48.91	95% Percentile	45.6
95% WH Approx. Gamma UTL with 95% Coverage	63	99% Percentile	62.12
95% HW Approx. Gamma UTL with 95% Coverage	67		
95% WH USL	64.33	95% HW USL	68.56

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.925	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	88.31	90% Percentile (z)	40.49
95% UPL (t)	56.69	95% Percentile (z)	51.56
95% USL	91.36	99% Percentile (z)	81.17

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	18	95% UTL with 95% Coverage	41.9
Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
		ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	41.9	95% BCA Bootstrap UTL with 95% Coverage	41.9
95% UPL	41.9	90% Percentile	34.66
90% Chebyshev UPL	55.52	95% Percentile	35.87
95% Chebyshev UPL	71.34	99% Percentile	40.69
95% USL	41.9		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (manganese)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
Minimum	137	First Quartile	341.3
Second Largest	896	Median	473
Maximum	981	Third Quartile	619.3
Mean	502.3	SD	231
Coefficient of Variation	0.46	Skewness	0.423
Mean of logged Data	6.104	SD of logged Data	0.523

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.113	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	1069	90% Percentile (z)	798.4
95% UPL (t)	915.2	95% Percentile (z)	882.3
95% USL	1081	99% Percentile (z)	1040

Gamma GOF Test

A-D Test Statistic	0.196	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.743	)etected data appear Gamma Distributed at 5% Significance Leve	
K-S Test Statistic	0.142	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.204	)etected data appear Gamma Distributed at 5% Significance Leve	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.49	k star (bias corrected MLE)	3.779
Theta hat (MLE)	111.9	Theta star (bias corrected MLE)	132.9
nu hat (MLE)	161.7	nu star (bias corrected)	136
MLE Mean (bias corrected)	502.3	MLE Sd (bias corrected)	258.4

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	1016	90% Percentile	848.8
95% Hawkins Wixley (HW) Approx. Gamma UPL	1040	95% Percentile	988.6
95% WH Approx. Gamma UTL with 95% Coverage	1299	99% Percentile	1288
95% HW Approx. Gamma UTL with 95% Coverage	1355		
95% WH USL	1322	95% HW USL	1381

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.149	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	1613	90% Percentile (z)	874.5
95% UPL (t)	1139	95% Percentile (z)	1057
95% USL	1657	99% Percentile (z)	1510

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	18	95% UTL with 95% Coverage	981
Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	981	95% BCA Bootstrap UTL with 95% Coverage	981
95% UPL	981	90% Percentile	791.7
90% Chebyshev UPL	1214	95% Percentile	908.8
95% Chebyshev UPL	1537	99% Percentile	966.6
95% USL	981		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (selenium)

General Statistics

Total Number of Observations	18	Number of Missing Observations	0
Number of Distinct Observations	17		
Number of Detects	15	Number of Non-Detects	3
Number of Distinct Detects	15	Number of Distinct Non-Detects	2
Minimum Detect	0.187	Minimum Non-Detect	0.183
Maximum Detect	0.486	Maximum Non-Detect	0.184
Variance Detected	0.00641	Percent Non-Detects	16.67%
Mean Detected	0.362	SD Detected	0.0801
Mean of Detected Logged Data	-1.043	SD of Detected Logged Data	0.252

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.131	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.332	KM SD	0.0972
95% UTL95% Coverage	0.571	95% KM UPL (t)	0.506
90% KM Percentile (z)	0.457	95% KM Percentile (z)	0.492
99% KM Percentile (z)	0.558	95% KM USL	0.576

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.317	SD	0.127
95% UTL95% Coverage	0.628	95% UPL (t)	0.543
90% Percentile (z)	0.479	95% Percentile (z)	0.525
99% Percentile (z)	0.612	95% USL	0.634

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.494	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.735	)etected data appear Gamma Distributed at 5% Significance Leve	
K-S Test Statistic	0.163	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.221	)etected data appear Gamma Distributed at 5% Significance Leve	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	18.7	k star (bias corrected MLE)	15
Theta hat (MLE)	0.0194	Theta star (bias corrected MLE)	0.0241
nu hat (MLE)	560.9	nu star (bias corrected)	450.1
MLE Mean (bias corrected)	0.362		
MLE Sd (bias corrected)	0.0935	95% Percentile of Chisquare (2kstar)	43.78

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.187	Mean	0.336
Maximum	0.486	Median	0.359
SD	0.0943	CV	0.281
k hat (MLE)	11.99	k star (bias corrected MLE)	10.03
Theta hat (MLE)	0.028	Theta star (bias corrected MLE)	0.0335
nu hat (MLE)	431.6	nu star (bias corrected)	361
MLE Mean (bias corrected)	0.336	MLE Sd (bias corrected)	0.106
95% Percentile of Chisquare (2kstar)	31.48	90% Percentile	0.477
95% Percentile	0.528	99% Percentile	0.631

The following statistics are computed using Gamma ROS Statistics on Imputed Data

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
, Approx. Gamma UTL with 95% Coverage	0.632	0.643	95% Approx. Gamma UPL	0.536	0.541
95% Gamma USL	0.639	0.652			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.332	SD (KM)	0.0972
Variance (KM)	0.00944	SE of Mean (KM)	0.0237
k hat (KM)	11.69	k star (KM)	9.78
nu hat (KM)	420.9	nu star (KM)	352.1
theta hat (KM)	0.0284	theta star (KM)	0.034
80% gamma percentile (KM)	0.417	90% gamma percentile (KM)	0.474
95% gamma percentile (KM)	0.524	99% gamma percentile (KM)	0.628

The following statistics are computed using gamma distribution and KM estimates

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
, Approx. Gamma UTL with 95% Coverage	0.643	0.657	95% Approx. Gamma UPL	0.541	0.547

95% KM Gamma Percentile	0.521	0.526	95% Gamma USL	0.652	0.666

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.896	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.336	Mean in Log Scale	-1.132
SD in Original Scale	0.0942	SD in Log Scale	0.309
95% UTL95% Coverage	0.687	95% BCA UTL95% Coverage	0.486
95% Bootstrap (%) UTL95% Coverage	0.486	95% UPL (t)	0.559
90% Percentile (z)	0.479	95% Percentile (z)	0.535
99% Percentile (z)	0.661	95% USL	0.698

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-1.152	95% KM UTL (Lognormal)95% Coverage	0.71
KM SD of Logged Data	0.33	95% KM UPL (Lognormal)	0.57
95% KM Percentile Lognormal (z)	0.544	95% KM USL (Lognormal)	0.723

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.317	Mean in Log Scale	-1.267
SD in Original Scale	0.127	SD in Log Scale	0.564
95% UTL95% Coverage	1.124	95% UPL (t)	0.772
90% Percentile (z)	0.581	95% Percentile (z)	0.713
99% Percentile (z)	1.047	95% USL	1.157

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	18	95% UTL with95% Coverage	0.486
Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
ximate Sample Size needed to achieve specified CC	59	95% UPL	0.486
95% USL	0.486	95% KM Chebyshev UPL	0.767

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (zinc)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
Minimum	18.4	First Quartile	30.53
Second Largest	74.8	Median	42.55
Maximum	81.5	Third Quartile	65.7
Mean	47.19	SD	21.17
Coefficient of Variation	0.448	Skewness	0.15
Mean of logged Data	3.747	SD of logged Data	0.494

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.453	d2max (for USL)	2.504

Normal GOF Test

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Data Not Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	99.11	90% Percentile (z)	74.32
95% UPL (t)	85.02	95% Percentile (z)	82.01
95% USL	100.2	99% Percentile (z)	96.43

Gamma GOF Test

A-D Test Statistic	0.589	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.743	)etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.166	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.204	)etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.81	k star (bias corrected MLE)	4.046
Theta hat (MLE)	9.811	Theta star (bias corrected MLE)	11.67
nu hat (MLE)	173.2	nu star (bias corrected)	145.6
MLE Mean (bias corrected)	47.19	MLE Sd (bias corrected)	23.46

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	93.72	90% Percentile	78.64
95% Hawkins Wixley (HW) Approx. Gamma UPL	95.48	95% Percentile	91.21
95% WH Approx. Gamma UTL with 95% Coverage	119	99% Percentile	118
95% HW Approx. Gamma UTL with 95% Coverage	123.4		
95% WH USL	121.1	95% HW USL	125.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.173	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	142.3	90% Percentile (z)	79.8
95% UPL (t)	102.4	95% Percentile (z)	95.48
95% USL	145.9	99% Percentile (z)	133.7

Nonparametric Distribution Free Background Statistics

Data appear Approximate Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	18	95% UTL with 95% Coverage	81.5
Approx, f used to compute achieved CC	0.947	imate Actual Confidence Coefficient achieved by UTL	0.603
		ɔximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	81.5	95% BCA Bootstrap UTL with 95% Coverage	81.5
95% UPL	81.5	90% Percentile	74.31
90% Chebyshev UPL	112.4	95% Percentile	75.81
95% Chebyshev UPL	142	99% Percentile	80.36
95% USL	81.5		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Background Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.110/21/2021 8:39:19 PM
From File	proucl_data_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Observations	1
Number of Bootstrap Operations	2000

Result (antimony)

General Statistics

Total Number of Observations	22	Number of Missing Observations	0
Number of Distinct Observations	13		
Number of Detects	8	Number of Non-Detects	14
Number of Distinct Detects	8	Number of Distinct Non-Detects	5
Minimum Detect	0.194	Minimum Non-Detect	0.166
Maximum Detect	0.624	Maximum Non-Detect	0.17
Variance Detected	0.0198	Percent Non-Detects	63.64%
Mean Detected	0.44	SD Detected	0.141
Mean of Detected Logged Data	-0.876	SD of Detected Logged Data	0.378

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.349	d2max (for USL)	2.603

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.149	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.266	KM SD	0.154
95% UTL95% Coverage	0.627	95% KM UPL (t)	0.536
90% KM Percentile (z)	0.463	95% KM Percentile (z)	0.519
99% KM Percentile (z)	0.624	95% KM USL	0.666

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.213	SD	0.193
95% UTL95% Coverage	0.668	95% UPL (t)	0.553
90% Percentile (z)	0.461	95% Percentile (z)	0.531
99% Percentile (z)	0.663	95% USL	0.717

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.278	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.716	)etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.18	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.294	)etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	9.193	k star (bias corrected MLE)	5.829
Theta hat (MLE)	0.0479	Theta star (bias corrected MLE)	0.0755
nu hat (MLE)	147.1	nu star (bias corrected)	93.27
MLE Mean (bias corrected)	0.44		
MLE Sd (bias corrected)	0.182	95% Percentile of Chisquare (2kstar)	20.57

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.209

Maximum	0.624	Median	0.143
SD	0.203	CV	0.973
k hat (MLE)	0.829	k star (bias corrected MLE)	0.746
Theta hat (MLE)	0.252	Theta star (bias corrected MLE)	0.28
nu hat (MLE)	36.46	nu star (bias corrected)	32.82
MLE Mean (bias corrected)	0.209	MLE Sd (bias corrected)	0.242
95% Percentile of Chisquare (2kstar)	4.963	90% Percentile	0.516
95% Percentile	0.695	99% Percentile	1.118

