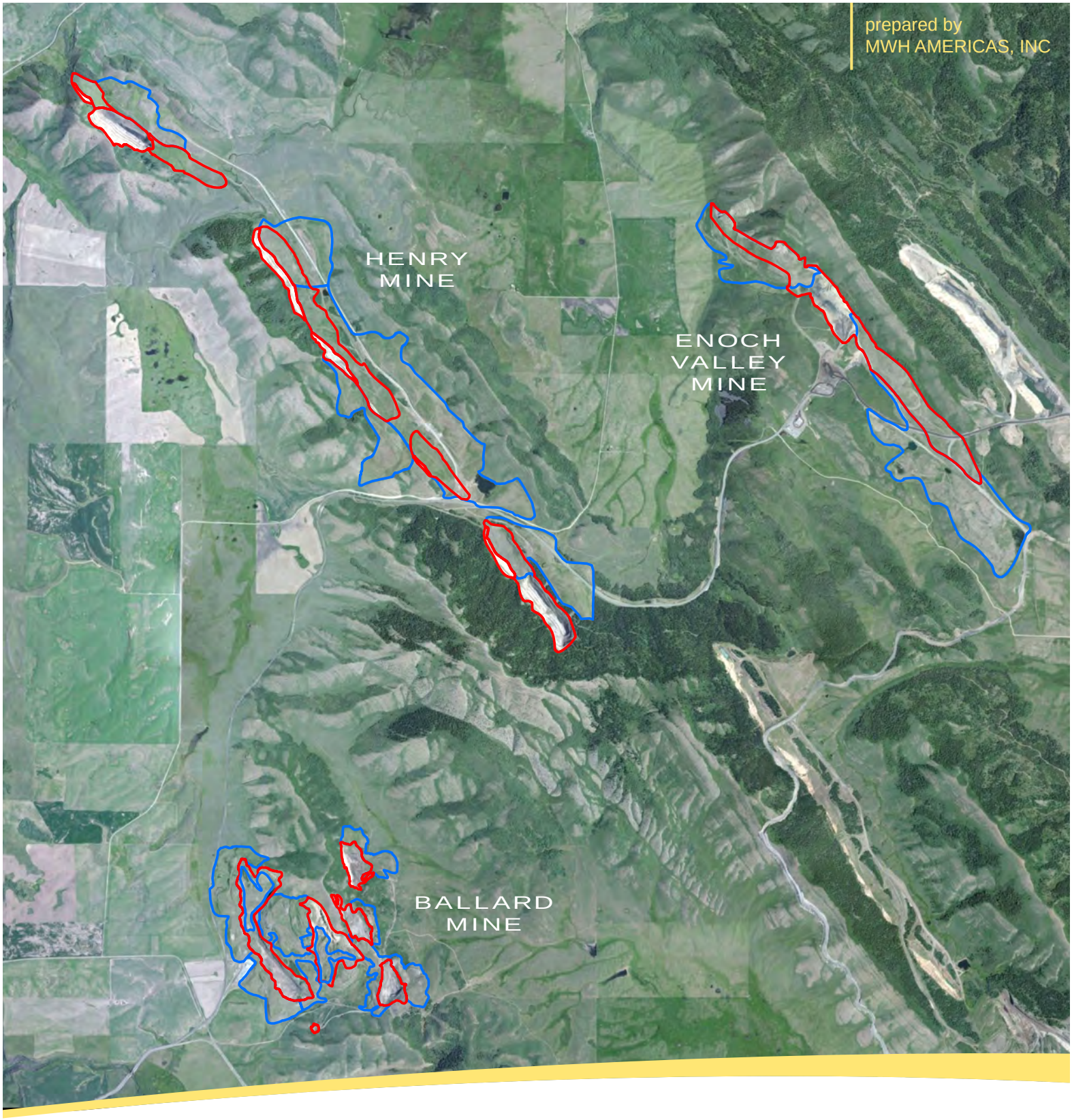

BACKGROUND LEVELS DEVELOPMENT TECHNICAL MEMORANDUM

Ballard, Henry, and Enoch Valley Mines
Remedial Investigation and Feasibility Study

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Revision 0

March 2013

prepared for
P4 PRODUCTION, LLC

MWH®
BUILDING A BETTER WORLD

BALLARD, HENRY, AND ENOCH VALLEY MINES

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

BACKGROUND LEVELS DEVELOPMENT TECHNICAL MEMORANDUM

Final
Revision 0

MARCH 2013

Prepared by:

MWH AMERICAS, INC.

Prepared for:

P4 PRODUCTION, LLC

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ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variances
A/Ts	Agencies and Tribes
ATSDR	Agency for Toxic Substances and Disease Registry
BLM	Bureau of Land Management (Department of Interior)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CO/AOC	Consent Order/Administrative Order on Consent
COPC	Constituent of Potential Concern
COPEC	Constituent of Potential Ecological Concern
DAR	Data Approval Request
DQUR	Data Quality and Usability Report
e.g.	*exempli gratia* (Latin, for example)
EE/CA	Engineering Evaluation and Cost Analysis
FS	Feasibility Study
FUBOB	A Functional Upper Bound of Background
HHERA	Human Health and Ecological Risk Assessment
i.e.	*id est.* (Latin, that is to say; in other words)
IDEQ	Idaho Department of Environmental Quality
MDL	Method Detection Limit
MMP	Monsanto Mine Pit
MWD	Monsanto Waste Dump
MMW	Monsanto Monitoring Well
MST	Monsanto Stream Location
MWH	MWH, Inc. (formerly Montgomery Watson Harza, Inc.)
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NORM	Naturally Occurring Radioactive Material
NRC	National Research Council
P4	P4 Production L.L.C.
PgmQAP	Program Quality Assurance Plan
QA	Quality Assurance
QC	Quality Control
QQ	Quantile-Quantile
RA	Risk Assessment
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
SAP	Sampling and Analysis Plan
SE	Southeast (SE Idaho)
SI	Site Investigation (component of the EE/CA)

SOW	Statement of Work (from the RI/FS AOC unless specified otherwise)
Sites	Ballard, Henry and Enoch Valley Mines as defined in the 2009 RI/FS AOC
Tribes	Shoshone-Bannock Tribes
UPL	Upper Prediction Limit
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Department of Agriculture, Forest Service
USGS	United States Geological Survey
USL	Upper Simultaneous Limit
UTL	Upper Tolerance Limit

1.0 INTRODUCTION

This *Background Levels Development Technical Memorandum* (*Background Levels Tech Memo*) has been prepared by MWH Americas, Inc. (MWH) on behalf of P4 Production, LLC (P4), in accordance with the requirements of the Administrative Settlement Agreement and Order on Consent/Consent Order for Remedial Investigation/Feasibility Study (2009 CO/AOC; USEPA, 2009). The 2009 CO/AOC is a voluntary agreement between P4 and the United States Environmental Protection Agency (EPA), the Idaho Department of Environmental Quality (IDEQ), the United States Department of Agriculture, Forest Service (Forest Service), the Fish and Wildlife Service (FWS), the United States Department of the Interior (DOI), Bureau of Land Management (BLM), the Shoshone-Bannock tribes (Tribes), collectively referred to as the Agencies and Tribes or A/Ts. This *Background Levels Tech Memo* supports the comprehensive mine-specific RI/FS that will be conducted at P4's three historic phosphate mines: Ballard, Henry and Enoch Valley mines (collectively, the "Sites"). The Sites were developed for their phosphate ore between 1951 and 2003 and are located approximately 13 to 19 miles north northeast of the City of Soda Springs in southeastern (SE) Idaho. Drawing 1-1 shows the location of each of the three Sites, including the configuration of the mine pits and waste rock dump areas.

1.1 Purpose and Objectives

Effective October 24, 2003, the United States Environmental Protection Agency ("EPA"), the Idaho Department of Environmental Quality ("IDEQ"), the United States Department of Agriculture, Forest Service ("Forest Service"), and P4 Production, L.L.C ("P4"), the latter as Respondent, voluntarily entered into an Administrative Order on Consent/Consent Order ("2003 CO/AOC"). The 2003 CO/AOC provided for the performance by P4 of a Site Investigation ("SI") and an Engineering Evaluation/Cost Analysis ("EE/CA") for the Enoch Valley Mine, the Ballard Mine, and the Henry Mine. In 2009, these same Agencies and P4 entered into the CO/AOC for Remedial Investigation/Feasibility Study for the Enoch Valley Mine, the Ballard Mine, and the Henry Mine (2009 CO/AOC) that superseded the 2003 CO/AOC.

As part of the 2009 CO/AOC, P4 submitted the *Remedial Investigation/Feasibility Study Work Plan for the P4 Sites* – Revision 2 Final (*RI/FS Work Pla*n) in May 2011, which was approved

by EPA on June 20, 2011. As part of the RI/FS scoping process, historical data were evaluated in the *RI/FS Work Plan* to identify data gaps and the additional data collection activities that must be completed under the RI before the risk assessment (RA) and FS processes can begin. This evaluation primarily used data collected under the 2003 CO/AOC. As part of the data gap analysis, it was determined that sufficient data for the various media have been collected to characterize background. As stated in the *RI/FS Work Plan*, previous Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Engineering Evaluation and Cost Analysis (EE/CA) studies collected background data that will be used as part of the current evaluation of background.

Background concentrations will be an important consideration in the RAs, the RI Reports, and the FS. Specifically, the background levels developed in this *Background Levels Tech Memo* will be used for the following purposes:

- The RI Report for characterization discussion, along with appropriate Agency-approved risk-based standards, of sampling results from various media. Comparison of sampling results will be based on an upper bound estimate of the background population, such as an upper simultaneous limit (USL) or maximum concentration, for each medium.
- The Human Health and Ecological Risk Assessment (HHERA) for the calculation of background risk estimates. The calculation of background risk estimates for use in the derivation of incremental risk will be based on 95% upper confidence limit (UCL) on the mean concentrations, or maximum detected concentrations, for consistency with the exposure point concentrations used in the calculation of Sites' risk estimates.
- The FS to identify portions of the Sites that are appropriate for consideration of remedial action, and as potential cleanup levels for COPCs/COPECs that have low risk-based screening levels relative to background levels. Background evaluations in the FS will be based on an upper bound estimate of the background population, such as a USL or maximum concentration, for each medium.

Thus, the background level for each COPC in each medium needs to be finalized and approved by the A/T prior to beginning these activities. This statistical evaluation of

background was identified as an RI/FS data gap and that while the A/Ts have not approved prior P4 derivations of calculated background levels presented for the EE/CA, this *Background Levels Tech Memo* is intended to provide such an evaluation for the RI/FS. The primary media for which background levels were calculated for the Sites are soil, groundwater, surface water, sediments and vegetation.

1.2 History of Background Investigation Activities at the P4 Sites

Background samples of various media have been collected dating back to the Site-Wide Investigations, which started in 1996 and ran through approximately 2004, when the investigations began focusing on specific mines with specific owners. An area-wide human HHERA was performed by the IDEQ in 2002 using sampling data collected throughout the region. Background samples at P4's historic Sites were also collected between 2002 and 2009 under the 2003 AOC/CO as part of an expedited CERCLA EE/CA approach that was consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). In 2009, the A/Ts determined that the RI/FS process (also under CERCLA) was more appropriate for assessment of risk to human health and the environment and the subsequent identification of cleanup solutions, if necessary. This *Background Levels Tech Memo* is part of the RI/FS process.

Background levels have previously been evaluated and reported in the Area-Wide Human Health and Ecological Risk Assessment Selenium Project Southeast Idaho Phosphate Mining Resource Area (Area-Wide Risk Assessment; IDEQ, 2002). The Final Area Wide Human Health and Ecological Risk Assessment, Selenium Project Southeast Idaho Phosphate Mining Resource Area (IDEQ, 2002) defined background riparian soils, and presumably sediments and surface waters, as areas upstream of mining facilities or as unimpacted reaches. Areas downstream of mining facilities were referred to as impacted reaches. In the context of EPA guidance for evaluating background concentrations at CERCLA sites, the Area-Wide background samples are the same as "naturally-occurring" background (EPA, 2002). The Area-Wide range, average, and 95% UCL background levels are summarized in Table 1-1. It must be noted that the data quality requirements may be less than the current data quality requirements under the RI/FS and the Area-Wide data were analyzed for a limited dataset.

Background data were also collected and evaluated under the 2003 AOC/CO area as referenced in the Comprehensive Site Investigation Sampling and Analysis Plan (SI SAP; MWH, 2004), as well as the draft Interim Phase I SIs Evaluation Summary (draft PIES document; MWH, 2007). These background evaluations were not approved by the A/T.

The EE/CA background evaluations were based on the analyte list agreed upon in the 2003 AOC, with slight adjustments made for the approved 2004 analyte list (MWH, 2004). This list of analytes also was based upon screening performed by IDEQ in the Area-Wide Investigations and Risk Assessment. The COPCs for which preliminary background levels were calculated are listed below.

- cadmium
- chromium
- copper
- molybdenum
- nickel
- selenium
- vanadium
- zinc

2.0 EVALUATION AND SELECTION OF BACKGROUND LOCATIONS

2.1 Background Location Selection

In general, background for the RI/FS for the Sites has been defined as "locations unaffected by P4 mining operations that are representative of pre-mining geological conditions." More specifically, "site" background refers to a location that is upstream, upgradient, or upwind of all potential P4 mining activities whereas "natural" background indicates that no potential on-site or off-site mining-related influence is present. A "site" background location may be influenced by other non-P4 mining activities. In the context of EPA guidance for evaluating background levels at CERCLA sites, "natural" background is the same as "naturally-occurring" background and "site" background is the equivalent of "anthropogenic" background (EPA, 2002). For this current evaluation of background data, P4 is proposing to use "natural" (i.e., naturally-occurring) background locations to the extent practicable as the inclusion of "site" background locations in the background dataset may bias the background levels. For several media (sediment, surface soil, riparian soils, and riparian vegetation), background stations were initially selected during the area-wide and EE/CA studies, although there have been additions to the number of sampling events as a result of ongoing RI/FS activities. Background sampling locations for all media are depicted on Drawing 1-1.

2.1.1 Surface Water, Sediment, and Riparian Soils

When evaluating surface water, sediment and riparian soil locations for background sampling, both potential surface water and groundwater flows (inputs) from adjacent mine areas were considered. The background stations for surface water, sediment, and riparian media were located in headwater drainages, upgradient of the P4 mines and other drainages around the mines that are not impacted by mining activities. Historically, there were other background locations upgradient of P4 mining activities, but these stations may have been influenced by other mining activities in the district. These stations are not included in this evaluation of background for surface water, sediment, and riparian media as further discussed in Section 2.2.1.

2.1.2 Upland Soil and Vegetation

The criteria for selection of upland soil and vegetation background samples is slightly different than for the surface water and riparian media. The background areas for upland soil and vegetation were required to meet the following criteria: 1) undisturbed by mining or waste rock disposal; 2) representative of the geology where other waste rock dumps have been placed; and 3) comparable in areal extent to the waste rock dumps that were characterized at the Sites during the 2009 Supplemental Soil and Vegetation Characterization program.

As stated in the *RI/FS Work Plan*, background data need to be representative of the entire geologic sequence that is ultimately disturbed by mining. This is important because the mined units of the Phosphoria Formation are known to be naturally elevated in some metals. It must be noted that the entire geologic sequence is not fully represented in the current background datasets for upland soil and vegetation included herein, as samples have not been collected from locations overlying or immediately downslope from the Phosphoria Formation. As a result, the background statistics for upland soil and vegetation presented in Section 4.0 likely are not all inclusive of pre-mining geological conditions at the Sites, in that one would expect elevated levels of arsenic and uranium which are found in high concentrations in the phosphate ore bodies contained in the Phosphoria Formation. This is important because the undisturbed Phosphoria Formation is known to be elevated in some metals (Herring, J.R. and Grauch, R.I., 2004) and excluding data from this unit may bias the representative background levels for some elements low. This may affect the calculation of incremental risk for some elements such as arsenic and uranium.

2.1.3 Groundwater

Background ground water quality is defined by the State of Idaho Ground Water Quality Rule (IDAPA 58.01.11; IDEQ, 2009a) as either of the following:

- Natural background is defined as the level of any constituent in the ground water within a specified area as determined by representative measurements of the ground water quality unaffected by human activities.

- Site background level is defined as the ground water quality at the hydraulically upgradient site boundary. In areas where the ground water quality is unaffected by human activities, the site background level is equivalent to natural background.

For the Sites, natural background levels were evaluated using well locations that are unaffected by P4 mining operations and represent the hydrogeologic framework (e.g., flowpaths and aquifers) as further discussed below.

2.2 Specific Locations for each Primary Media

Primary media are those media that represent the COPC sources identified at the Sites for human and ecological receptor exposures. They will be used as the principal components in the initial stages of the risk assessment. The Sites' primary media are:

- Sediment
- Surface Water
- Soil (upland and riparian)
- Vegetation (upland and riparian)
- Groundwater

Vegetation is more typically a receptor and would be considered a secondary medium based on the scheme presented here. However, it is recognized that vegetation in the SE Idaho phosphate mine area is one of the primary risk drivers to livestock and wildlife receptors via the consumption pathway. Therefore, there has been extensive vegetation sampling with vegetation being treated as a primary medium herein. The subsections below summarize the selection of background sample locations for each of the primary media.

2.2.1 Sediment, Surface Water, Riparian Soil, and Riparian Vegetation Background Locations

These four primary media have been grouped together, as samples of these media have been collected and often collocated from 9 background stream sampling locations around the Sites (i.e., "MST" sampling locations), as shown on Drawing 1-1. Samples of these media were collected during several sampling events between 2004 and 2010 as presented in Table 2-1. Sediment background locations have been sampled twice, in 2004 and 2010. The

surface water background locations have been sampled between one and seven times during 2004 to 2010. Stations were sampled both in the spring and fall. Similar to sediment, riparian soil samples from background stations were collected twice, in 2004 and 2010. Riparian vegetation samples were also collected during the 2004 sampling event. In addition, area-wide sediment and surface water and riparian data from 1997 to 2003 are available for, MST048, MST235, MST236, MST237, MST254, and MST101. However, per the *Data Quality and Usability Report/Data Approval Request* (*DQUR/DAR*; MWH, 2010a and Appendix B of the *RI/FS Work Plan*; MWH, 2011), these pre-2004 data were not utilized in the calculation of background and they are not discussed further in this Background Levels Tech Memo. All post-2004 sediment, surface water, and riparian media background stations and a statistical summary of selenium concentrations are shown on Drawing 2-1 and location details and rationale for each background sample location are provided in Table 2-2.

As shown in Table 2-2, none of the proposed background sediment, surface water, riparian soil, and riparian vegetation sample locations are characterized as "site" background locations. Upon further evaluation of the historical background data, P4 realigned two of the historical background locations from "site" to "natural" as defined on the spatial wire diagrams (SWDs) included in previous documents (e.g., the draft PIES document and the RI/FS Work Plan). The locations that were changed from “site” to “natural” background designations are MST048 and MST277.

MST048 is proximal to MST049 and MST254 on the Little Blackfoot River. In historical documents, MST048 was assigned as a "site" location whereas MST049 and MST254, both located further upstream, were designated as "natural" background. As there are no inputs from any of the mined areas to the river between these stations, all three stations are representative of natural background. Therefore, P4 revised the designation of MST048 to a "natural" background location, as shown on Table 2-2.

The second station to be changed from a "site" to "natural" background location, MST277, was evaluated and approved as a background location by the A/Ts for the *Supplemental Sediment and Riparian Soil Sampling and Analysis Plan* (MWH, 2010b). This background location is positioned outside of an area of possible Henry Mine sediment and surface water loading impacts on Long Valley Creek. It is uncertain why it was stated that there are possible effects from mining. However, it is noted that the P4 haul road is upstream of this

location. Data from this location appears to be in the range of the other background data based upon initial inspection. For example, riparian soil selenium concentrations from all background locations range from non-detect (<0.5 mg/kg) to 3.4 mg/kg and the selenium concentrations at MST277 range from 0.7 to 1.8 mg/kg. Similarly, in the sediment background dataset, the selenium concentrations range from non-detect to 4.5 mg/kg and the selenium concentrations at MST277 range from 0.7 to 1.6 mg/kg. In addition, during statistical tests that will be run to determine "background concentrations" for each medium, an outlier analysis will be performed, as discussed in Section 3.0. In the event that a sample result collected from one of the formerly designated "site" background locations is identified as an outlier, it will be considered for removal from the background dataset. In addition, sampling results collected from formerly designated "site" locations will be flagged in graphs of the data to see where they occur within the data distribution. This information will be used in a "weight of evidence" evaluation to determine the appropriateness of excluding the location from the background datasets.

It should also be noted that there are several background locations shown on the 2004, 2007, and 2008 SWDs (see Section 3 Figures of the *RI/FS Work Plan*) that were purposely not included in the proposed background stations listed in Table 2-2. This is because several of the locations were not deemed suitable natural background locations. For example, the proposed background dataset does not include MRV017, at Blackfoot Reservoir, as a background location. It also does not include MST226, MST274, and MST275. These stations were originally proposed for inclusion in the background dataset. However, after a site visit in June 2012 and discussions with the A/T (see 7/26/2012 Response to Comments in Appendix E), P4 agreed to remove these three stations from the background evaluation. In addition, six (6) stations characterized as "site" or "project" background on the SWDs were also excluded from the proposed background dataset. Three of these stations (MST128, MST129 and MST130) are located on Angus Creek upstream of Rasmussen Creek and are potentially affected by other mining operations. In addition, three stations (MST028, MST029 and MST229) are located on the Blackfoot River upstream of the confluence with Angus Creek. These stations also could be affected by other mining activities. Historical concentrations from these stations support potential impacts by other non-P4 mining activities. The "site" background data may help P4 and the A/Ts assess the influence (i.e., contamination impacts) to particular media located on the Sites from non-sites. However,

P4 believes that inclusion of "site" background stations would bias or skew the background data and this evaluation of background is proposing to use "natural" background data for this evaluation of medium-specific background levels.

Tabulated data for each medium and background location are presented in Tables 2-3 through 2-6. These data were evaluated by comparing non-detected and detected results to applicable screening levels. The data were evaluated to determine the adequacy of the method detection limit (MDL) by comparing the MDL for each analyte to its applicable screening level. The screening levels used in this comparison are from the A/T-approved *RI/FS Work Plan* (see Table 3-1 of that plan). Method detection limits for non-detect results are shaded when the MDL exceeds the analyte's screening level.

In addition, detected results in Tables 2-3 through 2-6 are evaluated to assist in the determination of "site" and "natural" background locations. As a result, detected results above medium-specific screening levels also are shaded in these tables.

It should be noted that the final representativeness and usability of individual data or sampling locations should not be determined through comparisons to screening levels, but through statistical evaluations performed during the calculation of Site-wide background levels and review of the physical sample location. These data will be evaluated further during the statistical testing presented in Section 4.0 for the presence of statistical outliers in the various background datasets. As discussed further below, as a result of the conservative nature of the screening benchmarks for some chemicals in some media, background concentrations may be higher than the screening levels. An example is arsenic for which human health-based screening levels are commonly at or below the range of background concentrations observed in most regions of the U.S. The fact that measured concentrations of arsenic in soil at a given location exceed a screening benchmark, such as the EPA Regional Screening Level (RSL) for arsenic in residential soil, does not necessarily mean that the concentrations are not representative of background. However, observations regarding the adequacy of these data, and whether or not results for individual sample locations appear to be consistent with the "natural" background designations described in Section 2.2, are included below.

2.2.1.1 Comparison of Sediment Concentrations to Screening Levels.

The MDLs for all analytes reported in sediment samples collected from background locations were below their respective screening level (Table 2-3). Comparison of detected results to sediment screening levels shows that several analytes are associated with a concentration in one or more samples that is higher than its respective screening level (Table 2-3).

- **Antimony** analysis was conducted on sediment samples collected at four of the nine background sediment locations, and was detected at one location (MST277). Detected concentrations of antimony at these locations were 4.8J and 5.0J mg/kg (J flag indicates data are estimated due to associated quality control data), and are slightly higher than the screening level of 3 mg/kg. At MST093, the antimony data were qualified during data validation as not detected at the reported concentration. As described in Section 3.0, these data will be further evaluated during the statistical analysis. Although regional background levels for antimony in sediment are not currently available, Kabata-Pendias (2001) cites a range of antimony concentrations in U.S. soils as 0.11 to 14.0 mg/kg. The sediment screening level for antimony and the range of detected concentrations of antimony in background sediment samples are within the range of reported background concentrations for antimony in soil. It should be noted that sediments and soils represent different geomorphologic environments, and background levels for antimony in soil are not directly comparable to background concentrations in sediment.

- **Cadmium** concentrations in nearly all samples (ranging from 0.22 to 3.84 mg/kg) are higher than the screening level of 0.583 mg/kg. However, this issue is believed attributable to the conservative nature of the screening benchmark for cadmium rather than concentrations of cadmium that may not be representative of background conditions. The *Area-Wide Risk Assessment* (IDEQ, 2002) determined that the mean background concentration for cadmium in sediment was 1.07 mg/kg. Also, Kabata-Pendias (2001) cites a range of cadmium concentrations in U.S. soils as <0.01 to 2.0 mg/kg. Clearly, the sediment screening level of 0.583 mg/kg for cadmium is within the range of reported background concentrations for cadmium in

soils (0.22 to 3.85 mg/kg) and the sediment screening level is less than the Area-Wide mean background concentration (1.07 mg/kg).

- **Nickel** concentrations in five of the nine background sediment locations are higher than the screening level for nickel. The highest concentration of nickel detected in background sediment samples (24.4 mg/kg at MST236) is slightly higher than the screening level for nickel. The *Area-Wide Risk Assessment* (IDEQ, 2002) determined that the mean background concentration for nickel in sediment was 19.13 mg/kg, and the range of nickel concentrations reported in Western U.S. soils is <5 – 700 mg/kg, with an arithmetic mean of 19 mg/kg (Shacklette and Boerngen, 1984). As was the case for cadmium, the sediment screening level for nickel (18 mg/kg) and nickel concentrations in the background sediment samples, are clearly within the range of background concentrations for nickel in Western U.S. soil and most are less than the Area-Wide background concentration.
- **Zinc** concentrations in three of the nine background sediment locations are higher than the screening level for zinc. The highest concentration of zinc detected in background sediment samples (152 mg/kg at MST277) is about one and a half times higher than the zinc screening level. *The Area-Wide Risk Assessment* (IDEQ, 2002) determined that the mean background concentration for zinc in sediment was 83.53 mg/kg. The range of zinc concentrations reported in Western U.S. soils is 10 – 2,100 mg/kg, with an arithmetic mean of 65 mg/kg (Shacklette and Boerngen, 1984). The arithmetic mean for zinc in the background sediment dataset is 98.7 mg/kg, which is well within the range of zinc concentrations in Western U.S. soils.

Selenium was not reported above the screening level at any background site but is mentioned as it often indicative of mining-related impacts. The highest concentration of selenium (1.6 mg/kg) is well below the screening level (4 mg/kg). The range of selenium concentrations reported in Western U.S. soils is <0.1 – 4.3 mg/kg (Shackl*ette and Boerngen, 1984)* and the Area-Wide sediment mean background concentration for selenium was 1.22 mg/kg.

For the other analytes discussed above, the highest concentrations were detected at MST277. However, this location is associated with an un-impacted drainage (Drawing 1-1 and

Drawing 2-1), and data were included as background sample locations in the A/T-approved *Supplemental Sediment and Riparian Soil Sampling and Analysis Plan* (MWH, 2010b). Based on the above, P4 believes that it is appropriate to include all of the sediment sampling locations and results summarized in Table 2-3 in the background sediment dataset.

2.2.1.2 Comparison of Surface Water Concentrations to Screening Levels.

The MDLs for all analytes sampled for in surface water are below their respective screening level, with the exception of aluminum, beryllium, boron, cobalt, silver, and thallium (Table 2-4). Beryllium, cobalt, silver, and thallium had several instances of the MDL reported above their respective screening levels; whereas only a few samples report MDLs greater than the screening levels for the other analytes. In the case of beryllium, the surface water screening level is very conservative, 0.0006 mg/L, and the most current analytical methods are unable to quantify data to such as level. There were no detected concentrations of beryllium above the MDL of 0.002 mg/L. Similarly, cobalt is not detected in a majority of the samples above the MDL of 0.003 mg/L. Both silver and thallium, also have conservative screening levels. Several surface water samples analyzed for silver and thallium are considered to be not detected based on the data validation, and the MDLs for all of these samples are greater than the screening levels. However, it is unlikely that inclusion of these data in the surface water background dataset for beryllium, cobalt, silver, and thallium will have a significant bias on the background concentrations in surface water for these analytes. Nevertheless, the limited nature of the dataset for these constituents will be evaluated in the Uncertainty Analysis section of the HHERA for the Sites, as appropriate.

Comparison of detected results to surface water screening levels shows that several analytes are associated with a concentration in one or more samples that is higher than its respective screening level (Table 2-4).

- **Aluminum** concentrations detected in surface water collected and analyzed from eight of the nine background locations for total aluminum (unfiltered fraction) are above the screening level of 0.087 mg/L. In most instances, dissolved aluminum concentrations are below detection limits. This suggests that the aluminum detected in unfiltered surface water samples collected and analyzed for total aluminum is from clay particles entrained in the water. This sediment entrainment is confirmed because when the samples are filtered and analyzed, the dissolved aluminum

concentrations are below the detection limit. In addition, aluminum concentrations in the background dataset support findings from the *RI/FS Work Plan* that show aluminum is often naturally elevated in waters throughout the Sites.

- **Barium** concentrations, both total and dissolved, in surface water collected from eight of the nine background locations are above its screening level of 0.003 mg/L during several spring and fall sampling events. Barium concentrations in these surface water samples range from 0.02 to 0.085 mg/L. Based on these data, it appears that surface water concentrations of barium in background locations naturally may exceed the screening level. However, no regional data exist to support this assumption.

- **Boron** concentrations, both total and dissolved, in surface water samples collected from seven of the nine background locations are above its screening level of 0.0016 mg/L during several spring and fall sampling events. Boron concentrations in these surface water samples range from 0.01 to 0.02 mg/L. Based on these data, it appears that the surface water concentration of boron in background locations naturally may exceed the screening level. However, no regional data exist to support this assumption.

- **Iron** concentrations in surface water are above the screening level of 0.158 mg/L at three of the nine surface water background locations. Samples were collected during several spring and fall sampling events. In most instances, elevated total iron was reported during multiple sampling events while the associated dissolved iron concentrations typically were below the MDL. This suggests that the iron detected in unfiltered surface water samples is from particulate matter entrained in the water. This sediment entrainment is confirmed because when the samples are filtered and analyzed, the dissolved iron concentrations are below the detection limit. In addition, the iron concentrations in the background dataset support findings from the *RI/FS Work Plan* that show iron often is naturally elevated in waters throughout the Sites.

- **Thallium** is detected in at least one surface water sample above its screening level of 0.00003 mg/L in five of the nine background stations with concentrations ranging

from 0.0001 to 0.0008 mg/L. Most of the remaining samples are flagged as not detected based on data validation. Based on these data, it appears that surface water concentrations of thallium in background locations may naturally exceed the screening level. However, no regional data exist to support this assumption.

Selenium concentrations in surface water samples were below the screening level in all samples collected from the nine background locations. This analyte is mentioned as it often indicative of mining-related impacts Based on the discussions above, P4 believes that it is appropriate to include all of the surface water sampling locations and results summarized in Table 2-4 in the background surface water dataset.

2.2.1.3 Comparison of Riparian Soil Concentrations to Screening Levels.

The MDLs for all analytes reported in riparian soils collected from background locations were below their respective screening level (Table 2-5). Comparison of detected riparian soil results to soil screening levels shows that only one analyte is associated with a concentration higher than its respective screening level (Table 2-5).

- **Arsenic,** reported in two riparian soil background locations, is higher than the screening level of 0.39 mg/kg. Arsenic concentrations in these riparian soil samples ranged between 2.78 and 5.44 mg/kg. However, this issue is believed attributable to the conservative nature of the screening benchmark for arsenic rather than concentrations of arsenic that may not be representative of background conditions. Although regional background levels for arsenic in riparian soils are not currently available, the range of arsenic concentrations reported in Western U.S. soils is <0.1 – 97 mg/kg, with an arithmetic mean of 7.2 mg/kg (Shacklette and Boerngen, 1984). Clearly, the soil screening level for arsenic is within the range of reported background concentrations for arsenic in soils. The range of arsenic concentrations in the background riparian soils is below the mean arsenic concentration reported for Western U.S. soils.

Based on the information presented above, P4 believes that it is appropriate to include all of the riparian soil sampling locations and results summarized in Table 2-5 in the background riparian soil datasets.

2.2.1.4 Comparison of Riparian Vegetation Concentrations to Screening Levels.

The MDLs for all analytes sampled for in riparian vegetation were below their respective screening level (Table 2-6). In addition, none of the riparian vegetation samples collected for analyses reported concentrations of constituents above their individual screening levels. It is noted that only five COPCs/COPECs, cadmium, copper, molybdenum, selenium, and zinc, were analyzed for during the 2004 background riparian vegetation investigation.

However, the 2009 upland vegetation data were analyzed for a more comprehensive COPC/COPEC list and were evaluated against screening levels in the *RI/FS Work Plan*. As shown on Tables 3-5, 3-21, and 3-37 of the *RI/FS Work Plan*, there are only three analytes (cadmium, molybdenum and selenium) consistently detected in riparian and upland vegetation that were greater than their respective screening levels.

Based on comparisons of vegetation concentrations to screening levels and the fact that all three analytes that consistently exceeded vegetation screening levels were included in the 2004 analytical suite, P4 does not believe that the historically-selective analyte list for the riparian vegetation data represents a significant data gap. Nevertheless, the limited nature of the analytical suite for riparian vegetation will be described in the Uncertainty Analysis section of the HHERA for the Sites.

In the HHERAs to be performed for the Sites, biota consumption pathways will be evaluated by inputting measured riparian vegetation concentrations into the dose equations for those chemicals with available riparian vegetation sampling results. For those chemicals without riparian vegetation sampling results, riparian vegetation concentrations will be modeled from riparian soil concentrations using published soil-to-plant bioaccumulation factors, as available.

2.2.2 Upland Soil and Vegetation Background Locations

As discussed in Section 2.1 above, background areas for upland soil and vegetation were selected from within each of the three Sites to capture samples undisturbed by mining or waste rock disposal which were representative of locations where waste rock dumps historically have been placed at the mine sites. Samples of these media were collected during summer 2009 as presented in Table 2-1, with some vegetation also re-sampled in fall 2009. It should be noted that the A/Ts advised P4 which areas would be acceptable to sample for

upland soil and vegetation, and that areas overlying or immediately downslope of undisturbed Phosphoria Formation were not to be targeted for sampling during this effort. This is important because the undisturbed Phosphoria Formation is known to be elevated in some metals.

The suitability of each background area based on A/T selection criteria was confirmed during a 2009 field survey. The originally proposed background areas documented in the *Supplemental Soil and Vegetation Sampling and Analysis Plan* (MWH, 2009) for the Ballard and Enoch Valley mines, MBB001 and MBE001, respectively, were utilized. At Henry mine, two potential background areas were proposed with one to be selected following the survey. During the survey it was discovered that the first background area, MBH001, had been disturbed by farming practices that had left very little native vegetation remaining. The second proposed background area, MBH002, had not been disturbed and was therefore chosen for the Henry Mine.

The three background areas, for upland soil and vegetation, consist primarily of native vegetation and undisturbed soil. The Ballard Mine background area is a quaking aspen forest with open patches of sagebrush community. The Henry Mine background area is a sagebrush shrub community, while the Enoch Valley Mine is a combination of both quaking aspen forest and sagebrush shrub communities. The upland soil and vegetation background stations and selenium concentrations are shown for each Site on Drawings 2-2, 2-3 and 2-4, and location details and rationale for each background sample location are provided in Table 2-7.

Tabulated data for each medium and background location are provided in Tables 2-8 and 2-9. These data tables for each medium also highlight detected concentrations and shade exceedances of screening levels for each analyte. As discussed in Section 2.2.1 above, the final representativeness and usability of individual data should not be determined through comparisons to screening levels but through statistical evaluations performed during the calculation of Site-wide background levels.

2.2.2.1 Comparison of Upland Soil Concentrations to Screening Levels.

The MDLs for all analytes sampled for in upland soils were below their respective screening level (Table 2-8). Comparison of detected results to soil screening levels shows that only

two analytes are associated with a concentration in one or more samples that is higher than its respective screening level (Table 2-8).

- **Arsenic** is reported in all 30 upland soil samples at concentrations higher than the screening level of 0.39 mg/kg. Arsenic concentrations in these samples ranged between 2.55 and 9.47 mg/kg. However, this issue is believed attributable to the conservative nature of the screening benchmark for arsenic rather than concentrations of arsenic that may not be representative of background conditions. Although regional background levels for arsenic in upland soils are not currently available, the range of arsenic concentrations reported in Western U.S. soils is <0.1 – 97 mg/kg, with an arithmetic mean of 7.2 mg/kg (Shacklette and Boerngen, 1984). Clearly, the soil screening level for arsenic is within the range of reported background concentrations for arsenic in soils. In addition, arsenic concentrations are known to be higher in the naturally occurring Phosphoria Formation than in other geologic materials.

- **Manganese** is detected at concentrations above the screening level for manganese in nine of ten upland soil samples at the Henry Mine, and five of ten samples at the Enoch Valley Mine. The highest concentration of manganese detected in background upland soils samples is about two-fold higher than the manganese screening level (3,990 mg/kg at Henry Mine). Although regional background levels for manganese in upland soils are not currently available, the range of manganese concentrations reported in Western U.S. soils is <2 – 7,000 mg/kg, with an arithmetic mean of 550 mg/kg (Shacklette and Boerngen, 1984). Clearly, the soil screening level for manganese is within the range of reported background concentrations for manganese in soils. In addition, these data support findings from the *RI/FS Work Plan* that show that manganese is often naturally elevated in background soils and waters throughout the Sites.

The highest concentrations of the above analytes are found at the Enoch Valley Mine. However, these locations are associated with undisturbed areas, and they were included as background sample locations in the A/T-approved *Supplemental Soil and Vegetation Sampling Characterization Sampling and Analysis Plan (*MWH, 2009). But, an evaluation of any outliers

will have to consider that the background areas are located within the mine areas, and wind deposition impacts cannot be positively excluded.

Based on the above, P4 believes that it is appropriate to include all of the upland soil sampling locations and results summarized in Table 2-8 in the background upland soil dataset.

2.2.2.2 Comparison of Upland Vegetation Concentrations to Screening Levels.

The MDLs for all analytes sampled for in upland vegetation were below their respective screening level, with the exception of molybdenum (Table 2-9). The MDLs for samples collected from two locations at the Enoch Valley Mine (MBE001-01 and MBE001-03) were about 3- to 5-fold higher than the screening level of 5 mg/kg for molybdenum. However, these MDLs are in the range of detected results for upland vegetation samples collected from other locations at the Sites. So, it is unlikely that inclusion of these data in the background dataset for molybdenum will have a significant bias on the background concentration for molybdenum in upland vegetation. As described in Section 2.2.1 above, these data will be further evaluated during the statistical analysis for the potential presence of statistical outliers.

Comparisons of detected vegetation results to vegetation screening levels show that several analytes have one or more detections that are higher than their respective screening levels (refer to Table 2-9).

- **Molybdenum** concentrations in upland vegetation are higher than the vegetation screening level for molybdenum of 5.0 mg/kg in eight of the 30 sample locations. The concentrations in these eight samples ranged from 5.08 to 240 mg/kg. These molybdenum concentrations were reported from vegetation samples collected in a variety of different vegetation types at both the Ballard and Enoch Valley Mines. Regional background levels for upland vegetation are not available. As described in Section 2.2.1 above, these data will be further evaluated during the statistical analysis for the presence of potential statistical outliers.
- **Selenium** concentrations in upland vegetation are higher than the screening level of 5 mg/kg in a variety of vegetation types from one sample location at the Enoch Valley Mine, MBE001-07. Other samples with selenium concentrations above the

screening level occurred in vegetation samples with molybdenum concentrations higher than its screening level. The selenium concentrations in these vegetation samples above the screening level ranged from 5.02 to 10.4 mg/kg. Regional background levels for upland vegetation are also not available. As described in Section 2.2.1, above, these data will be further evaluated during the statistical analysis for the potential presence of statistical outliers.

- **Boron** in one sample at one site at Enoch Valley was greater than the vegetation screening level. As described in Section 2.2.1 above, this result will be further evaluated during the statistical analysis for the potential presence of statistical outliers.

The highest concentrations of the above analytes were detected at the Ballard and Enoch Valley Mines. However, these locations are undisturbed areas, and they were included as background sample locations in the A/T-approved *Supplemental Soil and Vegetation Sampling Characterization Sampling and Analysis Plan (*MWH, 2009).

Based on the above, P4 believes that it is appropriate to include all of the upland vegetation sampling locations and results summarized in Table 2-9 in the background upland vegetation dataset.

2.2.3 Groundwater Background Locations

Wells selected to represent background groundwater quality for the Sites were evaluated from two groups located around the three Sites. The first group includes 13 agricultural and domestic wells selected from locations that are not directly downgradient of the Sites, or are at least, far enough downgradient that they can reasonably be expected to not be impacted by Site activities and are considered "natural background." This group of wells best represents the common sources of groundwater used near the Sites. However, because water for agricultural and domestic uses is not commonly withdrawn from the geologic units typically in contact with Site groundwater discharges, a second group of wells also have been considered in the background evaluation.

This second group of wells represents the specific hydrogeologic flowpaths most relevant to the Sites (i.e., the alluvial, Dinwoody Formation and Wells Formation). The nine wells are located in on-Site areas that have not been affected by Site contaminants but may be located

downgradient of the Sites. Initial screening of the groundwater data, as further discussed in Section 3.4, evaluated both groups of wells for inclusion in the background evaluation.

The background wells have been sampled between two and seven (depending on the well) times during 2004 to 2010 as presented on Table 2.1. The groundwater background stations and selenium concentrations are shown on Drawing 2-5. Also included on Drawing 2-5 are preliminary groundwater flow direction arrows as requested by the A/Ts. Groundwater flows throughout the Site are complex because of the multiple hydrostratigraphic systems and folded/faulted sedimentary rock sequences. It is very difficult to establish that piezometric measurements from any two wells are from the same hydrostratigraphic unit. Therefore, flow arrows included on Drawing 2-5, in the best of cases, are an approximation, and assessment of flow direction is based on hydrogeologic principles and direct lines of evidence along with secondary data. The RI Reports will provide detailed discussions of the flow systems. However, it should be noted that much of this discussion already is provided in the A/T-approved *RI/FS Work Plan* (Section 3.7.4). Establishment of the background groundwater locations uses a weight of evidence approach, including lack of apparent elevated source-related constituents and hydrogeologic rationale for the lack of impact (e.g., distance from sources, geology and/or flow direction).

The flow direction arrows included on Drawing 2-5 focus only on those areas and flow systems that contain background wells. For many of the agricultural and domestic wells, groundwater flow is very speculative. Identification of these wells as potential background locations is partly based on their distance from any source area. Vertical gradients are not depicted on the drawing and these are important at both the east Ballard and south Enoch Valley locations. For discussion, of the relevant hydrogeologic conditions in these areas, please see Sections 3.7.4.2 and 3.7.4.4 of the A/T-approved *RI/FS Work Plan*.

The monitoring well location details and rationale for each background sample locations for groundwater are provided in Table 2-10. Tabulated groundwater data for each background location are provided in Table 2-11. The data tables for each medium also highlight detected concentrations and shade exceedances of screening levels for each analyte. As discussed in Section 2.2.1 above, the final representativeness and usability of individual data should not be determined through comparisons of background sampling results to risk-based screening

levels, but through statistical evaluations performed during the calculation of Site-wide background levels.

2.2.3.1 Comparison of Groundwater Concentrations to Screening Levels.

The MDLs for all analytes reported in the groundwater dataset were below their respective screening levels (Table 2-11). Comparison of detected results to groundwater screening levels shows that there are several analytes that are higher than their respective screening levels (Table 2-11) as discussed below.

- **Aluminum** concentrations in groundwater samples were above the screening level of 0.2 mg/L in seven of 23 background locations with results ranging from 0.417 to 8.75 mg/L. These groundwater samples were analyzed from the unfiltered or total fraction during both spring and fall sampling events. In all instances, dissolved aluminum concentrations in groundwater are below the MDLs. An example would be MMW007, which has a total aluminum concentration of 0.47 mg/L and a dissolved aluminum concentration of <0.03 mg/L (i.e., the MDL) in the fall of 2007. This suggests that the aluminum detected in unfiltered groundwater samples collected and analyzed for total aluminum is from clay particles entrained in the water. In addition, the aluminum concentrations in the background dataset support findings from the *RI/FS Work Plan* that show that aluminum often is naturally elevated in the groundwater samples collected from wells located throughout the Sites.

- **Iron** concentrations in groundwater collected from eleven of 23 background well locations were greater than the screening level of 0.3 mg/L during several spring and fall sampling events. The iron concentrations ranged from 0.35 to 6.96 mg/L. These wells are generally the same wells that report aluminum concentrations greater than its screening level. In these monitoring wells, total iron in groundwater was greater than the screening level, and dissolved iron concentrations typically were below detection limits, again suggesting that the iron detected in unfiltered groundwater samples is from particulate matter entrained in the water. In the agricultural and production wells, if the total iron concentrations are greater than the screening level, then the dissolved iron concentrations also are greater than the iron screening level. This may be the result of well construction methods (i.e., steel

casing). Regardless, the iron concentrations in the background dataset support findings discussed in the *RI/FS Work Plan* that show iron is often naturally elevated in the groundwater collected from wells located throughout the Sites.

- **Manganese** concentrations in groundwater collected from 11 of 23 background monitoring locations report concentrations of total and dissolved manganese above the screening level of 0.05 mg/L during several spring and fall sampling events. The manganese concentrations ranged from 0.0524 to 0.915 mg/L. These are generally the same wells that report aluminum and iron screening values (with a couple of exceptions) above their screening levels. The manganese concentrations in the background dataset support findings discussed in the *RI/FS Work Plan* that show that manganese is often naturally elevated in the groundwater collected from wells located throughout the Sites.

In addition, arsenic, zinc, sulfate, and TDS concentrations are above their respective screening levels in one or two samples. However, these concentrations will be further evaluated during the statistical analyses as described in Section 3.0.

Based on the discussion above, P4 believes that it is appropriate to include all of the groundwater sampling locations and results summarized in Table 2-11 in the background groundwater dataset.

2.3 Availability and Selection of Secondary Media

Secondary media include biotic receptors and data from these receptors will be considered supporting information during the risk assessment. For example, if risk to a receptor is indicated based on a primary media, then available secondary media will be evaluated to confirm or refute the assessment. The secondary media are:

- Fish
- Benthic Macroinvertebrates
- Elk
- Bird Egg
- Cattle

- Small Mammals

The uses of these data are further established in the data usability and risk assessment methodology presented in the *DQUR/DAR* (MWH, 2010a and Appendix B of the *RI/FS Work Plan*; MWH, 2011) and the *Human Health and Ecological Risk Assessment Work Plan* (*HHERA Work Plan*; Appendix C of the *RI/FS Work Plan*). Table 2-1 provides a summary of these data uses for both the secondary and primary media.

The pre-2004 data listed in Table 2-1 have been collected using appropriate planning, sampling methods, trained sampling teams, analytical methods, and known laboratories with appropriate credentials. These data are useful for RI/FS scoping, site characterization, and supporting the FS evaluation of alternatives but are not for use in the quantitative risk assessment. It is anticipated that pre-2004 elk tissue, bird egg, and cattle study data will be acceptable to support the risk assessment after validation. Background will be evaluated for secondary media in the future, if necessary, and thus, are not included in this document.

3.0 STATISTICAL METHODS AND PROCEDURES FOR BACKGROUND CALCULATIONS

This section provides a description of the statistical and graphical methods that were used to establish background levels for COPCs in sediment, surface water, riparian soil and vegetation, upland soil and vegetation, and groundwater for use in the RI Reports, RA Reports and FS Reports to be prepared for the three Sites. The background level evaluation includes statistical and graphical refinement of the datasets presented in Section 2.0, and the development of upper bound estimates of background levels for COPCs in each of the above media.

3.1 Introduction

Previous documents prepared for the Sites, including EE/CA studies and the *RI/FS Work Plan*, utilized statistically derived, preliminary background levels (e.g., FUBOB preliminary background levels) that have not been agreed to by the A/Ts as discussed earlier.

For purposes of the current background evaluation, EE/CA data collected in 2004 for sediment, riparian soil and vegetation, and upland soil and vegetation, for the background locations presented in Section 2.0 were supplemented with additional background data collected after 2004. Specifically, additional background data were collected under the EE/CA for upland soil and upland vegetation in 2009, and under the RI/FS Work Plan for riparian soil and sediment in 2010. Data for surface water were collected between 2004 and 2010, and data for groundwater were collected between 2004 and 2010 (refer to Section 2.2 for specific background sample locations). Groundwater and surface water samples were not collected in 2011, but were collected in 2012 under an A/T-approved program. Data collected in June and September 2012 are not included in this Background Memorandum as the background summary statistics were developed prior to receiving validated 2012 sample results. However, as previously discussed with the A/T, the 2012 data were compared to the 2004-2010 datasets and are found to be within the range of historical values.

The statistical and graphical methods described in this section were conducted using the combined (i.e., EE/CA data and supplemental RI/FS background) datasets to derive background levels for each COPC in each medium presented in Section 4.0.

Background datasets for each constituent in each medium were combined into a single dataset for statistical evaluation and derivation of background levels. The Sites are located in the headwaters of several surface water drainages such that there are limited upstream locations from which un-impacted background surface water, sediment, riparian soil and riparian vegetation samples could be collected. As a result, it was not possible to collect statistically meaningful numbers of background samples for these media for individual Sites.

The primary decision criterion that was used during the selection of A/T-approved background sampling locations for upland soil and upland vegetation was undisturbed areas away from mining activities. Geologic representativeness of a background sampling area to a specific mine Site was a lesser criterion. It also should be noted that the entire geologic sequence was not represented in the current background datasets for upland soil and vegetation, as samples were not collected from locations overlying, or immediately downslope of the Phosphoria Formation even though there are several locations owned by P4 where the Phosphoria Formation is unmined and representative samples could be collected from a native unimpacted area if necessary. As a result, the background datasets for upland soil and vegetation represent only a portion of the geological characteristics, land formations and vegetative communities present at each mine site and likely are not representative of pre-mining geological conditions inside the pit boundaries at individual mine Sites. For example, upland soil and vegetation samples were collected from undisturbed areas overlying the Dinwoody Formation at the Henry and Enoch Valley Mine reference areas, and from over the Wells Formation at the Ballard Mine reference area. Because each of the Sites' background reference areas represents only one geologic formation, these data must be combined to capture the heterogeneous nature of the Sites. Even when these data from the three background reference areas are combined, the concentrations for upland soils and vegetation are likely to be biased low for certain elements, relative to the Sites because these datasets only represent the Wells and Dinwoody Formations; no background samples were collected from the Phosphoria Formation. Although the collection of background samples over a large geographic area has the potential to result in background datasets that contain more populations than are present at an individual mine site, this does not appear to be the case for the background datasets collected from the reference areas which likely contain fewer populations than are present at the Sites in total.

Similar to surface water, the P4 groundwater reference locations are generally in or near aquifer recharge areas so that groundwater flow is downgradient from individual monitoring locations and generally away from the Sites. As such, true upgradient groundwater sampling locations specific to an individual mine site are not present and those that would be possible are in locations and at depths not readily accessible (e.g., as in the case of Wells Formation). It is therefore necessary to look at background for groundwater more generally with groundwater monitoring locations more dispersed throughout the area of the Sites.

The pooling of background data across aquifers introduces some uncertainty in the background datasets. Major ion concentrations may vary between aquifers. For example, calcium and alkalinity may be naturally greater in the regional Wells Formation aquifer compared to the local alluvial aquifer. However, for most trace elements analytes like selenium, which are the primary concern of the RI/FS, distinct associations are not clear. Therefore, pooling of these data is unlikely to present a bias representation of these data, but provide a better statistical basis for the background levels. An exception may be groundwater from the Phosphoria Formation; however, this unit is not represented in the background datasets. In addition, because groundwater uses in the area are not predominately from any individual aquifer, a pooled dataset may be more similar to the potential groundwater use locations. For example, some domestic and industrial wells in the area of the Sites currently draw groundwater from multiple aquifers.

3.2 Summary of Possible Statistical Methods/Procedures

Statistical evaluations for background data generally include: 1) establishing final background datasets for each COPC in each medium using graphical or statistical procedures (e.g., outlier testing), and 2) deriving statistical, upper bound estimates of the background population for each COPC in each medium using the final background datasets. To establish final background datasets for each COPC in each medium, descriptive statistics, outlier analysis and comparative statistical analysis on the background datasets are typically performed to confirm whether all data in each background dataset for a given COPC and medium is representative of the 'true' background population. Descriptive statistics including the number of samples, the number of detections, the detection frequency, the maximum and minimum detected concentrations, the mean, and the standard deviation of the background data provide a preliminary examination of data.

An outlier analysis can identify potential outliers that are not representative of the true background population. Including real outliers in a dataset can potentially lead to Type I or Type II errors (USEPA, 2002a). Methods of outlier analysis include statistical outlier tests such as Dixon's test and Rosner's test, which are available in ProUCL 4.1.01 (USEPA, 2011) and Scout 1.00.01 (USEPA, 2008), and visual inspection for potential outliers using quantile-quantile (QQ) plots. Inappropriate exclusion of data points from a background dataset can also lead to Type I errors (i.e., false positives). Type I errors may occur during COPC/COPEC screening when the maximum concentration of an analyte appears to be higher than background because the background statistic (e.g., an UTL) was biased low. Low bias in the background statistic may occur when extreme values are mistakenly eliminated from the background dataset, and the range of background concentrations is reduced. Conversely, high bias and Type II errors (i.e., false negatives) may occur when extreme values are mistakenly retained in the background dataset.

Comparative statistical tests such as the two sample t-test, Wilcoxon Mann-Whitney test, and analysis of variances (ANOVA) can be used to determine if background data from different strata are statistically different or whether background data from different strata should be combined for the statistical background evaluation. A sampling design that accounts for differences between strata and produces one dataset that is inclusive of the whole populations is referred to as 'stratified random' sampling (USEPA, 2002b; USEPA, 2002c). In stratified random sampling, the whole population is divided into different strata, and simple random sampling is used within each stratum after the sample size is determined (USEPA, 2002b; USEPA, 2002c). Datasets collected using stratified random sampling are representative of the entire sampled population, and account for differences between strata (USEPA, 2002b; USEPA, 2002c), unlike datasets collected using simple random sampling.

When it is deemed appropriate to identify individual sub-populations of the background population, graphical and/or statistical procedures can be used to determine whether two or more sub-populations are present within the initial background dataset. If individual sub-populations are present, it may be appropriate to define each sub-population as a final dataset. Multiple sub-populations are common in background environmental media due to the heterogeneous nature (e.g., influences of different geological formations on overlying

soils) of such media. Decisions regarding the need to test for multiple sub-populations are based in large part on the nature of the sampling design and the robustness of the datasets.

For most media and constituents comprising the background datasets for the Sites, the number of suitable background locations are scarce and as a result, the numbers of samples at any individual mine Site are too limited to support meaningful comparative statistics. As an example, for several riparian media and groundwater, the limited number of viable background sampling locations (at the headwaters of sub-basins) restricted the number of samples that were collected at each mine. This resulted in low sample numbers for particular mines so the background datasets for individual mine Sites were combined into a single dataset for each medium (with A/Ts' concurrence).

Once the final background datasets are identified, statistics are derived to represent upper bound estimates of the background population. Statistics that are commonly used to represent the upper bound estimate of the background population include:

- 95% Upper prediction limit (UPL) – A prediction limit is an estimate of an interval in which future observations will fall into based on observed values. A 95% UPL represents the limit in which future observations will be less than or equal to the value, with a 95% confidence. Each future observation comparison to the 95% UPL has a 5% probability of exceeding the 95% UPL. As a result, when a 95% UPL is used to compare many future observations, a relatively high number of false positives (i.e., a value exceeding background that is within range of background values) could occur. The 95% UPL provides a good compromise between false positives and false negatives in most practical applications (USEPA, 2011b).
- 95/95 Upper tolerance limit (UTL) – A tolerance limit establishes the values in which a fixed proportion of a population would fall into. A 95/95 UTL represents the upper limit of a tolerance interval in which 95% of the observations from the background population will be less than or equal to the value, with a 95% confidence. Unlike a 95% UPL, a 95/95 UTL is designed to provide simultaneous coverage of 95% of all observations. Approximately 5% of background samples are expected to exceed a 95/95 UTL, which can be problematic if a 95/95 UTL is compared to many observations.

- 95% Upper simultaneous limit (USL) – A simultaneous limit establishes the values in which the entire population would fall into. A 95% USL represents the limit in which all background observations will be less than or equal to the value, with a 95% confidence. All background observations are expected to be below a 95% USL and it can be used to compare many observations. Comparisons of Site data to the 95% USL would not result in a large number of false positives, as would a 95% UPL or 95/95 UTL.
- Maximum value in the final dataset – When confidence is sufficient that the background dataset is representative of the 'true' background population, it may be appropriate to use the maximum value within the final dataset as the background statistic. Use of the maximum value as the background statistic reduces the potential for Type I errors (i.e., false positives) when the background population is completely characterized. However, since it is impossible to completely characterize the background population, the use of a maximum background value may produce false positives because it does not account for future observations.

In addition, the calculation of background risk estimates for use in the derivation of incremental risk will be based on 95% upper confidence limit (UCL) on the mean concentrations, or maximum detected concentrations, for consistency with the exposure point concentrations used in the calculation of Sites' risk estimates.

The selected statistical methods for the P4 background evaluation are described in Section 3.3 and were developed in accordance with, or in consideration of, the following guidance documents and/or reference materials:

- USEPA's Data Quality Assessment: Statistical Methods for Practitioners, EPA QA/G-9S. EPA/240/B-06/003. February (USEPA, 2006).
- Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (USEPA. 2002a).
- RCRA Waste Sampling Draft Technical Guidance - Planning, Implementation, and Assessment (USEPA. 2002b).

- Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan (USEPA. 2002c).

3.3 Selected Statistical Methods for the P4 Background Level Evaluation

The methods and procedures for deriving statistical limits for each COPC in sediment, surface water, riparian soil, riparian vegetation, upland soil, and upland vegetation are described below. Because IDEQ has developed specific guidance for the development of background levels for groundwater (IDEQ, 2009b), the statistical procedures to be used in the background evaluation for groundwater are described separately (refer to Section 3.4).

Initial background datasets are comprised of medium-specific background sampling results for each COPC in sediment, surface water, riparian soil, riparian vegetation, upland soil, and upland vegetation. As discussed above, the Sites are located in the headwaters of several surface water drainages or in recharge areas such that there are limited upstream/upgradient locations from which un-impacted background surface water, sediment, riparian soil, and riparian vegetation samples could be collected. Therefore, it was not possible or practicable to collect statistically meaningful numbers of background samples for these media from individual P4 mine sites.

All background sample results for a given COPC in a given medium are included in the initial background dataset for that COPC and medium. An outlier analysis consistent with the methods described in Section 3.2 then was performed on each initial dataset. The outlier analysis consisted of visual inspection using quantile-quantile (QQ) plots, and statistical outlier tests including Dixon's test and Rosner's test. These outlier tests were performed using ProUCL Version 4.1.01 (USEPA, 2011). Rosner's test was used when the sample size was equal or greater to 25, and Dixon's test was used when the sample size was less than 25. The decision to remove an outlier from a dataset should be based on a "weight-of-evidence" evaluation that includes visual inspection of graphical plots, results of outlier tests, and issues such as sampling anomalies or quality assurance/quality control (QA/QC) concerns. Visual inspection of graphical plots such as QQ plots provides information such as the presence of potential outliers, separate groups within the data and data distribution which cannot be determined by merely running statistical outlier tests. Potential outliers were identified as isolated data values that were separated from the majority of the dataset by visible large gaps.

These potential visual outliers were then tested with the appropriate outlier statistical tests to determine whether they are statistical outliers. Consequently, all statistical outliers were removed from the background datasets. If an outlier was identified in a sample, the data for other constituents from the same sample were not automatically removed as outliers.

Samples corresponding to individual sample locations were removed from the background datasets after the A/Ts expressed concerns about the locations, and a field visit was conducted on June 27, 2012 to confirm that the sample locations may have been impacted by the Sites. The remaining background sample locations are assumed to represent background conditions, and samples collected from these locations were included in the statistical evaluation and outlier analysis.

The fact that an outlier was identified for one constituent does not necessarily mean that the sample location was impacted by the Sites. There could be a variety of reasons why an individual analytical result is anomalous for one constituent. For example, inadvertent collection of a rock chip in a sample that is naturally high in one mineral or analytical error related to the method for analyzing the constituent. However, an anomalous result for one constituent doesn't mean that the entire sample is anomalous. The remaining constituents in that sample could be representative of their respective background populations. If sample results for an individual constituent were deemed to be representative of the background population based on these procedures, it was retained in the background dataset for that constituent. To do otherwise, would unnecessarily reduce the robustness of the background datasets. An outlier analysis was conducted for the combined medium-specific dataset prior to the estimation of statistical limits as described in the paragraph above.

3.3.1 Statistical Methods by Medium

Medium-specific methods and procedures for evaluating background are described in the following subsections.

3.3.1.1 Sediment, Surface Water, Riparian Soil and Vegetation.

Sediment, surface water, and riparian soil samples were collected in A/T-approved areas throughout the Sites, and are not representative of any individual mine. As a result, comparative statistical tests were not conducted to test for potential statistical differences between medium-specific reference areas. An outlier analysis was conducted for the

combined medium-specific dataset prior to the estimation of statistical limits. Summary statistics and statistical limits, as described in Section 3.2, were calculated for the combined medium-specific dataset for each COPC.

Riparian vegetation samples were collocated with riparian soil samples. As with riparian soil samples, riparian vegetation samples were collected in A/T-approved areas throughout the Sites, and therefore are not representative of any individual mine. Consistent with the statistical evaluation for riparian soil, riparian vegetation sampling results were combined across all riparian vegetation stations for each COPC. Unlike upland vegetation samples which were collected for discreet plant species or plant types (e.g., grasses, forbs), riparian vegetation samples represent composite samples across multiple species or types. Therefore, it was not possible to segregate riparian vegetation by plant species or types. Additional information about the riparian vegetation species found at the P4 Sites is presented in Appendix C of the *RI/FS Work Plan* (MWH, 2011). An outlier analysis was conducted for the combined riparian vegetation dataset prior to the estimation of statistical limits. Summary statistics and statistical limits, as described in Section 3.2, were calculated for the combined riparian vegetation dataset for each COPC.

3.3.1.2 Upland Soil and Vegetation.

As described in Sections 3.1 and 3.2, the primary decision criterion that was used during the selection of A/T-approved background sampling locations for upland soil and upland vegetation was undisturbed areas away from mining activities. Geologic representativeness of a background sampling area to a specific mine Site was a lesser criterion. As a result, the entire geologic sequence was not represented in the current background datasets for upland soil and vegetation for an individual Site. For example, upland soil and vegetation samples were collected from undisturbed areas overlying the Dinwoody Formation at the Henry and Enoch Valley Mine reference areas, and from over the Wells Formation at the Ballard Mine reference area. Because each Site' background reference area represents only one geologic formation, these data must be combined to capture the heterogeneous nature of the Sites. Even when data from the three background reference areas are combined, the concentrations for upland soils and vegetation are likely to be biased low for certain elements, relative to the Sites because these datasets only represent the Wells and Dinwoody Formations; no background samples were collected from the Phosphoria Formation (known

to contain elevated levels of Site COPCs). Thus, the upland soil samples collected from individual mine Sites were too limited to perform meaningful statistical comparisons Consistent with the above, sample results for upland soil were combined across all three upland soil reference areas for each COPC, and comparative statistical tests were not conducted to test for potential statistical differences between upland soil reference areas. An outlier analysis was conducted for the combined upland soil dataset prior to the estimation of statistical limits. Summary statistics and statistical limits, as described in Section 3.2 (below), were calculated for the combined upland soil dataset for each COPC.

Upland vegetation samples were co-located with upland soil samples. Consistent with the statistical evaluation for upland soil, sample results for upland vegetation were combined across all three upland vegetation reference areas for each COPC, and comparative statistical tests were not conducted to test for potential statistical differences between upland vegetation reference areas. The types of vegetation sampled at a given location were dependent upon the plant species available at that sample location. No attempt was made to collect samples of all available plant species within the reference areas, or to collect representative numbers of each plant species. As a result, comparative statistical tests were not conducted to test for potential differences between plant species. A review of the plant species consumed by the bird and mammal indicator receptors identified in the *HHERA Work* Plan in Appendix C of the *RI/FS Work Plan* (MWH, 2011) concluded that these indicator receptors consume a wide variety of plant species. As a result, all plant species are potentially applicable to all ecological indicator receptors. Therefore, upland vegetation data were not segregated for individual ecological receptors; rather, statistics were performed on the total 'combined' upland vegetation datasets for ecological receptors. Human receptors will only consume culturally significant plants; therefore, the upland vegetation data were segregated into culturally significant plant species identified by the A/Ts, as summarized in Section 3.2 of Appendix A2 of the *RI/FS Work Plan* (MWH, ,2011) and non-culturally significant plant species for purpose of the statistical evaluation for human receptors. An outlier analysis was conducted for the combined upland vegetation dataset prior to the estimation of statistical limits. Summary statistics and statistical limits, as described in Section 3.2, were calculated for each COPC in culturally significant, non-culturally significant and combined upland vegetation datasets.

3.3.2 Statistical Limits

For the final background datasets described in Section 3.3.1 above, summary statistics including the number of samples, number of detections, detection frequency, maximum and minimum detected concentrations, mean concentration, and the standard deviation were calculated and presented in summary tables (see Section 4.0). The final datasets were also tested for the underlying distributions (e.g., normal, lognormal, gamma) using ProUCL 4.1.01 (USEPA, 2011a) before statistical limits were estimated in order to determine which statistical limit estimates best described the respective background datasets.

The following statistical limits for potential use as a background level were calculated using ProUCL 4.1.01 (USEPA, 2011) or Scout 1.00.01 (USEPA, 2008), as appropriate for each COPC in each medium when five or more detections were present:

- 95% UPL
- 95/95 UTL
- 95% USL

The final background level for each COPC in each medium was selected by P4 in consultation with the A/Ts from one of the calculated upper bound statistics (i.e., 95% UPL, 95/95 UTL, 95% USL) or the maximum detected concentration. The 95% USL was selected as the proposed background level for future RI/FS activities because (1) some or all of the background datasets may be biased low because they exclude sampling on the Phosphoria Formation; (2) many of the background datasets contain limited sample sizes and, therefore, are unlikely to represent the full range of natural ambient concentrations in the vicinity of the Sites, and (3) this statistic should result in lower Type I error rates (i.e., false positives) and can be used to compare many observations.

When datasets contained fewer than 5 detects, the above statistics were not calculated; instead, the maximum detected concentration was proposed as the background level for a given COPC in a given medium. If there were no detected results, the highest method detection limit (MDL) was proposed as the background level for a given COPC in a given medium.

3.4 Specific Procedures for Groundwater Background Evaluations

As explained in Section 2.2.3 above, wells selected to represent natural background groundwater quality for the Sites were evaluated from two groups located around the three Sites. The first group includes agricultural and domestic wells and the second group includes on-Site wells. The on-Site wells are located in areas that have not been affected by Site contaminants as explained in Table 2-10 but may be located downgradient of the Sites. As discussed above for the other media, the Sites are located in the headwaters of several surface water drainages or in recharge areas such that there are limited upstream/upgradient locations from which un-impacted background groundwater samples could be collected. Therefore, it was not possible or practicable to collect statistically meaningful numbers of background samples for this medium from individual P4 mine sites.

The initial screening of these wells was a qualitative assessment of the hydrogeology and the selenium and sulfate concentrations. The selenium and sulfate concentrations are the most direct indicators of impacts from the Sites. The Site monitoring and production wells selected during the initial screening were subjected to further quantitative statistical treatment during the background evaluation. This included both a comparison to the wells contained in the first group (to assess similarity) and to on-Site wells to further quantify differences in the number and magnitude of COPCs in these two groups of Site wells. The assessment comparing background wells for similarity considered that wells installed in different geologic units may have different chemical signatures due to the unique geochemistry of each unit. The use of a pooled dataset across the different aquifers as well as data separated out by the different geologic units (shallow, intermediate, and deep) was evaluated, as further described Section 4.0. The initial list of Site monitoring wells including the formation and geologic/aquifer unit is summarized in Table 2-10. The table also includes the hydrogeologic rationale for inclusion of each well. Results of the screening during the quantitative portion of the background assessment, is discussed in Section 4.0.

Following this initial screening, the datasets were evaluated for adequate sample size and results below the detection limit were treated in accordance with the *Statistical Guidance for Determining Background Ground Water Quality and Degradation* (IDEQ, 2009b). An outlier analysis was conducted for the groundwater dataset prior to the estimation of statistical limits. The occurrence of seasonal or secular trends was also considered through qualitative

(visual) evaluation of concentration trend graphs, and no corrections of these data were necessary prior to the statistical analysis of the background groundwater concentrations. Summary statistics and statistical limits, as described in Section 3.2 for other media, were calculated for the groundwater dataset for each COPC.

Once the above steps were completed, the following statistical limits for potential use as a background level were calculated using ProUCL 4.1.01 (USEPA, 2011) or Scout 1.00.01 (USEPA, 2008), as appropriate for each COPC in each medium when five or more detections were present:

- 95% UPL
- 95/95 UTL
- 95% USL

Per IDEQ (2009b), "in cases where site conditions indicate that the ground water quality in downgradient wells differs from background conditions (because of existing site practices), data from multiple downgradient wells were compared to upgradient wells (an interwell analysis) via a parametric UPL calculated from pooled upgradient background data". However, the final background level for each COPC in groundwater was selected by P4 in consultation with the A/Ts from one of the calculated upper bound statistics (i.e., 95% UPL, 95/95 UTL, 95% USL).

The 95% USL was selected as the proposed background level for future RI/FS activities, as described in Section 3.3.2. When datasets contained fewer than 5 detects, the above statistics were not calculated; instead, the maximum detected concentration was proposed as the background level for a given COPC in a groundwater. If there were no detected results, the highest method detection limit (MDL) was proposed as the background level for a given COPC in a groundwater.

4.0 RESULTS OF THE BACKGROUND STATISTICAL EVALUATION

4.1 Introduction

The background data for the COPCs and COPECs in each medium were evaluated as described in Section 3.3.1. A preliminary COPC and COPEC screening of Site data was performed to identify those metals in each medium for which background levels will be required because some of the metals analyzed in the background sampling investigations will be screened out during the refined COPC and COPEC screening steps performed in the HHERAs for each of the Sites. As a result, several of the metals analyzed for in the background sampling investigations will not be carried forward into the quantitative HHERAs for the Sites. The preliminary COPC and COPEC screening steps for each medium are summarized in Tables 4-1 through Table 4-7.

The COPC/COPEC screening process was conducted in accordance with Appendix C of the *RI/FS Work Plan* (MWH, 2011), with the following exceptions:

- May 2012 soil and tap water Regional Screening Levels (RSLs), published by the USEPA (2012), were used instead of the 2010 USEPA RSLs because the RSLs have been updated since the *RI/FS Work Plan* was finalized.
- USEPA Region 3 (USEPA, 2006) Freshwater Sediment Screening Benchmarks replaced the Sediment Evaluation Framework (USACE et al., 2009) that was listed first on the sediment COPEC screening benchmark hierarchy, per October 26, 2012 A/T comments (refer to P4's response to A/T Comment S3 in Appendix E5)

The summary statistics for each medium are presented in Tables 4-8 through 4-14. The background datasets prior to the removal of outliers are referred to as 'uncensored' in Tables 4-8 through 4-14, and the background datasets following the removal of outliers are referred to as 'censored'. The QQ plots that were used to visually inspect each dataset for potential outliers are presented in Appendix D.

4.2 Sediment Background Levels

Visual inspection of the QQ plot for selenium identified one potential visual outlier. However, the value (1.60 mg/kg) was not a statistical outlier based on Dixon's statistical test

and, as a result, no outliers were removed from the sediment dataset for selenium prior to estimating statistical limits.

No potential visual outliers were identified for other COPECs in sediment. No statistical limits were estimated for antimony, arsenic, boron, copper, manganese, mercury, molybdenum, silver, thallium, and uranium because these constituents had fewer than five detected results. The proposed background levels for molybdenum are based on the maximum detection limit. The proposed background levels for the remaining constituents are based on maximum detected concentrations.

The maximum detected concentrations for these constituents are comparable to typical ambient sediment concentrations listed in Agency for Toxic Substances and Disease Registry's (ATSDR) toxicological profiles, or the typical ambient soil concentrations listed in ATSDR's toxicological profiles when ambient sediment concentrations are not available. Data summary and statistical limits for COPCs and COPECs in sediment are summarized in Table 4-8.

4.3 Surface Water Background levels

Visual inspection of the QQ plot for arsenic identified two potential visual outliers. The second highest visual outlier (0.0028 mg/L) was tested as a statistical outlier using Dixon's statistical test to determine whether the two highest values are statistical outliers (i.e., if the second highest value is a statistical outlier, then the highest value must also be a statistical outlier). Results of Dixon's test demonstrated that both visual outliers were also statistical outliers; therefore, they were removed from the arsenic surface water dataset prior to estimating statistical limits.

Visual inspection of the QQ plots for iron, manganese, vanadium and zinc identified one potential visual outlier for each chemical. Those visual outliers also are statistical outliers based on results of the Dixon's or Rosner's statistical test, and as a result, one outlier was removed from each of the surface water datasets for these metals prior to estimating the statistical limits.

Visual inspection of the QQ plots for nickel and potassium identified three potential visual outliers for each chemical. Those visual outliers are also statistical outliers based on statistical

results of the Rosner's statistical test, and as a result, three outliers were removed from each of the surface water datasets for nickel and potassium prior to estimating the statistical limits. The original potassium surface water QQ plot was scaled to include the highest statistical outlier, which was much higher than the rest of the data. As a result, the potassium surface water data were replotted to confirm that no additional visual outliers were present in the dataset after three statistical outliers were removed.

Visual inspection of the QQ plots for calcium and total chromium identified two and one potential visual outliers, respectively. However, the values were not statistical outliers based on Rosner's statistical tests and, as a result, no outliers were removed from the calcium and total chromium datasets prior to estimating the statistical limits. No potential visual outliers were identified for the other COPCs or COPECs in surface water.

No statistical limits were estimated for beryllium, boron, cadmium, cobalt, copper, molybdenum, silver and thallium because these constituents had fewer than five detected results. The proposed background levels for boron, cadmium and thallium are based on the maximum detected concentrations. The proposed background levels for beryllium, cobalt, copper, molybdenum and silver are based on maximum detection limit for non-detects.

The proposed background levels for detected constituents with fewer than five detected results are comparable to typical ambient surface water concentrations listed in ATSDR's toxicological profiles. Data summary and statistical limits for COPCs and COPECs in surface water are summarized in Table 4-9.

4.4 Riparian Soil Background levels

Visual inspection of the QQ plot for copper identified three potential visual outliers. The third highest value (29 mg/L) was tested as a statistical outlier using Dixon's statistical test to determine whether the three highest values are statistical outliers (i.e., if the third highest value is a statistical outlier, then the two higher values must also be statistical outliers). Results of Dixon's test demonstrated that the three visual outliers are also statistical outliers; therefore, the three outliers were removed from the copper riparian soil dataset prior to estimating statistical limits.

Visual inspection of the QQ plot for molybdenum identified one potential visual outlier. The visual outlier is also a statistical outlier according to the Dixon's statistical test and, as a result, one outlier was removed from the riparian soil dataset for molybdenum prior to estimating the statistical limits. No potential visual outliers were identified for the other COPCs or COPECs in riparian soil.

No statistical limits were estimated for antimony because antimony had fewer than five detected results. The proposed antimony background level is based on the maximum detected concentration. The maximum detected concentration of antimony in riparian soil is comparable to typical ambient soil concentrations listed in Shacklette and Boerngen (1984). Data summary and statistical limits for COPCs and COPECs in riparian soil are summarized in Table 4-10.

4.5 Riparian Vegetation Background levels

No potential visual outliers were identified for any COPECs in riparian vegetation. No statistical limits were estimated for selenium because selenium had fewer than five detected results. The proposed selenium background level is based on the maximum detected concentration. The maximum detected concentration for selenium in riparian vegetation is comparable to typical vegetation concentrations listed in Kabata-Pendias (2011). Data summary and statistical limits for COPCs and COPECs in riparian vegetation are summarized in Table 4-11.

4.6 Upland Soil Background levels

Visual inspection of the QQ plot for total uranium identified four potential visual outliers. Those four visual outliers were tested as statistical outliers using Rosner's statistical test, which showed that they are also statistical outliers. As a result, the four outliers were removed from the total uranium dataset prior to estimating the statistical limits. The uncensored total uranium upland soil QQ plot was scaled to include the highest two statistical outliers, which were much higher than the rest of the data. As a result, the total uranium upland soil data were replotted to confirm that no additional visual outliers were present in the dataset after four statistical outliers were removed.

Visual inspection of the QQ plot for total chromium identified two potential visual outliers. Those two visual outliers were tested as statistical outliers using Rosner's statistical test, which showed that they are also statistical outliers. As a result, two outliers were removed from the total chromium dataset prior to estimating the statistical limits.

Visual inspection of the QQ plots for mercury, nickel, selenium, silver, thallium, vanadium and zinc identified one potential visual outlier for each chemical. Those visual outliers are also statistical outliers based on the results of the Rosner's statistical test and, as a result, one outlier was removed from each of the upland soil datasets for mercury, nickel, selenium, silver, thallium, vanadium and zinc prior to estimating statistical limits. The original mercury, nickel, selenium, silver and thallium upland soil QQ plots were scaled to include statistical outliers, which were much higher than the rest of the respective upland soil data for each chemical. As a result, the upland soil data for each chemical were replotted to confirm that no additional visual outliers were present in the dataset after one statistical outlier was removed from each dataset. In addition, the non-detect results in the silver dataset post outlier removal were temporarily removed to better visualize the distribution of detected results for the silver upland soil dataset. No potential visual outliers were identified for the other COPCs or COPECs in upland soil.

No statistical limits were estimated for molybdenum because molybdenum had fewer than five detected results. The proposed molybdenum background level is based on the maximum detected concentration. The maximum detected concentration of molybdenum in upland soil is comparable to the typical ambient soil concentrations listed in Shacklette and Boerngen (1984). Data summary and statistical limits for COPCs and COPECs in upland soil are summarized in Table 4-11.

4.7 Upland Vegetation Background levels

4.7.1 Culturally Significant Plants

The non-detect results were temporarily removed to better visualize the distribution of detected results for the molybdenum and silver culturally significant plants datasets. Visual inspection of the QQ plots with and without non-detect results for molybdenum and silver identified two potential visual outliers for each metal. The second highest values for molybdenum (10.4 mg/kg) and silver (10.5 mg/kg) were tested as statistical outliers using

Dixon's statistical test to determine whether the two highest values are statistical outliers. Results of Dixon's test demonstrated that the two visual outliers in each dataset are also statistical outliers; therefore, the two outliers were removed from each of the datasets for molybdenum and silver in culturally significant upland vegetation prior to estimating statistical limits. The uncensored QQ plots with and without non-detect results for the molybdenum culturally significant upland vegetation dataset were scaled to include the highest two statistical outliers, which were much higher than the rest of the data. As a result, the molybdenum culturally significant upland vegetation data were replotted with and without non-detect results to confirm that no additional outliers were present in the dataset after two statistical outliers were removed.

Visual inspection of the QQ plots for boron identified one potential visual outlier. The visual outlier is also a statistical outlier based on results of the Rosner's statistical test and, as a result, one outlier was removed from the culturally significant upland vegetation dataset for boron prior to estimating statistical limits. The original boron culturally significant upland vegetation QQ plot was scaled to include the statistical outlier, which was much higher than the rest of the data. As a result, the boron culturally significant upland vegetation data were replotted to confirm that no additional visual outliers were present in the dataset after one statistical outlier was removed. No potential visual outliers were identified for the other COPECs in culturally significant upland vegetation. For mercury, QQ plots with and without non-detect results for the culturally significant upland vegetation dataset were used to determine whether visual outliers were present. The culturally significant upland vegetation dataset for selenium appears to follow a lognormal distribution, and as a result, the QQ plot for log-transformed selenium culturally significant upland vegetation data was used to determine whether visual outliers were present in the dataset.

No statistical limits were estimated for antimony, thallium and total uranium because these constituents had fewer than five detected results. Proposed background levels for thallium, total uranium and antimony are based on the maximum detected concentrations for thallium and total uranium and the maximum detection limit for antimony. Maximum detected concentrations of thallium and total uranium and maximum reporting limit for antimony are comparable to typical vegetation concentrations listed in Kabata-Pendias (2011). Data

summary and statistical limits for COPECs in culturally significant upland vegetation are summarized in Table 4-13.

4.7.2 Non-culturally Significant Plants

The non-detect results were temporarily removed to better visualize the distribution of detected results for the molybdenum non-culturally significant plants dataset. Visual inspection of the QQ plots with and without non-detect results for molybdenum in non-culturally significant upland vegetation identified six potential visual outliers. The visual outliers also are statistical outliers based on the results of Rosner's statistical test and, as a result, six outliers were removed from the non-culturally significant upland vegetation dataset for molybdenum prior to estimating statistical limits. The uncensored QQ plots with and without non-detect results for the molybdenum non-culturally significant upland vegetation dataset were scaled to include the highest two statistical outliers, which were much higher than the rest of the data. As a result, the molybdenum non-culturally significant upland vegetation data were replotted with and without non-detect results to confirm that no additional visual outliers were present in the dataset after six statistical outliers were removed.

Visual inspection of the non-culturally significant upland vegetation QQ plot for cadmium identified one potential visual outlier. The visual outlier is also a statistical outlier based on results of the Rosner's statistical test and, as a result, one outlier was removed from the non-culturally significant upland vegetation dataset for cadmium prior to estimating statistical limits. The uncensored cadmium non-culturally significant upland vegetation QQ plot was scaled to include the statistical outlier, which was much higher than the rest of the vegetation data. As a result, the cadmium non-culturally significant upland vegetation data were replotted to confirm that no additional visual outliers were present in the dataset after one statistical outlier was removed. No potential visual outliers were identified for other COPECs in non-culturally significant upland vegetation.

For mercury and silver, QQ plots with and without non-detect results were used to determine whether visual outliers were present. The non-detect results in the mercury and silver datasets were temporarily removed to better visualize the distribution of detected results for the mercury and silver non-culturally significant upland vegetation datasets. The

non-culturally significant upland vegetation dataset for selenium appears to follow a lognormal distribution, and as a result, the QQ plot for log-transformed selenium non-culturally significant upland vegetation data was used to determine whether visual outliers were present in the dataset.

No statistical limits were estimated for antimony and total uranium because these constituents had fewer than five detected results. Proposed background levels for antimony and total uranium are based on maximum detected concentrations. Maximum detected concentrations for these constituents are comparable to typical vegetation concentrations listed in Kabata-Pendias (2011). Data summary and statistical limits for COPECs in non-culturally significant upland vegetation are summarized in Table 4-13.

4.7.3 Combined Plant Types

The non-detect results were temporarily removed to better visualize the distribution of detected results for the molybdenum combined upland vegetation dataset. Visual inspection of the uncensored QQ plots with and without non-detect results for molybdenum in combined upland vegetation identified eight potential visual outliers. The visual outliers are also statistical outliers based on the results of Rosner's statistical test and, as a result, eight outliers were removed from the combined upland vegetation dataset for molybdenum prior to estimating statistical limits. The uncensored QQ plots with and without non-detect results for molybdenum in combined upland vegetation datasets were scaled to include the highest two statistical outliers, which were much higher than the rest of the data. As a result, the molybdenum combined upland vegetation data were replotted with and without non-detect results to confirm that no additional outliers were present in the dataset after eight statistical outliers were removed.

Visual inspection of the QQ plot for silver in combined upland vegetation identified two potential visual outliers. The second highest value (10.5 mg/kg) was tested as a statistical outlier using Dixon's test to determine whether the two highest values are statistical outliers. Result of Dixon's test demonstrated that the two visual outliers are also statistical outliers; therefore, the two outliers were removed from the combined upland vegetation dataset for silver prior to estimating the statistical limits. The original silver combined upland vegetation QQ plot was scaled to include the highest statistical outlier, which was much higher than the

rest of the data. As a result, the silver combined upland vegetation data were replotted to confirm that no additional outliers were present in the dataset after two statistical outliers were removed.

Visual inspection of the QQ plots for boron and cadmium in combined upland vegetation identified one potential visual outlier in each dataset. The visual outliers are also statistical outliers based on the results of Rosner's statistical test and, as a result, one outlier was removed from each of the combined upland vegetation datasets for boron and cadmium prior to estimating statistical limits. No potential visual outliers were identified for other COPECs in combined upland vegetation. The original boron and cadmium combined upland vegetation QQ plots were scaled to include the statistical outliers for each metal, which were much higher than the rest of the data for each metal. As a result, the boron and cadmium combined upland vegetation data were replotted to confirm that no additional outliers were present in the datasets after one statistical outlier was removed from each dataset. The combined upland vegetation dataset for selenium appears to follow a lognormal distribution, and as a result, the QQ plot for log-transformed selenium combined upland vegetation data was used to determine whether visual outliers were present in the dataset.

No statistical limits were estimated for antimony and total uranium because these constituents had fewer than five detected results. The proposed background levels for antimony and total uranium are based on maximum detected concentrations. The maximum detected concentrations of antimony and total uranium are comparable to the typical vegetation concentrations listed in Kabata-Pendias (2011). Data summary and statistical limits for COPECs in combined upland vegetation are summarized in Table 4-13.