The following statistics are computed using Gamma ROS Statistics on Imputed Data

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	1.09	1.264	95% Approx. Gamma UPL	0.73	0.797
95% Gamma USL	1.275	1.519			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.266	SD (KM)	0.154
Variance (KM)	0.0237	SE of Mean (KM)	0.0351
k hat (KM)	2.98	k star (KM)	2.604
nu hat (KM)	131.1	nu star (KM)	114.6
theta hat (KM)	0.0892	theta star (KM)	0.102
80% gamma percentile (KM)	0.385	90% gamma percentile (KM)	0.486
95% gamma percentile (KM)	0.581	99% gamma percentile (KM)	0.788

The following statistics are computed using gamma distribution and KM estimates

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.682	0.693	95% Approx. Gamma UPL	0.543	0.544
95% KM Gamma Percentile	0.518	0.518	95% Gamma USL	0.749	0.766

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.908	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.175	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.249	Mean in Log Scale	-1.601
SD in Original Scale	0.172	SD in Log Scale	0.654
95% UTL95% Coverage	0.938	95% BCA UTL95% Coverage	0.622
95% Bootstrap (%) UTL95% Coverage	0.624	95% UPL (t)	0.638
90% Percentile (z)	0.467	95% Percentile (z)	0.592
99% Percentile (z)	0.924	95% USL	1.107

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-1.461	95% KM UTL (Lognormal)95% Coverage	0.735
KM SD of Logged Data	0.491	95% KM UPL (Lognormal)	0.55
95% KM Percentile Lognormal (z)	0.52	95% KM USL (Lognormal)	0.832

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.213	Mean in Log Scale	-1.898
SD in Original Scale	0.193	SD in Log Scale	0.82
95% UTL95% Coverage	1.029	95% UPL (t)	0.634
90% Percentile (z)	0.429	95% Percentile (z)	0.577
99% Percentile (z)	1.01	95% USL	1.267

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	22	95% UTL with95% Coverage	0.624
Approx, f used to compute achieved CC	1.158	imate Actual Confidence Coefficient achieved by UTL	0.676
Approximate Sample Size needed to achieve specified CC	59	95% UPL	0.617
95% USL	0.624	95% KM Chebyshev UPL	0.952

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.

Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

Result (arsenic)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
Minimum	1.51	First Quartile	4.805
Second Largest	13.6	Median	7.03
Maximum	14.2	Third Quartile	9.175
Mean	7.186	SD	3.427
Coefficient of Variation	0.477	Skewness	0.428
Mean of logged Data	1.842	SD of logged Data	0.56

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.349	d2max (for USL)	2.603

Normal GOF Test

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0796	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	15.24	90% Percentile (z)	11.58
95% UPL (t)	13.22	95% Percentile (z)	12.82
95% USL	16.11	99% Percentile (z)	15.16

Gamma GOF Test

A-D Test Statistic	0.178	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.747	etected data appear Gamma Distributed at 5% Significance Lev
K-S Test Statistic	0.0883	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.186	etected data appear Gamma Distributed at 5% Significance Lev

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.009	k star (bias corrected MLE)	3.493
Theta hat (MLE)	1.792	Theta star (bias corrected MLE)	2.057
nu hat (MLE)	176.4	nu star (bias corrected)	153.7
MLE Mean (bias corrected)	7.186	MLE Sd (bias corrected)	3.845

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	14.8	90% Percentile	12.34
95% Hawkins Wixley (HW) Approx. Gamma UPL	15.18	95% Percentile	14.45
95% WH Approx. Gamma UTL with 95% Coverage	18.58	99% Percentile	18.98
95% HW Approx. Gamma UTL with 95% Coverage	19.43		
95% WH USL	20.39	95% HW USL	21.51

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.116	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	23.52	90% Percentile (z)	12.94
95% UPL (t)	16.91	95% Percentile (z)	15.86
95% USL	27.11	99% Percentile (z)	23.22

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	22	95% UTL with 95% Coverage	14.2
Approx, f used to compute achieved CC	1.158	imate Actual Confidence Coefficient achieved by UTL	0.676
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	14.2	95% BCA Bootstrap UTL with 95% Coverage	14.2
95% UPL	14.11	90% Percentile	12.06
90% Chebyshev UPL	17.7	95% Percentile	13.54
95% Chebyshev UPL	22.46	99% Percentile	14.07
95% USL	14.2		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (cadmium)

General Statistics

Total Number of Observations	22	Number of Missing Observations	0
Number of Distinct Observations	15		
Number of Detects	7	Number of Non-Detects	15
Number of Distinct Detects	7	Number of Distinct Non-Detects	8
Minimum Detect	0.095	Minimum Non-Detect	0.0857
Maximum Detect	0.184	Maximum Non-Detect	0.0874
Variance Detected	0.00119	Percent Non-Detects	68.18%
Mean Detected	0.136	SD Detected	0.0344
Mean of Detected Logged Data	-2.024	SD of Detected Logged Data	0.261

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.349	d2max (for USL)	2.603

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.102	KM SD	0.0295
95% UTL95% Coverage	0.171	95% KM UPL (t)	0.154
90% KM Percentile (z)	0.14	95% KM Percentile (z)	0.15
99% KM Percentile (z)	0.17	95% KM USL	0.179

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.0726	SD	0.048
95% UTL95% Coverage	0.185	95% UPL (t)	0.157
90% Percentile (z)	0.134	95% Percentile (z)	0.152
99% Percentile (z)	0.184	95% USL	0.197

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.318	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.707	›etected data appear Gamma Distributed at 5% Significance Lev‹
K-S Test Statistic	0.19	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.312	›etected data appear Gamma Distributed at 5% Significance Lev‹

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	17.69	k star (bias corrected MLE)	10.21
Theta hat (MLE)	0.00769	Theta star (bias corrected MLE)	0.0133
nu hat (MLE)	247.7	nu star (bias corrected)	142.9
MLE Mean (bias corrected)	0.136		
MLE Sd (bias corrected)	0.0426	95% Percentile of Chisquare (2kstar)	31.93

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0646
Maximum	0.184	Median	0.0362
SD	0.0552	CV	0.856
k hat (MLE)	1.447	k star (bias corrected MLE)	1.28
Theta hat (MLE)	0.0446	Theta star (bias corrected MLE)	0.0504
nu hat (MLE)	63.66	nu star (bias corrected)	56.32
MLE Mean (bias corrected)	0.0646	MLE Sd (bias corrected)	0.0571
95% Percentile of Chisquare (2kstar)	7.036	90% Percentile	0.14
95% Percentile	0.177	99% Percentile	0.263

The following statistics are computed using Gamma ROS Statistics on Imputed Data
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.258	0.277	95% Approx. Gamma UPL	0.185	0.192
95% Gamma USL	0.294	0.322			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.102	SD (KM)	0.0295
Variance (KM)	8.7194E-4	SE of Mean (KM)	0.0068
k hat (KM)	11.86	k star (KM)	10.27
nu hat (KM)	521.9	nu star (KM)	452.1
theta hat (KM)	0.00857	theta star (KM)	0.0099
80% gamma percentile (KM)	0.127	90% gamma percentile (KM)	0.144
95% gamma percentile (KM)	0.159	99% gamma percentile (KM)	0.19

The following statistics are computed using gamma distribution and KM estimates
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.173	0.173	95% Approx. Gamma UPL	0.152	0.152
95% KM Gamma Percentile	0.148	0.148	95% Gamma USL	0.182	0.183

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.918	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.177	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.0803	Mean in Log Scale	-2.647
SD in Original Scale	0.0442	SD in Log Scale	0.497
95% UTL95% Coverage	0.228	95% BCA UTL95% Coverage	0.184
95% Bootstrap (%) UTL95% Coverage	0.184	95% UPL (t)	0.17
90% Percentile (z)	0.134	95% Percentile (z)	0.16
99% Percentile (z)	0.225	95% USL	0.258

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-2.319	95% KM UTL (Lognormal)95% Coverage	0.174
KM SD of Logged Data	0.243	95% KM UPL (Lognormal)	0.151
95% KM Percentile Lognormal (z)	0.147	95% KM USL (Lognormal)	0.185

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.0726	Mean in Log Scale	-2.789
SD in Original Scale	0.048	SD in Log Scale	0.553
95% UTL95% Coverage	0.225	95% UPL (t)	0.163
90% Percentile (z)	0.125	95% Percentile (z)	0.153
99% Percentile (z)	0.222	95% USL	0.259

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	22	95% UTL with95% Coverage	0.184

Approx, f used to compute achieved CC	1.158	imate Actual Confidence Coefficient achieved by UTL	0.676
Approximate Sample Size needed to achieve specified CC	59	95% UPL	0.181
95% USL	0.184	95% KM Chebyshev UPL	0.233

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (chromium)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
Minimum	1.37	First Quartile	2.993
Second Largest	8	Median	3.82
Maximum	9.13	Third Quartile	4.625
Mean	4.094	SD	1.981
Coefficient of Variation	0.484	Skewness	1.258
Mean of logged Data	1.307	SD of logged Data	0.463

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.349	d2max (for USL)	2.603

Normal GOF Test

Shapiro Wilk Test Statistic	0.878	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.193	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	8.747	90% Percentile (z)	6.633
95% UPL (t)	7.579	95% Percentile (z)	7.352
95% USL	9.25	99% Percentile (z)	8.703

Gamma GOF Test

A-D Test Statistic	0.397	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	)etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.139	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.186	)etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.036	k star (bias corrected MLE)	4.38
Theta hat (MLE)	0.813	Theta star (bias corrected MLE)	0.935
nu hat (MLE)	221.6	nu star (bias corrected)	192.7
MLE Mean (bias corrected)	4.094	MLE Sd (bias corrected)	1.956

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	7.896	90% Percentile	6.715
95% Hawkins Wixley (HW) Approx. Gamma UPL	7.981	95% Percentile	7.749
95% WH Approx. Gamma UTL with 95% Coverage	9.727	99% Percentile	9.95
95% HW Approx. Gamma UTL with 95% Coverage	9.959		
95% WH USL	10.59	95% HW USL	10.92

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.125	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	10.97	90% Percentile (z)	6.689
95% UPL (t)	8.346	95% Percentile (z)	7.915
95% USL	12.34	99% Percentile (z)	10.85

Nonparametric Distribution Free Background Statistics

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	22	95% UTL with 95% Coverage	9.13
Approx, f used to compute achieved CC	1.158	imate Actual Confidence Coefficient achieved by UTL	0.676
		ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	9.13	95% BCA Bootstrap UTL with 95% Coverage	9.13
95% UPL	8.961	90% Percentile	7.499
90% Chebyshev UPL	10.17	95% Percentile	7.989
95% Chebyshev UPL	12.92	99% Percentile	8.893
95% USL	9.13		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (copper)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
Minimum	2.46	First Quartile	3.885
Second Largest	19	Median	5.57
Maximum	22	Third Quartile	9.41
Mean	7.583	SD	5.418
Coefficient of Variation	0.714	Skewness	1.464
Mean of logged Data	1.821	SD of logged Data	0.636

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.349	d2max (for USL)	2.603

Normal GOF Test

Shapiro Wilk Test Statistic	0.819	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.248	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	20.31	90% Percentile (z)	14.53
95% UPL (t)	17.11	95% Percentile (z)	16.49
95% USL	21.68	99% Percentile (z)	20.19

Gamma GOF Test

A-D Test Statistic	0.685	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.752	etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.191	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.187	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.591	k star (bias corrected MLE)	2.268
Theta hat (MLE)	2.926	Theta star (bias corrected MLE)	3.343
nu hat (MLE)	114	nu star (bias corrected)	99.81
MLE Mean (bias corrected)	7.583	MLE Sd (bias corrected)	5.035

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	17.75	90% Percentile	14.32
95% Hawkins Wixley (HW) Approx. Gamma UPL	17.95	95% Percentile	17.29
95% WH Approx. Gamma UTL with 95% Coverage	23.24	99% Percentile	23.83
95% HW Approx. Gamma UTL with 95% Coverage	24		
95% WH USL	25.92	95% HW USL	27.03

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.149	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	27.53	90% Percentile (z)	13.96
95% UPL (t)	18.92	95% Percentile (z)	17.59
95% USL	32.36	99% Percentile (z)	27.14

Nonparametric Distribution Free Background Statistics

Data appear Approximate Gamma Distribution at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	22	95% UTL with 95% Coverage	22
Approx, f used to compute achieved CC	1.158	imate Actual Confidence Coefficient achieved by UTL	0.676
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	22	95% BCA Bootstrap UTL with 95% Coverage	22
95% UPL	21.55	90% Percentile	14.34
90% Chebyshev UPL	24.2	95% Percentile	18.77
95% Chebyshev UPL	31.73	99% Percentile	21.37
95% USL	22		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (lead)

General Statistics

Total Number of Observations	21	Number of Distinct Observations	21
Minimum	5.11	First Quartile	8.17
Second Largest	22.1	Median	9.03
Maximum	30.9	Third Quartile	13
Mean	11.53	SD	6.161
Coefficient of Variation	0.535	Skewness	1.913
Mean of logged Data	2.34	SD of logged Data	0.445

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.371	d2max (for USL)	2.58

Normal GOF Test

Shapiro Wilk Test Statistic	0.799	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.223	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	26.14	90% Percentile (z)	19.42
95% UPL (t)	22.4	95% Percentile (z)	21.66
95% USL	27.43	99% Percentile (z)	25.86

Gamma GOF Test

A-D Test Statistic	0.779	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.193	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.19	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.94	k star (bias corrected MLE)	4.266
Theta hat (MLE)	2.333	Theta star (bias corrected MLE)	2.702
nu hat (MLE)	207.5	nu star (bias corrected)	179.2

MLE Mean (bias corrected)	11.53	MLE Sd (bias corrected)	5.581

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	22.37	90% Percentile	19
95% Hawkins Wixley (HW) Approx. Gamma UPL	22.43	95% Percentile	21.97
95% WH Approx. Gamma UTL with 95% Coverage	27.75	99% Percentile	28.28
95% HW Approx. Gamma UTL with 95% Coverage	28.15		
95% WH USL	29.8	95% HW USL	30.36

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.908	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.17	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.188	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	29.83	90% Percentile (z)	18.37
95% UPL (t)	22.78	95% Percentile (z)	21.59
95% USL	32.75	99% Percentile (z)	29.25

Nonparametric Distribution Free Background Statistics

Data appear Lognormal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	21	95% UTL with 95% Coverage	30.9
Approx, f used to compute achieved CC	1.105	imate Actual Confidence Coefficient achieved by UTL	0.659
		ɔximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	30.9	95% BCA Bootstrap UTL with 95% Coverage	30.9
95% UPL	30.02	90% Percentile	18.9
90% Chebyshev UPL	30.45	95% Percentile	22.1
95% Chebyshev UPL	39.02	99% Percentile	29.14
95% USL	30.9		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (manganese)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
Minimum	111	First Quartile	183
Second Largest	406	Median	252
Maximum	474	Third Quartile	306.8
Mean	253.4	SD	95.02
Coefficient of Variation	0.375	Skewness	0.761
Mean of logged Data	5.469	SD of logged Data	0.377

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.396	d2max (for USL)	2.557

Normal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.151	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	481	90% Percentile (z)	375.1
95% UPL (t)	421.7	95% Percentile (z)	409.6
95% USL	496.3	99% Percentile (z)	474.4

Gamma GOF Test

A-D Test Statistic	0.254	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.743	)etected data appear Gamma Distributed at 5% Significance Leve	
K-S Test Statistic	0.103	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.194	)etected data appear Gamma Distributed at 5% Significance Leve	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.712	k star (bias corrected MLE)	6.589
Theta hat (MLE)	32.85	Theta star (bias corrected MLE)	38.45
nu hat (MLE)	308.5	nu star (bias corrected)	263.6
MLE Mean (bias corrected)	253.4	MLE Sd (bias corrected)	98.7

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	441.9	90% Percentile	385.2
95% Hawkins Wixley (HW) Approx. Gamma UPL	446.1	95% Percentile	434.5
95% WH Approx. Gamma UTL with 95% Coverage	532.1	99% Percentile	537.3
95% HW Approx. Gamma UTL with 95% Coverage	542.6		
95% WH USL	557.1	95% HW USL	569.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.11	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.192	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	584.7	90% Percentile (z)	384.3
95% UPL (t)	462.2	95% Percentile (z)	440.6
95% USL	621.2	99% Percentile (z)	569.6

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	20	95% UTL with 95% Coverage	474
Approx, f used to compute achieved CC	1.053	imate Actual Confidence Coefficient achieved by UTL	0.642
		oximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	474	95% BCA Bootstrap UTL with 95% Coverage	474
95% UPL	470.6	90% Percentile	405.1
90% Chebyshev UPL	545.4	95% Percentile	409.4
95% Chebyshev UPL	677.8	99% Percentile	461.1
95% USL	474		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (selenium)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
Minimum	0.214	First Quartile	0.327
Second Largest	0.832	Median	0.516
Maximum	0.877	Third Quartile	0.602
Mean	0.499	SD	0.197
Coefficient of Variation	0.395	Skewness	0.233
Mean of logged Data	-0.777	SD of logged Data	0.429

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.349	d2max (for USL)	2.603

Normal GOF Test

Shapiro Wilk Test Statistic	0.958	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data appear Normal at 5% Significance Level	

Lilliefors Test Statistic	0.101	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	0.962	90% Percentile (z)	0.752
95% UPL (t)	0.846	95% Percentile (z)	0.823
95% USL	1.012	99% Percentile (z)	0.958

Gamma GOF Test

A-D Test Statistic	0.358	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	)etected data appear Gamma Distributed at 5% Significance Leve
K-S Test Statistic	0.122	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.186	)etected data appear Gamma Distributed at 5% Significance Leve

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.23	k star (bias corrected MLE)	5.41
Theta hat (MLE)	0.0801	Theta star (bias corrected MLE)	0.0923
nu hat (MLE)	274.1	nu star (bias corrected)	238.1
MLE Mean (bias corrected)	0.499	MLE Sd (bias corrected)	0.215

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.913	90% Percentile	0.786
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.926	95% Percentile	0.896
95% WH Approx. Gamma UTL with 95% Coverage	1.106	99% Percentile	1.128
95% HW Approx. Gamma UTL with 95% Coverage	1.136		
95% WH USL	1.197	95% HW USL	1.237

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.146	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	1.259	90% Percentile (z)	0.797
95% UPL (t)	0.978	95% Percentile (z)	0.931
95% USL	1.404	99% Percentile (z)	1.247

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	22	95% UTL with 95% Coverage	0.877
Approx, f used to compute achieved CC	1.158	imate Actual Confidence Coefficient achieved by UTL	0.676
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	0.877	95% BCA Bootstrap UTL with 95% Coverage	0.877
95% UPL	0.87	90% Percentile	0.763
90% Chebyshev UPL	1.104	95% Percentile	0.829
95% Chebyshev UPL	1.378	99% Percentile	0.868
95% USL	0.877		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (zinc)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
Minimum	11.3	First Quartile	15.63
Second Largest	44.8	Median	23.05
Maximum	48.8	Third Quartile	34.6

Mean	26.1	SD	11.43
Coefficient of Variation	0.438	Skewness	0.442
Mean of logged Data	3.167	SD of logged Data	0.452

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.349	d2max (for USL)	2.603

Normal GOF Test

Shapiro Wilk Test Statistic	0.923	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.152	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	52.96	90% Percentile (z)	40.75
95% UPL (t)	46.22	95% Percentile (z)	44.91
95% USL	55.86	99% Percentile (z)	52.7

Gamma GOF Test

A-D Test Statistic	0.575	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	)etected data appear Gamma Distributed at 5% Significance Lev
K-S Test Statistic	0.158	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.186	)etected data appear Gamma Distributed at 5% Significance Lev

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.416	k star (bias corrected MLE)	4.708
Theta hat (MLE)	4.819	Theta star (bias corrected MLE)	5.544
nu hat (MLE)	238.3	nu star (bias corrected)	207.1
MLE Mean (bias corrected)	26.1	MLE Sd (bias corrected)	12.03

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	49.48	90% Percentile	42.21
95% Hawkins Wixley (HW) Approx. Gamma UPL	50.12	95% Percentile	48.51
95% WH Approx. Gamma UTL with 95% Coverage	60.61	99% Percentile	61.85
95% HW Approx. Gamma UTL with 95% Coverage	62.19		
95% WH USL	65.87	95% HW USL	68.01

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	68.61	90% Percentile (z)	42.35
95% UPL (t)	52.56	95% Percentile (z)	49.91
95% USL	76.94	99% Percentile (z)	67.91

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	22	95% UTL with 95% Coverage	48.8
Approx, f used to compute achieved CC	1.158	imate Actual Confidence Coefficient achieved by UTL	0.676
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	48.8	95% BCA Bootstrap UTL with 95% Coverage	48.8
95% UPL	48.2	90% Percentile	41.07
90% Chebyshev UPL	61.17	95% Percentile	44.63
95% Chebyshev UPL	77.06	99% Percentile	47.96
95% USL	48.8		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.