4.8 Groundwater Background Levels

Groundwater background levels were developed for the shallow, intermediate, deep, and combined geologic units. The combined aquifer includes all background groundwater samples, including background samples that were not classified as shallow, intermediate or deep groundwater units. The classifications of each background well by geologic/aquifer unit are listed in Table 2-10. Background analyses for these groundwater units are summarized below.

4.8.1 Shallow Unit

Visual inspection of the QQ plots for total chromium identified two potential visual outliers. The second highest visual outlier (0.0103 mg/L) was tested as a statistical outlier using Dixon's statistical test to determine whether the two highest values are statistical outliers. Results of Dixon's test demonstrated that both visual outliers are also statistical outliers; therefore, the two outliers were removed from the shallow aquifer groundwater dataset for total chromium prior to estimating statistical limits.

Visual inspection of the QQ plots for selenium and zinc identified one potential visual outlier for each chemical. Those visual outliers are also statistical outliers based on the results of the Dixon's statistical test and, as a result, one outlier was removed from each of the shallow aquifer groundwater datasets for selenium and zinc prior to estimating statistical limits. No potential visual outliers were identified for other COPCs in the shallow aquifer groundwater dataset.

No statistical limits were estimated for arsenic, cobalt, lead, molybdenum and thallium because these constituents had fewer than five detected results. Proposed background levels for arsenic, lead, and thallium are based on maximum detected concentrations. Proposed background levels for cobalt and molybdenum are based on maximum detection limits for non-detects.

Proposed background levels for these constituents are comparable to typical ambient groundwater concentrations listed in ATSDR's toxicological profiles. Data summary and statistical limits for COPCs in shallow aquifer groundwater are summarized in Table 4-14.

4.8.2 Intermediate Unit

Visual inspection of the QQ plots for manganese and selenium identified one potential visual outlier for each metal. Those visual outliers also are statistical outliers based on results of Dixon's statistical test and, as a result, one outlier was removed from each of the intermediate aquifer groundwater datasets for manganese and selenium prior to estimating the statistical limits. No potential visual outliers were identified for other COPCs in intermediate aquifer groundwater.

No statistical limits were estimated for arsenic, cadmium, cobalt, lead, molybdenum and thallium because these constituents had fewer than five detected results. Proposed background levels for arsenic, cadmium, lead, and molybdenum are based on maximum detected concentrations. Proposed background levels for cobalt and thallium are based on maximum detection limits for non-detects. Proposed background levels for these constituents are comparable to typical ambient groundwater concentrations listed in ATSDR's toxicological profiles. Data summary and statistical limits for COPCs in intermediate aquifer groundwater are summarized in Table 4-14.

4.8.3 Deep Unit

No outlier analysis was conducted for any COPC in deep aquifer groundwater due to the small number of detected samples. No statistical limits were estimated for arsenic, cadmium, cobalt, lead, molybdenum, thallium, vanadium, and zinc because these constituents had fewer than five detected results. Proposed background levels for arsenic, cobalt, lead, thallium, and zinc are based on maximum detected concentrations.

Proposed background levels for cadmium, molybdenum and vanadium are based on maximum detection limits for non-detects. The proposed background levels for these constituents are comparable to typical ambient groundwater concentrations listed in ATSDR's toxicological profiles.

4.8.4 Combined Unit

Visual inspection of the QQ plots for arsenic, total chromium, selenium and zinc identified two potential visual outliers for each metal. The second highest visual outlier (0.0149 mg/L) for arsenic was tested as a statistical outlier using Dixon's statistical test to determine whether the two highest values are statistical outliers. Results of Dixon's test demonstrated that both visual outliers are also statistical outliers; therefore, the two outliers were removed from the combined aquifer groundwater dataset for arsenic prior to estimating statistical limits.

The visual outliers for total chromium, manganese, selenium and zinc are also statistical outliers based on results of Rosner's statistical test and, as a result, two outliers were removed from each of the combined groundwater datasets for total chromium, manganese,

selenium and zinc prior to estimating the statistical limits. The original manganese combined aquifer QQ plot was scaled to include the highest statistical outlier, which was much higher than the rest of the data. As a result, the manganese combined aquifer data were replotted to confirm that no additional outliers were present in the dataset after two statistical outliers were removed. No potential visual outliers were identified for other COPCs in combined groundwater.

No statistical limits were estimated for cobalt, molybdenum and thallium because these constituents had fewer than five detected results. Proposed background levels for these constituents are based on maximum detected concentrations. Proposed background levels for these constituents are comparable to typical ambient groundwater concentrations listed in ATSDR's toxicological profiles. Data summary and statistical limits for COPCs in combined groundwater are summarized in Table 4-14.

4.9 Summary of Proposed Background Levels

A summary of the proposed background level for each COPC in each medium is presented in Table 4-15. Proposed background levels for the Sites are the bolded values presented in Tables 4-8 through 4-14, which were selected based on the following decision criteria:

1. The 95% USL statistical result;
2. The maximum detected concentration, if insufficient detections were available to perform a statistical evaluation; and
3. The maximum MDL if all background sampling results for the COPC in the indicated medium were non-detect.

The background levels presented in Table 4-15 are proposed for use in all future RI/FS activities for the Sites.

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TABLES

TABLE 1-1
SUMMARY OF HISTORICAL BACKGROUND CONCENTRATIONS FOR PRIMARY MEDIA[1,2]

Medium	Study	Cadmium	Chromium	Copper	Molybdenum	Nickel	Selenium	Vanadium	Zinc
Sediment	Area-Wide Background Concentration Range[3]	0.10-5.10	11.00-100.00	3.20-25.00	NC	6.40-44.00	0.52-2.60	14.00-72.00	38.00-210.00
	Area-Wide Background Concentration Mean	1.07	39.59	11.34	NC	19.13	1.22	35.29	83.53
	Area-Wide Background Concentration 95% UCL	5.16	58.29	14.44	NC	26.42	1.52	44.40	112.67
Surface Water	Area-Wide Background Concentration Range[3]	0.0001-0.0007	0.0004-0.0058	0.0002-0.0033	NC	0.0003-0.0040	0.0011-0.0016	0.0005-0.0081	0.0100-0.0590
	Area-Wide Background Concentration Mean	NC	NC	NC	NC	0.0011	NC	NC	0.0145
	Area-Wide Background Concentration 95% UCL	NC	NC	NC	NC	0.0014	NC	NC	0.0246
Riparian Soil	Area-Wide Background Concentration Range[3]	0.42-2.70	30.00-110.00	6.80-26.00	NC	5.80-37.00	0.36-2.30	27.00-83.00	39.00-190.00
	Area-Wide Background Concentration Mean	1.04	51.80	17.19	NC	22.79	1.01	51.80	97.35
	Area-Wide Background Concentration 95% UCL	1.27	59.37	18.95	NC	25.47	1.18	56.61	108.78
Riparian Vegetation	Area-Wide Background Concentration Range[3]	NC	NC	NC	NC	NC	NC	NC	NC
	Area-Wide Background Concentration Mean	NC	NC	NC	NC	NC	NC	NC	NC
	Area-Wide Background Concentration 95% UCL	NC	NC	NC	NC	NC	NC	NC	NC
Upland Soil	Area-Wide Background Concentration Range[3]	0.57-14.00	21.00-130.00	9.60-32.00	NC	12.00-47.00	0.41-3.30	25.00-100.00	40.00-660.00
	Area-Wide Background Concentration Mean	2.75	46.30	17.56	NC	24.62	1.01	49.50	165.20
	Area-Wide Background Concentration 95% UCL	8.81	68.31	22.69	NC	33.24	1.92	60.31	341.77
Upland Vegetation	Area-Wide Background Concentration Range[3]	NC	NC	NC	NC	NC	NC	NC	NC
	Area-Wide Background Concentration Mean	NC	NC	NC	NC	NC	NC	NC	NC
	Area-Wide Background Concentration 95% UCL	NC	NC	NC	NC	NC	NC	NC	NC

TABLE 1-1
SUMMARY OF HISTORICAL BACKGROUND CONCENTRATIONS FOR PRIMARY MEDIA[1,2]

Medium	Study	Cadmium	Chromium	Copper	Molybdenum	Nickel	Selenium	Vanadium	Zinc
Groundwater	Area-Wide Background Concentration Range[3]	NC	NC	NC	NC	NC	NC	NC	NC
	Area-Wide Background Concentration Mean	NC	NC	NC	NC	NC	NC	NC	NC
	Area-Wide Background Concentration 95% UCL	NC	NC	NC	NC	NC	NC	NC	NC

NC - Not Calculated
[1] Table AT1-4 Summary of Descriptive Statistics for Background Areas in the Phosphate Resource Area from Area Wide Risk Management Plan, Selenium Area Wide
[2] Units for sediment, soil, and vegetation are mg/kg (dry weight) and units for surface water and groundwater are (mg/L).
[3] Range of detected data

TABLE 2-1
SUMMARY OF BACKGROUND DATA AND USES

Dataset	Dates of Collection	No. of Sampling Events	Data Quality Note	Scoping and Characterization	Risk Assessment	Feasibility Study
Primary Media						
Sediment	2004 & 2010	2	Validated to current validation standards – Unrestricted, relevant use during the RI/FS.	X	X	X
Surface Water	2004 - 2010	1 to 7		X	X	X
Riparian Soil	2004 & 2010	2		X	X	X
Riparian Vegetation	2004	1		X	X	X
Upland Soil	2009	1		X	X	X
Upland Vegetation	2009	1 to 2		X	X	X
Groundwater	2004 - 2010	2 to 7		X	X	X
Secondary Media						
Fish	1998 - 2000	3	Data collected under specific environmental data collection programs and plans. Data were not validated to current standards. However, data collection and analysis are well documented. These data could be evaluated and validated for higher level data uses, as necessary.	X		
Fish	2004	1		X	X	X
Benthic Macroinverts.	2004	1		X	X	X
Aquatic Invertebrates	1999 & 2000	2		X		
Small Mammals	2001	1		X		
Terrestrial Invertebrates	2002	1		X		
Cattle	1999 & 2000	2	Data quality and limitations can be validated to current standards	X	X	X
Bird Egg	1999 - 2001	3		X	X	X
Elk	1999 & 2000	2		X	X	X

Table 2-2
Sediment, Surface Water, Riparian Soil, and Riparian Vegetation Background Sample Locations and Rationale

Station	Feature Name or Mine	Latitude	Longitude	Natural or Site Background	Rationale	RI/FS Work Plan Drawing Cross-Reference
MST048	Little Blackfoot River	N42° 55' 12.99"	W111° 26' 26.78"	Natural	Positioned on the Little Blackfoot River downstream of Reese Creek outside of potential effects of mining.	Drawings 3-6, 3-8, 3-9, 3-10, 3-13
MST049	Little Blackfoot River	N42° 55' 18.26"	W111° 26' 25.24"	Natural	Positioned on the Little Blackfoot River upstream of Reese Creek and outside of potential effects of mining.	Drawings 3-1,3-6, 3-8, 3-9, 3-10, 3-13
MST093	Headwater of Wooley Valley Creek	N42° 50' 25.34"	W111° 28' 32.89"	Natural	Positioned upstream of possible Ballard Mine impacts on Wooley Valley Creek.	Drawings 3-6, 3-8, 3-11, 3-12, 3-13
MST101	Caldwell Creek	N42° 44' 09.34"	W111° 22' 12.76"	Natural	Positioned on tributary to Caldwell Creek above Slug Creek and the Blackfoot River.	Drawings 3-1, 3-6, 3-8, 3-9, 3-10, 3-13
MST235	Meadow Creek	N42° 55' 28.00"	W111° 30' 53.00"	Natural	Located on Meadow Creek above the Blackfoot Reservoir outside of potential effects of mining.	Drawings 3-1,3-6, 3-8, 3-9, 3-10, 3-13
MST236	Stewart Creek	N42° 41' 39.90"	W111° 11' 59.40"	Natural	Located on Stewart Creek above Diamond Creek outside of potential effects of mining.	Drawings 3-6, 3-8, 3-9, 3-10, 3-13
MST237	Timber Creek	N42° 41' 57.10"	W111° 11' 40.40"	Natural	Located on Timber Creek above Diamond Creek outside of potential effects of mining.	Drawings 3-6, 3-8, 3-9, 3-10, 3-13
MST254	Little Blackfoot River	N42° 55' 41.01"	W111° 26' 33.49"	Natural	Located on Little Blackfoot River upstream of potential impacts of mining.	Drawings 3-6, 3-8, 3-9, 3-10, 3-13
MST277	Spring-fed tributary above Long Valley Creek	N42° 51' 52.20"	W111° 29' 04.20"	Natural	Outside of area of possible Henry Mine impacts on Long Valley Creek.	Drawings 3-6, 3-8, 3-13

Notes:
Location (GPS) coordinates use the NAD27 datum and are presented in ddd mm ss.ss format (degrees minutes seconds).

TABLE 2-3
SEDIMENT BACKGROUND DATA
P4 RI/FS
(Page 1 of 1)

Location Identification	Field Sample Identification	Date Collected	Metals (mg/kg)																	Chemistry Parameters		
			Antimony	Arsenic	Boron	Cadmium	Chromium	Cobalt	Copper	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc	pH	TOC (%)	Percent Solids
			Screening Level[1]																			
			3[a]	5.9[b]	NE	0.583[c]	36.286[c]	50[d]	35.7[b]	460[d]	0.174[b]	NE	18[b]	4[e]	0.5[d]	NE	NE	57[f]	98[c]	N/A	N/A	N/A
MST048	052204SEMST048-0	5/22/2004	NA	NA	NA	**0.8**	**26.6**	NA	NA	NA	NA	NA	**17.2 J**	<0.5 U	NA	NA	NA	**28.3**	**81**	**8.1**	**2.5**	**40.9**
MST049	052204SEMST049-0	5/22/2004	NA	NA	NA	**1.16**	**26**	NA	NA	NA	NA	NA	**16.1 J**	**0.9 J**	NA	NA	NA	**28.8**	**76**	**7.8**	**4.5**	**19.9**
MST093	051304SEMST093-0	5/13/2004	NA	NA	NA	**1.81 J-**	**27.8**	NA	NA	NA	NA	NA	**19.7 J**	<0.5 U	NA	NA	NA	**37.9**	**93 J**	**6.6**	**2.8**	**58.1**
	1010-MST093A-SD-001-avg	10/4/2010	4.65 U	**2.735**	**8.4 J**	**1.91**	**17.95**	**5.385**	**14.4**	**400.5**	**0.027**	<0.5 U	**15.7**	**0.95 J**	**0.1605**	**0.1945**	NA	**20.8**	**93.4**	NA	NA	**87.65**
	1010-MST093B-SD-001	10/4/2010	3.2 U	**2.1**	**8.0 J**	**2.21**	**19.8**	**4.56**	**14.9**	**405**	**0.026**	<0.5 U	**17.2**	**1.0 J**	**0.165**	**0.171**	**2.03**	**28.6**	**107**	NA	**5.51**	**86**
	1010-MST093A-SD-001-2	10/4/2010	4.8 U	**2.89**	**8.5 J**	**1.94**	**18.2**	**6.21**	**14.3**	**400**	**0.029**	<0.5 U	**16.2**	**0.9 J**	**0.16**	**0.157**	**2.38**	**20.3**	**94.8**	NA	**6.98**	**88.9**
	1010-MST093A-SD-001-1	10/4/2010	4.5 U	**2.58**	**8.3 J**	**1.88**	**17.7**	**4.56**	**14.5**	**401**	**0.025**	<0.5 U	**15.2**	**1.0**	**0.161**	**0.232**	**2.3**	**21.3**	**92**	NA	**6.61**	**86.4**
MST101	051804SEMST101-0	5/18/2004	NA	NA	NA	**1.78**	**21.6**	NA	NA	NA	NA	NA	**20.6**	**0.7 J**	NA	NA	NA	**26.2**	**90**	**7.8**	**3.7**	**40**
MST235	052004SEMST235-0	5/20/2004	NA	NA	NA	**0.22 J**	**11.5**	NA	NA	NA	NA	NA	**5.8 J**	<0.5 U	NA	NA	NA	**11.3**	**18**	**7.4**	**1.5**	**42.6**
MST236	051804SEMST236-0	5/18/2004	NA	NA	NA	**3.05**	**31.9**	NA	NA	NA	NA	NA	**24.4**	<0.6 UJ	NA	NA	NA	**36.6**	**118**	**7**	**2**	**71.1**
MST237	051804SEMST237-0	5/18/2004	NA	NA	NA	**0.9**	**19.9**	NA	NA	NA	NA	NA	**18.1**	<0.6 UJ	NA	NA	NA	**25.5**	**66**	**7.8**	**2.3**	**52.5**
MST254	052004SEMST254-1-QA-avg	5/20/2004	NA	NA	NA	**0.783**	**20.4**	NA	NA	NA	NA	NA	**12.8 J**	<0.5 U	NA	NA	NA	**23.4 J**	**75.3 J**	**7.53**	**2.97**	**36.7**
	052004SEMST254-1-QA2	5/20/2004	NA	NA	NA	**0.81**	**20.5**	NA	NA	NA	NA	NA	**12.8 J**	<0.5 U	NA	NA	NA	**23.7 J**	**75 J**	**7.5**	**2.9**	**36.4**
	052004SEMST254-1-QA1	5/20/2004	NA	NA	NA	**0.76**	**20.3**	NA	NA	NA	NA	NA	**12.7 J**	<0.5 U	NA	NA	NA	**23.2 J**	**76 J**	**7.8**	**3.2**	**36.8**
	052004SEMST254-1-QA3	5/20/2004	NA	NA	NA	**0.78**	**20.5**	NA	NA	NA	NA	NA	**12.8 J**	<0.5 U	NA	NA	NA	**23.4 J**	**75 J**	**7.3**	**2.8**	**36.8**
MST277	052204SEMST277-1-QA-avg	5/22/2004	NA	NA	NA	**3.74**	**34.8 J**	NA	NA	NA	NA	NA	**23.1**	**0.8 J**	NA	NA	NA	**45.2**	**151**	**7**	**8.67**	**42.1**
	052204SEMST277-1-QA3	5/22/2004	NA	NA	NA	**3.72**	**34.7 J**	NA	NA	NA	NA	NA	**22.8**	**0.9 J**	NA	NA	NA	**45.1**	**151**	**7.2**	**8.6**	**41.1**
	052204SEMST277-1-QA2	5/22/2004	NA	NA	NA	**3.84**	**35.8 J**	NA	NA	NA	NA	NA	**23.3**	**0.7 J**	NA	NA	NA	**47.2**	**152**	**7.1**	**9**	**41.7**
	052204SEMST277-1-QA1	5/22/2004	NA	NA	NA	**3.67**	**33.8 J**	NA	NA	NA	NA	NA	**23.1**	**0.8 J**	NA	NA	NA	**43.3**	**150**	**6.7**	**8.4**	**43.4**
	1010-MST277B-SD-001	10/3/2010	**4.8 J-**	**4.55 J**	**6.2 J**	**2.95 J**	**25.3**	**8.62**	**25.5**	**200 J+**	**0.037**	1.3 U	**20.7**	**1.6**	**0.241**	**0.378**	**2.37**	**36.7**	**125**	NA	**4.58**	**79.8**
	1010-MST277A-SD-001	10/3/2010	**5.0 J-**	**3.23 J**	**7.6 J**	**1.92 J**	**16.7**	**6.22**	**20.6**	**194 J+**	**0.038**	1.5 U	**13.1**	**1.2**	**0.155**	**0.241**	**2.12**	**23.6**	**89.9**	NA	**6.86**	**89.1**

mg/kg milligrams per kilogram (dry weight).
Bold Bolded result indicates positively identified compound.
Shaded Indicates sample concentration is greater than the associated screening level.
NE Not established
N/A Not appicable
NA Not analyzed.
J Data are estimated due to associated quality control data.
UJ Potential low bias, possible false negative.
<#U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
#U The analyte was analyzed for and is considered not detected based on associated quality control data.
J- Data are estimated, potentially biased low, due to associated quality control data.
J+ Data are estimated, potentially biased high, due to associated quality control data.

Note: At background stations MST093 and MST277, composite sediment samples were collected from two locations A and B located approximately 50 feet apart. For example, at MST093A there was one composite sediment sample collected, and at MST093B, there was one composite sediment sample collected.

[1]Screening levels reported in Table 3-1 of the A/T-approved P4 Sites RI/FS Work Plan - Rev 2 Final (MWH, 2011)
[a]Buchman, M. 1999. NOAA HAZMAT Report 99-1.
[b]Aquatic life criteria for these metals are expressed as function of total hardness.
[c]The ARCS TEL for freshwater sediment in NOAA SQuiRT (Buchman, 2008)
[d]Guidelines for the protection and management of aquatic sediment quality in Ontario Aug 1993.
[e]Screening value from Van Derveer and Canton (1997)
[f]Freshwater sediment screening value not available; screening value presented based on themarine sediment AET (Buchman, 2008)

TABLE 2-4
SURFACE WATER BACKGROUND DATA
P4 RI/FS

Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Metals (mg/l)												
				Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
				Screening Level[1]												
				0.087[a]	0.03[b]	0.15[c]	0.003[b]	0.0006[b]	0.0016[b]	0.0006[c,d]	NE	0.011[c,d,e]	0.003[b]	0.011[c,d]	0.158[f]	0.0025[c,d]
MST048	052204SWMST048-0-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST048-0-F	5/22/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	50.6 K	NA	NA	NA	NA	NA
MST049	052204SWMST049-0-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST049-0-F	5/22/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	46.1 K	NA	NA	NA	NA	NA
	050506SWMST049-0-U	5/5/2006	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050506SWMST049-0-F	5/5/2006	Dissolved	0.11 JK	<0.0004 UK	0.0006 JK	0.036 K	<0.002 UK	NA	<0.0001 UK	30.3 K	0.0003 JK	<0.01 UK	<0.01 UK	0.08 K	0.0004 JK
	051407SWMST049-0-U	5/14/2007	Total	0.34 K	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051407SWMST049-0-F	5/14/2007	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UJK	52.1 J-K	<0.0001 UJK	NA	NA	NA	NA
	091207GWMST049-1-U	9/12/2007	Total	0.51 J+K	<0.0004 UK	0.001 JK	0.041 K	<0.002 UK	0.02 JK	<0.0001 UK	42.4 K	0.0011 K	<0.01 UK	<0.01 UK	0.56 K	0.0003 UK
	091207GWMST049-1-F	9/12/2007	Dissolved	<0.03 UK	<0.0004 UK	0.001 K	0.037 K	<0.002 UK	0.02 JK	<0.0001 UK	44.7 K	<0.0001 UK	<0.01 UK	<0.01 UK	0.05 K	<0.0001 UK
	091207GWMST049-2-U	9/12/2007	Total	0.55 J+K	<0.0004 UK	0.0009 JK	0.04 K	<0.002 UK	0.02 JK	<0.0001 UK	42.7 K	0.0007 K	<0.01 UK	<0.01 UK	0.61 K	0.0003 UK
	091207GWMST049-2-F	9/12/2007	Dissolved	<0.03 UK	<0.0004 UK	0.001 JK	0.038 K	<0.002 UK	0.01 JK	<0.0001 UK	43.9 K	0.0001 UK	<0.01 UK	<0.01 UK	0.05 K	<0.0001 UK
	091207GWMST049-3-U	9/12/2007	Total	0.55 J+K	<0.0004 UK	0.0009 JK	0.039 K	<0.002 UK	0.01 JK	<0.0001 UK	40.9 K	0.0006 K	<0.01 UK	<0.01 UK	0.57 K	0.0003 UK
	091207GWMST049-3-F	9/12/2007	Dissolved	<0.03 UK	<0.0004 UK	0.0009 JK	0.04 K	<0.002 UK	0.02 JK	<0.0001 UK	44.3 K	<0.0001 UK	<0.01 UK	<0.01 UK	0.06 K	<0.0001 UK
	091207GWMST049-avg-U	9/12/2007	Total	0.537 J+K	<0.0004 UK	0.000933 JK	0.04 K	<0.002 UK	0.0167 JK	<0.0001 UK	42 K	0.0008 K	<0.01 UK	<0.01 UK	0.58 K	<0.0001 UK
	091207GWMST049-avg-F	9/12/2007	Dissolved	<0.03 UK	<0.0004 UK	0.000967 JK	0.0383 K	<0.002 UK	0.0167 JK	<0.0001 UK	44.3 K	<0.0001 UK	<0.01 UK	<0.01 UK	0.0533 K	<0.0001 UK
	051008SWMST049-1-U	5/10/2008	Total	0.45 J+K	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST049-1-F	5/10/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	32.5 K	<0.0001 UK	NA	NA	NA	NA
	051008SWMST049-2-U	5/10/2008	Total	0.35 K	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST049-2-F	5/10/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	32 K	<0.0001 UK	NA	NA	NA	NA
	051008SWMST049-3-U	5/10/2008	Total	0.36 K	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST049-3-F	5/10/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	31.6 K	<0.0001 UK	NA	NA	NA	NA
	051008SWMST049-avg-U	5/10/2008	Total	0.387 J+K	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST049-avg-F	5/10/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	32 K	<0.0001 UK	NA	NA	NA	NA
	091908SWMST049-1-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-1-F	9/19/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	34.9	0.000982 U	NA	NA	0.0303 J	NA
	091908SWMST049-2-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-2-F	9/19/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	33.2	0.00148 U	NA	NA	0.029 J	NA
	091908SWMST049-3-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-3-F	9/19/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	35.4	0.00224 J+	NA	NA	0.0307 J	NA
	091908SWMST049-avg-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-avg-F	9/19/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	34.5	0.00224 J+	NA	NA	0.03 J	NA
MST093	051304SWMST093-0-U	5/13/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051304SWMST093-0-F	5/13/2004	Dissolved	NA	NA	NA	NA	NA	NA	NA	24.4 J-K	NA	NA	NA	NA	NA
	051006GWMST093-0-U	5/10/2006	Total	NA	NA	NA	NA	NA	NA	<0.0001 UK	NA	0.0004 UK	NA	NA	NA	NA
	051006GWMST093-0-F	5/10/2006	Dissolved	0.05 JK	<0.0004 UK	0.0015 UK	0.027 K	<0.002 UK	NA	<0.0001 UK	27.4 K	0.0003 JK	<0.01 UK	<0.01 UK	0.04 JK	<0.0001 UK
	050907SWMST093-0-U	5/9/2007	Total	0.3 K	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050907SWMST093-0-F	5/9/2007	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	45.8 K	<0.0001 UK	NA	NA	NA	NA
	051508GWMST093-0-U	5/15/2008	Total	0.08 JK	<0.0004 UK	0.0013 J+K	0.038 K	<0.002 UK	0.01 JK	<0.0001 UK	41.3 K	<0.0001 UK	<0.01 UK	<0.01 UK	0.05 K	<0.0001 UK
	051508GWMST093-0-F	5/15/2008	Dissolved	<0.03 UK	<0.0004 UK	0.0007 JK	0.042 K	<0.002 UK	<0.01 UK	<0.0001 UK	40.2 K	<0.0001 UK	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
	0905SWMST093-U	5/6/2009	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	0905SWMST093-F	5/6/2009	Dissolved	NA	NA	NA	NA	NA	NA	<0.000125 U	19.2	NA	NA	NA	0.0325 J	NA
	1005SWMST093-U	5/13/2010	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1005SWMST093-F	5/13/2010	Dissolved	NA	NA	NA	NA	NA	NA	<0.0003 U	41.1	NA	NA	NA	0.0319 J	NA

TABLE 2-4
SURFACE WATER BACKGROUND DATA
P4 RI/FS

Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Metals (mg/l)												
				Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
				Screening Level[1]												
				NE	0.12[g]	0.00077[b]	0.034[b]	0.052[c,d]	NE	0.005[c,e]	0.00036[b]	NE	0.00003[b]	0.142[g]	0.02[g]	0.12[c,d]
MST048	052204SWMST048-0-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052204SWMST048-0-F	5/22/2004	Dissolved	**9.7 K**	NA	NA	NA	**0.0004 JK**	**1.7 K**	NA	NA	**4.7 K**	NA	NA	**0.00052 K**	<0.002 UK
MST049	052204SWMST049-0-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052204SWMST049-0-F	5/22/2004	Dissolved	**9.4 K**	NA	NA	NA	**0.0005 JK**	**2.1 K**	NA	NA	**4.7 K**	NA	NA	**0.00065 K**	<0.002 UK
	050506SWMST049-0-U	5/5/2006	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	050506SWMST049-0-F	5/5/2006	Dissolved	**6.2 K**	**0.03 K**	<0.0002 U	<0.01 UK	**0.0016 JK**	**1.7 K**	NA	<0.01 UJK	**3.6 K**	**0.0001 JK**	**0.0002 JK**	<0.0002 UK	**0.005 JK**
	051407SWMST049-0-U	5/14/2007	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051407SWMST049-0-F	5/14/2007	Dissolved	**12.7 K**	NA	NA	NA	**0.0007 JK**	**0.3 JK**	NA	NA	**5.9 K**	NA	**0.0005 JK**	**0.0007 JK**	**0.002 JK**
	091207GWMST049-1-U	9/12/2007	Total	**12.7 K**	**0.0959 K**	**0.0002 J**	<0.01 UK	**0.0013 JK**	**1.0 JK**	<0.001 U	<0.01 UK	**6.8 K**	**0.0005 K**	**0.0006 K**	**0.0013 K**	**0.004 JK**
	091207GWMST049-1-F	9/12/2007	Dissolved	**13.3 K**	**0.018 K**	<0.0002 U	<0.01 UK	**0.0008 JK**	0.9 UK	<0.001 U	<0.01 UK	**7.2 K**	**0.0002 JK**	**0.0006 K**	**0.0008 JK**	<0.002 UK
	091207GWMST049-2-U	9/12/2007	Total	**12.9 K**	**0.0869 K**	<0.0002 U	<0.01 UK	**0.0009 JK**	**0.9 JK**	<0.001 U	<0.01 UK	**6.9 K**	**0.0002 JK**	**0.0006 K**	**0.0013 K**	**0.003 JK**
	091207GWMST049-2-F	9/12/2007	Dissolved	**13.1 K**	**0.0172 K**	<0.0002 U	<0.01 UK	**0.0008 JK**	1.0 UK	<0.001 U	<0.01 UK	**7.1 K**	**0.0001 JK**	**0.0005 K**	**0.0008 JK**	<0.002 UK
	091207GWMST049-3-U	9/12/2007	Total	**12.4 K**	**0.0871 K**	**0.0003 J**	<0.01 UK	**0.0009 JK**	**1.1 JK**	<0.001 U	<0.01 UK	**6.6 K**	**0.0001 JK**	**0.0006 K**	**0.0014 K**	**0.003 JK**
	091207GWMST049-3-F	9/12/2007	Dissolved	**13.2 K**	**0.017 K**	<0.0002 U	<0.01 UK	**0.0008 JK**	0.9 UK	<0.001 U	<0.01 UK	**7.5 K**	<0.0001 UK	**0.0005 K**	**0.0008 JK**	<0.002 UK
	091207GWMST049-avg-U	9/12/2007	Total	**12.7 K**	**0.09 K**	**0.00025 J**	<0.01 UK	**0.00103 JK**	**1.0 JK**	<0.001 U	<0.01 UK	**6.77 K**	**0.000267 JK**	**0.0006 K**	**0.00133 K**	**0.00333 JK**
	091207GWMST049-avg-F	9/12/2007	Dissolved	**13.2 K**	**0.0174 K**	<0.0002 U	<0.01 UK	**0.0008 JK**	<0.3 UK	<0.001 U	<0.01 UK	**7.27 K**	**0.00015 JK**	**0.000533 K**	**0.0008 JK**	<0.002 UK
	051008SWMST049-1-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051008SWMST049-1-F	5/10/2008	Dissolved	**7.3 K**	NA	NA	NA	**0.001 JK**	**2.0 K**	NA	NA	**4.4 K**	NA	**0.0002 JK**	**0.0008 JK**	<0.002 UK
	051008SWMST049-2-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051008SWMST049-2-F	5/10/2008	Dissolved	**7.3 K**	NA	NA	NA	**0.0011 JK**	**2.2 K**	NA	NA	**4.4 K**	NA	**0.0002 JK**	**0.0008 JK**	<0.002 UK
	051008SWMST049-3-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051008SWMST049-3-F	5/10/2008	Dissolved	**7.2 K**	NA	NA	NA	**0.0011 JK**	**2.1 K**	NA	NA	**4.4 K**	NA	**0.0002 JK**	**0.0008 JK**	<0.002 UK
	051008SWMST049-avg-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051008SWMST049-avg-F	5/10/2008	Dissolved	**7.27 K**	NA	NA	NA	**0.00107 JK**	**2.1 K**	NA	NA	**4.4 K**	NA	**0.0002 JK**	**0.0008 JK**	<0.002 UK
	091908SWMST049-1-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	<0.0005 U	NA	NA	NA	NA	NA	NA
	091908SWMST049-1-F	9/19/2008	Dissolved	**11.6**	**0.0198**	NA	NA	**0.00163 J**	**1.11**	NA	NA	**6.78**	NA	NA	<0.005 U	<0.005 U
	091908SWMST049-2-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	<0.0005 U	NA	NA	NA	NA	NA	NA
	091908SWMST049-2-F	9/19/2008	Dissolved	**11.1**	**0.021**	NA	NA	**0.00153 J**	**1.07**	NA	NA	**6.64**	NA	NA	<0.005 U	<0.005 U
	091908SWMST049-3-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	**0.00052 J**	NA	NA	NA	NA	NA	NA
	091908SWMST049-3-F	9/19/2008	Dissolved	**11.6**	**0.0193**	NA	NA	**0.00175 J**	**1.08**	NA	NA	**6.63**	NA	NA	<0.005 U	<0.005 U
	091908SWMST049-avg-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	**0.00052 J**	NA	NA	NA	NA	NA	NA
	091908SWMST049-avg-F	9/19/2008	Dissolved	**11.4**	**0.02**	NA	NA	**0.00164 J**	**1.09**	NA	NA	**6.68**	NA	NA	<0.005 U	<0.005 U
MST093	051304SWMST093-0-U	5/13/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051304SWMST093-0-F	5/13/2004	Dissolved	**4.0 J-K**	NA	NA	NA	**0.0008 J-K**	**0.4 J-K**	**0.001 J-**	NA	**7.0 J-K**	NA	NA	**0.0062 J-K**	NA
	051006GWMST093-0-U	5/10/2006	Total	NA	NA	NA	NA	**0.0015 JK**	NA	<0.001 U	NA	NA	NA	NA	**0.0032 K**	**0.002 JK**
	051006GWMST093-0-F	5/10/2006	Dissolved	**4.4 K**	**0.0038 K**	<0.0002 U	<0.01 UK	**0.0016 JK**	**1.3 K**	<0.001 U	<0.01 UK	**5.9 K**	<0.0001 UK	<0.0001 UK	**0.0031 K**	**0.006 JK**
	050907SWMST093-0-U	5/9/2007	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	050907SWMST093-0-F	5/9/2007	Dissolved	**7.4 K**	NA	NA	NA	**0.0039 K**	**1.2 JK**	NA	NA	**8.1 K**	NA	**0.0004 JK**	<0.0002 UK	<0.002 UK
	051508GWMST093-0-U	5/15/2008	Total	**6.3 K**	**0.0046 K**	<0.0002 U	<0.01 UK	**0.0013 JK**	**0.8 JK**	**0.001 J**	<0.01 UK	**7.0 K**	<0.0001 UK	**0.0002 JK**	**0.0053 K**	**0.003 JK**
	051508GWMST093-0-F	5/15/2008	Dissolved	**6.6 K**	**0.0062 K**	<0.0002 U	<0.01 UK	**0.002 JK**	**0.6 JK**	<0.001 U	<0.01 UJK	**7.3 K**	<0.0001 UK	**0.0002 JK**	**0.0052 K**	**0.003 JK**
	0905SWMST093-U	5/6/2009	Total	NA	NA	NA	NA	NA	NA	<0.0005 UJ	NA	NA	NA	NA	NA	NA
	0905SWMST093-F	5/6/2009	Dissolved	**3.44**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.005 U	NA
	1005SWMST093-U	5/13/2010	Total	NA	NA	NA	NA	NA	NA	**0.000544 J**	NA	NA	NA	NA	NA	NA
	1005SWMST093-F	5/13/2010	Dissolved	**6.97**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.005 U	NA

TABLE 2-4
SURFACE WATER BACKGROUND DATA
P4 RI/FS
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				Anions (mg/l)			Chemistry Parameters (mg/l)											Radionuclides (pCi/l)	
Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Chloride	Fluoride	Sulfate	Alkalinity, Total	Alkalinity, Hydroxide	Alkalinity, Bicarbonate	Alkalinity, Carbonate	Hardness	TKN	Nitrogen, NO2/NO3	Phosphorus	TSS	TDS	TOC	Gross Alpha	Gross Beta
				Screening Level[1]															
				NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MST048	052204SWMST048-0-U	5/22/2004	Total	NA	NA	NA	**167**	<2.0 U	**167**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST048-0-F	5/22/2004	Dissolved	**3.3**	NA	**5.3**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MST049	052204SWMST049-0-U	5/22/2004	Total	NA	NA	NA	**151**	<2.0 U	**151**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST049-0-F	5/22/2004	Dissolved	**3.7**	NA	**5.6**	**129**	<2.0 U	**129**	<2.0 U	NA	**0.4 J**	NA	NA	**6.0 J**	NA	NA	NA	NA
	050506SWMST049-0-U	5/5/2006	Total	NA	NA	NA	**175 J-**	NA	**163 J-**	**12 J-**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050506SWMST049-0-F	5/5/2006	Dissolved	**2.4 J**	NA	**3.1**	**159**	<2.0 U	**154**	**5.0 J**	NA	**0.5 J**	**0.16 J-**	NA	**10 J**	NA	NA	1.8 U	2 U
	051407SWMST049-0-U	5/14/2007	Total	NA	NA	NA	**159**	<2.0 U	**154**	**5.0 J**	NA	**0.5 J**	**0.16 J-**	NA	**6.0 J**	NA	NA	3.6 U	0.24 U
	051407SWMST049-0-F	5/14/2007	Dissolved	**3.3 J-**	NA	**6.2 J-**	**159**	<2.0 U	**154**	**4.67 J**	NA	**0.7 J**	**0.163 J-**	NA	**8.0 J**	NA	NA	**8**	**9.3**
	091207GWMST049-1-U	9/12/2007	Total	NA	NA	NA	**159**	<2.0 U	**155**	**4.0 J**	NA	**1.1**	**0.17 J-**	NA	<5.0 U	NA	NA	**8**	**9.3**
	091207GWMST049-1-F	9/12/2007	Dissolved	**4.4**	**0.2 J**	**6**	**96**	<2.0 U	**96**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091207GWMST049-2-U	9/12/2007	Total	NA	NA	NA	**96**	<2.0 U	**96**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091207GWMST049-2-F	9/12/2007	Dissolved	**4.4**	**0.2 J**	**6**	NA	NA	NA	NA	NA	NA	NA	NA	**17**	**230**	NA	NA	NA
	091207GWMST049-3-U	9/12/2007	Total	NA	NA	NA	**96**	<2.0 U	**96**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091207GWMST049-3-F	9/12/2007	Dissolved	**4.4**	**0.2 J**	**6**	NA	NA	NA	NA	NA	NA	NA	NA	**15.5**	**164**	NA	NA	NA
	091207GWMST049-avg-U	9/12/2007	Total	NA	NA	NA	**96**	<2.0 U	**96**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091207GWMST049-avg-F	9/12/2007	Dissolved	**4.4**	**0.2 J**	**6**	NA	NA	NA	NA	NA	NA	NA	NA	**16**	**172**	NA	NA	NA
	051008SWMST049-1-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**16.2**	**189**	NA	NA	NA
	051008SWMST049-1-F	5/10/2008	Dissolved	**3.9**	NA	**6**	NA	NA	NA	NA	**165**	NA	NA	**0.06 J-**	NA	**180 J-**	NA	NA	NA
	051008SWMST049-2-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST049-2-F	5/10/2008	Dissolved	**4.1**	NA	**6**	NA	NA	NA	NA	**166**	NA	NA	**0.06 J-**	NA	**180 J-**	NA	NA	NA
	051008SWMST049-3-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	NA	**101**	NA	NA	NA	NA	**130**	NA	NA	NA
	051008SWMST049-3-F	5/10/2008	Dissolved	**4.1**	NA	**6**	NA	NA	NA	NA	**164**	NA	NA	**0.06 J-**	NA	**180 J-**	NA	NA	NA
	051008SWMST049-avg-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	NA	**182**	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST049-avg-F	5/10/2008	Dissolved	**4.03**	NA	**6**	NA	NA	NA	NA	**165**	NA	NA	**0.06 J-**	NA	**180 J-**	NA	NA	NA
	091908SWMST049-1-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	**109**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-1-F	9/19/2008	Dissolved	**4.39**	NA	**5.3**	**137**	NA	NA	NA	**133**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-2-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	**110**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-2-F	9/19/2008	Dissolved	**4.45**	NA	**5.39**	**140**	NA	NA	NA	**136**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-3-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	**111**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-3-F	9/19/2008	Dissolved	**5.17**	NA	**5.58**	**141**	NA	NA	NA	**129**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-avg-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	**110**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST049-avg-F	9/19/2008	Dissolved	**4.67**	NA	**5.42**	**131**	NA	NA	NA	**135**	NA	NA	NA	NA	NA	NA	NA	NA
MST093	051304SWMST093-0-U	5/13/2004	Total	NA	NA	NA	**98**	<2.0 U	**98**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051304SWMST093-0-F	5/13/2004	Dissolved	**8.9**	NA	**16.6**	**110**	<2.0 U	**110**	<2.0 U	NA	**0.6**	<0.02 U	NA	<5.0 U	NA	**8.0**	NA	NA
	051006GWMST093-0-U	5/10/2006	Total	NA	NA	NA	**150**	<2.0 U	**150**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051006GWMST093-0-F	5/10/2006	Dissolved	**3.4**	NA	**4.9**	**109**	<2.0 U	**109**	<2.0 U	**129**	0.3 UJ	<0.02 U	NA	<5.0 U	**112**	NA	1.5 UJ	2.5 U
	050907SWMST093-0-U	5/9/2007	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**166**	NA	NA	NA
	050907SWMST093-0-F	5/9/2007	Dissolved	**4.6**	NA	**6.8**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051508GWMST093-0-U	5/15/2008	Total	NA	NA	NA	NA	NA	NA	NA	**87**	NA	NA	**0.12**	NA	**140**	NA	NA	NA
	051508GWMST093-0-F	5/15/2008	Dissolved	**6.8**	**0.2 J**	**12.7**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	0905SWMST093-U	5/6/2009	Total	NA	NA	NA	NA	NA	NA	NA	**145**	NA	NA	NA	NA	NA	NA	NA	NA
	0905SWMST093-F	5/6/2009	Dissolved	**4.86**	NA	**6.15**	NA	NA	NA	NA	**128**	NA	NA	**0.08 J-**	NA	**160 J-**	NA	NA	NA
	1005SWMST093-U	5/13/2010	Total	NA	NA	NA	NA	NA	NA	NA	**62.1**	NA	NA	NA	NA	NA	NA	NA	NA
	1005SWMST093-F	5/13/2010	Dissolved	**7.12**	NA	**10.7**	NA	NA	NA	NA	**131;131**	NA	NA	NA	NA	NA	NA	NA	NA

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SURFACE WATER BACKGROUND DATA
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Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Metals (mg/l)												
				Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
				Screening Level[1]												
				0.087[a]	0.03[b]	0.15[c]	0.003[b]	0.0006[b]	0.0016[b]	0.0006[c,d]	NE	0.011[c,d,e]	0.003[b]	0.011[c,d]	0.158[f]	0.0025[c,d]
MST101	051804SWMST101-0-U	5/18/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051804SWMST101-0-F	5/18/2004	Dissolved	NA	NA	NA	NA	NA	NA	NA	**75.2 J-K**	NA	NA	NA	NA	NA
	051106SWMST101-0-U	5/11/2006	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051106SWMST101-0-F	5/11/2006	Dissolved	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.076 K**	<0.002 UK	NA	<0.0001 UK	**60.1 K**	**0.0002 JK**	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
	050607SWMST101-0-U	5/6/2007	Total	**0.53 K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050607SWMST101-0-F	5/6/2007	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**70.2 K**	<0.0001 UK	NA	NA	NA	NA
	091507GWMST101-0-U	9/15/2007	Total	**0.1 J+K**	<0.0004 UK	<0.0005 UK	**0.081 K**	<0.002 UK	**0.02 JK**	<0.0001 UK	**70.3 K**	<0.0001 UK	<0.01 UK	<0.01 UK	**0.15 K**	<0.0001 UK
	091507GWMST101-0-F	9/15/2007	Dissolved	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.085 K**	<0.002 UK	**0.02 JK**	<0.0001 UK	**72.1 K**	<0.0001 UK	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
	051108SWMST101-0-U	5/11/2008	Total	**1.1 J+K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051108SWMST101-0-F	5/11/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**65.6 K**	<0.0001 UK	NA	NA	NA	NA
	091908SWMST101-0-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST101-0-F	9/19/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**63.9**	**0.00393 J+**	NA	NA	<0.025 U	NA
MST235	052004SWMST235-0-U	5/20/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST235-0-F	5/20/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**36.2 K**	NA	NA	NA	NA	NA
	050706SWMST235-0-U	5/7/2006	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050706SWMST235-0-F	5/7/2006	Dissolved	**0.12 JK**	<0.0004 UK	**0.0011 JK**	**0.053 K**	<0.002 UK	NA	<0.0001 UK	**31.1 K**	**0.0006 K**	<0.01 UK	<0.01 UK	**0.04 JK**	0.0003 UK
	051007SWMST235-0-U	5/10/2007	Total	**0.3 K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051007SWMST235-0-F	5/10/2007	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UJK	**52.1 K**	<0.0001 UK	NA	NA	NA	NA
	091207GWMST235-0-U	9/12/2007	Total	**0.11 JK**	<0.0004 UK	0.0008 UK	**0.047 K**	<0.002 UK	**0.02 JK**	<0.0001 UK	**38.9 K**	<0.0005 UK	<0.01 UK	<0.01 UK	**0.1 K**	0.0001 UK
	091207GWMST235-0-F	9/12/2007	Dissolved	<0.03 UK	<0.0004 UJK	**0.0008 JK**	**0.047 K**	<0.002 UK	**0.02 JK**	<0.0001 UK	**43.2 K**	<0.0001 UK	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
	051008SWMST235-0-U	5/10/2008	Total	**1.87 K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST235-0-F	5/10/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**28.4 K**	<0.0001 UK	NA	NA	NA	NA
	092008SWMST235-0-U	9/20/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	092008SWMST235-0-F	9/20/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**39.6**	**0.00257**	NA	NA	<0.025 U	NA
MST236	051804SWMST236-0-U	5/18/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051804SWMST236-0-F	5/18/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**53.6 K**	**0.0003 JK**	NA	NA	NA	NA
	051106SWMST236-0-U	5/11/2006	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051106SWMST236-0-F	5/11/2006	Dissolved	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.02 K**	<0.002 UK	NA	<0.0001 UK	**50.3 K**	0.0003 UK	<0.01 UK	<0.01 UK	<0.02 UK	**0.0002 JK**
	050407SWMST236-0-U	5/4/2007	Total	**0.04 JK**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050407SWMST236-0-F	5/4/2007	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**51.7 K**	<0.0001 UK	NA	NA	NA	NA
	091407GWMST236-0-U	9/14/2007	Total	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.02 K**	<0.002 UK	**0.02 JK**	<0.0001 UK	**50.1 K**	**0.0007 J+K**	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
	091407GWMST236-0-F	9/14/2007	Dissolved	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.021 K**	<0.002 UK	<0.01 UK	<0.0001 UK	**51.5 K**	<0.0001 UK	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
	051808SWMST236-0-U	5/18/2008	Total	**0.61 K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST236-0-F	5/18/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**53.1 K**	<0.0001 UK	NA	NA	NA	NA
	091808SWMST236-0-U	9/18/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091808SWMST236-0-F	9/18/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**50.4**	**0.000753 J**	NA	NA	<0.025 U	NA

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SURFACE WATER BACKGROUND DATA
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Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Metals (mg/l)												
				Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
				Screening Level[1]												
				NE	0.12[g]	0.00077[b]	0.034[b]	0.052[c,d]	NE	0.005[c,e]	0.00036[b]	NE	0.00003[b]	0.142[g]	0.02[g]	0.12[c,d]
MST101	051804SWMST101-0-U	5/18/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051804SWMST101-0-F	5/18/2004	Dissolved	**14.5 J-K**	NA	NA	NA	0.0006 UJK	**0.3 J-K**	NA	NA	**3.9 J-K**	NA	NA	**0.00042 J-K**	NA
	051106SWMST101-0-U	5/11/2006	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051106SWMST101-0-F	5/11/2006	Dissolved	**11.1 K**	**0.0359 K**	<0.0002 U	<0.01 UK	<0.0006 UK	**0.8 JK**	NA	<0.01 UK	**6.3 K**	<0.0001 UK	**0.0006 K**	**0.0004 JK**	**0.002 JK**
	050607SWMST101-0-U	5/6/2007	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	050607SWMST101-0-F	5/6/2007	Dissolved	**13.1 K**	NA	NA	NA	**0.0022 JK**	**0.6 JK**	NA	NA	**6.7 K**	NA	**0.0007 J+K**	0.0006 UK	<0.002 UK
	091507GWMST101-0-U	9/15/2007	Total	**12.8 K**	**0.0555 K**	<0.0002 U	<0.01 UK	**0.0011 JK**	**0.6 JK**	<0.001 U	<0.01 UK	**7.0 K**	**0.0008 J+K**	**0.0006 J+K**	**0.001 JK**	<0.002 UK
	091507GWMST101-0-F	9/15/2007	Dissolved	**13 K**	**0.0484 K**	<0.0002 U	<0.01 UK	**0.0016 JK**	**0.8 JK**	<0.001 U	<0.01 UJK	**7.1 K**	0.0001 UK	**0.0006 K**	**0.0008 JK**	<0.002 UK
	051108SWMST101-0-U	5/11/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051108SWMST101-0-F	5/11/2008	Dissolved	**12.2 K**	NA	NA	NA	**0.0016 JK**	**1.8 JK**	NA	NA	**6.4 K**	NA	**0.0006 K**	**0.0006 JK**	<0.002 UK
	091908SWMST101-0-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	**0.000543 J**	NA	NA	NA	NA	NA	NA
	091908SWMST101-0-F	9/19/2008	Dissolved	**11.7**	**0.0289**	NA	NA	**0.00353 J**	**0.77 J**	NA	NA	**6.89**	NA	NA	<0.005 U	<0.005 U
MST235	052004SWMST235-0-U	5/20/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052004SWMST235-0-F	5/20/2004	Dissolved	**13.7 K**	NA	NA	NA	**0.0005 JK**	**0.8 JK**	NA	NA	**11.9 K**	NA	NA	**0.0022 K**	<0.004 UK
	050706SWMST235-0-U	5/7/2006	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	050706SWMST235-0-F	5/7/2006	Dissolved	**8.4 K**	**0.0202 K**	<0.0002 U	<0.01 UK	**0.0008 JK**	**1.8 K**	NA	<0.01 UK	**7.0 K**	<0.0001 UK	0.0002 UK	**0.0004 JK**	**0.003 JK**
	051007SWMST235-0-U	5/10/2007	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051007SWMST235-0-F	5/10/2007	Dissolved	**15.2 K**	NA	NA	NA	**0.0011 JK**	**1.1 JK**	NA	NA	**12.4 K**	NA	**0.0007 JK**	**0.0029 JK**	<0.002 UJK
	091207GWMST235-0-U	9/12/2007	Total	**17.7 K**	**0.0042 K**	<0.0002 U	<0.01 UK	**0.0008 JK**	**1.8 JK**	<0.001 U	<0.01 UK	**17.7 K**	**0.0008 J+K**	**0.0011 K**	**0.0017 K**	<0.002 UK
	091207GWMST235-0-F	9/12/2007	Dissolved	**19 K**	**0.0026 JK**	<0.0002 U	<0.01 UK	**0.0009 JK**	**2.1 K**	<0.001 U	<0.01 UK	**19.1 K**	<0.0001 UK	**0.0011 K**	**0.0017 K**	<0.002 UK
	051008SWMST235-0-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051008SWMST235-0-F	5/10/2008	Dissolved	**6.9 K**	NA	NA	NA	**0.0014 JK**	**1.8 JK**	NA	NA	**5.9 K**	NA	**0.0003 JK**	**0.0339 K**	**0.005 JK**
	092008SWMST235-0-U	9/20/2008	Total	NA	NA	NA	NA	NA	NA	<0.0005 U	NA	NA	NA	NA	NA	NA
	092008SWMST235-0-F	9/20/2008	Dissolved	**17.3**	**0.00577**	NA	NA	**0.00169 J**	**2.07**	NA	NA	**18.4**	NA	NA	<0.005 U	<0.005 U
MST236	051804SWMST236-0-U	5/18/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051804SWMST236-0-F	5/18/2004	Dissolved	**12.1 K**	NA	NA	NA	<0.0002 UK	**0.4 JK**	<0.001 U	NA	**2.7 K**	NA	NA	0.00023 UK	**0.014 K**
	051106SWMST236-0-U	5/11/2006	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051106SWMST236-0-F	5/11/2006	Dissolved	**12.1 K**	**0.0021 JK**	<0.0002 U	<0.01 UK	<0.0006 UK	**0.5 JK**	NA	<0.01 UJK	**2.5 K**	**0.0001 JK**	**0.0003 JK**	<0.0002 UK	<0.002 UK
	050407SWMST236-0-U	5/4/2007	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	050407SWMST236-0-F	5/4/2007	Dissolved	**12 K**	NA	NA	NA	**0.0016 JK**	**0.7 JK**	NA	NA	**2.7 K**	NA	0.0003 UK	0.0004 UK	**0.004 JK**
	091407GWMST236-0-U	9/14/2007	Total	**11.4 K**	**0.0015 JK**	<0.0002 U	<0.01 UK	**0.0007 JK**	**0.4 JK**	<0.001 U	<0.01 UK	**2.7 K**	<0.0001 UK	0.0003 UK	**0.0004 JK**	**0.006 JK**
	091407GWMST236-0-F	9/14/2007	Dissolved	**11.5 K**	**0.0006 JK**	<0.0002 U	<0.01 UK	**0.0011 JK**	**0.5 JK**	<0.001 U	<0.01 UJK	**2.7 K**	0.0002 UK	**0.0003 JK**	**0.0004 JK**	<0.002 UK
	051808SWMST236-0-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 UJ	NA	NA	NA	NA	NA	NA
	051808SWMST236-0-F	5/18/2008	Dissolved	**12.2 K**	NA	NA	NA	**0.0016 JK**	**0.8 JK**	NA	NA	**2.6 K**	NA	**0.0002 JK**	<0.0002 UK	**0.003 JK**
	091808SWMST236-0-U	9/18/2008	Total	NA	NA	NA	NA	NA	NA	<0.0005 U	NA	NA	NA	NA	NA	NA
	091808SWMST236-0-F	9/18/2008	Dissolved	**11.3**	**0.00278 J+**	NA	NA	**0.0016 J**	**0.377 J**	NA	NA	**2.5**	NA	NA	<0.005 U	<0.005 U

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SURFACE WATER BACKGROUND DATA
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				Anions (mg/l)			Chemistry Parameters (mg/l)											Radionuclidies (pCi/l)	
Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Chloride	Fluoride	Sulfate	Alkalinity, Total	Alkalinity, Hydroxide	Alkalinity, Bicarbonate	Alkalinity, Carbonate	Hardness	TKN	Nitrogen, NO2/NO3	Phosphorus	TSS	TDS	TOC	Gross Alpha	Gross Beta
				Screening Level[1]															
				NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MST101	051804SWMST101-0-U	5/18/2004	Total	NA	NA	NA	**216**	<2.0 U	**216**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051804SWMST101-0-F	5/18/2004	Dissolved	**8.3**	NA	**19.4**	**205**	<2.0 U	**194**	**11 J**	NA	**0.1 J**	NA	NA	<5.0 U	NA	NA	NA	NA
	051106SWMST101-0-U	5/11/2006	Total	NA	NA	NA	**215**	<2.0 U	**206**	**9.0 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051106SWMST101-0-F	5/11/2006	Dissolved	**5.7**	NA	**13.5**	**221**	<2.0 U	**208**	**14 J**	NA	<0.1 U	**0.1 J-**	NA	<5.0 U	NA	NA	-0.39 U	1 U
	050607SWMST101-0-U	5/6/2007	Total	NA	NA	NA	**181**	<2.0 U	**178**	**3.0 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050607SWMST101-0-F	5/6/2007	Dissolved	**6.9**	NA	**16.6**	NA	NA	NA	NA	NA	NA	NA	NA	**5.0**	**262**	NA	NA	NA
	091507GWMST101-0-U	9/15/2007	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091507GWMST101-0-F	9/15/2007	Dissolved	**7.6**	**0.1 J**	**12.8**	NA	NA	NA	NA	**196**	NA	NA	NA	NA	**220**	NA	NA	NA
	051108SWMST101-0-U	5/11/2008	Total	NA	NA	NA	NA	NA	NA	NA	**229**	NA	NA	NA	NA	NA	NA	NA	NA
	051108SWMST101-0-F	5/11/2008	Dissolved	**6.4**	NA	**16.9**	NA	NA	NA	NA	**234**	NA	NA	0.03 UJ	NA	**220 J-**	NA	NA	NA
	091908SWMST101-0-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	**214**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST101-0-F	9/19/2008	Dissolved	**7.82**	NA	**12.1**	**216**	NA	NA	NA	**208**	NA	NA	NA	NA	NA	NA	NA	NA
MST235	052004SWMST235-0-U	5/20/2004	Total	NA	NA	NA	**122**	<2.0 U	**112**	**10 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST235-0-F	5/20/2004	Dissolved	**12.6**	NA	**25.3**	**146**	<2.0 U	**146**	<2.0 U	NA	**0.7**	NA	NA	**18 J**	NA	NA	NA	NA
	050706SWMST235-0-U	5/7/2006	Total	NA	NA	NA	**160**	<2.0 U	**154**	**6.0 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050706SWMST235-0-F	5/7/2006	Dissolved	**4.1**	NA	**2.3 J**	**137**	<2.0 U	**128**	**10 J**	NA	**0.1 J-**	<0.02 U	NA	<5.0 U	NA	NA	3 U	2.9 U
	051007SWMST235-0-U	5/10/2007	Total	NA	NA	NA	**85**	<2.0 U	**85**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051007SWMST235-0-F	5/10/2007	Dissolved	**13 J-**	NA	**31.4 J-**	NA	NA	NA	NA	NA	NA	NA	NA	**3.0 J**	**254**	NA	NA	NA
	091207GWMST235-0-U	9/12/2007	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091207GWMST235-0-F	9/12/2007	Dissolved	**22.3**	**0.3 J**	**47.4**	NA	NA	NA	NA	**112**	NA	NA	NA	NA	**140**	NA	NA	NA
	051008SWMST235-0-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	NA	**193**	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST235-0-F	5/10/2008	Dissolved	**5.6**	NA	**13**	NA	NA	NA	NA	**186**	NA	NA	NA	NA	**230 J-**	NA	NA	NA
	092008SWMST235-0-U	9/20/2008	Total	NA	NA	NA	NA	NA	NA	NA	**99**	NA	NA	NA	NA	NA	NA	NA	NA
	092008SWMST235-0-F	9/20/2008	Dissolved	**21.4**	NA	**42**	**150**	NA	NA	NA	**170**	NA	NA	NA	NA	NA	NA	NA	NA
MST236	051804SWMST236-0-U	5/18/2004	Total	NA	NA	NA	**120**	<2.0 U	**120**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051804SWMST236-0-F	5/18/2004	Dissolved	**0.6 J**	NA	**3.8**	**188**	<2.0 U	**181**	**7.0 J**	NA	<0.1 U	NA	NA	**6.0 J**	NA	NA	NA	NA
	051106SWMST236-0-U	5/11/2006	Total	NA	NA	NA	**172**	<2.0 U	**171**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051106SWMST236-0-F	5/11/2006	Dissolved	**0.9 J**	NA	**7.5**	**173**	<2.0 U	**166**	**8.0 J**	NA	<0.1 U	**0.08 J-**	NA	<5.0 U	NA	NA	3.1 U	0.2 U
	050407SWMST236-0-U	5/4/2007	Total	NA	NA	NA	**166**	<2.0 U	**159**	**7.0 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050407SWMST236-0-F	5/4/2007	Dissolved	**1 J**	NA	**8.2**	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**182**	NA	NA	NA
	091407GWMST236-0-U	9/14/2007	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091407GWMST236-0-F	9/14/2007	Dissolved	**1.1 J**	**0.1 J**	**7.5**	NA	NA	NA	NA	**175**	NA	NA	NA	NA	**190**	NA	NA	NA
	051808SWMST236-0-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	NA	**179**	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST236-0-F	5/18/2008	Dissolved	**1.3 J**	NA	**7.2 J-**	NA	NA	NA	NA	**176**	NA	NA	0.03 UJ	NA	**160 J-**	NA	NA	NA
	091808SWMST236-0-U	9/18/2008	Total	NA	NA	NA	NA	NA	NA	NA	**183**	NA	NA	NA	NA	NA	NA	NA	NA
	091808SWMST236-0-F	9/18/2008	Dissolved	**3.06**	NA	**31.5**	**186 J+**	NA	NA	NA	**172**	NA	NA	NA	NA	NA	NA	NA	NA

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SURFACE WATER BACKGROUND DATA
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Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Metals (mg/l)												
				Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
				Screening Level[1]												
				0.087[a]	0.03[b]	0.15[c]	0.003[b]	0.0006[b]	0.0016[b]	0.0006[c,d]	NE	0.011[c,d,e]	0.003[b]	0.011[c,d]	0.158[f]	0.0025[c,d]
MST237	051804SWMST237-0-U	5/18/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051804SWMST237-0-F	5/18/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**55.4 K**	NA	NA	NA	NA	NA
	051106SWMST237-0-U	5/11/2006	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051106SWMST237-0-F	5/11/2006	Dissolved	**0.04 JK**	<0.0004 UK	<0.0005 UK	**0.024 K**	<0.002 UK	NA	<0.0001 UK	**47.6 K**	**0.0003 JK**	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
	050407SWMST237-0-U	5/4/2007	Total	**0.4 K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050407SWMST237-0-F	5/4/2007	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**53 K**	<0.0001 UK	NA	NA	NA	NA
	051808SWMST237-1-U	5/18/2008	Total	**0.71 J+K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-1-F	5/18/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**50.4 K**	<0.0001 UK	NA	NA	NA	NA
	051808SWMST237-2-U	5/18/2008	Total	**0.91 J+K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-2-F	5/18/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**50 K**	<0.0001 UK	NA	NA	NA	NA
	051808SWMST237-3-U	5/18/2008	Total	**0.62 J+K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-3-F	5/18/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**49.8 K**	<0.0001 UK	NA	NA	NA	NA
	051808SWMST237-avg-U	5/18/2008	Total	**0.747 J+K**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-avg-F	5/18/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**50.1 K**	<0.0001 UK	NA	NA	NA	NA
	091808SWMST237-0-U	9/18/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091808SWMST237-0-F	9/18/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**53.4**	**0.00206 J+**	NA	NA	<0.025 U	NA
MST254	052004SWMST254-1-U	5/20/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST254-1-F	5/20/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**44.4 K**	NA	NA	NA	NA	NA
	052004SWMST254-2-U	5/20/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST254-2-F	5/20/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**44.4 K**	NA	NA	NA	NA	NA
	052004SWMST254-3-F	5/20/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UJK	**43.1 K**	NA	NA	NA	NA	NA
	052004SWMST254-avg-U	5/20/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST254-avg-F	5/20/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UJK	**44 K**	NA	NA	NA	NA	NA
	050506SWMST254-0-U	5/5/2006	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050506SWMST254-0-F	5/5/2006	Dissolved	**0.41 K**	<0.0004 UK	**0.0005 JK**	**0.035 K**	<0.002 UK	NA	**0.0001 JK**	**27.6 K**	**0.0006 K**	<0.01 UK	<0.01 UK	**0.25 K**	**0.0006 K**
	051407SWMST254-0-U	5/14/2007	Total	0.09 UK	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051407SWMST254-0-F	5/14/2007	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UJK	**54.4 J-K**	<0.0001 UJK	NA	NA	NA	NA
	091207GWMST254-0-U	9/12/2007	Total	**0.09 JK**	<0.0004 UK	**0.0026 K**	**0.029 K**	<0.002 UK	**0.02 JK**	<0.0001 UK	**19.7 K**	0.0003 UK	<0.01 UK	<0.01 UK	**0.17 K**	0.0001 UK
	091207GWMST254-0-F	9/12/2007	Dissolved	<0.03 UK	<0.0004 UJK	**0.0029 K**	**0.027 K**	<0.002 UK	**0.02 JK**	<0.0001 UK	**18.7 K**	<0.0001 UK	<0.01 UK	<0.01 UK	**0.09 K**	0.0001 UK
	051008SWMST254-0-U	5/10/2008	Total	**0.2 JK**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST254-0-F	5/10/2008	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UK	**29.8 K**	<0.0001 UK	NA	NA	NA	NA
	091908SWMST254-0-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST254-0-F	9/19/2008	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**16.8**	**0.00107 J**	NA	NA	<0.025 U	NA
MST277	052204SWMST277-1-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-1-F	5/22/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0005 UK	**93.5 K**	<0.0005 UK	NA	NA	NA	NA
	052204SWMST277-2-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-2-F	5/22/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0005 UK	**93 K**	<0.0005 UK	NA	NA	NA	NA
	052204SWMST277-3-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-3-F	5/22/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0005 UK	**93.1 K**	<0.0005 UK	NA	NA	NA	NA
	052204SWMST277-avg-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-avg-F	5/22/2004	Dissolved	NA	NA	NA	NA	NA	NA	<0.0005 UK	**93.2 K**	<0.0005 UK	NA	NA	NA	NA
	051006GWMST277-0-U	5/10/2006	Total	NA	NA	NA	NA	NA	NA	<0.0001 UK	NA	0.0004 UK	NA	NA	NA	NA
	051006GWMST277-0-F	5/10/2006	Dissolved	<0.03 UK	**0.0008 JK**	0.0028 UK	**0.08 K**	<0.002 UK	NA	<0.0001 UK	**66.3 K**	**0.0002 JK**	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
	051407SWMST277-0-U	5/14/2007	Total	<0.03 UK	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051407SWMST277-0-F	5/14/2007	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UJK	**91.3 J-K**	<0.0001 UJK	NA	NA	NA	NA
	051508GWMST277-0-U	5/15/2008	Total	0.05 UJK	<0.0004 UK	**0.0028 J+K**	**0.049 K**	<0.002 UK	**0.02 J+K**	<0.0001 UK	**62.3 K**	<0.0001 UK	<0.01 UK	<0.01 UK	**0.26 K**	0.0001 UK
	051508GWMST277-0-F	5/15/2008	Dissolved	<0.03 UK	0.0004 UK	**0.0028 K**	**0.047 K**	<0.002 UK	<0.01 UK	**0.0001 JK**	**58.2 K**	<0.0001 UK	<0.01 UK	<0.01 UK	**0.14 K**	<0.0001 UK

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SURFACE WATER BACKGROUND DATA
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Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Metals (mg/l)												
				Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
				Screening Level[1]												
				NE	0.12[g]	0.00077[b]	0.034[b]	0.052[c,d]	NE	0.005[c,e]	0.00036[b]	NE	0.00003[b]	0.142[g]	0.02[g]	0.12[c,d]
MST237	051804SWMST237-0-U	5/18/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051804SWMST237-0-F	5/18/2004	Dissolved	**12.5 K**	NA	NA	NA	0.0002 UK	**0.6 JK**	NA	NA	**3.7 K**	NA	NA	**0.00034 J+K**	**0.014 K**
	051106SWMST237-0-U	5/11/2006	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051106SWMST237-0-F	5/11/2006	Dissolved	**11.1 K**	**0.0133 K**	<0.0002 U	<0.01 UK	<0.0006 UK	**0.7 JK**	NA	<0.01 UK	**3.4 K**	<0.0001 UK	**0.0003 JK**	**0.0003 JK**	**0.005 JK**
	050407SWMST237-0-U	5/4/2007	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	050407SWMST237-0-F	5/4/2007	Dissolved	**12.5 K**	NA	NA	NA	**0.0017 JK**	**0.7 JK**	NA	NA	**3.6 K**	NA	0.0004 UK	0.0005 UK	<0.002 UK
	051808SWMST237-1-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051808SWMST237-1-F	5/18/2008	Dissolved	**11.7 K**	NA	NA	NA	**0.0012 JK**	**0.8 JK**	NA	NA	**3.6 K**	NA	**0.0004 JK**	0.0009 UK	**0.014 K**
	051808SWMST237-2-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051808SWMST237-2-F	5/18/2008	Dissolved	**11.6 K**	NA	NA	NA	**0.0011 JK**	**0.7 JK**	NA	NA	**3.6 K**	NA	**0.0004 JK**	0.0009 UK	**0.008 JK**
MST237	051808SWMST237-3-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051808SWMST237-3-F	5/18/2008	Dissolved	**11.6 K**	NA	NA	NA	**0.0012 JK**	**0.8 JK**	NA	NA	**3.5 K**	NA	**0.0004 JK**	0.0008 UK	**0.006 JK**
	051808SWMST237-avg-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051808SWMST237-avg-F	5/18/2008	Dissolved	**11.6 K**	NA	NA	NA	**0.00117 JK**	**0.767 JK**	NA	NA	**3.57 K**	NA	**0.0004 JK**	<0.0002 UK	**0.00933 JK**
	091808SWMST237-0-U	9/18/2008	Total	NA	NA	NA	NA	NA	NA	<0.0005 U	NA	NA	NA	NA	NA	NA
	091808SWMST237-0-F	9/18/2008	Dissolved	**11**	**0.0176**	NA	NA	**0.00221 J**	**0.601 J**	NA	NA	**3.81**	NA	NA	<0.005 U	<0.005 U
MST254	052004SWMST254-1-U	5/20/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052004SWMST254-1-F	5/20/2004	Dissolved	**8.3 K**	NA	NA	NA	**0.0006 JK**	**2.2 K**	NA	NA	**4.2 K**	NA	NA	**0.0005 J+K**	<0.004 UK
	052004SWMST254-2-U	5/20/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052004SWMST254-2-F	5/20/2004	Dissolved	**8.4 K**	NA	NA	NA	**0.0005 JK**	**2.3 K**	NA	NA	**4.2 K**	NA	NA	**0.00059 K**	<0.002 UK
	052004SWMST254-3-F	5/20/2004	Dissolved	**8.1 K**	NA	NA	NA	**0.0013 JK**	**2.1 K**	NA	NA	**4.1 K**	NA	NA	**0.00055 JK**	<0.002 UJK
	052004SWMST254-avg-U	5/20/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052004SWMST254-avg-F	5/20/2004	Dissolved	**8.27 K**	NA	NA	NA	**0.0008 JK**	**2.2 K**	NA	NA	**4.17 K**	NA	NA	**0.000547 J+K**	<0.004 UJK
	050506SWMST254-0-U	5/5/2006	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	050506SWMST254-0-F	5/5/2006	Dissolved	**5.6 K**	**0.0377 K**	<0.0002 U	<0.01 UK	**0.0008 JK**	**2.1 K**	NA	<0.01 UJK	**3.3 K**	**0.0001 JK**	**0.0002 JK**	<0.0002 UK	**0.008 JK**
	051407SWMST254-0-U	5/14/2007	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051407SWMST254-0-F	5/14/2007	Dissolved	**11.5 K**	NA	NA	NA	**0.0018 JK**	**1.6 JK**	NA	NA	**5.4 K**	NA	**0.0012 JK**	**0.0015 JK**	**0.062 JK**
	091207GWMST254-0-U	9/12/2007	Total	**9.3 K**	**0.0499 K**	<0.0002 U	<0.01 UK	**0.0009 JK**	**0.8 JK**	<0.001 U	<0.01 UK	**8.2 K**	<0.0001 UK	**0.0005 K**	**0.0017 K**	**0.01 K**
	091207GWMST254-0-F	9/12/2007	Dissolved	**9.0 K**	**0.0382 K**	<0.0002 U	<0.01 UK	**0.0009 JK**	**0.8 JK**	<0.001 U	<0.01 UK	**7.9 K**	<0.0001 UK	**0.0005 K**	**0.0018 K**	**0.009 JK**
	051008SWMST254-0-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051008SWMST254-0-F	5/10/2008	Dissolved	**6.6 K**	NA	NA	NA	**0.0012 JK**	**2.1 K**	NA	NA	**4.1 K**	NA	**0.0002 JK**	**0.0007 JK**	**0.015 K**
	091908SWMST254-0-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	**0.000628 J**	NA	NA	NA	NA	NA	NA
	091908SWMST254-0-F	9/19/2008	Dissolved	**10.2**	**0.0239**	NA	NA	**0.00154 J**	**1.02**	NA	NA	**5.93**	NA	NA	<0.005 U	<0.005 U
MST277	052204SWMST277-1-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052204SWMST277-1-F	5/22/2004	Dissolved	**8.8 K**	NA	NA	NA	**0.001 JK**	**9.1 K**	<0.001 U	NA	**6.9 K**	NA	NA	0.0004 UK	<0.01 UK
	052204SWMST277-2-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052204SWMST277-2-F	5/22/2004	Dissolved	**8.8 K**	NA	NA	NA	**0.002 JK**	**9.0 K**	<0.001 U	NA	**6.9 K**	NA	NA	0.0004 UK	<0.01 UK
	052204SWMST277-3-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052204SWMST277-3-F	5/22/2004	Dissolved	**8.9 K**	NA	NA	NA	**0.001 JK**	**9.1 K**	<0.001 U	NA	**7.1 K**	NA	NA	<0.0003 UK	<0.01 UK
	052204SWMST277-avg-U	5/22/2004	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	052204SWMST277-avg-F	5/22/2004	Dissolved	**8.83 K**	NA	NA	NA	**0.00133 JK**	**9.07 K**	<0.001 U	NA	**6.97 K**	NA	NA	<0.0003 UK	<0.01 UK
	051006GWMST277-0-U	5/10/2006	Total	NA	NA	NA	NA	**0.0008 JK**	NA	<0.001 U	NA	NA	NA	NA	**0.0039 K**	**0.003 JK**
	051006GWMST277-0-F	5/10/2006	Dissolved	**7.3 K**	**0.0077 K**	<0.0002 U	<0.01 UK	**0.0007 JK**	**2.3 K**	<0.001 U	<0.01 UK	**5.3 K**	<0.0001 UK	**0.0004 JK**	**0.0037 K**	**0.005 JK**
	051407SWMST277-0-U	5/14/2007	Total	NA	NA	NA	NA	NA	NA	<0.001 U	NA	NA	NA	NA	NA	NA
	051407SWMST277-0-F	5/14/2007	Dissolved	**8.8 K**	NA	NA	NA	**0.0016 JK**	**4.4 K**	NA	NA	**7.4 K**	NA	**0.0009 JK**	<0.0002 UJK	**0.004 JK**
	051508GWMST277-0-U	5/15/2008	Total	**5.1 K**	**0.196 J-K**	<0.0002 U	<0.01 UK	**0.0015 JK**	**4.9 K**	<0.001 U	<0.01 UK	**5.0 K**	<0.0001 UK	**0.0004 JK**	**0.0006 JK**	**0.005 JK**
	051508GWMST277-0-F	5/15/2008	Dissolved	**4.9 K**	**0.164 K**	<0.0002 U	<0.01 UK	**0.0033 K**	**4.6 K**	<0.001 U	<0.01 UK	**4.9 K**	<0.0001 UK	**0.0005 K**	0.0008 UK	**0.011 K**

TABLE 2-4
SURFACE WATER BACKGROUND DATA
P4 RI/FS
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				Anions (mg/l)			Chemistry Parameters (mg/l)											Radionuclidies (pCi/l)	
Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Chloride	Fluoride	Sulfate	Alkalinity, Total	Alkalinity, Hydroxide	Alkalinity, Bicarbonate	Alkalinity, Carbonate	Hardness	TKN	Nitrogen, NO2/NO3	Phosphorus	TSS	TDS	TOC	Gross Alpha	Gross Beta
				Screening Level[1]															
				NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MST237	051804SWMST237-0-U	5/18/2004	Total	NA	NA	NA	**159**	<2.0 U	**159**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051804SWMST237-0-F	5/18/2004	Dissolved	**1.4 J**	NA	**11.9**	**171**	<2.0 U	**165**	**6.0 J**	NA	**0.1 J**	NA	NA	**10 J**	NA	NA	NA	NA
	051106SWMST237-0-U	5/11/2006	Total	NA	NA	NA	**175**	<2.0 U	**163**	**12 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051106SWMST237-0-F	5/11/2006	Dissolved	**1.3 J**	NA	**10.9**	**157**	<2.0 U	**149**	**8.0 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050407SWMST237-0-U	5/4/2007	Total	NA	NA	NA	**158**	<2.0 U	**149**	**9.0 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050407SWMST237-0-F	5/4/2007	Dissolved	**1.6 J**	NA	**14.1**	**158**	<2.0 U	**149**	**8.67 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-1-U	5/18/2008	Total	NA	NA	NA	**159**	<2.0 U	**150**	**9.0 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-1-F	5/18/2008	Dissolved	**1.8 J**	NA	**14.1**	NA	NA	NA	NA	**184**	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-2-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**178**	NA	NA	NA
	051808SWMST237-2-F	5/18/2008	Dissolved	**1.8 J**	NA	**13.9**	NA	NA	NA	NA	**173**	NA	NA	NA	NA	NA	NA	NA	NA
MST237	051808SWMST237-3-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-3-F	5/18/2008	Dissolved	**1.7 J**	NA	**13.9**	NA	NA	NA	NA	**172**	NA	NA	NA	NA	NA	NA	NA	NA
	051808SWMST237-avg-U	5/18/2008	Total	NA	NA	NA	NA	NA	NA	NA	**165**	NA	NA	NA	NA	**170**	NA	NA	NA
	051808SWMST237-avg-F	5/18/2008	Dissolved	**1.77 J**	NA	**14**	NA	NA	NA	NA	**173**	NA	NA	NA	NA	NA	NA	NA	NA
	091808SWMST237-0-U	9/18/2008	Total	NA	NA	NA	NA	NA	NA	NA	**174**	NA	NA	NA	NA	NA	NA	NA	NA
	091808SWMST237-0-F	9/18/2008	Dissolved	**1.84**	NA	**13.6**	**165**	NA	NA	NA	**179**	NA	NA	NA	NA	NA	NA	NA	NA
MST254	052004SWMST254-1-U	5/20/2004	Total	NA	NA	NA	**138**	<2.0 U	**138**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST254-1-F	5/20/2004	Dissolved	**3.7**	NA	**6.1**	**132**	<2.0 U	**132**	<2.0 U	NA	**0.5 J**	NA	NA	<5.0 U	NA	NA	NA	NA
	052004SWMST254-2-U	5/20/2004	Total	NA	NA	NA	**137**	<2.0 U	**137**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST254-2-F	5/20/2004	Dissolved	**3.7**	NA	**6.2**	**173 J-**	NA	**167 J-**	**6.0 J-**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST254-3-F	5/20/2004	Dissolved	**3.7**	NA	**6.2**	**88**	<2.0 U	**53**	**35**	NA	**1.1 J-**	<0.02 U	NA	<5.0 U	NA	NA	1.4 U	1.4 U
	052004SWMST254-avg-U	5/20/2004	Total	NA	NA	NA	**141**	<2.0 U	**141**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052004SWMST254-avg-F	5/20/2004	Dissolved	**3.7**	NA	**6.17**	**93**	<2.0 U	**93**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
	050506SWMST254-0-U	5/5/2006	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**412**	NA	NA	NA
	050506SWMST254-0-F	5/5/2006	Dissolved	**2.4 J**	NA	**2.8 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051407SWMST254-0-U	5/14/2007	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051407SWMST254-0-F	5/14/2007	Dissolved	**4.4 J-**	NA	**6.3 J-**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091207GWMST254-0-U	9/12/2007	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	091207GWMST254-0-F	9/12/2007	Dissolved	**5.4**	**0.3 J**	2.5 U	NA	NA	NA	NA	**92**	NA	NA	NA	NA	**130**	NA	NA	NA
	051008SWMST254-0-U	5/10/2008	Total	NA	NA	NA	NA	NA	NA	NA	**183**	NA	NA	NA	NA	NA	NA	NA	NA
	051008SWMST254-0-F	5/10/2008	Dissolved	**4.1**	NA	**5.1 J+**	NA	NA	NA	NA	**84**	NA	NA	**0.05 J-**	NA	**120 J-**	NA	NA	NA
	091908SWMST254-0-U	9/19/2008	Total	NA	NA	NA	NA	NA	NA	NA	**102**	NA	NA	NA	NA	NA	NA	NA	NA
	091908SWMST254-0-F	9/19/2008	Dissolved	**4.19**	NA	**2.25**	**85.1**	NA	NA	NA	**84.1**	NA	NA	NA	NA	NA	NA	NA	NA
MST277	052204SWMST277-1-U	5/22/2004	Total	NA	NA	NA	**285**	<2.0 U	**251**	**34**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-1-F	5/22/2004	Dissolved	**4.5**	NA	**3.5**	**232**	<2.0 U	**232**	<2.0 U	NA	**0.5 J**	**0.08 J**	NA	<5.0 U	NA	**8.0**	NA	NA
	052204SWMST277-2-U	5/22/2004	Total	NA	NA	NA	**290**	<2.0 U	**256**	**34**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-2-F	5/22/2004	Dissolved	**4.4**	NA	**3.6**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-3-U	5/22/2004	Total	NA	NA	NA	**287**	<2.0 U	**249**	**37**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-3-F	5/22/2004	Dissolved	**4.5**	NA	**3.7**	**247 J-**	NA	**247 J-**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-avg-U	5/22/2004	Total	NA	NA	NA	**277**	<2.0 U	**247**	**31**	NA	NA	NA	NA	NA	NA	NA	NA	NA
	052204SWMST277-avg-F	5/22/2004	Dissolved	**4.47**	NA	**3.6**	**150**	<2.0 U	**150**	<2.0 U	**177**	**1.0**	<0.02 U	NA	<5.0 U	NA	NA	3.4 U	6.9 U
	051006GWMST277-0-U	5/10/2006	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051006GWMST277-0-F	5/10/2006	Dissolved	**2.7 J**	NA	**18**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051407SWMST277-0-U	5/14/2007	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	051407SWMST277-0-F	5/14/2007	Dissolved	**3.7 J-**	NA	**19.5 J-**	NA	NA	NA	NA	**196**	NA	NA	**0.11**	NA	**240**	NA	NA	NA
	051508GWMST277-0-U	5/15/2008	Total	NA	NA	NA	NA	NA	NA	NA	**264**	NA	NA	NA	NA	NA	NA	NA	NA
	051508GWMST277-0-F	5/15/2008	Dissolved	**2.6 J**	**0.1 J**	**19.7**	NA	NA	NA	NA	**166**	NA	NA	**0.44 J-**	NA	**240 J-**	NA	NA	NA

TABLE 2-4
SURFACE WATER BACKGROUND DATA
P4 RI/FS
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Location Identification	Field Sample Identification	Date Collected	Total/ Dissolved	Metals (mg/l)												
				Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
				Screening Level[1]												
				0.087[a]	0.03[b]	0.15[c]	0.003[b]	0.0006[b]	0.0016[b]	0.0006[c,d]	NE	0.011[c,d,e]	0.003[b]	0.011[c,d]	0.158[f]	0.0025[c,d]

mg/l	milligrams per liter.	TKN	Nitrogen, Kjeldahl, Total
Bold	Bolded result indicates positively identified compound.	TDS	Total dissolved solids
Shaded	Indicates sample concentration is greater than the associated screening level.	TSS	Total suspeded solids
Shaded	Indicates method detection limit is greater than the associated screening level.	TOC	Total organic carbon
NE	Not established	<#U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
NA	Not analyzed.	#U	The analyte was analyzed for and is considered not detected based on associated quality control data.
J	Data are estimated due to associated quality control data.	K	Serial dilutions not performed for samples analyzed by this method (EPA 200.7; 200.8).
UJ	Potential low bias, possible false negative.	J-	Data are estimated, potentially biased low, due to associated quality control data.
UK	Analyte is considered not detected based on data validation.	J+	Data are estimated, potentially biased high, due to associated quality control data.

Notes:

[1] Screening levels reported in Table 3-1 of the A/T-approved P4 Sites RI/FS Work Plan - Rev 2 Final (MWH, 2011)

[a]National Recommended Water Quality Criteria (USEPA, 2009); Freshwater Standards for Chronic Criteria (CCC)

[b]Chronic freshwater screening value in NOAA SQuiRT (Buchman, 2008)

[c]State of Idaho Surface Water Quality for Aquatic Life (IDAPA 58.01.02); Chronic Criteria (CCC)

[d]Aquatic life criteria for these metals are expressed as function of total hardness.