The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

Background Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/21/2021 8:40:42 PM
From File	proucl_data_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Observations	1
Number of Bootstrap Operations	2000

Result (antimony)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Minimum	0.226	First Quartile	2.086
Second Largest	20.3	Median	8.46
Maximum	33.7	Third Quartile	15.45
Mean	10.33	SD	10.01
Coefficient of Variation	0.969	Skewness	1.146
Mean of logged Data	1.553	SD of logged Data	1.647

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.156	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	37.73	90% Percentile (z)	23.16
95% UPL (t)	29.05	95% Percentile (z)	26.8
95% USL	33.21	99% Percentile (z)	33.62

Gamma GOF Test

A-D Test Statistic	0.324	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.765	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.146	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.763	k star (bias corrected MLE)	0.628
Theta hat (MLE)	13.54	Theta star (bias corrected MLE)	16.45
nu hat (MLE)	18.32	nu star (bias corrected)	15.07
MLE Mean (bias corrected)	10.33	MLE Sd (bias corrected)	13.04

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	41.52	90% Percentile	26.6
95% Hawkins Wixley (HW) Approx. Gamma UPL	47.2	95% Percentile	36.57
95% WH Approx. Gamma UTL with 95% Coverage	73.67	99% Percentile	60.6
95% HW Approx. Gamma UTL with 95% Coverage	92.77		
95% WH USL	55.42	95% HW USL	66.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.89	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.194	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	427.5	90% Percentile (z)	38.98
95% UPL (t)	102.6	95% Percentile (z)	70.9
95% USL	203.4	99% Percentile (z)	217.8

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	12	95% UTL with 95% Coverage	33.7
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	33.7	95% BCA Bootstrap UTL with 95% Coverage	33.7
95% UPL	33.7	90% Percentile	19.92
90% Chebyshev UPL	41.6	95% Percentile	26.33
95% Chebyshev UPL	55.76	99% Percentile	32.23
95% USL	33.7		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (arsenic)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Minimum	31.3	First Quartile	628
Second Largest	6440	Median	1320
Maximum	7100	Third Quartile	3710
Mean	2398	SD	2457
Coefficient of Variation	1.025	Skewness	0.986
Mean of logged Data	6.918	SD of logged Data	1.746

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test

Shapiro Wilk Test Statistic	0.859	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.237	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	9122	90% Percentile (z)	5547
95% UPL (t)	6992	95% Percentile (z)	6440
95% USL	8013	99% Percentile (z)	8115

Gamma GOF Test

A-D Test Statistic	0.259	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.77	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.133	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.256	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.699	k star (bias corrected MLE)	0.58
Theta hat (MLE)	3430	Theta star (bias corrected MLE)	4135
nu hat (MLE)	16.78	nu star (bias corrected)	13.92
MLE Mean (bias corrected)	2398	MLE Sd (bias corrected)	3149

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	9916	90% Percentile	6285
95% Hawkins Wixley (HW) Approx. Gamma UPL	11301	95% Percentile	8736
95% WH Approx. Gamma UTL with 95% Coverage	17851	99% Percentile	14682
95% HW Approx. Gamma UTL with 95% Coverage	22638		
95% WH USL	13337	95% HW USL	16009

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.194	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	119976	90% Percentile (z)	9467
95% UPL (t)	26413	95% Percentile (z)	17852
95% USL	54585	99% Percentile (z)	58676

Nonparametric Distribution Free Background Statistics

Data appear Approximate Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	12	95% UTL with 95% Coverage	7100
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	7100	95% BCA Bootstrap UTL with 95% Coverage	7100
95% UPL	7100	90% Percentile	6242
90% Chebyshev UPL	10071	95% Percentile	6737
95% Chebyshev UPL	13547	99% Percentile	7027
95% USL	7100		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (cadmium)

General Statistics

Total Number of Observations	12	Number of Missing Observations	0
Number of Distinct Observations	11		
Number of Detects	10	Number of Non-Detects	2
Number of Distinct Detects	9	Number of Distinct Non-Detects	2
Minimum Detect	0.131	Minimum Non-Detect	0.0871
Maximum Detect	0.81	Maximum Non-Detect	0.0873
Variance Detected	0.045	Percent Non-Detects	16.67%
Mean Detected	0.477	SD Detected	0.212
Mean of Detected Logged Data	-0.851	SD of Detected Logged Data	0.535

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.175	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.412	KM SD	0.234
95% UTL95% Coverage	1.053	95% KM UPL (t)	0.85
90% KM Percentile (z)	0.712	95% KM Percentile (z)	0.797
99% KM Percentile (z)	0.957	95% KM USL	0.947

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.405	SD	0.256
95% UTL95% Coverage	1.104	95% UPL (t)	0.882
90% Percentile (z)	0.732	95% Percentile (z)	0.825
99% Percentile (z)	0.999	95% USL	0.989

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.285	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.182	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.268	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.687	k star (bias corrected MLE)	3.347
Theta hat (MLE)	0.102	Theta star (bias corrected MLE)	0.142
nu hat (MLE)	93.74	nu star (bias corrected)	66.95
MLE Mean (bias corrected)	0.477		
MLE Sd (bias corrected)	0.261	95% Percentile of Chisquare (2kstar)	13.62

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.087	Mean	0.412
Maximum	0.81	Median	0.397
SD	0.245	CV	0.594
k hat (MLE)	2.335	k star (bias corrected MLE)	1.806
Theta hat (MLE)	0.176	Theta star (bias corrected MLE)	0.228
nu hat (MLE)	56.03	nu star (bias corrected)	43.36
MLE Mean (bias corrected)	0.412	MLE Sd (bias corrected)	0.307
95% Percentile of Chisquare (2kstar)	8.853	90% Percentile	0.821
95% Percentile	1.01	99% Percentile	1.431

The following statistics are computed using Gamma ROS Statistics on Imputed Data

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	1.615	1.78	95% Approx. Gamma UPL	1.081	1.138
95% Gamma USL	1.319	1.42			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.412	SD (KM)	0.234
Variance (KM)	0.0549	SE of Mean (KM)	0.0713
k hat (KM)	3.092	k star (KM)	2.375
nu hat (KM)	74.22	nu star (KM)	57
theta hat (KM)	0.133	theta star (KM)	0.173
80% gamma percentile (KM)	0.604	90% gamma percentile (KM)	0.77
95% gamma percentile (KM)	0.927	99% gamma percentile (KM)	1.27

The following statistics are computed using gamma distribution and KM estimates

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	1.534	1.681	95% Approx. Gamma UPL	1.039	1.089
95% KM Gamma Percentile	0.931	0.966	95% Gamma USL	1.261	1.349

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.219	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.419	Mean in Log Scale	-1.049
SD in Original Scale	0.235	SD in Log Scale	0.671
95% UTL95% Coverage	2.193	95% BCA UTL95% Coverage	0.81
95% Bootstrap (%) UTL95% Coverage	0.81	95% UPL (t)	1.226
90% Percentile (z)	0.827	95% Percentile (z)	1.055
99% Percentile (z)	1.666	95% USL	1.62

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-1.116	95% KM UTL (Lognormal)95% Coverage	2.566
KM SD of Logged Data	0.752	95% KM UPL (Lognormal)	1.337

95% KM Percentile Lognormal (z)	1.129	95% KM USL (Lognormal)	1.828

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.405	Mean in Log Scale	-1.231
SD in Original Scale	0.256	SD in Log Scale	1.012
95% UTL95% Coverage	4.648	95% UPL (t)	1.934
90% Percentile (z)	1.067	95% Percentile (z)	1.542
99% Percentile (z)	3.071	95% USL	2.945

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	12	95% UTL with95% Coverage	0.81
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
Approximate Sample Size needed to achieve specified CC	59	95% UPL	0.81
95% USL	0.81	95% KM Chebyshev UPL	1.475

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (chromium)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Minimum	2.25	First Quartile	4.92
Second Largest	10.5	Median	6.65
Maximum	11.9	Third Quartile	8.515
Mean	6.905	SD	2.736
Coefficient of Variation	0.396	Skewness	0.242
Mean of logged Data	1.848	SD of logged Data	0.452

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0985	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	14.39	90% Percentile (z)	10.41
95% UPL (t)	12.02	95% Percentile (z)	11.4
95% USL	13.16	99% Percentile (z)	13.27

Gamma GOF Test

A-D Test Statistic	0.167	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.732	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.104	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.246	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.132	k star (bias corrected MLE)	4.654
Theta hat (MLE)	1.126	Theta star (bias corrected MLE)	1.484
nu hat (MLE)	147.2	nu star (bias corrected)	111.7
MLE Mean (bias corrected)	6.905	MLE Sd (bias corrected)	3.201

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	13.32	90% Percentile	11.19
95% Hawkins Wixley (HW) Approx. Gamma UPL	13.6	95% Percentile	12.87

95% WH Approx. Gamma UTL with 95% Coverage	17.62	99% Percentile	16.43
95% HW Approx. Gamma UTL with 95% Coverage	18.39		
95% WH USL	15.28	95% HW USL	15.76

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.128	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	21.88	90% Percentile (z)	11.34
95% UPL (t)	14.79	95% Percentile (z)	13.36
95% USL	17.84	99% Percentile (z)	18.18

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	12	95% UTL with 95% Coverage	11.9
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	11.9	95% BCA Bootstrap UTL with 95% Coverage	11.9
95% UPL	11.9	90% Percentile	10.32
90% Chebyshev UPL	15.45	95% Percentile	11.13
95% Chebyshev UPL	19.32	99% Percentile	11.75
95% USL	11.9		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (copper)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Minimum	16.5	First Quartile	111.6
Second Largest	633	Median	195.5
Maximum	690	Third Quartile	372.8
Mean	274.4	SD	223
Coefficient of Variation	0.813	Skewness	0.895
Mean of logged Data	5.219	SD of logged Data	1.059

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test

Shapiro Wilk Test Statistic	0.892	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.192	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	884.5	90% Percentile (z)	560.2
95% UPL (t)	691.2	95% Percentile (z)	641.2
95% USL	783.9	99% Percentile (z)	793.2

Gamma GOF Test

A-D Test Statistic	0.158	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.104	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.25	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.408	k star (bias corrected MLE)	1.112
Theta hat (MLE)	194.8	Theta star (bias corrected MLE)	246.8
nu hat (MLE)	33.8	nu star (bias corrected)	26.68
MLE Mean (bias corrected)	274.4	MLE Sd (bias corrected)	260.2

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	864.5	90% Percentile	615.5
95% Hawkins Wixley (HW) Approx. Gamma UPL	926	95% Percentile	791.9
95% WH Approx. Gamma UTL with 95% Coverage	1390	99% Percentile	1199
95% HW Approx. Gamma UTL with 95% Coverage	1588		
95% WH USL	1096	95% HW USL	1210

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.117	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	3353	90% Percentile (z)	718.2
95% UPL (t)	1339	95% Percentile (z)	1055
95% USL	2079	99% Percentile (z)	2172

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	12	95% UTL with 95% Coverage	690
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	690	95% BCA Bootstrap UTL with 95% Coverage	690
95% UPL	690	90% Percentile	619.5
90% Chebyshev UPL	970.7	95% Percentile	658.7
95% Chebyshev UPL	1286	99% Percentile	683.7
95% USL	690		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (lead)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Minimum	57.5	First Quartile	3265
Second Largest	24900	Median	6165
Maximum	27000	Third Quartile	10258
Mean	8820	SD	8759
Coefficient of Variation	0.993	Skewness	1.398
Mean of logged Data	8.423	SD of logged Data	1.612

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test

Shapiro Wilk Test Statistic	0.815	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.223	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	32785	90% Percentile (z)	20045
95% UPL (t)	25193	95% Percentile (z)	23228
95% USL	28834	99% Percentile (z)	29197

Gamma GOF Test

A-D Test Statistic	0.292	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.761	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.128	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.253	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.885	k star (bias corrected MLE)	0.719
Theta hat (MLE)	9966	Theta star (bias corrected MLE)	12262
nu hat (MLE)	21.24	nu star (bias corrected)	17.26
MLE Mean (bias corrected)	8820	MLE Sd (bias corrected)	10399

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	32586	90% Percentile	21998
95% Hawkins Wixley (HW) Approx. Gamma UPL	36750	95% Percentile	29727
95% WH Approx. Gamma UTL with 95% Coverage	55903	99% Percentile	48137
95% HW Approx. Gamma UTL with 95% Coverage	69169		
95% WH USL	42729	95% HW USL	50398

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.202	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	374590	90% Percentile (z)	35912
95% UPL (t)	92616	95% Percentile (z)	64506
95% USL	181034	99% Percentile (z)	193527

Nonparametric Distribution Free Background Statistics

Data appear Approximate Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	12	95% UTL with 95% Coverage	27000
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	27000	95% BCA Bootstrap UTL with 95% Coverage	27000
95% UPL	27000	90% Percentile	23690
90% Chebyshev UPL	36171	95% Percentile	25845
95% Chebyshev UPL	48560	99% Percentile	26769
95% USL	27000		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (manganese)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	11
Minimum	765	First Quartile	95375
Second Largest	313000	Median	205500
Maximum	341000	Third Quartile	256250
Mean	181172	SD	115958
Coefficient of Variation	0.64	Skewness	-0.383
Mean of logged Data	11.48	SD of logged Data	1.773

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.207	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	498434	90% Percentile (z)	329779
95% UPL (t)	397923	95% Percentile (z)	371907
95% USL	446132	99% Percentile (z)	450932

Gamma GOF Test

A-D Test Statistic	1.13	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.759	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.326	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.253	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.933	k star (bias corrected MLE)	0.756
Theta hat (MLE)	194092	Theta star (bias corrected MLE)	239763
nu hat (MLE)	22.4	nu star (bias corrected)	18.14
MLE Mean (bias corrected)	181172	MLE Sd (bias corrected)	208419

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	660147	90% Percentile	446608
95% Hawkins Wixley (HW) Approx. Gamma UPL	786175	95% Percentile	599897
95% WH Approx. Gamma UTL with 95% Coverage	1110566	99% Percentile	963543
95% HW Approx. Gamma UTL with 95% Coverage	1468252		
95% WH USL	856810	95% HW USL	1073809

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.699	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.317	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.243	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	12419193	90% Percentile (z)	942182
95% UPL (t)	2670853	95% Percentile (z)	1794261
95% USL	5581833	99% Percentile (z)	6006920

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	12	95% UTL with 95% Coverage	341000
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	341000	95% BCA Bootstrap UTL with 95% Coverage	341000
95% UPL	341000	90% Percentile	311600
90% Chebyshev UPL	543252	95% Percentile	325600
95% Chebyshev UPL	707262	99% Percentile	337920
95% USL	341000		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Result (selenium)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Minimum	0.264	First Quartile	0.345
Second Largest	0.919	Median	0.432
Maximum	1.07	Third Quartile	0.514
Mean	0.504	SD	0.252
Coefficient of Variation	0.5	Skewness	1.511
Mean of logged Data	-0.78	SD of logged Data	0.432

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test

Shapiro Wilk Test Statistic	0.81	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.297	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	1.192	90% Percentile (z)	0.826
95% UPL (t)	0.974	95% Percentile (z)	0.917
95% USL	1.078	99% Percentile (z)	1.089

Gamma GOF Test

A-D Test Statistic	0.607	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.732	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.249	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.246	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.497	k star (bias corrected MLE)	4.179
Theta hat (MLE)	0.0916	Theta star (bias corrected MLE)	0.12
nu hat (MLE)	131.9	nu star (bias corrected)	100.3
MLE Mean (bias corrected)	0.504	MLE Sd (bias corrected)	0.246

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.999	90% Percentile	0.834
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.005	95% Percentile	0.965
95% WH Approx. Gamma UTL with 95% Coverage	1.338	99% Percentile	1.245
95% HW Approx. Gamma UTL with 95% Coverage	1.369		
95% WH USL	1.153	95% HW USL	1.169

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.219	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	1.495	90% Percentile (z)	0.798
95% UPL (t)	1.028	95% Percentile (z)	0.933
95% USL	1.231	99% Percentile (z)	1.253

Nonparametric Distribution Free Background Statistics

Data appear Approximate Gamma Distribution at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	12	95% UTL with 95% Coverage	1.07
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	1.07	95% BCA Bootstrap UTL with 95% Coverage	1.07
95% UPL	1.07	90% Percentile	0.891
90% Chebyshev UPL	1.289	95% Percentile	0.987
95% Chebyshev UPL	1.645	99% Percentile	1.053

95% USL	1.07

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

Result (zinc)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Minimum	109	First Quartile	233
Second Largest	1190	Median	522
Maximum	1310	Third Quartile	834.3
Mean	578.4	SD	407
Coefficient of Variation	0.704	Skewness	0.585
Mean of logged Data	6.082	SD of logged Data	0.832

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.736	d2max (for USL)	2.285

Normal GOF Test

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.171	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	1692	90% Percentile (z)	1100
95% UPL (t)	1339	95% Percentile (z)	1248
95% USL	1508	99% Percentile (z)	1525

Gamma GOF Test

A-D Test Statistic	0.282	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.249	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.944	k star (bias corrected MLE)	1.513
Theta hat (MLE)	297.6	Theta star (bias corrected MLE)	382.2
nu hat (MLE)	46.65	nu star (bias corrected)	36.32
MLE Mean (bias corrected)	578.4	MLE Sd (bias corrected)	470.2

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	1621	90% Percentile	1203
95% Hawkins Wixley (HW) Approx. Gamma UPL	1697	95% Percentile	1502
95% WH Approx. Gamma UTL with 95% Coverage	2488	99% Percentile	2178
95% HW Approx. Gamma UTL with 95% Coverage	2735		
95% WH USL	2006	95% HW USL	2148

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.18	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	4261	90% Percentile (z)	1271
95% UPL (t)	2072	95% Percentile (z)	1719
95% USL	2928	99% Percentile (z)	3031

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

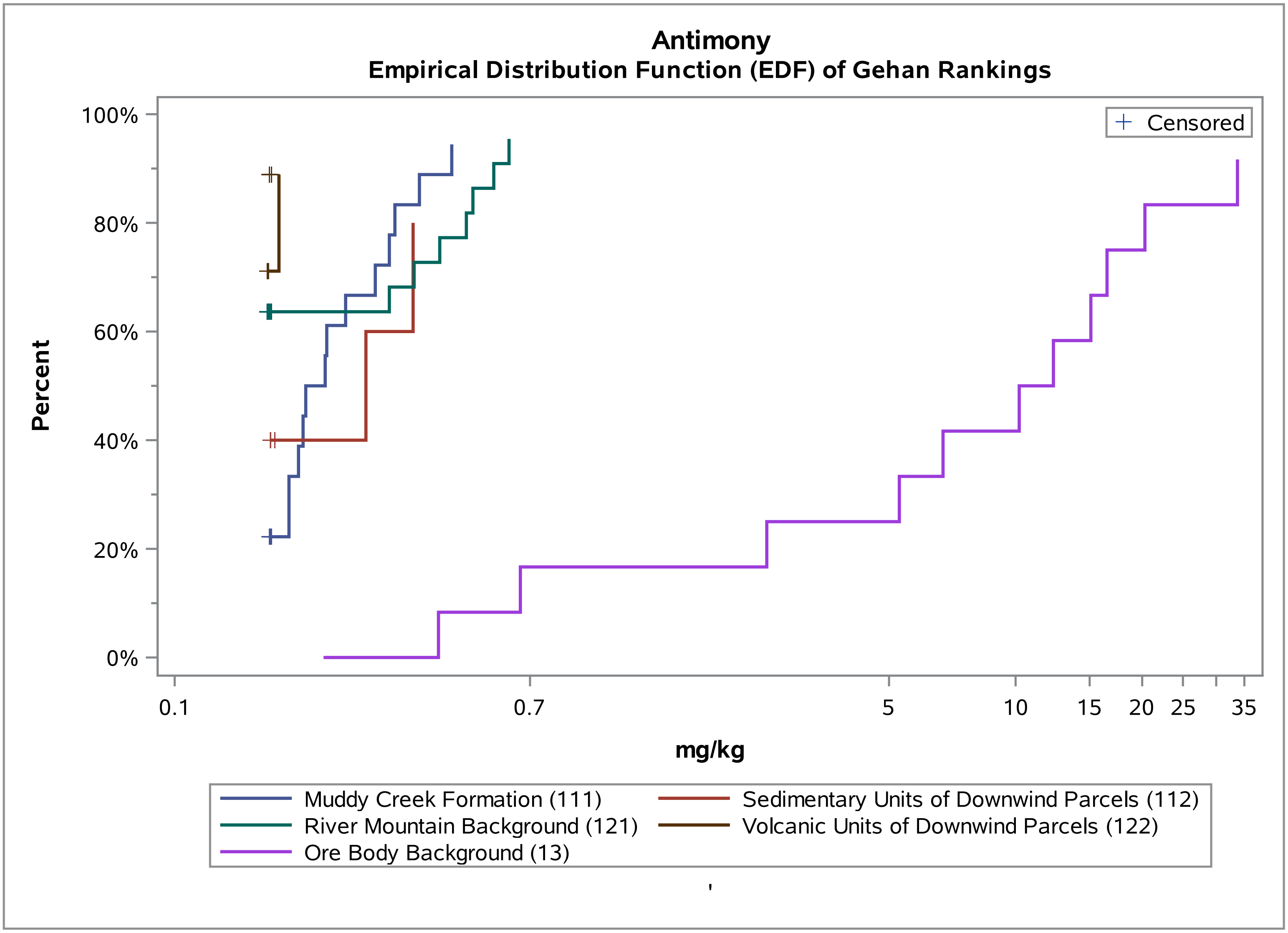
Nonparametric Upper Limits for Background Threshold Values