[e]Criterion is expressed as total recoverable (unfiltered concentration)

[f]Lowest Chronic Value (LCV) observed for fresh water daphnids. Source: ORNL, 1996

[g]Tier II Secondary Chronic Value. Source: ORNL, 1996

TABLE 2-5
RIPARIAN SOIL BACKGROUND DATA
P4 RI/FS
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			Metals (mg/kg)																	Chemistry Parameters		
Location Identification	Field Sample Identification	Date Collected	Antimony	Arsenic	Boron	Cadmium	Chromium	Cobalt	Copper	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc	pH	TOC (%)	Percent Solids
			Screening Level[1]																			
			31	0.39	16000	70	120000	23	3100	1800	5.6	390	1500	390	390	5	230	390	23000	N/A	N/A	N/A
MST048	SSMST048-0-C(5)	9/12/2004	NA	NA	NA	1.32	24.7 J	NA	15.3	NA	NA	0.28 U	15.9 J-	<0.5 U	NA	NA	NA	28.3 J-	85	7.2	4.1	79.9
MST049	SSMST049-0-C(5)	9/12/2004	NA	NA	NA	1.39	25.4 J	NA	15.3	NA	NA	0.45 J+	15.5 J-	<0.5 U	NA	NA	NA	29.4 J-	77	7	4	79.4
MST093	SSMST093-0-C(6)	9/9/2004	NA	NA	NA	2.72	22.9	NA	21.1 J	NA	NA	0.58	14.5	0.5 J-	NA	NA	NA	30.4	107	5.9	9.3	82.5
	1010-MST093A-RS-001-1	10/4/2010	3.2 UJ	3.03	10.1	1.81	18.7	5.14	17.5	543	0.023	<0.5 U	16	0.7 J	0.164	0.186	2.21	23.5	105	NA	5.6	91.9
	1010-MST093A-RS-001-2	10/4/2010	6.1 UJ	3.05	9.8 J	1.99	18.3	5.01 J	18	922	0.024	<0.5 U	17.4	0.7 J	0.155	0.189	2.29	24.6	105	NA	5.31	92
	1010-MST093A-RS-001-av	10/4/2010	4.65 UJ	3.04	9.95 J	1.9	18.5	5.075 J	17.75	732.5	0.0235	<0.5 U	16.7	0.7	0.16	0.1875	2.25	24.05	105	NA	5.455	91.95
	1010-MST093B-RS-001	10/4/2010	4.4 UJ	4.24	10	2.43	18.4	7.99 J	18.2	1080	0.035	0.7 J	19	1.0 J	0.158	0.16	2.54	32.2	104	NA	7.54	88.2
	1010-MST093A-RS-002-1	10/4/2010	3.9 UJ	3.05	9.7 J	3.63	17	4.58 J	17.6	337	0.046	<0.5 U	18.9	1.4	0.194	0.167	3.69	24.9	122	NA	10.5	79.4
	1010-MST093A-RS-002-2	10/4/2010	4.8 UJ	2.94	9.9 J	3.49	16.7	4.38 J	18.2	351	0.049	<0.5 U	18.3	1.3	0.215	0.176	3.83	24.4	120	NA	11.6	78.6
	1010-MST093A-RS-002-av	10/4/2010	4.35 UJ	2.995	9.8 J	3.56	16.85	4.48 J	17.9	344	0.0475	<0.5 U	18.6	1.35	0.205	0.1715	3.76	24.65	121	NA	11.05	79
	1010-MST093B-RS-002	10/4/2010	3.6 UJ	2.78	11.2	3.51	16.7	5.09 J	17.6	527	0.069	<0.5 U	17.1	1.5	0.223	0.17	2.03	24.3	117	NA	16	62.7
MST101	SSMST101-0-C(5)	9/15/2004	NA	NA	NA	1.79 J+	26 J	NA	19 J	NA	NA	0.47 J+	21.3 J	0.5 J	NA	NA	NA	32.6 J	99 J	7.4	5.3	74.2
MST235	SSMST235-0-C(7)	9/11/2004	NA	NA	NA	0.6	21.7 J	NA	10.5	NA	NA	0.17 U	10.4 J-	<0.5 U	NA	NA	NA	22.9 J-	42	6.9	1.7	87.5
MST236	SSMST236-0-C(9)	9/10/2004	NA	NA	NA	4.4 J	42.5	NA	18.8 J-	NA	NA	1.7 J	26.6 J	0.7 J	NA	NA	NA	52.4 J	158	6.3	3.7	72.2
MST237	SSMST237-0-C(6)	9/10/2004	NA	NA	NA	1.4 J	26.9	NA	15.9 J-	NA	NA	0.4 UJ	18.1 J	0.7 J	NA	NA	NA	34.5 J	91	6.6	4.4	70.3
MST254	SSMST254-0-C(5)	9/12/2004	NA	NA	NA	1.2	21 J	NA	12.1	NA	NA	0.43 J+	12.6 J-	<0.5 U	NA	NA	NA	24.9 J-	60	6	4.5	30.5
MST277	SSMST277-0-C(5)	9/14/2004	NA	NA	NA	3.4 J+	40.3 J	NA	29 J	NA	NA	0.43 J+	24.5 J	0.7 J	NA	NA	NA	57.3 J	139 J	6.6	12.6	60.5
	1010-MST277A-RS-002	10/3/2010	5.2 J-	3.0	5.6 J	1.73	18.5	5.64	18.8	148 J+	0.025	<0.5 U	14.6	1.1	0.154	0.244	1.6	25.5	84.5	NA	5.33	86
	1010-MST277A-RS-001	10/3/2010	4.6 J-	2.9	6.1 J	2.02	18.6	6.32	21	124 J+	0.03	0.6 U	15.9	1.4	0.163	0.291	1.83	26	87.7	NA	5.51	88.4
	1010-MST277B-RS-001	10/3/2010	5.5 J-	5.44	6.7 J	3.24	29.3	10.1	30	323 J+	0.042	1.3 U	24.4	1.7	0.265	0.428	2.53	42	144	NA	6.11	77.4
	1010-MST277B-RS-002	10/3/2010	5.3 J-	5.19	6.6 J	3.43	29.2	9.63	29.3	159 J+	0.042	1.5 U	24.5	1.8	0.278	0.418	3.01	42.1	142	NA	4.01	77.7

mg/kg milligrams per kilogram (dry weight).
Bold Bolded result indicates positively identified compound.
Shaded Indicates sample concentration is greater than the associated screening level.
N/A Not aplicable
NA Not analyzed.
J Data are estimated due to associated quality control data.
UJ Potential low bias, possible false negative.
<#U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
#U The analyte was analyzed for and is considered not detected based on associated quality control data.
J- Data are estimated, potentially biased low, due to associated quality control data.
J+ Data are estimated, potentially biased high, due to associated quality control data.

[1] Screening levels reported in Table 3-1 of the A/T-approved P4 Sites RI/FS Work Plan - Rev 2 Final (MWH, 2011)
USEPA Regional Screening Levels for Soil, Residential, Source: ORNL December 2009

http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

Note: At background stations MST093 and MST277, composite riparian soil samples were collected in 2010 from two locations A and B located approximately 50 feet apart. In addition, one riparian soil sample was collected from each bank for a total of four riparian soil samples at each station. For example, at MST093A there were two riparian soil samples collected -001 and -002, and at MST093B, there were two riparian soil samples collected -001 and -002.

TABLE 2-6
RIPARIAN VEGETATION BACKGROUND DATA
P4 RI/FS
(Page 1 of 1)

			Metals (mg/kg)					
Location Identification	**Field Sample Identification**	**Date Collected**	**Cadmium**	**Copper**	**Molybdenum**	**Selenium**	**Zinc**	**Percent Moisture**
			Screening Level[1]					
			10	**40**	**5**	**5**	**500**	**N/A**
MST048	VEMST048-0-C(5)	9/12/2004	**0.1 JT**	**4.5 T**	**0.63 T**	<0.5 UT	**44 T**	**53.6**
MST049	VEMST049-0-C(5)	9/12/2004	**0.14 JT**	**5.0 T**	**2.58 T**	<0.5 UT	**28 T**	**58.1**
MST093	VEMST093-0-C(6)	9/9/2004	**0.35 T**	**4.1 T**	**1.57 T**	<0.5 UT	**27 J-T**	**41.4**
MST101	VEMST101-0-C(5)	9/15/2004	**0.6 T**	**8.8 T**	**2.37 T**	**0.8 JT**	**64 T**	**79.3**
MST235	VEMST235-0-C(7)	9/11/2004	**0.11 JT**	**1.8 T**	**0.68 T**	<0.5 UT	**12 T**	**56.6**
MST236	VEMST236-0-C(9)	9/10/2004	**0.9 T**	**5.1 T**	**0.94 T**	<0.5 UT	**52 T**	**41.4**
MST237	VEMST237-0-C(6)	9/10/2004	**0.34 T**	**2.3 T**	**0.72 T**	<0.5 UT	**28 T**	**57**
MST254	VEMST254-0-C(5)	9/12/2004	**0.12 JT**	**2.9 T**	**0.91 T**	<0.5 UT	**23 T**	**56.5**
MST277	VEMST277-0-C(5)	9/14/2004	**0.18 JT**	**2.4 T**	**1.32 T**	<0.5 UT	**22 T**	**50.4**

mg/kg milligrams per kilogram (dry weight).
Bold Bolded result indicates positively identified compound.
J Data are estimated due to associated quality control data.
T Laboratory SOP does not address biotic matrices; biotic-specific LCS/SRM not analyzed.
<U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J- Data are estimated, potentially biased low, due to associated quality control data.
J+ Data are estimated, potentially biased high, due to associated quality control data.
N/A Not applicable
[1] Screening levels reported in Table 3-1 of the A/T-approved P4 Sites RI/FS Work Plan - Rev 2 Final (MWH, 2011)
Mineral tolerance of animals, second revised edition, 2005 National Research Council, published by the National Academics Press, WA DC, 496 pages

Table 2-7
Upland Soil and Vegetation Background Sample Locations and Rationale

Station	Mine	Latitude	Longitude	Rationale
MBB-001	Ballard Mine	W111° 28' 57.97"	N42° 50' 44.03"	Collected from the Wells Formation in an area of undisturbed ground - i.e., natural background locations based on the A/T-approved Supplemental Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009).
MBB-002		W111° 29' 01.39"	N42° 50' 40.98"	
MBB-003		W111° 29' 03.48"	N42° 50' 40.12"	
MBB-004		W111° 29' 00.03"	N42° 50' 39.86"	
MBB-005		W111° 28' 52.91"	N42° 50' 36.24"	
MBB-006		W111° 28' 56.87"	N42° 50' 33.95"	
MBB-007		W111° 28' 52.53"	N42° 50' 32.31"	
MBB-008		W111° 28' 50.07"	N42° 50' 32.35"	
MBB-009		W111° 28' 48.07"	N42° 50' 31.28"	
MBB-010		W111° 28' 53.98"	N42° 50' 28.11"	
MBH-001	Henry Mine	W111° 25' 35.55"	N42° 53' 23.56"	Collected from the Dinwoody Formation in an area of undisturbed ground - i.e., natural background locations based on the A/T-approved Supplemental Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009).
MBH-002		W111° 25' 29.00"	N42° 53' 24.96"	
MBH-003		W111° 25' 20.17"	N42° 53' 20.69"	
MBH-004		W111° 25' 25.93"	N42° 53' 23.06"	
MBH-005		W111° 25' 24.33"	N42° 53' 20.66"	
MBH-006		W111° 25' 18.47"	N42° 53' 15.94"	
MBH-007		W111° 25' 07.95"	N42° 53' 12.83"	
MBH-008		W111° 25' 14.29"	N42° 53' 14.87"	
MBH-009		W111° 25' 22.02"	N42° 53' 17.49"	
MBH-010		W111° 28' 43.47"	N42° 53' 28.29"	
MBE-001	Enoch Valley Mine	W111° 28' 45.74"	N42° 53' 26.56"	Collected from the Dinwoody Formation in an area of undisturbed ground - i.e., natural background locations based on the A/T-approved Supplemental Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009).
MBE-002		W111° 28' 45.54"	N42° 53' 25.52"	
MBE-003		W111° 28' 42.28"	N42° 53' 27.00"	
MBE-004		W111° 28' 44.26"	N42° 53' 22.63"	
MBE-005		W111° 28' 43.13"	N42° 53' 22.27"	
MBE-006		W111° 28' 34.65"	N42° 53' 16.50"	
MBE-007		W111° 28' 33.16"	N42° 53' 16.98"	
MBE-008		W111° 28' 31.38"	N42° 53' 14.03"	
MBE-009		W111° 28' 28.30"	N42° 53' 13.58"	
MBE-010		W111° 28' 57.97"	N42° 50' 44.03"	

Notes:
Location (GPS) coordinates use the NAD27 datum and are presented in ddd mm ss format (degrees minutes seconds).

TABLE 2-8
UPLAND SOIL BACKGROUND DATA
P4 RI/FS
(Page 1 of 1)

Location Identification	Field Sample Identification	Date Collected	Antimony	Arsenic	Boron	Cadmium	Chromium (Total)	Chromium (VI)	Cobalt	Copper	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc
			Metals (mg/kg)																	
			Screening Level[1]																	
			31	0.39	16000	70	120000	NE	23	3100	1800	5.6	390	1500	390	390	5	230	390	23000
Ballard	0906-MBB001-01-SS	7/10/2009	<0.372 U	2.96	3.93	1.4	13.1	<0.246 U	5.27	9.98	437	0.0231 J	<1.12 U	13	0.304	0.0916 J	0.165	0.782	14.8	82.2
	0906-MBB001-02-SS	7/10/2009	<0.373 U	3.27	3.03 J	1.58	14.5	<0.244 U	5.51	10.2	455	0.0209 J	<1.12 U	13.2	0.361	0.0945 J	0.176	0.849	15.4	83.7
	0906-MBB001-03-SS	7/10/2009	<0.383 U	3.38	3.05 J	1.48	16.3	<0.248 U	5.32	10.8	405	0.0229 J	<1.15 U	17.1	0.379	0.0931 J	0.183	0.827	17.5	88.8
	0906-MBB001-04-SS	7/10/2009	<0.382 U	2.99	3.51 J	1.79	14	<0.249 U	4.83	10.6	424	0.0264 J	<1.15 U	14.2	0.414	0.0921 J	0.155	0.806	16	99.7
	0906-MBB001-05-SS	7/9/2009	0.717 U	2.55	2.74 J-	1.63	9.87	<0.489 U	4.11	9.58	419	0.0198 J	<1.11 U	13.5 J-	0.25 J-	0.0795 J	0.118	0.688	10.7 J+	101
	0906-MBB001-06-SS	7/10/2009	0.419 J	3.48	6.09	2.26	14.2	<0.242 U	3.86	11.9	442	0.0243 J	<1.12 U	14.9	0.418	0.0924 J	0.158	0.854	16.3 J+	97
	0906-MBB001-07-SS-1	7/10/2009	<0.347 U	3.48	4.93	2.13	10.3	<0.244 U	3.39	9.41	327	0.0235 J	<1.04 U	12.4	0.366	0.0668 J	0.129	0.587	15.4 J+	110
	0906-MBB001-07-SS-2	7/10/2009	<0.351 U	3.42	3.01 J	2.61	13.6	<0.246 U	3.44	9.91	327	0.0256 J	<1.05 U	13	0.417	0.079 J	0.143	0.74	17.2	101
	0906-MBB001-07-SS-3	7/10/2009	0.529 J	3.02	11.7	2.15	9.32	<0.246 U	3.29	8.93	356	0.0183 J	<1.12 U	12.2	0.281	0.0651 J	0.121	0.593	12.9 J+	113
	0906-MBB001-07-SS-avg	7/10/2009	0.529 J	3.31	6.55 J	2.3	11.1	<0.246 U	3.37	9.42	337	0.0225 J	<1.12 U	12.5	0.355	0.0703 J	0.131	0.64	15.2 J+	108
	0906-MBB001-08-SS	7/9/2009	0.854 J+	2.69	4.13 J-	1.42	10.9	<0.248 U	4.53	8.6	352	0.0194 J	<1.13 U	13.3 J-	0.391 J-	0.107 J	0.159	0.675	13.8 J+	76.7
	0906-MBB001-09-SS	7/9/2009	0.777 J+	2.64	4.73 J-	2.85	10.5	<0.497 U	4.47	10.6	462	0.019 J	<1.11 U	13.9 J-	0.376 J-	0.108 J	0.142	0.711	12.9 J+	130
	0906-MBB001-10-SS	7/10/2009	0.477 J	3.66	11.2	3.39	11.6	<0.248 U	3.89	10.9	360	0.0272 J	<1.1 U	20.2	0.485	0.0848 J	0.172	0.689	17.9 J+	148
Henry	0906-MBH002-01-SS	6/18/2009	0.53 J	8.1	22.3 J-	0.881	20.7 J-	<0.249 U	10.7	24	2120	0.0261 J	<1.14 U	23.8 J-	0.643 J	<0.242 U	0.154	<0.484 U	26.2	63.1 J
	0906-MBH002-02-SS	6/18/2009	<0.375 U	8.25	18.6 J-	1.15	22.6 J-	<0.496 U	12.4	25.1	2840	0.0319 J	<1.13 U	27.2 J-	1.26	<0.249 U	0.152	0.509 J	26.6	78.3 J
	0906-MBH002-03-SS	6/18/2009	<0.38 U	7.47	15.7 J-	1.1	23.1 J-	<0.498 U	11.1	24.7	2540	0.0425 J	<1.14 U	25.4 J-	1.02	<0.249 U	0.144	0.559 J	26.5	65 J
	0906-MBH002-04-SS	6/18/2009	<0.378 U	9.01	15.4 J-	0.79	20.9 J-	<0.495 U	10.7	23.6	2190	0.0276 J	<1.13 U	24.2 J-	0.874 J	<0.248 U	0.155	<0.495 U	27.1	61.6 J
	0906-MBH002-05-SS	6/18/2009	0.423 J	8.0	13	0.997 J+	20.5	<0.25 U	13.1 J-	28.7	1890	0.0263 J-	<1.12 U	26.2	0.736 J	<0.247 U	0.139	0.571 J+	22.9	75.5 J
	0906-MBH002-06-SS	6/17/2009	<0.373 U	7.15	1.92 J	0.572	22.5 J	<0.248 U	11.9	21.2	2730	0.015 J	<1.12 UJ	26.1	0.626	0.104 J	0.154	0.416	25	93.1 J
	0906-MBH002-07-SS-1	6/16/2009	<0.755 U	9.47 J+	4.12	0.818 J+	22.5	<0.479 UJ	12.1	24.9	2600 J	0.0217 J	<1.13 U	27.1	0.745 J+	<0.248 U	0.161	0.689 J	27.1	79.7
	0906-MBH002-07-SS-2	6/16/2009	<0.368 U	8.37 J+	8.57	0.983 J+	23.4	<0.246 UJ	11.2	24.6	2600 J	0.024 J	<1.1 U	25.9	0.666 J+	<0.249 U	0.177	0.564 J	28.1	78.1
	0906-MBH002-07-SS-3	6/16/2009	<0.359 U	7.95 J+	8.69	1.08 J+	19.2	<0.498 UJ	11.3	23.5	2700 J	0.0262 J	<1.08 U	24.2	0.741 J+	<0.24 U	0.15	<0.48 U	23.7	78.6
	0906-MBH002-07-SS-avg	6/16/2009	<0.755 U	8.6 J+	7.13	0.96 J+	21.7	<0.498 UJ	11.5	24.3	2630 J	0.024 J	<1.13 U	25.7	0.717 J+	<0.249 U	0.163	0.627 J	26.3	78.8
	0906-MBH002-08-SS	6/18/2009	0.469 J	8.58	12.8	0.746 J+	17.2	<0.499 U	9.23 J-	21.3	1500	0.0225 J-	<1.15 U	22.8	0.477 J	0.11 J	0.15	0.395 J+	22.4	57.7 J
	0906-MBH002-09-SS	6/16/2009	<0.747 U	6.6 J+	4.71	0.858 J+	20.5	<0.488 UJ	13.3	21.6	3990 J	0.0231 J	<1.12 U	26.7	0.863 J+	<0.25 U	0.152	<0.5 U	22.2	84.1
	0906-MBH002-10-SS	6/18/2009	<0.366 U	7.24	13.8	0.792 J+	20.7	<0.486 U	11.9 J-	23.6	2920	0.0243 J-	<1.1 U	26.6	0.677 J	<0.247 U	0.144	<0.494 U	23	66 J
Enoch Valley	0906-MBE001-01-SS	6/22/2009	<0.353 U	4.98	16.4 J-	0.538	22.2	<0.498 UJ	13.1	27.2 J+	3460	0.0318 J	<1.06 U	27.7	0.64 J	0.0834 J	0.134	0.818	20.2	98.5 J
	0906-MBE001-03-SS	6/21/2009	<0.373 U	6.05 J	3.46 J-	1.67	23.4 J	<0.25 U	12	27.5	2660	0.0456 J	<1.12 U	27.3	0.917 J	0.126 J	0.189	1.18	24.9 J+	134
	0906-MBE001-04-SS	6/21/2009	<0.384 U	5.37 J	2.64 J	2.52	18.1 J	<0.248 U	9.1	13.9	2440 J	0.0303 J	<1.15 U	19.6	0.696 J	0.136 J	0.209	1.6	24 J+	111
	0906-MBE001-05-SS	6/21/2009	<0.352 U	5.62 J	7.7 J	1.11	21.3 J	<0.498 U	9.69	21.8	2040 J	0.0507 J	<1.06 U	22.5	0.816 J	0.118 J	0.159	0.986	22.1 J+	141
	0906-MBE001-06-SS	6/21/2009	<0.383 U	3.77 J	8.17 J	1.14	16.8 J	<0.247 U	8.76	16.7	1350 J	0.0249 J	<1.15 U	21.7	0.935 J	0.128 J	0.176	1.05	18.5 J+	111
	0906-MBE001-07-SS-1	6/21/2009	0.66 J	7.47	11.2 J-	9.39	46.3	<0.5 UJ	7.69	29.1 J+	877	0.075 J	3.46	60.4	6.65 J	0.513	0.442	10.8	53.7	230 J
	0906-MBE001-07-SS-2	6/21/2009	0.431 J	6.99	11.4 J-	7.99	38.7	<0.491 UJ	9.0	27.9 J+	1110	0.061 J	2.65	59	5.38 J	0.313	0.446	7.81	48.8	213 J
	0906-MBE001-07-SS-3	6/21/2009	<0.351 U	8.5	32.2 J-	11.6	44.1	<0.496 UJ	7.97	34.7 J+	974	0.0878 J	4.24	70.2	8.63 J	0.442 J	0.555	12	54.1	281 J
	0906-MBE001-07-SS-avg	6/21/2009	0.546 J	7.65	18.3 J-	9.66	43	<0.5 UJ	8.22	30.6 J+	987	0.0746 J	3.45	63.2	6.89 J	0.423 J	0.481	10.2	52.2	241 J
	0906-MBE001-08-SS	6/21/2009	<0.384 U	6.49 J	2.47 J-	6.5	32.1 J	<0.496 U	9.78	21.6	1150	0.0347 J	<1.15 U	27.2	1.66 J	0.206	0.292	4.89	31.2 J+	139
	0906-MBE001-09-SS	6/21/2009	<0.343 U	5.72	21.3 J-	5.07	24.7	<0.497 UJ	11.4	20.5 J+	2170	0.0352 J	<1.03 U	32.2	0.834 J	0.156 J	0.256	2.55	29.8	139 J
	0906-MBE001-10-SS	6/21/2009	<0.379 U	4.54 J	<1.89 UJ	2.04	20.1 J	<0.493 U	7.7	16.9	1580	0.0239 J	<1.14 U	21	0.537 J	0.15 J	0.195	1.61	24.4 J+	115
	0906-MBE001-AH2-SS	6/22/2009	0.504 J	7.05	9.86 J-	8.9	44.8	<0.25 UJ	8.28	21.2	564	0.0252 J	1.62 J	28.4	2.0 J	0.251	0.293	9.21	36.8 J+	130 J

mg/kg milligrams per kilogram (dry weight).
Bold Bolded result indicates positively identified compound.
Shaded Indicates sample concentration is greater than the associated screening level.
NE Not established
J Data are estimated due to associated quality control data.
UJ Potential low bias, possible false negative.
<#U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
#U The analyte was analyzed for and is considered not detected based on associated quality control data.
J- Data are estimated, potentially biased low, due to associated quality control data.
J+ Data are estimated, potentially biased high, due to associated quality control data.
[1] Screening levels reported in Table 3-1 of the A/T-approved P4 Sites RI/FS Work Plan - Rev 2 Final (MWH, 2011)

USEPA Regional Screening Levels for Soil, Residential, Source: ORNL December 2009
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

TABLE 2-9
UPLAND VEGETATION BACKGROUND DATA
P4 RI/FS
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				Metals (mg/kg)																
Mine Name	Location Identification	Field Sample Identification	Date Collected	Antimony	Arsenic	Boron	Cadmium	Chromium	Cobalt	Copper	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc
				Screening Level[1]																
				NE	30	150	10	100	25	40	2000	NE	5	100	5	NE	NE	NE	50	500
Ballard	MBB001-01	0906-MBB001-01-FB	7/10/2009	<0.495 U	0.179 J	23.7	0.478	1.26	<0.125 U	7.91	45.6	<0.00998 U	2.43 J	1.28	0.73	<0.0499 U	<0.00998 U	<0.0998 U	0.435 J	19.2 J
		0906-MBB001-01-GS	7/10/2009	<0.499 U	<0.0747 UJ	4.23 J	0.11 J	1.49	<0.125 U	6.23	46.9 J-	<0.0199 U	3.3	0.571 J	0.285	<0.0498 U	<0.00996 U	<0.0996 U	0.356 J	21.8
		0906-MBB001-01-SM-SYAL	7/10/2009	<0.495 U	<0.072 UJ	10.6	0.0874 J	1.18	<0.12 U	7.55	134 J-	<0.0192 U	<1.49 U	1.02	0.134 J	38.2	<0.0096 U	<0.096 U	0.294 J	41.3
		0906-MBB001-01-SM-POTR	7/10/2009	<0.496 U	<0.0712 UJ	13.2	1.34 J	1.21	<0.119 U	5.96	17.7 J-	<0.019 U	<1.49 U	0.816	<0.0949 U	<0.0474 U	<0.00949 U	<0.0949 U	0.326 J	53.2
		0906-MBB001-01-SL-AMAL	7/10/2009	<0.497 U	<0.0724 UJ	20.9	0.239 J	1.79	<0.121 U	6.3	69.3 J-	0.041 J+	2.17 J	1.14	0.532	<0.0483 U	<0.00965 U	<0.0965 U	0.532	32.4
		0906-MBB001-01-SL-POTR	7/10/2009	<0.495 U	<0.0747 UJ	20.5	0.898 J	1.69	<0.125 U	4.45	30.8 J-	<0.0199 U	<1.49 U	1.34	0.463	<0.0498 U	<0.00996 U	<0.0996 U	0.456 J	73.9
		0906-MBB001-01-SM-AMAL	7/10/2009	<0.497 U	<0.0743 UJ	11.6	0.366 J	1.2	<0.124 U	6.07	10.6 J-	<0.0198 U	<1.49 U	1.01	<0.099 U	<0.0495 U	<0.0099 U	<0.099 U	0.319 J	17.9
		0906-MBB001-01-SL-SYAL	7/10/2009	<0.5 U	<0.0749 UJ	43.6	0.0361 J	1.53	<0.125 U	5.22	47.2 J-	0.0244 J+	2.71 J	3.1	0.291	<0.0499 U	<0.00998 U	<0.0998 U	0.416 J	22
		0908-MBB001-01-FB	8/25/2009	<0.497 U	0.143 J	50.9	0.337	2.5	<0.12 U	12.4	75.5	0.0292 J-	5.08	1.57	0.549 J+	<0.0482 U	<0.00963 U	<0.0963 U	0.787	39.9
	MBB001-02	0906-MBB001-02-SL-AMAL	7/10/2009	<0.499 U	<0.0706 UJ	20.8	0.4 J	1.06	<0.118 U	6.61	100 J-	<0.0188 U	1.8 J	1.82	0.613	<0.0471 U	<0.00942 U	<0.0942 U	0.268 J	42.6
		0906-MBB001-02-GF	7/10/2009	<0.497 U	<0.073 UJ	10.6	0.218 J	1.49	<0.122 U	5.68	28.1 J-	<0.0486 U	2.93 J	0.696 J	0.27	<0.0486 U	<0.00973 U	<0.0973 U	0.278 J	24.9
		0906-MBB001-02-SL-POTR	7/10/2009	<0.497 U	<0.072 UJ	23.7	1.2	1.62	0.142 J	5.84	33.7	<0.0096 U	<1.49 U	2.16	0.126 J	<0.048 U	<0.0096 U	<0.096 U	0.447 J	82.4 J
		0906-MBB001-02-SM-POTR	7/10/2009	<0.498 U	<0.0738 UJ	14.2	1.3	0.925	<0.123 U	6.62	18.6	<0.00984 U	<1.49 U	1.05	0.129 J	<0.0492 U	<0.00984 U	<0.0984 U	0.256 J	52 J
		0906-MBB001-02-SM-AMAL	7/10/2009	<0.514 U	<0.075 UJ	16.6	0.613	0.663	<0.125 U	8.47	23.7	<0.01 U	<1.54 U	1.47	<0.1 U	<0.05 U	<0.01 U	<0.1 U	0.167 J	32.6 J
	MBB001-03	0906-MBB001-03-SL-SYAL	7/10/2009	<0.5 U	<0.0735 UJ	40	0.0531 J	1.03	<0.123 U	6.49	52.9	<0.0098 U	<1.5 U	3.64	0.103 J	<0.049 U	<0.0098 U	<0.098 U	0.253 J	22.1 J
		0906-MBB001-03-GF	7/10/2009	<0.498 U	0.0869 J	12.9	0.37	1.43	<0.124 U	5.16	36.5	<0.00994 U	3.01	1.06	0.39	<0.0497 U	<0.00994 U	<0.0994 U	0.39 J	25.5 J
		0906-MBB001-03-SM-SYAL	7/10/2009	<0.499 U	<0.0744 UJ	7.91	0.139	0.942	<0.124 U	11.5	66.7	<0.00992 U	<1.5 U	1.12	<0.0992 U	<0.0496 U	<0.00992 U	<0.0992 U	0.231 J	37.7 J
	MBB001-04	0906-MBB001-04-SM-SYAL	7/10/2009	<0.497 U	<0.074 UJ	9.9	0.197	0.771	<0.123 U	7.69	111	<0.00986 U	<1.49 U	1.12	3.18	<0.0493 U	<0.00986 U	<0.0986 U	0.191 J	37.1 J
		0906-MBB001-04-SM-POTR	7/10/2009	<0.499 U	<0.0737 UJ	13.2	1.95	1.39	<0.123 U	7.06	19.2	<0.00982 U	<1.5 U	1.23	0.283	<0.0491 U	<0.00982 U	<0.0982 U	0.367 J	61.1 J
		0906-MBB001-04-SL-SYAL	7/10/2009	<0.497 U	<0.0723 UJ	39.3	0.0983	1.37	<0.12 U	4.98	63.8	<0.00963 U	1.71 J	2.73	0.835	<0.0482 U	<0.00963 U	<0.0963 U	0.37 J	18.5 J
		0906-MBB001-04-SL-POTR	7/10/2009	<0.495 U	<0.0717 UJ	23.5	1.16	1.26	<0.12 U	5.5	30.2	<0.00956 U	<1.48 U	1.53	<0.0956 U	<0.0478 U	<0.00956 U	<0.0956 U	0.335 J	87.6 J
		0906-MBB001-04-SM-AMAL	7/10/2009	<0.5 U	<0.0747 UJ	13.2	0.362	0.847	<0.125 U	10.6	17.6	<0.00996 U	<1.5 U	0.892	<0.0996 U	<0.0498 U	<0.00996 U	<0.0996 U	0.201 J	24.4 J
		0906-MBB001-04-GF	7/10/2009	<0.498 U	0.147 J	14.1	0.13	1.38	<0.122 U	5.39	39.6	<0.00973 U	1.74 J	1.38	0.685	<0.0486 U	<0.00973 U	<0.0973 U	0.318 J	23.3 J
		0906-MBB001-04-SL-AMAL	7/10/2009	<0.5 U	<0.075 UJ	17.2	0.289	1.18	<0.125 U	7.17	102	<0.01 U	<1.5 U	1.17	<0.1 U	<0.05 U	<0.01 U	<0.1 U	0.305 J	34.4 J
	MBB001-05	0906-MBB001-05-FB	7/9/2009	<0.488 U	13.1	23.4	0.138	1.83	<0.122 U	5.64	31.4	<0.0195 U	20.6	2.19	4.41	<0.0488 U	<0.00977 U	<0.0977 U	0.429 J	27.7
		0906-MBB001-05-GS	7/9/2009	<0.496 U	0.079 J	6.06	0.173	1.57	<0.123 U	5.63	24.9	<0.0197 U	206	0.489 U	0.347	<0.0493 U	<0.00986 U	<0.0986 U	0.336 J	19.4
		0908-MBB001-05-FB	8/25/2009	<0.486 U	0.159 J	42.5	0.375	1.98	<0.123 U	5.17	49	<0.0196 U	2.66 J	1.78	0.671	<0.049 U	<0.0098 U	<0.098 U	1.14	22.8
	MBB001-06	0906-MBB001-06-SM-PRVI	7/10/2009	<1.09 U	17.1 J	11.9	0.0915 J	3.65	<0.222 U	8.33	71.3 J-	<0.0356 U	24.4	1.15 J	0.179 J	<0.089 U	<0.0178 U	<0.178 U	0.973	23.3
		0906-MBB001-06-SL-PRVI	7/10/2009	<0.495 U	<0.0731 UJ	28.7	0.0273 J	0.871	<0.122 U	7.17	65.7 J-	<0.0487 U	10.4	2.4	0.579	<0.0487 U	<0.00975 U	<0.0975 U	0.261 J	22
		0906-MBB001-06-GF	7/10/2009	<0.498 U	<0.0721 UJ	15	0.535 J	1.8	<0.12 U	5.26	41.5 J-	<0.0192 U	99.6	0.692 J	0.2	<0.0481 U	<0.00962 U	<0.0962 U	0.484	30.4
	MBB001-07	0906-MBB001-07-SL-2-SYAL	7/10/2009	<0.496 U	<0.0735 UJ	44.6	0.0646 J	1.17	<0.123 U	5.07	62.8	0.0174 J	2.17 J	1.67	<0.098 U	<0.049 U	<0.0098 U	<0.098 U	0.35 J	23.8 J
		0906-MBB001-07-SL-1-SYAL	7/10/2009	<0.499 U	<0.072 UJ	49.7	0.0602 J	1.1	<0.12 U	5.55	95.9 J-	0.0622 J+	<1.5 U	1.76	0.498	<0.048 U	<0.0096 U	<0.096 U	0.288 J	24.6
		0906-MBB001-07-GF-2	7/10/2009	<0.495 U	<0.0749 UJ	19.8	0.374	1.31	<0.125 U	5.68	47.5	<0.00998 U	1.75 J	0.798 J	0.205	<0.0499 U	<0.00998 U	<0.0998 U	0.358 J	30.9 J
		0906-MBB001-07-GF-1	7/10/2009	<0.497 U	<0.0734 UJ	16.7	0.242 J	1.85	<0.122 U	4.42	44 J-	<0.0196 U	1.91 J	1.07	1.7	<0.0489 U	<0.00978 U	<0.0978 U	0.468 J	25.1
		0906-MBB001-07-SM-avg-SYAL	7/10/2009	<0.498 U	<0.0732 UJ	11.9	0.211 J	1.08	<0.122 U	5.98	226 J-	<0.0478 U	<1.49 U	0.483 J	0.296 J	<0.0488 U	<0.00977 U	<0.0977 U	0.324 J	35.4 J
		0906-MBB001-07-SL-3-SYAL	7/10/2009	<0.496 U	<0.0706 UJ	37.3	0.0676 J	1.47	<0.118 U	4.17	48.2 J-	<0.0471 U	<1.49 U	1.68	1.37	<0.0471 U	<0.00942 U	<0.0942 U	0.372 J	18.4
		0906-MBB001-07-SM-3-SYAL	7/10/2009	<0.495 U	<0.0732 UJ	14.7	0.161 J	0.888	<0.122 U	4.79	138 J-	<0.0195 U	<1.49 U	0.345 J	<0.0977 U	<0.0488 U	<0.00977 U	<0.0977 U	0.262 J	20.5
		0906-MBB001-07-SM-1-SYAL	7/10/2009	<0.496 U	<0.0717 UJ	8.69	0.264 J	1.41	<0.12 U	5.22	388 J-	<0.0478 U	<1.49 U	0.391 J	0.161 J	<0.0478 U	<0.00956 U	<0.0956 U	0.434 J	38
		0906-MBB001-07-SM-2-SYAL	7/10/2009	<0.498 U	<0.0727 UJ	12.4	0.207	0.956	<0.121 U	7.92	153	<0.00969 U	<1.49 U	0.712 J	0.43	<0.0484 U	<0.00969 U	<0.0969 U	0.277 J	47.8 J
		0906-MBB001-07-GF-3	7/10/2009	<0.497 U	<0.0728 UJ	11.4	0.413 J	1.64	<0.121 U	6.33	46 J-	<0.0485 U	147	0.778	0.229	<0.0485 U	<0.00971 U	<0.0971 U	0.393 J	26
		0906-MBB001-07-SL-avg-SYAL	7/10/2009	<0.499 U	<0.0735 UJ	43.9	0.0641 J	1.25	<0.123 U	4.93	69 J-	0.0398 J	2.17 J	1.7	0.934	<0.049 U	<0.0098 U	<0.098 U	0.337 J	22.3 J
		0906-MBB001-07-GF-avg	7/10/2009	<0.497 U	<0.0749 UJ	16	0.343 J	1.6	<0.125 U	5.48	45.8 J-	<0.0485 U	50.2 J	0.882 J	0.711	<0.0499 U	<0.00998 U	<0.0998 U	0.406 J	27.3 J
	MBB001-08	0906-MBB001-08-GS	7/9/2009	<0.49 U	12.7	12.3	0.219	1.83	<0.125 U	5.81	49.4	<0.0498 U	4.61	0.841	0.318	<0.0498 U	<0.00996 U	<0.0996 U	0.384 J	25
		0906-MBB001-08-FB	7/9/2009	<0.495 U	0.112 J	29.8	0.466	1.32	<0.125 U	4.87	41.8	<0.0498 U	4.6	1.55	1.63	<0.0498 U	0.0257	<0.0996 U	0.456 J	26.6
		0908-MBB001-08-FB	8/25/2009	<0.498 U	0.113 J	41.2	0.261	1.67	<0.123 U	7.37	55.9	<0.0196 U	4.79	1.05	0.423	<0.049 U	<0.0098 U	<0.098 U	0.466 J	35
	MBB001-09	0906-MBB001-09-SL-AMAL	7/9/2009	<0.496 U	<0.0731 U	21.3	0.345	0.985	<0.122 U	6.43	64	<0.0195 U	2.45 J	1.04	1.16	<0.0487 U	<0.00975 U	<0.0975 U	0.281 J	36.5
		0906-MBB001-09-SM-AMAL	7/9/2009	<0.493 U	<0.073 U	12.2	0.357	1.16	<0.122 U	4.26	17.7	<0.0195 U	<1.48 U	0.683 J	0.272	<0.0486 U	<0.00973 U	<0.0973 U	0.312 J	26.9
		0906-MBB001-09-GF	7/9/2009	<0.496 U	0.372	14	0.313	1.66	<0.123 U	5.52	27.4	<0.0197 U	5.63	1.02	1.77	<0.0493 U	<0.00986 U	<0.0986 U	0.332 J	23.2
	MBB001-10	0906-MBB001-10-SM-POTR	7/10/2009	<0.492 U	<0.0728 U	11.3 J	0.332	0.801	<0.121 U	5.05	12.5 J-	<0.0189 U	<1.48 UJ	0.905	0.598 J	<0.0485 U	<0.00971 U	<0.0971 U	0.189 J	20.9
		0906-MBB001-10-FB	7/10/2009	<0.495 U	<0.074 U	23.7 J	0.131	1.07	<0.123 U	4.68	43.1 J-	0.0211 J	2.34 J-	1.09	0.243 J	<0.0493 U	<0.00986 U	<0.0986 U	0.31 J	35.3
		0906-MBB001-10-GS	7/10/2009	<0.996 U	<0.075 U	<4.98 UJ	0.38	1.09	<0.125 U	5.96	41.9	NA	240 J-	0.605 J	0.308 J	<0.05 U	<0.01 U	<0.1 U	0.22 J	39.4
		0906-MBB001-10-SL-POTR	7/10/2009	<0.499 U	<0.0731 U	21.3 J	0.394	1.09	<0.122 U	7.2	80.4 J-	<0.0196 U	<1.5 UJ	1.53	0.166 J	<0.0487 U	<0.00975 U	<0.0975 U	0.424 J	37.4
		0908-MBB001-10-FB	8/25/2009	<0.499 U	0.113 J	33.8	0.18	2.06	<0.125 U	6.8	67.9	<0.02 U	2.52 J	1.42	0.661	<0.05 U	<0.01 U	<0.1 U	0.539	58.4

TABLE 2-9
UPLAND VEGETATION BACKGROUND DATA
P4 RI/FS
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				Metals (mg/kg)																
Mine Name	Location Identification	Field Sample Identification	Date Collected	Antimony	Arsenic	Boron	Cadmium	Chromium	Cobalt	Copper	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc
				Screening Level[1]																
				NE	30	150	10	100	25	40	2000	NE	5	100	5	NE	NE	NE	50	500
Henry	MBH002-01	0906-MBH002-01-SL-ARTR	6/18/2009	<0.475 U	0.199 J-	39.8	0.142	1.97	<0.124 U	13.1	144	<0.00994 U	<1.43 U	1.25	0.722	<0.0497 U	<0.00994 U	<0.0994 U	0.631	31.8
		0906-MBH002-01-GF	6/18/2009	<0.495 U	0.091 J-	9.94	0.108	1.9	<0.125 U	5.2	76.5	<0.00998 U	<1.49 U	1.11	0.383 J+	<0.0499 U	<0.00998 U	<0.0998 U	0.513	24.3
		0906-MBH002-01-SM-ARTR	6/18/2009	<0.464 U	0.185 J-	14.9	0.265	4.12	<0.121 U	9.23	57	<0.00967 U	<1.39 U	1.92	0.581	<0.0484 U	<0.00967 U	0.162 J	1.05	17.9
	MBH002-02	0906-MBH002-02-GF	6/18/2009	<0.493 U	0.09 J	7.78	0.0849 J	3.39 J	<0.12 U	4.34	73.6	<0.00962 U	2.63 J	0.639 J	0.456 J+	<0.0481 U	<0.00962 U	<0.0962 U	0.945	23.1
		0906-MBH002-02-SL-ARTR	6/18/2009	<0.493 U	0.0827 J	42.6	0.177	3.09 J	<0.117 U	19.4	144	<0.00935 U	<1.48 U	1.04	0.318 J+	<0.0467 U	<0.00935 U	<0.0935 U	0.84	65
		0906-MBH002-02-SM-ARTR	6/18/2009	<0.487 U	<0.0712 U	10.7	0.127	2.48 J	<0.119 U	5.66	67.7	<0.00949 U	<1.46 U	0.42 J	0.123 UJ	<0.0474 U	<0.00949 U	<0.0949 U	0.703	17
	MBH002-03	0906-MBH002-03-GF	6/18/2009	<0.479 U	0.225 J-	6.18	0.231	3.45	<0.116 U	4.85	75.6	<0.00928 U	1.84 J	1.56	0.941	<0.0464 U	<0.00928 U	<0.0928 U	0.988	30.6
		0906-MBH002-03-SL-AMAL	6/18/2009	<0.487 U	5.87 J-	12.5	0.0248 J	2.15	<0.121 U	3.67	25.6	<0.00971 U	<1.46 U	1.18	0.575	<0.0485 U	<0.00971 U	<0.0971 U	0.558	12.1
		0906-MBH002-03-SL-ARTR	6/18/2009	<0.486 U	0.142 J-	47.8	0.106	2.23	<0.116 U	7.24	80.5	0.00946 J+/B	<1.46 U	0.799	0.594	<0.0464 U	<0.00928 U	<0.0928 U	0.71	14.3
		0906-MBH002-03-SM-AMAL	6/18/2009	<0.497 U	<0.0735 U	9.6	0.0872 J	3.0 J	<0.123 U	3.55	322	0.0135 J	<1.49 U	0.48 J	0.324 J+	<0.049 U	<0.0098 U	<0.098 U	0.849	14.7
		0906-MBH002-03-SM-ARTR	6/18/2009	<0.48 U	<0.0718 UJ	28.4	0.202	1.66	<0.12 U	5.91	142	<0.00958 U	<1.44 U	0.485 J	0.239 J+	<0.0479 U	<0.00958 U	<0.0958 U	0.445 J	16.3
	MBH002-04	0906-MBH002-04-GF	6/18/2009	<0.48 U	0.314 J-	12.4	0.117	2.58	0.145 J	6.23	91	<0.00973 U	1.77 J	3.49	1.12	<0.0486 U	<0.00973 U	<0.0973 U	0.867	24.6
	MBH002-05	0906-MBH002-05-FB	6/18/2009	<0.495 U	0.914 J	29.5	0.277	7.36	1.29	9.68	261	<0.0094 U	<1.48 U	4.71	0.518	0.0705 J	0.0145 J	<0.094 U	3.67	25.1
		0906-MBH002-05-GS	6/18/2009	<0.498 U	<0.0713 UJ	3.66 J	<0.0238 U	3.07	<0.119 U	7.19	35.1	<0.00951 U	1.89 J	0.665 J	0.265 J+	0.598	<0.00951 U	<0.0951 U	0.383 J	19.7
		0906-MBH002-05-SL-ARTR	6/18/2009	<0.496 U	0.0781 J	29.2	0.145	2.77	<0.121 U	15.7	75.8	0.0109 J	<1.49 U	1.01	0.34	0.122 J	<0.00965 U	<0.0965 U	0.577	24.2
		0906-MBH002-05-SL-PUTR	6/18/2009	<0.496 U	<0.0717 UJ	30.1	0.0284 J	1.86	<0.12 U	4.88	29.4	<0.00956 U	<1.49 U	2.23	0.169 J+/B	0.0928 J	<0.00956 U	<0.0956 U	0.495	18
		0906-MBH002-05-SL-SYAL	6/18/2009	<0.497 U	<0.0735 UJ	36.3	<0.0245 U	2.44	<0.123 U	5.17	84.8	<0.0098 U	<1.49 U	1.16	0.216 J+/B	<0.049 U	<0.0098 U	<0.098 U	0.392 J	16.6
		0906-MBH002-05-SM-ARTR	6/18/2009	<0.967 U	<0.0708 UJ	26	0.211	2.23	<0.118 U	13.6	24.3	<0.00943 U	<2.9 U	0.676 J	0.145 J+/B	<0.0472 U	<0.00943 U	<0.0943 U	0.402 J	19.1
		0906-MBH002-05-SM-PUTR	6/18/2009	<0.496 U	<0.0704 UJ	10.4	0.0696 J	2.64	<0.117 U	4.65	12.2	<0.00938 U	<1.49 U	1.46	0.153 J+/B	0.0505 J	<0.00938 U	<0.0938 U	0.555	9.74
		0906-MBH002-05-SM-SYAL	6/18/2009	<0.495 U	<0.0746 UJ	9.04	0.0697 J	3.86	0.125 J	4.2	293	<0.00994 U	<1.48 U	1.39	0.11 J+/B	0.134 J	<0.00994 U	<0.0994 U	0.576	16.7
		0908-MBH002-05-FB	8/25/2009	<0.489 U	0.516 J	41.8	0.082 J	1.83 J	<0.614 U	6.81	84.3	<0.0196 U	<1.47 U	<0.982 U	1.63	<0.0491 U	<0.00982 U	<0.0982 U	<0.614 U	16.4
	MBH002-06	0906-MBH002-06-GF	6/17/2009	<0.481 U	0.21 J+/B	16.7	0.483	4.75	0.367 J	5.46	130	<0.00988 UJ	2.01 J	2.0	0.296 J+/B	<0.0494 U	<0.00988 U	<0.0988 U	1.58	22.8 J-
		0906-MBH002-06-SL-SYAL	6/17/2009	<0.481 U	<0.0676 U	20.8	<0.0225 U	2.5	<0.113 U	4.06	183	<0.00901 UJ	1.54 J	1.16	0.209 J+/B	<0.045 U	<0.00901 U	<0.0901 U	0.676	17.3 J-
		0906-MBH002-06-SM-SYAL	6/17/2009	<0.498 U	<0.0741 U	9.68	0.0681 J	2.57	<0.124 U	6.04	366	<0.00988 UJ	<1.49 U	0.819	0.108 J+/B	<0.0494 U	<0.00988 U	<0.0988 U	0.664	33.9 J-
	MBH002-07	0906-MBH002-07-SM-2-ARTR	6/16/2009	<0.489 U	0.0782 J	19.9	0.127	1.63	<0.122 U	11.5	29.7	<0.0157 U	<1.47 U	0.528 J	0.2	0.0925 J	<0.00978 U	<0.0978 U	0.387 J	18.2
		0906-MBH002-07-GF-avg	6/16/2009	<0.499 U	0.118 J	10.1	0.11 J	2.78	<0.122 U	5.07	49.5	<0.0186 U	2.25 J	0.926 J	0.326	<0.0486 U	<0.00973 U	<0.0973 U	0.652 J	18.8
		0906-MBH002-07-GF-2	6/16/2009	<0.499 U	0.074 J	9.92	0.0454 J	3.64	<0.116 U	5.09	47.6	<0.0186 UJ	2.25 J	0.569 J	0.318	<0.0466 UJ	<0.00931 U	<0.0931 U	0.947	19.9
		0906-MBH002-07-SL-2-SYAL	6/16/2009	<0.492 U	<0.0737 U	34	<0.0246 U	1.15	<0.123 U	4.16	253	<0.0157 U	<1.48 U	1.06	0.199	<0.0491 U	<0.00982 U	<0.0982 U	0.275 J	17
		0906-MBH002-07-SM-2-SYAL	6/16/2009	<0.977 U	<0.0653 U	10.3 J	0.0868 J	3.23	<0.109 U	4.54	189	<0.0174 UJ	<2.93 U	0.961	<0.0871 U	<0.0436 UJ	<0.00871 U	<0.0871 U	0.918	17.6
		0906-MBH002-07-SL-avg-ARTR	6/16/2009	<0.498 U	0.136 J	26.4	0.0852 J	1.62	<0.117 U	11	84.7	0.0209 J	<1.49 U	0.77 J	0.578	<0.0468 U	<0.00936 U	<0.0936 U	0.486 J	19.2
		0906-MBH002-07-SL-1-ARTR	6/16/2009	<0.484 U	0.188 J	25.2	0.0902 J	1.93	<0.114 U	9.35	84.5	0.0209 J	<1.45 U	0.727 J	0.689	<0.0457 U	<0.00914 U	<0.0914 U	0.553	18.5
		0906-MBH002-07-SL-3-SYAL	6/16/2009	<0.5 U	<0.0735 UJ	31.5	0.0262 J	1.28	<0.123 U	4.73	151	<0.0157 U	2.32 J	0.925	0.551	<0.049 U	<0.0098 U	<0.098 U	0.335 J	20
		0906-MBH002-07-GF-3	6/16/2009	<0.488 U	0.149 J	11	0.115	2.32	<0.122 U	5.4	51.1	<0.0156 U	<1.46 U	1.13	0.287	<0.0486 U	<0.00973 U	<0.0973 U	0.576	16.1
		0906-MBH002-07-SM-1-ARTR	6/16/2009	<0.493 U	0.0884 J	10.1	0.189	2.06	<0.116 U	8.84	47.9	<0.0149 U	2.23 J	0.726 J	0.234	<0.0466 U	<0.00931 U	<0.0931 U	0.495	19.7
		0906-MBH002-07-SL-2-ARTR	6/16/2009	<0.498 U	0.0834 J	27.6	0.0801 J	1.31	<0.117 U	12.6	84.8	<0.015 U	<1.49 U	0.813	0.467	<0.0468 U	<0.00936 U	<0.0936 U	0.419 J	19.9
		0906-MBH002-07-GF-1	6/16/2009	<0.479 U	0.131 J	9.48	0.171	2.38	<0.116 U	4.72	49.9	<0.0149 U	<1.44 U	1.08	0.373	<0.0465 U	<0.00929 U	<0.0929 U	0.432 J	20.5
		0906-MBH002-07-SL-1-PUTR	6/16/2009	<0.497 U	<0.0721 U	9.49	0.0599 J	1.53	<0.12 U	3.28	10.2	<0.0154 U	<1.49 U	1.47	0.237	<0.0481 U	<0.00962 U	<0.0962 U	0.467 J	4.8
		0906-MBH002-07-SM-1-PUTR	6/16/2009	<0.489 U	<0.0709 U	9.11	0.0619 J	0.959	<0.118 U	2.05	9.95	<0.0151 U	<1.47 U	0.533 J	0.109 J	<0.0473 U	<0.00945 U	<0.0945 U	0.273 J	4.66
		0906-MBH002-07-SM-3-SYAL	6/16/2009	<0.498 U	<0.0713 U	10.3	0.0427 J	1.03	<0.119 U	6.89	159	<0.0152 U	<1.49 U	0.645 J	0.16 J	<0.0475 U	<0.00951 U	<0.0951 U	0.204 J	20.8
		0906-MBH002-07-SL-avg-SYAL	6/16/2009	<0.5 U	<0.0737 U	32.8	0.0262 J	1.22	<0.123 U	4.45	202	<0.0157 U	2.32 J	0.993	0.375	<0.0491 U	<0.00982 U	<0.0982 U	0.305 J	18.5
		0906-MBH002-07-SM-avg-ARTR	6/16/2009	<0.493 U	0.0833 J	15	0.158	1.85	<0.122 U	10.2	38.8	<0.0157 U	2.23 J	0.627 J	0.217	0.0925 J	<0.00978 U	<0.0978 U	0.441 J	19
		0906-MBH002-07-SM-avg-SYAL	6/16/2009	<0.977 U	<0.0713 U	10.3 J	0.0648 J	2.13	<0.119 U	5.72	174	<0.0174 U	<2.93 U	0.803 J	0.16 J	<0.0475 U	<0.00951 U	<0.0951 U	0.561 J	19.2
	MBH002-08	0906-MBH002-08-SM-SYAL	6/18/2009	<0.839 U	<0.0716 UJ	6.42 J	<0.0239 U	1.56	<0.119 U	6.85	120	<0.00954 U	<2.52 U	0.678 J	0.0996 U	0.0996 J	<0.00954 U	<0.0954 U	0.336 J	6.73
		0906-MBH002-08-SL-CHNA	6/18/2009	<0.858 U	0.195 J-	35.5	0.0606 J	2.67	<0.125 U	19.5	84.8	<0.00996 U	<2.57 U	0.869	0.812	<0.0498 U	<0.00996 U	<0.0996 U	0.801	38
		0906-MBH002-08-SL-ARTR	6/18/2009	<0.969 U	0.153 J-	34.3	0.0584 J	2.55	<0.123 U	7.05	74.7	<0.00982 U	<2.91 U	0.798	0.557	<0.0491 U	<0.00982 U	<0.0982 U	0.816	9.78
		0906-MBH002-08-SM-CHNA	6/18/2009	<1.0 U	0.266 J-	17.8	0.171	2.59	<0.133 U	15	55.5	<0.0106 U	<3.0 U	0.754 J	1.2	<0.0532 U	<0.0106 U	<0.106 U	0.756	24.1
		0906-MBH002-08-SM-ARTR	6/18/2009	<1.55 U	0.079 J-	17.1	0.145	1.83	<0.12 U	8.63	33.4	<0.00962 U	<4.66 U	0.694 J	0.257 J+	<0.0481 U	<0.00962 U	<0.0962 U	0.58	10.1
		0906-MBH002-08-SL-SYAL	6/18/2009	<0.794 U	<0.0698 UJ	38	<0.0233 U	1.83	0.138 J	5.03	180	<0.00931 U	<2.38 U	2.14	0.319 J+	0.299	<0.00931 U	<0.0931 U	0.5	12.6
		0906-MBH002-08-FB	6/18/2009	<0.496 U	0.193 J-	19.8	0.23	2.32	0.223 J	5.87	96.1	<0.00929 U	<1.49 U	1.58	0.291 J+	0.105 J	<0.00929 U	<0.0929 U	0.893	18.1
		0906-MBH002-08-GS	6/18/2009	<0.499 U	6.67 J-	3.7 J	0.0289 J	2.17	<0.123 U	4.9	63.9	<0.0098 U	2.54 J	0.57 J	0.362 J+	0.118 J	<0.0098 U	<0.098 U	0.432 J	20.5
		0908-MBH002-08-FB	8/25/2009	<0.491 U	0.198 J	22.8	0.0937 J	1.28	<0.124 U	4.53	59	<0.00992 UJ	<1.47 U	0.602 J	0.832	<0.0496 U	<0.00992 U	<0.0992 U	0.376 J	16.3 J-

TABLE 2-9
UPLAND VEGETATION BACKGROUND DATA
P4 RI/FS
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				Metals (mg/kg)																
Mine Name	Location Identification	Field Sample Identification	Date Collected	Antimony	Arsenic	Boron	Cadmium	Chromium	Cobalt	Copper	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc
				Screening Level[1]																
				NE	30	150	10	100	25	40	2000	NE	5	100	5	NE	NE	NE	50	500
Henry	MBH002-09	0906-MBH002-09-GF	6/16/2009	<0.48 U	0.105 J	10.2	0.134	2.31	<0.116 U	6.22	71.6	0.0306 J	1.48 J	0.887	0.241	<0.0462 U	<0.00924 U	<0.0924 U	0.544	24.1
		0906-MBH002-09-SM-PUTR	6/16/2009	<0.499 U	<0.0746 UJ	<2.5 U	0.109	1.65	<0.124 U	3.25	0.603	<0.0159 U	<1.5 U	0.962	0.211	<0.0497 U	<0.00994 U	<0.0994 U	0.445 J	0.551 J
		0906-MBH002-09-SL-PUTR	6/16/2009	<0.494 U	<0.0721 UJ	40.6	0.0284 J	1.29	<0.12 U	3.16	33.2	<0.0154 U	<1.48 U	1.29	0.167 J	<0.0481 U	<0.00962 U	<0.0962 U	0.366 J	19.8
	MBH002-10	0906-MBH002-10-SL-PUTR	6/18/2009	<0.963 U	0.0978 J	20.7	0.0528 J	2.38	<0.125 U	9.11	21	0.0589 J	<2.89 U	1.24	0.415	0.368	<0.01 U	<0.1 U	0.537	15.5
		0906-MBH002-10-SL-SYAL	6/18/2009	<0.499 U	<0.0721 UJ	52	<0.024 U	2.64	<0.12 U	3.89	269	<0.00962 U	2.19 J	1.22	0.301	0.296	<0.00962 U	<0.0962 U	0.472 J	14.9
		0906-MBH002-10-SL-CHNA	6/18/2009	<0.917 U	0.38 J-	45.7	0.0964 J	2.82	0.423 J	11.8	195	<0.00986 U	<2.75 U	1.68	0.637	0.242	<0.00986 U	<0.0986 U	1.49	40
		0906-MBH002-10-SM-SYAL	6/18/2009	<1.66 U	0.0945 J	39.1	0.142	2.54	0.24 J	6.96	542	<0.0098 U	<4.97 U	0.975	0.199 J+/B	10.5	<0.0098 U	<0.098 U	0.915	30.2
		0906-MBH002-10-SM-PUTR	6/18/2009	<0.965 U	0.0866 J	26.2	0.271	2.89	<0.123 U	5.29	54.5	<0.00984 U	<2.9 U	0.965	0.226 J+/B	<0.0492 U	<0.00984 U	<0.0984 U	0.578	14.6
		0906-MBH002-10-SM-CHNA	6/18/2009	<0.926 U	6.7 J-	26.9	0.109	2.24	<0.123 U	8.49	101	<0.00984 U	<2.78 U	0.778 J	0.647	0.0743 J	<0.00984 U	<0.0984 U	0.62	21.7
		0906-MBH002-10-SM-ARTR	6/18/2009	<1.17 U	<0.0732 UJ	20	0.227	3.31	<0.122 U	6.17	20.9	0.0672 J	<3.51 U	0.675 J	0.232 J+/B	<0.0488 U	<0.00977 U	<0.0977 U	0.625	10.6
		0906-MBH002-10-SM-AMAL	6/18/2009	<0.962 U	<0.0746 UJ	10.1	0.0717 J	2.36	<0.124 U	4.2	18.4	<0.00994 U	<2.88 U	0.73 J	0.242 J+/B	0.0562 J	<0.00994 U	<0.0994 U	0.614	13
		0906-MBH002-10-FB	6/18/2009	<0.499 U	0.325 J	22.4	0.357	3.63	0.48	5.79	162	<0.00921 U	<1.5 U	1.92	0.492	<0.046 U	<0.00921 U	<0.0921 U	1.41	19.4
		0906-MBH002-10-GS	6/18/2009	<0.499 U	0.109 J	4.5 J	<0.0238 U	3.15	<0.119 U	5.59	58.9	<0.00951 U	2.87 J	0.662 J	0.393	0.18 J	<0.00951 U	<0.0951 U	0.518	24.8
		0906-MBH002-10-SL-AMAL	6/18/2009	<0.496 U	<0.0744 UJ	16.8	<0.0248 U	2.18	<0.124 U	5.82	93.2	0.0142 J	<1.49 U	0.884	0.197 J+/B	0.179 J	<0.00992 U	<0.0992 U	0.384 J	23.6
		0906-MBH002-10-SL-ARTR	6/18/2009	<0.496 U	0.288 J	35.2	0.15	3.45	0.203 J	6.03	128	<0.00912 U	<1.49 U	1.43	0.76	<0.0456 U	<0.00912 U	<0.0912 U	1.09	13.9
		0908-MBH002-10-FB	8/25/2009	<0.489 U	0.268 J	27.4	0.644	4.22	0.36 J	4.71	161	<0.00963 UJ	1.91 J	1.68	0.392	<0.0482 U	<0.00963 U	<0.0963 U	1.65	18.2 J-
	MBH002-CS	0908-MBH002-CS-JUSC-STEM	8/25/2009	<0.495 U	5.45 J	9.09	0.122	2.59	<0.12 U	5.41	29.4	<0.00963 UJ	<1.48 U	1.07	0.192 J	<0.0482 U	<0.00963 U	<0.0963 U	0.817	15.4
		0908-MBH002-CS-JUSC-LEAF	8/25/2009	<0.498 U	<0.0741 UJ	14.2	0.0465 J	2.53	<0.124 U	4.35	106	0.0748 J-	<1.49 U	0.903	0.181 J	<0.0494 U	<0.00988 U	<0.0988 U	0.739	23
Enoch Valley	MBE001-01	0906-MBE001-01-SL-SYAL	6/22/2009	<5.0 U	0.0996 J	364	0.295	2.25	<0.12 U	5.68	1170 J-	NA	<15 U	1.99	0.124 J	<0.048 U	<0.0096 U	0.101 J	1.64	289
		0906-MBE001-01-SM-AMAL	6/22/2009	<0.5 U	<0.0741 U	20.7	0.0357 J	1.21	<0.124 U	11.5	26.8 J-	<0.0198 UJ	<1.5 U	0.884	<0.0988 U	<0.0494 U	<0.00988 U	<0.0988 U	0.372 J	30.2
		0906-MBE001-01-SM-ARTR	6/22/2009	<0.499 U	0.0953 J	16.4	0.131	1.25	<0.122 U	11.4	47 J-	<0.0195 UJ	<1.5 U	0.896	0.344	<0.0488 U	<0.00977 U	<0.0977 U	0.558	20.1
		0906-MBE001-01-SL-PRVI	6/22/2009	<0.497 U	<0.0738 U	16.8	0.0369 J	1.3	<0.123 U	5.47	195 J-	NA	<1.49 U	1.74	0.1 J	<0.0492 U	<0.00984 U	<0.0984 U	0.487 J	26.3
		0906-MBE001-01-SM-PRVI	6/22/2009	<0.497 U	<0.07 U	16.1	0.0447 J	1.31	<0.117 U	5.29	72 J-	<0.0187 UJ	<1.49 U	1.07	<0.0933 U	<0.0466 U	<0.00933 U	<0.0933 U	0.401 J	39.4
		0906-MBE001-01-SM-ROWI	6/22/2009	<1.05 U	<0.0683 U	40	0.0448 J	1.25	<0.114 U	7.38	35.7	<0.0182 UJ	<3.15 U	0.795	<0.0911 U	<0.0455 U	<0.00911 U	<0.0911 U	0.393 J	11.6
		0906-MBE001-01-SM-SYAL	6/22/2009	<0.481 U	<0.0734 U	11.5	0.101	1.61	<0.122 U	8.64	375	<0.0196 UJ	<1.44 U	0.809	0.0992 J	<0.0489 U	<0.00978 U	<0.0978 U	0.57	36.7
		0906-MBE001-01-FB	6/22/2009	<0.484 U	0.0765 J	19.3	0.0252 J	1.45	<0.123 U	6.7	73	NA	<1.45 U	1.47	0.456	<0.0492 U	<0.00984 U	<0.0984 U	0.446 J	27.2
		0906-MBE001-01-SL-PUTR	6/22/2009	<0.495 U	<0.0747 UJ	20.9	0.0596 J	1.66	<0.125 U	3.98	25.9 J-	NA	<1.49 U	2.12	0.176 J	<0.0498 U	<0.00996 U	<0.0996 U	0.909	21.5
		0906-MBE001-01-SM-PUTR	6/22/2009	<0.5 U	<0.0744 U	11.9	0.117	1.65	<0.124 U	3.73	24.8 J-	<0.0198 UJ	<1.5 U	1.22	<0.0992 U	<0.0496 U	<0.00992 U	<0.0992 U	0.767	13.4
		0906-MBE001-01-SL-ROWI	6/22/2009	<1.23 U	<0.149 U	26.4	<0.0496 U	2.11	<0.248 U	6.67	501	NA	<3.69 U	0.932 J	<0.198 U	<0.0992 U	<0.0198 U	<0.198 U	0.54 J	51.8
		0906-MBE001-01-SL-ARTR	6/22/2009	<0.5 U	0.259 J	35.3	0.111	1.92	<0.125 U	12.1	230 J-	<0.02 UJ	<1.5 U	1.09	1.06	<0.0499 U	<0.00998 U	<0.0998 U	0.944	24.9
		0906-MBE001-01-SL-AMAL	6/22/2009	<0.496 U	<0.0702 U	24.5	<0.0234 U	0.978	<0.117 U	8.51	122 J-	NA	<1.49 U	1.25	<0.0936 U	<0.0468 U	<0.00936 U	<0.0936 U	0.298 J	39.3
		0906-MBE001-01-GS	6/22/2009	<0.5 U	0.23 J	2.76 J	0.0472 J	2.8	<0.124 U	7.2	71.1 J-	NA	1.98 J	0.936	0.921	<0.0497 U	<0.00994 U	<0.0994 U	0.524	20.9
		0908-MBE001-01-FB	8/24/2009	<0.487 U	0.153 J	68.3	0.0591 J	2.79	<0.125 U	7.21	88.8	0.0206 J	1.65 J	1.09	0.633 J	<0.0499 U	<0.00998 U	<0.0998 U	0.827	37.5
	MBE001-03	0906-MBE001-03-SL-SYAL	6/21/2009	<0.498 U	0.119 UJ	28.2	0.071 J	1.03	<0.125 U	9.01	167	0.0273 J-	<1.49 U	1.26	0.25 J+	<0.0499 UJ	<0.00998 U	<0.0998 U	0.351 J	36.4
		0906-MBE001-03-SM-SYAL	6/21/2009	<0.499 U	0.116 UJ	7.53	0.316	1.29	<0.123 U	5.26	591	<0.00982 UJ	<1.5 U	0.64 J	0.345 J+	<0.0491 UJ	<0.00982 U	<0.0982 U	0.877	39.2
		0906-MBE001-03-GF	6/21/2009	<0.481 U	<0.075 UJ	13.7	0.265	1.96	<0.125 U	7.93	82.2	<0.02 U	1.77 J	1.83	0.392	<0.05 U	<0.01 U	<0.1 U	0.642	34.5
		0906-MBE001-03-SM-PRVI	6/21/2009	<8.62 U	0.0829 UJ	<43.1 U	<0.0247 U	0.139 J	<0.124 U	<0.148 U	44.6	<0.00988 UJ	<25.9 U	<0.198 U	<0.0988 U	<0.0494 UJ	<0.00988 U	<0.0988 U	<0.124 U	39
		0906-MBE001-03-SL-PRVI	6/21/2009	<0.499 U	0.113 UJ	17	<0.0248 U	1.26	<0.124 U	7.45	101	<0.0099 UJ	<1.5 U	3.06	0.383 J+	<0.0495 UJ	<0.0099 U	<0.099 U	0.502	20.7
	MBE001-04	0906-MBE001-04-GF	6/21/2009	<0.493 U	0.15 J	24.2	1.22	1.56	<0.112 U	10.9	56.7	<0.0179 U	1.98 J	2.21	0.636	<0.0447 UJ	<0.00894 U	<0.0894 U	0.488	44.1
		0906-MBE001-04-CS-WILD ST	6/21/2009	<0.496 U	<0.284 U	20.5	0.194 J	3.35	<0.473 U	13	67.4	<0.0379 UJ	1.63 J	1.25 J	<0.379 U	<0.189 U	<0.0379 U	<0.379 U	1.08 J	18.7 J-
		0906-MBE001-04-SL-SYAL	6/21/2009	<0.5 U	<0.0743 UJ	27.4	0.0534 J	1.47	<0.124 U	5.07	146 J-	<0.0198 U	<1.5 U	4.94	0.146 J	<0.0495 U	<0.0099 U	<0.099 U	0.346 J	21.1
		0906-MBE001-04-SM-SYAL	6/21/2009	<0.551 U	<0.0658 U	6.45	0.334	1.69	<0.11 U	6.07	287	<0.0175 U	<1.65 U	1.22	0.125 J	<0.0439 UJ	<0.00877 U	<0.0877 U	0.639	19.3
		0906-MBE001-04-SM-PRVI	6/21/2009	<0.493 U	<0.0741 UJ	11.8	0.603	1.72	<0.124 U	5.2	99.7	<0.0198 U	<1.48 U	1.63	<0.0988 U	<0.0494 U	<0.00988 U	<0.0988 U	0.454 J	17.7
		0906-MBE001-04-SL-PRVI	6/21/2009	<0.499 U	<0.075 UJ	13.3	0.314	1.72	<0.125 U	6.06	248	<0.02 U	<1.5 U	2.9	0.298	<0.05 U	<0.01 U	<0.1 U	0.435 J	21.1
	MBE001-05	0906-MBE001-05-GF	6/21/2009	<0.497 U	0.145 UJ	14.9	0.145	1.57	<0.125 U	10.3	55.8	<0.00998 UJ	<1.49 U	1.45	0.359	<0.0499 UJ	<0.00998 U	<0.0998 U	0.554	37.6
	MBE001-06	0906-MBE001-06-GF	6/21/2009	<0.479 U	0.0918 J	10.8	0.137	3.2	<0.125 U	8.62	53.6	<0.02 U	3.63	1.92	0.56	<0.0499 U	<0.00998 U	<0.0998 U	0.726	28.5
	MBE001-07	0906-MBE001-07-GS-1	6/21/2009	<0.493 U	<0.0727 U	3.04 J	0.303	2.34	<0.121 U	6.45	47.4	<0.0194 U	8.18	1.14	2.63	<0.0484 U	<0.00969 U	<0.0969 U	0.437 J	25.5 J-
		0906-MBE001-07-FB-1	6/21/2009	<0.865 U	0.0981 J+	28.8	1.24	1.7	<0.123 U	12.5	43.4	<0.0196 U	9.15	1.65	5.28	0.0529 J	0.0141 J	<0.0982 U	0.573	46.8 J-
		0906-MBE001-07-SL-ARTR-1	6/21/2009	<0.498 U	0.438 J+	23.2	0.209	2.28	<0.122 U	9.46	123	0.0198 J	<1.49 U	3.24	2.08	<0.0487 U	<0.00975 U	<0.0975 U	0.965	20.2 J-
		0906-MBE001-07-SM-ARTR-1	6/21/2009	<0.498 U	0.266 J+	23.6	0.314	1.31	<0.112 U	10.4	45.9	<0.018 U	<1.49 U	2.85	1.47	<0.045 U	<0.00899 U	<0.0899 U	0.499	20.7
		0906-MBE001-07-FB-2	6/21/2009	<0.484 U	0.0876 J+	17.9	0.391	2.05	<0.125 U	6.4	32.3	<0.02 U	6.58	2.2	6.42	<0.0499 U	<0.00998 U	<0.0998 U	0.539	31.7 J-
		0906-MBE001-07-SM-ARTR-avg	6/21/2009	<0.498 U	0.241 J	22.8	0.36	1.23	<0.125 U	10.2	54	<0.0199 U	<1.49 U	2.88	1.31	<0.0498 U	<0.00996 U	<0.0996 U	0.495 J	21.4
		0906-MBE001-07-SL-ARTR-avg	6/21/2009	<0.5 U	0.326 J+	22.1	0.209	2.02	<0.122 U	10.3	137	0.0198 J	<1.5 U	3.45	1.65	<0.0487 U	<0.00975 U	<0.0975 U	0.879	20.9 J-
		0906-MBE001-07-GS-avg	6/21/2009	<0.497 U	<0.0727 U	3.04 J	0.259	2.38	<0.121 U	5.58	41.7	<0.0194 U	8.11	0.882 J	3.26	<0.0484 U	0.014 J	<0.0969 U	0.432 J	23 J-
		0906-MBE001-07-FB-avg	6/21/2009	<0.865 U	2.28 J+	27.1	0.741	1.92	<0.125 U	9.25	40	<0.02 U	8.91	2.24	5.02	0.0529 J	0.0122 J	<0.0998 U	0.593	37.9 J-
		0906-MBE001-07-GS-2	6/21/2009	<0.477 U	<0.0723 U	<2.39 U	0.226	2.32	<0.12 U	5.52	38.7	<0.0193 U	5.75	0.69 J	3.17	<0.0482 U	<0.00963 U	<0.0963 U	0.315 J	21.5 J-

TABLE 2-9
UPLAND VEGETATION BACKGROUND DATA
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				Metals (mg/kg)																
Mine Name	**Location Identification**	**Field Sample Identification**	**Date Collected**	**Antimony**	**Arsenic**	**Boron**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**	**Manganese**	**Mercury**	**Molybdenum**	**Nickel**	**Selenium**	**Silver**	**Thallium**	**Uranium**	**Vanadium**	**Zinc**
				Screening Level[1]																
				NE	**30**	**150**	**10**	**100**	**25**	**40**	**2000**	**NE**	**5**	**100**	**5**	**NE**	**NE**	**NE**	**50**	**500**
Enoch Valley		0906-MBE001-07-FB-3	6/21/2009	<0.479 U	**6.66 J+**	**34.7**	**0.593**	**2.01**	<0.122 U	**8.84**	**44.3**	<0.0195 U	**11**	**2.86**	**3.35**	<0.0486 U	**0.0103 J**	<0.0973 U	**0.666**	**35.1 J-**
		0906-MBE001-07-GS-3	6/21/2009	<0.497 U	<0.07 U	<2.48 U	**0.247**	**2.47**	<0.117 U	**4.76**	**39.1**	<0.0187 U	**10.4**	**0.815**	**3.97**	<0.0466 U	**0.014 J**	<0.0933 U	**0.543**	**22.1 J-**
		0906-MBE001-07-SM-ARTR-3	6/21/2009	<0.497 U	**0.215 J**	**21.9**	**0.405**	**1.14**	<0.125 U	**9.9**	**62.1**	<0.0199 U	<1.49 U	**2.91**	**1.14**	<0.0498 UJ	<0.00996 U	<0.0996 U	**0.491 J**	**22**
		0906-MBE001-07-SL-ARTR-3	6/21/2009	<0.5 U	**0.214 J+**	**21**	**0.208**	**1.75**	<0.12 U	**11.2**	**151**	<0.0192 U	<1.5 U	**3.66**	**1.21**	<0.048 U	<0.0096 U	<0.096 U	**0.792**	**21.6**
		0908-MBE001-07-FB-1	8/24/2009	<0.494 U	**0.374 J**	**54.1**	**0.533**	**1.49 J**	<0.612 U	**3.32**	**17.3**	<0.0196 UJ	**30.2**	**1.04 J**	**10.4**	<0.0489 U	**0.0112 J**	<0.0978 U	<0.612 U	**26 J-**
		0908-MBE001-07-FB-2	8/24/2009	<0.495 U	**0.102 J**	**35**	**1.88**	**1.61**	<0.124 U	**4.74**	**33**	<0.0198 UJ	**8.17**	**1.28**	**2.89**	<0.0494 U	**0.0337**	<0.0988 U	**0.53**	**28.8 J-**
		0908-MBE001-07-FB-3	8/24/2009	<0.499 U	<0.0731 U	**79.1**	**0.501**	**1.62**	<0.122 U	**4.85**	**27.7**	<0.0195 UJ	**13.5**	**1.43**	**8.55**	<0.0487 U	<0.00975 U	<0.0975 U	**0.544**	**17.5 J-**
		0908-MBE001-07-FB-avg	8/24/2009	<0.499 U	**0.238 J**	**56.1**	**0.971**	**1.57 J**	<0.612 U	**4.3**	**26**	<0.0198 UJ	**17.3**	**1.25 J**	**7.28**	<0.0494 U	**0.0225 J**	<0.0988 U	**0.537**	**24.1 J-**
	MBE001-08	0906-MBE001-08-SM-SYAL	6/21/2009	<0.471 U	<0.065 U	**6.32**	**0.59**	**2.62**	<0.108 U	**8.08**	**146**	<0.00867 UJ	<1.41 U	**1.97**	**0.429**	<0.0433 U	<0.00867 U	<0.0867 U	**0.884**	**18.6 J-**
		0906-MBE001-08-SL-SYAL	6/21/2009	<0.499 U	0.0831 UJ	**18.7**	**0.16**	**1.6**	<0.124 U	**10.5**	**55.9**	<0.00992 UJ	<1.5 U	**2.05**	**0.223 J+**	<0.0496 UJ	<0.00992 U	<0.0992 U	**0.331 J**	**33.5**
		0906-MBE001-08-GF	6/21/2009	<0.498 U	**12.3 J+**	**20.2**	**2.52**	**2.71**	<0.123 U	**13.2**	**41**	<0.00982 UJ	**1.71 J**	**3.54**	**0.471 J+**	<0.0491 UJ	<0.00982 U	<0.0982 U	**1.14**	**38.6**
	MBE001-09	0906-MBE001-09-GS	6/21/2009	<1.61 U	<0.368 U	<8.06 U	**0.422 J**	**2.0**	<0.613 U	**4.7**	**35**	<0.049 UJ	<4.84 U	**1.13 J**	**1.09**	<0.245 UJ	<0.049 U	<0.49 U	**0.717 J**	**19.6**
		0906-MBE001-09-SM-SYAL	6/21/2009	<0.498 U	0.122 UJ	**11.4**	**0.228**	**1.49**	<0.123 U	**6.43**	**355**	<0.00984 UJ	<1.49 U	**0.985**	**0.274 J+**	<0.0492 UJ	<0.00984 U	<0.0984 U	**0.631**	**30.2**
		0906-MBE001-09-SM-POTR	6/21/2009	<0.501 U	0.0867 UJ	**12.6**	**1.89**	**1.18**	<0.124 U	**4.05**	**22.5**	<0.00992 UJ	<1.5 U	**0.864**	**0.251 J+**	<0.0496 UJ	<0.00992 U	<0.0992 U	**0.4 J**	**49.3**
		0906-MBE001-09-SM-ARTR	6/21/2009	<1.18 U	0.333 UJ	**18.7**	**1.81**	**2.26**	<0.269 U	**9.58**	**52.8**	<0.0216 UJ	<3.55 U	**1.52 J**	**0.746**	<0.108 UJ	<0.0216 U	<0.216 U	**1.18**	**21.8**
		0906-MBE001-09-SL-AMAL	6/21/2009	**5.41**	0.0931 UJ	**24.2**	**0.308**	**1.08**	<0.125 U	**6.22**	**178**	<0.01 UJ	**7.53**	**2.94**	**0.214 J+**	<0.05 UJ	<0.01 U	<0.1 U	**0.338 J**	**34.5**
		0906-MBE001-09-SL-ARTR	6/21/2009	<0.485 U	**0.466 J+**	**21.9**	**1.73**	**2.69**	**0.299 J**	**11.3**	**187**	**0.0173 J-**	<1.45 U	**2.36**	**1.21**	<0.0496 UJ	**0.0117 J**	<0.0992 U	**1.73**	**30**
		0906-MBE001-09-SL-POTR	6/21/2009	<0.497 U	0.0931 UJ	**13.2**	**1.51**	**1.39**	<0.125 U	**4.11**	**22.6**	<0.00998 UJ	<1.49 U	**2.77**	**0.246 J+**	<0.0499 UJ	<0.00998 U	<0.0998 U	**0.472 J**	**73.4**
		0906-MBE001-09-SL-SYAL	6/21/2009	<0.5 U	0.0872 UJ	**20.7**	**0.0285 J**	**1.27**	<0.125 U	**4.58**	**134**	<0.01 UJ	<1.5 U	**3.5**	**0.255 J+**	<0.05 UJ	<0.01 U	<0.1 U	**0.365 J**	**23.4**
		0906-MBE001-09-FB	6/21/2009	<0.468 U	**0.417 J+**	**26.4**	**0.697**	**3.16**	**0.319 J**	**10.5**	**86.1**	<0.00982 UJ	<1.4 U	**4.57**	**0.764**	<0.0491 UJ	<0.00982 U	<0.0982 U	**1.67**	**42.7**
		0906-MBE001-09-SM-AMAL	6/21/2009	<0.5 U	0.0796 UJ	**13.8**	**0.568**	**1.55**	<0.124 U	**7.53**	**35.6**	**0.0273 J-**	<1.5 U	**1.94**	0.149 U	<0.0494 UJ	<0.00988 U	<0.0988 U	**0.547**	**23.3**
		0908-MBE001-09-FB	8/24/2009	<0.494 U	**0.172 J**	**37.5**	**0.79**	**2.71**	<0.123 U	**5.21**	**60.9**	**0.0117 J**	**2.01 J**	**1.94**	**0.778 J**	<0.0493 U	<0.00986 U	<0.0986 U	**1.16**	**43.5**
	MBE001-10	0906-MBE001-10-SL-SYAL	6/21/2009	<0.495 U	<0.0672 U	**20**	**0.0563 J**	**1.8**	<0.112 U	**6.44**	**125**	**0.0876 J-**	<1.48 U	**3.77**	**0.362**	<0.0448 U	<0.00896 U	<0.0896 U	**0.6**	**30.8 J-**
		0906-MBE001-10-SM-SYAL	6/21/2009	<0.488 U	**7.69 J+**	**8.72**	**0.293**	**2.45**	<0.118 U	**7.0**	**296**	**0.0482 J-**	<1.46 U	**1.31**	**0.287**	<0.0473 U	<0.00947 U	<0.0947 U	**1.17**	**35.6 J-**
		0906-MBE001-10-GF	6/21/2009	<0.485 U	**0.229 J+**	**24.4**	**0.486**	**3.53**	**0.182 J**	**10.4**	**47.3**	<0.00952 UJ	<1.46 U	**2.89**	**0.593**	<0.0476 U	<0.00952 U	<0.0952 U	**1.05**	**38.8 J-**
	MBE001-AL02	0906-MBE001-AL02-SM-SYAL	6/22/2009	<0.499 U	**12.4 J**	**13.8**	**0.9**	**2.3**	<0.155 U	**6.53**	**181 J-**	NA	<1.5 U	**1.7**	**0.182 J**	<0.0622 U	<0.0124 U	<0.124 U	**0.831**	**52.6**
		0906-MBE001-AL02-SM-PUTR	6/22/2009	<0.5 U	<0.0743 UJ	**19.5**	**0.955**	**2.56**	<0.124 U	**4.7**	**82.1 J-**	NA	<1.5 U	**5.33**	**0.381**	<0.0495 U	**0.0109 J**	<0.099 U	**1.19**	**18.9**
		0906-MBE001-AL02-SL-SYAL	6/22/2009	<0.5 U	<0.0749 UJ	**18.5**	**1.61**	**2.02**	<0.125 U	**13.3**	**18.8 J-**	NA	<1.5 U	**2.57**	**0.214**	<0.0499 U	<0.00998 U	<0.0998 U	**0.657**	**20.8**
		0906-MBE001-AL02-SM-ARTR	6/22/2009	<0.5 U	<0.0735 UJ	**29.5**	**0.236**	**1.92**	<0.123 U	**4.1**	**57.4 J-**	NA	<1.5 U	**3.58**	**0.259**	<0.049 U	<0.0098 U	<0.098 U	**0.52**	**30.4**
		0906-MBE001-AL02-SL-PUTR	6/22/2009	<0.5 U	<0.0747 UJ	**27.4**	**0.358**	**1.47**	<0.125 U	**4.04**	**31.5 J-**	NA	<1.5 U	**4.7**	**0.325**	<0.0498 U	<0.00996 U	<0.0996 U	**0.506**	**19.3**
		0906-MBE001-AL02-SL-ARTR	6/22/2009	<0.5 U	**0.0996 J**	**22.7**	**1.09**	**2.22**	<0.124 U	**14.4**	**48.5 J-**	NA	<1.5 U	**3.5**	**0.38**	<0.0497 U	<0.00994 U	<0.0994 U	**0.979**	**24.8**
		0906-MBE001-AL02-GF	6/22/2009	<0.499 U	**0.108 J**	**26.3**	**1.58**	**2.76**	**0.137 J**	**7.91**	**46.9 J-**	NA	<1.5 U	**3.01**	**0.419**	<0.0494 U	<0.00988 U	**0.108 J**	**0.954**	**47.3**

mg/kg milligrams per kilogram (dry weight).
Bold Bolded result indicates positively identified compound.
NA Not analyzed.
NE Not established
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J- Data are estimated, potentially biased low, due to associated quality control data.

Shaded Indicates sample concentration is greater than the associated screening level.
Shaded Indicates method detection limit is greater than the associated screening level.
UJ Potential low bias, possible false negative.
<#U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
#U The analyte was analyzed for and is considered not detected based on associated quality control data.
J+ Data are estimated, potentially biased high, due to associated quality control data.