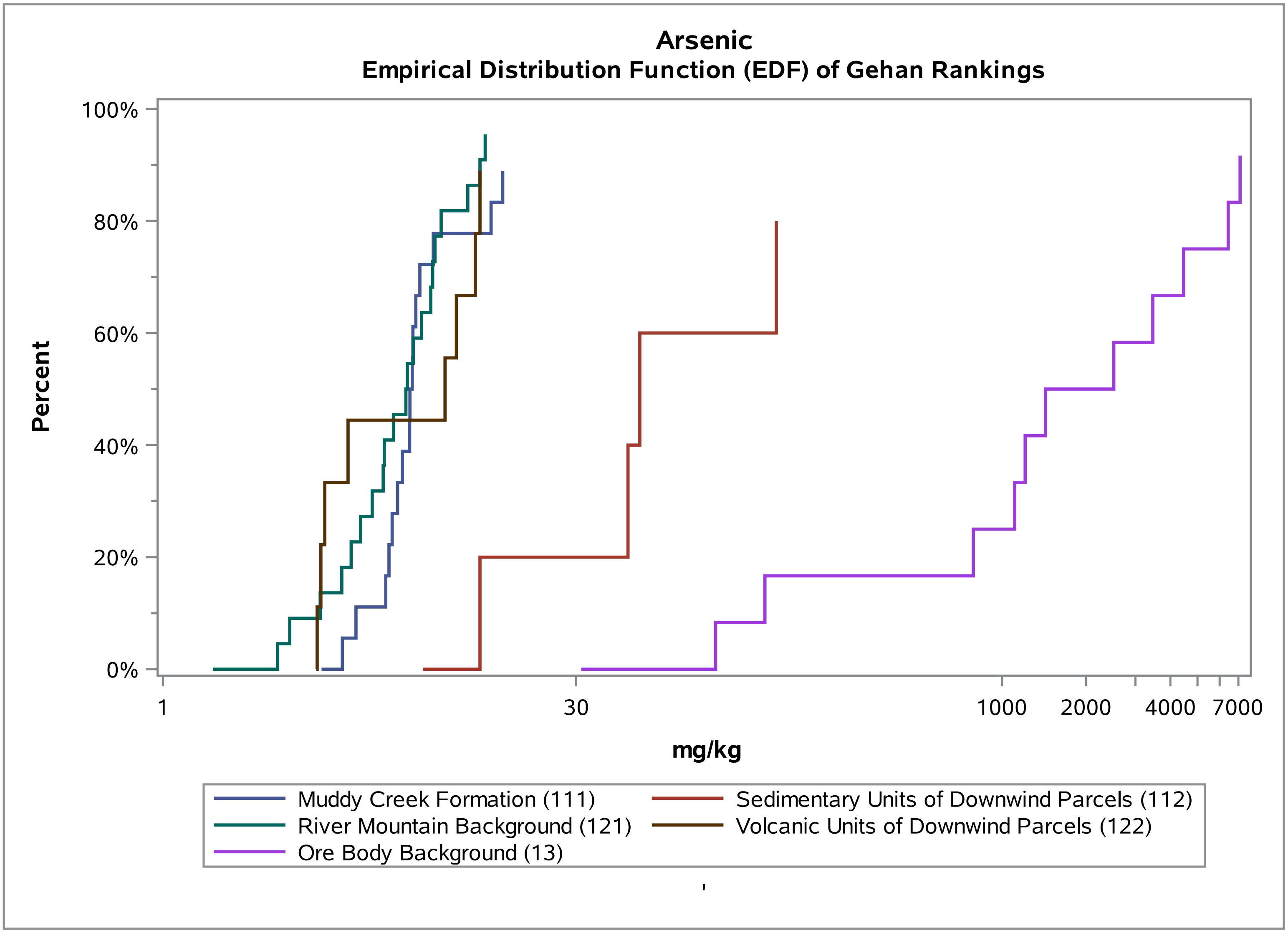
Order of Statistic, r	12	95% UTL with 95% Coverage	1310
Approx, f used to compute achieved CC	0.632	imate Actual Confidence Coefficient achieved by UTL	0.46
		›ximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	1310	95% BCA Bootstrap UTL with 95% Coverage	1310
95% UPL	1310	90% Percentile	1158
90% Chebyshev UPL	1849	95% Percentile	1244
95% Chebyshev UPL	2425	99% Percentile	1297
95% USL	1310		

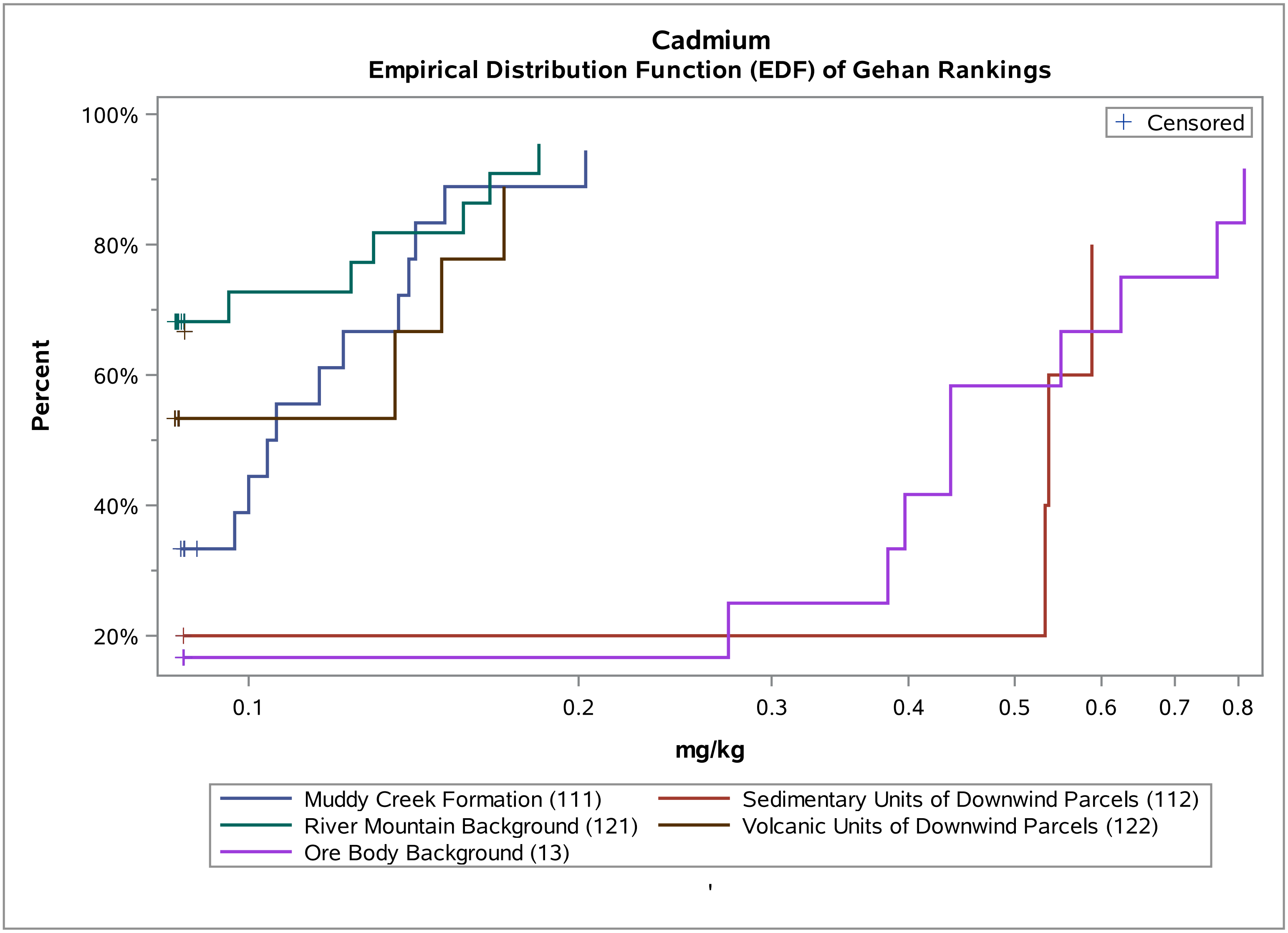
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