[1] Screening levels reported in Table 3-1 of the A/T-approved P4 Sites RI/FS Work Plan - Rev 2 Final (MWH, 2011)
Mineral tolerance of animals, second revised edition, 2005 National Research Council, published by the National Academics Press, WA DC, 496 pages

Allium - onion (scientific name undetermined)
AMAL - serviceberry (*Amelanchier alnifolia*)
AR - active ore haul road
ARLU - white sagebrush (*Artemisia ludoviciana*)
ARTR - big sagebrush (*Artemisia tridentata*)
BB - Ballard Mine background
BE - Enoch Valley Mine background
BH - Henry Mine background
BS - Ballard Mine shop
CAAR - Siberian peashrub (*Caragana arborescens*)
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PRVI - chokecherry (*Prunus virginiana*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
ROWI - Wood's rose (*Rosa woodsii*)
SF - shrub fruit
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)
TA - Enoch Valley Minte tipple area
VE - vegetation sample
WD - waste rock dump
Wild St - wild strawberry

Table 2-10
Groundwater Background Sample Locations and Rationale

Station	Feature Name	Mine	Formation	Aquifer Unit	Latitude	Longitude	Natural or Site Background	Rationale	RI/FS Work Plan Drawing Cross-Reference
MAW001	School Bus Well	NA	ND	NA	N42° 53' 15.00"	W111° 26' 39.99"	Natural	Located some distance from Sites and well is not expected to be in a direct flowpath. Representative of the current domestic and agricultural groundwater uses in the vicinity of the Sites.	Drawing 3-14
MAW002	Sharp Field Well	NA	Alluvium[a]	Shallow	N42° 53' 51.00"	W111° 26' 41.99"	Natural		Drawing 3-14
MAW003	Peterson Field Well	NA	Thaynes[b]	Intermediate	N42° 53' 24.00"	W111° 27' 21.59"	Natural		Drawing 3-14
MAW004	Dredge Field Well	NA	ND	NA	N42° 51' 57.01"	W111° 29' 22.21"	Natural		Drawing 3-14
MAW005	Vasser Windmill Field Well	NA	Alluvium, Wells[a]	NA	N42° 51' 44.32"	W111° 23' 08.79"	Natural		Drawing 3-14
MAW006	Godfrey Field Well West	NA	Basalt[a]	Shallow	N42° 51' 59.54"	W111° 30' 49.85"	Natural		Drawing 3-14
MAW007	Godfrey Field Well North	NA	Alluvium[a]	Shallow	N42° 52' 29.99"	W111° 29' 49.20"	Natural		Drawing 3-14
MDW001	Peterson House Well	NA	Travertine[a]	Shallow	N42° 53' 24.00"	W111° 27' 25.99"	Natural		Drawing 3-14
MDW002	Thompson House Well	NA	Alluvium, Thaynes[a]	NA	N42° 54' 17.97"	W111° 26' 46.58"	Natural		Drawing 3-14
MDW003	Taylor House Well	NA	ND	NA	N42° 52' 29.99"	W111° 26' 45.99"	Natural		Drawing 3-14
MDW004	Godfrey House Well	NA	ND	NA	N42° 49' 26.39"	W111° 33' 14.40"	Natural		Drawing 3-14
MDW005	Cedar Bay RV Park Well	NA	Alluvium, Travertine[a]	Shallow	N42° 54' 32.40"	W111° 31' 51.59"	Natural		Drawing 3-14
MDW006	Ellis House Well	NA	ND	NA	N42° 54' 43.20"	W111° 28' 47.99"	Natural		Drawing 3-14
MMW007	South of EVM South Dump; near edge of dump footprint	Enoch Valley	Alluvium/ Dinwoody	Shallow	N42° 51' 48.6"	W111° 23' 29.8"	Natural	Located in an area where favorable piezometric gradients have prevented site contaminants from impacting the groundwater (to be further evaluated in RI Report).	Drawings 3-45. 3-46
MMW008	South of EVM South Dump; south and downgradient of MMW007	Enoch Valley	Alluvium/ Dinwoody	Shallow	N42° 53' 34.6"	W111° 25' 33.8"	Natural		Drawings 3-45. 3-46
MMW025	Along the south end of Enoch Valley Mine, near MMW007	Enoch Valley	Dinwoody	Intermediate	N42° 51' 49.16"	W111° 23' 31.95"	Natural		Drawings 3-45, 3-46
MMW026	Northeast of MPW006 and MMW008	Enoch Valley	Wells	Deep	N42° 51' 56.48"	W111° 23' 25.75"	Natural	Wells Formation locations not impacted by the Sites (long flowpaths or lack of source contribution – to be further evaluated in RI Report)	Drawings 3-45, 3-46
MMW030	Along the southwestern portion of Ballard Mine in the vicinity of MW-16A	Ballard	Wells	Deep	N42° 49' 10.72"	W111° 29' 17.03"	Natural		Drawings 3-15, 3-16, 3-17
MMW031	Along the western perimeter of Ballard Mine north of MMW017 and on the east side of the haul road.	Ballard	Wells	Deep	N42° 50' 11.87"	W111° 29' 43.05"	Natural		Drawings 3-15, 3-18, 3-19
MMW032	Adjacent to MWD084	Ballard	Alluvium/ Dinwoody	Shallow	N42° 50' 09.3"	W111° 28' 21.8"	Natural	Groundwater isolated from waste rock by low permeability alluvium and likely in area of upwelling ground water similar to MMW033 (to be further evaluated in RI Report)	Drawings 3-15, 3-16, 3-17
MMW033	Deeper Well Nested with MMW029	Ballard	Dinwoody	Intermediate	N42° 49' 35.3"	W111° 28' 11.9"	Natural	Located in area of upwelling groundwater that is preventing site contaminants from impacting the deeper groundwater monitored by well (indicated with nested wells).	Drawings 3-15, 3-16, 3-17
MPW019	EVM shop/office	Enoch Valley	Dinwoody or Thaynes	Intermediate	N42° 52' 37.40"	W111° 25' 16.52"	Natural	Located some distance from Sites and well is not expected to be in a direct flowpath	Drawings 3-14, 3-45, 3-46

Notes:
ND - not determined
NA - not assigned
Location (GPS) coordinates use the NAD27 datum and are presented in ddd mm ss format (degrees minutes seconds).
[a] Formation was interpreted from logs and geologic maps, so some wells may be open to multiple formations.
[b] Well logs were not found for these agricultural and domestic wells, so construction information is limited

TABLE 2-11
GROUNDWATER BACKGROUND DATA
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Location Identification	Aquifer/ Unit	Date Collected	Field Sample Identification	Total/ Dissolved	Metals (mg/l)												
					Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
					Screening Level[1]												
					0.2[a]	0.006[a]	0.01[b]	2[a]	0.004[a]	7.3[c]	0.005[a]	NE	0.1[a]	0.011[c]	1.3[a]	0.3[a]	0.015[a]
MAW001	NA	5/17/2004	051704GWMAW001-1-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	**0.0009 JK**	NA	NA	NA	NA
			051704GWMAW001-1-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**61.6 K**	<0.0002 UK	NA	NA	NA	NA
			051704GWMAW001-2-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	**0.001 J+K**	NA	NA	NA	NA
			051704GWMAW001-2-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**68.2 K**	**0.0002 JK**	NA	NA	NA	NA
			051704GWMAW001-3-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	0.0007 UK	NA	NA	NA	NA
			051704GWMAW001-3-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**68.7 K**	<0.0002 UK	NA	NA	NA	NA
			051704GWMAW001-avg-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	**0.00095 J+K**	NA	NA	NA	NA
			051704GWMAW001-avg-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**66.2 K**	**0.0002 JK**	NA	NA	NA	NA
		5/20/2008	052008GWMAW001-0-U	Total	**0.04 J+K**	NA	NA	NA	NA	NA	<0.0001 UK	**68.5 K**	NA	NA	NA	**0.09 J+K**	NA
			052008GWMAW001-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**69.7 K**	NA	NA	NA	**0.04 JK**	NA
MAW002	Shallow	5/19/2004	051904GWMAW002-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	<0.0002 UK	NA	NA	NA	NA
			051904GWMAW002-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**61.5 K**	<0.0002 UK	NA	NA	NA	NA
		6/11/2008	061108GWMAW002-0-U	Total	0.04 UK	NA	NA	NA	NA	NA	<0.0001 UK	**54.4 K**	NA	NA	NA	**0.48 K**	NA
			061108GWMAW002-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**51.3 K**	NA	NA	NA	**0.54 K**	NA
MAW003	Intermediate	5/19/2004	051904GWMAW003-0-U	Total	NA	NA	NA	NA	NA	NA	**0.0004 JK**	NA	**0.0044 K**	NA	NA	NA	NA
			051904GWMAW003-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**34 K**	**0.0013 K**	NA	NA	NA	NA
		5/19/2008	051908GWMAW003-0-U	Total	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**68.8 K**	NA	NA	NA	<0.02 UK	NA
			051908GWMAW003-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**69.2 K**	NA	NA	NA	<0.02 UK	NA
MAW004	NA	5/21/2004	052104GWMAW004-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	**0.0002 JK**	NA	NA	NA	NA
			052104GWMAW004-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**177 K**	<0.0002 UK	NA	NA	NA	NA
		6/12/2008	061208GWMAW004-0-U	Total	**0.04 JK**	NA	NA	NA	NA	NA	<0.0001 UK	**167 K**	NA	NA	NA	**3.47 K**	NA
			061208GWMAW004-0-F	Dissolved	**0.12 JK**	NA	NA	NA	NA	NA	<0.0001 UK	**166 K**	NA	NA	NA	**3.41 K**	NA
MAW005	NA	5/17/2004	051704GWMAW005-0-U	Total	NA	NA	NA	NA	NA	NA	**0.0016 K**	NA	**0.0048 K**	NA	NA	NA	NA
			051704GWMAW005-0-F	Dissolved	NA	NA	NA	NA	NA	NA	**0.0006 JK**	**106 K**	<0.0002 UK	NA	NA	NA	NA
		12/3/2008	120308GWMAW005-0-U	Total	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	NA	**0.00188 J**	NA	NA	**0.078 J**	NA
			120308GWMAW005-0-F	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**99**	**0.00163 J**	NA	NA	<0.025 U	NA
MAW006	Shallow	9/15/2004	GWMAW006-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	**0.0031 K**	NA	NA	NA	NA
			GWMAW006-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UJK	**38.2 K**	**0.001 JK**	NA	NA	NA	NA
		6/12/2008	061208GWMAW006-0-U	Total	**4.65 K**	NA	NA	NA	NA	NA	**0.0002 JK**	**43.5 K**	NA	NA	NA	**4.09 K**	NA
			061208GWMAW006-0-F	Dissolved	**0.05 JK**	NA	NA	NA	NA	NA	<0.0001 UK	**41.2 K**	NA	NA	NA	<0.02 UK	NA
MAW007	Shallow	10/6/2004	AW007-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0001 UJK	NA	**0.0007 JK**	NA	NA	NA	NA
			AW007-0-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**58.2 J-K**	**0.0001 J-K**	NA	NA	NA	NA
		6/11/2008	061108GWMAW007-0-U	Total	0.13 UK	NA	NA	NA	NA	NA	<0.0001 UK	**65.3 K**	NA	NA	NA	**1.27 K**	NA
			061108GWMAW007-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**62.3 K**	NA	NA	NA	**0.84 K**	NA
MDW001	Shallow	5/19/2004	051904GWMDW001-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	0.0004 UK	NA	NA	NA	NA
			051904GWMDW001-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**67.3 K**	<0.0002 UK	NA	NA	NA	NA
		5/19/2008	051908GWMDW001-0-U	Total	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**61.6 K**	NA	NA	NA	**0.04 JK**	NA
			051908GWMDW001-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**64.9 K**	NA	NA	NA	<0.02 UK	NA
MDW002	NA	5/19/2004	051904GWMDW002-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	0.0006 UK	NA	NA	NA	NA
			051904GWMDW002-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**54 K**	**0.0006 JK**	NA	NA	NA	NA
		6/10/2008	061008GWMDW002-0-U	Total	**0.04 JK**	NA	NA	NA	NA	NA	<0.0001 UK	**40.5 K**	NA	NA	NA	0.03 UK	NA
			061008GWMDW002-0-F	Dissolved	**0.04 JK**	NA	NA	NA	NA	NA	<0.0001 UK	**40.3 K**	NA	NA	NA	<0.02 UK	NA

TABLE 2-11
GROUNDWATER BACKGROUND DATA
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Location Identification	Aquifer/ Unit	Date Collected	Field Sample Identification	Total/ Dissolved	Metals (mg/l)												
					Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
					Screening Level[1]												
					NE	0.05[a]	0.002[a]	0.18[c]	0.73[c]	NE	0.05[a]	0.1[a]	NE	0.002[a]	0.03[b]	0.26[c]	5[a]
MAW001	NA	5/17/2004	051704GWMAW001-1-U	Total	NA	NA	NA	NA	0.0016 UK	NA	<0.001 U	NA	NA	NA	NA	**0.0007 K**	**0.03 K**
			051704GWMAW001-1-F	Dissolved	**11.3 K**	NA	NA	NA	<0.0004 UK	**0.6 JK**	<0.001 U	NA	**5.7 K**	NA	NA	0.0002 UK	**0.021 K**
			051704GWMAW001-2-U	Total	NA	NA	NA	NA	**0.0015 JK**	NA	<0.001 U	NA	NA	NA	NA	**0.0009 K**	**0.023 K**
			051704GWMAW001-2-F	Dissolved	**12.5 K**	NA	NA	NA	**0.001 JK**	**0.5 JK**	<0.001 U	NA	**6.0 K**	NA	NA	0.0002 UK	**0.015 JK**
			051704GWMAW001-3-U	Total	NA	NA	NA	NA	**0.0012 JK**	NA	<0.001 U	NA	NA	NA	NA	**0.0006 K**	**0.018 JK**
			051704GWMAW001-3-F	Dissolved	**12.7 K**	NA	NA	NA	**0.0007 JK**	**0.6 JK**	<0.001 U	NA	**6.0 K**	NA	NA	0.0002 UK	**0.015 JK**
			051704GWMAW001-avg-U	Total	NA	NA	NA	NA	**0.00135 JK**	NA	<0.001 U	NA	NA	NA	NA	**0.000733 K**	**0.0237 JK**
			051704GWMAW001-avg-F	Dissolved	**12.2 K**	NA	NA	NA	**0.00085 JK**	**0.567 JK**	<0.001 U	NA	**5.9 K**	NA	NA	<0.0001 UK	**0.017 JK**
		5/20/2008	052008GWMAW001-0-U	Total	**13.2 K**	**0.0185 K**	NA	NA	**0.0013 JK**	**0.8 JK**	**0.002 J**	NA	NA	NA	NA	0.0002 UK	**0.009 JK**
			052008GWMAW001-0-F	Dissolved	**13.6 K**	0.0014 UK	NA	NA	**0.0016 JK**	**0.6 JK**	**0.002 J**	NA	**6.1 K**	NA	NA	**0.0002 JK**	0.008 UJK
MAW002	Shallow	5/19/2004	051904GWMAW002-0-U	Total	NA	NA	NA	NA	**0.0016 JK**	NA	<0.001 U	NA	NA	NA	NA	<0.0001 UK	**0.038 K**
			051904GWMAW002-0-F	Dissolved	**21.7 K**	NA	NA	NA	**0.0012 JK**	**2.0 K**	<0.001 U	NA	**21.7 K**	NA	NA	<0.0001 UK	**0.026 K**
		6/11/2008	061108GWMAW002-0-U	Total	**15.9 K**	**0.114 K**	NA	NA	**0.0011 JK**	1.9 UK	**0.002 J**	NA	NA	NA	NA	**0.0026 K**	**0.075 K**
			061108GWMAW002-0-F	Dissolved	**15.4 K**	**0.141 K**	NA	NA	**0.0016 JK**	**1.5 JK**	**0.002 J**	NA	**9.5 K**	NA	NA	**0.0027 K**	**0.105 K**
MAW003	Intermediate	5/19/2004	051904GWMAW003-0-U	Total	NA	NA	NA	NA	**0.0028 K**	NA	<0.001 U	NA	NA	NA	NA	**0.007 K**	**0.296 K**
			051904GWMAW003-0-F	Dissolved	**8.6 K**	NA	NA	NA	<0.0004 UK	**0.4 JK**	<0.001 U	NA	**9.0 K**	NA	NA	**0.0017 K**	**0.179 K**
		5/19/2008	051908GWMAW003-0-U	Total	**13.3 K**	**0.0006 JK**	NA	NA	**0.0013 JK**	**0.6 JK**	**0.002 J**	NA	NA	NA	NA	<0.0002 UK	**0.014 K**
			051908GWMAW003-0-F	Dissolved	**13.6 K**	<0.0005 UK	NA	NA	**0.0016 JK**	**0.7 JK**	**0.002 J**	NA	**6.1 K**	NA	NA	**0.0002 JK**	**0.017 J+K**
MAW004	NA	5/21/2004	052104GWMAW004-0-U	Total	NA	NA	NA	NA	**0.0049 K**	NA	<0.001 U	NA	NA	NA	NA	**0.0007 K**	**0.037 K**
			052104GWMAW004-0-F	Dissolved	**61.4 K**	NA	NA	NA	**0.0028 K**	**4.8 K**	<0.001 U	NA	**10.2 K**	NA	NA	**0.0007 J+K**	**0.008 JK**
		6/12/2008	061208GWMAW004-0-U	Total	**54.6 K**	**0.16 K**	NA	NA	**0.0045 K**	**5.1 K**	<0.001 U	NA	NA	NA	NA	**0.0005 JK**	**0.005 JK**
			061208GWMAW004-0-F	Dissolved	**53.4 K**	**0.17 K**	NA	NA	**0.0065 K**	**4.9 K**	<0.001 U	NA	**10.4 K**	NA	NA	**0.0009 JK**	**0.006 JK**
MAW005	NA	5/17/2004	051704GWMAW005-0-U	Total	NA	NA	NA	NA	**0.0038 J+K**	NA	<0.001 U	NA	NA	NA	NA	**0.0024 K**	**21.3 K**
			051704GWMAW005-0-F	Dissolved	**38.4 K**	NA	NA	NA	**0.0019 JK**	**5.7 K**	<0.001 U	NA	**103 K**	NA	NA	0.0002 UK	**2.91 K**
		12/3/2008	120308GWMAW005-0-U	Total	NA	**0.00204**	NA	NA	**0.00285 J**	NA	**0.000763 J**	NA	NA	NA	NA	<0.025 U	**2.48**
			120308GWMAW005-0-F	Dissolved	**35.8**	**0.00139 J**	NA	NA	**0.00316 J**	**4.86**	<0.0005 U	NA	**94.2**	NA	NA	<0.025 U	**2.19**
MAW006	Shallow	9/15/2004	GWMAW006-0-U	Total	NA	NA	NA	NA	**0.0049 K**	NA	<0.001 U	NA	NA	NA	NA	**0.0114 K**	**0.036 K**
			GWMAW006-0-F	Dissolved	**10.2 K**	NA	NA	NA	**0.0023 JK**	**1.6 K**	<0.001 UJ	NA	**8.7 K**	NA	NA	**0.00806 JK**	**0.022 K**
		6/12/2008	061208GWMAW006-0-U	Total	**12.5 K**	**0.193 K**	NA	NA	**0.0049 K**	**2.7 K**	<0.001 U	NA	NA	NA	NA	**0.0115 K**	**0.04 K**
			061208GWMAW006-0-F	Dissolved	**10.9 K**	**0.0059 K**	NA	NA	**0.0017 JK**	**1.9 JK**	<0.001 U	NA	**9.5 K**	NA	NA	**0.0075 K**	**0.031 K**
MAW007	Shallow	10/6/2004	AW007-0-U	Total	NA	NA	NA	NA	**0.0029 K**	NA	<0.001 U	NA	NA	NA	NA	**0.0009 K**	**0.087 JK**
			AW007-0-F	Dissolved	**19.9 J-K**	NA	NA	NA	**0.0007 J-K**	**2.8 J-K**	NA	NA	**12.5 J-K**	NA	NA	NA	**0.053 J-K**
		6/11/2008	061108GWMAW007-0-U	Total	**22.7 K**	**0.357 K**	NA	NA	**0.0015 JK**	**3.7 K**	<0.001 U	NA	NA	NA	NA	**0.0009 JK**	**0.073 K**
			061108GWMAW007-0-F	Dissolved	**21.9 K**	**0.354 J+K**	NA	NA	**0.0017 JK**	**3.1 K**	<0.001 U	NA	**13.5 K**	NA	NA	<0.0002 UK	**0.045 K**
MDW001	Shallow	5/19/2004	051904GWMDW001-0-U	Total	NA	NA	NA	NA	**0.001 JK**	NA	<0.001 U	NA	NA	NA	NA	**0.0004 JK**	**0.021 K**
			051904GWMDW001-0-F	Dissolved	**12.6 K**	NA	NA	NA	**0.0011 JK**	**0.5 JK**	<0.001 U	NA	**5.9 K**	NA	NA	0.0002 UK	**0.02 JK**
		5/19/2008	051908GWMDW001-0-U	Total	**7.1 K**	**0.0013 JK**	NA	NA	**0.0006 JK**	**1.1 JK**	<0.001 U	NA	NA	NA	NA	**0.0016 K**	**0.031 K**
			051908GWMDW001-0-F	Dissolved	**7.1 K**	<0.0005 UK	NA	NA	**0.0011 JK**	**1.1 JK**	<0.001 U	NA	**11.2 K**	NA	NA	**0.0018 K**	**0.032 K**
MDW002	NA	5/19/2004	051904GWMDW002-0-U	Total	NA	NA	NA	NA	**0.0009 JK**	NA	<0.001 U	NA	NA	NA	NA	**0.0041 K**	**0.045 K**
			051904GWMDW002-0-F	Dissolved	**19.1 K**	NA	NA	NA	**0.0016 JK**	**2.4 K**	<0.001 U	NA	**21 K**	NA	NA	**0.0039 K**	**0.06 K**
		6/10/2008	061008GWMDW002-0-U	Total	**14.5 K**	**0.0006 JK**	NA	NA	**0.0009 JK**	**2.4 K**	<0.001 U	NA	NA	NA	NA	**0.0072 K**	**0.309 K**
			061008GWMDW002-0-F	Dissolved	**14.2 K**	**0.0008 JK**	NA	NA	**0.0013 JK**	**1.8 JK**	<0.001 U	NA	**21.6 K**	NA	NA	**0.0074 K**	**0.329 K**

TABLE 2-11
GROUNDWATER BACKGROUND DATA
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				Anions (mg/l)			Chemistry Parameters (mg/l)											Radionuclides (pCi/l)	
Location Identification	Aquifer/ Unit	Date Collected	Field Sample Identification	Chloride	Fluoride	Sulfate	Alkalinity, Total	Alkalinity, Hydroxide	Alkalinity, Bicarbonate	Alkalinity, Carbonate	Hardness	TKN	Nitrogen, NO2/NO3	Phosphorus	TSS	TDS	TOC	Gross Alpha	Gross Beta
				Screening Level[1]															
				250[a]	4[a]	250[a]	NE	NE	NE	NE	NE	NE	NE	NE	NE	500[a]	NE	NE	NE
MAW001	NA	5/17/2004	051704GWMAW001-1-U	NA	NA	NA	<2.0 U	181	181	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMAW001-1-F	12.1	NA	11.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMAW001-2-U	NA	NA	NA	<2.0 U	180	180	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMAW001-2-F	8	NA	11.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMAW001-3-U	NA	NA	NA	<2.0 U	149	149	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMAW001-3-F	12.3	NA	11.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMAW001-avg-U	NA	NA	NA	<2.0 U	170	170	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMAW001-avg-F	10.8	NA	11.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/20/2008	052008GWMAW001-0-U	NA	NA	NA	<2.0 U	181	181	<2.0 U	226	0.7 J+	0.55	NA	<5.0 U	NA	NA	1.1 UJ	1 U
			052008GWMAW001-0-F	19.9	NA	13.9	NA	NA	NA	NA	230	NA	NA	NA	NA	240 J-	NA	NA	NA
MAW002	Shallow	5/19/2004	051904GWMAW002-0-U	NA	NA	NA	<2.0 U	252	252	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051904GWMAW002-0-F	3.2	NA	<0.5 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		6/11/2008	061108GWMAW002-0-U	NA	NA	NA	<2.0 U	185	185	<2.0 U	201	0.4 U	1.24	NA	<5.0 U	NA	NA	<2.2 U	1.7 UJ
			061108GWMAW002-0-F	5.3	NA	9.9	NA	NA	NA	NA	192	NA	NA	0.14 J-	NA	240 J-	NA	NA	NA
MAW003	Intermediate	5/19/2004	051904GWMAW003-0-U	NA	NA	NA	<2.0 U	114	114	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051904GWMAW003-0-F	4.8	NA	6.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/19/2008	051908GWMAW003-0-U	NA	NA	NA	<2.0 U	181	181	<2.0 U	227	0.2 U	0.53	NA	<5.0 U	NA	NA	1.1 UJ	2.5 U
			051908GWMAW003-0-F	19.9	NA	13.9	NA	NA	NA	NA	229	NA	NA	NA	NA	250 J-	NA	NA	NA
MAW004	NA	5/21/2004	052104GWMAW004-0-U	NA	NA	NA	<2.0 U	703	703	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			052104GWMAW004-0-F	7.5	NA	7.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		6/12/2008	061208GWMAW004-0-U	NA	NA	NA	<2.0 U	615	615	<2.0 U	642	0.5 J	0.03 J	NA	<5.0 U	NA	NA	2.1 U	8.2 UJ
			061208GWMAW004-0-F	7.7	NA	9.3 J-	NA	NA	NA	NA	634	NA	NA	0.13 J-	NA	680 J-	NA	NA	NA
MAW005	NA	5/17/2004	051704GWMAW005-0-U	NA	NA	NA	<2.0 U	148	148	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMAW005-0-F	136	NA	268	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		12/3/2008	120308GWMAW005-0-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	712	NA	NA	NA
			120308GWMAW005-0-F	132	NA	276	NA	164	NA	NA	395	NA	NA	NA	NA	NA	NA	NA	NA
MAW006	Shallow	9/15/2004	GWMAW006-0-U	NA	NA	NA	<2.0 U	123	123	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			GWMAW006-0-F	9.2	NA	10.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		6/12/2008	061208GWMAW006-0-U	NA	NA	NA	<2.0 U	112	112	<2.0 U	160	<0.1 U	6.4	NA	57	NA	NA	<2.4 U	2.7 UJ
			061208GWMAW006-0-F	10.1	NA	10.7	NA	NA	NA	NA	148	NA	NA	0.13 J-	NA	200 J-	NA	NA	NA
MAW007	Shallow	10/6/2004	AW007-0-U	NA	NA	NA	<2.0 U	242	242	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			AW007-0-F	11.7	NA	23.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		6/11/2008	061108GWMAW007-0-U	NA	NA	NA	<2.0 U	225	225	<2.0 U	257	0.8 J+	<0.02 U	NA	17 J	NA	NA	2.2 U	4.3 UJ
			061108GWMAW007-0-F	11.8	NA	19.3	NA	NA	NA	NA	246	NA	NA	0.25 J-	NA	300 J-	NA	NA	NA
MDW001	Shallow	5/19/2004	051904GWMDW001-0-U	NA	NA	NA	<2.0 U	188	188	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051904GWMDW001-0-F	12.5	NA	11.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/19/2008	051908GWMDW001-0-U	NA	NA	NA	<2.0 U	156	156	<2.0 U	183	0.2 UJ	7.28	NA	<5.0 U	NA	NA	3.4 UJ	3.9 U
			051908GWMDW001-0-F	15	NA	6.4	NA	NA	NA	NA	191	NA	NA	0.08 J-	NA	280 J-	NA	NA	NA
MDW002	NA	5/19/2004	051904GWMDW002-0-U	NA	NA	NA	<2.0 U	148	148	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051904GWMDW002-0-F	31.8	NA	44.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		6/10/2008	061008GWMDW002-0-U	NA	NA	NA	<2.0 U	139	139	<2.0 U	161	0.1 UJ	2.36	NA	<5.0 U	NA	NA	3.7 U	<4.1 UJ
			061008GWMDW002-0-F	21.8	NA	21.7	NA	NA	NA	NA	159	NA	NA	0.12 J-	NA	240 J-	NA	NA	NA

TABLE 2-11
GROUNDWATER BACKGROUND DATA
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Location Identification	Aquifer/ Unit	Date Collected	Field Sample Identification	Total/ Dissolved	Metals (mg/l)												
					Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
					Screening Level[1]												
					0.2[a]	0.006[a]	0.01[b]	2[a]	0.004[a]	7.3[c]	0.005[a]	NE	0.1[a]	0.011[c]	1.3[a]	0.3[a]	0.015[a]
MDW003	NA	5/19/2004	051904GWMDW003-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	0.0007 UK	NA	NA	NA	NA
			051904GWMDW003-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**74.2 K**	**0.0004 JK**	NA	NA	NA	NA
		5/21/2008	052108GWMDW003-0-U	Total	**0.12 JK**	NA	NA	NA	NA	NA	<0.0001 UK	**40.5 J-K**	NA	NA	NA	**0.19 K**	NA
			052108GWMDW003-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**40.5 J-K**	NA	NA	NA	**0.05 K**	NA
MDW004	NA	5/22/2004	052204GWMDW004-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	**0.0017 K**	NA	NA	NA	NA
			052204GWMDW004-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**73.3 K**	**0.0011 K**	NA	NA	NA	NA
		5/19/2008	051908GWMDW004-0-U	Total	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**63.8 K**	NA	NA	NA	**0.05 JK**	NA
			051908GWMDW004-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**66.6 K**	NA	NA	NA	<0.02 UK	NA
MDW005	Shallow	5/22/2004	052204GWMDW005-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	**0.0004 JK**	NA	NA	NA	NA
			052204GWMDW005-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**145 K**	**0.0004 JK**	NA	NA	NA	NA
		5/21/2008	052108GWMDW005-0-U	Total	**0.13 JK**	NA	NA	NA	NA	NA	<0.0001 UK	**140 J-K**	NA	NA	NA	**0.05 J+K**	NA
			052108GWMDW005-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**138 J-K**	NA	NA	NA	**0.06 K**	NA
MDW006	NA	5/22/2004	052204GWMDW006-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0002 UK	NA	**0.0009 JK**	NA	NA	NA	NA
			052204GWMDW006-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**66.1 K**	**0.0007 JK**	NA	NA	NA	NA
		6/11/2008	061108GWMDW006-0-U	Total	0.05 UK	NA	NA	NA	NA	NA	<0.0001 UK	**63.7 K**	NA	NA	NA	**0.05 JK**	NA
			061108GWMDW006-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**58 K**	NA	NA	NA	<0.02 UK	NA
MMW007	Shallow	10/18/2007	101807GWMMW007-0-U	Total	**0.47 K**	<0.0004 UK	<0.0005 UK	**0.021 K**	<0.002 UK	**0.01 JK**	<0.0001 UK	**30.8 K**	**0.0009 J+K**	<0.01 UK	<0.01 UK	**0.35 K**	**0.0004 JK**
			101807GWMMW007-0-F	Dissolved	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.021 K**	<0.002 UK	<0.01 UK	<0.0001 UK	**32 K**	<0.0001 UK	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
		5/21/2008	052108GWMMW007-0-U	Total	**0.09 JK**	<0.0004 UK	<0.0005 UK	**0.016 JK**	<0.002 UK	**0.02 JK**	<0.0001 UK	**73.9 J-K**	0.001 UK	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
			052108GWMMW007-0-F	Dissolved	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.017 JK**	<0.002 UK	**0.01 JK**	<0.0001 UK	**72.9 J-K**	<0.0001 UK	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
		9/23/2008	092308GWMMW007-0-U	Total	**0.417**	NA	NA	NA	NA	NA	<0.000125 U	NA	**0.0019 J**	NA	NA	**0.357**	NA
			092308GWMMW007-0-F	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**38.1**	**0.00119 J**	NA	NA	<0.025 U	NA
		6/1/2009	0905GWMMW007-U	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			0905GWMMW007-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/25/2010	1005GWMMW007-U	Total	NA	NA	NA	NA	NA	NA	<0.0003 U	NA	NA	NA	NA	NA	NA
			1005GWMBW007-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW008	Shallow	10/18/2007	101807GWMMW008-0-U	Total	**3.18 K**	<0.0004 UK	**0.0006 JK**	**0.033 K**	<0.002 UK	**0.01 JK**	<0.0001 UK	**27.5 K**	0.0014 UK	<0.01 UK	<0.01 UK	**2.77 K**	**0.0012 K**
			101807GWMMW008-0-F	Dissolved	**0.03 JK**	<0.0004 UK	**0.0006 JK**	**0.01 JK**	<0.002 UK	<0.01 UK	<0.0001 UK	**26.2 K**	0.0002 UK	<0.01 UK	<0.01 UK	<0.02 UK	<0.0001 UK
		5/20/2008	052008GWMMW008-0-U	Total	**2.56 J+K**	NA	NA	NA	NA	NA	**0.0002 JK**	**32.8 K**	NA	NA	NA	**2.15 J+K**	NA
			052008GWMMW008-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**33.7 K**	NA	NA	NA	**0.03 JK**	NA
		9/21/2008	092108GWMMW008-0-U	Total	**8.75**	NA	NA	NA	NA	NA	**0.000522**	NA	**0.0224**	NA	NA	**6.96**	NA
			092108GWMMW008-0-F	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**29.9**	**0.00265**	NA	NA	**0.0354 J**	NA
		6/1/2009	0905GWMMW008-U	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			0905GWMMW008-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW025	Intermediate	9/25/2008	092508GWMMW025-0-U	Total	**1.38**	NA	NA	NA	NA	NA	<0.000125 U	NA	**0.00285**	NA	NA	**1.01**	NA
			092508GWMMW025-0-F	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**20.5**	**0.00119 J**	NA	NA	**0.0417 J**	NA
		5/19/2009	0905GWMMW025-U	Total	**0.216**	<0.00025 U	**0.000989 J**	**0.0102**	<0.0005 U	NA	<0.000125 U	NA	**0.00117 J**	<0.00025 U	**0.000716 J+/B**	**0.155**	<0.00025 U
			0905GWMMW025-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**21.9**	NA	NA	NA	<0.025 U	NA
		6/17/2010	1005GWMMW025-U	Total	NA	NA	NA	NA	NA	NA	<0.0003 U	NA	NA	NA	NA	NA	NA
			1005GWMMW025-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW026	Deep	10/7/2008	100708GWMMW026-0-U	Total	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	NA	**0.00243**	NA	NA	<0.025 U	NA
			100708GWMMW026-0-F	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**37**	**0.00279**	NA	NA	<0.025 U	NA
		5/29/2009	0905GWMMW026-U	Total	<0.05 U	<0.00025 U	**0.000266 J**	**0.0216**	<0.0005 U	NA	<0.000125 U	NA	**0.00154 J**	**0.000281 J**	<0.0005 U	**0.0382 J**	<0.00025 U
			0905GWMMW026-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**36.2**	NA	NA	NA	**0.0513 J**	NA
MMW030	Deep	9/21/2008	092108GWMMW030-0-U	Total	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	NA	**0.00227**	NA	NA	<0.025 U	NA
			092108GWMMW030-0-F	Dissolved	**0.106**	NA	NA	NA	NA	NA	<0.000125 U	**29.7**	**0.00237**	NA	NA	**0.0833 J**	NA
		5/19/2009	0905GWMMW030-U	Total	**0.426**	**0.00269**	**0.0267**	**0.0964**	<0.0005 U	NA	<0.000125 U	NA	**0.00203**	**0.000436 J**	**0.00169 J+/B**	**0.353**	**0.00432**
			0905GWMMW030-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**29.6**	NA	NA	NA	<0.025 U	NA
		5/19/2010	1005GWMMW030-U	Total	NA	NA	NA	NA	NA	NA	<0.0003 U	NA	NA	NA	NA	NA	NA
			1005GWMMW030-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW031	Deep	9/20/2008	092008GWMMW031-0-U	Total	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	NA	**0.00442**	NA	NA	<0.025 U	NA
			092008GWMMW031-0-F	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**31.7**	**0.00507**	NA	NA	**0.0255 J**	NA
		5/13/2009	0905GWMMW031-U	Total	<0.05 U	<0.00025 U	**0.000456 J**	**0.0355**	<0.0005 U	NA	<0.000125 U	NA	**0.0029**	<0.00025 U	<0.0005 U	<0.025 U	<0.00025 U
			0905GWMMW031-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**33.2**	NA	NA	NA	<0.025 U	NA
		5/17/2010	1005GWMMW031-U	Total	NA	NA	NA	NA	NA	NA	<0.0003 U	NA	NA	NA	NA	NA	NA
			1005GWMMW031-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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GROUNDWATER BACKGROUND DATA
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Location Identification	Aquifer/ Unit	Date Collected	Field Sample Identification	Total/ Dissolved	Metals (mg/l)												
					Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
					Screening Level[1]												
					NE	0.05[a]	0.002[a]	0.18[c]	0.73[c]	NE	0.05[a]	0.1[a]	NE	0.002[a]	0.03[b]	0.26[c]	5[a]
MDW003	NA	5/19/2004	051904GWMDW003-0-U	Total	NA	NA	NA	NA	0.0013 JK	NA	0.002 J	NA	NA	NA	NA	0.0007 K	0.005 JK
			051904GWMDW003-0-F	Dissolved	6.5 K	NA	NA	NA	0.0012 JK	0.5 JK	0.001 J	NA	6.0 K	NA	NA	0.0002 UK	<0.004 UK
		5/21/2008	052108GWMDW003-0-U	Total	10.2 K	0.915 K	NA	NA	0.0121 K	0.7 JK	0.002 J	NA	NA	NA	NA	0.0006 UK	<0.002 UK
			052108GWMDW003-0-F	Dissolved	10.5 K	0.862 K	NA	NA	0.0024 JK	0.8 JK	0.002 J	NA	18.3 K	NA	NA	0.0003 JK	0.002 JK
MDW004	NA	5/22/2004	052204GWMDW004-0-U	Total	NA	NA	NA	NA	0.0015 UK	NA	<0.001 U	NA	NA	NA	NA	0.0018 K	0.078 K
			052204GWMDW004-0-F	Dissolved	20.4 K	NA	NA	NA	0.0004 JK	2.2 K	<0.001 U	NA	15 K	NA	NA	0.0018 K	0.085 K
		5/19/2008	051908GWMDW004-0-U	Total	21.8 K	0.002 JK	NA	NA	0.001 JK	2.7 K	0.002 J	NA	NA	NA	NA	0.0026 K	0.394 K
			051908GWMDW004-0-F	Dissolved	21.6 K	0.003 JK	NA	NA	0.0017 JK	2.6 K	<0.001 U	NA	14.1 K	NA	NA	0.0029 K	0.428 K
MDW005	Shallow	5/22/2004	052204GWMDW005-0-U	Total	NA	NA	NA	NA	0.0025 J+K	NA	<0.001 U	NA	NA	NA	NA	0.0004 JK	0.052 K
			052204GWMDW005-0-F	Dissolved	38.3 K	NA	NA	NA	0.0016 JK	2.4 K	<0.001 U	NA	16 K	NA	NA	0.0005 UK	0.056 K
		5/21/2008	052108GWMDW005-0-U	Total	38.9 K	0.0026 JK	NA	NA	0.0044 K	2.5 K	0.002 J	NA	NA	NA	NA	0.0005 UK	0.08 K
			052108GWMDW005-0-F	Dissolved	39.1 K	0.0049 K	NA	NA	0.004 K	2.5 K	0.001 J	NA	16.4 K	NA	NA	0.0003 JK	0.084 K
MDW006	NA	5/22/2004	052204GWMDW006-0-U	Total	NA	NA	NA	NA	0.0011 UK	NA	<0.001 U	NA	NA	NA	NA	0.0028 K	0.035 K
			052204GWMDW006-0-F	Dissolved	27 K	NA	NA	NA	0.0006 JK	2.8 K	<0.001 U	NA	44.9 K	NA	NA	0.0026 K	0.033 K
		6/11/2008	061108GWMDW006-0-U	Total	27.1 K	0.0063 K	NA	NA	0.0012 JK	3.2 K	<0.001 U	NA	NA	NA	NA	0.0023 K	0.185 K
			061108GWMDW006-0-F	Dissolved	25.2 K	0.0065 K	NA	NA	0.0016 JK	2.5 K	<0.001 U	NA	39.7 K	NA	NA	0.0022 K	0.195 K
MMW007	Shallow	10/18/2007	101807GWMMW007-0-U	Total	7.6 K	0.0804 K	<0.0002 U	<0.01 UK	0.0013 JK	0.8 JK	0.002 J	<0.01 UK	12.1 K	0.0002 JK	0.0003 JK	0.0003 J+K	0.006 JK
			101807GWMMW007-0-F	Dissolved	7.9 K	0.0715 K	<0.0002 U	<0.01 UK	0.0008 JK	0.4 JK	0.002 J	0.01 UJK	12.2 K	<0.0001 UK	0.0002 JK	0.0006 JK	0.003 JK
		5/21/2008	052108GWMMW007-0-U	Total	6.9 K	0.0015 JK	<0.0002 U	<0.01 UK	0.0021 UK	0.5 JK	0.005 J	<0.01 UK	5.9 K	<0.0001 UK	0.0005 JK	0.0004 UK	<0.002 UK
			052108GWMMW007-0-F	Dissolved	7.1 K	<0.0005 UK	<0.0002 U	0.02 JK	0.0011 JK	0.6 JK	0.005 J	<0.01 UK	6.2 K	<0.0001 UK	0.0004 JK	<0.0002 UK	0.004 JK
		9/23/2008	092308GWMMW007-0-U	Total	NA	0.61	NA	NA	0.00397 J	NA	0.00237 J	NA	NA	NA	NA	<0.005 U	0.00526 J
			092308GWMMW007-0-F	Dissolved	9.62	0.582	NA	NA	0.00376 J	0.746 J	0.00256 J	NA	17.8	NA	NA	<0.005 U	<0.005 U
		6/1/2009	0905GWMMW007-U	Total	NA	NA	NA	NA	NA	NA	0.00119	NA	NA	NA	NA	NA	NA
			0905GWMMW007-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/25/2010	1005GWMMW007-U	Total	NA	NA	NA	NA	NA	NA	0.00155	NA	NA	NA	NA	NA	NA
			1005GWMBW007-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW008	Shallow	10/18/2007	101807GWMMW008-0-U	Total	10.8 K	0.339 K	<0.0002 U	<0.01 UK	0.0015 JK	1.4 JK	<0.001 U	<0.01 UK	11.2 K	<0.0001 UK	0.0007 K	0.0021 J+K	0.011 K
			101807GWMMW008-0-F	Dissolved	10.2 K	0.167 K	<0.0002 U	<0.01 UK	<0.0006 UK	0.8 JK	<0.001 U	0.01 UJK	11.2 K	<0.0001 UK	0.0006 K	0.0007 JK	0.004 JK
		5/20/2008	052008GWMMW008-0-U	Total	12.3 K	0.269 K	NA	NA	0.0023 JK	1.5 JK	<0.001 U	NA	NA	NA	NA	0.001 J+K	0.015 K
			052008GWMMW008-0-F	Dissolved	12.4 K	0.388 K	NA	NA	0.002 JK	1.5 JK	<0.001 U	NA	20.8 K	NA	NA	0.0004 JK	0.008 UJK
		9/21/2008	092108GWMMW008-0-U	Total	NA	0.456	NA	NA	0.00883	NA	0.00138 J	NA	NA	NA	NA	0.0147	0.326
			092108GWMMW008-0-F	Dissolved	10.9	0.39	NA	NA	0.00298 J	1.2	0.000754 J	NA	18.7	NA	NA	<0.005 U	0.0125 J
		6/1/2009	0905GWMMW008-U	Total	NA	NA	NA	NA	NA	NA	0.000606 J	NA	NA	NA	NA	NA	NA
			0905GWMMW008-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW025	Intermediate	9/25/2008	092508GWMMW025-0-U	Total	NA	0.0699	NA	NA	0.00188 J	NA	0.000879 J	NA	NA	NA	NA	<0.005 U	0.00578 UJ
			092508GWMMW025-0-F	Dissolved	7.95	0.0304	NA	NA	0.00113 J	2.18	0.00061 J	NA	25.1	NA	NA	<0.005 U	<0.005 U
		5/19/2009	0905GWMMW025-U	Total	NA	0.0209	<0.0001 U	<0.005 U	0.00115 J	NA	0.00168	<0.00025 U	NA	<0.00005 U	0.000889 J	<0.005 U	0.00502 UJ/E
			0905GWMMW025-F	Dissolved	8.26	NA	NA	NA	NA	1.03	NA	NA	25.5	NA	NA	NA	NA
		6/17/2010	1005GWMMW025-U	Total	NA	NA	NA	NA	NA	NA	<0.0005 U	NA	NA	NA	NA	NA	NA
			1005GWMMW025-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW026	Deep	10/7/2008	100708GWMMW026-0-U	Total	NA	0.00544	NA	NA	0.00174 J	NA	0.0013	NA	NA	NA	NA	<0.005 U	0.111
			100708GWMMW026-0-F	Dissolved	16	0.00553	NA	NA	0.00207 J	1.55	0.0012	NA	29.4	NA	NA	<0.005 U	0.111
		5/29/2009	0905GWMMW026-U	Total	NA	0.044	<0.0001 U	<0.005 U	0.00168 J	NA	0.00107 J	<0.00025 U	NA	<0.00005 U	0.00116	<0.005 U	0.00831 J
			0905GWMMW026-F	Dissolved	16.2	NA	NA	NA	NA	1.41	NA	NA	28.7	NA	NA	NA	NA
MMW030	Deep	9/21/2008	092108GWMMW030-0-U	Total	NA	0.0846	NA	NA	0.00279 J	NA	<0.0005 UJ	NA	NA	NA	NA	<0.005 U	<0.005 U
			092108GWMMW030-0-F	Dissolved	20.2	0.101	NA	NA	0.00277 J	1.65	0.000572 J	NA	20.6	NA	NA	<0.005 U	0.0063 J
		5/19/2009	0905GWMMW030-U	Total	NA	0.0923	<0.0001 U	<0.005 U	0.00254 J	NA	0.00116	<0.00025 U	NA	0.000054 J	0.00171	<0.005 U	0.0133 UJ/B
			0905GWMMW030-F	Dissolved	19.8	NA	NA	NA	NA	1.65	NA	NA	21.6	NA	NA	NA	NA
		5/19/2010	1005GWMMW030-U	Total	NA	NA	NA	NA	NA	NA	<0.0005 U	NA	NA	NA	NA	NA	NA
			1005GWMMW030-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW031	Deep	9/20/2008	092008GWMMW031-0-U	Total	NA	0.00149 J	NA	NA	0.0014 J	NA	0.000874 J	NA	NA	NA	NA	<0.005 U	<0.005 U
			092008GWMMW031-0-F	Dissolved	6.43	0.00236	NA	NA	0.00163 J	1.28	0.00124 J	NA	8.05	NA	NA	<0.005 U	<0.005 U
		5/13/2009	0905GWMMW031-U	Total	NA	<0.0005 U	<0.0001 U	<0.005 U	0.00102 J	NA	0.000683 J	<0.00025 U	NA	<0.00005 U	0.000292 J	<0.005 U	<0.005 U
			0905GWMMW031-F	Dissolved	6.87	NA	NA	NA	NA	1.14	NA	NA	7.15	NA	NA	NA	NA
		5/17/2010	1005GWMMW031-U	Total	NA	NA	NA	NA	NA	NA	0.001	NA	NA	NA	NA	NA	NA
			1005GWMMW031-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 2-11
GROUNDWATER BACKGROUND DATA
P4 RI/FS

				Anions (mg/l)			Chemistry Parameters (mg/l)											Radionuclides (pCi/l)	
Location Identification	Aquifer/ Unit	Date Collected	Field Sample Identification	Chloride	Fluoride	Sulfate	Alkalinity, Total	Alkalinity, Hydroxide	Alkalinity, Bicarbonate	Alkalinity, Carbonate	Hardness	TKN	Nitrogen, NO2/NO3	Phosphorus	TSS	TDS	TOC	Gross Alpha	Gross Beta
				Screening Level[1]															
				250[a]	4[a]	250[a]	NE	NE	NE	NE	NE	NE	NE	NE	NE	500[a]	NE	NE	NE
MDW003	NA	5/19/2004	051904GWMDW003-0-U	NA	NA	NA	<2.0 U	**189**	**189**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051904GWMDW003-0-F	**7.8**	NA	**6.4**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/21/2008	052108GWMDW003-0-U	NA	NA	NA	<2.0 U	**101**	**101**	<2.0 U	**143**	0.2 UJ	**0.15**	NA	<5.0 U	NA	NA	0.26 U	2.3 UJ
			052108GWMDW003-0-F	**7.2**	NA	**61.6**	NA	NA	NA	NA	**144**	NA	NA	**0.07 J-**	NA	**220 J-**	NA	NA	NA
MDW004	NA	5/22/2004	052204GWMDW004-0-U	NA	NA	NA	<2.0 U	**254**	**254**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			052204GWMDW004-0-F	**7.8**	NA	**15.1**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/19/2008	051908GWMDW004-0-U	NA	NA	NA	<2.0 U	**227**	**227**	<2.0 U	**249**	0.2 UJ	**6.0**	NA	<5.0 U	NA	NA	<1.7 UJ	4.7 U
			051908GWMDW004-0-F	**10**	NA	**14.7**	NA	NA	NA	NA	**255**	NA	NA	**0.11 J-**	NA	**330 J-**	NA	NA	NA
MDW005	Shallow	5/22/2004	052204GWMDW005-0-U	NA	NA	NA	<2.0 U	**455**	**455**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			052204GWMDW005-0-F	**16.5**	NA	**43.7**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/21/2008	052108GWMDW005-0-U	NA	NA	NA	<2.0 U	**443**	**443**	<2.0 U	**510**	0.1 UJ	**0.21**	NA	**7.0 J**	NA	NA	1.8 U	1 UJ
			052108GWMDW005-0-F	**18.4**	NA	**44.7**	NA	NA	NA	NA	**506**	NA	NA	**0.06 J**	NA	**550 J-**	NA	NA	NA
MDW006	NA	5/22/2004	052204GWMDW006-0-U	NA	NA	NA	<2.0 U	**145**	**145**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			052204GWMDW006-0-F	**58**	NA	**103**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		6/11/2008	061108GWMDW006-0-U	NA	NA	NA	<2.0 U	**140**	**140**	<2.0 U	**271**	0.2 U	**2.96**	NA	<5.0 U	NA	NA	0.77 U	1.8 UJ
			061108GWMDW006-0-F	**53.2**	NA	**110**	NA	NA	NA	NA	**249**	NA	NA	**0.12 J-**	NA	**420 J-**	NA	NA	NA
MMW007	Shallow	10/18/2007	101807GWMMW007-0-U	NA	NA	NA	**104**	<2.0 U	**104**	<2.0 U	NA	**0.1 J-**	**0.26**	NA	<5.0 U	NA	NA	3.1 U	0.62 U
			101807GWMMW007-0-F	**5.7**	<0.1 U	**21**	NA	NA	NA	NA	**112**	NA	NA	**0.02 J-**	NA	**170 J-**	NA	NA	NA
		5/21/2008	052108GWMMW007-0-U	NA	NA	NA	**189**	<2.0 U	**189**	<2.0 U	**213**	**0.7 J**	**0.4**	NA	<5.0 U	NA	NA	5.7 U	2.8 UJ
			052108GWMMW007-0-F	**8.1**	<0.1 U	**8.8**	NA	NA	NA	NA	**211**	NA	NA	**0.07 J-**	NA	**230 J-**	NA	NA	NA
		9/23/2008	092308GWMMW007-0-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**3.5 J**	**210**	NA	NA	NA
			092308GWMMW007-0-F	**7.22**	NA	**55.1**	**100 J-**	NA	NA	NA	**135**	NA	NA	NA	NA	NA	NA	NA	NA
		6/1/2009	0905GWMMW007-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**196**	NA	NA	NA
			0905GWMMW007-F	NA	NA	**35.1**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/25/2010	1005GWMMW007-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**168**	NA	NA	NA
			1005GWMBW007-F	NA	NA	**22.3**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW008	Shallow	10/18/2007	101807GWMMW008-0-U	NA	NA	NA	**115**	<2.0 U	**115**	<2.0 U	NA	**0.1 J-**	**0.03 J**	NA	**74**	NA	NA	3.5 U	-0.82 U
			101807GWMMW008-0-F	**4.6**	**0.1 J**	**9.2**	NA	NA	NA	NA	**107**	NA	NA	**0.01 J-**	NA	**150 J-**	NA	NA	NA
		5/20/2008	052008GWMMW008-0-U	NA	NA	NA	**110**	<2.0 U	**110**	<2.0 U	**133**	**1.0 J+**	**0.11**	NA	**139**	NA	NA	4.1 U	1.5 U
			052008GWMMW008-0-F	**12.3**	NA	**35.9**	NA	NA	NA	NA	**135**	NA	NA	NA	NA	**180 J-**	NA	NA	NA
		9/21/2008	092108GWMMW008-0-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**184**	NA	NA	NA
			092108GWMMW008-0-F	**11.2 J-**	NA	**29.6**	**123**	NA	NA	NA	**120**	NA	NA	NA	NA	NA	NA	NA	NA
		6/1/2009	0905GWMMW008-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**176**	NA	NA	NA
			0905GWMMW008-F	NA	NA	**16.7**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW025	Intermediate	9/25/2008	092508GWMMW025-0-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**16**	**184**	NA	NA	NA
			092508GWMMW025-0-F	**4.28**	NA	**9.66 J-**	**122**	NA	NA	NA	**84.1**	NA	NA	NA	NA	NA	NA	NA	NA
		5/19/2009	0905GWMMW025-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**4.5 J**	**204**	NA	<2.46 U	<2.29 U
			0905GWMMW025-F	**4.09**	NA	**13.9**	**118**	NA	NA	NA	**88.6**	NA	**0.342**	NA	NA	NA	NA	NA	NA
		6/17/2010	1005GWMMW025-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**190**	NA	NA	NA
			1005GWMMW025-F	NA	NA	**13**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW026	Deep	10/7/2008	100708GWMMW026-0-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**276**	NA	NA	NA
			100708GWMMW026-0-F	**5.12**	NA	**19.5**	**213**	NA	NA	NA	**158**	NA	NA	NA	NA	NA	NA	NA	NA
		5/29/2009	0905GWMMW026-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**414**	NA	**4.22**	<3.2 U
			0905GWMMW026-F	**4.89**	NA	**19.7**	**198**	NA	NA	NA	**157**	NA	<0.025 U	NA	NA	NA	NA	NA	NA
MMW030	Deep	9/21/2008	092108GWMMW030-0-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**234**	NA	NA	NA
			092108GWMMW030-0-F	**12 J-**	NA	**15**	**181**	NA	NA	NA	**157**	NA	NA	NA	NA	NA	NA	NA	NA
		5/19/2009	0905GWMMW030-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**19.5**	**282**	NA	**5.08**	3.84 U
			0905GWMMW030-F	**13.2**	NA	**16.4**	**170**	NA	NA	NA	**155**	NA	**0.221**	NA	NA	NA	NA	NA	NA
		5/19/2010	1005GWMMW030-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**232**	NA	NA	NA
			1005GWMMW030-F	NA	NA	**17.2**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MMW031	Deep	9/20/2008	092008GWMMW031-0-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**156**	NA	NA	NA
			092008GWMMW031-0-F	**7.17 J-**	NA	**3.21**	**125**	NA	NA	NA	**106**	NA	NA	NA	NA	NA	NA	NA	NA
		5/13/2009	0905GWMMW031-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**156**	NA	<3.46 U	**3.53**
			0905GWMMW031-F	**7.29**	NA	**6.1**	**125**	NA	NA	NA	**111**	NA	**0.371**	NA	NA	NA	NA	NA	NA
		5/17/2010	1005GWMMW031-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**172**	NA	NA	NA
			1005GWMMW031-F	NA	NA	**3.41**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Location Identification	Aquifer/ Unit	Date Collected	Field Sample Identification	Total/ Dissolved	Metals (mg/l)												
					Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
					Screening Level[1]												
					0.2[a]	0.006[a]	0.01[b]	2[a]	0.004[a]	7.3[c]	0.005[a]	NE	0.1[a]	0.011[c]	1.3[a]	0.3[a]	0.015[a]
MMW032	Shallow	9/25/2009	0909GWMMW032-U	Total	**0.718**	NA	NA	NA	NA	NA	**0.000433 J**	NA	**0.0103**	NA	NA	**0.396**	NA
			0909GWMMW032-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**51.9**	NA	NA	NA	**0.0301 J**	NA
		5/20/2010	1005GWMMW032-U	Total	**0.196**	<0.0005 U	**0.000815 J**	**0.0509**	<0.0005 U	NA	**0.000315 J**	NA	**0.00474**	<0.0005 U	<0.001 U	**0.136 J**	**0.000544 J**
			1005GWMMW032-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**50.6**	NA	NA	NA	**0.0323 J**	NA
MMW033	Intermediate	9/25/2009	0909GWMMW033-U	Total	**1.74**	NA	NA	NA	NA	NA	<0.000125 U	NA	**0.00524**	NA	NA	**1.16**	NA
			0909GWMMW033-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**44.4**	NA	NA	NA	<0.025 U	NA
		5/20/2010	1005GWMMW033-U	Total	**0.594**	**0.000542 J**	**0.0149**	**0.0261**	<0.0005 U	NA	<0.0003 U	NA	**0.00237**	<0.0005 U	<0.001 U	**0.273 J**	**0.000523 J**
			1005GWMMW033-F	Dissolved	NA	NA	NA	NA	NA	NA	NA	**21.1**	NA	NA	NA	**0.0392 J**	NA
MPW019	Intermediate	5/17/2004	051704GWMPW019-0-U	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMPW019-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0002 UK	**72.3 K**	<0.0002 UK	NA	NA	NA	NA
		9/15/2004	GWMPW019-0-U	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			GWMPW019-0-F	Dissolved	NA	NA	NA	NA	NA	NA	<0.0001 UJK	**68.9 K**	<0.0001 UJK	NA	NA	NA	NA
		6/22/2005	062205GWMPW019-0-U	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			062205GWMPW019-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**70.8 K**	0.0002 UK	NA	NA	**0.16 K**	NA
		5/14/2006	051406GWMPW019-0-U	Total	NA	NA	NA	NA	NA	NA	<0.0001 UK	NA	**0.0003 JK**	NA	NA	NA	NA
			051406GWMPW019-0-F	Dissolved	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.107 K**	<0.002 UK	NA	<0.0001 UK	**70 K**	**0.0001 JK**	<0.01 UK	<0.01 UK	**0.35 K**	<0.0001 UK
		9/15/2007	091507GWMPW019-0-U	Total	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.116 K**	<0.002 UK	**0.02 JK**	<0.0001 UK	**72.5 K**	**0.0013 K**	<0.01 UK	<0.01 UK	**0.58 K**	**0.0015 K**
			091507GWMPW019-0-F	Dissolved	<0.03 UK	<0.0004 UK	<0.0005 UK	**0.116 K**	<0.002 UK	**0.01 JK**	<0.0001 UK	**72.5 K**	<0.0001 UK	<0.01 UK	<0.01 UK	**0.37 K**	0.0003 UK
		5/18/2008	051808GWMPW019-0-U	Total	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**77.1 K**	NA	NA	NA	**1.68 K**	NA
			051808GWMPW019-0-F	Dissolved	<0.03 UK	NA	NA	NA	NA	NA	<0.0001 UK	**71.9 K**	NA	NA	NA	**0.2 K**	NA
		9/23/2008	092308GWMPW019-0-U	Total	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	NA	**0.00123 J**	NA	NA	**0.125**	NA
			092308GWMPW019-0-F	Dissolved	<0.05 U	NA	NA	NA	NA	NA	<0.000125 U	**68.4**	**0.00102 J**	NA	NA	**0.0595 J**	NA

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Location Identification	Aquifer/ Unit	Date Collected	Field Sample Identification	Total/ Dissolved	Metals (mg/l)												
					Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
					Screening Level[1]												
					NE	0.05[a]	0.002[a]	0.18[c]	0.73[c]	NE	0.05[a]	0.1[a]	NE	0.002[a]	0.03[b]	0.26[c]	5[a]
MMW032	Shallow	9/25/2009	0909GWMMW032-U	Total	NA	**0.0491**	NA	NA	**0.00407**	NA	**0.00267**	NA	NA	NA	NA	**0.0128**	**0.0541**
			0909GWMMW032-F	Dissolved	**14.1**	NA	NA	NA	NA	**0.925 J**	NA	NA	**22.8**	NA	NA	NA	NA
		5/20/2010	1005GWMMW032-U	Total	NA	**0.0216**	<0.0001 U	<0.005 U	**0.00299 J**	NA	**0.00133**	**0.0165**	NA	<0.0001 U	**0.0027**	<0.005 U	<0.0125 UJ
			1005GWMMW032-F	Dissolved	**15.1**	NA	NA	NA	NA	**0.879 J**	NA	NA	**8.67**	NA	NA	NA	NA
MMW033	Intermediate	9/25/2009	0909GWMMW033-U	Total	NA	**0.344**	NA	NA	**0.00337 J**	NA	**0.00577**	NA	NA	NA	NA	**0.013**	**0.0425**
			0909GWMMW033-F	Dissolved	**25.7**	NA	NA	NA	NA	**0.895 J**	NA	NA	**22**	NA	NA	NA	NA
		5/20/2010	1005GWMMW033-U	Total	NA	**0.0561**	<0.0001 U	**0.0239 J**	<0.002 U	NA	**0.00101**	<0.0005 U	NA	<0.0001 U	**0.0172**	<0.005 U	<0.0125 UJ
			1005GWMMW033-F	Dissolved	**14.1**	NA	NA	NA	NA	**0.822 J**	NA	NA	**76.7**	NA	NA	NA	NA
MPW019	Intermediate	5/17/2004	051704GWMPW019-0-U	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMPW019-0-F	Dissolved	**9.9 K**	NA	NA	NA	<0.0004 UK	**0.8 JK**	<0.001 U	NA	**6.9 K**	NA	NA	0.0002 UK	**0.036 K**
		9/15/2004	GWMPW019-0-U	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			GWMPW019-0-F	Dissolved	**9.5 K**	NA	NA	NA	**0.0045 JK**	**0.6 JK**	<0.001 UJ	NA	**6.8 K**	NA	NA	0.00018 UK	**0.012 K**
		6/22/2005	062205GWMPW019-0-U	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			062205GWMPW019-0-F	Dissolved	**9.7 K**	**0.0472 K**	NA	NA	<0.0006 UK	**0.6 JK**	**0.001 J**	NA	**7.3 K**	NA	NA	<0.0002 UK	**0.026 K**
		5/14/2006	051406GWMPW019-0-U	Total	NA	NA	NA	NA	<0.0006 UK	NA	<0.001 U	NA	NA	NA	NA	**0.0002 JK**	**0.699 K**
			051406GWMPW019-0-F	Dissolved	**10.2 K**	**0.0755 K**	<0.0002 U	<0.01 UK	<0.0006 UK	**0.7 JK**	<0.001 U	<0.01 UJK	**7.3 K**	<0.0001 UK	**0.0012 K**	<0.0002 UK	**0.568 K**
		9/15/2007	091507GWMPW019-0-U	Total	**10.2 K**	**0.0464 K**	<0.0002 U	<0.01 UK	**0.0013 JK**	**0.9 JK**	<0.001 U	<0.01 UK	**7.3 K**	<0.0001 UK	**0.0015 K**	**0.0003 JK**	**0.07 K**
			091507GWMPW019-0-F	Dissolved	**10 K**	**0.0434 K**	<0.0002 U	<0.01 UK	**0.0017 JK**	**0.7 JK**	<0.001 U	<0.01 UJK	**7.2 K**	0.0001 UK	**0.0014 K**	**0.0002 JK**	**0.058 K**
		5/18/2008	051808GWMPW019-0-U	Total	**10.8 K**	**0.0524 K**	NA	NA	**0.0011 JK**	**0.8 JK**	**0.001 J**	NA	NA	NA	NA	**0.0012 K**	**0.284 K**
			051808GWMPW019-0-F	Dissolved	**10.2 K**	**0.0469 K**	NA	NA	**0.0028 JK**	**0.8 JK**	**0.001 J**	NA	**7.2 K**	NA	NA	**0.0011 K**	**0.234 K**
		9/23/2008	092308GWMPW019-0-U	Total	NA	**0.036**	NA	NA	**0.00346 J**	NA	**0.00149**	NA	NA	NA	NA	<0.005 U	**0.0339**
			092308GWMPW019-0-F	Dissolved	**9.53**	**0.036**	NA	NA	**0.00328 J**	**0.699 J**	**0.00142**	NA	**7.13**	NA	NA	<0.005 U	**0.0344**

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				Anions (mg/l)			Chemistry Parameters (mg/l)											Radionuclides (pCi/l)	
Location Identification	**Aquifer/ Unit**	**Date Collected**	**Field Sample Identification**	**Chloride**	**Fluoride**	**Sulfate**	**Alkalinity, Total**	**Alkalinity, Hydroxide**	**Alkalinity, Bicarbonate**	**Alkalinity, Carbonate**	**Hardness**	**TKN**	**Nitrogen, NO2/NO3**	**Phosphorus**	**TSS**	**TDS**	**TOC**	**Gross Alpha**	**Gross Beta**
				Screening Level[1]															
				250[a]	**4[a]**	**250[a]**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**500[a]**	**NE**	**NE**	**NE**
MMW032	Shallow	9/25/2009	0909GWMMW032-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**14.5**	**248**	NA	**7.95**	3.98 U
			0909GWMMW032-F	**4.01**	NA	**9.96**	**231**	NA	NA	NA	**188**	NA	**0.479**	NA	NA	NA	NA	NA	NA
		5/20/2010	1005GWMMW032-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**5.5**	**226**	NA	5.85 U	5.76 U
			1005GWMMW032-F	**3.93**	NA	**5.16**	**204**	NA	NA	NA	**188**	NA	**0.485**	NA	NA	NA	NA	4.08 U	<4.97 U
MMW033	Intermediate	9/25/2009	0909GWMMW033-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**41.5**	**266**	NA	7 U	**4.83**
			0909GWMMW033-F	**5.22**	NA	**30.9**	**224**	NA	NA	NA	**217**	NA	**0.238**	NA	NA	NA	NA	NA	NA
		5/20/2010	1005GWMMW033-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**9.0**	**324**	NA	**27.8**	**8.86**
			1005GWMMW033-F	**5.1**	NA	**37.9**	**253**	NA	NA	NA	**111**	NA	**0.026 J**	NA	NA	NA	NA	**26.4**	**8.34**
MPW019	Intermediate	5/17/2004	051704GWMPW019-0-U	NA	NA	NA	**216**	<2.0 U	**216**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			051704GWMPW019-0-F	**6.1**	NA	**8.3**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		9/15/2004	GWMPW019-0-U	NA	NA	NA	**218**	<2.0 U	**218**	<2.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
			GWMPW019-0-F	**6.7**	NA	**9.8**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		6/22/2005	062205GWMPW019-0-U	NA	NA	NA	**192**	<2.0 U	**192**	<2.0 U	NA	NA	**0.06 J**	NA	NA	NA	NA	NA	NA
			062205GWMPW019-0-F	**8**	NA	**8.3**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		5/14/2006	051406GWMPW019-0-U	NA	NA	NA	**219**	<2.0 U	**219**	<2.0 U	NA	<0.1 U	**0.02 J**	NA	<5.0 U	NA	**5.0 J**	NA	NA
			051406GWMPW019-0-F	**8**	NA	**8.1**	NA	NA	NA	NA	**217**	NA	NA	<0.01 U	NA	**250**	NA	NA	NA
		9/15/2007	091507GWMPW019-0-U	NA	NA	NA	**214**	<2.0 U	**214**	<2.0 U	NA	<0.1 U	**0.06 J-**	NA	<5.0 U	NA	NA	0.39 U	-0.3 U
			091507GWMPW019-0-F	**8**	**0.3 J**	**8.9**	NA	NA	NA	NA	**222**	NA	NA	0.02 UJ	NA	**230 J-**	NA	NA	NA
		5/18/2008	051808GWMPW019-0-U	NA	NA	NA	**194**	<2.0 U	**194**	<2.0 U	**237**	0.2 UJ	**0.1**	NA	**6.0 J**	NA	NA	3.5 UJ	4.3 U
			051808GWMPW019-0-F	**10**	NA	**10.1**	NA	NA	NA	NA	**222**	NA	NA	**0.04 J-**	NA	**270 J-**	NA	NA	NA
		9/23/2008	092308GWMPW019-0-U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<2.5 U	**258**	NA	NA	NA
			092308GWMPW019-0-F	**11.3**	NA	**9.7**	**213 J-**	NA	NA	NA	**210**	NA	NA	NA	NA	NA	NA	NA	NA

mg/l	milligrams per liter.
Bold	Bolded result indicates positively identified compound.
Shaded	Indicates sample concentration is greater than the associated screening level
NA	Not analyzed.
NE	Not established
J	Data are estimated due to associated quality control data.
UJ	Potential low bias, possible false negative.
<#U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
#U	The analyte was analyzed for and is considered not detected based on associated quality control data.
K	Serial dilutions not performed for samples analyzed by this method (EPA 200.7; 200.8).
J+	Data are estimated, potentially biased low, due to associated quality control data.
J-	Data are estimated, potentially biased high, due to associated quality control data.

[1] Screening levels reported in Table 3-1 of the A/T-approved P4 Sites RI/FS Work Plan - Rev 2 Final (MWH, 2011)
[a]State of Idaho Ground Water Quality Rule (IDAPA 58.01.11). Note that secondary MCLs are listed for pH, aluminum, chloride, iron, manganese, pH, silver, sulfate, TDS and zinc
[b]USEPA primary and secondary Maximum Contaminant Level (MCL), National Primary Drinking Water Regulations, EPA.
[c]USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Site

Table 4-1
Summary of Preliminary COPECs in Sediment P4 Mining Sites, Idaho

Sampling Parameter	Maximum Detected Concentration (mg/kg)	Ecological: Sediment Screening Level [a] (mg/kg)	Ecological: Preliminary Sediment COPEC (Yes/No)	Sediment: Will BTVs be Established? (Yes/No)
Aluminum	31,100	25,500 [b]	**Yes**	No [c]
Antimony	12	2.0	**Yes**	**Yes**
Arsenic	25	9.8	**Yes**	**Yes**
Boron	28	- -	**Yes**	**Yes**
Cadmium	1,290	0.99	**Yes**	**Yes**
Chromium	1,030	43	**Yes**	**Yes**
Cobalt	43	50	No	No
Copper	186	32	**Yes**	**Yes**
Iron	34,100	20,000	**Yes**	No [c]
Manganese	5,550	460	**Yes**	**Yes**
Mercury	0.68	0.18	**Yes**	**Yes**
Molybdenum	20	- -	**Yes**	**Yes**
Nickel	2,580	23	**Yes**	**Yes**
Selenium	1,300	2.0	**Yes**	**Yes**
Silver	4.1	1.0	**Yes**	**Yes**
Thallium	3.7	- -	**Yes**	**Yes**
Uranium	90	- -	**Yes**	**Yes**
Vanadium	940	- -	**Yes**	**Yes**
Zinc	25,800	121	**Yes**	**Yes**

Notes:

[a] Sediment screening levels are based on the USEPA Region 3 BTAG freshwater sediment screening benchmarks, unless otherwise noted (USEPA, 2012).

[b] Great Lakes ARCS program TEL as cited in NOAA SQuiRT table (Buchman 2008).

[c] No BTVs will be established for aluminum and iron because no sediment background data are available for these metals.

"- -" - not available
ARCS - assessment and remediation of contaminated sediments
BTAG - Biological Technical Assistance Group
BTV - background threshold value
COPEC - chemicals of potential ecological concern
mg/kg - milligrams per kilogram
NOAA - National Oceanic and Atmospheric Administration
SQuiRT table - Screening Quick Reference Tables
TEL - threshold effects level
USEPA - United States Environmental Protection Agency

TABLE 4-2
Summary of Preliminary COPCs and COPECs in Surface Water P4 Mining Sites, Idaho

		Human Health		Ecological		Surface Water
Sampling Parameter	**Maximum Detected Concentration (mg/L)**	**Proposed COPC Screening Criteria [a] (mg/L)**	**Preliminary COPC (Yes/No)**	**Proposed COPEC Screening Criteria [d] (mg/L)**	**Preliminary COPEC (Yes/No)**	**Will BTVs be Established? (Yes/No)**
Aluminum, dissolved	0.91	16	No	0.087	**Yes**	**Yes**
Antimony, Dissolved	0.0031	0.0056	No	0.030	No	No
Arsenic, Dissolved	0.056	0.010	**Yes**	0.15	No [e]	**Yes**
Barium, Dissolved	0.14	1.0	No	0.0040	**Yes**	**Yes**
Beryllium, Dissolved	0.0020	0.016	No	0.00066	**Yes**	**Yes**
Boron, Dissolved	0.40	3.1	No	0.0016	**Yes**	**Yes**
Cadmium, dissolved	0.13	0.0069	**Yes**	0.00060	**Yes**	**Yes**
Calcium, dissolved	496	- -	No [b]	116	**Yes**	**Yes**
Chromium, dissolved	0.0090	0.000031	**Yes** [c]	0.011	No	**Yes**
Cobalt, Dissolved	0.030	0.0047	**Yes**	0.0040	**Yes**	**Yes**
Copper, Dissolved	0.38	1.3	No [e]	0.011	**Yes**	**Yes**
Iron, dissolved	1.4	0.30	No [b]	0.16	**Yes**	**Yes**
Lead, Dissolved	0.00060	0.015	No [e]	0.0025	No [e]	No [e]
Magnesium, dissolved	154	- -	No [b]	82	**Yes**	**Yes**
Manganese, dissolved	3.5	0.050	**Yes**	0.11	**Yes**	**Yes**
Mercury, Dissolved	0.00050	0.0043	No [e]	0.00077	No [e]	No [e]
Molybdenum, Dissolved	0.16	0.078	**Yes**	0.37	No	**Yes**
Nickel, dissolved	2.2	0.61	**Yes**	0.052	**Yes**	**Yes**
Potassium, dissolved	102	- -	No [b]	53	**Yes**	**Yes**
Selenium, total	2.8	0.17	**Yes**	0.0050	**Yes**	**Yes**
Silver, Dissolved	0.010	0.071	No [e]	0.0034	**Yes**	**Yes**
Sodium, dissolved	69	- -	No [b]	680	No	No
Thallium, Dissolved	0.0013	0.00024	**Yes**	0.012	No	**Yes**
Uranium, dissolved	0.060	0.047	**Yes**	0.0026	**Yes**	**Yes**
Vanadium, dissolved	0.13	0.078	**Yes**	0.020	**Yes**	**Yes**
Zinc, dissolved	10	7.4	**Yes**	0.12	**Yes**	**Yes**

Notes:

[a] The proposed COPC screening criteria are based on the following hierarchy of sources:

1) State of Idaho Surface Water Quality for Domestic Water Supply Use (IDAPA 58.01.02).
2) National Recommended Water Quality Criteria (USEPA, 2009); Criteria for Human Health for Organism Consumption of Water + Organism (W+O) and Organism Only (O Only).
3) USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (USEPA, 2012).
4) Public Health Assessment: Southeast Idaho Phosphate Mining Resource Area (USDHHS, PHS and ATSDR, 2006).
5) USEPA primary and secondary Maximum Contaminant Level (MCLs), National Primary Drinking Water Regulations (USEPA, 2008).

TABLE 4-2
Summary of Preliminary COPCs and COPECs in Surface Water P4 Mining Sites, Idaho

		Human Health		Ecological		Surface Water
Sampling Parameter	**Maximum Detected Concentration (mg/L)**	**Proposed COPC Screening Criteria [a] (mg/L)**	**Preliminary COPC (Yes/No)**	**Proposed COPEC Screening Criteria [d] (mg/L)**	**Preliminary COPEC (Yes/No)**	**Will BTVs be Established? (Yes/No)**

[b] The analyte was not selected as a COPC because it is a naturally occurring essential nutrient with low toxicity.

[c] Consistent with the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011), the total chromium results are compared to the hexavalent chromium standard.

[d] Refer to Appendix C of the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011).

[e] The USEPA (2002) has identified this analyte as a potentially bioaccumulative constituent; during preparation of the remedial investigation reports, a Site-specific Tier 2 screen will be conducted to evaluate whether or not this analyte should be carried forward into the quantitative HHERA.

"- -" - not available
BTV - background threshold value
COPC - chemicals of potential concern
COPEC - chemicals of potential ecological concern
HHERA - human health and ecological risk assessment
mg/L - milligrams per liter
USEPA - United States Environmental Protection Agency

TABLE 4-3
Summary of Preliminary Riparian Soil COPCs and COPECs P4 Mining Sites, Idaho

Sampling Parameter	Maximum Detected Concentration (mg/kg)	Human Health: Residential USEPA Regional Screening Levels for Soil (mg/kg)	Human Health: Carcinogen/ Non-carcinogen	Human Health: Soil Screening Level [a] (mg/kg)	Human Health: Preliminary COPC based on Residential Screening Level	Ecological: Lowest Soil Screening Level [b] (mg/kg)	Ecological: Preliminary COPEC (Yes/No)	Riparian Soil: Will BTVs be Established? (Yes/No)
Antimony	8.7	31	NC	3.1	**Yes**	0.27	**Yes**	**Yes**
Arsenic	5.44	0.39	C	0.39	**Yes**	18	No [d]	**Yes**
Boron	11.2	16,000	NC	1,600	No	0.50	**Yes**	**Yes**
Cadmium	131	70	NC	7.0	**Yes**	0.36	**Yes**	**Yes**
Chromium	2780	120,000	NC	12,000	No	0.40	**Yes**	**Yes**
Cobalt	10.1	23	NC	2.3	**Yes**	13	No	**Yes**
Copper	130	3,100	NC	310	No [d]	28	**Yes**	**Yes**
Manganese	1,080	1,800	NC	180	**Yes**	220	**Yes** [c]	**Yes**
Mercury	0.069	23.0	NC	2.3	No	0.10	No [d]	No [d]
Molybdenum	48.6	390	NC	39	**Yes**	2.0	**Yes**	**Yes**
Nickel	1,620	1,500	NC	150	**Yes**	38	**Yes**	**Yes**
Selenium	570	390	NC	39	**Yes**	0.52	**Yes**	**Yes**
Silver	0.278	390	NC	39	No [d]	4.2	No [d]	No [d]
Thallium	0.428	0.78	NC	0.078	**Yes**	1.0	**Yes** [e]	**Yes**
Uranium	3.83	230	NC	23	No	5.0	**Yes** [e]	**Yes**
Vanadium	773	390	NC	39	**Yes**	2.0	**Yes**	**Yes**
Zinc	4,500	23,000	NC	2,300	**Yes**	46	**Yes**	**Yes**

Notes:

[a] The soil screening level is equal to the May 2012 USEPA Residential Soil Regional Screening Level (RSL) for carcinogens (equivalent to a cancer risk of one-in-a-million), or 1/10th the USEPA Residential Soil RSL for non-carcinogens (equivalent to a hazard quotient of 0.1), to account for potential cumulative effects of exposure to multiple contaminants.

[b] Refer to Appendix C of the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011).

[c] Because the maximum detected concentration of this analyte does not exceed the lower of screening benchmarks for birds or mammals (4,000 mg/kg), it will only be evaluated qualitatively for impacts on lower trophic level receptors (i.e., plants or the soil community, as appropriate).

TABLE 4-3
Summary of Preliminary Riparian Soil COPCs and COPECs P4 Mining Sites, Idaho

Sampling Parameter	Maximum Detected Concentration (mg/kg)	Human Health: Residential USEPA Regional Screening Levels for Soil (mg/kg)	Human Health: Carcinogen/ Non-carcinogen	Human Health: Soil Screening Level [a] (mg/kg)	Human Health: Preliminary COPC based on Residential Screening Level	Ecological: Lowest Soil Screening Level [b] (mg/kg)	Ecological: Preliminary COPEC (Yes/No)	Riparian Soil: Will BTVs be Established? (Yes/No)

[d] The USEPA (2002) has identified this analyte as a potentially bioaccumulative constituent; during preparation of the remedial investigation reports, a Site-specific Tier 2 screen will be conducted to evaluate whether or not this analyte should be carried forward into the quantitative HHERA.

[e] Analyte was identified as a COPEC because neither avian or mammalian benchmarks are available for this chemical.

BTV - background threshold value
C - carcinogen
COPC - chemical of potential concern
COPEC - chemicals of potential ecological concern
HHERA - human health and ecological risk assessment
mg/kg - milligrams per kilogram
NC - non-carcinogen
USEPA - United States Environmental Protection Agency

TABLE 4-4
Summary of Preliminary Riparian Vegetation COPECs P4 Mining Sites, Idaho

Sampling Parameter	Maximum Detected Concentration (mg/kg)	Vegetation Screening Value [a] (mg/kg)	Will Riparian Vegetation BTVs be Established? (Yes/No)
Aluminum	ND	1,000	No
Antimony	ND	- -	No
Arsenic	ND	30	No [b]
Barium	ND	- -	No
Beryllium	ND	- -	No
Boron	ND	150	No
Cadmium	11.1	10	**Yes**
Chromium	ND	100	No
Cobalt	ND	25	No
Copper	8.50	40	No [b]
Iron	ND	500	No
Lead	ND	100	No [b]
Manganese	ND	2,000	No
Mercury	ND	- -	No [b]
Molybdenum	45.9	5.0	**Yes**
Nickel	ND	100	No [b]
Selenium	65	5	**Yes**
Silver	ND	- -	No [b]
Thallium	ND	- -	No
Uranium	ND	- -	No
Vanadium	ND	50	No
Zinc	335	500	No [b]

Notes:

[a] Table 2-1 of Mineral tolerance of animals, second revised edition, National Research Council (2005), published by the National Academic Press, Washington, DC.

[b] The USEPA (2002) has identified this analyte as a potentially bioaccumulative constituent; during preparation of the remedial investigation reports, a Site-specific Tier 2 screen will be conducted to evaluate whether or not this analyte should be carried forward into the quantitative HHERA.

"- -" - not available
BTV - background threshold value
COPEC - chemicals of potential ecological concern
HHERA - human health and ecological risk assessment
mg/kg - milligrams per kilogram
ND - non-detect
USEPA - United States Environmental Protection Agency

TABLE 4-5
Summary of Preliminary Upland Soil COPCs and COPECs P4 Mining Sites, Idaho

		Human Health				Ecological		Upland Soil
Sampling Parameter	**Maximum Detected Concentration (mg/kg)**	**Residential USEPA Regional Screening Levels for Soil (mg/kg)**	**Carcinogen/ Non-Carcinogen**	**Soil Screening Level [a] (mg/kg)**	**Preliminary COPC based on Residential Screening Level**	**Lowest Soil Screening Level [b] (mg/kg)**	**Preliminary COPEC (Yes/No)**	**Will BTVs be Established? (Yes/No)**
Antimony	11	31	NC	3.1	**Yes**	0.27	**Yes**	**Yes**
Arsenic	45.5	0.39	C	0.39	**Yes**	18	**Yes**	**Yes**
Boron	60.9	16,000	NC	1,600	No	0.50	**Yes**	**Yes**
Cadmium	167	70	NC	7.0	**Yes**	0.36	**Yes**	**Yes**
Chromium	766	120,000	NC	12,000	No	0.40	**Yes**	**Yes**
Cobalt	25.6	23	NC	2.3	**Yes**	13	**Yes** [c]	**Yes**
Copper	1,280	3,100	NC	310	**Yes**	28	**Yes**	**Yes**
Manganese	5,180	1,800	NC	180	**Yes**	220	**Yes**	**Yes**
Mercury	0.892	23.0	NC	2.3	No	0.10	**Yes**	**Yes**
Molybdenum	48.7	390	NC	39	**Yes**	2.0	**Yes**	**Yes**
Nickel	1,750	1,500	NC	150	**Yes**	38	**Yes**	**Yes**
Selenium	318	390	NC	39	**Yes**	0.52	**Yes**	**Yes**
Silver	14.4	390	NC	39	No [d]	4.2	**Yes**	**Yes**
Thallium	3.68	0.78	NC	0.078	**Yes**	1.0	**Yes**	**Yes**
Uranium	151	230	NC	23	**Yes**	5.0	**Yes**	**Yes**
Vanadium	1,370	390	NC	39	**Yes**	2.0	**Yes**	**Yes**
Zinc	6,670	23,000	NC	2,300	**Yes**	46	**Yes**	**Yes**

Notes:

[a] The soil screening level is equal to the May 2012 USEPA Residential Soil Regional Screening Level (RSL) for carcinogens (equivalent to a cancer risk of one-in-a-million), or 1/10th the USEPA Residential Soil RSL for non-carcinogens (equivalent to a hazard quotient of 0.1), to account for potential cumulative effects of exposure to multiple contaminants.

[b] Refer to Appendix C of the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011).

[c] Because the maximum detected concentration of this analyte does not exceed the lower of screening benchmarks for birds or mammals (120 mg/kg), it will only be evaluated qualitatively for impacts on lower trophic level receptors (i.e., plants or the soil community, as appropriate).

[d] The USEPA (2002) has identified this analyte as a potentially bioaccumulative constituent; during preparation of the remedial investigation reports, a Site-specific Tier 2 screen will be conducted to evaluate whether or not this analyte should be carried forward into the quantitative HHERA.

BTV - background threshold value
C - carcinogen
COPC - chemical of potential concern
COPEC - chemicals of potential ecological concern
HHERA - human health and ecological risk assessment
mg/kg - milligrams per kilogram
NC - non-carcinogen
USEPA - United States Environmental Protection Agency

TABLE 4-6
Summary of Preliminary Upland Vegetation COPECs P4 Mining Sites, Idaho

Sampling Parameter	Maximum Detected Concentration (mg/kg)	Vegetation Screening Value [a] (mg/kg)	Will Upland Vegetation BTVs be Established? (Yes/No)
Aluminum	ND	1,000	No
Antimony	5.41	- -	**Yes**
Arsenic	23.6	30	No [b]
Barium	ND	- -	No
Beryllium	ND	- -	No
Boron	364	150	**Yes**
Cadmium	21.5	10	**Yes**
Chromium	20.7	100	No
Cobalt	1.29	25	No
Copper	20.1	40	No [b]
Iron	ND	500	No
Lead	ND	100	No [b]
Manganese	1,170	2,000	No
Mercury	0.128	- -	**Yes**
Molybdenum	425	5	**Yes**
Nickel	66.0	100	No [b]
Selenium	1,010	5.0	**Yes**
Silver	38.2	- -	**Yes**
Thallium	3.83	- -	**Yes**
Uranium	2.75	- -	**Yes**
Vanadium	25.2	50	No
Zinc	363	500	No [b]

Notes:

[a] Table 2-1 of Mineral tolerance of animals, second revised edition, National Research Council (2005), published by the National Academic Press, Washington, DC.

[b] The USEPA (2002) has identified this analyte as a potentially bioaccumulative constituent; during preparation of the remedial investigation reports, a Site-specific Tier 2 screen will be conducted to evaluate whether or not this analyte should be carried forward into the quantitative HHERA.

"- -" - not available
BTV - background threshold value
COPEC - chemicals of potential ecological concern
HHERA - human health and ecological risk assessment
mg/kg - milligrams per kilogram
ND - non-detect
USEPA - United States Environmental Protection Agency

TABLE 4-7
Summary of Preliminary COPCs in Groundwater P4 Mining Sites, Idaho

Sampling Parameter	Maximum Detected Concentration (mg/L)	Human Health: Proposed COPC Screening Criteria [a] (mg/L)	Human Health: Preliminary COPC (Yes/No)	Groundwater: Will BTVs be Established? (Yes/No)
Aluminum, total	14.4	16	No	No
Antimony, total	0.00269	0.0060	No	No
Arsenic, total	0.0267	0.000045	**Yes**	**Yes**
Barium, total	0.288	2.9	No	No
Boron, total	0.0400	3.1	No	No
Cadmium, total	0.0257	0.0069	**Yes**	**Yes**
Calcium, total	224	- -	No [b]	No
Chromium, total	0.282	0.000031	**Yes** [c]	**Yes**
Cobalt, total	0.0100	0.0047	**Yes**	**Yes**
Copper, total	0.0231	0.62	No	No
Iron, total	26.4	11	No [b]	No
Lead, total	0.0286	0.015	**Yes**	**Yes**
Magnesium, total	54.6	- -	No [b]	No
Manganese, total	3.39	0.32	**Yes**	**Yes**
Mercury, total	0.000200	0.0043	No	No
Molybdenum, total	0.110	0.078	**Yes**	**Yes**
Nickel, total	0.251	0.30	No	No
Potassium, total	5.90	- -	No [b]	No
Selenium, total	2.46	0.078	**Yes**	**Yes**
Silver, total	0.0165	0.071	No	No
Sodium, total	84.9	- -	No [b]	No
Thallium, total	0.00110	0.00016	**Yes**	**Yes**
Uranium, total	0.0128	0.047	No	No
Vanadium, total	0.281	0.078	**Yes**	**Yes**
Zinc, total	617	4.7	**Yes**	**Yes**

Notes:

[a] The proposed COPC screening criteria are based on the following hierarchy of sources:

1) USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (USEPA, 2012).
2) Remedial action and monitoring levels; Area-Wide Risk Management Plan (RMP; IDEQ, 2004).
3) State of Idaho Ground Water Quality Rule (IDAPA 58.01.11).
4) USEPA primary and secondary Maximum Contaminant Level (MCLs) and National Primary Drinking Water Regulations (USEPA, 2008).
5) Public Health Assessment: Southeast Idaho Phosphate Mining Resource Area (USDHHS, PHS and ATSDR, 2006).

TABLE 4-7
Summary of Preliminary COPCs in Groundwater P4 Mining Sites, Idaho

Sampling Parameter	Maximum Detected Concentration (mg/L)	Human Health: Proposed COPC Screening Criteria [a] (mg/L)	Human Health: Preliminary COPC (Yes/No)	Groundwater: Will BTVs be Established? (Yes/No)

[b] The analyte was not selected as a COPC because it is a naturally occurring essential nutrient with low toxicity.
[c] Consistent with the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011), the total chromium results are compared to the hexavalent chromium

"- -" - not available
BTV - background threshold value
COPC - chemicals of potential concern
mg/L - milligrams per liter
USEPA - United States Environmental Protection Agency

Table 4-8
Summary Statistics for Background Metals in Sediment

Constituent	Uncensored Data									Censored Data														Ecological COPEC Screening Criteria (mg/kg)
	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Statistical Method [a]	95% UCL [b] (mg/kg)	95% UPL [b] (mg/kg)	95/95 UTL [b] (mg/kg)	95% USL [c] (mg/kg)	
Antimony																								
Combined:	4	2	50	5.00	4.80	3.00	3.00	3.95	1.10	4	2	50	**5.00**	4.80	3.00	3.00	3.95	1.10	NA	NC	NC	NC	NC	2.0
Arsenic																								
Combined:	4	4	100	4.55	2.10	NA	NA	3.15	1.04	4	4	100	**4.55**	2.10	NA	NA	3.15	1.04	NA	NC	NC	NC	NC	9.8
Boron																								
Combined:	4	4	100	8.40	6.20	NA	NA	7.55	0.957	4	4	100	**8.40**	6.20	NA	NA	7.55	0.957	NA	NC	NC	NC	NC	- -
Cadmium																								
Combined:	13	13	100	3.74	0.220	NA	NA	1.79	1.02	13	13	100	3.74	0.220	NA	NA	1.79	1.02	Normal	2.29	3.68	4.52	**4.17**	0.99
Chromium, total																								
Combined:	13	13	100	34.8	11.5	NA	NA	23.1	6.42	13	13	100	34.8	11.5	NA	NA	23.1	6.42	Normal	26.3	35.0	40.2	**38.1**	43
Copper																								
Combined:	4	4	100	25.5	14.4	NA	NA	18.9	5.25	4	4	100	**25.5**	14.4	NA	NA	18.9	5.3	NA	NC	NC	NC	NC	32
Manganese																								
Combined:	4	4	100	405	194	NA	NA	300	119	4	4	100	**405**	194	NA	NA	300	119	NA	NC	NC	NC	NC	460
Mercury																								
Combined:	4	4	100	0.0380	0.0260	NA	NA	0.0320	0.00638	4	4	100	**0.0380**	0.0260	NA	NA	0.0320	0.00638	NA	NC	NC	NC	NC	0.18
Molybdenum																								
Combined:	4	0	0	ND	ND	**0.500**	0.500	0.500	ND	4	0	0	ND	ND	**0.500**	0.500	0.500	ND	NA	NC	NC	NC	NC	- -
Nickel																								
Combined:	13	13	100	24.4	5.80	NA	NA	17.3	4.89	13	13	100	24.4	5.80	NA	NA	17.3	4.89	Normal	19.7	26.3	30.3	**28.7**	23
Selenium																								
Combined:	13	7	54	1.60	0.700	0.600	0.500	0.80	0.33	13	7	54	1.60	0.700	0.600	0.500	0.796	0.332	Kaplan-Meier	1.01	1.35	1.57	**1.48**	2.0
Silver																								
Combined:	4	4	100	0.241	0.155	NA	NA	0.180	0.0406	4	4	100	**0.241**	0.155	NA	NA	0.180	0.0406	NA	NC	NC	NC	NC	1.0
Thallium																								
Combined:	4	4	100	0.378	0.171	NA	NA	0.246	0.0926	4	4	100	**0.378**	0.171	NA	NA	0.246	0.0926	NA	NC	NC	NC	NC	- -
Uranium																								
Combined:	3	3	100	2.37	2.03	NA	NA	2.17	0.176	3	3	100	**2.37**	2.03	NA	NA	2.17	0.176	NA	NC	NC	NC	NC	- -
Vanadium																								
Combined:	13	13	100	45.2	11.3	NA	NA	28.7	8.75	13	13	100	45.2	11.3	NA	NA	28.7	8.75	Normal	33.0	44.9	52.1	**49.1**	- -
Zinc																								
Combined:	13	13	100	151	18.0	NA	NA	91.0	32.0	13	13	100	151	18.0	NA	NA	91.0	32.0	Normal	107	150	177	**166**	121

Notes:

[a] Statistical method for 95% UCL, 95% UPL and 95/95 UTL.

[b] 95% UCL, 95% UPL and 95/95 UTL values were calculated using ProUCL 4.1.01 (USEPA, 2011). The Kaplan-Meier statistical method was used to calculate the upper limits when multiple detection limits are present in the dataset.

[c] 95% USL values were calculated using Scout 1.00.01 (USEPA, 2008). For analytes with a detection frequency below 100%, the 95% USL values were calculated using the Kaplan Meier method.

Boldface value indicates the proposed background level for a given metal. As described in Section 3.3, the 95% USL was selected as the proposed background level for datasets containing five or more detections. When a dataset contained fewer than five detections, the maximum detected concentration was proposed as the background level. If there were no detected results in a dataset, the maximum detection limit for non-detects was proposed as the background level.

Table 4-8
Summary Statistics for Background Metals in Sediment

	Uncensored Data									Censored Data														
Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Statistical Method [a]	95% UCL [b] (mg/kg)	95% UPL [b] (mg/kg)	95/95 UTL [b] (mg/kg)	95% USL [c] (mg/kg)	Ecological COPEC Screening Criteria (mg/kg)

% - percent
COPEC - chemical of potential ecological concern
mg/kg - milligram per kilogram
NA - not applicable
NC - not calculated
ND - not detected
UCL - Upper Confidence Limit
UPL - Upper Prediction Limit
USL - Upper Simultaneous Limit
UTL - Upper Tolerance Limit

Table 4-9
Summary Statistics for Background Metals in Surface Water

	Uncensored Data									Censored Data															
Constituent [a]	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Mean Concentration (mg/L)	Standard Deviation (mg/L)	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Mean Concentration (mg/L)	Standard Deviation (mg/L)	Statistical Method for 95% UCL	95% UCL [b] (mg/L)	Statistical Method for 95% UPL and 95/95 UTL	95% UPL [b] (mg/L)	95/95 UTL [b] (mg/L)	95% USL [c] (mg/L)	Lower of COPC or COPEC Screening Criteria [d] (mg/L)
Aluminum																									
Combined:	21	5	23.8	0.410	0.0400	0.0500	0.0300	0.0633	0.0832	21	5	23.8	0.410	0.0400	0.0500	0.0300	0.0633	0.0832	Kaplan-Meier	0.0990	Kaplan-Meier	0.207	0.255	**0.272**	0.087
Arsenic																									
Combined:	15	8	53.3	0.00290	0.000500	0.000500	0.000500	0.000924	0.000805	13	6	46.2	0.00110	0.000500	0.000500	0.000500	0.000628	0.000205	Kaplan-Meier	0.000735	Normal	0.00113	0.00143	**0.00109**	0.010
Barium																									
Combined:	15	15	100	0.0850	0.0200	NA	NA	0.0439	0.0213	15	15	100	0.0850	0.0200	NA	NA	0.0439	0.0213	Gamma	0.0550	Gamma	0.0877	0.114	**0.0953**	0.0040
Beryllium																									
Combined:	15	0	0	ND	ND	0.00200	0.00200	0.00200	ND	15	0	0	ND	ND	**0.00200**	0.00200	0.00200	ND	NA	NC	NA	NC	NC	NC	0.00066
Boron																									
Combined:	7	4	57.1	0.0200	0.0167	0.0100	0.0100	0.0152	0.00504	7	4	57.1	**0.0200**	0.0167	0.0100	0.0100	0.0152	0.00504	NA	NC	NA	NC	NC	NC	0.0016
Cadmium																									
Combined:	44	2	4.55	0.000100	0.000100	0.000500	0.000100	0.000122	0.0000687	44	2	4.55	**0.000100**	0.000100	0.000500	0.000100	0.000122	0.0000687	NA	NC	NA	NC	NC	NC	0.00060
Calcium																									
Combined:	46	46	100	93.2	16.8	NA	NA	47.7	17.2	46	46	100	93.2	16.8	NA	NA	47.7	17.2	Normal	52.0	Normal	77.0	83.6	**98.1**	116
Chromium, total																									
Combined:	37	14	37.8	0.00393	0.000200	0.000500	0.000100	0.000490	0.000846	37	14	37.8	0.00393	0.000200	0.000500	0.000100	0.000490	0.000846	Kaplan-Meier	0.000775	Kaplan-Meier	0.00193	0.00227	**0.00284**	0.000031
Cobalt																									
Combined:	15	0	0	ND	ND	0.0100	0.0100	0.0100	1.76E-10	15	0	0	ND	ND	**0.0100**	0.0100	0.0100	1.76E-10	NA	NC	NA	NC	NC	NC	0.00398
Copper																									
Combined:	15	0	0	ND	ND	0.0100	0.0100	0.0100	1.760E-10	15	0	0	ND	ND	**0.0100**	0.0100	0.0100	1.76E-10	NA	NC	NA	NC	NC	NC	0.011
Iron																									
Combined:	23	10	43.5	0.250	0.0300	0.0250	0.0200	0.0466	0.0530	22	9	40.9	0.140	0.0300	0.0250	0.0200	0.0374	0.0298	Kaplan-Meier	0.0526	Kaplan-Meier	0.0892	0.105	**0.112**	0.158
Magnesium																									
Combined:	46	46	100	19.0	3.44	NA	NA	10.2	3.42	46	46	100	19.0	3.44	NA	NA	10.2	3.42	Normal	11.1	Normal	16.0	17.3	**20.2**	82
Manganese																									
Combined:	21	21	100	0.164	0.000600	NA	NA	0.0251	0.0348	20	20	100	0.048	0.000600	NA	NA	0.0182	0.0145	Normal	0.0238	Normal	0.0438	0.0529	**0.0552**	0.050
Molybdenum																									
Combined:	15	0	0	ND	ND	0.0100	0.0100	0.0100	1.76E-10	15	0	0	ND	ND	**0.0100**	0.0100	0.0100	1.76E-10	NA	NC	NA	NC	NC	NC	0.078
Nickel																									
Combined:	44	38	86.4	0.00390	0.000400	0.000600	0.000200	0.00131	0.000821	41	35	85.4	0.00221	0.000400	0.000600	0.000200	0.00115	0.000553	Kaplan-Meier	0.00129	Kaplan-Meier	0.00206	0.00228	**0.00270**	0.052

Table 4-9
Summary Statistics for Background Metals in Surface Water

	Uncensored Data									Censored Data															
Constituent [a]	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Mean Concentration (mg/L)	Standard Deviation (mg/L)	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Mean Concentration (mg/L)	Standard Deviation (mg/L)	Statistical Method for 95% UCL	95% UCL [b] (mg/L)	Statistical Method for 95% UPL and 95/95 UTL	95% UPL [b] (mg/L)	95/95 UTL [b] (mg/L)	95% USL [c] (mg/L)	Lower of COPC or COPEC Screening Criteria [d] (mg/L)
Potassium																									
Combined:	44	43	97.7	9.07	0.300	0.300	0.300	1.46	1.51	41	40	97.6	2.30	0.300	0.300	0.300	1.13	0.658	Kaplan-Meier	1.58	Kaplan-Meier	2.24	2.50	**3.00**	53
Selenium																									
Combined:	45	5	11.1	0.00100	0.000520	0.00100	0.00100	0.000916	0.000183	45	5	11.1	0.00100	0.000520	0.00100	0.00100	0.000916	0.000183	Kaplan-Meier	0.000579	Kaplan-Meier	0.000679	0.000708	**0.000772**	0.0050
Silver																									
Combined:	15	0	0	ND	ND	0.0100	0.0100	0.0100	1.76E-10	15	0	0	ND	ND	**0.0100**	0.0100	0.0100	1.76E-10	NA	NC	NA	NC	NC	NC	0.0034
Thallium																									
Combined:	15	4	26.7	0.000150	0.000100	0.000100	0.000100	0.000103	0.0000129	15	4	26.7	**0.000150**	0.000100	0.000100	0.000100	0.000103	0.0000129	NA	NC	NA	NC	NC	NC	0.00024
Uranium																									
Combined:	29	25	86.2	0.00120	0.000200	0.000100	0.000100	0.000429	0.000289	29	25	86.2	0.00120	0.000200	0.000100	0.000100	0.000429	0.000289	Kaplan-Meier	0.000529	Gamma	0.00143	0.00200	**0.00118**	0.0026
Vanadium																									
Combined:	46	25	54.3	0.0339	0.000300	0.00500	0.0000500	0.00246	0.00514	45	24	53.3	0.00620	0.000300	0.00500	0.0000500	0.00176	0.00200	Kaplan-Meier	0.00140	Kaplan-Meier	0.00330	0.00381	**0.00491**	0.020
Zinc																									
Combined:	42	20	47.6	0.0620	0.00200	0.0100	0.00200	0.00627	0.00950	41	19	46.3	0.0150	0.00200	0.0100	0.00200	0.00491	0.00360	Kaplan-Meier	0.00525	Kaplan-Meier	0.0104	0.0119	**0.0147**	0.12

Notes:

[a] Dissolved concentrations are presented for all constituents except for selenium, where total selenium concentrations are presented.

[b] 95% UCL, 95% UPL and 95/95 UTL values were calculated using ProUCL 4.1.01 (USEPA, 2011).

[c] 95% USL values were calculated using Scout 1.00.01 (USEPA, 2008). For analytes with a detection frequency below 100%, the 95% USL values were calculated using the Kaplan Meier method.

[d] Dissolved surface water screening criteria are presented for all constituents except for selenium, where total selenium surface water screening criteria are presented.

Boldface value indicates the proposed background level for a given metal. As described in Section 3.3, the 95% USL was selected as the proposed background level for datasets containing five or more detections. When a dataset contained fewer than five detections, the maximum detected concentration was proposed as the background level. If there were no detected results in a dataset, the maximum detection limit for non-detects was proposed as the background level.

% - percent
COPC - chemical of potential concern
COPEC - chemical of potential ecological concern
mg/L - milligram per liter
NA - not applicable
NC - not calculated
ND - non-detect
UCL - Upper Confidence Limit
UPL - Upper Prediction Limit
USL - Upper Simultaneous Limit
UTL - Upper Tolerance Limit

Table 4-10
Summary Statistics for Background Metals in Riparian Soil

	Uncensored Data							Censored Data														
Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Statistical Method for 95% UCL	95% UCL [a] (mg/kg)	Statistical Method for 95% UPL and 95/95 UTL	95% UPL [a] (mg/kg)	95/95 UTL [a] (mg/kg)	95% USL [b] (mg/kg)	Lower of COPC or COPEC Screening Criteria (mg/kg)
Antimony																					
Combined:	8	4	50.0	5.50	4.60	4.69	1.13	8	4	50	**5.50**	4.60	4.69	1.13	NA	NC	NA	NC	NC	NC	0.27
Arsenic																					
Combined:	8	8	100	5.44	2.78	3.70	1.10	8	8	100	5.44	2.78	3.70	1.10	Normal	4.43	Non-parametric	5.44	5.44	**5.93**	0.39
Boron																					
Combined:	8	8	100	11.2	5.60	8.24	2.20	8	8	100	11.2	5.60	8.24	2.20	Normal	9.72	Normal	12.7	15.3	**12.7**	0.50
Cadmium																					
Combined:	17	17	100	4.40	0.600	2.36	1.08	17	17	100	4.40	0.600	2.36	1.08	Normal	2.81	Normal	4.29	5.03	**5.02**	0.36
Chromium, Total																					
Combined:	17	17	100	42.5	16.7	24.6	7.56	17	17	100	42.5	16.7	24.6	7.56	Gamma	27.9	Gamma	38.6	45.5	**43.3**	0.40
Cobalt																					
Combined:	8	8	100	10.1	4.48	6.79	2.18	8	8	100	10.1	4.48	6.79	2.18	Normal	8.25	Normal	11.2	13.7	**11.2**	2.3
Copper																					
Combined:	17	17	100	30.0	10.5	19.3	5.57	14	14	100	21.1	10.5	17.1	3.03	Normal	18.5	Normal	22.7	25.0	**24.3**	28
Manganese																					
Combined:	8	8	100	1,080	124	430	336	8	8	100	1,080	124	430	336	Normal	655	Normal	1,104	1,500	**1,112**	180
Molybdenum																					
Combined:	17	7	41.2	1.70	0.430	0.498	0.359	16	6	38	0.700	0.430	0.423	0.188	Kaplan-Meier	0.508	Kaplan-Meier	0.605	0.659	**0.653**	2.0
Nickel																					
Combined:	17	17	100	26.6	10.4	18.2	4.60	17	17	100	26.6	10.4	18.2	4.60	Normal	20.2	Normal	26.5	29.7	**29.6**	38
Selenium																					
Combined:	17	13	76.5	1.80	0.500	0.921	0.463	17	13	76	1.80	0.500	0.921	0.463	Kaplan-Meier	1.12	Normal	1.84	2.22	**2.03**	0.52
Thallium																					
Combined:	8	8	100	0.428	0.160	0.259	0.111	8	8	100	0.428	0.160	0.259	0.111	Normal	0.333	Normal	0.481	0.611	**0.483**	0.078
Uranium																					
Combined:	8	8	100	3.76	1.60	2.44	0.694	8	8	100	3.76	1.60	2.44	0.694	Normal	2.91	Normal	3.84	4.65	**3.85**	5.0

Table 4-10
Summary Statistics for Background Metals in Riparian Soil

	Uncensored Data							Censored Data													
Constituent	**Number of Samples**	**Number of Detections**	**Detection Frequency (%)**	**Maximum Detected Concentration (mg/kg)**	**Minimum Detected Concentration (mg/kg)**	**Mean Concentration (mg/kg)**	**Standard Deviation (mg/kg)**	**Number of Samples**	**Number of Detections**	**Detection Frequency (%)**	**Maximum Detected Concentration (mg/kg)**	**Minimum Detected Concentration (mg/kg)**	**Mean Concentration (mg/kg)**	**Standard Deviation (mg/kg)**	**Statistical Method for 95% UCL**	**95% UCL [a] (mg/kg)**	**Statistical Method for 95% UPL and 95/95 UTL**	**95% UPL [a] (mg/kg)**	**95/95 UTL [a] (mg/kg)**	**95% USL [b] (mg/kg)**	**Lower of COPC or COPEC Screening Criteria (mg/kg)**
Vanadium																					
Combined:	17	17	100	57.3	22.9	32.6	10.2	17	17	100	57.3	22.9	32.6	10.2	Gamma	37.0	Gamma	51.3	60.6	**57.9**	2.0
Zinc																					
Combined:	17	17	100	158	42.0	104	31.0	17	17	100	158	42.00	104	31.0	Normal	117	Normal	159	181	**180**	46

Notes:

[a] 95% UCL, 95% UPL and 95/95 UTL values were calculated using ProUCL 4.1.01 (USEPA, 2011).

[b] 95% USL values were calculated using Scout 1.00.01 (USEPA, 2008). For analytes with a detection frequency below 100%, the 95% USL values were calculated using the Kaplan Meier method.

Boldface value indicates the proposed background level for a given metal. As described in Section 3.3, the 95% USL was selected as the proposed background level for datasets containing five or more detections. When a dataset contained fewer than five detections, the maximum detected concentration was proposed as the background level. If there were no detected results in a dataset, the maximum detection limit for non-detects was proposed as the background level.

% - percent
COPC - chemical of potential concern
COPEC - chemical of potential ecological concern
mg/kg - milligram per kilogram
NA - not applicable
NC - not calculated
UCL - Upper Confidence Limit
UPL - Upper Prediction Limit
USL - Upper Simultaneous Limit
UTL - Upper Tolerance Limit

Table 4-11

Summary Statistics for Background Metals in Riparian Vegetation

	Uncensored Data							Censored Data												
Constituent	**Number of Samples**	**Number of Detections**	**Detection Frequency (%)**	**Maximum Detected Concentration (mg/kg)**	**Minimum Detected Concentration (mg/kg)**	**Mean Concentration (mg/kg)**	**Standard Deviation (mg/kg)**	**Number of Samples**	**Number of Detections**	**Detection Frequency (%)**	**Maximum Detected Concentration (mg/kg)**	**Minimum Detected Concentration (mg/kg)**	**Mean Concentration (mg/kg)**	**Standard Deviation (mg/kg)**	**Statistical Method [a]**	**95% UCL [b] (mg/kg)**	**95% UPL [b] (mg/kg)**	**95/95 UTL [b] (mg/kg)**	**95% USL [c] (mg/kg)**	**Vegetation Screening Criteria [d] (mg/kg)**
Cadmium																				
Combined:	9	9	100	0.900	0.100	0.316	0.274	9	9	100	0.900	0.100	0.316	0.274	Gamma	0.552	0.958	1.63	**0.893**	10
Molybdenum																				
Combined:	9	9	100	2.58	0.630	1.30	0.734	9	9	100	2.58	0.630	1.30	0.734	Normal	1.76	2.74	3.53	**2.85**	5.0
Selenium																				
Combined:	9	1	11	0.800	0.800	0.533	0.100	9	1	11	**0.800**	0.800	0.533	0.100	NA	NC	NC	NC	NC	5.0

Notes:

[a] Statistical method for 95% UCL, 95% UPL and 95/95 UTL.

[b] 95% UCL, 95% UPL and 95/95 UTL values were calculated using ProUCL 4.1.01 (USEPA, 2011). The Kaplan-Meier statistical method was used to calculate the upper limits when multiple detection limits are present in the dataset.

[c] 95% USL values were calculated using Scout 1.00.01 (USEPA, 2008). For analytes with a detection frequency below 100%, the 95% USL values were calculated using the Kaplan Meier method.

[d] Table 2-1 of Mineral tolerance of animals, second revised edition, 2005 National Research Council, published by the National Academic Press, Washington, DC.

Boldface value indicates the proposed background level for a given metal. As described in Section 3.3, the 95% USL was selected as the proposed background level for datasets containing five or more detections. When a dataset contained fewer than five detections, the maximum detected concentration was proposed as the background level. If there were no detected results in a dataset, the maximum detection limit for non-detects was proposed as the background level.

% - percent
mg/kg - milligram per kilogram
NA - not applicable
NC - not calculated
UCL - Upper Confidence Limit
UPL - Upper Prediction Limit
USL - Upper Simultaneous Limit
UTL - Upper Tolerance Limit

Table 4-12
Summary Statistics for Background Metals in Upland Soil

	Uncensored Data							Censored Data													
Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Statistical Method for 95% UCL	95% UCL [a] (mg/kg)	Statistical Method for 95% UPL and 95/95 UTL	95% UPL [a] (mg/kg)	95/95 UTL [a] (mg/kg)	95% USL [b] (mg/kg)	Lower of COPC or COPEC Screening Criteria (mg/kg)
Antimony																					
Combined:	30	10	33.3	0.854	0.419	0.458	0.142	30	10	33.3	0.854	0.419	0.458	0.142	Kaplan-Meier	0.499	Kaplan-Meier	0.641	0.691	**0.745**	0.27
Arsenic																					
Combined:	30	30	100	9.01	2.550	5.57	2.15	30	30	100	9.01	2.55	5.57	2.15	Gamma	6.35	Gamma	10.0	11.8	**11.5**	0.39
Boron																					
Combined:	30	29	96.7	22.3	1.920	8.88	6.34	30	29	96.7	22.3	1.92	8.88	6.34	Kaplan-Meier	13.9	Gamma	25.7	34.2	**26.0**	0.50
Cadmium																					
Combined:	30	30	100	9.66	0.538	2.27	2.31	30	30	100	9.66	0.538	2.27	2.31	Non-Parametric	4.11	Non-Parametric	9.24	9.66	**8.61**	0.36
Chromium, total																					
Combined:	30	30	100	44.8	9.87	20.1	8.23	28	28	100	32.1	9.87	18.4	5.27	Normal	20.1	Normal	27.5	30.2	**32.7**	0.40
Cobalt																					
Combined:	30	30	100	13.3	3.37	8.63	3.31	30	30	100	13.3	3.37	8.63	3.31	Gamma	9.88	Gamma	15.8	18.6	**17.7**	2.3
Copper																					
Combined:	30	30	100	30.6	8.60	18.6	6.89	30	30	100	30.6	8.60	18.6	6.89	Normal	20.8	Non-Parametric	29.6	30.6	**37.5**	28
Manganese																					
Combined:	30	30	100	3,990	337	1,595	1,093	30	30	100	3,990	337	1,595	1,093	Non-Parametric	2,465	Non-Parametric	3,699	3,990	**4,595**	180
Mercury																					
Combined:	30	30	100	0.0746	0.0150	0.0289	0.0117	29	29	100	0.0507	0.0150	0.0273	0.00805	Normal	0.0298	Lognormal	0.0418	0.0478	**0.0493**	0.10
Molybdenum																					
Combined:	30	2	6.67	3.45	1.620	1.21	0.433	30	2	6.67	**3.45**	1.62	1.21	0.433	NA	NC	NA	NC	NC	NC	2.0
Nickel																					
Combined:	30	30	100	63.2	12.5	23.0	9.55	29	29	100	32.2	12.5	21.7	5.90	Normal	23.5	Non-Parametric	30.3	32.2	**37.8**	38
Selenium																					
Combined:	30	30	100	6.89	0.250	0.918	1.19	29	29	100	2.00	0.250	0.712	0.397	Gamma	0.841	Gamma	1.43	1.73	**1.80**	0.52
Silver																					
Combined:	30	22	73.3	0.423	0.0703	0.163	0.0841	29	21	72.4	0.251	0.0703	0.154	0.0695	Kaplan-Meier	0.132	Kaplan-Meier	0.185	0.205	**0.225**	4.2
Thallium																					
Combined:	30	30	100	0.481	0.118	0.182	0.0704	29	29	100	0.293	0.118	0.171	0.0428	Normal	0.185	Non-Parametric	0.293	0.293	**0.288**	0.078

Table 4-12
Summary Statistics for Background Metals in Upland Soil

	Uncensored Data							Censored Data													
Constituent	**Number of Samples**	**Number of Detections**	**Detection Frequency (%)**	**Maximum Detected Concentration (mg/kg)**	**Minimum Detected Concentration (mg/kg)**	**Mean Concentration (mg/kg)**	**Standard Deviation (mg/kg)**	**Number of Samples**	**Number of Detections**	**Detection Frequency (%)**	**Maximum Detected Concentration (mg/kg)**	**Minimum Detected Concentration (mg/kg)**	**Mean Concentration (mg/kg)**	**Standard Deviation (mg/kg)**	**Statistical Method for 95% UCL**	**95% UCL [a] (mg/kg)**	**Statistical Method for 95% UPL and 95/95 UTL**	**95% UPL [a] (mg/kg)**	**95/95 UTL [a] (mg/kg)**	**95% USL [b] (mg/kg)**	**Lower of COPC or COPEC Screening Criteria (mg/kg)**
Uranium, total																					
Combined:	30	26	86.7	10.2	0.395	1.56	2.38	26	22	84.6	1.61	0.395	0.762	0.316	Kaplan-Meier	0.875	Kaplan-Meier	1.31	1.48	**1.61**	5.0
Vanadium																					
Combined:	30	30	100	52.2	10.7	22.8	8.16	29	29	100	36.8	10.7	21.7	6.08	Normal	23.7	Normal	32.3	35.3	**38.4**	2.0
Zinc																					
Combined:	30	30	100	241	57.7	103	37.2	29	29	100	148	57.7	98.5	27.1	Normal	107	Normal	145	159	**173**	46

Notes:

[a] 95% UCL, 95% UPL and 95/95 UTL values were calculated using ProUCL 4.1.01 (USEPA, 2011).

[b] 95% USL values were calculated using Scout 1.00.01 (USEPA, 2008). For analytes with a detection frequency below 100%, the 95% USL values were calculated using the Kaplan Meier method.

Boldface value indicates the proposed background level for a given metal. As described in Section 3.3, the 95% USL was selected as the proposed background level for datasets containing five or more detections. When a dataset contained fewer than five detections, the maximum detected concentration was proposed as the background level. If there were no detected results in a dataset, the maximum detection limit for non-detects was proposed as the background level.

% - percent
COPC - chemical of potential concern
COPEC - chemical of potential ecological concern
mg/kg - milligram per kilogram
UCL - Upper Confidence Limit
UPL - Upper Prediction Limit
USL - Upper Simultaneous Limit
UTL - Upper Tolerance Limit

Table 4-13
Summary Statistics for Background Metals in Upland Vegetation

Constituent / Plant Type	Plant Type [a]	Uncensored Data: Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Censored Data: Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Statistical Method for 95% UCL	95% UCL [b] (mg/kg)	Statistical Method for 95% UPL and 95/95 UTL	95% UPL [b] (mg/kg)	95/95 UTL [b] (mg/kg)	95% USL [c] (mg/kg)	Vegetation Screening Criteria (mg/kg)
Antimony																										
Combined:																										
	Culturally Significant	76	0	0	ND	ND	8.62	0.464	0.744	1.07	76	0	0	ND	ND	**8.62**	0.464	0.744	1.07	NA	NC	NA	NC	NC	NC	
	Non-Culturally Significant	84	1	1.19	5.41	5.41	1.61	0.468	0.629	0.565	84	1	1.19	**5.41**	5.41	1.61	0.468	0.629	0.565	NA	NC	NA	NC	NC	NC	- -
	Combined	160	1	0.625	5.41	5.41	8.62	0.464	0.684	0.844	160	1	0.625	**5.41**	5.41	8.62	0.464	0.684	0.844	NA	NC	NA	NC	NC	NC	
Boron																										
Combined:																										
	Culturally Significant	76	75	98.7	364	6.32	43.1	43.1	26.4	40.9	75	74	98.7	52.0	6.32	43.1	43.1	21.9	11.7	Kaplan-Meier	23.9	Gamma	43.5	49.0	**57.1**	
	Non-Culturally Significant	84	81	96.4	68.3	2.76	8.06	2.50	20.2	12.8	84	81	96.4	68.3	2.76	8.06	2.50	20.2	12.8	Kaplan-Meier	22.5	Kaplan-Meier	41.5	45.1	**60.4**	150
	Combined	160	156	97.5	364	2.76	43.1	2.50	23.2	29.7	159	155	97.5	68.3	2.76	43.1	2.50	21.0	12.3	Kaplan-Meier	22.5	Kaplan-Meier	41.0	43.5	**61.7**	
Cadmium																										
Combined:																										
	Culturally Significant	76	69	90.8	1.95	0.0262	0.0248	0.0225	0.367	0.514	76	69	90.8	1.95	0.0262	0.0248	0.0225	0.367	0.514	Kaplan-Meier	0.624	Kaplan-Meier	1.22	1.37	**1.96**	
	Non-Culturally Significant	84	79	94.0	2.52	0.0248	0.0496	0.0234	0.302	0.373	83	78	94.0	1.58	0.0248	0.0496	0.0234	0.275	0.283	Kaplan-Meier	0.410	Kaplan-Meier	0.745	0.824	**1.16**	10
	Combined	160	148	92.5	2.52	0.0248	0.0496	0.0225	0.333	0.445	159	147	92.5	1.95	0.0248	0.0496	0.0225	0.319	0.411	Kaplan-Meier	0.461	Kaplan-Meier	0.999	1.08	**1.70**	
Mercury																										
Combined:																										
	Culturally Significant	70	12	17.1	0.0876	0.00946	0.0487	0.00867	0.0192	0.0161	70	12	17.1	0.0876	0.00946	0.0487	0.00867	0.0192	0.0161	Kaplan-Meier	0.0175	Kaplan-Meier	0.0796	0.0439	**0.0602**	
	Non-Culturally Significant	75	10	13.3	0.0589	0.0117	0.0498	0.00921	0.0179	0.0115	75	10	13.3	0.0589	0.0117	0.0498	0.00921	0.0179	0.0115	Kaplan-Meier	0.0154	Kaplan-Meier	0.0261	0.0282	**0.0365**	- -
	Combined	145	22	15.2	0.0876	0.00946	0.0498	0.00867	0.0186	0.0139	145	22	15.2	0.0876	0.00946	0.0498	0.00867	0.0186	0.0139	Kaplan-Meier	0.0149	Kaplan-Meier	0.0328	0.0353	**0.0526**	
Molybdenum																										
Combined:																										
	Culturally Significant	76	10	13.2	24.4	1.54	25.9	1.39	2.69	4.19	74	8	10.8	2.71	1.54	25.9	1.39	2.29	3.25	Kaplan-Meier	1.65	Kaplan-Meier	1.97	2.04	**2.28**	
	Non-Culturally Significant	84	42	50.0	240	1.48	4.84	1.40	9.82	35.7	78	36	46.2	8.91	1.48	4.84	1.40	2.46	1.52	Kaplan-Meier	2.57	Kaplan-Meier	4.78	5.22	**6.95**	5
	Combined	160	52	32.5	240	1.48	25.9	1.39	6.43	26.2	152	44	28.9	8.91	1.48	25.9	1.39	2.38	2.51	Kaplan-Meier	2.09	Kaplan-Meier	3.84	4.08	**5.78**	
Selenium																										
Combined:																										
	Culturally Significant	76	67	88.2	3.18	0.0992	0.379	0.0933	0.398	0.457	76	67	88.2	3.18	0.0992	0.379	0.0933	0.398	0.457	Kaplan-Meier	0.493	Kaplan-Meier	1.16	1.29	**1.81**	
	Non-Culturally Significant	84	74	88.1	7.28	0.109	0.198	0.0911	0.693	1.08	84	74	88.1	7.28	0.109	0.198	0.0911	0.693	1.08	Kaplan-Meier	0.920	Kaplan-Meier	2.49	2.79	**4.07**	5
	Combined	160	141	88.1	7.28	0.0992	0.379	0.0911	0.553	0.853	160	141	88.1	7.28	0.0992	0.379	0.0911	0.553	0.853	Kaplan-Meier	0.662	Kaplan-Meier	1.96	2.13	**3.41**	
Silver																										
Combined:																										
	Culturally Significant	76	8	10.5	38.2	0.0925	0.189	0.0433	0.701	4.52	74	6	8.11	0.299	0.0925	0.189	0.0433	0.0620	0.0458	Kaplan-Meier	0.106	Kaplan-Meier	0.155	0.165	**0.203**	
	Non-Culturally Significant	84	13	15.5	0.598	0.0505	0.245	0.0447	0.0703	0.0767	84	13	15.5	0.598	0.0505	0.245	0.0447	0.0703	0.0767	Kaplan-Meier	0.0827	Kaplan-Meier	0.192	0.212	**0.300**	- -
	Combined	160	21	13.1	38.2	0.0505	0.245	0.0433	0.370	3.12	158	19	12.0	0.598	0.0505	0.245	0.0433	0.0665	0.0640	Kaplan-Meier	0.0732	Kaplan-Meier	0.166	0.178	**0.270**	
Thallium																										
Combined:																										
	Culturally Significant	76	1	1.3	0.0117	0.0117	0.0379	0.00867	0.0104	0.00362	76	1	1.32	**0.0117**	0.0117	0.0379	0.00867	0.0104	0.00362	NA	NC	NA	NC	NC	NC	
	Non-Culturally Significant	84	6	7.14	0.0257	0.0109	0.0490	0.00894	0.0108	0.00492	84	6	7.14	0.0257	0.0109	0.0490	0.00894	0.0108	0.00492	Kaplan-Meier	0.0117	Kaplan-Meier	0.0148	0.0154	**0.0179**	- -
	Combined	160	7	4.38	0.0257	0.0109	0.0490	0.00867	0.0106	0.00435	160	7	4.38	0.0257	0.0109	0.0490	0.00867	0.0106	0.00435	Kaplan-Meier	0.0113	Kaplan-Meier	0.0137	0.0140	**0.0163**	

Table 4-13
Summary Statistics for Background Metals in Upland Vegetation

Constituent / Plant Type	Plant Type [a]	Uncensored Data: Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Censored Data: Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	Statistical Method for 95% UCL	95% UCL [b] (mg/kg)	Statistical Method for 95% UPL and 95/95 UTL	95% UPL [b] (mg/kg)	95/95 UTL [b] (mg/kg)	95% USL [c] (mg/kg)	Vegetation Screening Criteria (mg/kg)
Uranium, total																										
Combined:																										
	Culturally Significant	76	2	2.63	0.162	0.101	0.379	0.0867	0.104	0.0368	76	2	2.63	**0.162**	0.101	0.379	0.0867	0.104	0.0368	NA	NC	NA	NC	NC	NC	
	Non-Culturally Significant	84	1	1.19	0.108	0.108	0.490	0.0894	0.104	0.0441	84	1	1.19	**0.108**	0.108	0.490	0.0894	0.104	0.0441	NA	NC	NA	NC	NC	NC	- -
	Combined	160	3	1.88	0.162	0.101	0.490	0.0867	0.104	0.0407	160	3	1.88	**0.162**	0.101	0.490	0.0867	0.104	0.0407	NA	NC	NA	NC	NC	NC	

Notes:

[a] Plant species that were identified as culturally significant species by the A/Ts are summarized in Section 3.2 of Appendix A2 of the RI/FS Work Plan.

[b] 95% UPL and 95/95 UTL values were calculated using ProUCL 4.1.01 (USEPA, 2011). As recommended by ProUCL 4.1.01, the Kaplan-Meier method was preferred when the data set contains multiple detection limits.

[c] 95% USL values were calculated using Scout 1.00.01 (USEPA, 2008). For analytes with a detection frequency below 100%, the 95% USL values were calculated using the Kaplan Meier method.

Boldface value indicates the proposed background level for a given metal. As described in Section 3.3, the 95% USL was selected as the proposed background level for datasets containing five or more detections. When a dataset contained fewer than five detections, the maximum detected concentration was proposed as the background level. If there were no detected results in a dataset, the maximum detection limit for non-detects was proposed as the background level.

% - percent
"- -" - not available
mg/kg - milligram per kilogram
NA - not applicable
NC - not calculated
ND - non-detect
UPL - Upper Prediction Limit
USL - Upper Simultaneous Limit
UTL - Upper Tolerance Limit

Table 4-14
Summary Statistics for Background Metals in Groundwater

	Uncensored Data									Censored Data															
Constituent[a]	Number of Samples	Number of Detections[a]	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Mean Concentration (mg/L)	Standard Deviation (mg/L)	Number of Samples	Number of Detections[a]	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Mean Detected Concentration (mg/L)	Standard Deviation (mg/L)	Statistical Method for 95% UCL	95% UCL[b] (mg/L)	Statistical Method for 95% UPL and 95/95 UTL	95% UPL[b] (mg/L)	95/95 UTL[b] (mg/L)	95% USL[c] (mg/L)	Human Health COPC Screening Criteria[d] (mg/L)
Arsenic																									
Shallow:	4	2	50.0	0.000815	0.000600	0.000500	0.000500	0.000604	0.000149	4	2	50.0	**0.000815**	0.000600	0.000500	0.000500	0.000604	0.000149	NA	NC	NA	NA	NC	NC	
Intermediate:	3	2	66.7	0.0149	0.000989	0.000500	0.000500	0.00546	0.00818	3	2	66.7	**0.0149**	0.000989	0.000500	0.000500	0.00546	0.00818	NA	NC	NA	NA	NC	NC	0.000045
Deep:	3	3	100	0.0267	0.000266	NA	NA	0.00914	0.0152	3	3	100	**0.0267**	0.000266	NA	NA	0.00914	0.0152	NA	NC	NA	NA	NC	NC	
Combined:	10	7	70.0	0.0267	0.000266	0.000500	0.000500	0.00462	0.00897	8	5	62.5	0.000989	0.000266	0.000500	0.000500	0.000578	0.000226	Kaplan-Meier	0.000723	Normal	0.00113	0.00132	**0.00103**	
Cadmium																									
Shallow:	19	5	26.3	0.000522	0.000200	0.000300	0.000100	0.000194	0.000122	19	5	26.3	0.000522	0.000200	0.000300	0.000100	0.000194	0.000122	Kaplan-Meier	0.000274	Kaplan-Meier	0.000392	0.000449	**0.000458**	
Intermediate:	11	1	9.09	0.000400	0.000400	0.000300	0.000100	0.000173	0.000107	11	1	9.09	**0.000400**	0.000400	0.000300	0.000100	0.000173	0.000107	NA	NC	NA	NA	NC	NC	0.0069
Deep:	8	0	0	ND	ND	0.000300	0.000125	0.000169	0.0000810	8	0	0	ND	ND	**0.000300**	0.000125	0.000169	0.0000810	NA	NC	NA	NA	NC	NC	
Combined:	52	7	13.5	0.00160	0.000200	0.000300	0.000100	0.000201	0.000220	51	6	11.8	0.000522	0.000200	0.000300	0.000100	0.000174	0.0000974	Kaplan-Meier	0.000233	Kaplan-Meier	0.000322	0.000344	**0.000401**	
Chromium, total																									
Shallow:	12	8	66.7	0.0224	0.000400	0.00100	0.000200	0.00386	0.00652	10	6	60.0	0.00474	0.000400	0.00100	0.000200	0.00136	0.00149	Kaplan-Meier	0.00224	Kaplan-Meier	0.00405	0.00544	**0.00441**	
Intermediate:	8	8	100	0.00524	0.000300	NA	NA	0.00236	0.00172	8	8	100	0.00524	0.000300	NA	NA	0.00236	0.00172	Normal	0.00351	Normal	0.00582	0.00785	**0.00586**	0.000031
Deep:	6	6	100	0.00442	0.00154	NA	NA	0.002598	0.000999	6	6	100	0.00442	0.00154	NA	NA	0.00260	0.000999	Normal	0.00342	Normal	0.00477	0.00630	**0.00442**	
Combined:	34	28	82.4	0.0224	0.000200	0.00100	0.00020	0.00269	0.00405	32	26	81.3	0.00524	0.000200	0.00100	0.00020	0.00184	0.00152	Kaplan-Meier	0.00232	Kaplan-Meier	0.00444	0.00514	**0.00604**	
Cobalt																									
Shallow:	4	0	0	ND	ND	0.0100	0.000500	0.00763	0.00475	4	0	0	ND	ND	**0.0100**	0.000500	0.00763	0.00475	NA	NC	NA	NA	NC	NC	
Intermediate:	3	0	0	ND	ND	0.01000	0.00025	0.00358	0.00556	3	0	0	ND	ND	**0.0100**	0.000250	0.00358	0.00556	NA	NC	NA	NA	NC	NC	0.0047
Deep:	3	2	66.7	0.000436	0.000281	0.000250	0.000250	0.000322	0.000100	3	2	66.7	**0.000436**	0.000281	0.000250	0.000250	0.000322	0.000100	NA	NC	NA	NA	NC	NC	
Combined:	10	2	20.0	0.0004	0.000281	0.0100	0.0003	0.00422	0.00497	10	2	20.0	**0.000436**	0.000281	0.0100	0.000250	0.00422	0.00497	NA	NC	NA	NA	NC	NC	
Lead																									
Shallow:	4	3	75.0	0.00120	0.000400	0.000100	0.000100	0.000561	0.000464	4	3	75.0	**0.00120**	0.000400	0.000100	0.000100	0.000561	0.000464	NA	NC	NA	NA	NC	NC	
Intermediate:	3	2	66.7	0.00150	0.000523	0.000250	0.000250	0.000758	0.000657	3	2	66.7	**0.00150**	0.000523	0.000250	0.000250	0.000758	0.000657	NA	NC	NA	NA	NC	NC	0.015
Deep:	3	1	33.3	0.00432	0.00432	0.000250	0.000250	0.00161	0.00235	3	1	33.3	**0.00432**	0.00432	0.000250	0.000250	0.00161	0.00235	NA	NC	NA	NA	NC	NC	
Combined:	10	6	60.0	0.00432	0.000400	0.000250	0.000100	0.000934	0.00127	9	5	55.6	0.00150	0.000400	0.000250	0.000100	0.000557	0.000477	Kaplan-Meier	0.000911	Kaplan-Meier	0.00140	0.00182	**0.00146**	
Manganese																									
Shallow:	13	13	100	0.610	0.00130	NA	NA	0.192	0.199	13	13	100	0.610	0.00130	NA	NA	0.192	0.199	Normal	0.290	Normal	0.560	0.724	**0.656**	
Intermediate:	8	8	100	0.344	0.000600	NA	NA	0.0783	0.110	7	7	100	0.0699	0.000600	NA	NA	0.0403	0.0234	Normal	0.0575	Normal	0.0889	0.120	**0.0856**	0.32
Deep:	6	5	83.3	0.0923	0.00149	0.000500	0.000500	0.0381	0.0423	6	5	83.3	0.0923	0.00149	0.000500	0.000500	0.0381	0.0423	Kaplan-Meier	0.0736	Normal	0.131	0.199	**0.108**	
Combined:	34	33	97.1	0.915	0.000600	0.000500	0.000500	0.1310	0.205	32	31	96.9	0.456	0.000600	0.000500	0.000500	0.0915	0.1258	Kaplan-Meier	0.189	Gamma	0.367	0.542	**0.435**	
Molybdenum																									
Shallow:	4	0	0	ND	ND	0.0100	0.00500	0.00875	0.00250	4	0	0	ND	ND	**0.0100**	0.00500	0.00875	0.00250	NA	NC	NA	NA	NC	NC	
Intermediate:	3	1	33.3	0.0239	0.0239	0.01000	0.00500	0.0130	0.00979	3	1	33.3	**0.0239**	0.0239	0.0100	0.00500	0.0130	0.00979	NA	NC	NA	NA	NC	NC	0.078
Deep:	3	0	0	ND	ND	0.00500	0.00500	0.00500	8.23E-11	3	0	0	ND	ND	**0.00500**	0.00500	0.00500	8.23E-11	NA	NC	NA	NA	NC	NC	
Combined:	10	1	10.0	0.0239	0.0239	0.0100	0.0050	0.00889	0.00583	10	1	10.0	**0.0239**	0.0239	0.0100	0.00500	0.00889	0.00583	NA	NC	NA	NA	NC	NC	
Selenium																									
Shallow:	21	11	52.4	0.00500	0.000606	0.00100	0.00100	0.00153	0.000963	20	10	50.0	0.00267	0.000606	0.00100	0.00100	0.00135	0.000557	Kaplan-Meier	0.00144	Normal	0.00268	0.00330	**0.00292**	
Intermediate:	11	7	63.6	0.00577	0.000879	0.00100	0.000500	0.00158	0.00145	10	6	60.0	0.00200	0.000879	0.00100	0.000500	0.00116	0.000438	Kaplan-Meier	0.00141	Kaplan-Meier	0.00191	0.00230	**0.00201**	0.078
Deep:	8	6	75.0	0.00130	0.000683	0.000500	0.000500	0.000886	0.000301	8	6	75.0	0.00130	0.000683	0.000500	0.000500	0.000886	0.000301	Kaplan-Meier	0.00110	Normal	0.00156	0.00199	**0.00139**	
Combined:	54	29	53.7	0.00577	0.000606	0.00100	0.00050	0.00138	0.000935	52	27	51.9	0.00267	0.000606	0.00100	0.00050	0.00122	0.000498	Kaplan-Meier	0.00124	Kaplan-Meier	0.00206	0.00226	**0.00278**	
Thallium																									
Shallow:	4	1	25.0	0.000200	0.000200	0.000100	0.000100	0.000125	0.0000500	4	1	25.0	**0.000200**	0.000200	0.000100	0.000100	0.000125	0.0000500	NA	NC	NA	NA	NC	NC	
Intermediate:	3	0	0	ND	ND	0.000100	0.0000500	0.0000833	0.0000289	3	0	0	ND	ND	**0.000100**	0.0000500	0.0000833	0.0000289	NA	NC	NA	NA	NC	NC	0.00016
Deep:	3	1	33.3	0.0000538	0.0000538	0.0000500	0.0000500	0.0000513	0.00000219	3	1	33.3	**0.0000538**	0.0000538	0.0000500	0.0000500	0.0000513	0.00000219	NA	NC	NA	NA	NC	NC	
Combined:	10	2	20.0	0.000200	0.0000538	0.000100	0.000050	0.0000904	0.0000456	10	2	20.0	**0.000200**	0.0000538	0.000100	0.000050	0.0000904	0.0000456	NA	NC	NA	NA	NC	NC	

Table 4-14
Summary Statistics for Background Metals in Groundwater

	Uncensored Data									Censored Data															
Constituent[a]	Number of Samples	Number of Detections[a]	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Mean Concentration (mg/L)	Standard Deviation (mg/L)	Number of Samples	Number of Detections[a]	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Mean Detected Concentration (mg/L)	Standard Deviation (mg/L)	Statistical Method for 95% UCL	95% UCL[b] (mg/L)	Statistical Method for 95% UPL and 95/95 UTL	95% UPL[b] (mg/L)	95/95 UTL[b] (mg/L)	95% USL[c] (mg/L)	Human Health COPC Screening Criteria[d] (mg/L)
Vanadium																									
Shallow:	18	13	72.2	0.0147	0.000300	0.00500	0.000100	0.00395	0.00502	18	13	72.2	0.0147	0.000300	0.00500	0.000100	0.00395	0.00502	Kaplan-Meier	0.00881	Kaplan-Meier	0.0123	0.0156	**0.0159**	0.078
Intermediate:	10	5	50.0	0.0130	0.000200	0.00500	0.00020	0.00419	0.00400	10	5	50.0	0.0130	0.000200	0.00500	0.000200	0.00419	0.00400	Kaplan-Meier	0.00502	Kaplan-Meier	0.0102	0.0142	**0.0112**	
Deep:	6	0	0	ND	ND	0.00500	0.00500	0.00500	0	6	0	0	ND	ND	**0.00500**	0.00500	0.00500	0	NA	NC	NA	NA	NC	NC	
Combined:	48	29	60.4	0.0147	0.000200	0.0250	0.0001	0.00405	0.00488	48	29	60.4	0.0147	0.000200	0.0250	0.000100	0.00405	0.00488	Kaplan-Meier	0.00512	Kaplan-Meier	0.00909	0.0105	**0.0138**	
Zinc																									
Shallow:	18	16	88.9	0.326	0.00526	0.0125	0.00200	0.0536	0.0733	17	15	88.2	0.0870	0.00526	0.0125	0.00200	0.0376	0.0283	Kaplan-Meier	0.0495	Kaplan-Meier	0.0870	0.106	**0.106**	4.7
Intermediate:	10	7	70.0	0.699	0.0140	0.0125	0.0050	0.146	0.224	10	7	70.0	0.699	0.0140	0.0125	0.00500	0.146	0.224	Kaplan-Meier	0.282	Kaplan-Meier	0.554	0.763	**0.608**	
Deep:	6	2	33.3	0.111	0.00831	0.00500	0.00500	0.0232	0.0430	6	2	33.3	**0.111**	0.00831	0.00500	0.00500	0.0232	0.0430	NA	NC	NA	NC	NC	NC	
Combined:	48	38	79.2	21.3	0.00500	0.0125	0.0020	0.572	3.08	46	36	78.3	0.699	0.00500	0.0125	0.00200	0.0803	0.135	Kaplan-Meier	0.167	Kaplan-Meier	0.307	0.358	**0.471**	

Notes:

[a] Summary statistics for all constituents are based on total concentrations.

[b] 95% UCL, 95% UPL and 95/95 UTL values were calculated using ProUCL 4.1.01 (USEPA, 2011).

[c] 95% USL values were calculated using Scout 1.00.01 (USEPA, 2008). For analytes with a detection frequency below 100%, the 95% USL values were calculated using the Kaplan Meier method.

[d] Direct contact with groundwater by ecological receptors is incomplete (Figure C4-2); therefore, only human health groundwater screening criteria are presented. Total groundwater screening criteria are presented for all constituents.

Boldface value indicates the proposed background level for a given metal. As described in Section 3.3, the 95% USL was selected as the proposed background level for datasets containing five or more detections. When a dataset contained fewer than five detections, the maximum detected concentration was proposed as the background level. If there were no detected results in a dataset, the maximum detection limit for non-detects was proposed as the background level.

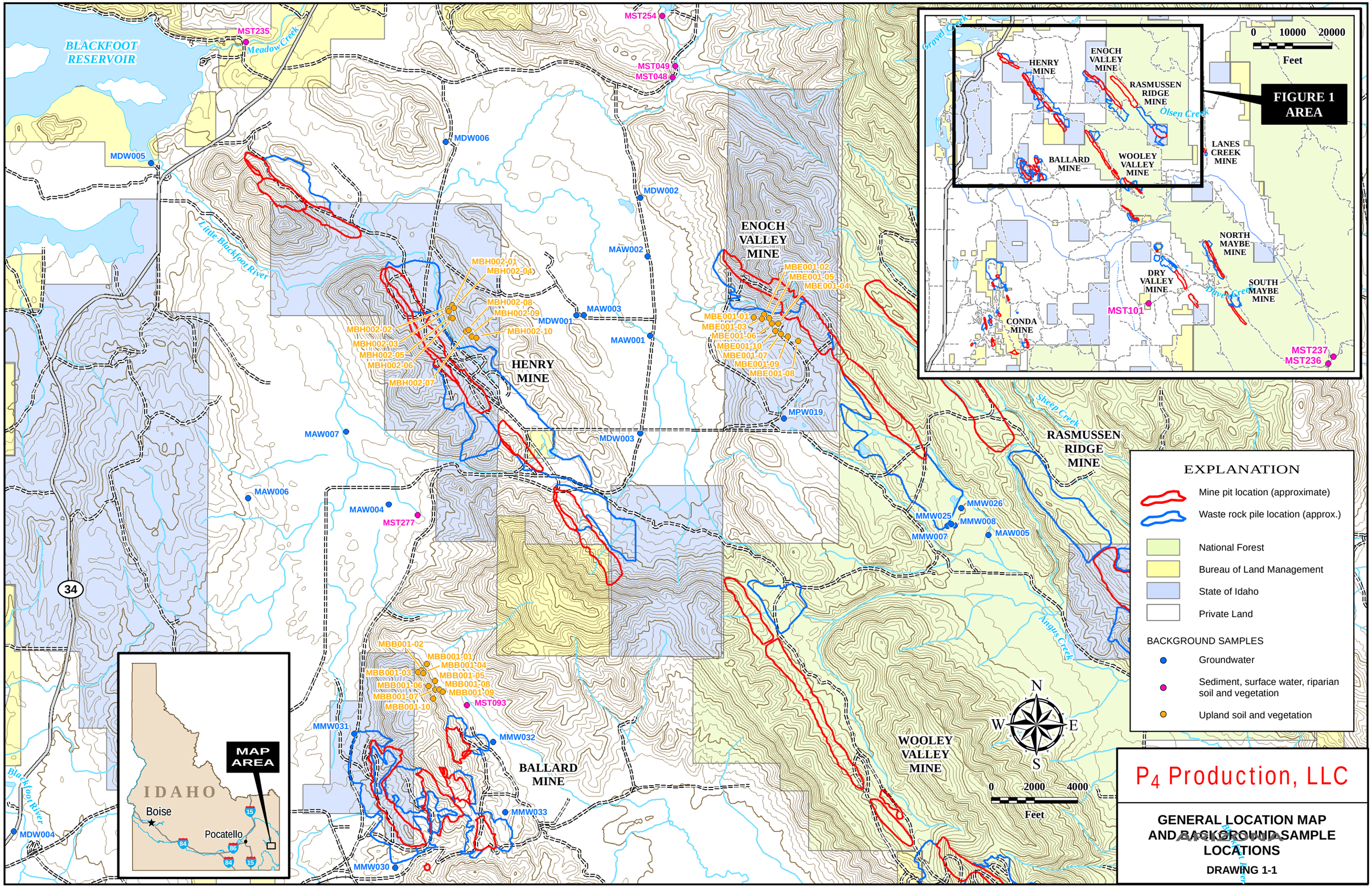
% - percent
COPC - chemical of potential concern
mg/L - milligram per liter
NA - not applicable
NC - not calculated
ND - not detected
UPL - Upper Prediction Limit
USL - Upper Simultaneous Limit
UTL - Upper Tolerance Limit

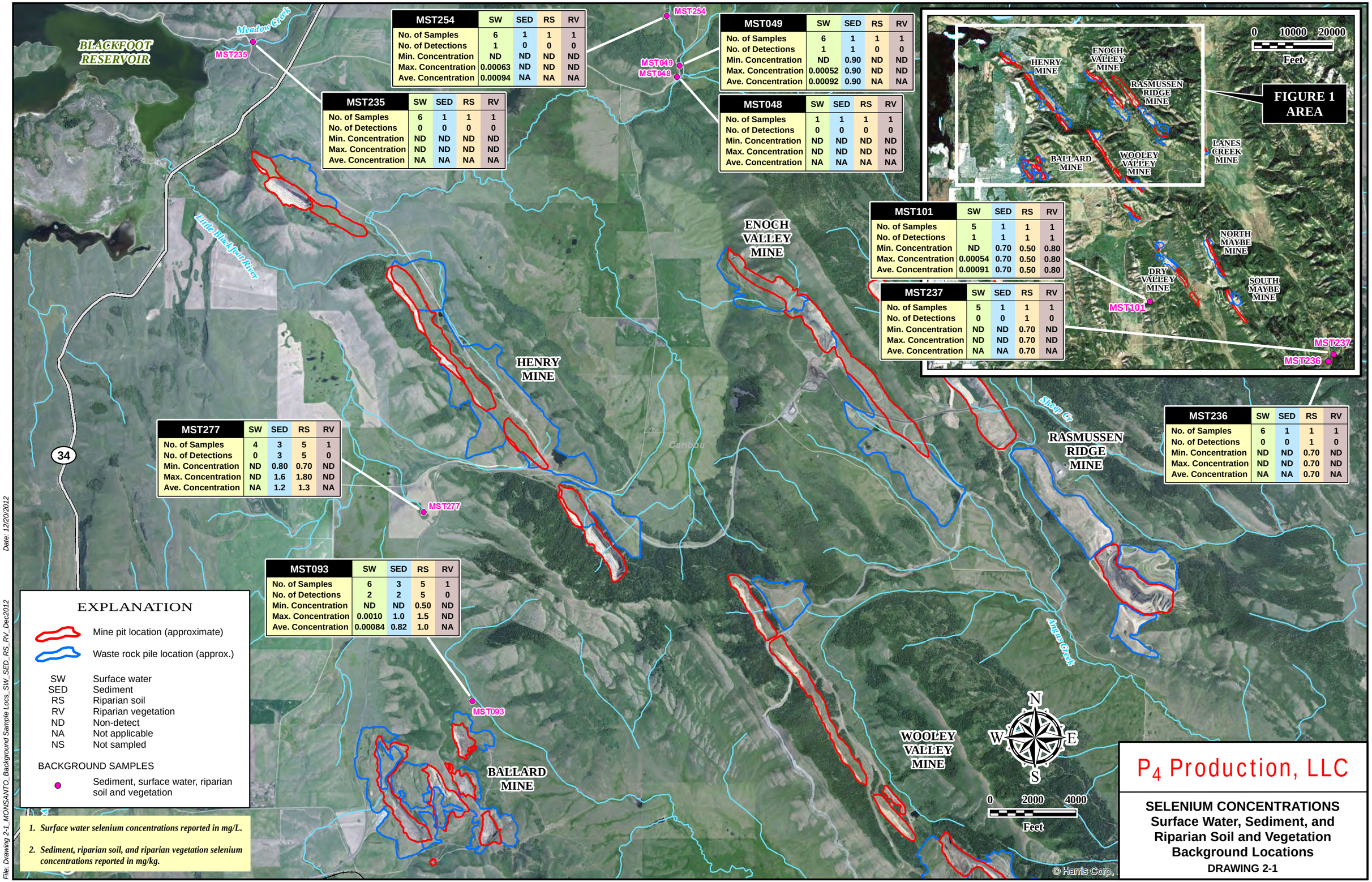
Table 4-15
Summary of Proposed Background Levels By Medium

Analyte	Sediment (mg/kg)	Surface Water (mg/L)	Riparian Soil (mg/kg)	Riparian Veg[1] (mg/kg)	Upland Soil (mg/kg)	Upland Veg[1,2] (mg/kg)	Groundwater[3] (mg/L)
Aluminum	NC	0.272	NC	NC	NC	NC	NC
Antimony	5.00	NC	5.50	NC	0.745	5.41	NC
Arsenic	4.55	0.00109	5.93	NC	11.5	NC	0.00103
Barium	NC	0.0953	NC	NC	NC	NC	NC
Beryllium	NC	0.00200	NC	NC	NC	NC	NC
Boron	8.40	0.0200	12.7	NC	26.0	61.7	NC
Cadmium	4.17	0.000100	5.02	0.893	8.61	1.70	0.000401
Calcium	NC	98.1	NC	NC	NC	NC	NC
Chromium, total	38.1	0.00284	43.3	NC	32.7	NC	0.00604
Cobalt	NC	0.0100	11.2	NC	17.7	NC	0.000436
Copper	25.5	0.0100	24.3	NC	37.5	NC	NC
Iron	NC	0.112	NC	NC	NC	NC	NC
Lead	NC	NC	NC	NC	NC	NC	0.00146
Magnesium	NC	20.2	NC	NC	NC	NC	NC
Manganese	405	0.0552	1,112	NC	4,595	NC	0.435
Mercury	0.0380	NC	NC	NC	0.0493	0.0526	NC
Molybdenum	0.500	0.0100	0.653	2.85	3.45	5.78	0.0239
Nickel	28.7	0.00270	29.6	NC	37.8	NC	NC
Potassium	NC	3.0	NC	NC	NC	NC	NC
Selenium	1.48	0.000772	2.03	0.800	1.80	3.41	0.00278
Silver	0.241	0.0100	NC	NC	0.225	0.270	NC
Thallium	0.378	0.000150	0.483	NC	0.288	0.0163	0.000200
Uranium	2.37	0.00118	3.85	NC	1.61	0.162	NC
Vanadium	49.1	0.00491	57.9	NC	38.4	NC	0.0138
Zinc	166	0.0147	180	NC	173	NC	0.471

Notes:
NC - not calculated per screening Tables 4-1 to 4-7
[1]Units are mg/kg dry weight
[2]Upland vegetation levels are for combined scenario. See Table 4-13 for culturally significant and non-culturally significant plant background levels
[3]Groundwater level are for combined scenario. See Table 4-14 for background levels by geologic/aquifer unit.

DRAWINGS


BLACKFOOT RESERVOIR
Meadow Creek
Little Blackfoot River
Blackfoot River
Sheep Creek
Angus Creek
Olsen Creek
Gravel Creek
Dry Creek
MST235
MST254
MST049
MST048
MDW005
MDW006
MDW002
MAW002
MAW003
MDW001
MAW001
MPW019
MDW003
MAW007
MAW006
MAW004
MST277
MDW004
MMW031
MMW032
MMW033
MMW030
MMW026
MMW025
MMW008
MMW007
MAW005
MST093
MST101
MST237
MST236
ENOCH VALLEY MINE
HENRY MINE
RASMUSSEN RIDGE MINE
BALLARD MINE
WOOLEY VALLEY MINE
LANES CREEK MINE
NORTH MAYBE MINE
SOUTH MAYBE MINE
DRY VALLEY MINE
CONDA MINE
MBH002-01
MBH002-04
MBH002-08
MBH002-09
MBH002-02
MBH002-03
MBH002-05
MBH002-06
MBH002-07
MBH002-10
MBE001-02
MBE001-05
MBE001-04
MBE001-01
MBE001-03
MBE001-06
MBE001-10
MBE001-07
MBE001-09
MBE001-08
MBB001-02
MBB001-01
MBB001-04
MBB001-03
MBB001-05
MBB001-06
MBB001-08
MBB001-07
MBB001-09
MBB001-10
34
0 10000 20000
Feet
FIGURE 1 AREA
MAP AREA
IDAHO
Boise
Pocatello
15
84
86
N
S
E
W
0 2000 4000
Feet
EXPLANATION
Mine pit location (approximate)
Waste rock pile location (approx.)
National Forest
Bureau of Land Management
State of Idaho
Private Land
BACKGROUND SAMPLES
Groundwater
Sediment, surface water, riparian soil and vegetation
Upland soil and vegetation
P4 Production, LLC
GENERAL LOCATION MAP AND BACKGROUND SAMPLE LOCATIONS
DRAWING 1-1
FILE J:\Industrial Projects\P4 Monsanto\Background Level Memo\FIGURES_Dec2012\Drawing 1-1_MONSANTO_Background Loc Map and Background Sample Locs_Dec2012.mxd
29 Nov 2012



MST254	SW	SED	RS	RV
No. of Samples	6	1	1	1
No. of Detections	1	0	0	0
Min. Concentration	ND	ND	ND	ND
Max. Concentration	0.00063	ND	ND	ND
Ave. Concentration	0.00094	NA	NA	NA

MST049	SW	SED	RS	RV
No. of Samples	6	1	1	1
No. of Detections	1	1	0	0
Min. Concentration	ND	0.90	ND	ND
Max. Concentration	0.00052	0.90	ND	ND
Ave. Concentration	0.00092	0.90	NA	NA

MST235	SW	SED	RS	RV
No. of Samples	6	1	1	1
No. of Detections	0	0	0	0
Min. Concentration	ND	ND	ND	ND
Max. Concentration	ND	ND	ND	ND
Ave. Concentration	NA	NA	NA	NA

MST048	SW	SED	RS	RV
No. of Samples	1	1	1	1
No. of Detections	0	0	0	0
Min. Concentration	ND	ND	ND	ND
Max. Concentration	ND	ND	ND	ND
Ave. Concentration	NA	NA	NA	NA

MST101	SW	SED	RS	RV
No. of Samples	5	1	1	1
No. of Detections	1	1	1	1
Min. Concentration	ND	0.70	0.50	0.80
Max. Concentration	0.00054	0.70	0.50	0.80
Ave. Concentration	0.00091	0.70	0.50	0.80

MST237	SW	SED	RS	RV
No. of Samples	5	1	1	1
No. of Detections	0	0	1	0
Min. Concentration	ND	ND	0.70	ND
Max. Concentration	ND	ND	0.70	ND
Ave. Concentration	NA	NA	0.70	NA

MST236	SW	SED	RS	RV
No. of Samples	6	1	1	1
No. of Detections	0	0	1	0
Min. Concentration	ND	ND	0.70	ND
Max. Concentration	ND	ND	0.70	ND
Ave. Concentration	NA	NA	0.70	NA

MST277	SW	SED	RS	RV
No. of Samples	4	3	5	1
No. of Detections	0	3	5	0
Min. Concentration	ND	0.80	0.70	ND
Max. Concentration	ND	1.6	1.80	ND
Ave. Concentration	NA	1.2	1.3	NA

MST093	SW	SED	RS	RV
No. of Samples	6	3	5	1
No. of Detections	2	2	5	0
Min. Concentration	ND	ND	0.50	ND
Max. Concentration	0.0010	1.0	1.5	ND
Ave. Concentration	0.00084	0.82	1.0	NA

EXPLANATION

Mine pit location (approximate)

Waste rock pile location (approx.)

SW	Surface water
SED	Sediment
RS	Riparian soil
RV	Riparian vegetation
ND	Non-detect
NA	Not applicable
NS	Not sampled

BACKGROUND SAMPLES

Sediment, surface water, riparian soil and vegetation

1. *Surface water selenium concentrations reported in mg/L.*
2. *Sediment, riparian soil, and riparian vegetation selenium concentrations reported in mg/kg.*

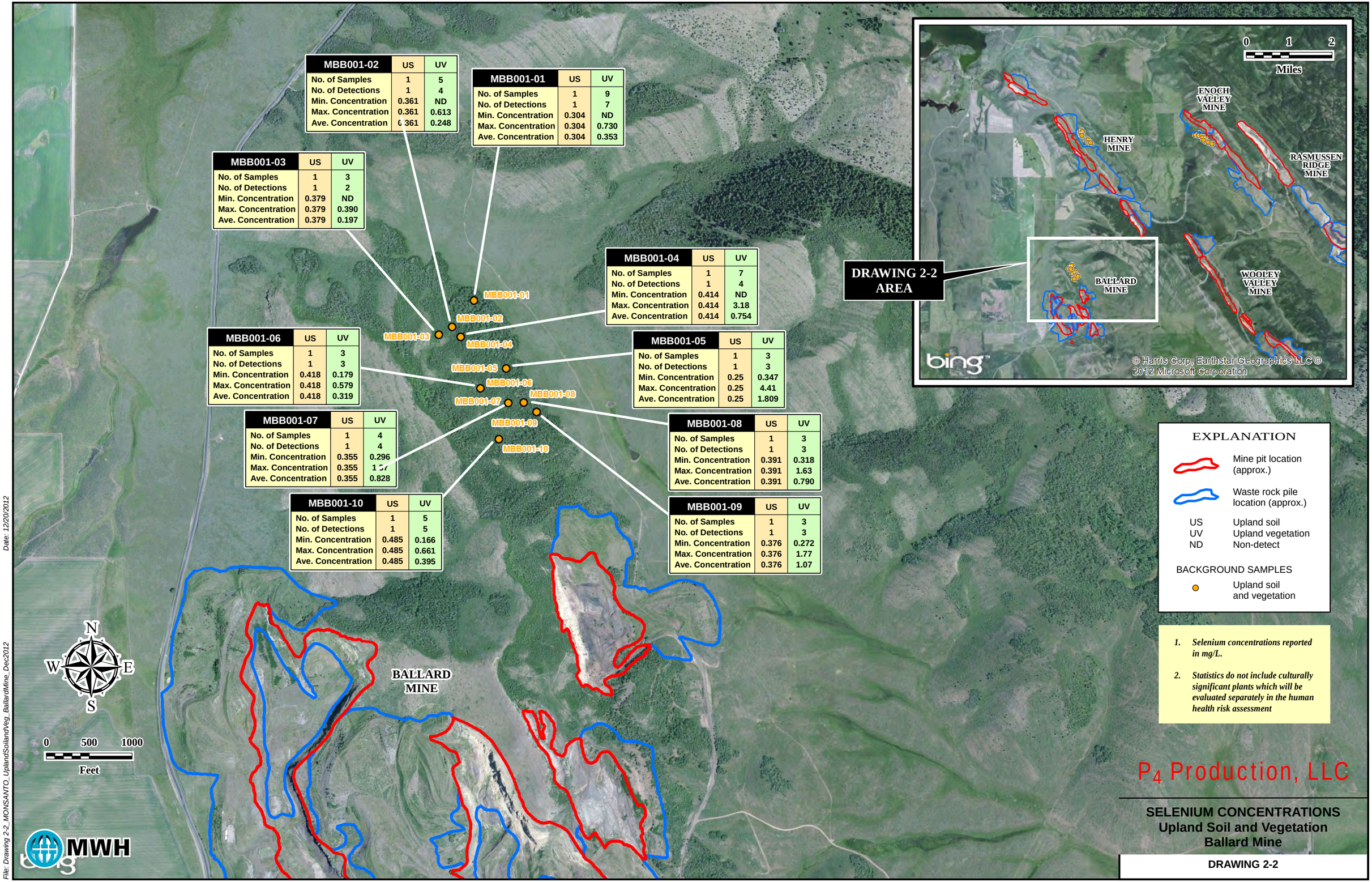
P_4 Production, LLC

SELENIUM CONCENTRATIONS
Surface Water, Sediment, and Riparian Soil and Vegetation Background Locations

DRAWING 2-1

Date: 12/20/2012

File: Drawing 2-1_MONSANTO_Background Sample Locs_SW_SED_RS_RV_Dec2012



MBB001-02	US	UV
No. of Samples	1	5
No. of Detections	1	4
Min. Concentration	0.361	ND
Max. Concentration	0.361	0.613
Ave. Concentration	0.361	0.248

MBB001-01	US	UV
No. of Samples	1	9
No. of Detections	1	7
Min. Concentration	0.304	ND
Max. Concentration	0.304	0.730
Ave. Concentration	0.304	0.353

MBB001-03	US	UV
No. of Samples	1	3
No. of Detections	1	2
Min. Concentration	0.379	ND
Max. Concentration	0.379	0.390
Ave. Concentration	0.379	0.197

MBB001-04	US	UV
No. of Samples	1	7
No. of Detections	1	4
Min. Concentration	0.414	ND
Max. Concentration	0.414	3.18
Ave. Concentration	0.414	0.754

MBB001-06	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	0.418	0.179
Max. Concentration	0.418	0.579
Ave. Concentration	0.418	0.319

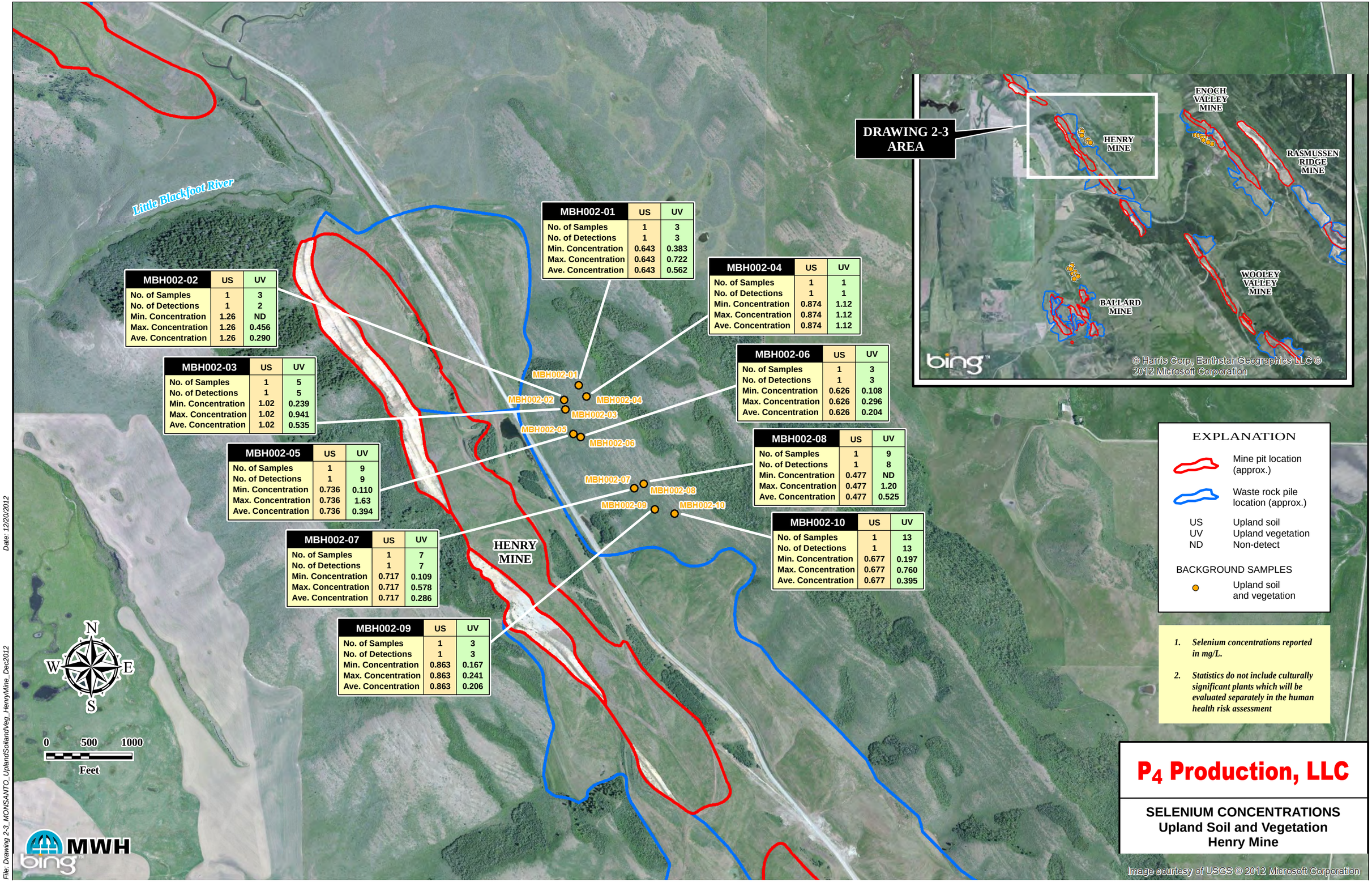
MBB001-05	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	0.25	0.347
Max. Concentration	0.25	4.41
Ave. Concentration	0.25	1.809

MBB001-07	US	UV
No. of Samples	1	4
No. of Detections	1	4
Min. Concentration	0.355	0.296
Max. Concentration	0.355	1.57
Ave. Concentration	0.355	0.828

MBB001-08	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	0.391	0.318
Max. Concentration	0.391	1.63
Ave. Concentration	0.391	0.790

MBB001-10	US	UV
No. of Samples	1	5
No. of Detections	1	5
Min. Concentration	0.485	0.166
Max. Concentration	0.485	0.661
Ave. Concentration	0.485	0.395

MBB001-09	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	0.376	0.272
Max. Concentration	0.376	1.77
Ave. Concentration	0.376	1.07



MBH002-01	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	0.643	0.383
Max. Concentration	0.643	0.722
Ave. Concentration	0.643	0.562

MBH002-02	US	UV
No. of Samples	1	3
No. of Detections	1	2
Min. Concentration	1.26	ND
Max. Concentration	1.26	0.456
Ave. Concentration	1.26	0.290

MBH002-03	US	UV
No. of Samples	1	5
No. of Detections	1	5
Min. Concentration	1.02	0.239
Max. Concentration	1.02	0.941
Ave. Concentration	1.02	0.535

MBH002-04	US	UV
No. of Samples	1	1
No. of Detections	1	1
Min. Concentration	0.874	1.12
Max. Concentration	0.874	1.12
Ave. Concentration	0.874	1.12

MBH002-05	US	UV
No. of Samples	1	9
No. of Detections	1	9
Min. Concentration	0.736	0.110
Max. Concentration	0.736	1.63
Ave. Concentration	0.736	0.394

MBH002-06	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	0.626	0.108
Max. Concentration	0.626	0.296
Ave. Concentration	0.626	0.204

MBH002-07	US	UV
No. of Samples	1	7
No. of Detections	1	7
Min. Concentration	0.717	0.109
Max. Concentration	0.717	0.578
Ave. Concentration	0.717	0.286

MBH002-08	US	UV
No. of Samples	1	9
No. of Detections	1	8
Min. Concentration	0.477	ND
Max. Concentration	0.477	1.20
Ave. Concentration	0.477	0.525

MBH002-09	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	0.863	0.167
Max. Concentration	0.863	0.241
Ave. Concentration	0.863	0.206

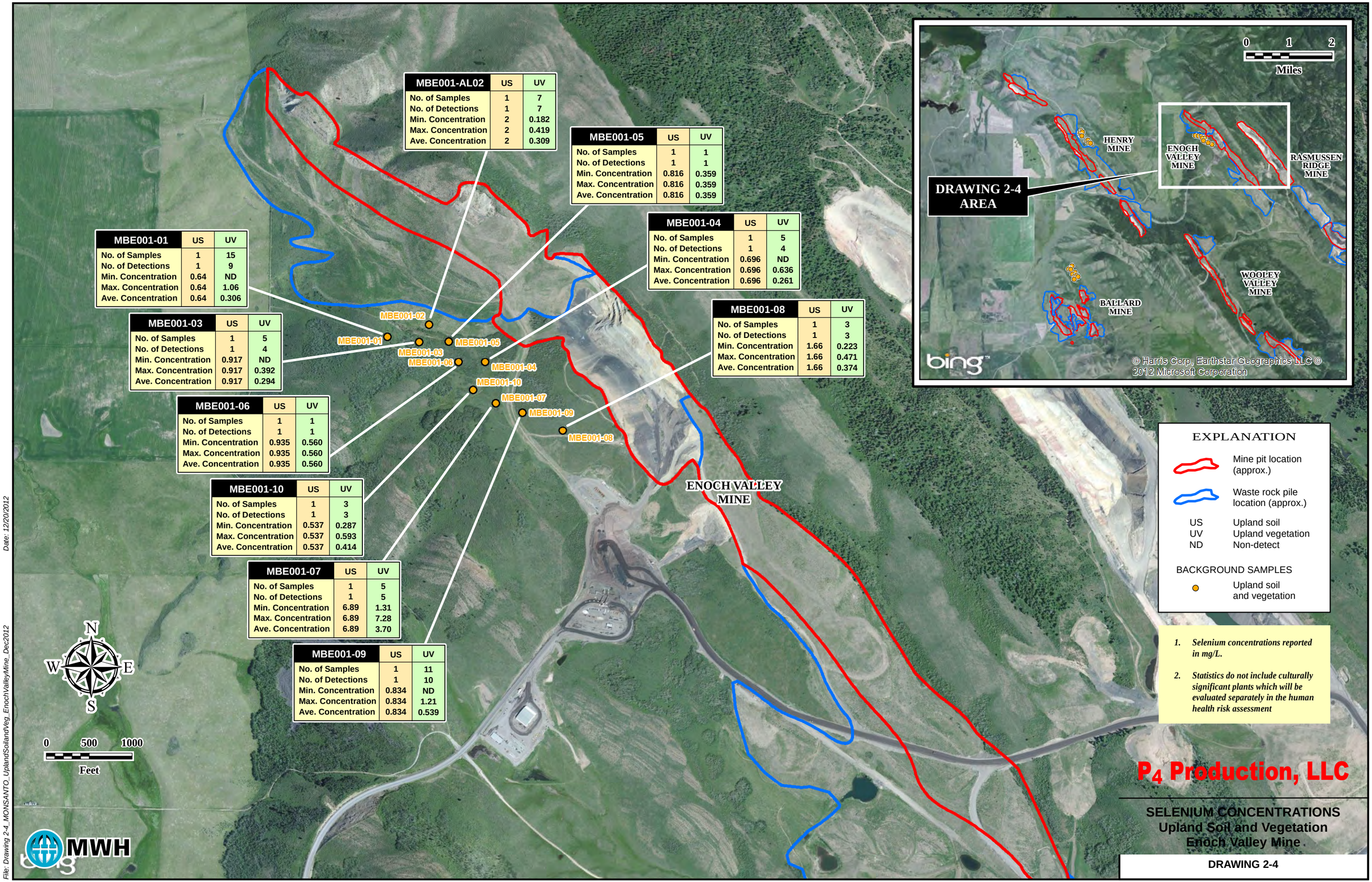
MBH002-10	US	UV
No. of Samples	1	13
No. of Detections	1	13
Min. Concentration	0.677	0.197
Max. Concentration	0.677	0.760
Ave. Concentration	0.677	0.395

P_4 Production, LLC

SELENIUM CONCENTRATIONS
Upland Soil and Vegetation
Henry Mine

Date: 12/20/2012

File: Drawing 2-3_MONSANTO_UplandSoilandVeg_HenryMine_Dec2012



MBE001-AL02	US	UV
No. of Samples	1	7
No. of Detections	1	7
Min. Concentration	2	0.182
Max. Concentration	2	0.419
Ave. Concentration	2	0.309

MBE001-05	US	UV
No. of Samples	1	1
No. of Detections	1	1
Min. Concentration	0.816	0.359
Max. Concentration	0.816	0.359
Ave. Concentration	0.816	0.359

MBE001-04	US	UV
No. of Samples	1	5
No. of Detections	1	4
Min. Concentration	0.696	ND
Max. Concentration	0.696	0.636
Ave. Concentration	0.696	0.261

MBE001-01	US	UV
No. of Samples	1	15
No. of Detections	1	9
Min. Concentration	0.64	ND
Max. Concentration	0.64	1.06
Ave. Concentration	0.64	0.306

MBE001-03	US	UV
No. of Samples	1	5
No. of Detections	1	4
Min. Concentration	0.917	ND
Max. Concentration	0.917	0.392
Ave. Concentration	0.917	0.294

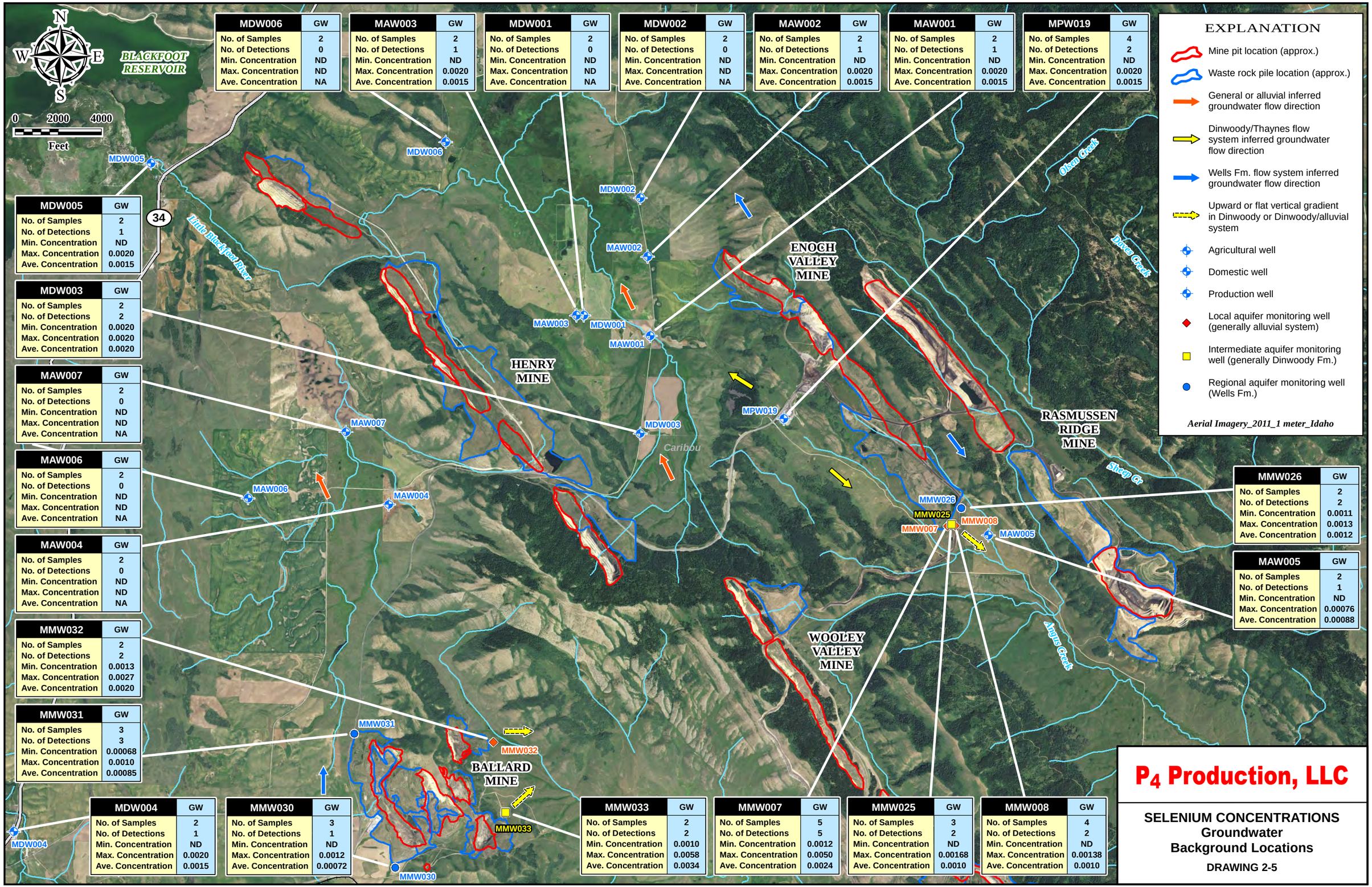
MBE001-08	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	1.66	0.223
Max. Concentration	1.66	0.471
Ave. Concentration	1.66	0.374

MBE001-06	US	UV
No. of Samples	1	1
No. of Detections	1	1
Min. Concentration	0.935	0.560
Max. Concentration	0.935	0.560
Ave. Concentration	0.935	0.560

MBE001-10	US	UV
No. of Samples	1	3
No. of Detections	1	3
Min. Concentration	0.537	0.287
Max. Concentration	0.537	0.593
Ave. Concentration	0.537	0.414

MBE001-07	US	UV
No. of Samples	1	5
No. of Detections	1	5
Min. Concentration	6.89	1.31
Max. Concentration	6.89	7.28
Ave. Concentration	6.89	3.70

MBE001-09	US	UV
No. of Samples	1	11
No. of Detections	1	10
Min. Concentration	0.834	ND
Max. Concentration	0.834	1.21
Ave. Concentration	0.834	0.539



MDW006	GW
No. of Samples	2
No. of Detections	0
Min. Concentration	ND
Max. Concentration	ND
Ave. Concentration	NA

MAW003	GW
No. of Samples	2
No. of Detections	1
Min. Concentration	ND
Max. Concentration	0.0020
Ave. Concentration	0.0015

MDW001	GW
No. of Samples	2
No. of Detections	0
Min. Concentration	ND
Max. Concentration	ND
Ave. Concentration	NA

MDW002	GW
No. of Samples	2
No. of Detections	0
Min. Concentration	ND
Max. Concentration	ND
Ave. Concentration	NA

MAW002	GW
No. of Samples	2
No. of Detections	1
Min. Concentration	ND
Max. Concentration	0.0020
Ave. Concentration	0.0015

MAW001	GW
No. of Samples	2
No. of Detections	1
Min. Concentration	ND
Max. Concentration	0.0020
Ave. Concentration	0.0015

MPW019	GW
No. of Samples	4
No. of Detections	2
Min. Concentration	ND
Max. Concentration	0.0020
Ave. Concentration	0.0015

MDW005	GW
No. of Samples	2
No. of Detections	1
Min. Concentration	ND
Max. Concentration	0.0020
Ave. Concentration	0.0015

MDW003	GW
No. of Samples	2
No. of Detections	2
Min. Concentration	0.0020
Max. Concentration	0.0020
Ave. Concentration	0.0020

MAW007	GW
No. of Samples	2
No. of Detections	0
Min. Concentration	ND
Max. Concentration	ND
Ave. Concentration	NA

MAW006	GW
No. of Samples	2
No. of Detections	0
Min. Concentration	ND
Max. Concentration	ND
Ave. Concentration	NA

MAW004	GW
No. of Samples	2
No. of Detections	0
Min. Concentration	ND
Max. Concentration	ND
Ave. Concentration	NA

MMW032	GW
No. of Samples	2
No. of Detections	2
Min. Concentration	0.0013
Max. Concentration	0.0027
Ave. Concentration	0.0020

MMW031	GW
No. of Samples	3
No. of Detections	3
Min. Concentration	0.00068
Max. Concentration	0.0010
Ave. Concentration	0.00085

MMW026	GW
No. of Samples	2
No. of Detections	2
Min. Concentration	0.0011
Max. Concentration	0.0013
Ave. Concentration	0.0012

MAW005	GW
No. of Samples	2
No. of Detections	1
Min. Concentration	ND
Max. Concentration	0.00076
Ave. Concentration	0.00088

MDW004	GW
No. of Samples	2
No. of Detections	1
Min. Concentration	ND
Max. Concentration	0.0020
Ave. Concentration	0.0015

MMW030	GW
No. of Samples	3
No. of Detections	1
Min. Concentration	ND
Max. Concentration	0.0012
Ave. Concentration	0.00072

MMW033	GW
No. of Samples	2
No. of Detections	2
Min. Concentration	0.0010
Max. Concentration	0.0058
Ave. Concentration	0.0034

MMW007	GW
No. of Samples	5
No. of Detections	5
Min. Concentration	0.0012
Max. Concentration	0.0050
Ave. Concentration	0.0024

MMW025	GW
No. of Samples	3
No. of Detections	2
Min. Concentration	ND
Max. Concentration	0.00168
Ave. Concentration	0.0010

MMW008	GW
No. of Samples	4
No. of Detections	2
Min. Concentration	ND
Max. Concentration	0.00138
Ave. Concentration	0.0010

P_4 Production, LLC

SELENIUM CONCENTRATIONS
Groundwater
Background Locations

DRAWING 2-5

DATE: 8 Mar 2013

FILE: J:\Industrial Projects\P4 Monsanto\Background Level Memo\FIGURES_Dec2012\Drawing 2-5_MONSANTO_Background Sample Locs_GW_aerial_Mar2013.mxd

APPENDICES

APPENDIX A

ProUCL USER'S GUIDE

To download the ProUCL 4.1 User and Technical Guide, use the following website
http://www.epa.gov/osp/hstl/tsc/software.htm

APPENDIX B

BACKGROUND DATASETS -

ProUCL AND SCOUT INPUT SHEETS FOR EACH MEDIUM

APPENDIX C

ProUCL AND SCOUT OUTPUT SHEETS FOR EACH MEDIUM

SEDIMENT – OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options

From File	Sed values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Selenium

Number of data = 7

10% critical value: 0.434

5% critical value: 0.507

1% critical value: 0.637

1. Data Value 1.6 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.444

For 10% significance level, 1.6 is an outlier.