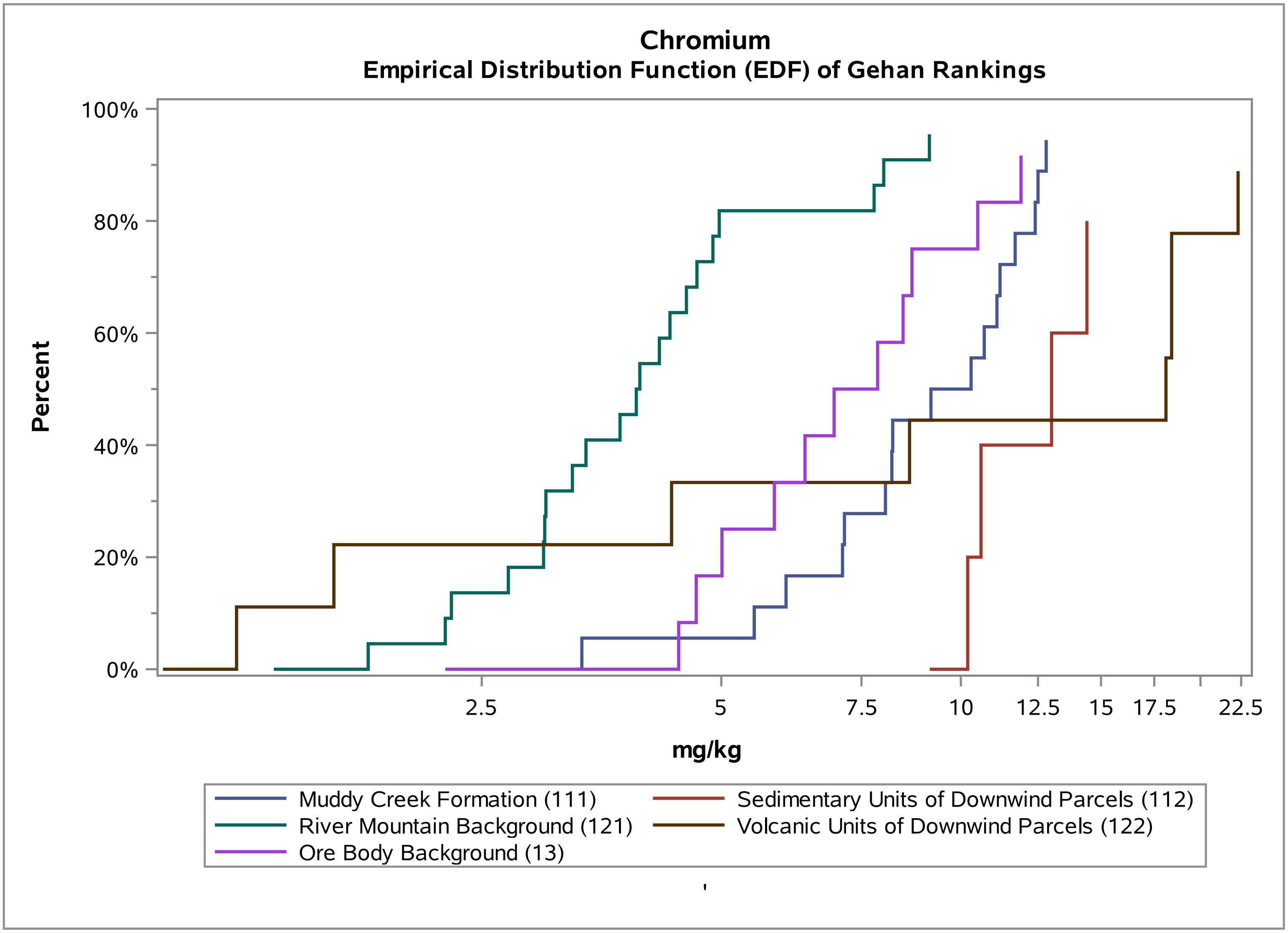
APPENDIX E

Empirical Distribution Functions

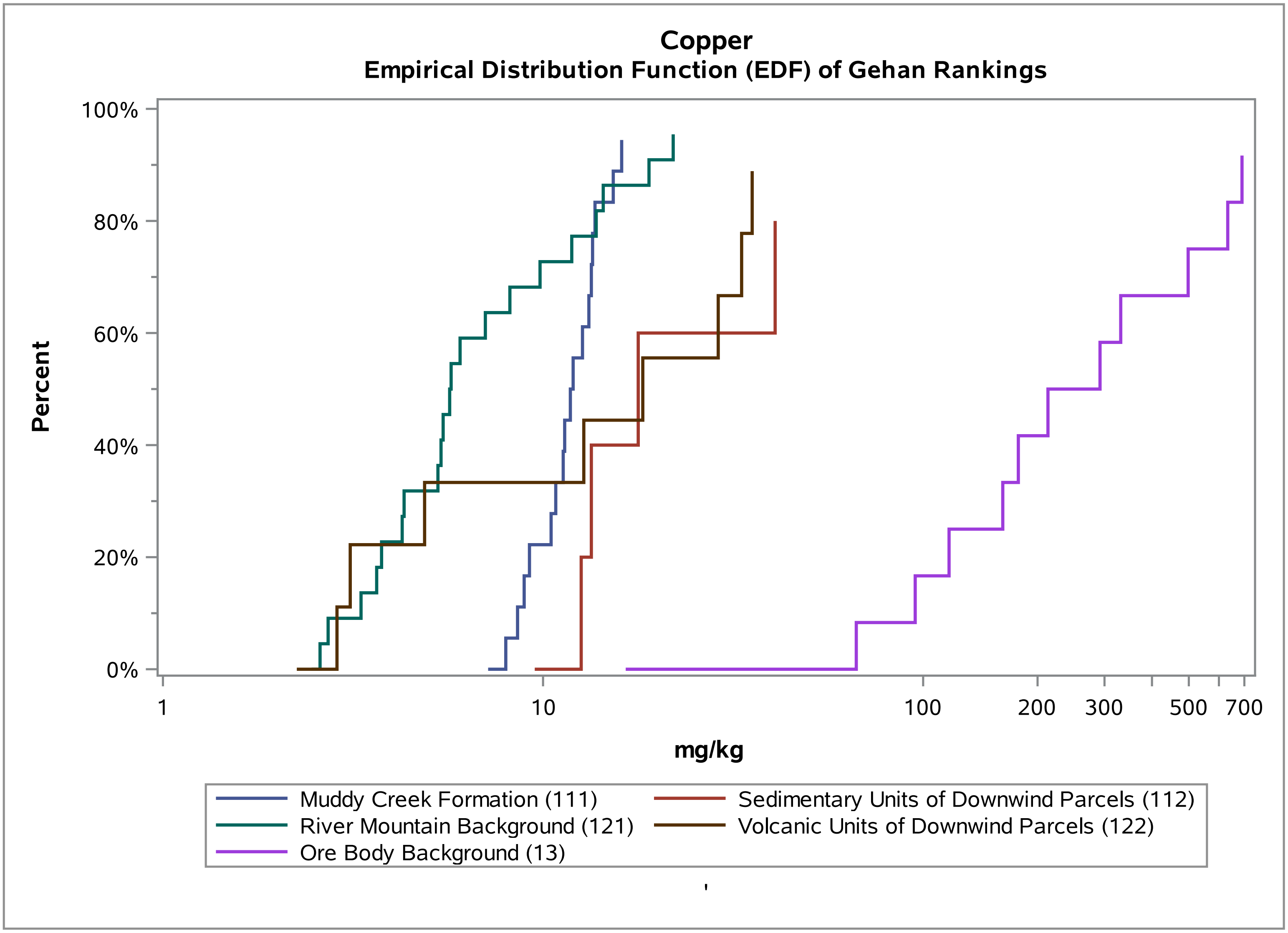

Antimony
Empirical Distribution Function (EDF) of Gehan Rankings
Censored
100%
80%
60%
40%
20%
0%
Percent
0.1
0.7
5
10
15
20
25
35
mg/kg
Muddy Creek Formation (111)
Sedimentary Units of Downwind Parcels (112)
River Mountain Background (121)
Volcanic Units of Downwind Parcels (122)
Ore Body Background (13)

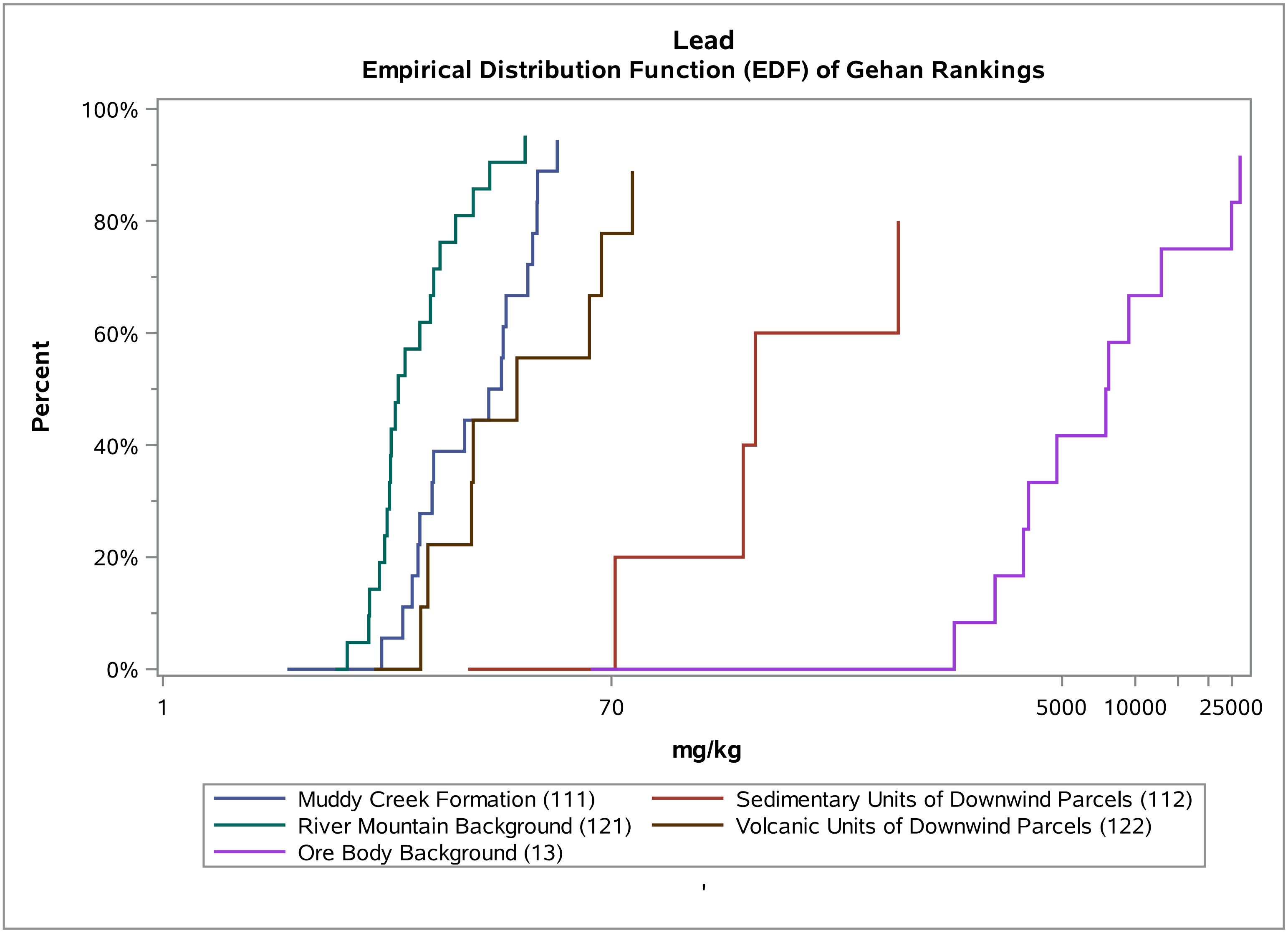

Arsenic
Empirical Distribution Function (EDF) of Gehan Rankings
Percent
100%
80%
60%
40%
20%
0%
1
30
1000
2000
4000
7000
mg/kg
Muddy Creek Formation (111)
River Mountain Background (121)
Ore Body Background (13)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)

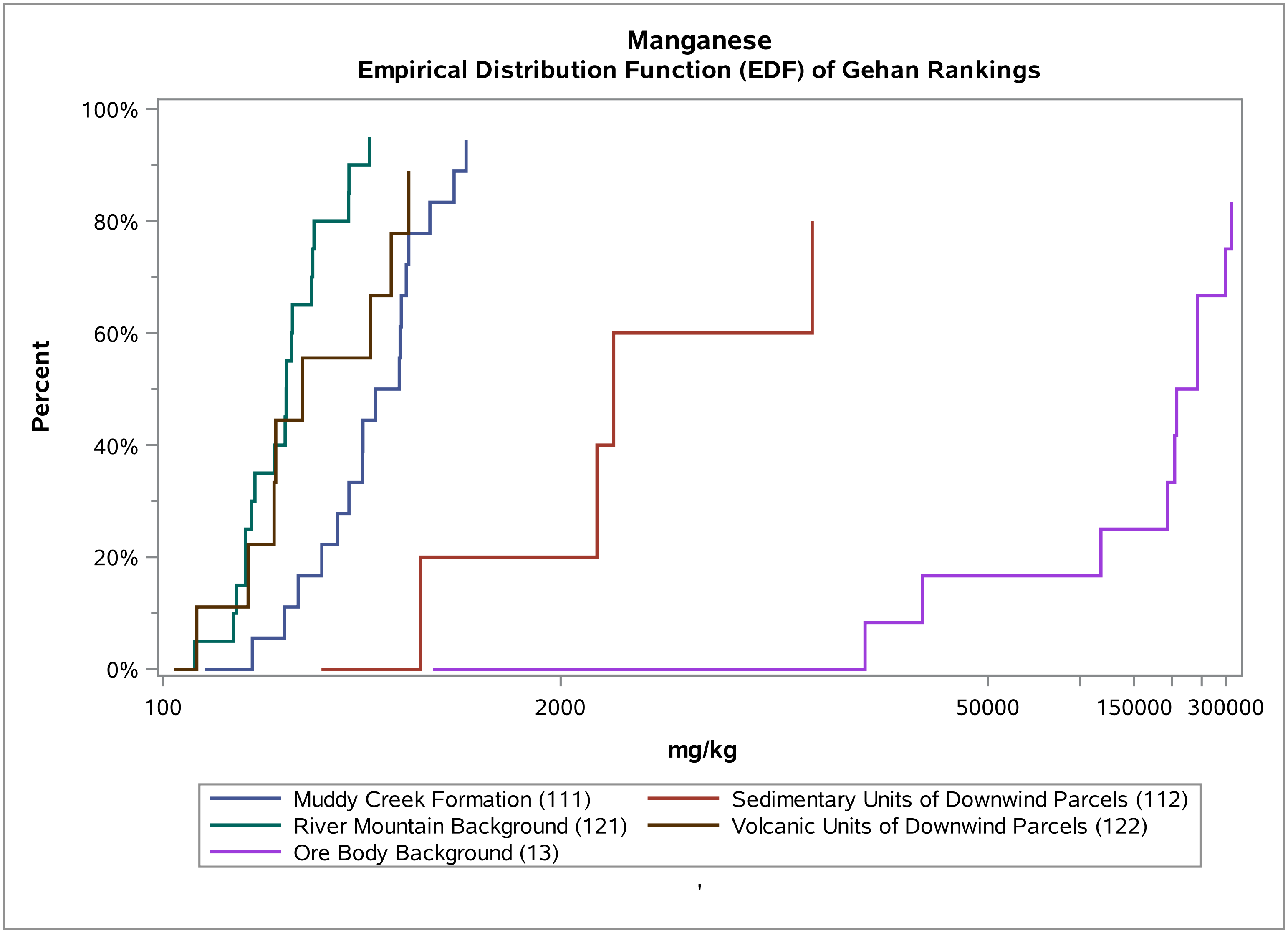

Cadmium
Empirical Distribution Function (EDF) of Gehan Rankings
Censored
Percent
100%
80%
60%
40%
20%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
mg/kg
Muddy Creek Formation (111)
River Mountain Background (121)
Ore Body Background (13)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)