For 5% significance level, 1.6 is not an outlier.

For 1% significance level, 1.6 is not an outlier.

2. Data Value 0.7 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.111

For 10% significance level, 0.7 is not an outlier.

For 5% significance level, 0.7 is not an outlier.

For 1% significance level, 0.7 is not an outlier.

SEDIMENT – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sed values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	6		

Raw Statistics		Log-transformed Statistics	
Minimum	0.22	Minimum of Log Data	-1.514
Maximum	3.74	Maximum of Log Data	1.319
Mean	1.787	Mean of log Data	0.372
Median	1.81	SD of log Data	0.761
SD	1.024		
Std. Error of Mean	0.284		
Coefficient of Variation	0.573		
Skewness	0.398		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.958	Shapiro Wilk Test Statistic	0.898
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2.294	95% H-UCL	3.326
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3.713
95% Adjusted-CLT UCL (Chen-1995)	2.288	97.5% Chebyshev (MVUE) UCL	4.503
95% Modified-t UCL (Johnson-1978)	2.299	99% Chebyshev (MVUE) UCL	6.055

Gamma Distribution Test		Data Distribution
k star (bias corrected)	2.016	Data appear Normal at 5% Significance Level
Theta Star	0.886	
MLE of Mean	1.787	
MLE of Standard Deviation	1.259	
nu star	52.42	
Approximate Chi Square Value (.05)	36.79	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 2.254
Adjusted Chi Square Value	34.93	95% Jackknife UCL 2.294
		95% Standard Bootstrap UCL 2.227
Anderson-Darling Test Statistic	0.321	95% Bootstrap-t UCL 2.308
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL 2.319
Kolmogorov-Smirnov Test Statistic	0.196	95% Percentile Bootstrap UCL 2.238
Kolmogorov-Smirnov 5% Critical Value	0.239	95% BCA Bootstrap UCL 2.237
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 3.026
		97.5% Chebyshev(Mean, Sd) UCL 3.561
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 4.614

95% Approximate Gamma UCL	2.547
95% Adjusted Gamma UCL	2.682

Potential UCL to Use Use 95% Student's-t UCL 2.294

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium, Total

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	6		

Raw Statistics		**Log-transformed Statistics**	
Minimum	11.5	Minimum of Log Data	2.442
Maximum	34.8	Maximum of Log Data	3.55
Mean	23.1	Mean of log Data	3.101
Median	21.6	SD of log Data	0.296
SD	6.42		
Std. Error of Mean	1.781		
Coefficient of Variation	0.278		
Skewness	0.156		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.98	Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	26.27	95% H-UCL	27.33
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	31.5
95% Adjusted-CLT UCL (Chen-1995)	26.11	97.5% Chebyshev (MVUE) UCL	35.12
95% Modified-t UCL (Johnson-1978)	26.28	99% Chebyshev (MVUE) UCL	42.22

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	10.21	**Data appear Normal at 5% Significance Level**	
Theta Star	2.263		
MLE of Mean	23.1		
MLE of Standard Deviation	7.23		
nu star	265.3		
Approximate Chi Square Value (.05)	228.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	26.03
Adjusted Chi Square Value	223.8	95% Jackknife UCL	26.27
		95% Standard Bootstrap UCL	25.88
Anderson-Darling Test Statistic	0.204	95% Bootstrap-t UCL	26.42
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL	26.27
Kolmogorov-Smirnov Test Statistic	0.127	95% Percentile Bootstrap UCL	25.98
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL	26.02
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	30.86

97.5% Chebyshev(Mean, Sd) UCL	34.22
99% Chebyshev(Mean, Sd) UCL	40.81

Assuming Gamma Distribution

95% Approximate Gamma UCL	26.81
95% Adjusted Gamma UCL	27.39

Potential UCL to Use — Use 95% Student's-t UCL 26.27

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Nickel

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12
Number of Missing Values	6		

Raw Statistics

Minimum	5.8
Maximum	24.4
Mean	17.27
Median	17.2
SD	4.891
Std. Error of Mean	1.356
Coefficient of Variation	0.283
Skewness	-0.861

Log-transformed Statistics

Minimum of Log Data	1.758
Maximum of Log Data	3.195
Mean of log Data	2.798
SD of log Data	0.368

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.949
Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.811
Shapiro Wilk Critical Value	0.866

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	19.69

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	19.15
95% Modified-t UCL (Johnson-1978)	19.63

Assuming Lognormal Distribution

95% H-UCL	21.64
95% Chebyshev (MVUE) UCL	25.34
97.5% Chebyshev (MVUE) UCL	28.74
99% Chebyshev (MVUE) UCL	35.44

Gamma Distribution Test

k star (bias corrected)	7.668
Theta Star	2.252
MLE of Mean	17.27
MLE of Standard Deviation	6.236
nu star	199.4
Approximate Chi Square Value (.05)	167.7
Adjusted Level of Significance	0.0301
Adjusted Chi Square Value	163.6
Anderson-Darling Test Statistic	0.587
Anderson-Darling 5% Critical Value	0.734
Kolmogorov-Smirnov Test Statistic	0.195

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	19.5
95% Jackknife UCL	19.69
95% Standard Bootstrap UCL	19.4
95% Bootstrap-t UCL	19.41
95% Hall's Bootstrap UCL	19.26
95% Percentile Bootstrap UCL	19.36

Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL	19.07
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	23.18
		97.5% Chebyshev(Mean, Sd) UCL	25.74
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	30.77
95% Approximate Gamma UCL	20.53		
95% Adjusted Gamma UCL	21.05		
Potential UCL to Use		Use 95% Student's-t UCL	19.69

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Selenium

General Statistics

Number of Valid Data	13	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	6
Number of Missing Values	6	Percent Non-Detects	46.15%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.7	Minimum Detected	-0.357
Maximum Detected	1.6	Maximum Detected	0.47
Mean of Detected	1.021	Mean of Detected	-0.012
SD of Detected	0.3	SD of Detected	0.272
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	6
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	7
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	46.15%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Test Statistic	0.96
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	

Mean	0.673
SD	0.446
95% DL/2 (t) UCL	0.893

Mean	-0.618
SD	0.711
95% H-Stat (DL/2) UCL	1.132

Maximum Likelihood Estimate(MLE) Method	
Mean	0.66
SD	0.479
95% MLE (t) UCL	0.897
95% MLE (Tiku) UCL	0.941

Log ROS Method	
Mean in Log Scale	-0.375
SD in Log Scale	0.469
Mean in Original Scale	0.761
SD in Original Scale	0.366
95% t UCL	0.942
95% Percentile Bootstrap UCL	0.928
95% BCA Bootstrap UCL	0.95
95% H UCL	1.016

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	8.789
Theta Star	0.116
nu star	123
A-D Test Statistic	0.28
5% A-D Critical Value	0.708
K-S Test Statistic	0.708
5% K-S Critical Value	0.312

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	1.6
Mean	0.568
Median	0.7
SD	0.555
k star	0.191
Theta star	2.975
Nu star	4.961
AppChi2	1.134
95% Gamma Approximate UCL	2.483
95% Adjusted Gamma UCL	3.133

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.873
SD	0.259
SE of Mean	0.0776
95% KM (t) UCL	1.011
95% KM (z) UCL	1.001
95% KM (jackknife) UCL	0.997
95% KM (bootstrap t) UCL	1.084
95% KM (BCA) UCL	1.092
95% KM (Percentile Bootstrap) UCL	1.046
95% KM (Chebyshev) UCL	1.211
97.5% KM (Chebyshev) UCL	1.358
99% KM (Chebyshev) UCL	1.646

Potential UCLs to Use

95% KM (t) UCL	1.011
95% KM (Percentile Bootstrap) UCL	1.046

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	6		

Raw Statistics		Log-transformed Statistics	
Minimum	11.3	Minimum of Log Data	2.425

Maximum	45.2	Maximum of Log Data	3.811
Mean	28.68	Mean of log Data	3.306
Median	28.3	SD of log Data	0.347
SD	8.752		
Std. Error of Mean	2.427		
Coefficient of Variation	0.305		
Skewness	0.0334		

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.964
Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.906
Shapiro Wilk Critical Value	0.866

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	33.01

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	32.7
95% Modified-t UCL (Johnson-1978)	33.01

Assuming Lognormal Distribution

95% H-UCL	35.24
95% Chebyshev (MVUE) UCL	41.1
97.5% Chebyshev (MVUE) UCL	46.4
99% Chebyshev (MVUE) UCL	56.82

Gamma Distribution Test

k star (bias corrected)	7.881
Theta Star	3.639
MLE of Mean	28.68
MLE of Standard Deviation	10.22
nu star	204.9
Approximate Chi Square Value (.05)	172.8
Adjusted Level of Significance	0.0301
Adjusted Chi Square Value	168.6
Anderson-Darling Test Statistic	0.373
Anderson-Darling 5% Critical Value	0.734
Kolmogorov-Smirnov Test Statistic	0.147
Kolmogorov-Smirnov 5% Critical Value	0.237

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	32.68
95% Jackknife UCL	33.01
95% Standard Bootstrap UCL	32.46
95% Bootstrap-t UCL	33.24
95% Hall's Bootstrap UCL	33.15
95% Percentile Bootstrap UCL	32.47
95% BCA Bootstrap UCL	32.62
95% Chebyshev(Mean, Sd) UCL	39.27
97.5% Chebyshev(Mean, Sd) UCL	43.84
99% Chebyshev(Mean, Sd) UCL	52.84

Assuming Gamma Distribution

95% Approximate Gamma UCL	34.02
95% Adjusted Gamma UCL	34.87

Potential UCL to Use

Use 95% Student's-t UCL 33.01

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zinc

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	6		

Raw Statistics	
Minimum	18
Maximum	151
Mean	91.05
Median	90
SD	31.99
Std. Error of Mean	8.872
Coefficient of Variation	0.351
Skewness	-0.408

Log-transformed Statistics	
Minimum of Log Data	2.89
Maximum of Log Data	5.017
Mean of log Data	4.422
SD of log Data	0.513

Relevant UCL Statistics

Normal Distribution Test	
Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.747
Shapiro Wilk Critical Value	0.866

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution	
95% Student's-t UCL	106.9
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	104.6
95% Modified-t UCL (Johnson-1978)	106.7

Assuming Lognormal Distribution	
95% H-UCL	130.1
95% Chebyshev (MVUE) UCL	153.8
97.5% Chebyshev (MVUE) UCL	179.7
99% Chebyshev (MVUE) UCL	230.5

Gamma Distribution Test	
k star (bias corrected)	4.471
Theta Star	20.36
MLE of Mean	91.05
MLE of Standard Deviation	43.06
nu star	116.2
Approximate Chi Square Value (.05)	92.36
Adjusted Level of Significance	0.0301
Adjusted Chi Square Value	89.33
Anderson-Darling Test Statistic	0.802
Anderson-Darling 5% Critical Value	0.736
Kolmogorov-Smirnov Test Statistic	0.228
Kolmogorov-Smirnov 5% Critical Value	0.237

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution	
95% Approximate Gamma UCL	114.6
95% Adjusted Gamma UCL	118.5

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics	
95% CLT UCL	105.6
95% Jackknife UCL	106.9
95% Standard Bootstrap UCL	105.3
95% Bootstrap-t UCL	107
95% Hall's Bootstrap UCL	106.7
95% Percentile Bootstrap UCL	104.9
95% BCA Bootstrap UCL	105.1
95% Chebyshev(Mean, Sd) UCL	129.7
97.5% Chebyshev(Mean, Sd) UCL	146.5
99% Chebyshev(Mean, Sd) UCL	179.3

Potential UCL to Use	
Use 95% Student's-t UCL	106.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

SEDIMENT – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sed values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Cadmium

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
Tolerance Factor	2.671	Number of Missing Values	6

Raw Statistics		Log-Transformed Statistics	
Minimum	0.22	Minimum	-1.514
Maximum	3.74	Maximum	1.319
Second Largest	3.05	Second Largest	1.115
First Quartile	0.9	First Quartile	-0.105
Median	1.81	Median	0.593
Third Quartile	2.21	Third Quartile	0.793
Mean	1.787	Mean	0.372
SD	1.024	SD	0.761
Coefficient of Variation	0.573		
Skewness	0.398		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.958	Shapiro Wilk Test Statistic	0.898
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	4.523	95% UTL with 95% Coverage	11.07
95% UPL (t)	3.682	95% UPL (t)	5.926
90% Percentile (z)	3.1	90% Percentile (z)	3.847
95% Percentile (z)	3.472	95% Percentile (z)	5.071
99% Percentile (z)	4.17	99% Percentile (z)	8.517

Gamma Distribution Test		Data Distribution Test
k star	2.016	Data appear Normal at 5% Significance Level
Theta Star	0.886	
MLE of Mean	1.787	
MLE of Standard Deviation	1.259	
nu star	52.42	
A-D Test Statistic	0.321	**Nonparametric Statistics**
5% A-D Critical Value	0.741	90% Percentile 3.03
K-S Test Statistic	0.196	95% Percentile 3.326
5% K-S Critical Value	0.239	99% Percentile 3.657

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

90% Percentile	3.469
95% Percentile	4.228
99% Percentile	5.911
95% WH Approx. Gamma UPL	4.473
95% HW Approx. Gamma UPL	4.702
95% WH Approx. Gamma UTL with 95% Coverage	6.463
95% HW Approx. Gamma UTL with 95% Coverage	7.083
95% UTL with 95% Coverage	3.74
95% Percentile Bootstrap UTL with 95% Coverage	3.74
95% BCA Bootstrap UTL with 95% Coverage	3.74
95% UPL	3.74
95% Chebyshev UPL	6.421
Upper Threshold Limit Based upon IQR	4.175

Chromium, Total

General Statistics

Total Number of Observations	13
Tolerance Factor	2.671
Number of Distinct Observations	13
Number of Missing Values	6

Raw Statistics

Minimum	11.5
Maximum	34.8
Second Largest	31.9
First Quartile	19.8
Median	21.6
Third Quartile	26.6
Mean	23.1
SD	6.42
Coefficient of Variation	0.278
Skewness	0.156

Log-Transformed Statistics

Minimum	2.442
Maximum	3.55
Second Largest	3.463
First Quartile	2.986
Median	3.073
Third Quartile	3.281
Mean	3.101
SD	0.296

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.98
Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.866

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	40.24
95% UPL (t)	34.97
90% Percentile (z)	31.32
95% Percentile (z)	33.66
99% Percentile (z)	38.03

Assuming Lognormal Distribution

95% UTL with 95% Coverage	48.99
95% UPL (t)	38.42
90% Percentile (z)	32.48
95% Percentile (z)	36.16
99% Percentile (z)	44.24

Gamma Distribution Test

k star	10.21
Theta Star	2.263
MLE of Mean	23.1
MLE of Standard Deviation	7.23
nu star	265.3
A-D Test Statistic	0.204
5% A-D Critical Value	0.734

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	31.08

K-S Test Statistic	0.127	95% Percentile	33.06
5% K-S Critical Value	0.237	99% Percentile	34.45

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

90% Percentile	32.71	95% UTL with 95% Coverage	34.8
95% Percentile	36.13	95% Percentile Bootstrap UTL with 95% Coverage	34.8
99% Percentile	43.14	95% BCA Bootstrap UTL with 95% Coverage	34.8
		95% UPL	34.8
		95% Chebyshev UPL	52.14
95% WH Approx. Gamma UPL	36.83	Upper Threshold Limit Based upon IQR	36.8
95% HW Approx. Gamma UPL	37.17		
95% WH Approx. Gamma UTL with 95% Coverage	44.75		
95% HW Approx. Gamma UTL with 95% Coverage	45.63		

Nickel

General Statistics

Total Number of Observations	13	Number of Distinct Observations	12
Tolerance Factor	2.671	Number of Missing Values	6

Raw Statistics		Log-Transformed Statistics	
Minimum	5.8	Minimum	1.758
Maximum	24.4	Maximum	3.195
Second Largest	23.1	Second Largest	3.14
First Quartile	15.7	First Quartile	2.754
Median	17.2	Median	2.845
Third Quartile	20.6	Third Quartile	3.025
Mean	17.27	Mean	2.798
SD	4.891	SD	0.368
Coefficient of Variation	0.283		
Skewness	-0.861		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.949	Shapiro Wilk Test Statistic	0.811
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	30.33	95% UTL with 95% Coverage	43.82
95% UPL (t)	26.32	95% UPL (t)	32.39
90% Percentile (z)	23.54	90% Percentile (z)	26.29
95% Percentile (z)	25.31	95% Percentile (z)	30.04
99% Percentile (z)	28.65	99% Percentile (z)	38.6

Gamma Distribution Test		Data Distribution Test
k star	7.668	Data appear Normal at 5% Significance Level
Theta Star	2.252	
MLE of Mean	17.27	
MLE of Standard Deviation	6.236	
nu star	199.4	

A-D Test Statistic	0.587
5% A-D Critical Value	0.734
K-S Test Statistic	0.195
5% K-S Critical Value	0.237

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

90% Percentile	22.62
95% Percentile	23.62
99% Percentile	24.24

Assuming Gamma Distribution

90% Percentile	25.59
95% Percentile	28.64
99% Percentile	34.97
95% WH Approx. Gamma UPL	29.3
95% HW Approx. Gamma UPL	29.91
95% WH Approx. Gamma UTL with 95% Coverage	36.46
95% HW Approx. Gamma UTL with 95% Coverage	37.84

95% UTL with 95% Coverage	24.4
95% Percentile Bootstrap UTL with 95% Coverage	24.4
95% BCA Bootstrap UTL with 95% Coverage	24.4
95% UPL	24.4
95% Chebyshev UPL	39.39
Upper Threshold Limit Based upon IQR	27.95

Selenium

General Statistics

Number of Valid Data	13
Number of Distinct Detected Data	7
Tolerance Factor	2.671
Number of Missing Values	6
Number of Detected Data	7
Number of Non-Detect Data	6
Percent Non-Detects	46.15%

Raw Statistics

Minimum Detected	0.7
Maximum Detected	1.6
Mean of Detected	1.021
SD of Detected	0.3
Minimum Non-Detect	0.5
Maximum Non-Detect	0.6

Log-transformed Statistics

Minimum Detected	-0.357
Maximum Detected	0.47
Mean of Detected	-0.012
SD of Detected	0.272
Minimum Non-Detect	-0.693
Maximum Non-Detect	-0.511

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	6
Number treated as Detected with Single DL	7
Single DL Non-Detect Percentage	46.15%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.899
5% Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.96
5% Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.673
SD	0.446
95% UTL 95% Coverage	1.863
95% UPL (t)	1.497
90% Percentile (z)	1.244
95% Percentile (z)	1.406
99% Percentile (z)	1.71

Maximum Likelihood Estimate(MLE) Method

Mean	0.66
SD	0.479
95% UTL with 95% Coverage	1.939
95% UPL (t)	1.546
90% Percentile (z)	1.274
95% Percentile (z)	1.448
99% Percentile (z)	1.774

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-0.618
SD (Log Scale)	0.711
95% UTL 95% Coverage	3.597
95% UPL (t)	2.006
90% Percentile (z)	1.34
95% Percentile (z)	1.735
99% Percentile (z)	2.816

Log ROS Method

Mean in Original Scale	0.761
SD in Original Scale	0.366
95% UTL with 95% Coverage	2.403
95% BCA UTL with 95% Coverage	1.6
95% Bootstrap (%) UTL with 95% Coverage	1.6
95% UPL (t)	1.636
90% Percentile (z)	1.253
95% Percentile (z)	1.486
99% Percentile (z)	2.045

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	8.789
Theta Star	0.116
nu star	123
A-D Test Statistic	0.28
5% A-D Critical Value	0.708
K-S Test Statistic	0.213
5% K-S Critical Value	0.312

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.873
SD	0.259
SE of Mean	0.0776
95% KM UTL with 95% Coverage	1.565
95% KM Chebyshev UPL	2.045
95% KM UPL (t)	1.352
90% Percentile (z)	1.205
95% Percentile (z)	1.299
99% Percentile (z)	1.476

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.568
Median	0.7
SD	0.555
k star	0.191
Theta star	2.975
Nu star	4.961
95% Percentile of Chisquare (2k)	1.99
90% Percentile	1.716
95% Percentile	2.96
99% Percentile	6.413

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	3.245
95% Hawkins Wixley (HW) Approx. Gamma UPL	4.666
95% WH Approx. Gamma UTL with 95% Coverage	6.521
95% HW Approx. Gamma UTL with 95% Coverage	11.55

Note: DL/2 is not a recommended method.

Vanadium

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13

Tolerance Factor	2.671	Number of Missing Values	6

Raw Statistics		Log-Transformed Statistics	
Minimum	11.3	Minimum	2.425
Maximum	45.2	Maximum	3.811
Second Largest	37.9	Second Largest	3.635
First Quartile	23.6	First Quartile	3.161
Median	28.3	Median	3.343
Third Quartile	36.6	Third Quartile	3.6
Mean	28.68	Mean	3.306
SD	8.752	SD	0.347
Coefficient of Variation	0.305		
Skewness	0.0334		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.964	Shapiro Wilk Test Statistic	0.906
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	52.06	95% UTL with 95% Coverage	68.94
95% UPL (t)	44.87	95% UPL (t)	51.85
90% Percentile (z)	39.9	90% Percentile (z)	42.57
95% Percentile (z)	43.08	95% Percentile (z)	48.29
99% Percentile (z)	49.05	99% Percentile (z)	61.17

Gamma Distribution Test		Data Distribution Test
k star	7.881	Data appear Normal at 5% Significance Level
Theta Star	3.639	
MLE of Mean	28.68	
MLE of Standard Deviation	10.22	
nu star	204.9	
A-D Test Statistic	0.373	
5% A-D Critical Value	0.734	
K-S Test Statistic	0.147	
5% K-S Critical Value	0.237	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
90% Percentile	37.66
95% Percentile	40.82
99% Percentile	44.32

Assuming Gamma Distribution			
90% Percentile	42.31	95% UTL with 95% Coverage	45.2
95% Percentile	47.29	95% Percentile Bootstrap UTL with 95% Coverage	45.2
99% Percentile	57.62	95% BCA Bootstrap UTL with 95% Coverage	45.2
		95% UPL	45.2
		95% Chebyshev UPL	68.28
95% WH Approx. Gamma UPL	48.36	Upper Threshold Limit Based upon IQR	56.1
95% HW Approx. Gamma UPL	49.07		
95% WH Approx. Gamma UTL with 95% Coverage	60.07		
95% HW Approx. Gamma UTL with 95% Coverage	61.79		

General Statistics

Total Number of Observations	13	Number of Distinct Observations	13
Tolerance Factor	2.671	Number of Missing Values	6

Raw Statistics

Minimum	18
Maximum	151
Second Largest	125
First Quartile	76
Median	90
Third Quartile	107
Mean	91.05
SD	31.99
Coefficient of Variation	0.351
Skewness	-0.408

Log-Transformed Statistics

Minimum	2.89
Maximum	5.017
Second Largest	4.828
First Quartile	4.331
Median	4.5
Third Quartile	4.673
Mean	4.422
SD	0.513

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.747
Shapiro Wilk Critical Value	0.866

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	176.5
95% UPL (t)	150.2
90% Percentile (z)	132
95% Percentile (z)	143.7
99% Percentile (z)	165.5

Assuming Lognormal Distribution

95% UTL with 95% Coverage	327.9
95% UPL (t)	215.1
90% Percentile (z)	160.7
95% Percentile (z)	193.6
99% Percentile (z)	274.7

Gamma Distribution Test

k star	4.471
Theta Star	20.36
MLE of Mean	91.05
MLE of Standard Deviation	43.06
nu star	116.2

A-D Test Statistic	0.802
5% A-D Critical Value	0.736
K-S Test Statistic	0.228
5% K-S Critical Value	0.237

Data follow Appx. Gamma Distribution at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	123.6
95% Percentile	135.4
99% Percentile	147.9

Assuming Gamma Distribution

90% Percentile	148.7
95% Percentile	171.4
99% Percentile	219.7
95% WH Approx. Gamma UPL	176.8
95% HW Approx. Gamma UPL	183.6
95% WH Approx. Gamma UTL with 95% Coverage	231.8
95% HW Approx. Gamma UTL with 95% Coverage	247.1

95% UTL with 95% Coverage	151
95% Percentile Bootstrap UTL with 95% Coverage	151
95% BCA Bootstrap UTL with 95% Coverage	151
95% UPL	151
95% Chebyshev UPL	235.7
Upper Threshold Limit Based upon IQR	153.5

SEDIMENT – USL OUTPUTS

Robust Simultaneous Intervals/Limits (SLs)

Date/Time of Computation	8/30/2012 5:01:29 PM
User Selected Options	
From File	C:\Documents and Settings\Valerie C Chen\My Documents\Val's documents from C\Monsanto\Background TM\I
Full Precision	OFF
Confidence Coefficient	0.9
PROP Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	PROP SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Huber Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	Huber SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Tukey Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Tukey Biweight SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
Lax/Kafadar Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Lax/Kafadar SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
MVT Method	Triming Percentage of 10.08%
	MVT SLs derived using 10 Iterations and initial estimates of median/1.48MAD.

D2Max represents unsquared critical value of Max-MD (Mahalanobis Distances) computed based upon Wsum Values

Cadmium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	13	1.787	1.81	1.024	1.349	2.331	-0.6	4.174

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	1.81	1.349	1.787	1.024	13	2.331	-0.6	4.174
Huber	1.81	1.349	1.787	1.024	13	2.331	-0.6	4.174
Tukey Biweight	1.81	1.349	1.761	1.047	12.17	2.293	-0.64	4.163
Lax Kafadar Biweight	1.81	1.349	1.74	1.043	11.64	2.268	-0.625	4.106
MVT	1.81	1.349	1.624	0.877	12	2.285	-0.379	3.628

Chromium, Total

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	13	23.1	21.6	6.42	6.523	2.331	8.134	38.06

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	21.6	6.523	23.1	6.42	13	2.331	8.134	38.06
Huber	21.6	6.523	23.1	6.42	13	2.331	8.134	38.06
Tukey Biweight	21.6	6.523	22.97	6.615	11.65	2.268	7.974	37.97
Lax Kafadar Biweight	21.6	6.523	22.98	6.752	11.73	2.272	7.644	38.32
MVT	21.6	6.523	22.12	5.61	12	2.285	9.301	34.94

Nickel

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	13	17.27	17.2	4.891	5.041	2.331	5.871	28.67

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	17.2	5.041	18.05	3.68	12.17	2.293	9.611	26.49
Huber	17.2	5.041	17.45	4.521	12.8	2.322	6.955	27.95

Tukey Biweight	17.2	5.041	17.69	4.758	11.72	2.271	6.882	28.5
Lax Kafadar Biweight	17.2	5.041	17.78	4.585	11.49	2.26	7.418	28.14
MVT	17.2	5.041	18.23	3.625	12	2.285	9.942	26.51

Selenium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	13	0.796	0.7	0.332	0.297	2.331	0.0225	1.57

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.7	0.297	0.738	0.24	12.12	2.291	0.188	1.288
Huber	0.7	0.297	0.78	0.298	12.75	2.319	0.0883	1.472
Tukey Biweight	0.7	0.297	0.737	0.313	11.37	2.253	0.0317	1.443
Lax Kafadar Biweight	0.7	0.297	0.732	0.283	11.24	2.247	0.0952	1.369
MVT	0.7	0.297	0.729	0.238	12	2.285	0.186	1.273

Vanadium

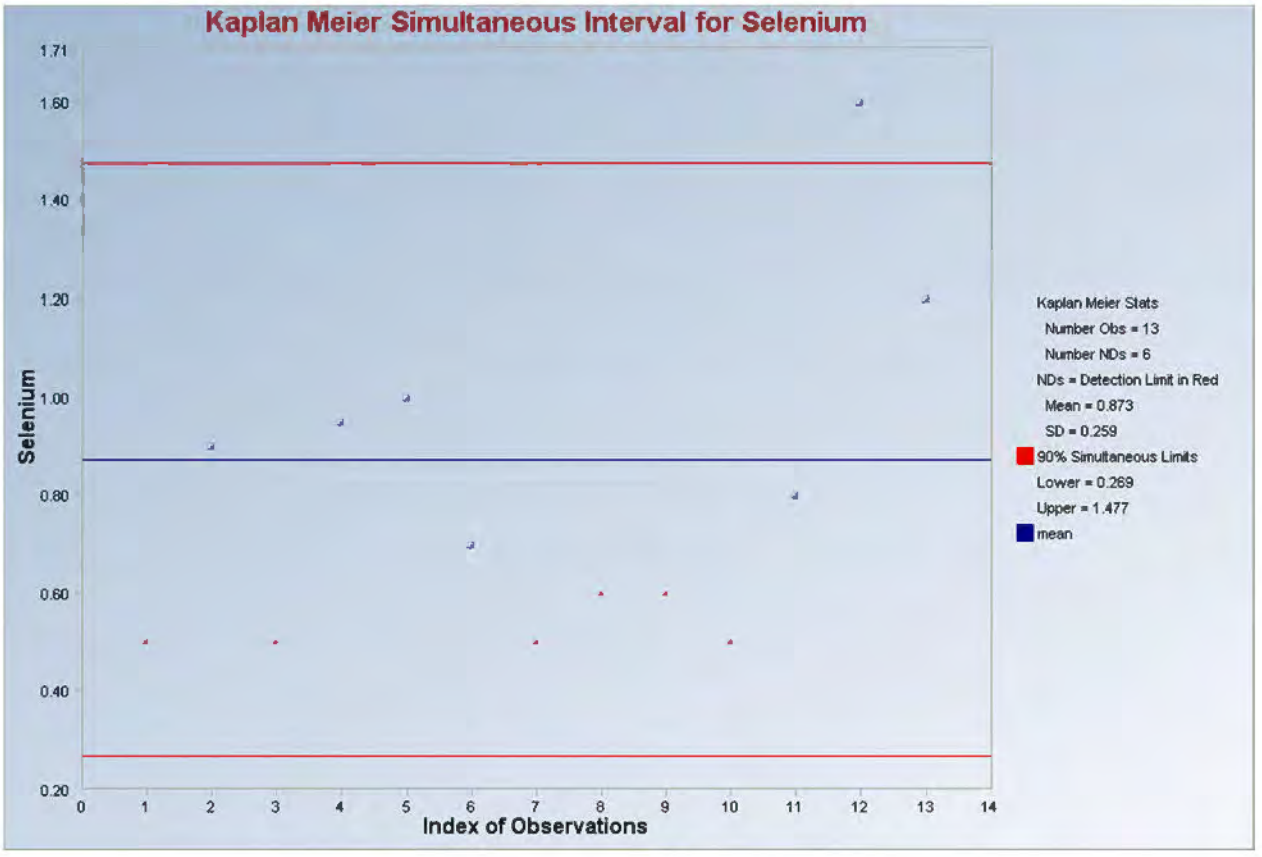
	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	13	28.68	28.3	8.752	7.265	2.331	8.287	49.08

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	28.3	7.265	28.68	8.752	13	2.331	8.287	49.08
Huber	28.3	7.265	28.68	8.752	13	2.331	8.287	49.08
Tukey Biweight	28.3	7.265	28.57	8.88	11.08	2.238	8.69	48.44
Lax Kafadar Biweight	28.3	7.265	28.63	8.827	11.65	2.268	8.611	48.64
MVT	28.3	7.265	30.13	7.335	12	2.285	13.37	46.89

Zinc

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	13	91.05	90	31.99	21.79	2.331	16.5	165.6

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	90	21.79	92.98	18.81	11.31	2.25	50.66	135.3
Huber	90	21.79	91.97	30.17	12.84	2.323	21.87	162.1
Tukey Biweight	90	21.79	92.99	29.19	10.54	2.208	28.55	157.4
Lax Kafadar Biweight	90	21.79	92.83	25.86	11.09	2.239	34.94	150.7
MVT	90	21.79	97.13	24.3	12	2.285	41.6	152.7


Kaplan Meier Simultaneous Interval for Selenium
Selenium
Index of Observations
1.71
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Kaplan Meier Stats
Number Obs = 13
Number NDs = 6
NDs = Detection Limit in Red
Mean = 0.873
SD = 0.259
90% Simultaneous Limits
Lower = 0.269
Upper = 1.477
mean

SURFACE WATER – OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options

From File	SW Input_values_a.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Arsenic_1

Number of data = 7

10% critical value: 0.434

5% critical value: 0.507

1% critical value: 0.637

1. Data Value 0.0028 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.739

For 10% significance level, 0.0028 is an outlier.

For 5% significance level, 0.0028 is an outlier.

For 1% significance level, 0.0028 is an outlier.

2. Data Value 0.0005 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.043

For 10% significance level, 0.0005 is not an outlier.

For 5% significance level, 0.0005 is not an outlier.

For 1% significance level, 0.0005 is not an outlier.

Outlier Tests for Selected Variables

User Selected Options

From File	SW Input_values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	2

Rosner's Outlier Test for Calcium

Mean	**47.74**
Standard Deviation	**17.23**
Number of data	**46**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	47.74	17.04	93.2	43	2.668	3.09	3.45
2	46.73	15.99	91.3	45	2.788	3.09	3.44

For 5% Significance Level, there is no Potential Outlier

For 1% Significance Level, there is no Potential Outlier

Outlier Tests for Selected Variables

User Selected Options

From File	SW Input_values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	3

Rosner's Outlier Test for Nickel

Mean	**0.00145**
Standard Deviation	**0.0007877**
Number of data	**38**
Number of suspected outliers	**3**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.00145	0.0007773	0.0039	10	3.146	3.01	3.36
2	0.00139	0.0006835	0.00353	15	3.133	3	3.34
3	0.00133	0.0005881	0.0033	38	3.351	2.99	3.33

For 5% significance level, there are 3 Potential Outliers

Therefore, Potential Statistical Outliers are

0.0039, 0.00353, 0.0033

For 1% Significance Level, there are 3 Potential Outliers

Therefore, Potential Statistical Outliers are

0.0039, 0.00353, 0.0033

Rosner's Outlier Test for Potassium

Mean	**1.49**
Standard Deviation	**1.519**
Number of data	**43**
Number of suspected outliers	**3**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	1.49	1.501	9.07	40	5.05	3.07	3.41
2	1.309	0.963	4.6	43	3.416	3.06	3.4
3	1.229	0.821	4.4	42	3.863	3.05	3.39

For 5% significance level, there are 3 Potential Outliers

Therefore, Potential Statistical Outliers are

9.07, 4.6, 4.4

For 1% Significance Level, there are 3 Potential Outliers

Therefore, Potential Statistical Outliers are

9.07, 4.6, 4.4

Outlier Tests for Selected Variables

User Selected Options

From File	SW Input_values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Aluminum

Number of data = 5

10% critical value: 0.557

5% critical value: 0.642

1% critical value: 0.78

1. Data Value 0.41 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.784

For 10% significance level, 0.41 is an outlier.

For 5% significance level, 0.41 is an outlier.

For 1% significance level, 0.41 is an outlier.

2. Data Value 0.04 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.027

For 10% significance level, 0.04 is not an outlier.

For 5% significance level, 0.04 is not an outlier.

For 1% significance level, 0.04 is not an outlier.

Dixon's Outlier Test for Chromium, total

Number of data = 14

10% critical value: 0.492

5% critical value: 0.546

1% critical value: 0.641

1. Data Value 0.00393 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.466

For 10% significance level, 0.00393 is not an outlier.

For 5% significance level, 0.00393 is not an outlier.

For 1% significance level, 0.00393 is not an outlier.

2. Data Value 0.0002 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.049

For 10% significance level, 0.0002 is not an outlier.

For 5% significance level, 0.0002 is not an outlier.

For 1% significance level, 0.0002 is not an outlier.

Dixon's Outlier Test for Iron

Number of data = 10

10% critical value: 0.409

5% critical value: 0.477

1% critical value: 0.597

1. Data Value 0.25 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.504

For 10% significance level, 0.25 is an outlier.

For 5% significance level, 0.25 is an outlier.

For 1% significance level, 0.25 is not an outlier.

2. Data Value 0.03 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.017

For 10% significance level, 0.03 is not an outlier.

For 5% significance level, 0.03 is not an outlier.

For 1% significance level, 0.03 is not an outlier.

Dixon's Outlier Test for Manganese

Number of data = 21

10% critical value: 0.391

5% critical value: 0.44

1% critical value: 0.524

1. Data Value 0.164 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.779

For 10% significance level, 0.164 is an outlier.

For 5% significance level, 0.164 is an outlier.

For 1% significance level, 0.164 is an outlier.

2. Data Value 0.0006 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.053

For 10% significance level, 0.0006 is not an outlier.

For 5% significance level, 0.0006 is not an outlier.

For 1% significance level, 0.0006 is not an outlier.

Dixon's Outlier Test for Selenium

Number of data = 5

10% critical value: 0.557

5% critical value: 0.642

1% critical value: 0.78

1. Data Value 0.001 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.775

For 10% significance level, 0.001 is an outlier.

For 5% significance level, 0.001 is an outlier.

For 1% significance level, 0.001 is not an outlier.

2. Data Value 0.00052 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.048

For 10% significance level, 0.00052 is not an outlier.

For 5% significance level, 0.00052 is not an outlier.

For 1% significance level, 0.00052 is not an outlier.

Dixon's Outlier Test for Thallium

Number of data = 4

10% critical value: 0.679

5% critical value: 0.765

1% critical value: 0.889

1. Data Value 0.00015 is a Potential Outlier (Upper Tail)?

Test Statistic: 1.000

For 10% significance level, 0.00015 is an outlier.

For 5% significance level, 0.00015 is an outlier.

For 1% significance level, 0.00015 is an outlier.

2. Data Value 0.0001 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.000

For 10% significance level, 0.0001 is not an outlier.

For 5% significance level, 0.0001 is not an outlier.

For 1% significance level, 0.0001 is not an outlier.

Rosner's Outlier Test for Vanadium

Mean	**0.00282**
Standard Deviation	**0.00666**
Number of data	**25**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.00282	0.00653	0.0339	17	4.76	2.82	3.14

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 0.0339 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 0.0339 is a Potential Statistical Outlier

Dixon's Outlier Test for Zinc

Number of data = 20

10% critical value: 0.401

5% critical value: 0.45

1% critical value: 0.535

1. Data Value 0.062 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.814

For 10% significance level, 0.062 is an outlier.

For 5% significance level, 0.062 is an outlier.

For 1% significance level, 0.062 is an outlier.

2. Data Value 0.002 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.083

For 10% significance level, 0.002 is not an outlier.

For 5% significance level, 0.002 is not an outlier.

For 1% significance level, 0.002 is not an outlier.

SURFACE WATER – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	SW Input_values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum

General Statistics

Number of Valid Data	21	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	16
Number of Missing Values	99	Percent Non-Detects	76.19%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.04	Minimum Detected	-3.219
Maximum Detected	0.41	Maximum Detected	-0.892
Mean of Detected	0.146	Mean of Detected	-2.287
SD of Detected	0.152	SD of Detected	0.915
Minimum Non-Detect	0.03	Minimum Non-Detect	-3.507
Maximum Non-Detect	0.05	Maximum Non-Detect	-2.996

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	17
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	4
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	80.95%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.75	Shapiro Wilk Test Statistic	0.922
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.049	Mean	-3.598
SD	0.0878	SD	0.884
95% DL/2 (t) UCL	0.0821	95% H-Stat (DL/2) UCL	0.0651
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-5.044
		SD in Log Scale	2.016
		Mean in Original Scale	0.0389
		SD in Original Scale	0.0916
		95% t UCL	0.0734
		95% Percentile Bootstrap UCL	0.076

95% BCA Bootstrap UCL	0.0978
95% H-UCL	0.322

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.743
Theta Star	0.196
nu star	7.43
A-D Test Statistic	0.425
5% A-D Critical Value	0.686
K-S Test Statistic	0.686
5% K-S Critical Value	0.362

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.41
Mean	0.0348
Median	0.000001
SD	0.0931
k star	0.121
Theta star	0.286
Nu star	5.103
AppChi2	1.2
95% Gamma Approximate UCL	0.148
95% Adjusted Gamma UCL	0.167

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0652
SD	0.0802
SE of Mean	0.0196
95% KM (t) UCL	0.099
95% KM (z) UCL	0.0974
95% KM (jackknife) UCL	0.092
95% KM (bootstrap t) UCL	0.158
95% KM (BCA) UCL	0.148
95% KM (Percentile Bootstrap) UCL	0.134
95% KM (Chebyshev) UCL	0.15
97.5% KM (Chebyshev) UCL	0.187
99% KM (Chebyshev) UCL	0.26

Potential UCLs to Use

95% KM (t) UCL	0.099

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Arsenic_2

General Statistics

Number of Valid Data	13	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	7
Number of Missing Values	103	Percent Non-Detects	53.85%

Raw Statistics

Minimum Detected	0.0005
Maximum Detected	0.0011
Mean of Detected	0.0007778
SD of Detected	0.0002258
Minimum Non-Detect	0.0005
Maximum Non-Detect	0.0005

Log-transformed Statistics

Minimum Detected	-7.601
Maximum Detected	-6.812
Mean of Detected	-7.195
SD of Detected	0.295
Minimum Non-Detect	-7.601
Maximum Non-Detect	-7.601

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.971
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.981
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0004936
SD	0.0003103
95% DL/2 (t) UCL	0.000647

Maximum Likelihood Estimate(MLE) Method

Mean	0.0004676
SD	0.0003587
95% MLE (t) UCL	0.0006449
95% MLE (Tiku) UCL	0.0006961

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-7.787
SD	0.601
95% H-Stat (DL/2) UCL	0.0007335

Log ROS Method

Mean in Log Scale	-7.702
SD in Log Scale	0.57
Mean in Original Scale	0.0005232
SD in Original Scale	0.0002925
95% t UCL	0.0006678
95% Percentile Bootstrap UCL	0.0006521
95% BCA Bootstrap UCL	0.0006613
95% H UCL	0.0007635

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	7.184
Theta Star	0.0001083
nu star	86.21
A-D Test Statistic	0.174
5% A-D Critical Value	0.698
K-S Test Statistic	0.698
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.0011
Mean	0.0003723
Median	0.0001664
SD	0.0004195
k star	0.268
Theta star	0.00139
Nu star	6.973
AppChi2	2.155
95% Gamma Approximate UCL	0.0012
95% Adjusted Gamma UCL	0.00145

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0006282
SD	0.000197
SE of Mean	5.984E-05
95% KM (t) UCL	0.0007349
95% KM (z) UCL	0.0007267
95% KM (jackknife) UCL	0.0007265
95% KM (bootstrap t) UCL	0.0007566
95% KM (BCA) UCL	0.0008462
95% KM (Percentile Bootstrap) UCL	0.0008
95% KM (Chebyshev) UCL	0.0008891
97.5% KM (Chebyshev) UCL	0.001
99% KM (Chebyshev) UCL	0.00122

Potential UCLs to Use

95% KM (t) UCL	0.0007349
95% KM (Percentile Bootstrap) UCL	0.0008

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Barium

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13
Number of Missing Values	105		

Raw Statistics

Minimum	0.02
Maximum	0.085
Mean	0.0439
Median	0.0383
SD	0.0213
Std. Error of Mean	0.00551
Coefficient of Variation	0.486
Skewness	0.902

Log-transformed Statistics

Minimum of Log Data	-3.912
Maximum of Log Data	-2.465
Mean of log Data	-3.231
SD of log Data	0.47

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.881
Shapiro Wilk Critical Value	0.881

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.881

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.0536

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.0543
95% Modified-t UCL (Johnson-1978)	0.0538

Assuming Lognormal Distribution

95% H-UCL	0.057
95% Chebyshev (MVUE) UCL	0.0676
97.5% Chebyshev (MVUE) UCL	0.0778
99% Chebyshev (MVUE) UCL	0.098

Gamma Distribution Test

k star (bias corrected)	4.004
Theta Star	0.011
MLE of Mean	0.0439
MLE of Standard Deviation	0.0219
nu star	120.1
Approximate Chi Square Value (.05)	95.81
Adjusted Level of Significance	0.0324
Adjusted Chi Square Value	93.14
Anderson-Darling Test Statistic	0.382
Anderson-Darling 5% Critical Value	0.739
Kolmogorov-Smirnov Test Statistic	0.134
Kolmogorov-Smirnov 5% Critical Value	0.222

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.0529
95% Jackknife UCL	0.0536
95% Standard Bootstrap UCL	0.0524
95% Bootstrap-t UCL	0.0567
95% Hall's Bootstrap UCL	0.0543
95% Percentile Bootstrap UCL	0.053
95% BCA Bootstrap UCL	0.0545
95% Chebyshev(Mean, Sd) UCL	0.0679
97.5% Chebyshev(Mean, Sd) UCL	0.0783
99% Chebyshev(Mean, Sd) UCL	0.0987

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.055
95% Adjusted Gamma UCL	0.0566

Potential UCL to Use

Use 95% Approximate Gamma UCL 0.055

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Beryllium

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15
Number of Missing Values	105	Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Beryllium was not processed!

Boron

General Statistics

Number of Valid Data	7	Number of Detected Data	4
Number of Distinct Detected Data	2	Number of Non-Detect Data	3
Number of Missing Values	113	Percent Non-Detects	42.86%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0167	Minimum Detected	-4.092
Maximum Detected	0.02	Maximum Detected	-3.912
Mean of Detected	0.0192	Mean of Detected	-3.957
SD of Detected	0.00165	SD of Detected	0.0902
Minimum Non-Detect	0.01	Minimum Non-Detect	-4.605
Maximum Non-Detect	0.01	Maximum Non-Detect	-4.605

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only | Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.63
5% Shapiro Wilk Critical Value	0.748

Data not Normal at 5% Significance Level

Shapiro Wilk Test Statistic	0.63
5% Shapiro Wilk Critical Value	0.748

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0131
SD	0.00767
95% DL/2 (t) UCL	0.0187
Maximum Likelihood Estimate(MLE) Method	
Mean	0.0131
SD	0.00763
95% MLE (t) UCL	0.0187
95% MLE (Tiku) UCL	0.0196

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-4.532
SD	0.72
95% H-Stat (DL/2) UCL	0.0332
Log ROS Method	
Mean in Log Scale	-4.042
SD in Log Scale	0.128
Mean in Original Scale	0.0177
SD in Original Scale	0.00225
95% t UCL	0.0193
95% Percentile Bootstrap UCL	0.019
95% BCA Bootstrap UCL	0.019
95% H UCL	0.0195

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	42.5
Theta Star	0.0004512
nu star	340
A-D Test Statistic	0.96
5% A-D Critical Value	0.657
K-S Test Statistic	0.657
5% K-S Critical Value	0.394

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.00987
Maximum	0.02
Mean	0.0163
Median	0.0167
SD	0.00402
k star	9.885
Theta star	0.00165
Nu star	138.4
AppChi2	112.2
95% Gamma Approximate UCL	0.0201
95% Adjusted Gamma UCL	N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0181
SD	0.00163
SE of Mean	0.0007127
95% KM (t) UCL	0.0195
95% KM (z) UCL	0.0193
95% KM (jackknife) UCL	N/A
95% KM (bootstrap t) UCL	N/A
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	N/A
95% KM (Chebyshev) UCL	0.0212
97.5% KM (Chebyshev) UCL	0.0226
99% KM (Chebyshev) UCL	0.0252

Potential UCLs to Use

95% KM (t) UCL	0.0195
95% KM (% Bootstrap) UCL	N/A

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cadmium

General Statistics

Number of Valid Data	44	Number of Detected Data	2
Number of Distinct Detected Data	1	Number of Non-Detect Data	42
Number of Missing Values	76	Percent Non-Detects	95.45%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Cadmium was not processed!

Calcium

General Statistics

Number of Valid Observations	46	Number of Distinct Observations	45
Number of Missing Values	74		

Raw Statistics		Log-transformed Statistics	
Minimum	16.8	Minimum of Log Data	2.821
Maximum	93.2	Maximum of Log Data	4.535
Mean	47.74	Mean of log Data	3.796
Median	50.2	SD of log Data	0.391
SD	17.23		
Std. Error of Mean	2.54		
Coefficient of Variation	0.361		
Skewness	0.479		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.945	Shapiro Wilk Critical Value	0.945
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	52.01	95% H-UCL	53.44
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	60.43
95% Adjusted-CLT UCL (Chen-1995)	52.11	97.5% Chebyshev (MVUE) UCL	65.8
95% Modified-t UCL (Johnson-1978)	52.04	99% Chebyshev (MVUE) UCL	76.37

Gamma Distribution Test		Data Distribution
k star (bias corrected)	6.905	Data appear Normal at 5% Significance Level
Theta Star	6.914	
MLE of Mean	47.74	
MLE of Standard Deviation	18.17	
nu star	635.3	
Approximate Chi Square Value (.05)	577.8	**Nonparametric Statistics**
Adjusted Level of Significance	0.0448	95% CLT UCL 51.92
Adjusted Chi Square Value	576	95% Jackknife UCL 52.01
		95% Standard Bootstrap UCL 51.9
Anderson-Darling Test Statistic	0.548	95% Bootstrap-t UCL 52.26
Anderson-Darling 5% Critical Value	0.751	95% Hall's Bootstrap UCL 52.29
Kolmogorov-Smirnov Test Statistic	0.122	95% Percentile Bootstrap UCL 51.93

Kolmogorov-Smirnov 5% Critical Value	0.131	95% BCA Bootstrap UCL	52.01
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	58.81
		97.5% Chebyshev(Mean, Sd) UCL	63.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	73.02
95% Approximate Gamma UCL	52.49		
95% Adjusted Gamma UCL	52.65		
Potential UCL to Use		Use 95% Student's-t UCL	52.01

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium, total

General Statistics

Number of Valid Data	37	Number of Detected Data	14
Number of Distinct Detected Data	9	Number of Non-Detect Data	23
Number of Missing Values	83	Percent Non-Detects	62.16%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.00393	Maximum Detected	-5.539
Mean of Detected	0.0011	Mean of Detected	-7.296
SD of Detected	0.00115	SD of Detected	1.016
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	29
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	8
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	78.38%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.782	Shapiro Wilk Test Statistic	0.901
5% Shapiro Wilk Critical Value	0.874	5% Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0004533	Mean	-8.873
SD	0.0008612	SD	1.414
95% DL/2 (t) UCL	0.0006923	95% H-Stat (DL/2) UCL	0.0007539
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-9.251
		SD in Log Scale	1.904
		Mean in Original Scale	0.0004471
		SD in Original Scale	0.0008641
		95% t UCL	0.0006869
		95% Percentile Bootstrap UCL	0.0007025
		95% BCA Bootstrap UCL	0.000738

95% H-UCL	0.00184

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.967
Theta Star	0.00114
nu star	27.07
A-D Test Statistic	0.764
5% A-D Critical Value	0.757
K-S Test Statistic	0.757
5% K-S Critical Value	0.234

Data follow Appr. Gamma Distribution at 5% Significance Level

Data Distribution Test with Detected Values Only

Data Follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.00393
Mean	0.0004175
Median	0.000001
SD	0.0008777
k star	0.207
Theta star	0.00202
Nu star	15.3
AppChi2	7.473
95% Gamma Approximate UCL	0.0008549
95% Adjusted Gamma UCL	0.000883

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0005416
SD	0.0008097
SE of Mean	0.0001382
95% KM (t) UCL	0.0007748
95% KM (z) UCL	0.0007688
95% KM (jackknife) UCL	0.0007694
95% KM (bootstrap t) UCL	0.0009682
95% KM (BCA) UCL	0.0008096
95% KM (Percentile Bootstrap) UCL	0.0007942
95% KM (Chebyshev) UCL	0.00114
97.5% KM (Chebyshev) UCL	0.0014
99% KM (Chebyshev) UCL	0.00192

Potential UCLs to Use

95% KM (t) UCL	0.0007748

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cobalt

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15
Number of Missing Values	105	Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Cobalt was not processed!

Copper

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15

Number of Missing Values	105	Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Copper was not processed!

Iron_1

General Statistics

Number of Valid Data	22	Number of Detected Data	9
Number of Distinct Detected Data	8	Number of Non-Detect Data	13
Number of Missing Values	98	Percent Non-Detects	59.09%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.03	Minimum Detected	-3.507
Maximum Detected	0.14	Maximum Detected	-1.966
Mean of Detected	0.0597	Mean of Detected	-2.961
SD of Detected	0.0371	SD of Detected	0.544
Minimum Non-Detect	0.02	Minimum Non-Detect	-3.912
Maximum Non-Detect	0.025	Maximum Non-Detect	-3.689

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	9
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	59.09%

Warning: There are only 9 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.808	Shapiro Wilk Test Statistic	0.886
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0309	Mean	-3.882
SD	0.0336	SD	0.857
95% DL/2 (t) UCL	0.0432	95% H-Stat (DL/2) UCL	0.0466
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0102	Mean in Log Scale	-3.993
SD	0.0543	SD in Log Scale	1.037
95% MLE (t) UCL	0.0301	Mean in Original Scale	0.0306
95% MLE (Tiku) UCL	0.038	SD in Original Scale	0.034

95% t UCL	0.0431
95% Percentile Bootstrap UCL	0.0428
95% BCA Bootstrap UCL	0.0457
95% H UCL	0.0574

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.508
Theta Star	0.0238
nu star	45.14
A-D Test Statistic	0.579
5% A-D Critical Value	0.726
K-S Test Statistic	0.726
5% K-S Critical Value	0.281

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.14
Mean	0.0244
Median	0.000001
SD	0.0378
k star	0.149
Theta star	0.164
Nu star	6.555
AppChi2	1.93
95% Gamma Approximate UCL	0.083
95% Adjusted Gamma UCL	0.0916

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0422
SD	0.0267
SE of Mean	0.00604
95% KM (t) UCL	0.0526
95% KM (z) UCL	0.0521
95% KM (jackknife) UCL	0.0514
95% KM (bootstrap t) UCL	0.0603
95% KM (BCA) UCL	0.055
95% KM (Percentile Bootstrap) UCL	0.0532
95% KM (Chebyshev) UCL	0.0685
97.5% KM (Chebyshev) UCL	0.0799
99% KM (Chebyshev) UCL	0.102

Potential UCLs to Use

95% KM (t) UCL	0.0526

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Magnesium

General Statistics

Number of Valid Observations	46	Number of Distinct Observations	40
Number of Missing Values	74		

Raw Statistics

Minimum	3.44
Maximum	19
Mean	10.21
Median	11.1
SD	3.415
Std. Error of Mean	0.504
Coefficient of Variation	0.334
Skewness	0.0741

Log-transformed Statistics

Minimum of Log Data	1.235
Maximum of Log Data	2.944
Mean of log Data	2.26
SD of log Data	0.38

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.97
Shapiro Wilk Critical Value	0.945

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.932
Shapiro Wilk Critical Value	0.945

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	11.06

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	11.04
95% Modified-t UCL (Johnson-1978)	11.06

Assuming Lognormal Distribution

95% H-UCL	11.41
95% Chebyshev (MVUE) UCL	12.86
97.5% Chebyshev (MVUE) UCL	13.98
99% Chebyshev (MVUE) UCL	16.18

Gamma Distribution Test

k star (bias corrected)	7.5
Theta Star	1.361
MLE of Mean	10.21
MLE of Standard Deviation	3.728
nu star	690
Approximate Chi Square Value (.05)	630.1
Adjusted Level of Significance	0.0448
Adjusted Chi Square Value	628.2
Anderson-Darling Test Statistic	0.91
Anderson-Darling 5% Critical Value	0.75
Kolmogorov-Smirnov Test Statistic	0.173
Kolmogorov-Smirnov 5% Critical Value	0.131

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	11.18
95% Adjusted Gamma UCL	11.21

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	11.04
95% Jackknife UCL	11.06
95% Standard Bootstrap UCL	11.03
95% Bootstrap-t UCL	11.04
95% Hall's Bootstrap UCL	11.08
95% Percentile Bootstrap UCL	11
95% BCA Bootstrap UCL	11.09
95% Chebyshev(Mean, Sd) UCL	12.41
97.5% Chebyshev(Mean, Sd) UCL	13.36
99% Chebyshev(Mean, Sd) UCL	15.22

Potential UCL to Use

Use 95% Student's-t UCL 11.06

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Manganese_1

General Statistics

Number of Valid Observations	20
Number of Missing Values	96
Number of Distinct Observations	20

Raw Statistics

Minimum	0.0006
Maximum	0.0484
Mean	0.0182
Median	0.0175
SD	0.0145
Std. Error of Mean	0.00324
Coefficient of Variation	0.798
Skewness	0.522

Log-transformed Statistics

Minimum of Log Data	-7.419
Maximum of Log Data	-3.028
Mean of log Data	-4.5
SD of log Data	1.205

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.92
Shapiro Wilk Critical Value	0.905

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.912
Shapiro Wilk Critical Value	0.905

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.0238

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.0239
95% Modified-t UCL (Johnson-1978)	0.0238

Assuming Lognormal Distribution

95% H-UCL	0.0517
95% Chebyshev (MVUE) UCL	0.051
97.5% Chebyshev (MVUE) UCL	0.0637
99% Chebyshev (MVUE) UCL	0.0886

Gamma Distribution Test

k star (bias corrected)	1.016
Theta Star	0.0179
MLE of Mean	0.0182
MLE of Standard Deviation	0.018
nu star	40.62
Approximate Chi Square Value (.05)	27.02
Adjusted Level of Significance	0.038
Adjusted Chi Square Value	26.14
Anderson-Darling Test Statistic	0.438
Anderson-Darling 5% Critical Value	0.765
Kolmogorov-Smirnov Test Statistic	0.156
Kolmogorov-Smirnov 5% Critical Value	0.199

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.0273
95% Adjusted Gamma UCL	0.0282

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.0235
95% Jackknife UCL	0.0238
95% Standard Bootstrap UCL	0.0234
95% Bootstrap-t UCL	0.0244
95% Hall's Bootstrap UCL	0.0239
95% Percentile Bootstrap UCL	0.0233
95% BCA Bootstrap UCL	0.024
95% Chebyshev(Mean, Sd) UCL	0.0323
97.5% Chebyshev(Mean, Sd) UCL	0.0384
99% Chebyshev(Mean, Sd) UCL	0.0504

Potential UCL to Use

Use 95% Student's-t UCL 0.0238

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mercury

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15
Number of Missing Values	105	Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Mercury was not processed!

Molybdenum

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15
Number of Missing Values	105	Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Molybdenum was not processed!

Nickel_1

General Statistics

Number of Valid Data	41	Number of Detected Data	35
Number of Distinct Detected Data	20	Number of Non-Detect Data	6
Number of Missing Values	77	Percent Non-Detects	14.63%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0004	Minimum Detected	-7.824
Maximum Detected	0.00221	Maximum Detected	-6.115
Mean of Detected	0.00127	Mean of Detected	-6.751
SD of Detected	0.0004883	SD of Detected	0.44
Minimum Non-Detect	0.0002	Minimum Non-Detect	-8.517
Maximum Non-Detect	0.0006	Maximum Non-Detect	-7.419

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	9
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	32
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	21.95%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Test Statistic	0.917
5% Shapiro Wilk Critical Value	0.934	5% Shapiro Wilk Critical Value	0.934
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00112	Mean	-7.031
SD	0.000593	SD	0.823
95% DL/2 (t) UCL	0.00127	95% H-Stat (DL/2) UCL	0.00164
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.00111	Mean in Log Scale	-6.885
SD	0.000604	SD in Log Scale	0.524
95% MLE (t) UCL	0.00127	Mean in Original Scale	0.00116
95% MLE (Tiku) UCL	0.00128	SD in Original Scale	0.0005338

95% t UCL	0.0013
95% Percentile Bootstrap UCL	0.00129
95% BCA Bootstrap UCL	0.0013
95% H UCL	0.00138

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.567
Theta Star	0.0002287
nu star	389.7
A-D Test Statistic	0.979
5% A-D Critical Value	0.749
K-S Test Statistic	0.749
5% K-S Critical Value	0.149

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.00221
Mean	0.0011
Median	0.0011
SD	0.0006254
k star	0.773
Theta star	0.00142
Nu star	63.39
AppChi2	46.08
95% Gamma Approximate UCL	0.00151
95% Adjusted Gamma UCL	0.00153

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.00115
SD	0.0005381
SE of Mean	8.53E-05
95% KM (t) UCL	0.00129
95% KM (z) UCL	0.00129
95% KM (jackknife) UCL	0.00128
95% KM (bootstrap t) UCL	0.00129
95% KM (BCA) UCL	0.0013
95% KM (Percentile Bootstrap) UCL	0.0013
95% KM (Chebyshev) UCL	0.00152
97.5% KM (Chebyshev) UCL	0.00168
99% KM (Chebyshev) UCL	0.002

Potential UCLs to Use

95% KM (t) UCL	0.00129
95% KM (Percentile Bootstrap) UCL	0.0013

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Potassium_1

General Statistics

Number of Valid Data	41	Number of Detected Data	40
Number of Distinct Detected Data	22	Number of Non-Detect Data	1
Number of Missing Values	75	Percent Non-Detects	2.44%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.3	Minimum Detected	-1.204
Maximum Detected	2.3	Maximum Detected	0.833
Mean of Detected	1.15	Mean of Detected	-0.0339
SD of Detected	0.653	SD of Detected	0.616
Minimum Non-Detect	0.3	Minimum Non-Detect	-1.204
Maximum Non-Detect	0.3	Maximum Non-Detect	-1.204

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.869
5% Shapiro Wilk Critical Value	0.94

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.918
5% Shapiro Wilk Critical Value	0.94

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	1.125
SD	0.664
95% DL/2 (t) UCL	1.3
Maximum Likelihood Estimate(MLE) Method	
Mean	1.121
SD	0.663
95% MLE (t) UCL	1.296
95% MLE (Tiku) UCL	1.29

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-0.0794
SD	0.674
95% H-Stat (DL/2) UCL	1.44
Log ROS Method	
Mean in Log Scale	-0.0718
SD in Log Scale	0.655
Mean in Original Scale	1.127
SD in Original Scale	0.662
95% t UCL	1.301
95% Percentile Bootstrap UCL	1.303
95% BCA Bootstrap UCL	1.304
95% H UCL	1.421

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.826
Theta Star	0.407
nu star	226.1
A-D Test Statistic	1.16
5% A-D Critical Value	0.755
K-S Test Statistic	0.755
5% K-S Critical Value	0.14

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	2.3
Mean	1.122
Median	0.8
SD	0.67
k star	1.1
Theta star	1.02
Nu star	90.21
AppChi2	69.31
95% Gamma Approximate UCL	1.46
95% Adjusted Gamma UCL	1.474

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	1.129
SD	0.65
SE of Mean	0.103
95% KM (t) UCL	1.302
95% KM (z) UCL	1.298
95% KM (jackknife) UCL	1.302
95% KM (bootstrap t) UCL	1.322
95% KM (BCA) UCL	1.296
95% KM (Percentile Bootstrap) UCL	1.295
95% KM (Chebyshev) UCL	1.578
97.5% KM (Chebyshev) UCL	1.772
99% KM (Chebyshev) UCL	2.153

Potential UCLs to Use

95% KM (Chebyshev) UCL	1.578

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Selenium

General Statistics

Number of Valid Data	45	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	40
Number of Missing Values	76	Percent Non-Detects	88.89%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.00052	Minimum Detected	-7.562
Maximum Detected	0.001	Maximum Detected	-6.908
Mean of Detected	0.000647	Mean of Detected	-7.375
SD of Detected	0.0002016	SD of Detected	0.271
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.001	Maximum Non-Detect	-6.908

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	44
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	1
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	97.78%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.709	Shapiro Wilk Test Statistic	0.751
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0004941	Mean	-7.637
SD	0.0001086	SD	0.234
95% DL/2 (t) UCL	0.0005213	95% H-Stat (DL/2) UCL	0.0005263
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-7.696
		SD in Log Scale	0.304
		Mean in Original Scale	0.0004761
		SD in Original Scale	0.0001506
		95% t UCL	0.0005138
		95% Percentile Bootstrap UCL	0.0005134
		95% BCA Bootstrap UCL	0.0005177
		95% H-UCL	0.0005167

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	6.389	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	0.0001013	
nu star	63.89	
A-D Test Statistic	0.768	Nonparametric Statistics

5% A-D Critical Value	0.679
K-S Test Statistic	0.679
5% K-S Critical Value	0.357

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.001
Mean	0.000335
Median	0.0003237
SD	0.0003032
k star	0.378
Theta star	0.0008868
Nu star	34
AppChi2	21.66
95% Gamma Approximate UCL	0.0005257
95% Adjusted Gamma UCL	0.0005338

Note: DL/2 is not a recommended method.

Kaplan-Meier (KM) Method	
Mean	0.0005496
SD	7.618E-05
SE of Mean	1.762E-05
95% KM (t) UCL	0.0005792
95% KM (z) UCL	0.0005786
95% KM (jackknife) UCL	0.0005755
95% KM (bootstrap t) UCL	0.0006277
95% KM (BCA) UCL	0.0006445
95% KM (Percentile Bootstrap) UCL	0.0006064
95% KM (Chebyshev) UCL	0.0006264
97.5% KM (Chebyshev) UCL	0.0006596
99% KM (Chebyshev) UCL	0.0007249

Potential UCLs to Use

95% KM (t) UCL	0.0005792

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Silver

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15
Number of Missing Values	105	Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Silver was not processed!

Thallium

General Statistics

Number of Valid Data	15	Number of Detected Data	4
Number of Distinct Detected Data	2	Number of Non-Detect Data	11
Number of Missing Values	105	Percent Non-Detects	73.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0001	Minimum Detected	-9.21
Maximum Detected	0.00015	Maximum Detected	-8.805
Mean of Detected	0.0001125	Mean of Detected	-9.109
SD of Detected	0.000025	SD of Detected	0.203
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21

Maximum Non-Detect	0.0001	Maximum Non-Detect	-9.21

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.63
5% Shapiro Wilk Critical Value	0.748

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.63
5% Shapiro Wilk Critical Value	0.748

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	6.667E-05
SD	3.086E-05
95% DL/2 (t) UCL	8.07E-05

Maximum Likelihood Estimate(MLE) Method

Mean	7.897E-05
SD	2.98E-05
95% MLE (t) UCL	9.252E-05
95% MLE (Tiku) UCL	0.0001056

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-9.692
SD	0.376
95% H-Stat (DL/2) UCL	8.062E-05

Log ROS Method

Mean in Log Scale	-9.674
SD in Log Scale	0.447
Mean in Original Scale	6.911E-05
SD in Original Scale	3.221E-05
95% t UCL	8.376E-05
95% Percentile Bootstrap UCL	8.318E-05
95% BCA Bootstrap UCL	8.44E-05
95% H UCL	8.842E-05

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	7.822
Theta Star	1.438E-05
nu star	62.58
A-D Test Statistic	0.961
5% A-D Critical Value	0.657
K-S Test Statistic	0.657
5% K-S Critical Value	0.394

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0001033
SD	1.247E-05
SE of Mean	3.719E-06
95% KM (t) UCL	0.0001099
95% KM (z) UCL	0.0001095
95% KM (jackknife) UCL	N/A
95% KM (bootstrap t) UCL	N/A

Maximum	0.00015	95% KM (BCA) UCL	N/A
Mean	3.724E-05	95% KM (Percentile Bootstrap) UCL	N/A
Median	0.000001	95% KM (Chebyshev) UCL	0.0001195
SD	5.07E-05	97.5% KM (Chebyshev) UCL	0.0001266
k star	0.356	99% KM (Chebyshev) UCL	0.0001403
Theta star	0.0001045		
Nu star	10.69	**Potential UCLs to Use**	
AppChi2	4.378	95% KM (t) UCL	0.0001099
95% Gamma Approximate UCL	9.093E-05	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Uranium

General Statistics

Number of Valid Data	29	Number of Detected Data	25
Number of Distinct Detected Data	10	Number of Non-Detect Data	4
Number of Missing Values	91	Percent Non-Detects	13.79%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.0012	Maximum Detected	-6.725
Mean of Detected	0.0004813	Mean of Detected	-7.788
SD of Detected	0.0002771	SD of Detected	0.556
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.0001	Maximum Non-Detect	-9.21

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.871	Shapiro Wilk Test Statistic	0.927
5% Shapiro Wilk Critical Value	0.918	5% Shapiro Wilk Critical Value	0.918
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0004218	Mean	-8.08
SD	0.0002978	SD	0.903
95% DL/2 (t) UCL	0.0005159	95% H-Stat (DL/2) UCL	0.0006959
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0004051	Mean in Log Scale	-7.965
SD	0.0003206	SD in Log Scale	0.688
95% MLE (t) UCL	0.0005063	Mean in Original Scale	0.000431
95% MLE (Tiku) UCL	0.0005067	SD in Original Scale	0.0002868
		95% t UCL	0.0005216
		95% Percentile Bootstrap UCL	0.0005201
		95% BCA Bootstrap UCL	0.0005379

95% H UCL	0.0005797

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	3.12
Theta Star	0.0001543
nu star	156
A-D Test Statistic	0.566
5% A-D Critical Value	0.75
K-S Test Statistic	0.75
5% K-S Critical Value	0.176

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.0012
Mean	0.0004151
Median	0.0004
SD	0.0003069
k star	0.671
Theta star	0.0006185
Nu star	38.93
AppChi2	25.64
95% Gamma Approximate UCL	0.0006303
95% Adjusted Gamma UCL	0.0006465

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0004425
SD	0.0002701
SE of Mean	5.119E-05
95% KM (t) UCL	0.0005296
95% KM (z) UCL	0.0005267
95% KM (jackknife) UCL	0.0005293
95% KM (bootstrap t) UCL	0.0005469
95% KM (BCA) UCL	0.0005287
95% KM (Percentile Bootstrap) UCL	0.0005287
95% KM (Chebyshev) UCL	0.0006656
97.5% KM (Chebyshev) UCL	0.0007622
99% KM (Chebyshev) UCL	0.0009518

Potential UCLs to Use

95% KM (BCA) UCL	0.0005287

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium_1

General Statistics

Number of Valid Data	45	Number of Detected Data	24
Number of Distinct Detected Data	19	Number of Non-Detect Data	21
Number of Missing Values	75	Percent Non-Detects	46.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0003	Minimum Detected	-8.112
Maximum Detected	0.0062	Maximum Detected	-5.083
Mean of Detected	0.00153	Mean of Detected	-6.916
SD of Detected	0.00161	SD of Detected	0.912
Minimum Non-Detect	0.00005	Minimum Non-Detect	-9.903
Maximum Non-Detect	0.005	Maximum Non-Detect	-5.298

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	43
Number treated as Detected	2
Single DL Non-Detect Percentage	95.56%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.745
5% Shapiro Wilk Critical Value	0.916

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.00129
SD	0.00144
95% DL/2 (t) UCL	0.00165
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.913
5% Shapiro Wilk Critical Value	0.916

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-7.436
SD	1.421
95% H-Stat (DL/2) UCL	0.003
Log ROS Method	
Mean in Log Scale	-7.691
SD in Log Scale	1.25
Mean in Original Scale	0.0009633
SD in Original Scale	0.00134
95% t UCL	0.0013
95% Percentile Bootstrap UCL	0.0013
95% BCA Bootstrap UCL	0.00137
95% H-UCL	0.00165

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.164
Theta Star	0.00131
nu star	55.88
A-D Test Statistic	1.243
5% A-D Critical Value	0.766
K-S Test Statistic	0.766
5% K-S Critical Value	0.182

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.0062
Mean	0.0009575
Median	0.00042
SD	0.00141
k star	0.271
Theta star	0.00353
Nu star	24.41
AppChi2	14.16
95% Gamma Approximate UCL	0.00165
95% Adjusted Gamma UCL	0.00168

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.00105
SD	0.00132
SE of Mean	0.0002109
95% KM (t) UCL	0.0014
95% KM (z) UCL	0.0014
95% KM (jackknife) UCL	0.00139
95% KM (bootstrap t) UCL	0.00151
95% KM (BCA) UCL	0.00148
95% KM (Percentile Bootstrap) UCL	0.00142
95% KM (Chebyshev) UCL	0.00197
97.5% KM (Chebyshev) UCL	0.00237
99% KM (Chebyshev) UCL	0.00315

Potential UCLs to Use

95% KM (t) UCL	0.0014
95% KM (% Bootstrap) UCL	0.00142

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Data	41	Number of Detected Data	19
Number of Distinct Detected Data	11	Number of Non-Detect Data	22
Number of Missing Values	79	Percent Non-Detects	53.66%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.002	Minimum Detected	-6.215
Maximum Detected	0.015	Maximum Detected	-4.2
Mean of Detected	0.0067	Mean of Detected	-5.193
SD of Detected	0.00421	SD of Detected	0.636
Minimum Non-Detect	0.002	Minimum Non-Detect	-6.215
Maximum Non-Detect	0.01	Maximum Non-Detect	-4.605

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	37
Number treated as Detected	4
Single DL Non-Detect Percentage	90.24%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.872	Shapiro Wilk Test Statistic	0.945
5% Shapiro Wilk Critical Value	0.901	5% Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00401	Mean	-5.906
SD	0.00387	SD	0.875
95% DL/2 (t) UCL	0.00502	95% H-Stat (DL/2) UCL	0.00543
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-6.008
		SD in Log Scale	0.963
		Mean in Original Scale	0.00385
		SD in Original Scale	0.00393
		95% t UCL	0.00488
		95% Percentile Bootstrap UCL	0.00496
		95% BCA Bootstrap UCL	0.00504
		95% H-UCL	0.00556

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	2.409	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.00278	
nu star	91.55	
A-D Test Statistic	0.484	Nonparametric Statistics
5% A-D Critical Value	0.749	Kaplan-Meier (KM) Method
K-S Test Statistic	0.749	Mean 0.00427
5% K-S Critical Value	0.2	SD 0.00362
Data appear Gamma Distributed at 5% Significance Level		SE of Mean 0.0005856
		95% KM (t) UCL 0.00525
Assuming Gamma Distribution		95% KM (z) UCL 0.00523
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 0.00524

Minimum	0.000001
Maximum	0.015
Mean	0.00318
Median	0.0001627
SD	0.00438
k star	0.199
Theta star	0.016
Nu star	16.28
AppChi2	8.163
95% Gamma Approximate UCL	0.00635
95% Adjusted Gamma UCL	0.00652

95% KM (bootstrap t) UCL	0.00542
95% KM (BCA) UCL	0.00545
95% KM (Percentile Bootstrap) UCL	0.00545
95% KM (Chebyshev) UCL	0.00682
97.5% KM (Chebyshev) UCL	0.00792
99% KM (Chebyshev) UCL	0.0101

Potential UCLs to Use

95% KM (t) UCL	0.00525

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

SURFACE WATER – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	SW Input_values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Aluminum

General Statistics

Number of Valid Data	21	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	16
Tolerance Factor	2.371	Percent Non-Detects	76.19%
Number of Missing Values	99		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.04	Minimum Detected	-3.219
Maximum Detected	0.41	Maximum Detected	-0.892
Mean of Detected	0.146	Mean of Detected	-2.287
SD of Detected	0.152	SD of Detected	0.915
Minimum Non-Detect	0.03	Minimum Non-Detect	-3.507
Maximum Non-Detect	0.05	Maximum Non-Detect	-2.996

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	17
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	80.95%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.75
5% Shapiro Wilk Critical Value	0.762

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.922
5% Shapiro Wilk Critical Value	0.762

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.049
	SD	0.0878
95% UTL	95% Coverage	0.257
	95% UPL (t)	0.204
	90% Percentile (z)	0.162
	95% Percentile (z)	0.193
	99% Percentile (z)	0.253

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-3.598
	SD (Log Scale)	0.884
95% UTL	95% Coverage	0.222
	95% UPL (t)	0.13
	90% Percentile (z)	0.0849
	95% Percentile (z)	0.117
	99% Percentile (z)	0.214

Maximum Likelihood Estimate(MLE) Method	
Mean	-0.173
SD	0.249
95% UTL with 95% Coverage	0.417
95% UPL (t)	0.266
90% Percentile (z)	0.146
95% Percentile (z)	0.236
99% Percentile (z)	0.405

Log ROS Method	
Mean in Original Scale	0.0389
SD in Original Scale	0.0916
95% UTL with 95% Coverage	0.767
95% BCA UTL with 95% Coverage	0.41
95% Bootstrap (%) UTL with 95% Coverage	0.41
95% UPL (t)	0.226
90% Percentile (z)	0.0853
95% Percentile (z)	0.177
99% Percentile (z)	0.701

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.743
Theta Star	0.196
nu star	7.43
A-D Test Statistic	0.425
5% A-D Critical Value	0.686
K-S Test Statistic	0.283
5% K-S Critical Value	0.362

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0348
Median	0.000001
SD	0.0931
k star	0.121
Theta star	0.286
Nu star	5.103
95% Percentile of Chisquare (2k)	1.384
90% Percentile	0.0988
95% Percentile	0.198
99% Percentile	0.5

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0652
SD	0.0802
SE of Mean	0.0196
95% KM UTL with 95% Coverage	0.255
95% KM Chebyshev UPL	0.423
95% KM UPL (t)	0.207
90% Percentile (z)	0.168
95% Percentile (z)	0.197
99% Percentile (z)	0.252

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.133
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.126
95% WH Approx. Gamma UTL with 95% Coverage	0.266
95% HW Approx. Gamma UTL with 95% Coverage	0.308

Note: DL/2 is not a recommended method.

Arsenic_2

General Statistics

Number of Valid Data	13
Number of Detected Data	6
Number of Distinct Detected Data	6
Number of Non-Detect Data	7
Tolerance Factor	2.671
Percent Non-Detects	53.85%
Number of Missing Values	103

Raw Statistics

Minimum Detected	0.0005
Maximum Detected	0.0011
Mean of Detected	0.0007778
SD of Detected	0.0002258

Log-transformed Statistics

Minimum Detected	-7.601
Maximum Detected	-6.812
Mean of Detected	-7.195
SD of Detected	0.295

Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.971
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.981
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0004936
	SD	0.0003103
95% UTL	95% Coverage	0.00132
	95% UPL (t)	0.00107
	90% Percentile (z)	0.0008912
	95% Percentile (z)	0.001
	99% Percentile (z)	0.00122

Maximum Likelihood Estimate(MLE) Method

	Mean	0.0004676
	SD	0.0003587
95% UTL with	95% Coverage	0.00143
	95% UPL (t)	0.00113
	90% Percentile (z)	0.0009273
	95% Percentile (z)	0.00106
	99% Percentile (z)	0.0013

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-7.787
	SD (Log Scale)	0.601
95% UTL	95% Coverage	0.00207
	95% UPL (t)	0.00126
	90% Percentile (z)	0.0008973
	95% Percentile (z)	0.00112
	99% Percentile (z)	0.00168

Log ROS Method

	Mean in Original Scale	0.0005232
	SD in Original Scale	0.0002925
95% UTL with	95% Coverage	0.00207
95% BCA UTL with	95% Coverage	0.0011
95% Bootstrap (%) UTL with	95% Coverage	0.0011
	95% UPL (t)	0.0013
	90% Percentile (z)	0.0009387
	95% Percentile (z)	0.00115
	99% Percentile (z)	0.0017

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	7.184
Theta Star	0.0001083
nu star	86.21
A-D Test Statistic	0.174
5% A-D Critical Value	0.698
K-S Test Statistic	0.159
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0003723
Median	0.0001664

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0006282
	SD	0.000197
	SE of Mean	5.984E-05
95% KM UTL with	95% Coverage	0.00115
	95% KM Chebyshev UPL	0.00152
	95% KM UPL (t)	0.0009925
	90% Percentile (z)	0.0008807
	95% Percentile (z)	0.0009522

SD	0.0004195
k star	0.268
Theta star	0.00139
Nu star	6.973
95% Percentile of Chisquare (2k)	2.542
90% Percentile	0.00111
95% Percentile	0.00176
99% Percentile	0.00349

99% Percentile (z)	0.00109

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00204
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00257
95% WH Approx. Gamma UTL with 95% Coverage	0.00414
95% HW Approx. Gamma UTL with 95% Coverage	0.00621

Note: DL/2 is not a recommended method.

Barium

General Statistics

Total Number of Observations	15
Tolerance Factor	2.566
Number of Distinct Observations	13
Number of Missing Values	105

Raw Statistics

Minimum	0.02
Maximum	0.085
Second Largest	0.08
First Quartile	0.027
Median	0.0383
Third Quartile	0.05
Mean	0.0439
SD	0.0213
Coefficient of Variation	0.486
Skewness	0.902

Log-Transformed Statistics

Minimum	-3.912
Maximum	-2.465
Second Largest	-2.526
First Quartile	-3.612
Median	-3.262
Third Quartile	-2.998
Mean	-3.231
SD	0.47

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.881
Shapiro Wilk Critical Value	0.881

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.881

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	0.0986
95% UPL (t)	0.0827
90% Percentile (z)	0.0712
95% Percentile (z)	0.079
99% Percentile (z)	0.0935

Assuming Lognormal Distribution

95% UTL with 95% Coverage	0.132
95% UPL (t)	0.0929
90% Percentile (z)	0.0722
95% Percentile (z)	0.0856
99% Percentile (z)	0.118

Gamma Distribution Test

k star	4.004
Theta Star	0.011
MLE of Mean	0.0439
MLE of Standard Deviation	0.0219
nu star	120.1
A-D Test Statistic	0.382
5% A-D Critical Value	0.739

Data Distribution Test

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.0784

K-S Test Statistic	0.134	95% Percentile	0.0815
5% K-S Critical Value	0.222	99% Percentile	0.0843

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution			
90% Percentile	0.0733	95% UTL with 95% Coverage	0.085
95% Percentile	0.085	95% Percentile Bootstrap UTL with 95% Coverage	0.085
99% Percentile	0.11	95% BCA Bootstrap UTL with 95% Coverage	0.085
		95% UPL	0.085
		95% Chebyshev UPL	0.14
95% WH Approx. Gamma UPL	0.0877	Upper Threshold Limit Based upon IQR	0.0845
95% HW Approx. Gamma UPL	0.0887		
95% WH Approx. Gamma UTL with 95% Coverage	0.114		
95% HW Approx. Gamma UTL with 95% Coverage	0.118		

Beryllium

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Beryllium was not processed!

Boron

General Statistics

Number of Valid Data	7	Number of Detected Data	4
Number of Distinct Detected Data	2	Number of Non-Detect Data	3
Tolerance Factor	3.399	Percent Non-Detects	42.86%
Number of Missing Values	113		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0167	Minimum Detected	-4.092
Maximum Detected	0.02	Maximum Detected	-3.912
Mean of Detected	0.0192	Mean of Detected	-3.957
SD of Detected	0.00165	SD of Detected	0.0902
Minimum Non-Detect	0.01	Minimum Non-Detect	-4.605
Maximum Non-Detect	0.01	Maximum Non-Detect	-4.605

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.63
5% Shapiro Wilk Critical Value	0.748

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.63
5% Shapiro Wilk Critical Value	0.748

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0131
	SD	0.00767
95% UTL	95% Coverage	0.0392
	95% UPL (t)	0.029
	90% Percentile (z)	0.0229
	95% Percentile (z)	0.0257
	99% Percentile (z)	0.0309

Maximum Likelihood Estimate(MLE) Method

	Mean	0.0131
	SD	0.00763
95% UTL with	95% Coverage	0.039
	95% UPL (t)	0.0289
	90% Percentile (z)	0.0228
	95% Percentile (z)	0.0256
	99% Percentile (z)	0.0308

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-4.532
	SD (Log Scale)	0.72
95% UTL	95% Coverage	0.124
	95% UPL (t)	0.048
	90% Percentile (z)	0.0271
	95% Percentile (z)	0.0352
	99% Percentile (z)	0.0574

Log ROS Method

	Mean in Original Scale	0.0177
	SD in Original Scale	0.00225
95% UTL with	95% Coverage	0.0271
95% BCA UTL with	95% Coverage	0.02
95% Bootstrap (%) UTL with	95% Coverage	0.02
	95% UPL (t)	0.0229
	90% Percentile (z)	0.0207
	95% Percentile (z)	0.0217
	99% Percentile (z)	0.0236

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	42.5
Theta Star	0.0004512
nu star	340
A-D Test Statistic	0.96
5% A-D Critical Value	0.657
K-S Test Statistic	0.468
5% K-S Critical Value	0.394

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0163
Median	0.0167
SD	0.00402
k star	9.885
Theta star	0.00165

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0181
	SD	0.00163
	SE of Mean	0.0007127
95% KM UTL with	95% Coverage	0.0237
	95% KM Chebyshev UPL	0.0257
	95% KM UPL (t)	0.0215
	90% Percentile (z)	0.0202
	95% Percentile (z)	0.0208
	99% Percentile (z)	0.0219

Gamma ROS Limits with Extrapolated Data

Nu star	138.4	95% Wilson Hilferty (WH) Approx. Gamma UPL	0.0264
95% Percentile of Chisquare (2k)	31.12	95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0267
		95% WH Approx. Gamma UTL with 95% Coverage	0.035
90% Percentile	0.0232	95% HW Approx. Gamma UTL with 95% Coverage	0.0359
95% Percentile	0.0257		
99% Percentile	0.0307		

Note: DL/2 is not a recommended method.

Cadmium

General Statistics

Number of Valid Data	44	Number of Detected Data	2
Number of Distinct Detected Data	1	Number of Non-Detect Data	42

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Cadmium was not processed!

Calcium

General Statistics

Total Number of Observations	46	Number of Distinct Observations	45
Tolerance Factor	2.079	Number of Missing Values	74

Raw Statistics		Log-Transformed Statistics	
Minimum	16.8	Minimum	2.821
Maximum	93.2	Maximum	4.535
Second Largest	91.3	Second Largest	4.514
First Quartile	34.93	First Quartile	3.553
Median	50.2	Median	3.916
Third Quartile	54.2	Third Quartile	3.993
Mean	47.74	Mean	3.796
SD	17.23	SD	0.391
Coefficient of Variation	0.361		
Skewness	0.479		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.945	Shapiro Wilk Critical Value	0.945
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	83.56	95% UTL with 95% Coverage	100.4
95% UPL (t)	76.99	95% UPL (t)	86.5
90% Percentile (z)	69.82	90% Percentile (z)	73.51
95% Percentile (z)	76.08	95% Percentile (z)	84.73
99% Percentile (z)	87.82	99% Percentile (z)	110.6

Gamma Distribution Test

k star	6.905
Theta Star	6.914
MLE of Mean	47.74
MLE of Standard Deviation	18.17
nu star	635.3

A-D Test Statistic	0.548
5% A-D Critical Value	0.751
K-S Test Statistic	0.122
5% K-S Critical Value	0.131

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	68.25
95% Percentile	74.43
99% Percentile	92.35

Assuming Gamma Distribution

90% Percentile	72
95% Percentile	81.01
99% Percentile	99.79
95% WH Approx. Gamma UPL	81.62
95% HW Approx. Gamma UPL	82.6
95% WH Approx. Gamma UTL with 95% Coverage	91.71
95% HW Approx. Gamma UTL with 95% Coverage	93.44

95% UTL with 95% Coverage	91.3
95% Percentile Bootstrap UTL with 95% Coverage	92.73
95% BCA Bootstrap UTL with 95% Coverage	91.3
95% UPL	85.67
95% Chebyshev UPL	123.6
Upper Threshold Limit Based upon IQR	83.11

Chromium, total

General Statistics

Number of Valid Data	37
Number of Distinct Detected Data	9
Tolerance Factor	2.14
Number of Missing Values	83
Number of Detected Data	14
Number of Non-Detect Data	23
Percent Non-Detects	62.16%

Raw Statistics

Minimum Detected	0.0002
Maximum Detected	0.00393
Mean of Detected	0.0011
SD of Detected	0.00115
Minimum Non-Detect	0.0001
Maximum Non-Detect	0.0005

Log-transformed Statistics

Minimum Detected	-8.517
Maximum Detected	-5.539
Mean of Detected	-7.296
SD of Detected	1.016
Minimum Non-Detect	-9.21
Maximum Non-Detect	-7.601

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	29
Number treated as Detected with Single DL	8
Single DL Non-Detect Percentage	78.38%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.782
5% Shapiro Wilk Critical Value	0.874

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.901
5% Shapiro Wilk Critical Value	0.874

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0004533
SD	0.0008612
95% UTL 95% Coverage	0.0023
95% UPL (t)	0.00193
90% Percentile (z)	0.00156
95% Percentile (z)	0.00187
99% Percentile (z)	0.00246

Maximum Likelihood Estimate(MLE) Method

Mean	-0.00125
SD	0.00221
95% UTL with 95% Coverage	0.00348
95% UPL (t)	0.00253
90% Percentile (z)	0.00158
95% Percentile (z)	0.00239
99% Percentile (z)	0.00389

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-8.873
SD (Log Scale)	1.414
95% UTL 95% Coverage	0.00289
95% UPL (t)	0.00157
90% Percentile (z)	0.0008575
95% Percentile (z)	0.00143
99% Percentile (z)	0.00376

Log ROS Method

Mean in Original Scale	0.0004471
SD in Original Scale	0.0008641
95% UTL with 95% Coverage	0.00565
95% BCA UTL with 95% Coverage	0.00393
95% Bootstrap (%) UTL with 95% Coverage	0.00393
95% UPL (t)	0.0025
90% Percentile (z)	0.0011
95% Percentile (z)	0.0022
99% Percentile (z)	0.00806

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.967
Theta Star	0.00114
nu star	27.07
A-D Test Statistic	0.764
5% A-D Critical Value	0.757
K-S Test Statistic	0.224
5% K-S Critical Value	0.234

Data follow Appx. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0004175
Median	0.000001
SD	0.0008777
k star	0.207
Theta star	0.00202
Nu star	15.3
95% Percentile of Chisquare (2k)	2.112
90% Percentile	0.00126
95% Percentile	0.00213
99% Percentile	0.00451

Data Distribution Test with Detected Values Only

Data follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0005416
SD	0.0008097
SE of Mean	0.0001382
95% KM UTL with 95% Coverage	0.00227
95% KM Chebyshev UPL	0.00412
95% KM UPL (t)	0.00193
90% Percentile (z)	0.00158
95% Percentile (z)	0.00187
99% Percentile (z)	0.00243

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00168
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00176
95% WH Approx. Gamma UTL with 95% Coverage	0.00264
95% HW Approx. Gamma UTL with 95% Coverage	0.00306

Note: DL/2 is not a recommended method.

Cobalt

General Statistics

Number of Valid Data	15	Number of Detected Data	0

Number of Distinct Detected Data	0	Number of Non-Detect Data	15

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Cobalt was not processed!

Copper

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Copper was not processed!

Iron_1

General Statistics

Number of Valid Data	22	Number of Detected Data	9
Number of Distinct Detected Data	8	Number of Non-Detect Data	13
Tolerance Factor	2.349	Percent Non-Detects	59.09%
Number of Missing Values	98		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.03	Minimum Detected	-3.507
Maximum Detected	0.14	Maximum Detected	-1.966
Mean of Detected	0.0597	Mean of Detected	-2.961
SD of Detected	0.0371	SD of Detected	0.544
Minimum Non-Detect	0.02	Minimum Non-Detect	-3.912
Maximum Non-Detect	0.025	Maximum Non-Detect	-3.689

Data with Multiple Detection Limits	Single Detection Limit Scenario	
Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect with Single DL	13
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected with Single DL	9
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	59.09%

Warning: There are only 9 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.808
5% Shapiro Wilk Critical Value	0.829

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.886
5% Shapiro Wilk Critical Value	0.829

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0309
SD	0.0336
95% UTL 95% Coverage	0.11
95% UPL (t)	0.09
90% Percentile (z)	0.0739
95% Percentile (z)	0.0861
99% Percentile (z)	0.109

Maximum Likelihood Estimate(MLE) Method

Mean	0.0102
SD	0.0543
95% UTL with 95% Coverage	0.138
95% UPL (t)	0.106
90% Percentile (z)	0.0797
95% Percentile (z)	0.0994
99% Percentile (z)	0.136

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-3.882
SD (Log Scale)	0.857
95% UTL 95% Coverage	0.154
95% UPL (t)	0.0932
90% Percentile (z)	0.0619
95% Percentile (z)	0.0845
99% Percentile (z)	0.152

Log ROS Method

Mean in Original Scale	0.0306
SD in Original Scale	0.034
95% UTL with 95% Coverage	0.211
95% BCA UTL with 95% Coverage	0.138
95% Bootstrap (%) UTL with 95% Coverage	0.14
95% UPL (t)	0.114
90% Percentile (z)	0.0697
95% Percentile (z)	0.102
99% Percentile (z)	0.206

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.508
Theta Star	0.0238
nu star	45.14
A-D Test Statistic	0.579
5% A-D Critical Value	0.726
K-S Test Statistic	0.26
5% K-S Critical Value	0.281

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0244
Median	0.000001
SD	0.0378
k star	0.149
Theta star	0.164
Nu star	6.555
95% Percentile of Chisquare (2k)	1.642
90% Percentile	0.0724
95% Percentile	0.135
99% Percentile	0.316

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0422
SD	0.0267
SE of Mean	0.00604
95% KM UTL with 95% Coverage	0.105
95% KM Chebyshev UPL	0.161
95% KM UPL (t)	0.0892
90% Percentile (z)	0.0764
95% Percentile (z)	0.0861
99% Percentile (z)	0.104

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.122
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.148
95% WH Approx. Gamma UTL with 95% Coverage	0.226
95% HW Approx. Gamma UTL with 95% Coverage	0.326

Note: DL/2 is not a recommended method.

Magnesium

General Statistics

Total Number of Observations	46	Number of Distinct Observations	40
Tolerance Factor	2.079	Number of Missing Values	74

Raw Statistics

Minimum	3.44
Maximum	19
Second Largest	17.3
First Quartile	7.325
Median	11.1
Third Quartile	12.2
Mean	10.21
SD	3.415
Coefficient of Variation	0.334
Skewness	0.0741

Log-Transformed Statistics

Minimum	1.235
Maximum	2.944
Second Largest	2.851
First Quartile	1.991
Median	2.407
Third Quartile	2.501
Mean	2.26
SD	0.38

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.97
Shapiro Wilk Critical Value	0.945

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.932
Shapiro Wilk Critical Value	0.945

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	17.31
95% UPL (t)	16.01
90% Percentile (z)	14.59
95% Percentile (z)	15.83
99% Percentile (z)	18.16

Assuming Lognormal Distribution

95% UTL with 95% Coverage	21.11
95% UPL (t)	18.26
90% Percentile (z)	15.59
95% Percentile (z)	17.9
99% Percentile (z)	23.18

Gamma Distribution Test

k star	7.5
Theta Star	1.361
MLE of Mean	10.21
MLE of Standard Deviation	3.728
nu star	690

A-D Test Statistic	0.91
5% A-D Critical Value	0.75
K-S Test Statistic	0.173
5% K-S Critical Value	0.131

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	13.45
95% Percentile	15.03
99% Percentile	18.24

Assuming Gamma Distribution

90% Percentile	15.18
95% Percentile	17.01
99% Percentile	20.81
95% WH Approx. Gamma UPL	17.14
95% HW Approx. Gamma UPL	17.37
95% WH Approx. Gamma UTL with 95% Coverage	19.18
95% UTL with 95% Coverage	17.3
95% Percentile Bootstrap UTL with 95% Coverage	18.05
95% BCA Bootstrap UTL with 95% Coverage	17.88
95% UPL	16.57
95% Chebyshev UPL	25.26
Upper Threshold Limit Based upon IQR	19.51

95% HW Approx. Gamma UTL with 95% Coverage 19.57

Manganese_1

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
Tolerance Factor	2.396	Number of Missing Values	96

Raw Statistics		Log-Transformed Statistics	
Minimum	0.0006	Minimum	-7.419
Maximum	0.0484	Maximum	-3.028
Second Largest	0.0382	Second Largest	-3.265
First Quartile	0.00528	First Quartile	-5.26
Median	0.0175	Median	-4.046
Third Quartile	0.0292	Third Quartile	-3.535
Mean	0.0182	Mean	-4.5
SD	0.0145	SD	1.205
Coefficient of Variation	0.798		
Skewness	0.522		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.92	Shapiro Wilk Test Statistic	0.912
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	0.0529	95% UTL with 95% Coverage	0.199
95% UPL (t)	0.0438	95% UPL (t)	0.0939
90% Percentile (z)	0.0367	90% Percentile (z)	0.052
95% Percentile (z)	0.042	95% Percentile (z)	0.0805
99% Percentile (z)	0.0519	99% Percentile (z)	0.183

Gamma Distribution Test		Data Distribution Test
k star	1.016	Data appear Normal at 5% Significance Level
Theta Star	0.0179	
MLE of Mean	0.0182	
MLE of Standard Deviation	0.018	
nu star	40.62	
A-D Test Statistic	0.438	**Nonparametric Statistics**
5% A-D Critical Value	0.765	90% Percentile 0.0378
K-S Test Statistic	0.156	95% Percentile 0.0387
5% K-S Critical Value	0.199	99% Percentile 0.0465
Data appear Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution			
90% Percentile	0.0416	95% UTL with 95% Coverage	0.0484
95% Percentile	0.0541	95% Percentile Bootstrap UTL with 95% Coverage	0.0484
99% Percentile	0.0829	95% BCA Bootstrap UTL with 95% Coverage	0.0484
		95% UPL	0.0479
		95% Chebyshev UPL	0.0829

95% WH Approx. Gamma UPL	0.0572	Upper Threshold Limit Based upon IQR	0.065
95% HW Approx. Gamma UPL	0.0618		
95% WH Approx. Gamma UTL with 95% Coverage	0.0833		
95% HW Approx. Gamma UTL with 95% Coverage	0.0951		

Mercury

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Mercury was not processed!

Molybdenum

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Molybdenum was not processed!

Nickel_1

General Statistics

Number of Valid Data	41	Number of Detected Data	35
Number of Distinct Detected Data	20	Number of Non-Detect Data	6
Tolerance Factor	2.11	Percent Non-Detects	14.63%
Number of Missing Values	77		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0004	Minimum Detected	-7.824
Maximum Detected	0.00221	Maximum Detected	-6.115
Mean of Detected	0.00127	Mean of Detected	-6.751
SD of Detected	0.0004883	SD of Detected	0.44
Minimum Non-Detect	0.0002	Minimum Non-Detect	-8.517
Maximum Non-Detect	0.0006	Maximum Non-Detect	-7.419

Data with Multiple Detection Limits	Single Detection Limit Scenario
Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect with Single DL 9

For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Detected with Single DL 32
Single DL Non-Detect Percentage 21.95%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.94
5% Shapiro Wilk Critical Value	0.934

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.917
5% Shapiro Wilk Critical Value	0.934

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.00112
	SD	0.000593
95% UTL	95% Coverage	0.00237
	95% UPL (t)	0.00213
	90% Percentile (z)	0.00188
	95% Percentile (z)	0.00209
	99% Percentile (z)	0.0025

Maximum Likelihood Estimate(MLE) Method

	Mean	0.00111
	SD	0.000604
95% UTL with	95% Coverage	0.00238
	95% UPL (t)	0.00214
	90% Percentile (z)	0.00188
	95% Percentile (z)	0.0021
	99% Percentile (z)	0.00252

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-7.031
	SD (Log Scale)	0.823
95% UTL	95% Coverage	0.00502
	95% UPL (t)	0.00359
	90% Percentile (z)	0.00254
	95% Percentile (z)	0.00342
	99% Percentile (z)	0.00599

Log ROS Method

	Mean in Original Scale	0.00116
	SD in Original Scale	0.0005338
95% UTL with	95% Coverage	0.00309
95% BCA UTL with	95% Coverage	0.0022
95% Bootstrap (%) UTL with	95% Coverage	0.00221
	95% UPL (t)	0.0025
	90% Percentile (z)	0.002
	95% Percentile (z)	0.00242
	99% Percentile (z)	0.00346

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.567
Theta Star	0.0002287
nu star	389.7
A-D Test Statistic	0.979
5% A-D Critical Value	0.749
K-S Test Statistic	0.192
5% K-S Critical Value	0.149

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0011
Median	0.0011
SD	0.0006254
k star	0.773
Theta star	0.00142
Nu star	63.39
95% Percentile of Chisquare (2k)	5.078
90% Percentile	0.00269
95% Percentile	0.0036

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.00115
	SD	0.0005381
	SE of Mean	8.53E-05
95% KM UTL with	95% Coverage	0.00228
	95% KM Chebyshev UPL	0.00352
	95% KM UPL (t)	0.00206
	90% Percentile (z)	0.00184
	95% Percentile (z)	0.00203
	99% Percentile (z)	0.0024

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		0.00347
95% Hawkins Wixley (HW) Approx. Gamma UPL		0.00423
95% WH Approx. Gamma UTL with	95% Coverage	0.00449
95% HW Approx. Gamma UTL with	95% Coverage	0.0058

99% Percentile	0.00576

Note: DL/2 is not a recommended method.

Potassium_1

General Statistics

Number of Valid Data	41	Number of Detected Data	40
Number of Distinct Detected Data	22	Number of Non-Detect Data	1
Tolerance Factor	2.11	Percent Non-Detects	2.44%
Number of Missing Values	75		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.3	Minimum Detected	-1.204
Maximum Detected	2.3	Maximum Detected	0.833
Mean of Detected	1.15	Mean of Detected	-0.0339
SD of Detected	0.653	SD of Detected	0.616
Minimum Non-Detect	0.3	Minimum Non-Detect	-1.204
Maximum Non-Detect	0.3	Maximum Non-Detect	-1.204

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.869	Shapiro Wilk Test Statistic	0.918
5% Shapiro Wilk Critical Value	0.94	5% Shapiro Wilk Critical Value	0.94
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.125	Mean (Log Scale)	-0.0794
SD	0.664	SD (Log Scale)	0.674
95% UTL 95% Coverage	2.526	95% UTL 95% Coverage	3.832
95% UPL (t)	2.256	95% UPL (t)	2.914
90% Percentile (z)	1.976	90% Percentile (z)	2.192
95% Percentile (z)	2.217	95% Percentile (z)	2.8
99% Percentile (z)	2.669	99% Percentile (z)	4.432
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.121	Mean in Original Scale	1.127
SD	0.663	SD in Original Scale	0.662
95% UTL with 95% Coverage	2.521	95% UTL with 95% Coverage	3.705
		95% BCA UTL with 95% Coverage	1.8
		95% Bootstrap (%) UTL with 95% Coverage	2.3
95% UPL (t)	2.252	95% UPL (t)	2.84
90% Percentile (z)	1.972	90% Percentile (z)	2.154
95% Percentile (z)	2.213	95% Percentile (z)	2.732
99% Percentile (z)	2.665	99% Percentile (z)	4.268

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	2.826	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.407	
nu star	226.1	

A-D Test Statistic	1.16
5% A-D Critical Value	0.755
K-S Test Statistic	0.18
5% K-S Critical Value	0.14

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	1.122
Median	0.8
SD	0.67
k star	1.1
Theta star	1.02
Nu star	90.21
95% Percentile of Chisquare (2k)	6.374
90% Percentile	2.523
95% Percentile	3.25
99% Percentile	4.926

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	1.129
SD	0.65
SE of Mean	0.103
95% KM UTL with 95% Coverage	2.502
95% KM Chebyshev UPL	3.999
95% KM UPL (t)	2.238
90% Percentile (z)	1.963
95% Percentile (z)	2.199
99% Percentile (z)	2.642

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	2.851
95% Hawkins Wixley (HW) Approx. Gamma UPL	3.257
95% WH Approx. Gamma UTL with 95% Coverage	3.519
95% HW Approx. Gamma UTL with 95% Coverage	4.183

Note: DL/2 is not a recommended method.

Selenium

General Statistics

Number of Valid Data	45	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	40
Tolerance Factor	2.085	Percent Non-Detects	88.89%
Number of Missing Values	76		

Raw Statistics

Minimum Detected	0.00052
Maximum Detected	0.001
Mean of Detected	0.000647
SD of Detected	0.0002016
Minimum Non-Detect	0.0005
Maximum Non-Detect	0.001

Log-transformed Statistics

Minimum Detected	-7.562
Maximum Detected	-6.908
Mean of Detected	-7.375
SD of Detected	0.271
Minimum Non-Detect	-7.601
Maximum Non-Detect	-6.908

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	44
Number treated as Detected with Single DL	1
Single DL Non-Detect Percentage	97.78%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.709
5% Shapiro Wilk Critical Value	0.762

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0004941
	SD	0.0001086
95% UTL	95% Coverage	0.0007206
	95% UPL (t)	0.0006786
	90% Percentile (z)	0.0006333
	95% Percentile (z)	0.0006728
	99% Percentile (z)	0.0007468

Maximum Likelihood Estimate(MLE) Method N/A

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.751
5% Shapiro Wilk Critical Value	0.762

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-7.637
	SD (Log Scale)	0.234
95% UTL	95% Coverage	0.0007852
	95% UPL (t)	0.0007174
	90% Percentile (z)	0.0006506
	95% Percentile (z)	0.0007084
	99% Percentile (z)	0.0008308

Log ROS Method

	Mean in Original Scale	0.0004761
	SD in Original Scale	0.0001506
	Mean in Log Scale	-7.696
	SD in Log Scale	0.304
95% UTL	95% Coverage	0.0008564
	95% UPL (t)	0.0007616
	90% Percentile (z)	0.000671
	95% Percentile (z)	0.0007493
	99% Percentile (z)	0.0009214

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	6.389
Theta Star	0.0001013
nu star	63.89

A-D Test Statistic	0.768
5% A-D Critical Value	0.679
K-S Test Statistic	0.319
5% K-S Critical Value	0.357

Data follow Appx. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.000335
Median	0.0003237
SD	0.0003032
k star	0.378
Theta star	0.0008868
Nu star	34
95% Percentile of Chisquare (2k)	3.201
90% Percentile	0.0009556
95% Percentile	0.00142
99% Percentile	0.00259

Data Distribution Test with Detected Values Only

Data follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0005496
	SD	7.618E-05
	SE of Mean	1.762E-05
95% KM UTL with	95% Coverage	0.0007085
	95% KM Chebyshev UPL	0.0008854
	95% KM UPL (t)	0.000679
	90% Percentile (z)	0.0006472
	95% Percentile (z)	0.0006749
	99% Percentile (z)	0.0007268

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		0.00141
95% Hawkins Wixley (HW) Approx. Gamma UPL		0.00173
95% WH Approx. Gamma UTL with	95% Coverage	0.00196
95% HW Approx. Gamma UTL with	95% Coverage	0.00259

Note: DL/2 is not a recommended method.

Silver

General Statistics

Number of Valid Data	15	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	15

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Silver was not processed!

Thallium

General Statistics

Number of Valid Data	15	Number of Detected Data	4
Number of Distinct Detected Data	2	Number of Non-Detect Data	11
Tolerance Factor	2.566	Percent Non-Detects	73.33%
Number of Missing Values	105		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0001	Minimum Detected	-9.21
Maximum Detected	0.00015	Maximum Detected	-8.805
Mean of Detected	0.0001125	Mean of Detected	-9.109
SD of Detected	0.000025	SD of Detected	0.203
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.0001	Maximum Non-Detect	-9.21

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.63	Shapiro Wilk Test Statistic	0.63
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	6.667E-05
SD	3.086E-05
95% UTL 95% Coverage	0.0001459
95% UPL (t)	0.0001228
90% Percentile (z)	0.0001062
95% Percentile (z)	0.0001174
99% Percentile (z)	0.0001385

DL/2 Substitution Method

Mean (Log Scale)	-9.692
SD (Log Scale)	0.376
95% UTL 95% Coverage	0.000162
95% UPL (t)	0.0001224
90% Percentile (z)	0.0001
95% Percentile (z)	0.0001146
99% Percentile (z)	0.0001481

Maximum Likelihood Estimate(MLE) Method

Mean	7.897E-05
SD	2.98E-05
95% UTL with 95% Coverage	0.0001554
95% UPL (t)	0.0001332
90% Percentile (z)	0.0001172
95% Percentile (z)	0.000128
99% Percentile (z)	0.0001483

Log ROS Method

Mean in Original Scale	6.911E-05
SD in Original Scale	3.221E-05
95% UTL with 95% Coverage	0.0001982
95% BCA UTL with 95% Coverage	0.00015
95% Bootstrap (%) UTL with 95% Coverage	0.00015
95% UPL (t)	0.0001419
90% Percentile (z)	0.0001116
95% Percentile (z)	0.0001313
99% Percentile (z)	0.000178

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	7.822
Theta Star	1.438E-05
nu star	62.58
A-D Test Statistic	0.961
5% A-D Critical Value	0.657
K-S Test Statistic	0.468
5% K-S Critical Value	0.394

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0001033
SD	1.247E-05
SE of Mean	3.719E-06
95% KM UTL with 95% Coverage	0.0001353
95% KM Chebyshev UPL	0.0001595
95% KM UPL (t)	0.000126
90% Percentile (z)	0.0001193
95% Percentile (z)	0.0001239
99% Percentile (z)	0.0001324

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	3.724E-05
Median	0.000001
SD	5.07E-05
k star	0.356
Theta star	0.0001045
Nu star	10.69
95% Percentile of Chisquare (2k)	3.08
90% Percentile	0.0001072
95% Percentile	0.000161
99% Percentile	0.0002977

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.0001741
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0001939
95% WH Approx. Gamma UTL with 95% Coverage	0.000325
95% HW Approx. Gamma UTL with 95% Coverage	0.0004093

Note: DL/2 is not a recommended method.

Uranium

General Statistics

Number of Valid Data	29
Number of Detected Data	25
Number of Distinct Detected Data	10
Number of Non-Detect Data	4

Tolerance Factor	2.232	Percent Non-Detects	13.79%
Number of Missing Values	91		

Raw Statistics

Minimum Detected	0.0002
Maximum Detected	0.0012
Mean of Detected	0.0004813
SD of Detected	0.0002771
Minimum Non-Detect	0.0001
Maximum Non-Detect	0.0001

Log-transformed Statistics

Minimum Detected	-8.517
Maximum Detected	-6.725
Mean of Detected	-7.788
SD of Detected	0.556
Minimum Non-Detect	-9.21
Maximum Non-Detect	-9.21

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.871
5% Shapiro Wilk Critical Value	0.918

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.927
5% Shapiro Wilk Critical Value	0.918

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0004218
	SD	0.0002978
95% UTL	95% Coverage	0.00109
	95% UPL (t)	0.0009372
	90% Percentile (z)	0.0008035
	95% Percentile (z)	0.0009117
	99% Percentile (z)	0.00111

Maximum Likelihood Estimate(MLE) Method

	Mean	0.0004051
	SD	0.0003206
95% UTL with	95% Coverage	0.00112
	95% UPL (t)	0.0009597
	90% Percentile (z)	0.0008159
	95% Percentile (z)	0.0009324
	99% Percentile (z)	0.00115

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-8.08
	SD (Log Scale)	0.903
95% UTL	95% Coverage	0.00233
	95% UPL (t)	0.00148
	90% Percentile (z)	0.000986
	95% Percentile (z)	0.00137
	99% Percentile (z)	0.00253

Log ROS Method

	Mean in Original Scale	0.000431
	SD in Original Scale	0.0002868
95% UTL with	95% Coverage	0.00161
95% BCA UTL with	95% Coverage	0.0012
95% Bootstrap (%) UTL with	95% Coverage	0.0012
	95% UPL (t)	0.00114
	90% Percentile (z)	0.0008392
	95% Percentile (z)	0.00108
	99% Percentile (z)	0.00172

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	3.12
Theta Star	0.0001543
nu star	156
A-D Test Statistic	0.566
5% A-D Critical Value	0.75
K-S Test Statistic	0.138
5% K-S Critical Value	0.176

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

	Mean	0.0004151

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0004425
	SD	0.0002701
	SE of Mean	5.119E-05
95% KM UTL with	95% Coverage	0.00105
	95% KM Chebyshev UPL	0.00164
	95% KM UPL (t)	0.0009098
	90% Percentile (z)	0.0007886

Median	0.0004
SD	0.0003069
k star	0.671
Theta star	0.0006185
Nu star	38.93
95% Percentile of Chisquare (2k)	4.639
90% Percentile	0.00105
95% Percentile	0.00143
99% Percentile	0.00235
95% Percentile (z)	0.0008868
99% Percentile (z)	0.00107

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00143
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00173
95% WH Approx. Gamma UTL with 95% Coverage	0.002
95% HW Approx. Gamma UTL with 95% Coverage	0.00261

Note: DL/2 is not a recommended method.

Vanadium_1

General Statistics

Number of Valid Data	45
Number of Distinct Detected Data	19
Tolerance Factor	2.085
Number of Missing Values	75
Number of Detected Data	24
Number of Non-Detect Data	21
Percent Non-Detects	46.67%

Raw Statistics

Minimum Detected	0.0003
Maximum Detected	0.0062
Mean of Detected	0.00153
SD of Detected	0.00161
Minimum Non-Detect	0.00005
Maximum Non-Detect	0.005

Log-transformed Statistics

Minimum Detected	-8.112
Maximum Detected	-5.083
Mean of Detected	-6.916
SD of Detected	0.912
Minimum Non-Detect	-9.903
Maximum Non-Detect	-5.298

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	43
Number treated as Detected with Single DL	2
Single DL Non-Detect Percentage	95.56%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.745
5% Shapiro Wilk Critical Value	0.916

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.913
5% Shapiro Wilk Critical Value	0.916

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.00129
SD	0.00144
95% UTL 95% Coverage	0.00429
95% UPL (t)	0.00373
90% Percentile (z)	0.00313
95% Percentile (z)	0.00365
99% Percentile (z)	0.00463

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-7.436
SD (Log Scale)	1.421
95% UTL 95% Coverage	0.0114
95% UPL (t)	0.00659
90% Percentile (z)	0.00364
95% Percentile (z)	0.0061
99% Percentile (z)	0.0161

Log ROS Method

Mean in Original Scale	0.0009633

SD in Original Scale	0.00134
Mean in Log Scale	-7.691
SD in Log Scale	1.25
95% UTL 95% Coverage	0.00619
95% UPL (t)	0.00382
90% Percentile (z)	0.00227
95% Percentile (z)	0.00357
99% Percentile (z)	0.00837

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.164
Theta Star	0.00131
nu star	55.88
A-D Test Statistic	1.243
5% A-D Critical Value	0.766
K-S Test Statistic	0.265
5% K-S Critical Value	0.182

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0009575
Median	0.00042
SD	0.00141
k star	0.271
Theta star	0.00353
Nu star	24.41
95% Percentile of Chisquare (2k)	2.561
90% Percentile	0.00285
95% Percentile	0.00452
99% Percentile	0.00891

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.00105
SD	0.00132
SE of Mean	0.0002109
95% KM UTL with 95% Coverage	0.00381
95% KM Chebyshev UPL	0.00688
95% KM UPL (t)	0.0033
90% Percentile (z)	0.00275
95% Percentile (z)	0.00323
99% Percentile (z)	0.00413

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00413
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00493
95% WH Approx. Gamma UTL with 95% Coverage	0.00594
95% HW Approx. Gamma UTL with 95% Coverage	0.00773

Note: DL/2 is not a recommended method.

Zinc_1

General Statistics

Number of Valid Data	41	Number of Detected Data	19
Number of Distinct Detected Data	11	Number of Non-Detect Data	22
Tolerance Factor	2.11	Percent Non-Detects	53.66%
Number of Missing Values	79		

Raw Statistics

Minimum Detected	0.002
Maximum Detected	0.015
Mean of Detected	0.0067
SD of Detected	0.00421
Minimum Non-Detect	0.002
Maximum Non-Detect	0.01

Log-transformed Statistics

Minimum Detected	-6.215
Maximum Detected	-4.2
Mean of Detected	-5.193
SD of Detected	0.636
Minimum Non-Detect	-6.215
Maximum Non-Detect	-4.605

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	37
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	90.24%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.872
5% Shapiro Wilk Critical Value	0.901

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.945
5% Shapiro Wilk Critical Value	0.901

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.00401
	SD	0.00387
95% UTL	95% Coverage	0.0122
	95% UPL (t)	0.0106
	90% Percentile (z)	0.00896
	95% Percentile (z)	0.0104
	99% Percentile (z)	0.013

Maximum Likelihood Estimate(MLE) Method

	Mean	N/A
	SD	N/A
95% UTL with	95% Coverage	N/A
	95% UPL (t)	N/A
	90% Percentile (z)	N/A
	95% Percentile (z)	N/A
	99% Percentile (z)	N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-5.906
	SD (Log Scale)	0.875
95% UTL	95% Coverage	0.0172
	95% UPL (t)	0.0121
	90% Percentile (z)	0.00835
	95% Percentile (z)	0.0115
	99% Percentile (z)	0.0208

Log ROS Method

	Mean in Original Scale	0.00385
	SD in Original Scale	0.00393
95% UTL with	95% Coverage	0.0188
95% BCA UTL with	95% Coverage	0.014
95% Bootstrap (%) UTL with	95% Coverage	0.015
	95% UPL (t)	0.0127
	90% Percentile (z)	0.00845
	95% Percentile (z)	0.012
	99% Percentile (z)	0.0231

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.409
Theta Star	0.00278
nu star	91.55
A-D Test Statistic	0.484
5% A-D Critical Value	0.749
K-S Test Statistic	0.183
5% K-S Critical Value	0.2

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.00318
Median	0.0001627
SD	0.00438
k star	0.199
Theta star	0.016
Nu star	16.28
95% Percentile of Chisquare (2k)	2.05

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.00427
	SD	0.00362
	SE of Mean	0.0005856
95% KM UTL with	95% Coverage	0.0119
	95% KM Chebyshev UPL	0.0203
	95% KM UPL (t)	0.0104
	90% Percentile (z)	0.00891
	95% Percentile (z)	0.0102
	99% Percentile (z)	0.0127

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		0.0147
95% Hawkins Wixley (HW) Approx. Gamma UPL		0.0178
95% WH Approx. Gamma UTL with	95% Coverage	0.0222

90% Percentile	0.00963	95% HW Approx. Gamma UTL with	95% Coverage 0.03
95% Percentile	0.0164		
99% Percentile	0.0352		

Note: DL/2 is not a recommended method.

SURFACE WATER – USL OUTPUTS

Robust Simultaneous Intervals/Limits (SLs)

Date/Time of Computation	11/27/2012 8:32:51 PM
User Selected Options	
From File	C:\Documents and Settings\Valerie C Chen\My Documents\Val's documents from C\Monsanto\Background TM\Fr
Full Precision	OFF
Confidence Coefficient	0.9
PROP Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	PROP SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Huber Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	Huber SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Tukey Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Tukey Biweight SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
Lax/Kafadar Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Lax/Kafadar SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
MVT Method	Triming Percentage of 10.08%
	MVT SLs derived using 10 Iterations and initial estimates of median/1.48MAD.

D2Max represents unsquared critical value of Max-MD (Mahalanobis Distances) computed based upon Wsum Values

Barium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	15	0.0439	0.0383	0.0213	0.0168	2.409	-0.00748	0.0953

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.0383	0.0168	0.0439	0.0213	15	2.409	-0.00748	0.0953
Huber	0.0383	0.0168	0.0439	0.0213	15	2.409	-0.00748	0.0953
Tukey Biweight	0.0383	0.0168	0.0393	0.0216	12.49	2.308	-0.0105	0.0892
Lax Kafadar Biweight	0.0383	0.0168	0.0411	0.0203	13.22	2.34	-0.00633	0.0885
MVT	0.0383	0.0168	0.041	0.0187	14	2.372	-0.00344	0.0853

Calcium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	46	47.74	50.2	17.23	14.75	2.924	-2.635	98.12

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	50.2	14.75	46.33	14.9	44.59	2.912	2.932	89.73
Huber	50.2	14.75	47.35	16.4	45.6	2.921	-0.549	95.25
Tukey Biweight	50.2	14.75	46.47	16.99	39.4	2.861	-2.159	95.09
Lax Kafadar Biweight	50.2	14.75	46.84	17.95	41.3	2.881	-4.875	98.55
MVT	50.2	14.75	47.05	13.59	42	2.887	7.811	86.29

Magnesium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	46	10.21	11.1	3.415	3.113	2.924	0.224	20.2

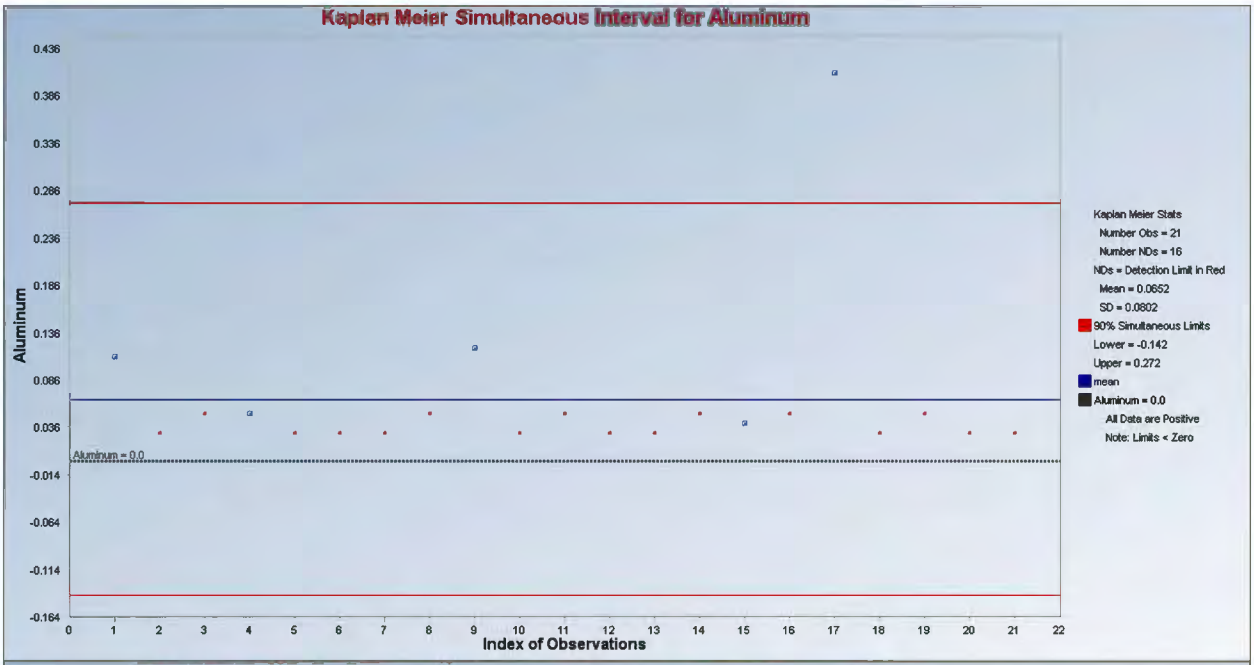
Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	11.1	3.113	10.09	3.209	45.36	2.919	0.723	19.46
Huber	11.1	3.113	10.18	3.348	45.83	2.923	0.394	19.96
Tukey Biweight	11.1	3.113	10.21	3.486	39.94	2.867	0.211	20.2

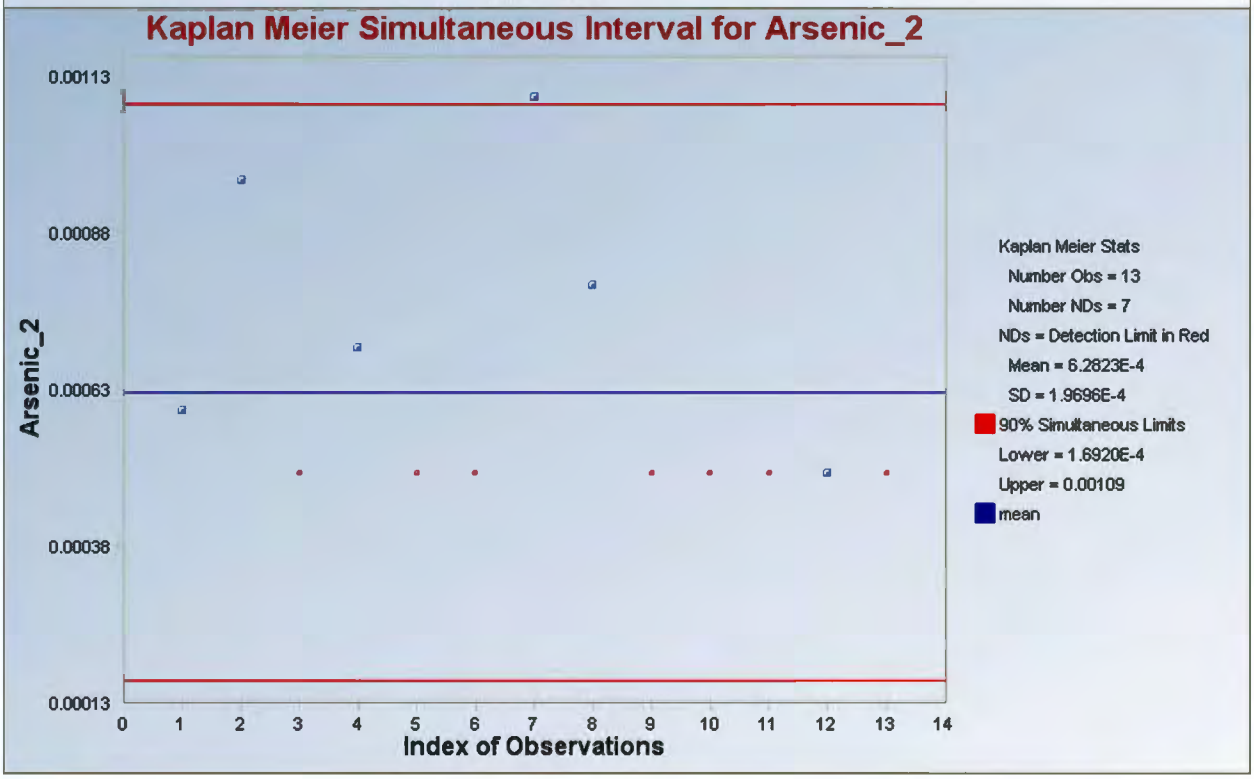
Lax Kafadar Biweight	11.1	3.113	10.2	3.724	41.61	2.884	-0.54	20.94
MVT	11.1	3.113	10.14	2.762	42	2.887	2.167	18.12

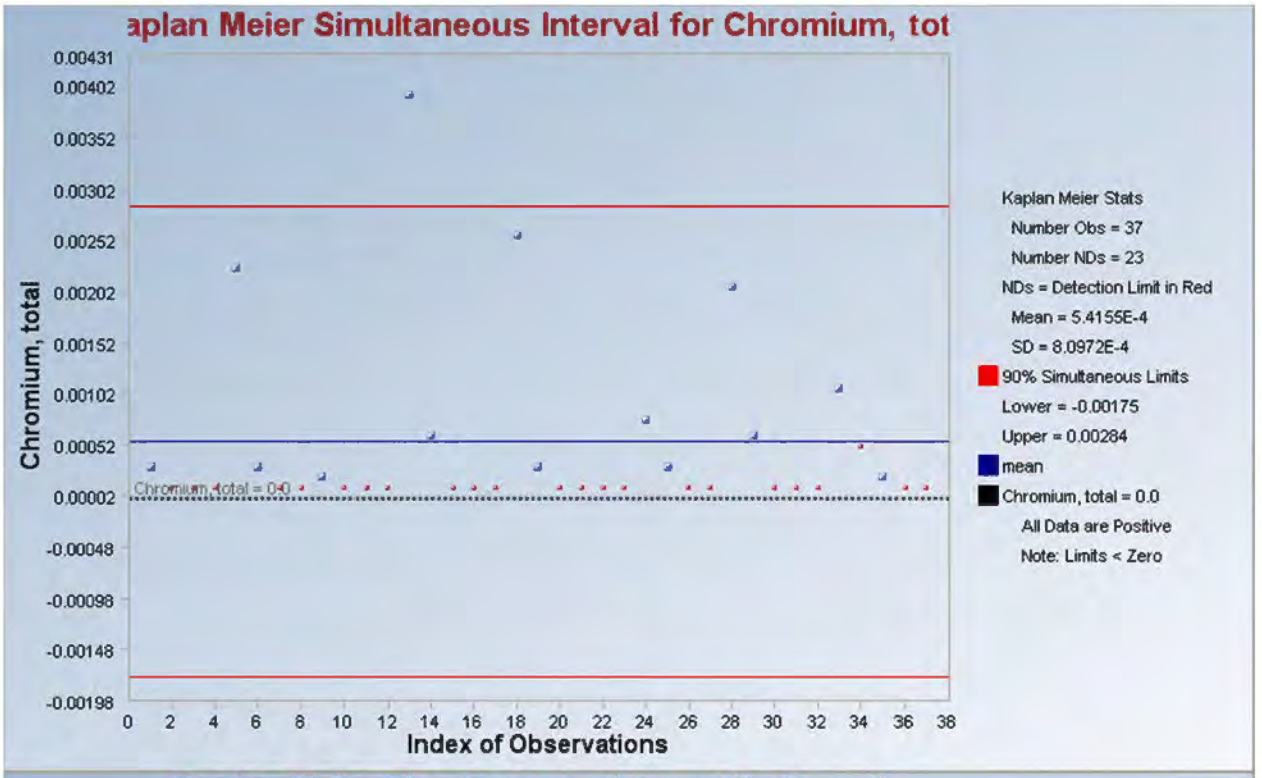
Manganese_1

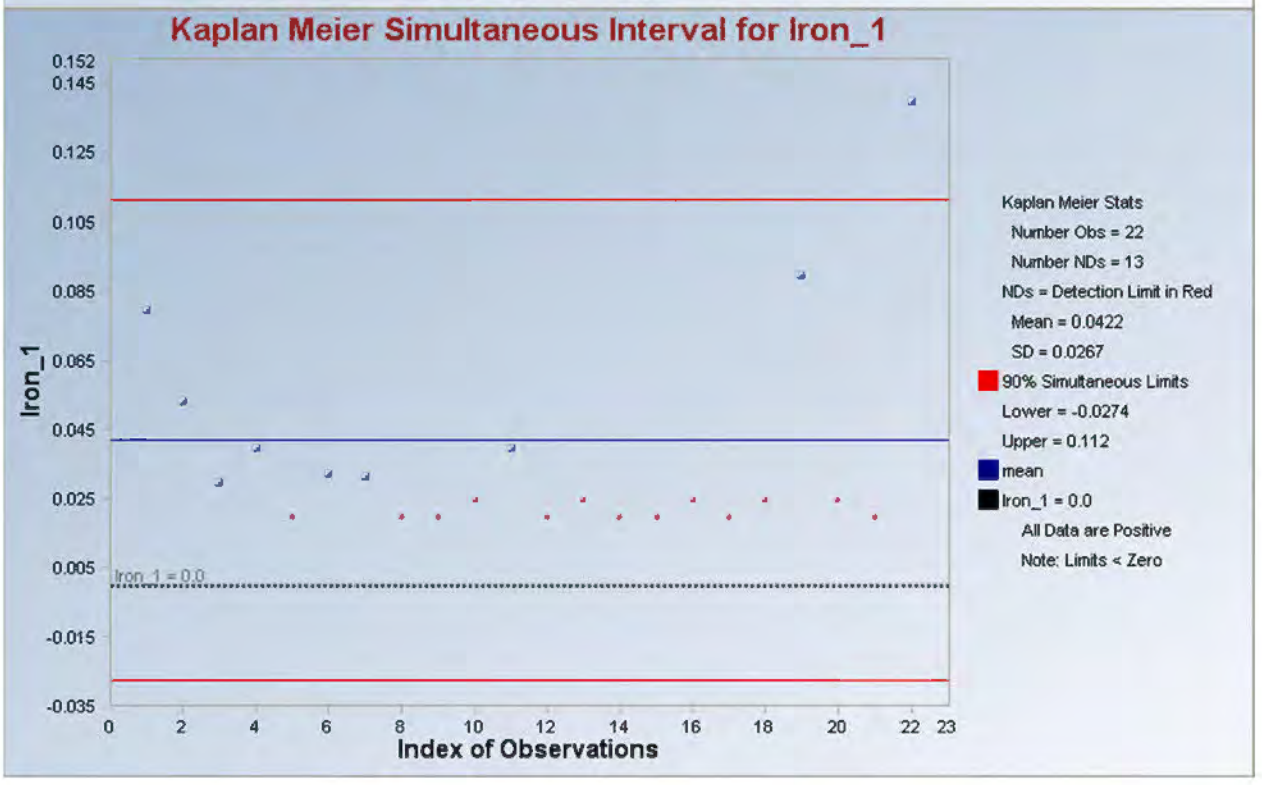
	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	20	0.0182	0.0175	0.0145	0.018	2.557	-0.0189	0.0552

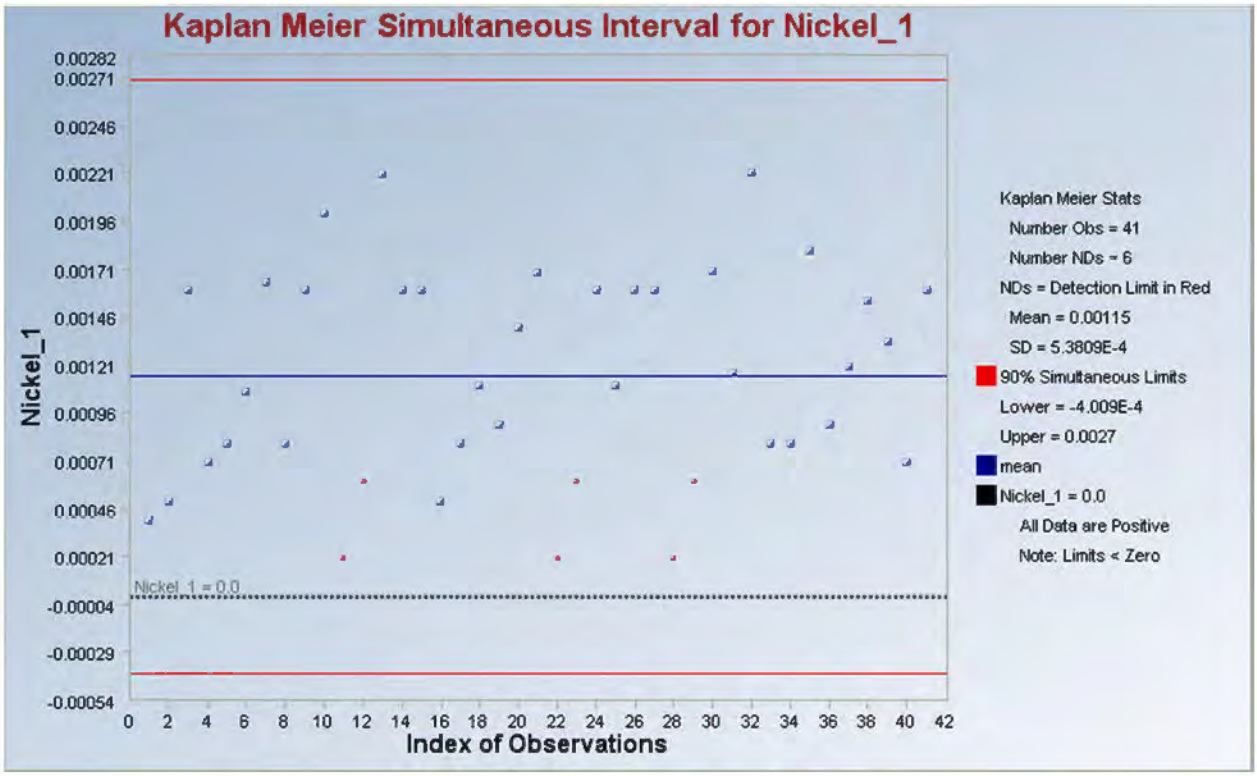
Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.0175	0.018	0.0182	0.0145	20	2.557	-0.0189	0.0552
Huber	0.0175	0.018	0.0182	0.0145	20	2.557	-0.0189	0.0552
Tukey Biweight	0.0175	0.018	0.0175	0.015	18.52	2.518	-0.0202	0.0553
Lax Kafadar Biweight	0.0175	0.018	0.0173	0.0153	17.99	2.504	-0.0211	0.0556
MVT	0.0175	0.018	0.0154	0.0122	18	2.504	-0.0152	0.0459

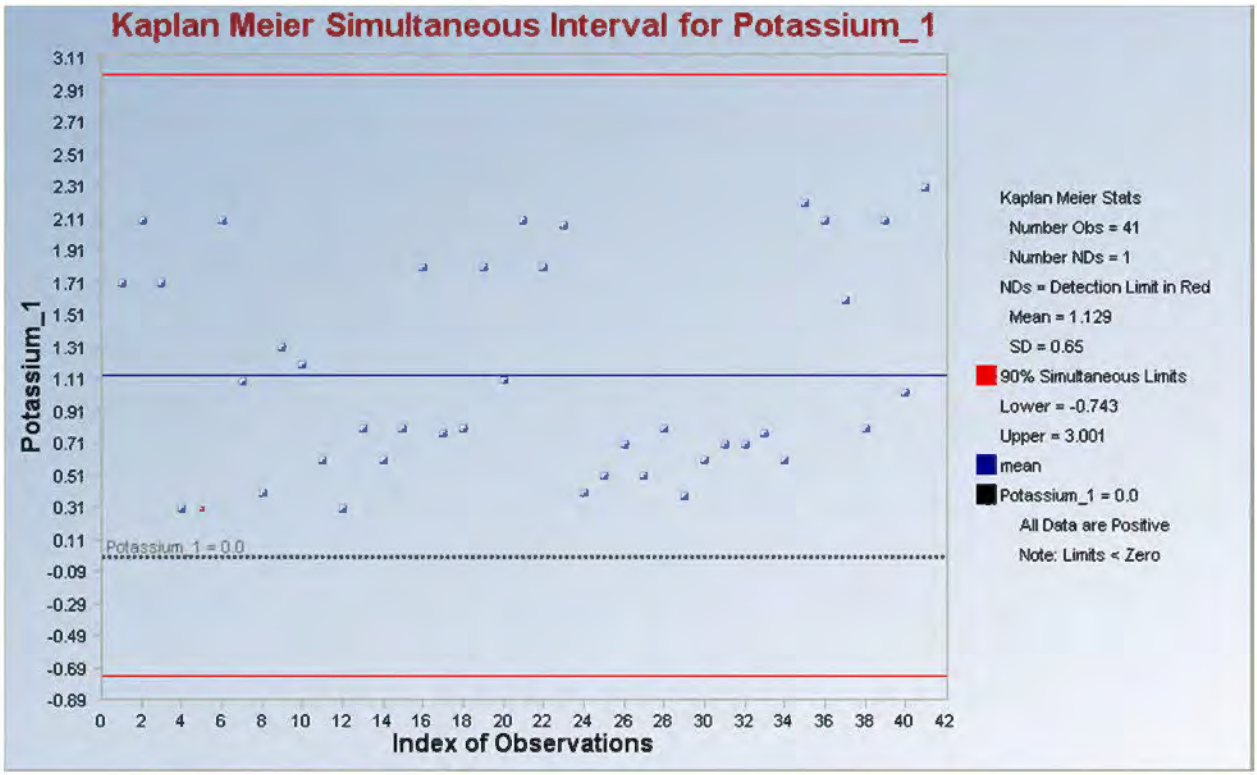

Kaplan Meier Simultaneous Interval for Aluminum
Aluminum
Index of Observations
Aluminum = 0.0
Kaplan Meier Stats
Number Obs = 21
Number NDs = 16
NDs = Detection Limit in Red
Mean = 0.0652
SD = 0.0802
90% Simultaneous Limits
Lower = -0.142
Upper = 0.272
mean
Aluminum = 0.0
All Data are Positive
Note: Limits < Zero

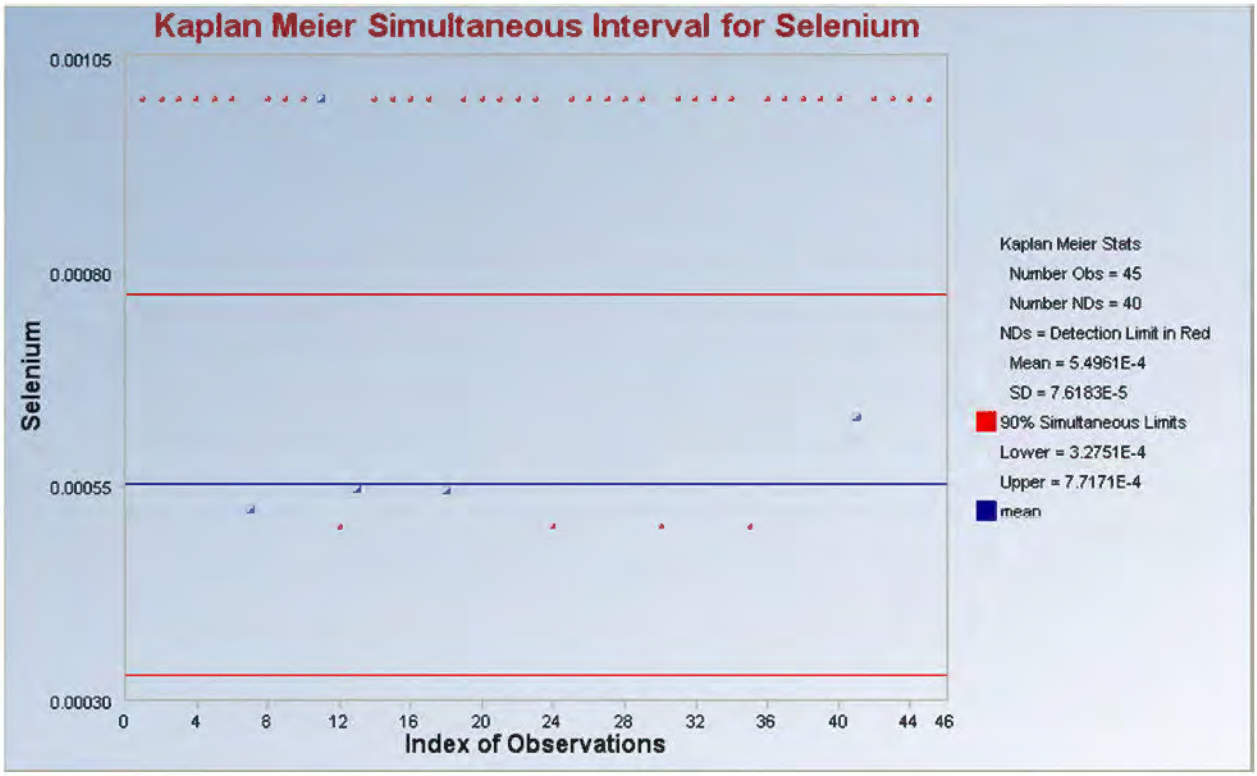

Kaplan Meier Simultaneous Interval for Arsenic_2
Arsenic_2
Index of Observations
Kaplan Meier Stats
Number Obs = 13
Number NDs = 7
NDs = Detection Limit in Red
Mean = 6.2823E-4
SD = 1.9696E-4
90% Simultaneous Limits
Lower = 1.6920E-4
Upper = 0.00109
mean

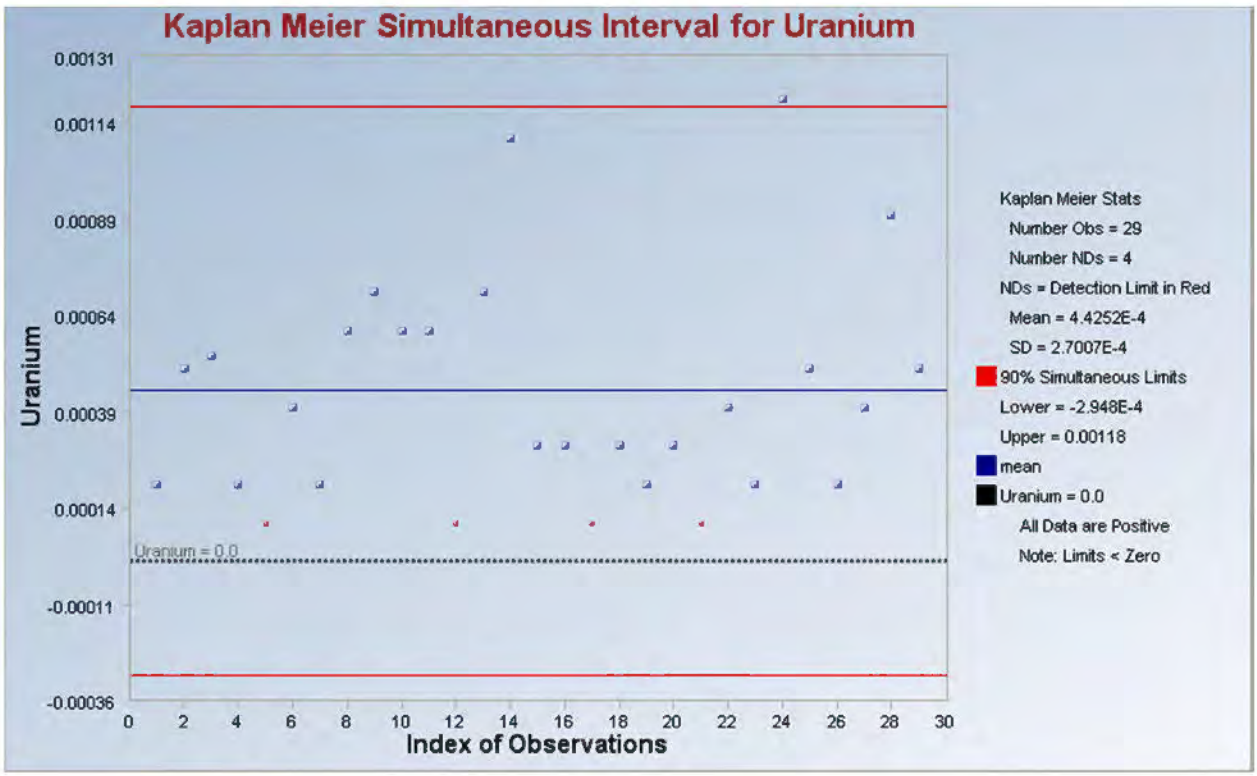

aplan Meier Simultaneous Interval for Chromium, tot
Chromium, total
Index of Observations
Chromium, total = 0.0
Kaplan Meier Stats
Number Obs = 37
Number NDs = 23
NDs = Detection Limit in Red
Mean = 5.4155E-4
SD = 8.0972E-4
90% Simultaneous Limits
Lower = -0.00175
Upper = 0.00284
mean
Chromium, total = 0.0
All Data are Positive
Note: Limits < Zero

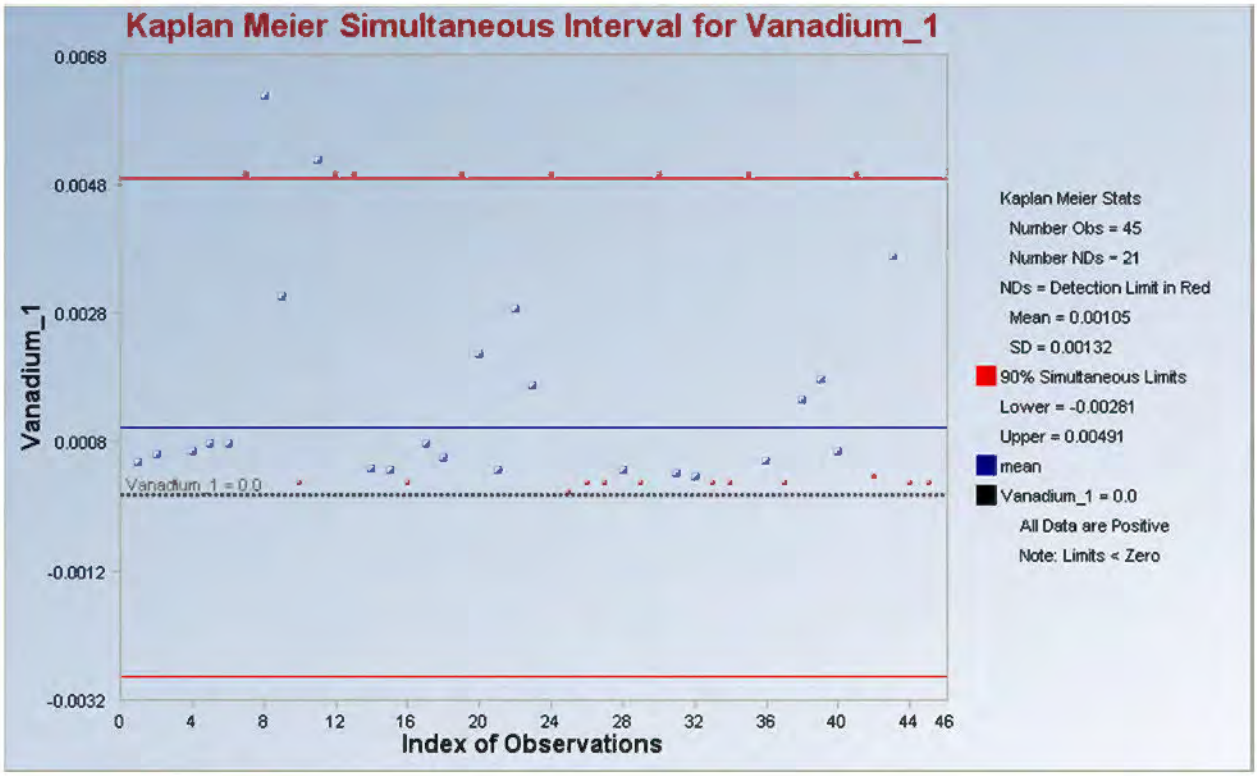

Kaplan Meier Simultaneous Interval for Iron_1
Iron_1
Index of Observations
Iron_1 = 0.0
Kaplan Meier Stats
Number Obs = 22
Number NDs = 13
NDs = Detection Limit in Red
Mean = 0.0422
SD = 0.0267
90% Simultaneous Limits
Lower = -0.0274
Upper = 0.112
mean
Iron_1 = 0.0
All Data are Positive
Note: Limits < Zero

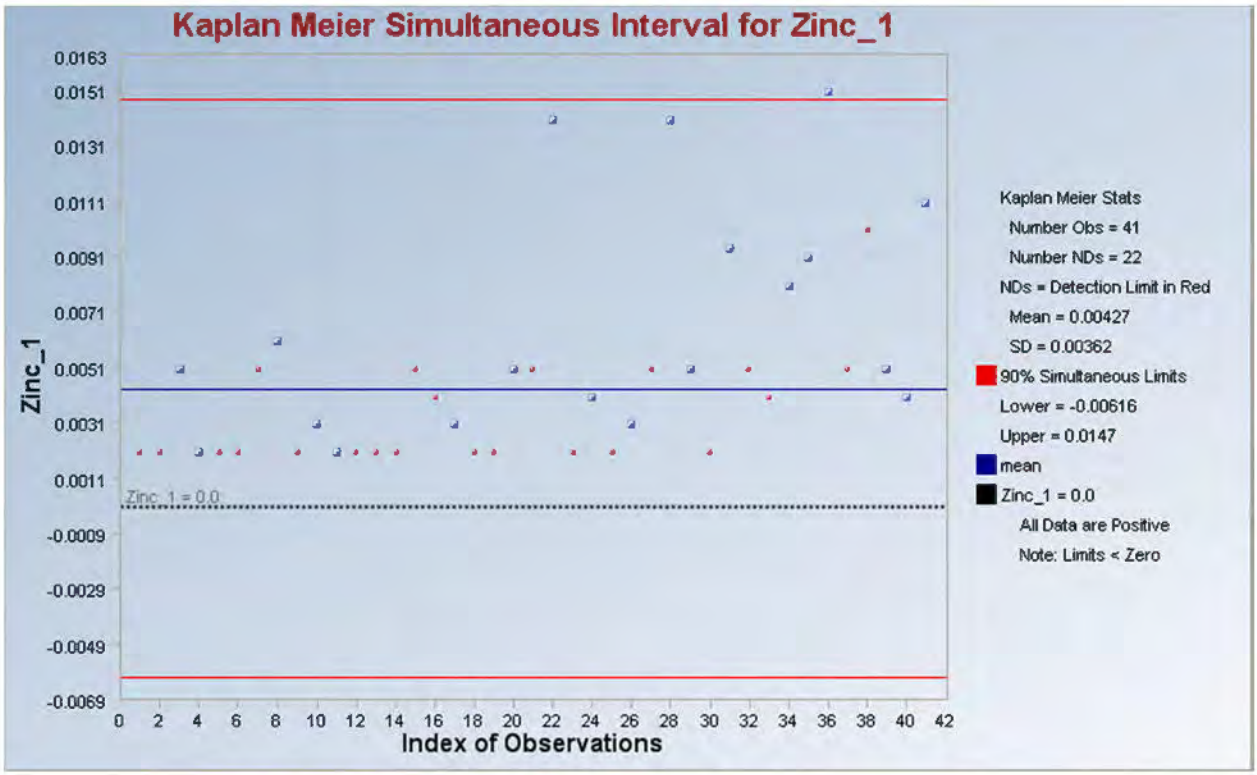

Kaplan Meier Simultaneous Interval for Nickel_1
Nickel_1
Index of Observations
Nickel_1 = 0.0
Kaplan Meier Stats
Number Obs = 41
Number NDs = 6
NDs = Detection Limit in Red
Mean = 0.00115
SD = 5.3809E-4
90% Simultaneous Limits
Lower = -4.009E-4
Upper = 0.0027
mean
Nickel_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Potassium_1
Potassium_1
Index of Observations
Potassium_1 = 0.0
Kaplan Meier Stats
Number Obs = 41
Number NDs = 1
NDs = Detection Limit in Red
Mean = 1.129
SD = 0.65
90% Simultaneous Limits
Lower = -0.743
Upper = 3.001
mean
Potassium_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Selenium
Selenium
0.00105
0.00080
0.00055
0.00030
0 4 8 12 16 20 24 28 32 36 40 44 46
Index of Observations
Kaplan Meier Stats
Number Obs = 45
Number NDs = 40
NDs = Detection Limit in Red
Mean = 5.4961E-4
SD = 7.6183E-5
90% Simultaneous Limits
Lower = 3.2751E-4
Upper = 7.7171E-4
mean


Kaplan Meier Simultaneous Interval for Uranium
Uranium
0.00131
0.00114
0.00089
0.00064
0.00039
0.00014
-0.00011
-0.00036
Uranium = 0.0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Index of Observations
Kaplan Meier Stats
Number Obs = 29
Number NDs = 4
NDs = Detection Limit in Red
Mean = 4.4252E-4
SD = 2.7007E-4
90% Simultaneous Limits
Lower = -2.948E-4
Upper = 0.00118
mean
Uranium = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Vanadium_1
Vanadium_1
Index of Observations
Vanadium_1 = 0.0
Kaplan Meier Stats
Number Obs = 45
Number NDs = 21
NDs = Detection Limit in Red
Mean = 0.00105
SD = 0.00132
90% Simultaneous Limits
Lower = -0.00281
Upper = 0.00491
mean
Vanadium_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Zinc_1
Zinc_1
Index of Observations
Zinc_1 = 0.0
Kaplan Meier Stats
Number Obs = 41
Number NDs = 22
NDs = Detection Limit in Red
Mean = 0.00427
SD = 0.00362
90% Simultaneous Limits
Lower = -0.00616
Upper = 0.0147
mean
Zinc_1 = 0.0
All Data are Positive
Note: Limits < Zero

RIPARIAN SOIL– OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options

From File	Rip Soil Input Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Cadmium

Number of data = 17
10% critical value: 0.438
5% critical value: 0.49
1% critical value: 0.577

1. Data Value 4.4 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.289

For 10% significance level, 4.4 is not an outlier.
For 5% significance level, 4.4 is not an outlier.
For 1% significance level, 4.4 is not an outlier.

2. Data Value 0.6 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.247

For 10% significance level, 0.6 is not an outlier.
For 5% significance level, 0.6 is not an outlier.
For 1% significance level, 0.6 is not an outlier.

Dixon's Outlier Test for Mercury

Number of data = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Data Value 0.069 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.489

For 10% significance level, 0.069 is an outlier.
For 5% significance level, 0.069 is not an outlier.
For 1% significance level, 0.069 is not an outlier.

2. Data Value 0.0235 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.063

For 10% significance level, 0.0235 is not an outlier.
For 5% significance level, 0.0235 is not an outlier.

For 1% significance level, 0.0235 is not an outlier.

Dixon's Outlier Test for Molybdenum

Number of data = 7

10% critical value: 0.434

5% critical value: 0.507

1% critical value: 0.637

1. Data Value 1.7 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.787

For 10% significance level, 1.7 is an outlier.

For 5% significance level, 1.7 is an outlier.

For 1% significance level, 1.7 is an outlier.

2. Data Value 0.43 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.000

For 10% significance level, 0.43 is not an outlier.

For 5% significance level, 0.43 is not an outlier.

For 1% significance level, 0.43 is not an outlier.

Dixon's Outlier Test for Uranium

Number of data = 8

10% critical value: 0.479

5% critical value: 0.554

1% critical value: 0.683

1. Data Value 3.76 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.389

For 10% significance level, 3.76 is not an outlier.

For 5% significance level, 3.76 is not an outlier.

For 1% significance level, 3.76 is not an outlier.

2. Data Value 1.6 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.163

For 10% significance level, 1.6 is not an outlier.

For 5% significance level, 1.6 is not an outlier.

For 1% significance level, 1.6 is not an outlier.

Outlier Tests for Selected Variables

User Selected Options

From File	Rip Soil Input Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Chromium, Total_1

Number of data = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Data Value 40.3 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.507

For 10% significance level, 40.3 is an outlier.
For 5% significance level, 40.3 is not an outlier.
For 1% significance level, 40.3 is not an outlier.

2. Data Value 16.7 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.136

For 10% significance level, 16.7 is not an outlier.
For 5% significance level, 16.7 is not an outlier.
For 1% significance level, 16.7 is not an outlier.

Dixon's Outlier Test for Copper_1

Number of data = 15
10% critical value: 0.472
5% critical value: 0.525
1% critical value: 0.616

1. Data Value 29 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.584

For 10% significance level, 29 is an outlier.
For 5% significance level, 29 is an outlier.
For 1% significance level, 29 is not an outlier.

2. Data Value 10.5 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.457

For 10% significance level, 10.5 is not an outlier.
For 5% significance level, 10.5 is not an outlier.

For 1% significance level, 10.5 is not an outlier.

Dixon's Outlier Test for Thallium_1

Number of data = 7

10% critical value: 0.434

5% critical value: 0.507

1% critical value: 0.637

1. Data Value 0.418 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.492

For 10% significance level, 0.418 is an outlier.

For 5% significance level, 0.418 is not an outlier.

For 1% significance level, 0.418 is not an outlier.

2. Data Value 0.16 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.039

For 10% significance level, 0.16 is not an outlier.

For 5% significance level, 0.16 is not an outlier.

For 1% significance level, 0.16 is not an outlier.