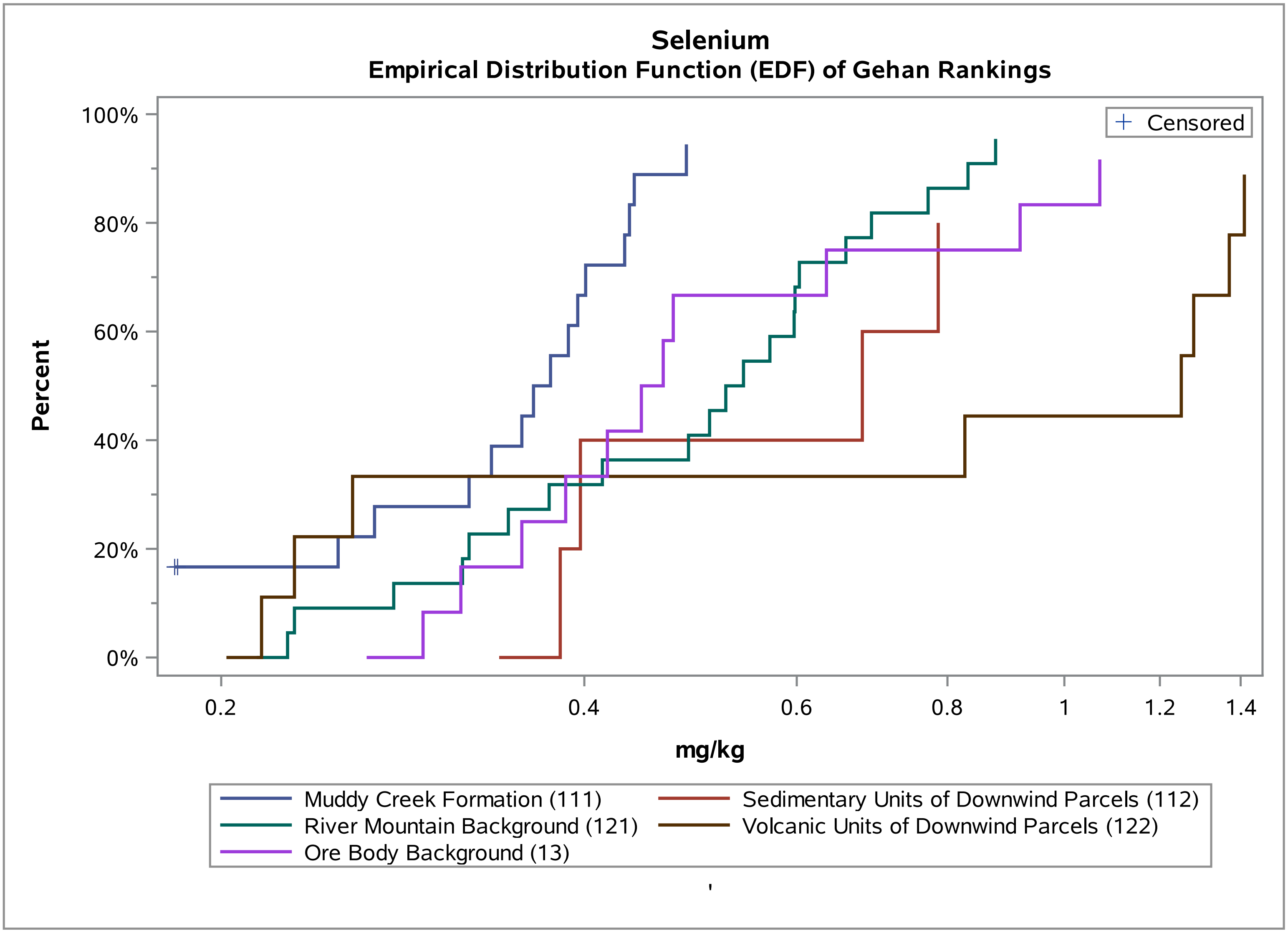


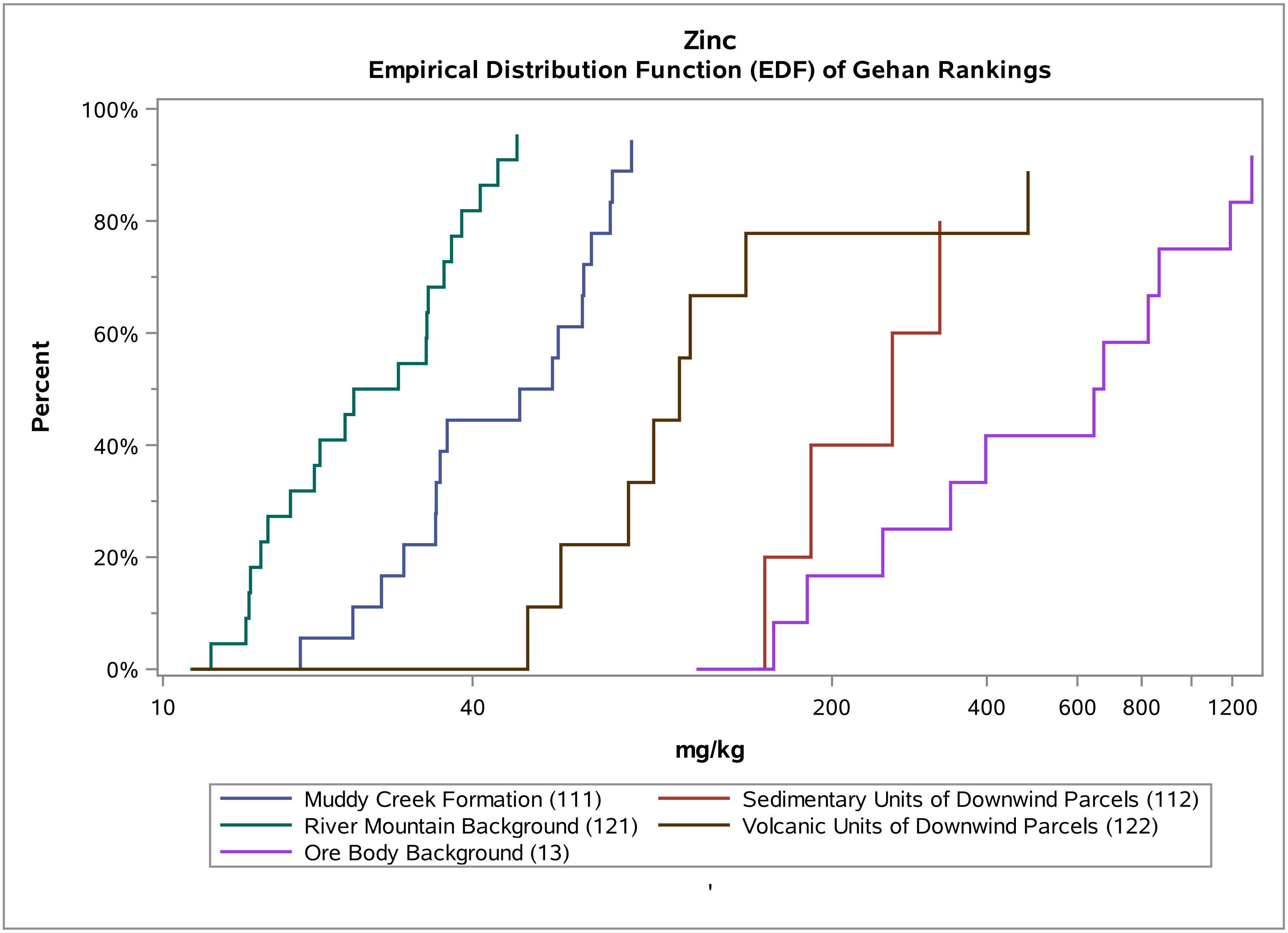
Chromium
Empirical Distribution Function (EDF) of Gehan Rankings
Percent
100%
80%
60%
40%
20%
0%
2.5
5
7.5
10
12.5
15
17.5
22.5
mg/kg
Muddy Creek Formation (111)
River Mountain Background (121)
Ore Body Background (13)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)


Copper
Empirical Distribution Function (EDF) of Gehan Rankings
Percent
100%
80%
60%
40%
20%
0%
1
10
100
200
300
500
700
mg/kg
Muddy Creek Formation (111)
River Mountain Background (121)
Ore Body Background (13)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)


Lead
Empirical Distribution Function (EDF) of Gehan Rankings
Percent
100%
80%
60%
40%
20%
0%
1
70
5000
10000
25000
mg/kg
Muddy Creek Formation (111)
River Mountain Background (121)
Ore Body Background (13)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)


Manganese
Empirical Distribution Function (EDF) of Gehan Rankings
Percent
100%
80%
60%
40%
20%
0%
100
2000
50000
150000
300000
mg/kg
Muddy Creek Formation (111)
Sedimentary Units of Downwind Parcels (112)
River Mountain Background (121)
Volcanic Units of Downwind Parcels (122)
Ore Body Background (13)


Selenium
Empirical Distribution Function (EDF) of Gehan Rankings
Censored
100%
80%
60%
40%
20%
0%
Percent
0.2
0.4
0.6
0.8
1
1.2
1.4
mg/kg
Muddy Creek Formation (111)
River Mountain Background (121)
Ore Body Background (13)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)


Zinc
Empirical Distribution Function (EDF) of Gehan Rankings
100%
80%
60%
40%
20%
0%
Percent
10
40
200
400
600
800
1200
mg/kg
Muddy Creek Formation (111)
River Mountain Background (121)
Ore Body Background (13)
Sedimentary Units of Downwind Parcels (112)
Volcanic Units of Downwind Parcels (122)