RIPARIAN SOIL – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Rip Soil Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	8	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	4
Number of Missing Values	19	Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	4.6	Minimum Detected	1.526
Maximum Detected	5.5	Maximum Detected	1.705
Mean of Detected	5.15	Mean of Detected	1.637
SD of Detected	0.387	SD of Detected	0.0774
Minimum Non-Detect	3.6	Minimum Non-Detect	1.281
Maximum Non-Detect	6.1	Maximum Non-Detect	1.808

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	8
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.897	Shapiro Wilk Test Statistic	0.883
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	3.756	Mean	1.239
SD	1.55	SD	0.451
95% DL/2 (t) UCL	4.794	95% H-Stat (DL/2) UCL	5.634
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	1.557
		SD in Log Scale	0.106
		Mean in Original Scale	4.768
		SD in Original Scale	0.507
		95% t UCL	5.108
		95% Percentile Bootstrap UCL	5.051

95% BCA Bootstrap UCL	5.06
95% H-UCL	5.138

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	56.92
Theta Star	0.0905
nu star	455.3
A-D Test Statistic	0.406
5% A-D Critical Value	0.657
K-S Test Statistic	0.657
5% K-S Critical Value	0.394

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	3.57
Maximum	5.5
Mean	4.556
Median	4.648
SD	0.767
k star	24.41
Theta star	0.187
Nu star	390.5
AppChi2	345.7
95% Gamma Approximate UCL	5.147
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	4.914
SD	0.372
SE of Mean	0.162
95% KM (t) UCL	5.222
95% KM (z) UCL	5.181
95% KM (jackknife) UCL	5.308
95% KM (bootstrap t) UCL	5.103
95% KM (BCA) UCL	5.367
95% KM (Percentile Bootstrap) UCL	5.357
95% KM (Chebyshev) UCL	5.622
97.5% KM (Chebyshev) UCL	5.928
99% KM (Chebyshev) UCL	6.53

Potential UCLs to Use

95% KM (t) UCL	5.222
95% KM (Percentile Bootstrap) UCL	5.357

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Arsenic

General Statistics

Number of Valid Observations	8
Number of Missing Values	19
Number of Distinct Observations	8

Raw Statistics

Minimum	2.78
Maximum	5.44
Mean	3.698
Median	3.02
SD	1.099
Std. Error of Mean	0.388
Coefficient of Variation	0.297
Skewness	0.935

Log-transformed Statistics

Minimum of Log Data	1.022
Maximum of Log Data	1.694
Mean of log Data	1.272
SD of log Data	0.278

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.772
Shapiro Wilk Critical Value	0.818

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.787
Shapiro Wilk Critical Value	0.818

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	4.434

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	4.474
95% Modified-t UCL (Johnson-1978)	4.455

Assuming Lognormal Distribution

95% H-UCL	4.591
95% Chebyshev (MVUE) UCL	5.277
97.5% Chebyshev (MVUE) UCL	5.963
99% Chebyshev (MVUE) UCL	7.31

Gamma Distribution Test

k star (bias corrected)	9.022
Theta Star	0.41
MLE of Mean	3.698
MLE of Standard Deviation	1.231
nu star	144.3
Approximate Chi Square Value (.05)	117.6
Adjusted Level of Significance	0.0195
Adjusted Chi Square Value	111.5
Anderson-Darling Test Statistic	0.932
Anderson-Darling 5% Critical Value	0.716
Kolmogorov-Smirnov Test Statistic	0.36
Kolmogorov-Smirnov 5% Critical Value	0.294

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	4.54
95% Adjusted Gamma UCL	4.789

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	4.337
95% Jackknife UCL	4.434
95% Standard Bootstrap UCL	4.288
95% Bootstrap-t UCL	5.063
95% Hall's Bootstrap UCL	4.347
95% Percentile Bootstrap UCL	4.293
95% BCA Bootstrap UCL	4.34
95% Chebyshev(Mean, Sd) UCL	5.391
97.5% Chebyshev(Mean, Sd) UCL	6.124
99% Chebyshev(Mean, Sd) UCL	7.563

Potential UCL to Use

Use 95% Student's-t UCL 4.434

or 95% Modified-t UCL 4.455

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Boron

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Number of Missing Values	19		

Raw Statistics

Minimum	5.6
Maximum	11.2

Log-transformed Statistics

Minimum of Log Data	1.723
Maximum of Log Data	2.416

Mean	8.244	Mean of log Data	2.077
Median	8.25	SD of log Data	0.273
SD	2.198		
Std. Error of Mean	0.777		
Coefficient of Variation	0.267		
Skewness	0.0635		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.856
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.859
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	9.716

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	9.541
95% Modified-t UCL (Johnson-1978)	9.719

Assuming Lognormal Distribution

95% H-UCL	10.21
95% Chebyshev (MVUE) UCL	11.73
97.5% Chebyshev (MVUE) UCL	13.23
99% Chebyshev (MVUE) UCL	16.19

Gamma Distribution Test

k star (bias corrected)	9.916
Theta Star	0.831
MLE of Mean	8.244
MLE of Standard Deviation	2.618
nu star	158.7
Approximate Chi Square Value (.05)	130.5
Adjusted Level of Significance	0.0195
Adjusted Chi Square Value	124.1
Anderson-Darling Test Statistic	0.675
Anderson-Darling 5% Critical Value	0.716
Kolmogorov-Smirnov Test Statistic	0.285
Kolmogorov-Smirnov 5% Critical Value	0.294

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	10.02
95% Adjusted Gamma UCL	10.54

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	9.522
95% Jackknife UCL	9.716
95% Standard Bootstrap UCL	9.451
95% Bootstrap-t UCL	9.669
95% Hall's Bootstrap UCL	9.205
95% Percentile Bootstrap UCL	9.406
95% BCA Bootstrap UCL	9.444
95% Chebyshev(Mean, Sd) UCL	11.63
97.5% Chebyshev(Mean, Sd) UCL	13.1
99% Chebyshev(Mean, Sd) UCL	15.98

Potential UCL to Use

Use 95% Student's-t UCL 9.716

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cadmium

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	17
Number of Missing Values	11		

Raw Statistics

Minimum	0.6
Maximum	4.4
Mean	2.355
Median	2.02
SD	1.075
Std. Error of Mean	0.261
Coefficient of Variation	0.456
Skewness	0.261

Log-transformed Statistics

Minimum of Log Data	-0.511
Maximum of Log Data	1.482
Mean of log Data	0.742
SD of log Data	0.521

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.945
Shapiro Wilk Critical Value	0.892

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.937
Shapiro Wilk Critical Value	0.892

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	2.811

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	2.802
95% Modified-t UCL (Johnson-1978)	2.813

Assuming Lognormal Distribution

95% H-UCL	3.145
95% Chebyshev (MVUE) UCL	3.746
97.5% Chebyshev (MVUE) UCL	4.335
99% Chebyshev (MVUE) UCL	5.491

Gamma Distribution Test

k star (bias corrected)	3.769
Theta Star	0.625
MLE of Mean	2.355
MLE of Standard Deviation	1.213
nu star	128.1
Approximate Chi Square Value (.05)	103
Adjusted Level of Significance	0.0346
Adjusted Chi Square Value	100.6
Anderson-Darling Test Statistic	0.382
Anderson-Darling 5% Critical Value	0.742
Kolmogorov-Smirnov Test Statistic	0.161
Kolmogorov-Smirnov 5% Critical Value	0.21

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	2.93
95% Adjusted Gamma UCL	2.999

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	2.784
95% Jackknife UCL	2.811
95% Standard Bootstrap UCL	2.763
95% Bootstrap-t UCL	2.857
95% Hall's Bootstrap UCL	2.812
95% Percentile Bootstrap UCL	2.778
95% BCA Bootstrap UCL	2.777
95% Chebyshev(Mean, Sd) UCL	3.492
97.5% Chebyshev(Mean, Sd) UCL	3.984
99% Chebyshev(Mean, Sd) UCL	4.95

Potential UCL to Use

Use 95% Student's-t UCL 2.811

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium, Total

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	16
Number of Missing Values	11		

Raw Statistics

Minimum	16.7
Maximum	42.5
Mean	24.56
Median	22.9
SD	7.556
Std. Error of Mean	1.833
Coefficient of Variation	0.308
Skewness	1.313

Log-transformed Statistics

Minimum of Log Data	2.815
Maximum of Log Data	3.75
Mean of log Data	3.162
SD of log Data	0.28

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.853
Shapiro Wilk Critical Value	0.892

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.917
Shapiro Wilk Critical Value	0.892

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	27.76

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	28.19
95% Modified-t UCL (Johnson-1978)	27.85

Assuming Lognormal Distribution

95% H-UCL	27.94
95% Chebyshev (MVUE) UCL	31.82
97.5% Chebyshev (MVUE) UCL	34.99
99% Chebyshev (MVUE) UCL	41.21

Gamma Distribution Test

k star (bias corrected)	10.73
Theta Star	2.288
MLE of Mean	24.56
MLE of Standard Deviation	7.496
nu star	364.9
Approximate Chi Square Value (.05)	321.6
Adjusted Level of Significance	0.0346
Adjusted Chi Square Value	317.4
Anderson-Darling Test Statistic	0.579
Anderson-Darling 5% Critical Value	0.739
Kolmogorov-Smirnov Test Statistic	0.159
Kolmogorov-Smirnov 5% Critical Value	0.209

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	27.57
95% Jackknife UCL	27.76
95% Standard Bootstrap UCL	27.39
95% Bootstrap-t UCL	29.21
95% Hall's Bootstrap UCL	30.23
95% Percentile Bootstrap UCL	27.71
95% BCA Bootstrap UCL	27.93
95% Chebyshev(Mean, Sd) UCL	32.54
97.5% Chebyshev(Mean, Sd) UCL	36
99% Chebyshev(Mean, Sd) UCL	42.79

Assuming Gamma Distribution

95% Approximate Gamma UCL	27.86
95% Adjusted Gamma UCL	28.23

Potential UCL to Use

Use 95% Approximate Gamma UCL 27.86

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cobalt

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Number of Missing Values	19		

Raw Statistics		Log-transformed Statistics	
Minimum	4.48	Minimum of Log Data	1.5
Maximum	10.1	Maximum of Log Data	2.313
Mean	6.791	Mean of log Data	1.873
Median	5.98	SD of log Data	0.31
SD	2.177		
Std. Error of Mean	0.77		
Coefficient of Variation	0.321		
Skewness	0.682		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Test Statistic	0.905
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	8.249	95% H-UCL	8.697
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.03
95% Adjusted-CLT UCL (Chen-1995)	8.255	97.5% Chebyshev (MVUE) UCL	11.44
95% Modified-t UCL (Johnson-1978)	8.28	99% Chebyshev (MVUE) UCL	14.21

Gamma Distribution Test		Data Distribution
k star (bias corrected)	7.455	Data appear Normal at 5% Significance Level
Theta Star	0.911	
MLE of Mean	6.791	
MLE of Standard Deviation	2.487	
nu star	119.3	
Approximate Chi Square Value (.05)	95.07	**Nonparametric Statistics**
Adjusted Level of Significance	0.0195	95% CLT UCL 8.057
Adjusted Chi Square Value	89.6	95% Jackknife UCL 8.249
		95% Standard Bootstrap UCL 7.96
Anderson-Darling Test Statistic	0.45	95% Bootstrap-t UCL 8.851
Anderson-Darling 5% Critical Value	0.715	95% Hall's Bootstrap UCL 8.115
Kolmogorov-Smirnov Test Statistic	0.198	95% Percentile Bootstrap UCL 8.051
Kolmogorov-Smirnov 5% Critical Value	0.294	95% BCA Bootstrap UCL 8.163

Data appear Gamma Distributed at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL 10.15
97.5% Chebyshev(Mean, Sd) UCL 11.6
99% Chebyshev(Mean, Sd) UCL 14.45

Assuming Gamma Distribution

95% Approximate Gamma UCL 8.521
95% Adjusted Gamma UCL 9.04

Potential UCL to Use

Use 95% Student's-t UCL 8.249

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Copper_2

General Statistics

Number of Valid Observations 14
Number of Missing Values 11
Number of Distinct Observations 12

Raw Statistics

Minimum 10.5
Maximum 21.1
Mean 17.09
Median 17.83
SD 3.033
Std. Error of Mean 0.811
Coefficient of Variation 0.177
Skewness -0.9

Log-transformed Statistics

Minimum of Log Data 2.351
Maximum of Log Data 3.049
Mean of log Data 2.822
SD of log Data 0.197

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.916
Shapiro Wilk Critical Value 0.874

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.868
Shapiro Wilk Critical Value 0.874

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 18.52

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 18.21
95% Modified-t UCL (Johnson-1978) 18.49

Assuming Lognormal Distribution

95% H-UCL 18.93
95% Chebyshev (MVUE) UCL 21.07
97.5% Chebyshev (MVUE) UCL 22.78
99% Chebyshev (MVUE) UCL 26.14

Gamma Distribution Test

k star (bias corrected) 23.56
Theta Star 0.725
MLE of Mean 17.09
MLE of Standard Deviation 3.521
nu star 659.6
Approximate Chi Square Value (.05) 601
Adjusted Level of Significance 0.0312
Adjusted Chi Square Value 593.6

Anderson-Darling Test Statistic 0.675
Anderson-Darling 5% Critical Value 0.734

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 18.42
95% Jackknife UCL 18.52
95% Standard Bootstrap UCL 18.38
95% Bootstrap-t UCL 18.33
95% Hall's Bootstrap UCL 18.27

Kolmogorov-Smirnov Test Statistic	0.231	95% Percentile Bootstrap UCL	18.31
Kolmogorov-Smirnov 5% Critical Value	0.228	95% BCA Bootstrap UCL	18.16
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	20.62
		97.5% Chebyshev(Mean, Sd) UCL	22.15
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	25.16
95% Approximate Gamma UCL	18.76		
95% Adjusted Gamma UCL	18.99		

Potential UCL to Use		Use 95% Student's-t UCL	18.52

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Manganese

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Number of Missing Values	19		

Raw Statistics		Log-transformed Statistics	
Minimum	124	Minimum of Log Data	4.82
Maximum	1080	Maximum of Log Data	6.985
Mean	429.7	Mean of log Data	5.794
Median	333.5	SD of log Data	0.793
SD	335.7		
Std. Error of Mean	118.7		
Coefficient of Variation	0.781		
Skewness	1.164		

Warning: There are only 8 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.871	Shapiro Wilk Test Statistic	0.936
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	654.6	95% H-UCL	1083
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	962.3
95% Adjusted-CLT UCL (Chen-1995)	677.1	97.5% Chebyshev (MVUE) UCL	1193

95% Modified-t UCL (Johnson-1978)	662.7
99% Chebyshev (MVUE) UCL	1647

Gamma Distribution Test

k star (bias corrected)	1.34
Theta Star	320.8
MLE of Mean	429.7
MLE of Standard Deviation	371.3
nu star	21.43
Approximate Chi Square Value (.05)	11.91
Adjusted Level of Significance	0.0195
Adjusted Chi Square Value	10.17
Anderson-Darling Test Statistic	0.312
Anderson-Darling 5% Critical Value	0.724
Kolmogorov-Smirnov Test Statistic	0.206
Kolmogorov-Smirnov 5% Critical Value	0.297

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	773
95% Adjusted Gamma UCL	905.9

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	624.9
95% Jackknife UCL	654.6
95% Standard Bootstrap UCL	614.2
95% Bootstrap-t UCL	806.5
95% Hall's Bootstrap UCL	828.7
95% Percentile Bootstrap UCL	620.5
95% BCA Bootstrap UCL	645.1
95% Chebyshev(Mean, Sd) UCL	947
97.5% Chebyshev(Mean, Sd) UCL	1171
99% Chebyshev(Mean, Sd) UCL	1611

Potential UCL to Use

Use 95% Student's-t UCL 654.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mercury

General Statistics

Number of Valid Observations	8
Number of Missing Values	19
Number of Distinct Observations	7

Raw Statistics

Minimum	0.0235
Maximum	0.069
Mean	0.0393
Median	0.0385
SD	0.0148
Std. Error of Mean	0.00522
Coefficient of Variation	0.376
Skewness	1.143

Log-transformed Statistics

Minimum of Log Data	-3.751
Maximum of Log Data	-2.674
Mean of log Data	-3.295
SD of log Data	0.357

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.906
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.0491

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.0501
95% Modified-t UCL (Johnson-1978)	0.0495

Assuming Lognormal Distribution

95% H-UCL	0.0527
95% Chebyshev (MVUE) UCL	0.0608
97.5% Chebyshev (MVUE) UCL	0.0702
99% Chebyshev (MVUE) UCL	0.0886

Gamma Distribution Test

k star (bias corrected)	5.656
Theta Star	0.00694
MLE of Mean	0.0393
MLE of Standard Deviation	0.0165
nu star	90.49
Approximate Chi Square Value (.05)	69.56
Adjusted Level of Significance	0.0195
Adjusted Chi Square Value	64.93
Anderson-Darling Test Statistic	0.247
Anderson-Darling 5% Critical Value	0.716
Kolmogorov-Smirnov Test Statistic	0.126
Kolmogorov-Smirnov 5% Critical Value	0.294

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.0511
95% Adjusted Gamma UCL	0.0547

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.0478
95% Jackknife UCL	0.0491
95% Standard Bootstrap UCL	0.0473
95% Bootstrap-t UCL	0.0526
95% Hall's Bootstrap UCL	0.0582
95% Percentile Bootstrap UCL	0.0473
95% BCA Bootstrap UCL	0.0493
95% Chebyshev(Mean, Sd) UCL	0.062
97.5% Chebyshev(Mean, Sd) UCL	0.0718
99% Chebyshev(Mean, Sd) UCL	0.0911

Potential UCL to Use

Use 95% Student's-t UCL 0.0491

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Molybdenum_1

General Statistics

Number of Valid Data	16	Number of Detected Data	6
Number of Distinct Detected Data	5	Number of Non-Detect Data	10
Number of Missing Values	12	Percent Non-Detects	62.50%

Raw Statistics

Minimum Detected	0.43
Maximum Detected	0.7
Mean of Detected	0.51
SD of Detected	0.109
Minimum Non-Detect	0.17
Maximum Non-Detect	1.5

Log-transformed Statistics

Minimum Detected	-0.844
Maximum Detected	-0.357
Mean of Detected	-0.69
SD of Detected	0.198
Minimum Non-Detect	-1.772
Maximum Non-Detect	0.405

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	16
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.802
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.823
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.387
SD	0.203
95% DL/2 (t) UCL	0.476
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-1.103
SD	0.607
95% H-Stat (DL/2) UCL	0.56
Log ROS Method	
Mean in Log Scale	-0.871
SD in Log Scale	0.214
Mean in Original Scale	0.428
SD in Original Scale	0.0998
95% t UCL	0.472
95% Percentile Bootstrap UCL	0.471
95% BCA Bootstrap UCL	0.481
95% H-UCL	0.473

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	14.78
Theta Star	0.0345
nu star	177.4
A-D Test Statistic	0.614
5% A-D Critical Value	0.697
K-S Test Statistic	0.697
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.11
Maximum	0.7
Mean	0.371
Median	0.405
SD	0.173
k star	3.001
Theta star	0.123

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.468
SD	0.0757
SE of Mean	0.0226
95% KM (t) UCL	0.508
95% KM (z) UCL	0.505
95% KM (jackknife) UCL	0.506
95% KM (bootstrap t) UCL	0.577
95% KM (BCA) UCL	0.518
95% KM (Percentile Bootstrap) UCL	0.508
95% KM (Chebyshev) UCL	0.567
97.5% KM (Chebyshev) UCL	0.61
99% KM (Chebyshev) UCL	0.693

Nu star	96.04
AppChi2	74.44
95% Gamma Approximate UCL	0.478
95% Adjusted Gamma UCL	0.493

Potential UCLs to Use

95% KM (t) UCL	0.508
95% KM (Percentile Bootstrap) UCL	0.508

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Nickel

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	15
Number of Missing Values	11		

Raw Statistics		Log-transformed Statistics	
Minimum	10.4	Minimum of Log Data	2.342
Maximum	26.6	Maximum of Log Data	3.281
Mean	18.25	Mean of log Data	2.874
Median	17.1	SD of log Data	0.255
SD	4.603		
Std. Error of Mean	1.116		
Coefficient of Variation	0.252		
Skewness	0.376		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.946	Shapiro Wilk Test Statistic	0.963
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	20.2	95% H-UCL	20.55
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	23.23
95% Adjusted-CLT UCL (Chen-1995)	20.19	97.5% Chebyshev (MVUE) UCL	25.38
95% Modified-t UCL (Johnson-1978)	20.21	99% Chebyshev (MVUE) UCL	29.6

Gamma Distribution Test		Data Distribution
k star (bias corrected)	13.78	Data appear Normal at 5% Significance Level
Theta Star	1.324	
MLE of Mean	18.25	
MLE of Standard Deviation	4.915	
nu star	468.7	
Approximate Chi Square Value (.05)	419.5	**Nonparametric Statistics**
Adjusted Level of Significance	0.0346	95% CLT UCL 20.08
Adjusted Chi Square Value	414.6	95% Jackknife UCL 20.2
		95% Standard Bootstrap UCL 19.97
Anderson-Darling Test Statistic	0.334	95% Bootstrap-t UCL 20.41
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 20.24
Kolmogorov-Smirnov Test Statistic	0.143	95% Percentile Bootstrap UCL 19.97
Kolmogorov-Smirnov 5% Critical Value	0.209	95% BCA Bootstrap UCL 20.21

Data appear Gamma Distributed at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL	23.11
97.5% Chebyshev(Mean, Sd) UCL	25.22
99% Chebyshev(Mean, Sd) UCL	29.35

Assuming Gamma Distribution

95% Approximate Gamma UCL	20.39
95% Adjusted Gamma UCL	20.63

Potential UCL to Use

Use 95% Student's-t UCL 20.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Selenium

General Statistics

Number of Valid Data	17	Number of Detected Data	13
Number of Distinct Detected Data	9	Number of Non-Detect Data	4
Number of Missing Values	11	Percent Non-Detects	23.53%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.5	Minimum Detected	-0.693
Maximum Detected	1.8	Maximum Detected	0.588
Mean of Detected	1.05	Mean of Detected	-0.0429
SD of Detected	0.456	SD of Detected	0.452
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	0.5	Maximum Non-Detect	-0.693

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.901	Shapiro Wilk Test Statistic	0.909
5% Shapiro Wilk Critical Value	0.866	5% Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.862	Mean	-0.359
SD	0.528	SD	0.706
95% DL/2 (t) UCL	1.085	95% H-Stat (DL/2) UCL	1.336
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.841	Mean in Log Scale	-0.296
SD	0.554	SD in Log Scale	0.619
95% MLE (t) UCL	1.076	Mean in Original Scale	0.881
95% MLE (Tiku) UCL	1.083	SD in Original Scale	0.505
		95% t UCL	1.095
		95% Percentile Bootstrap UCL	1.08
		95% BCA Bootstrap UCL	1.098
		95% H UCL	1.26

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	4.372	Data appear Normal at 5% Significance Level

Theta Star	0.24
nu star	113.7

A-D Test Statistic	0.538
5% A-D Critical Value	0.736
K-S Test Statistic	0.736
5% K-S Critical Value	0.237

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	1.8
Mean	0.803
Median	0.7
SD	0.606
k star	0.232
Theta star	3.459
Nu star	7.892
AppChi2	2.673
95% Gamma Approximate UCL	2.371
95% Adjusted Gamma UCL	2.68

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.921
SD	0.449
SE of Mean	0.113
95% KM (t) UCL	1.118
95% KM (z) UCL	1.107
95% KM (jackknife) UCL	1.117
95% KM (bootstrap t) UCL	1.15
95% KM (BCA) UCL	1.147
95% KM (Percentile Bootstrap) UCL	1.126
95% KM (Chebyshev) UCL	1.415
97.5% KM (Chebyshev) UCL	1.628
99% KM (Chebyshev) UCL	2.048

Potential UCLs to Use

95% KM (t) UCL	1.118
95% KM (Percentile Bootstrap) UCL	1.126

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Thallium

General Statistics

Number of Valid Observations	8
Number of Missing Values	19
Number of Distinct Observations	8

Raw Statistics

Minimum	0.16
Maximum	0.428
Mean	0.259
Median	0.216
SD	0.111
Std. Error of Mean	0.0391
Coefficient of Variation	0.427
Skewness	0.878

Log-transformed Statistics

Minimum of Log Data	-1.833
Maximum of Log Data	-0.849
Mean of log Data	-1.426
SD of log Data	0.403

Warning: There are only 8 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.818
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.857
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.333

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.336
95% Modified-t UCL (Johnson-1978)	0.335

Assuming Lognormal Distribution

95% H-UCL	0.364
95% Chebyshev (MVUE) UCL	0.419
97.5% Chebyshev (MVUE) UCL	0.489
99% Chebyshev (MVUE) UCL	0.626

Gamma Distribution Test

k star (bias corrected)	4.404
Theta Star	0.0587
MLE of Mean	0.259
MLE of Standard Deviation	0.123
nu star	70.47
Approximate Chi Square Value (.05)	52.15
Adjusted Level of Significance	0.0195
Adjusted Chi Square Value	48.18
Anderson-Darling Test Statistic	0.598
Anderson-Darling 5% Critical Value	0.718
Kolmogorov-Smirnov Test Statistic	0.25
Kolmogorov-Smirnov 5% Critical Value	0.295

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.35
95% Adjusted Gamma UCL	0.378

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.323
95% Jackknife UCL	0.333
95% Standard Bootstrap UCL	0.32
95% Bootstrap-t UCL	0.357
95% Hall's Bootstrap UCL	0.357
95% Percentile Bootstrap UCL	0.321
95% BCA Bootstrap UCL	0.329
95% Chebyshev(Mean, Sd) UCL	0.429
97.5% Chebyshev(Mean, Sd) UCL	0.503
99% Chebyshev(Mean, Sd) UCL	0.648

Potential UCL to Use

Use 95% Student's-t UCL 0.333

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Uranium

General Statistics

Number of Valid Observations	8
Number of Missing Values	19
Number of Distinct Observations	8

Raw Statistics

Minimum	1.6
Maximum	3.76
Mean	2.444
Median	2.39
SD	0.694
Std. Error of Mean	0.245
Coefficient of Variation	0.284
Skewness	0.887

Log-transformed Statistics

Minimum of Log Data	0.47
Maximum of Log Data	1.324
Mean of log Data	0.86
SD of log Data	0.274

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.984
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	2.908

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	2.929
95% Modified-t UCL (Johnson-1978)	2.921

Assuming Lognormal Distribution

95% H-UCL	3.028
95% Chebyshev (MVUE) UCL	3.478
97.5% Chebyshev (MVUE) UCL	3.927
99% Chebyshev (MVUE) UCL	4.807

Gamma Distribution Test

k star (bias corrected)	9.506
Theta Star	0.257
MLE of Mean	2.444
MLE of Standard Deviation	0.793
nu star	152.1
Approximate Chi Square Value (.05)	124.6
Adjusted Level of Significance	0.0195
Adjusted Chi Square Value	118.3
Anderson-Darling Test Statistic	0.179
Anderson-Darling 5% Critical Value	0.716
Kolmogorov-Smirnov Test Statistic	0.156
Kolmogorov-Smirnov 5% Critical Value	0.294

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	2.983
95% Adjusted Gamma UCL	3.142

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	2.847
95% Jackknife UCL	2.908
95% Standard Bootstrap UCL	2.82
95% Bootstrap-t UCL	3.081
95% Hall's Bootstrap UCL	3.344
95% Percentile Bootstrap UCL	2.838
95% BCA Bootstrap UCL	2.929
95% Chebyshev(Mean, Sd) UCL	3.513
97.5% Chebyshev(Mean, Sd) UCL	3.975
99% Chebyshev(Mean, Sd) UCL	4.884

Potential UCL to Use

Use 95% Student's-t UCL 2.908

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Vanadium

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	17
Number of Missing Values	11		

Raw Statistics		Log-transformed Statistics	
Minimum	22.9	Minimum of Log Data	3.131
Maximum	57.3	Maximum of Log Data	4.048
Mean	32.56	Mean of log Data	3.443
Median	29.4	SD of log Data	0.279
SD	10.22		
Std. Error of Mean	2.478		
Coefficient of Variation	0.314		
Skewness	1.387		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.825	Shapiro Wilk Test Statistic	0.884
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	36.89	95% H-UCL	37.02
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	42.16
95% Adjusted-CLT UCL (Chen-1995)	37.53	97.5% Chebyshev (MVUE) UCL	46.35
95% Modified-t UCL (Johnson-1978)	37.02	99% Chebyshev (MVUE) UCL	54.59

Gamma Distribution Test		Data Distribution
k star (bias corrected)	10.57	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	3.079	
MLE of Mean	32.56	
MLE of Standard Deviation	10.01	
nu star	359.5	
Approximate Chi Square Value (.05)	316.5	**Nonparametric Statistics**
Adjusted Level of Significance	0.0346	95% CLT UCL 36.64
Adjusted Chi Square Value	312.3	95% Jackknife UCL 36.89
		95% Standard Bootstrap UCL 36.54
Anderson-Darling Test Statistic	0.872	95% Bootstrap-t UCL 39.24
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL 38.76
Kolmogorov-Smirnov Test Statistic	0.167	95% Percentile Bootstrap UCL 36.65
Kolmogorov-Smirnov 5% Critical Value	0.209	95% BCA Bootstrap UCL 37.43
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 43.36
		97.5% Chebyshev(Mean, Sd) UCL 48.04
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 57.22
95% Approximate Gamma UCL	36.98	
95% Adjusted Gamma UCL	37.47	
Potential UCL to Use		Use 95% Approximate Gamma UCL 36.98

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zinc

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	17

Number of Missing Values	11

Raw Statistics

Minimum	42
Maximum	158
Mean	103.7
Median	104
SD	30.99
Std. Error of Mean	7.515
Coefficient of Variation	0.299
Skewness	-0.059

Log-transformed Statistics

Minimum of Log Data	3.738
Maximum of Log Data	5.063
Mean of log Data	4.593
SD of log Data	0.336

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.978
Shapiro Wilk Critical Value	0.892

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical Value	0.892

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	116.8

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	116
95% Modified-t UCL (Johnson-1978)	116.8

Assuming Lognormal Distribution

95% H-UCL	122.5
95% Chebyshev (MVUE) UCL	141.8
97.5% Chebyshev (MVUE) UCL	158
99% Chebyshev (MVUE) UCL	189.9

Gamma Distribution Test

k star (bias corrected)	8.696
Theta Star	11.93
MLE of Mean	103.7
MLE of Standard Deviation	35.17
nu star	295.7
Approximate Chi Square Value (.05)	256.8
Adjusted Level of Significance	0.0346
Adjusted Chi Square Value	253
Anderson-Darling Test Statistic	0.258
Anderson-Darling 5% Critical Value	0.739
Kolmogorov-Smirnov Test Statistic	0.119
Kolmogorov-Smirnov 5% Critical Value	0.209

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	119.4
95% Adjusted Gamma UCL	121.2

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	116.1
95% Jackknife UCL	116.8
95% Standard Bootstrap UCL	115.8
95% Bootstrap-t UCL	115.8
95% Hall's Bootstrap UCL	116.9
95% Percentile Bootstrap UCL	115.5
95% BCA Bootstrap UCL	115.2
95% Chebyshev(Mean, Sd) UCL	136.5
97.5% Chebyshev(Mean, Sd) UCL	150.6
99% Chebyshev(Mean, Sd) UCL	178.5

Potential UCL to Use

Use 95% Student's-t UCL 116.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide

adjustments for positvely skewed data sets.

RIPARIAN SOIL – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Rip Soil Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	8	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	4
Tolerance Factor	3.187	Percent Non-Detects	50.00%
Number of Missing Values	19		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	4.6	Minimum Detected	1.526
Maximum Detected	5.5	Maximum Detected	1.705
Mean of Detected	5.15	Mean of Detected	1.637
SD of Detected	0.387	SD of Detected	0.0774
Minimum Non-Detect	3.6	Minimum Non-Detect	1.281
Maximum Non-Detect	6.1	Maximum Non-Detect	1.808

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	8
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.897	Shapiro Wilk Test Statistic	0.883
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	3.756	Mean (Log Scale)	1.239
SD	1.55	SD (Log Scale)	0.451
95% UTL 95% Coverage	8.695	95% UTL 95% Coverage	14.55
95% UPL (t)	6.87	95% UPL (t)	8.551
90% Percentile (z)	5.742	90% Percentile (z)	6.157
95% Percentile (z)	6.305	95% Percentile (z)	7.254
99% Percentile (z)	7.361	99% Percentile (z)	9.866

Maximum Likelihood Estimate(MLE) Method N/A

Log ROS Method

Mean in Original Scale	4.768
SD in Original Scale	0.507
Mean in Log Scale	1.557
SD in Log Scale	0.106
95% UTL 95% Coverage	6.643
95% UPL (t)	5.866
90% Percentile (z)	5.432
95% Percentile (z)	5.645
99% Percentile (z)	6.066

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	56.92
Theta Star	0.0905
nu star	455.3
A-D Test Statistic	0.406
5% A-D Critical Value	0.657
K-S Test Statistic	0.317
5% K-S Critical Value	0.394

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	4.914
SD	0.372
SE of Mean	0.162
95% KM UTL with 95% Coverage	6.1
95% KM Chebyshev UPL	6.634
95% KM UPL (t)	5.662
90% Percentile (z)	5.391
95% Percentile (z)	5.526
99% Percentile (z)	5.78

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	4.556
Median	4.648
SD	0.767
k star	24.41
Theta star	0.187
Nu star	390.5
95% Percentile of Chisquare (2k)	66.12
90% Percentile	5.771
95% Percentile	6.172
99% Percentile	6.971

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	6.265
95% Hawkins Wixley (HW) Approx. Gamma UPL	6.29
95% WH Approx. Gamma UTL with 95% Coverage	7.472
95% HW Approx. Gamma UTL with 95% Coverage	7.549

Note: DL/2 is not a recommended method.

Arsenic

General Statistics

Total Number of Observations	8
Tolerance Factor	3.187
Number of Distinct Observations	8
Number of Missing Values	19

Raw Statistics

Minimum	2.78
Maximum	5.44
Second Largest	5.19
First Quartile	2.971
Median	3.02
Third Quartile	4.478

Log-Transformed Statistics

Minimum	1.022
Maximum	1.694
Second Largest	1.647
First Quartile	1.089
Median	1.105
Third Quartile	1.495

Mean	3.698	Mean	1.272
SD	1.099	SD	0.278
Coefficient of Variation	0.297		
Skewness	0.935		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.772
Shapiro Wilk Critical Value	0.818

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.787
Shapiro Wilk Critical Value	0.818

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	7.199
95% UPL (t)	5.906
90% Percentile (z)	5.106
95% Percentile (z)	5.505
99% Percentile (z)	6.254

Assuming Lognormal Distribution

95% UTL with 95% Coverage	8.648
95% UPL (t)	6.237
90% Percentile (z)	5.095
95% Percentile (z)	5.636
99% Percentile (z)	6.81

Gamma Distribution Test

k star	9.022
Theta Star	0.41
MLE of Mean	3.698
MLE of Standard Deviation	1.231
nu star	144.3

A-D Test Statistic	0.932
5% A-D Critical Value	0.716
K-S Test Statistic	0.36
5% K-S Critical Value	0.294

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

90% Percentile	5.265
95% Percentile	5.353
99% Percentile	5.423

Assuming Gamma Distribution

90% Percentile	5.338
95% Percentile	5.928
99% Percentile	7.146
95% WH Approx. Gamma UPL	6.1
95% HW Approx. Gamma UPL	6.131
95% WH Approx. Gamma UTL with 95% Coverage	7.987
95% HW Approx. Gamma UTL with 95% Coverage	8.129

95% UTL with 95% Coverage	5.44
95% Percentile Bootstrap UTL with 95% Coverage	5.44
95% BCA Bootstrap UTL with 95% Coverage	5.44
95% UPL	5.44
95% Chebyshev UPL	8.777
Upper Threshold Limit Based upon IQR	6.737

Boron

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Tolerance Factor	3.187	Number of Missing Values	19

Raw Statistics

Minimum	5.6
Maximum	11.2
Second Largest	10
First Quartile	6.475
Median	8.25
Third Quartile	9.963
Mean	8.244
SD	2.198
Coefficient of Variation	0.267
Skewness	0.0635

Log-Transformed Statistics

Minimum	1.723
Maximum	2.416
Second Largest	2.303
First Quartile	1.867
Median	2.092
Third Quartile	2.299
Mean	2.077
SD	0.273

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.856
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.859
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	15.25
95% UPL (t)	12.66
90% Percentile (z)	11.06
95% Percentile (z)	11.86
99% Percentile (z)	13.36

Assuming Lognormal Distribution

95% UTL with 95% Coverage	19.04
95% UPL (t)	13.81
90% Percentile (z)	11.32
95% Percentile (z)	12.5
99% Percentile (z)	15.06

Gamma Distribution Test

k star	9.916
Theta Star	0.831
MLE of Mean	8.244
MLE of Standard Deviation	2.618
nu star	158.7

A-D Test Statistic	0.675
5% A-D Critical Value	0.716
K-S Test Statistic	0.285
5% K-S Critical Value	0.294

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	10.36
95% Percentile	10.78
99% Percentile	11.12

Assuming Gamma Distribution

90% Percentile	11.73
95% Percentile	12.97
99% Percentile	15.52

95% UTL with 95% Coverage	11.2
95% Percentile Bootstrap UTL with 95% Coverage	11.2
95% BCA Bootstrap UTL with 95% Coverage	11.2
95% UPL	11.2
95% Chebyshev UPL	18.41

95% WH Approx. Gamma UPL	13.33
95% HW Approx. Gamma UPL	13.44
95% WH Approx. Gamma UTL with 95% Coverage	17.27
95% HW Approx. Gamma UTL with 95% Coverage	17.64
Upper Threshold Limit Based upon IQR	15.19

Cadmium

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Tolerance Factor	2.486	Number of Missing Values	11

Raw Statistics		Log-Transformed Statistics	
Minimum	0.6	Minimum	-0.511
Maximum	4.4	Maximum	1.482
Second Largest	3.56	Second Largest	1.27
First Quartile	1.4	First Quartile	0.336
Median	2.02	Median	0.703
Third Quartile	3.4	Third Quartile	1.224
Mean	2.355	Mean	0.742
SD	1.075	SD	0.521
Coefficient of Variation	0.456		
Skewness	0.261		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.945	Shapiro Wilk Test Statistic	0.937
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	5.028	95% UTL with 95% Coverage	7.674
95% UPL (t)	4.287	95% UPL (t)	5.358
90% Percentile (z)	3.733	90% Percentile (z)	4.097
95% Percentile (z)	4.124	95% Percentile (z)	4.95
99% Percentile (z)	4.856	99% Percentile (z)	7.062

Gamma Distribution Test		Data Distribution Test
k star	3.769	Data appear Normal at 5% Significance Level
Theta Star	0.625	
MLE of Mean	2.355	
MLE of Standard Deviation	1.213	
nu star	128.1	
A-D Test Statistic	0.382	
5% A-D Critical Value	0.742	
K-S Test Statistic	0.161	
5% K-S Critical Value	0.21	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
90% Percentile	3.53
95% Percentile	3.728
99% Percentile	4.266

Assuming Gamma Distribution			
90% Percentile	3.982	95% UTL with 95% Coverage	4.4
		95% Percentile Bootstrap UTL with 95% Coverage	4.4

95% Percentile	4.639	95% BCA Bootstrap UTL with 95% Coverage	4.4
99% Percentile	6.046	95% UPL	4.4
		95% Chebyshev UPL	7.178
95% WH Approx. Gamma UPL	4.777	Upper Threshold Limit Based upon IQR	6.4
95% HW Approx. Gamma UPL	4.887		
95% WH Approx. Gamma UTL with 95% Coverage	6.15		
95% HW Approx. Gamma UTL with 95% Coverage	6.42		

Chromium, Total

General Statistics

Total Number of Observations	17	Number of Distinct Observations	16
Tolerance Factor	2.486	Number of Missing Values	11

Raw Statistics		Log-Transformed Statistics	
Minimum	16.7	Minimum	2.815
Maximum	42.5	Maximum	3.75
Second Largest	40.3	Second Largest	3.696
First Quartile	18.5	First Quartile	2.918
Median	22.9	Median	3.131
Third Quartile	26.9	Third Quartile	3.292
Mean	24.56	Mean	3.162
SD	7.556	SD	0.28
Coefficient of Variation	0.308		
Skewness	1.313		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.853	Shapiro Wilk Test Statistic	0.917
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	43.34	95% UTL with 95% Coverage	47.32
95% UPL (t)	38.13	95% UPL (t)	39.02
90% Percentile (z)	34.24	90% Percentile (z)	33.79
95% Percentile (z)	36.99	95% Percentile (z)	37.4
99% Percentile (z)	42.13	99% Percentile (z)	45.25

Gamma Distribution Test		Data Distribution Test
k star	10.73	Data appear Gamma Distributed at 5% Significance Level
Theta Star	2.288	
MLE of Mean	24.56	
MLE of Standard Deviation	7.496	
nu star	364.9	
A-D Test Statistic	0.579	**Nonparametric Statistics**
5% A-D Critical Value	0.739	90% Percentile 33.7
K-S Test Statistic	0.159	95% Percentile 40.74
5% K-S Critical Value	0.209	99% Percentile 42.15
Data appear Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution

90% Percentile	34.52
95% Percentile	38.04
99% Percentile	45.26
95% WH Approx. Gamma UPL	38.58
95% HW Approx. Gamma UPL	38.67
95% WH Approx. Gamma UTL with 95% Coverage	45.5
95% HW Approx. Gamma UTL with 95% Coverage	45.9
95% UTL with 95% Coverage	42.5
95% Percentile Bootstrap UTL with 95% Coverage	42.5
95% BCA Bootstrap UTL with 95% Coverage	42.5
95% UPL	42.5
95% Chebyshev UPL	58.45
Upper Threshold Limit Based upon IQR	39.5

Cobalt

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Tolerance Factor	3.187	Number of Missing Values	19

Raw Statistics

Minimum	4.48
Maximum	10.1
Second Largest	9.63
First Quartile	5.086
Median	5.98
Third Quartile	8.4
Mean	6.791
SD	2.177
Coefficient of Variation	0.321
Skewness	0.682

Log-Transformed Statistics

Minimum	1.5
Maximum	2.313
Second Largest	2.265
First Quartile	1.627
Median	1.787
Third Quartile	2.125
Mean	1.873
SD	0.31

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.875
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.905
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	13.73
95% UPL (t)	11.17
90% Percentile (z)	9.58
95% Percentile (z)	10.37
99% Percentile (z)	11.85

Assuming Lognormal Distribution

95% UTL with 95% Coverage	17.46
95% UPL (t)	12.12
90% Percentile (z)	9.675
95% Percentile (z)	10.83
99% Percentile (z)	13.37

Gamma Distribution Test

k star	7.455

Data Distribution Test

Data appear Normal at 5% Significance Level

Theta Star	0.911
MLE of Mean	6.791
MLE of Standard Deviation	2.487
nu star	119.3

A-D Test Statistic	0.45
5% A-D Critical Value	0.715
K-S Test Statistic	0.198
5% K-S Critical Value	0.294

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

90% Percentile	9.771
95% Percentile	9.936
99% Percentile	10.07

Assuming Gamma Distribution

90% Percentile	10.11
95% Percentile	11.33
99% Percentile	13.87
95% WH Approx. Gamma UPL	11.71
95% HW Approx. Gamma UPL	11.8
95% WH Approx. Gamma UTL with 95% Coverage	15.67
95% HW Approx. Gamma UTL with 95% Coverage	16.04

95% UTL with 95% Coverage	10.1
95% Percentile Bootstrap UTL with 95% Coverage	10.1
95% BCA Bootstrap UTL with 95% Coverage	10.1
95% UPL	10.1
95% Chebyshev UPL	16.86
Upper Threshold Limit Based upon IQR	13.37

Copper_2

General Statistics

Total Number of Observations	14
Tolerance Factor	2.614

Number of Distinct Observations	12
Number of Missing Values	11

Raw Statistics

Minimum	10.5
Maximum	21.1
Second Largest	21
First Quartile	15.45
Median	17.83
Third Quartile	18.8
Mean	17.09
SD	3.033
Coefficient of Variation	0.177
Skewness	-0.9

Log-Transformed Statistics

Minimum	2.351
Maximum	3.049
Second Largest	3.045
First Quartile	2.737
Median	2.881
Third Quartile	2.934
Mean	2.822
SD	0.197

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.916
Shapiro Wilk Critical Value	0.874

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.868
Shapiro Wilk Critical Value	0.874

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	25.02
95% UPL (t)	22.65
90% Percentile (z)	20.98
95% Percentile (z)	22.08
99% Percentile (z)	24.15

Assuming Lognormal Distribution

95% UTL with 95% Coverage	28.16
95% UPL (t)	24.13
90% Percentile (z)	21.64
95% Percentile (z)	23.25
99% Percentile (z)	26.6

Gamma Distribution Test

k star	23.56
Theta Star	0.725
MLE of Mean	17.09
MLE of Standard Deviation	3.521
nu star	659.6

A-D Test Statistic	0.675
5% A-D Critical Value	0.734
K-S Test Statistic	0.231
5% K-S Critical Value	0.228

Data follow Appx. Gamma Distribution at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	20.4
95% Percentile	21.04
99% Percentile	21.09

Assuming Gamma Distribution

90% Percentile	21.73
95% Percentile	23.26
99% Percentile	26.33
95% WH Approx. Gamma UPL	23.52
95% HW Approx. Gamma UPL	23.66
95% WH Approx. Gamma UTL with 95% Coverage	26.79
95% HW Approx. Gamma UTL with 95% Coverage	27.09

95% UTL with 95% Coverage	21.1
95% Percentile Bootstrap UTL with 95% Coverage	21.1
95% BCA Bootstrap UTL with 95% Coverage	21.1
95% UPL	21.1
95% Chebyshev UPL	30.77
Upper Threshold Limit Based upon IQR	23.83

Manganese

General Statistics

Total Number of Observations	8
Tolerance Factor	3.187
Number of Distinct Observations	8
Number of Missing Values	19

Raw Statistics

Minimum	124
Maximum	1080
Second Largest	732.5
First Quartile	156.3
Median	333.5
Third Quartile	578.4
Mean	429.7
SD	335.7
Coefficient of Variation	0.781
Skewness	1.164

Log-Transformed Statistics

Minimum	4.82
Maximum	6.985
Second Largest	6.596
First Quartile	5.051
Median	5.809
Third Quartile	6.35
Mean	5.794
SD	0.793

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.871
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Shapiro Wilk Test Statistic	0.936
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	1500
95% UPL (t)	1104
90% Percentile (z)	859.9
95% Percentile (z)	981.9
99% Percentile (z)	1211

Assuming Lognormal Distribution

95% UTL with 95% Coverage	4105
95% UPL (t)	1614
90% Percentile (z)	906.7
95% Percentile (z)	1209
99% Percentile (z)	2075

Gamma Distribution Test

k star	1.34
Theta Star	320.8
MLE of Mean	429.7
MLE of Standard Deviation	371.3
nu star	21.43

A-D Test Statistic	0.312
5% A-D Critical Value	0.724
K-S Test Statistic	0.206
5% K-S Critical Value	0.297

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	836.8
95% Percentile	958.4
99% Percentile	1056

Assuming Gamma Distribution

90% Percentile	920.5
95% Percentile	1163
99% Percentile	1714
95% WH Approx. Gamma UPL	1306
95% HW Approx. Gamma UPL	1359
95% WH Approx. Gamma UTL with 95% Coverage	2282
95% HW Approx. Gamma UTL with 95% Coverage	2529

95% UTL with 95% Coverage	1080
95% Percentile Bootstrap UTL with 95% Coverage	1080
95% BCA Bootstrap UTL with 95% Coverage	1080
95% UPL	1080
95% Chebyshev UPL	1982
Upper Threshold Limit Based upon IQR	1212

Mercury

General Statistics

Total Number of Observations	8
Tolerance Factor	3.187

Number of Distinct Observations	7
Number of Missing Values	19

Raw Statistics

Minimum	0.0235
Maximum	0.069
Second Largest	0.0475
First Quartile	0.0288
Median	0.0385
Third Quartile	0.0434
Mean	0.0393
SD	0.0148
Coefficient of Variation	0.376
Skewness	1.143

Log-Transformed Statistics

Minimum	-3.751
Maximum	-2.674
Second Largest	-3.047
First Quartile	-3.552
Median	-3.261
Third Quartile	-3.139
Mean	-3.295
SD	0.357

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.906
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	0.0863
95% UPL (t)	0.0689
90% Percentile (z)	0.0582
95% Percentile (z)	0.0635
99% Percentile (z)	0.0736

Assuming Lognormal Distribution

95% UTL with 95% Coverage	0.115
95% UPL (t)	0.0759
90% Percentile (z)	0.0585
95% Percentile (z)	0.0666
99% Percentile (z)	0.085

Gamma Distribution Test

k star	5.656
Theta Star	0.00694
MLE of Mean	0.0393
MLE of Standard Deviation	0.0165
nu star	90.49

A-D Test Statistic	0.247
5% A-D Critical Value	0.716
K-S Test Statistic	0.126
5% K-S Critical Value	0.294

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.054
95% Percentile	0.0615
99% Percentile	0.0675

Assuming Gamma Distribution

90% Percentile	0.0613
95% Percentile	0.0697
99% Percentile	0.0874
95% WH Approx. Gamma UPL	0.0725
95% HW Approx. Gamma UPL	0.0733
95% WH Approx. Gamma UTL with 95% Coverage	0.1
95% HW Approx. Gamma UTL with 95% Coverage	0.103

95% UTL with 95% Coverage	0.069
95% Percentile Bootstrap UTL with 95% Coverage	0.069
95% BCA Bootstrap UTL with 95% Coverage	0.069
95% UPL	0.069
95% Chebyshev UPL	0.107
Upper Threshold Limit Based upon IQR	0.0653

Molybdenum_1

General Statistics

Number of Valid Data	16
Number of Distinct Detected Data	5
Tolerance Factor	2.524
Number of Missing Values	12

Number of Detected Data	6
Number of Non-Detect Data	10
Percent Non-Detects	62.50%

Raw Statistics

Minimum Detected	0.43
Maximum Detected	0.7
Mean of Detected	0.51
SD of Detected	0.109
Minimum Non-Detect	0.17
Maximum Non-Detect	1.5

Log-transformed Statistics

Minimum Detected	-0.844
Maximum Detected	-0.357
Mean of Detected	-0.69
SD of Detected	0.198
Minimum Non-Detect	-1.772
Maximum Non-Detect	0.405

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	16
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.802
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.823
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.387
	SD	0.203
95% UTL	95% Coverage	0.9
	95% UPL (t)	0.754
	90% Percentile (z)	0.647
	95% Percentile (z)	0.721
	99% Percentile (z)	0.86

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-1.103
	SD (Log Scale)	0.607
95% UTL	95% Coverage	1.534
	95% UPL (t)	0.993
	90% Percentile (z)	0.722
	95% Percentile (z)	0.9
	99% Percentile (z)	1.361

Log ROS Method

	Mean in Original Scale	0.428
	SD in Original Scale	0.0998
	Mean in Log Scale	-0.871
	SD in Log Scale	0.214
95% UTL	95% Coverage	0.718
	95% UPL (t)	0.616
	90% Percentile (z)	0.551
	95% Percentile (z)	0.595
	99% Percentile (z)	0.689

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	14.78
Theta Star	0.0345
nu star	177.4

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

A-D Test Statistic	0.614
5% A-D Critical Value	0.697
K-S Test Statistic	0.313
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.371
Median	0.405
SD	0.173
k star	3.001
Theta star	0.123
Nu star	96.04
95% Percentile of Chisquare (2k)	12.6
90% Percentile	0.658
95% Percentile	0.778
99% Percentile	1.038

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.468
SD	0.0757
SE of Mean	0.0226
95% KM UTL with 95% Coverage	0.659
95% KM Chebyshev UPL	0.808
95% KM UPL (t)	0.605
90% Percentile (z)	0.565
95% Percentile (z)	0.593
99% Percentile (z)	0.644

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.808
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.837
95% WH Approx. Gamma UTL with 95% Coverage	1.074
95% HW Approx. Gamma UTL with 95% Coverage	1.143

Note: DL/2 is not a recommended method.

Nickel

General Statistics

Total Number of Observations	17
Tolerance Factor	2.486
Number of Distinct Observations	15
Number of Missing Values	11

Raw Statistics

Minimum	10.4
Maximum	26.6
Second Largest	24.5
First Quartile	15.5
Median	17.1
Third Quartile	21.3
Mean	18.25
SD	4.603
Coefficient of Variation	0.252
Skewness	0.376

Log-Transformed Statistics

Minimum	2.342
Maximum	3.281
Second Largest	3.199
First Quartile	2.741
Median	2.839
Third Quartile	3.059
Mean	2.874
SD	0.255

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.892

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	29.69
95% UPL (t)	26.52
90% Percentile (z)	24.15
95% Percentile (z)	25.82
99% Percentile (z)	28.95

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.963
Shapiro Wilk Critical Value	0.892

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% UTL with 95% Coverage	33.4
95% UPL (t)	28.01
90% Percentile (z)	24.56
95% Percentile (z)	26.94
99% Percentile (z)	32.06

Gamma Distribution Test

k star	13.78
Theta Star	1.324
MLE of Mean	18.25
MLE of Standard Deviation	4.915
nu star	468.7

A-D Test Statistic	0.334
5% A-D Critical Value	0.738
K-S Test Statistic	0.143
5% K-S Critical Value	0.209

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	24.5
95% Percentile	24.92
99% Percentile	26.26

Assuming Gamma Distribution

90% Percentile	24.76
95% Percentile	27.01
99% Percentile	31.58
95% WH Approx. Gamma UPL	27.35
95% HW Approx. Gamma UPL	27.5
95% WH Approx. Gamma UTL with 95% Coverage	31.73
95% HW Approx. Gamma UTL with 95% Coverage	32.09

95% UTL with 95% Coverage	26.6
95% Percentile Bootstrap UTL with 95% Coverage	26.6
95% BCA Bootstrap UTL with 95% Coverage	26.6
95% UPL	26.6
95% Chebyshev UPL	38.89
Upper Threshold Limit Based upon IQR	30

Selenium

General Statistics

Number of Valid Data	17
Number of Distinct Detected Data	9
Tolerance Factor	2.486
Number of Missing Values	11
Number of Detected Data	13
Number of Non-Detect Data	4
Percent Non-Detects	23.53%

Raw Statistics

Minimum Detected	0.5
Maximum Detected	1.8
Mean of Detected	1.05
SD of Detected	0.456
Minimum Non-Detect	0.5
Maximum Non-Detect	0.5

Log-transformed Statistics

Minimum Detected	-0.693
Maximum Detected	0.588
Mean of Detected	-0.0429
SD of Detected	0.452
Minimum Non-Detect	-0.693
Maximum Non-Detect	-0.693

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.901
5% Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.909
5% Shapiro Wilk Critical Value	0.866

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.862
SD	0.528

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-0.359
SD (Log Scale)	0.706

95% UTL	95% Coverage 2.174	95% UTL	95% Coverage 4.038
95% UPL (t)	1.81	95% UPL (t)	2.482
90% Percentile (z)	1.538	90% Percentile (z)	1.726
95% Percentile (z)	1.73	95% Percentile (z)	2.23
99% Percentile (z)	2.09	99% Percentile (z)	3.607

Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.841	Mean in Original Scale	0.881
SD	0.554	SD in Original Scale	0.505
95% UTL with	95% Coverage 2.219	95% UTL with	95% Coverage 3.469
		95% BCA UTL with	95% Coverage 1.8
		95% Bootstrap (%) UTL with	95% Coverage 1.8
95% UPL (t)	1.837	95% UPL (t)	2.263
90% Percentile (z)	1.551	90% Percentile (z)	1.645
95% Percentile (z)	1.753	95% Percentile (z)	2.06
99% Percentile (z)	2.131	99% Percentile (z)	3.142

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	4.372
Theta Star	0.24
nu star	113.7
A-D Test Statistic	0.538
5% A-D Critical Value	0.736
K-S Test Statistic	0.236
5% K-S Critical Value	0.237

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.921
SD	0.449
SE of Mean	0.113
95% KM UTL with	95% Coverage 2.036
95% KM Chebyshev UPL	2.934
95% KM UPL (t)	1.727
90% Percentile (z)	1.496
95% Percentile (z)	1.659
99% Percentile (z)	1.965

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data	
Mean	0.803
Median	0.7
SD	0.606
k star	0.232
Theta star	3.459
Nu star	7.892
95% Percentile of Chisquare (2k)	2.296
90% Percentile	2.421
95% Percentile	3.972
99% Percentile	8.145

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	3.89
95% Hawkins Wixley (HW) Approx. Gamma UPL	5.699
95% WH Approx. Gamma UTL with 95% Coverage	6.677
95% HW Approx. Gamma UTL with 95% Coverage	11.54

Note: DL/2 is not a recommended method.

Thallium

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Tolerance Factor	3.187	Number of Missing Values	19

Raw Statistics		Log-Transformed Statistics	
Minimum	0.16	Minimum	-1.833

Maximum	0.428
Second Largest	0.418
First Quartile	0.171
Median	0.216
Third Quartile	0.323
Mean	0.259
SD	0.111
Coefficient of Variation	0.427
Skewness	0.878

Maximum	-0.849
Second Largest	-0.872
First Quartile	-1.765
Median	-1.542
Third Quartile	-1.144
Mean	-1.426
SD	0.403

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.818
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.857
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	0.611
95% UPL (t)	0.481
90% Percentile (z)	0.4
95% Percentile (z)	0.441
99% Percentile (z)	0.516

Assuming Lognormal Distribution

95% UTL with 95% Coverage	0.868
95% UPL (t)	0.54
90% Percentile (z)	0.403
95% Percentile (z)	0.466
99% Percentile (z)	0.614

Gamma Distribution Test

k star	4.404
Theta Star	0.0587
MLE of Mean	0.259
MLE of Standard Deviation	0.123
nu star	70.47

A-D Test Statistic	0.598
5% A-D Critical Value	0.718
K-S Test Statistic	0.25
5% K-S Critical Value	0.295

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.421
95% Percentile	0.425
99% Percentile	0.427

95% UTL with 95% Coverage	0.428
95% Percentile Bootstrap UTL with 95% Coverage	0.428
95% BCA Bootstrap UTL with 95% Coverage	0.428
95% UPL	0.428
95% Chebyshev UPL	0.77
Upper Threshold Limit Based upon IQR	0.55

Assuming Gamma Distribution

90% Percentile	0.424
95% Percentile	0.489
99% Percentile	0.628
95% WH Approx. Gamma UPL	0.513
95% HW Approx. Gamma UPL	0.519
95% WH Approx. Gamma UTL with 95% Coverage	0.735
95% HW Approx. Gamma UTL with 95% Coverage	0.761

Uranium

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Tolerance Factor	3.187	Number of Missing Values	19

Raw Statistics		Log-Transformed Statistics	
Minimum	1.6	Minimum	0.47
Maximum	3.76	Maximum	1.324
Second Largest	3.01	Second Largest	1.102
First Quartile	1.98	First Quartile	0.682
Median	2.39	Median	0.87
Third Quartile	2.658	Third Quartile	0.975
Mean	2.444	Mean	0.86
SD	0.694	SD	0.274
Coefficient of Variation	0.284		
Skewness	0.887		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.946	Shapiro Wilk Test Statistic	0.984
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	4.654	95% UTL with 95% Coverage	5.666
95% UPL (t)	3.837	95% UPL (t)	4.102
90% Percentile (z)	3.333	90% Percentile (z)	3.359
95% Percentile (z)	3.585	95% Percentile (z)	3.711
99% Percentile (z)	4.057	99% Percentile (z)	4.474

Gamma Distribution Test		Data Distribution Test
k star	9.506	Data appear Normal at 5% Significance Level
Theta Star	0.257	
MLE of Mean	2.444	
MLE of Standard Deviation	0.793	
nu star	152.1	
A-D Test Statistic	0.179	**Nonparametric Statistics**
5% A-D Critical Value	0.716	90% Percentile 3.235
K-S Test Statistic	0.156	95% Percentile 3.498
5% K-S Critical Value	0.294	99% Percentile 3.708

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

90% Percentile	3.499
95% Percentile	3.877
99% Percentile	4.654
95% WH Approx. Gamma UPL	3.985
95% HW Approx. Gamma UPL	4.011
95% WH Approx. Gamma UTL with 95% Coverage	5.187
95% HW Approx. Gamma UTL with 95% Coverage	5.287
95% UTL with 95% Coverage	3.76
95% Percentile Bootstrap UTL with 95% Coverage	3.76
95% BCA Bootstrap UTL with 95% Coverage	3.76
95% UPL	3.76
95% Chebyshev UPL	5.65
Upper Threshold Limit Based upon IQR	3.674

Vanadium

General Statistics

Total Number of Observations	17
Tolerance Factor	2.486
Number of Distinct Observations	17
Number of Missing Values	11

Raw Statistics

Minimum	22.9
Maximum	57.3
Second Largest	52.4
First Quartile	24.9
Median	29.4
Third Quartile	34.5
Mean	32.56
SD	10.22
Coefficient of Variation	0.314
Skewness	1.387

Log-Transformed Statistics

Minimum	3.131
Maximum	4.048
Second Largest	3.959
First Quartile	3.215
Median	3.381
Third Quartile	3.541
Mean	3.443
SD	0.279

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.825
Shapiro Wilk Critical Value	0.892

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.884
Shapiro Wilk Critical Value	0.892

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	57.96
95% UPL (t)	50.92
90% Percentile (z)	45.65
95% Percentile (z)	49.37
99% Percentile (z)	56.33

Assuming Lognormal Distribution

95% UTL with 95% Coverage	62.68
95% UPL (t)	51.7
90% Percentile (z)	44.77
95% Percentile (z)	49.55
99% Percentile (z)	59.95

Gamma Distribution Test

k star	10.57
Theta Star	3.079
MLE of Mean	32.56
MLE of Standard Deviation	10.01
nu star	359.5
A-D Test Statistic	0.872
5% A-D Critical Value	0.739
K-S Test Statistic	0.167

Data Distribution Test

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

90% Percentile	46.22
95% Percentile	53.38

5% K-S Critical Value	0.209	99% Percentile	56.52

Data follow Appx. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

90% Percentile	45.87	95% UTL with 95% Coverage	57.3
95% Percentile	50.59	95% Percentile Bootstrap UTL with 95% Coverage	57.3
99% Percentile	60.25	95% BCA Bootstrap UTL with 95% Coverage	57.3
		95% UPL	57.3
		95% Chebyshev UPL	78.39
95% WH Approx. Gamma UPL	51.3	Upper Threshold Limit Based upon IQR	48.9
95% HW Approx. Gamma UPL	51.39		
95% WH Approx. Gamma UTL with 95% Coverage	60.57		
95% HW Approx. Gamma UTL with 95% Coverage	61.04		

Zinc

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Tolerance Factor	2.486	Number of Missing Values	11

Raw Statistics		Log-Transformed Statistics	
Minimum	42	Minimum	3.738
Maximum	158	Maximum	5.063
Second Largest	144	Second Largest	4.97
First Quartile	85	First Quartile	4.443
Median	104	Median	4.644
Third Quartile	121	Third Quartile	4.796
Mean	103.7	Mean	4.593
SD	30.99	SD	0.336
Coefficient of Variation	0.299		
Skewness	-0.059		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.978	Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892

Data appear Normal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	180.7	95% UTL with 95% Coverage	227.7
95% UPL (t)	159.4	95% UPL (t)	180.6
90% Percentile (z)	143.4	90% Percentile (z)	152
95% Percentile (z)	154.7	95% Percentile (z)	171.7
99% Percentile (z)	175.8	99% Percentile (z)	215.8

Gamma Distribution Test		Data Distribution Test
k star	8.696	Data appear Normal at 5% Significance Level
Theta Star	11.93	
MLE of Mean	103.7	
MLE of Standard Deviation	35.17	
nu star	295.7	

A-D Test Statistic	0.258
5% A-D Critical Value	0.739
K-S Test Statistic	0.119
5% K-S Critical Value	0.209

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

90% Percentile	142.8
95% Percentile	146.8
99% Percentile	155.8

Assuming Gamma Distribution

90% Percentile	150.6
95% Percentile	167.5
99% Percentile	202.5
95% WH Approx. Gamma UPL	170.4
95% HW Approx. Gamma UPL	172.5
95% WH Approx. Gamma UTL with 95% Coverage	204
95% HW Approx. Gamma UTL with 95% Coverage	208.7

95% UTL with 95% Coverage	158
95% Percentile Bootstrap UTL with 95% Coverage	158
95% BCA Bootstrap UTL with 95% Coverage	158
95% UPL	158
95% Chebyshev UPL	242.7
Upper Threshold Limit Based upon IQR	175

RIPARIAN SOIL – USL OUTPUTS

Robust Simultaneous Intervals/Limits (SLs)

Date/Time of Computation	8/21/2012 12:16:09 PM
User Selected Options	
From File	C:\Documents and Settings\Valerie C Chen\My Documents\Val's documents from C\Monsanto\Background TM\I
Full Precision	OFF
Confidence Coefficient	0.9
PROP Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	PROP SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Huber Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	Huber SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Tukey Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Tukey Biweight SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
Lax/Kafadar Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Lax/Kafadar SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
MVT Method	Triming Percentage of 10.08%
	MVT SLs derived using 10 Iterations and initial estimates of median/1.48MAD.

D2Max represents unsquared critical value of Max-MD (Mahalanobis Distances) computed based upon Wsum Values

Arsenic

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	3.698	3.02	1.099	0.267	2.032	1.466	5.93

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	3.02	0.267	2.943	0.105	5	1.671	2.768	3.118
Huber	3.02	0.267	3.698	1.099	8	2.032	1.466	5.93
Tukey Biweight	3.02	0.267	2.944	0.189	4.924	1.658	2.63	3.258
Lax Kafadar Biweight	3.02	0.267	2.947	0.152	4.769	1.63	2.699	3.195
MVT	3.02	0.267	3.698	1.099	8	2.032	1.466	5.93

Boron

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	8.244	8.25	2.198	2.557	2.032	3.778	12.71

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	8.25	2.557	8.244	2.198	8	2.032	3.778	12.71
Huber	8.25	2.557	8.244	2.198	8	2.032	3.778	12.71
Tukey Biweight	8.25	2.557	8.234	2.347	7.37	1.975	3.598	12.87
Lax Kafadar Biweight	8.25	2.557	8.232	2.412	7.294	1.968	3.486	12.98
MVT	8.25	2.557	8.244	2.198	8	2.032	3.778	12.71

Cadmium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	17	2.355	2.02	1.075	1.038	2.475	-0.306	5.016

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	2.02	1.038	2.355	1.075	17	2.475	-0.306	5.016
Huber	2.02	1.038	2.355	1.075	17	2.475	-0.306	5.016

Tukey Biweight	2.02	1.038	2.315	1.149	14.98	2.408	-0.452	5.081
Lax Kafadar Biweight	2.02	1.038	2.33	1.252	15.59	2.429	-0.711	5.37
MVT	2.02	1.038	2.228	0.968	16	2.443	-0.137	4.592

Chromium, Total

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	17	24.56	22.9	7.556	6.523	2.475	5.855	43.26

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	22.9	6.523	22.45	4.396	15.11	2.413	11.84	33.06
Huber	22.9	6.523	24.26	6.98	16.72	2.466	7.049	41.48
Tukey Biweight	22.9	6.523	22.97	6.907	14.72	2.399	6.4	39.54
Lax Kafadar Biweight	22.9	6.523	22.74	6.074	14.45	2.389	8.232	37.25
MVT	22.9	6.523	23.43	6.172	16	2.443	8.353	38.52

Cobalt

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	6.791	5.98	2.177	1.783	2.032	2.368	11.21

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	5.98	1.783	6.791	2.177	8	2.032	2.368	11.21
Huber	5.98	1.783	6.791	2.177	8	2.032	2.368	11.21
Tukey Biweight	5.98	1.783	6.514	2.384	6.784	1.915	1.948	11.08
Lax Kafadar Biweight	5.98	1.783	6.664	2.384	7.299	1.968	1.973	11.36
MVT	5.98	1.783	6.791	2.177	8	2.032	2.368	11.21

Copper_2

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	14	17.09	17.83	3.033	2.298	2.372	9.896	24.28

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	17.83	2.298	17.82	2.016	12.45	2.306	13.17	22.47
Huber	17.83	2.298	17.12	2.968	13.92	2.369	10.09	24.16
Tukey Biweight	17.83	2.298	17.69	2.946	11.61	2.266	11.02	24.37
Lax Kafadar Biweight	17.83	2.298	17.5	2.724	12.2	2.295	11.25	23.75
MVT	17.83	2.298	17.6	2.464	13	2.331	11.85	23.34

Manganese

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	429.7	333.5	335.7	280.9	2.032	-252.3	1112

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	333.5	280.9	355.7	232.3	7.183	1.957	-98.82	810.2
Huber	333.5	280.9	427.2	331.7	7.97	2.029	-245.8	1100
Tukey Biweight	333.5	280.9	370.2	334.8	6.881	1.926	-274.5	1015

Lax Kafadar Biweight	333.5	280.9	378.8	299.6	7.002	1.938	-201.9	959.4
MVT	333.5	280.9	429.7	335.7	8	2.032	-252.3	1112

Mercury

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	0.0393	0.0385	0.0148	0.013	2.032	0.00928	0.0692

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.0385	0.013	0.0355	0.00934	7.099	1.948	0.0173	0.0537
Huber	0.0385	0.013	0.0388	0.014	7.884	2.022	0.0105	0.0671
Tukey Biweight	0.0385	0.013	0.0371	0.0144	6.994	1.938	0.00927	0.0649
Lax Kafadar Biweight	0.0385	0.013	0.0373	0.0136	7.074	1.946	0.0109	0.0638
MVT	0.0385	0.013	0.0393	0.0148	8	2.032	0.00928	0.0692

Nickel

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	17	18.25	17.1	4.603	3.706	2.475	6.857	29.64

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	17.1	3.706	18.25	4.603	17	2.475	6.857	29.64
Huber	17.1	3.706	18.25	4.603	17	2.475	6.857	29.64
Tukey Biweight	17.1	3.706	17.81	4.923	14.22	2.38	6.094	29.53
Lax Kafadar Biweight	17.1	3.706	18.07	5.137	15.48	2.426	5.605	30.53
MVT	17.1	3.706	17.73	4.202	16	2.443	7.459	27.99

Thallium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	0.259	0.216	0.111	0.0752	2.032	0.0341	0.483

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.216	0.0752	0.208	0.0528	6.108	1.836	0.111	0.305
Huber	0.216	0.0752	0.259	0.111	8	2.032	0.0341	0.483
Tukey Biweight	0.216	0.0752	0.227	0.119	6.302	1.86	0.00553	0.449
Lax Kafadar Biweight	0.216	0.0752	0.247	0.107	7.113	1.95	0.0392	0.456
MVT	0.216	0.0752	0.259	0.111	8	2.032	0.0341	0.483

Uranium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	2.444	2.39	0.694	0.682	2.032	1.035	3.853

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	2.39	0.682	2.311	0.506	7.265	1.965	1.316	3.305
Huber	2.39	0.682	2.444	0.694	8	2.032	1.035	3.853
Tukey Biweight	2.39	0.682	2.381	0.701	7.163	1.955	1.011	3.75
Lax Kafadar Biweight	2.39	0.682	2.378	0.669	7.134	1.952	1.072	3.684

MVT	2.39	0.682	2.444	0.694	8	2.032	1.035	3.853

Vanadium

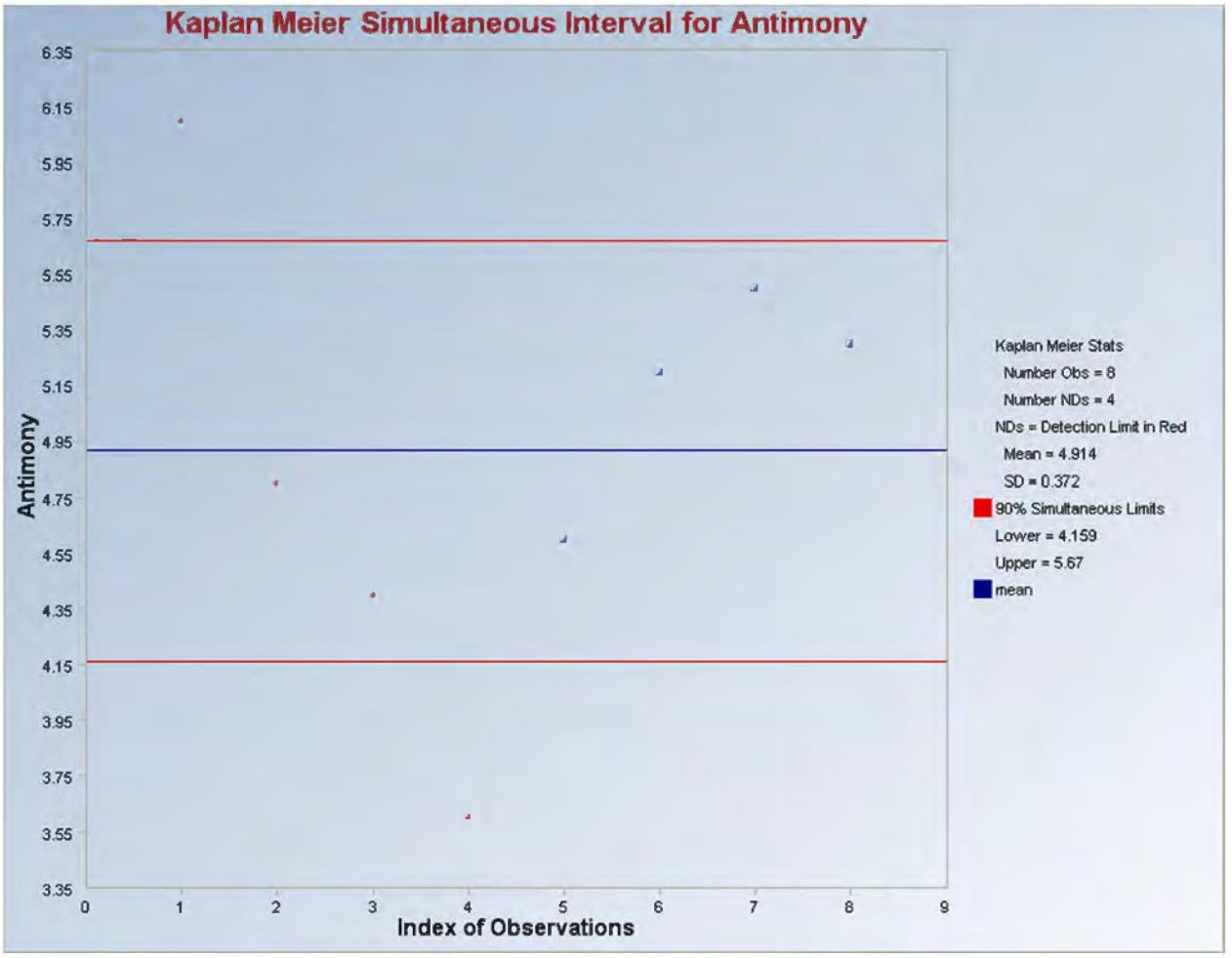
	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	17	32.56	29.4	10.22	7.042	2.475	7.271	57.85

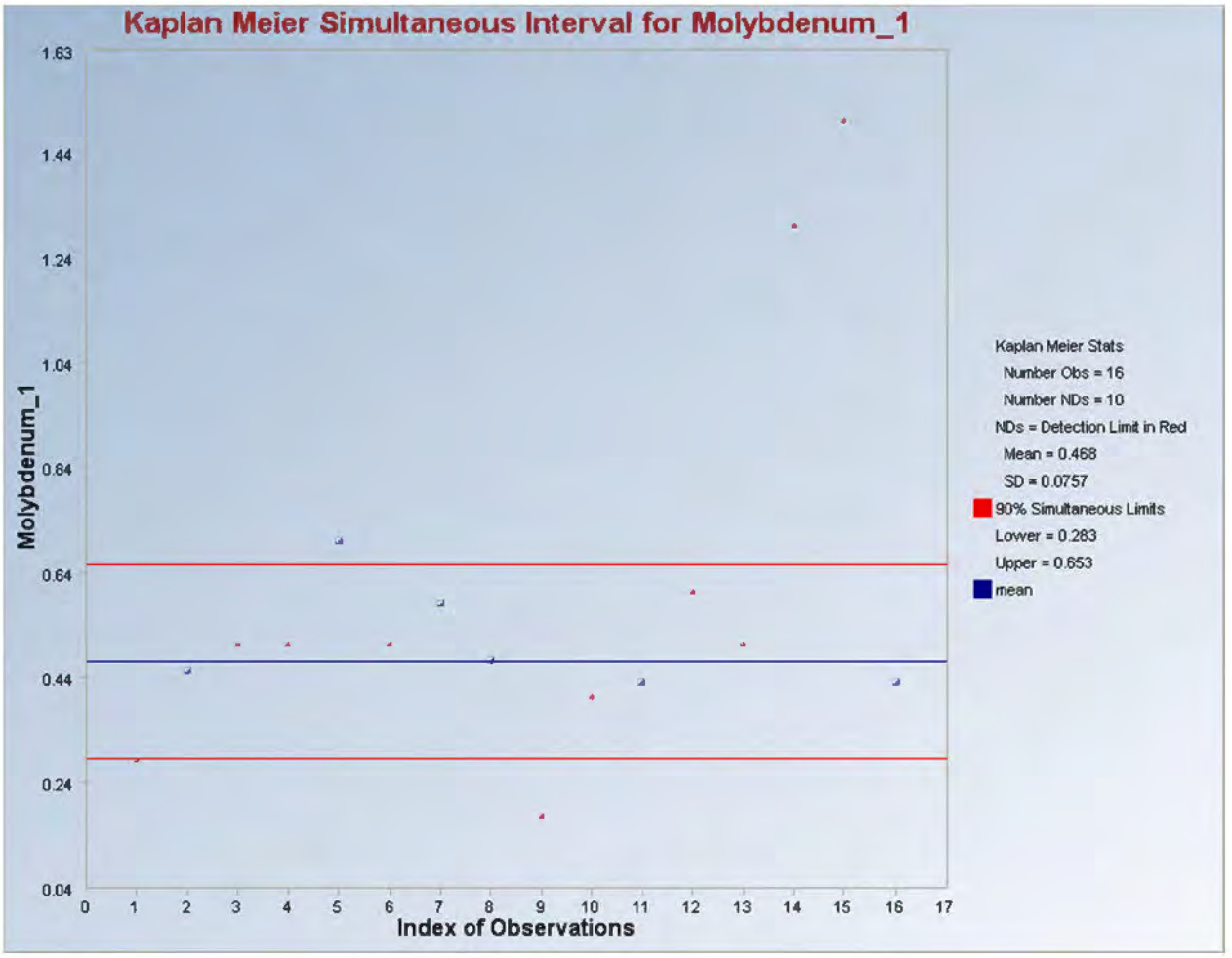
Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	29.4	7.042	29.86	6.225	15.17	2.415	14.83	44.9
Huber	29.4	7.042	32.28	9.641	16.81	2.469	8.473	56.08
Tukey Biweight	29.4	7.042	29.2	8.641	13.85	2.366	8.755	49.64
Lax Kafadar Biweight	29.4	7.042	29.19	7.017	13.84	2.365	12.59	45.78
MVT	29.4	7.042	31.01	8.247	16	2.443	10.86	51.16

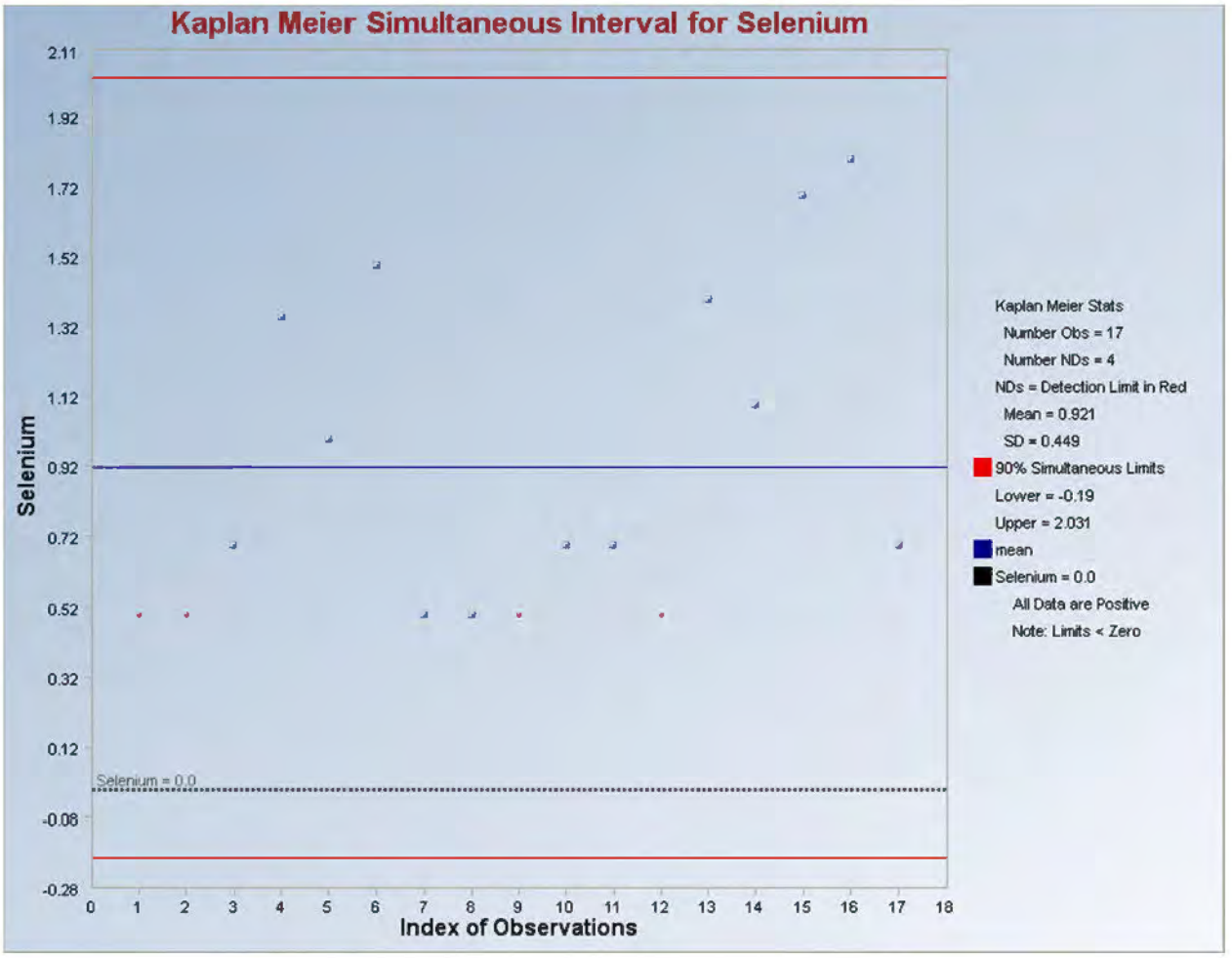
Zinc

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	17	103.7	104	30.99	28.17	2.475	27.03	180.4

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	104	28.17	103.7	30.99	17	2.475	27.03	180.4
Huber	104	28.17	103.7	30.99	17	2.475	27.03	180.4
Tukey Biweight	104	28.17	103.9	32.23	14.79	2.402	26.47	181.3
Lax Kafadar Biweight	104	28.17	103.9	33.44	15.39	2.423	22.84	184.9
MVT	104	28.17	107.6	27.46	16	2.443	40.47	174.7


Kaplan Meier Simultaneous Interval for Antimony
Antimony
Index of Observations
6.35
6.15
5.95
5.75
5.55
5.35
5.15
4.95
4.75
4.55
4.35
4.15
3.95
3.75
3.55
3.35
0
1
2
3
4
5
6
7
8
9
Kaplan Meier Stats
Number Obs = 8
Number NDs = 4
NDs = Detection Limit in Red
Mean = 4.914
SD = 0.372
90% Simultaneous Limits
Lower = 4.159
Upper = 5.67
mean


Kaplan Meier Simultaneous Interval for Molybdenum_1
Molybdenum_1
1.63
1.44
1.24
1.04
0.84
0.64
0.44
0.24
0.04
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Index of Observations
Kaplan Meier Stats
Number Obs = 16
Number NDs = 10
NDs = Detection Limit in Red
Mean = 0.468
SD = 0.0757
90% Simultaneous Limits
Lower = 0.283
Upper = 0.653
mean


Kaplan Meier Simultaneous Interval for Selenium
Selenium
Index of Observations
2.11
1.92
1.72
1.52
1.32
1.12
0.92
0.72
0.52
0.32
0.12
-0.08
-0.28
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Selenium = 0.0
Kaplan Meier Stats
Number Obs = 17
Number NDs = 4
NDs = Detection Limit in Red
Mean = 0.921
SD = 0.449
90% Simultaneous Limits
Lower = -0.19
Upper = 2.031
mean
Selenium = 0.0
All Data are Positive
Note: Limits < Zero

RIPARIAN VEGETATION – OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options

From File	Rip Veg Input Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Molybdenum_1

Number of data = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Data Value 2.37 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.473

For 10% significance level, 2.37 is not an outlier.
For 5% significance level, 2.37 is not an outlier.
For 1% significance level, 2.37 is not an outlier.

2. Data Value 0.63 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.053

For 10% significance level, 0.63 is not an outlier.
For 5% significance level, 0.63 is not an outlier.
For 1% significance level, 0.63 is not an outlier.

Dixon's Outlier Test for Cadmium

Number of data = 9
10% critical value: 0.441
5% critical value: 0.512
1% critical value: 0.635

1. Data Value 0.9 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.380

For 10% significance level, 0.9 is not an outlier.
For 5% significance level, 0.9 is not an outlier.
For 1% significance level, 0.9 is not an outlier.

2. Data Value 0.1 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.020

For 10% significance level, 0.1 is not an outlier.
For 5% significance level, 0.1 is not an outlier.

For 1% significance level, 0.1 is not an outlier.

RIPARIAN VEGETATION – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Rip Veg Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium

General Statistics

Number of Valid Observations	9	Number of Distinct Observations	9

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.1	Minimum of Log Data	-2.303
Maximum	0.9	Maximum of Log Data	-0.105
Mean	0.316	Mean of log Data	-1.451
Median	0.18	SD of log Data	0.796
SD	0.274		
Std. Error of Mean	0.0913		
Coefficient of Variation	0.868		
Skewness	1.474		

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.803	Shapiro Wilk Test Statistic	0.902
Shapiro Wilk Critical Value	0.829	Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.485	95% H-UCL	0.709
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.676
95% Adjusted-CLT UCL (Chen-1995)	0.514	97.5% Chebyshev (MVUE) UCL	0.834
95% Modified-t UCL (Johnson-1978)	0.493	99% Chebyshev (MVUE) UCL	1.146

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	1.295	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.244	
MLE of Mean	0.316	
MLE of Standard Deviation	0.277	
nu star	23.31	
Approximate Chi Square Value (.05)	13.32	**Nonparametric Statistics**
Adjusted Level of Significance	0.0231	95% CLT UCL 0.466
Adjusted Chi Square Value	11.76	95% Jackknife UCL 0.485
		95% Standard Bootstrap UCL 0.453
Anderson-Darling Test Statistic	0.519	95% Bootstrap-t UCL 0.69

Anderson-Darling 5% Critical Value	0.731	95% Hall's Bootstrap UCL	1.161
Kolmogorov-Smirnov Test Statistic	0.224	95% Percentile Bootstrap UCL	0.462
Kolmogorov-Smirnov 5% Critical Value	0.283	95% BCA Bootstrap UCL	0.488
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.714
		97.5% Chebyshev(Mean, Sd) UCL	0.886
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.224
95% Approximate Gamma UCL	0.552		
95% Adjusted Gamma UCL	0.625		

Potential UCL to Use	Use 95% Approximate Gamma UCL 0.552

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Molybdenum

General Statistics

Number of Valid Observations	9	Number of Distinct Observations	9

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.63	Minimum of Log Data	-0.462
Maximum	2.58	Maximum of Log Data	0.948
Mean	1.302	Mean of log Data	0.134
Median	0.94	SD of log Data	0.53
SD	0.734		
Std. Error of Mean	0.245		
Coefficient of Variation	0.564		
Skewness	1.006		

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.841	Shapiro Wilk Test Statistic	0.904
Shapiro Wilk Critical Value	0.829	Shapiro Wilk Critical Value	0.829
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1.757	95% H-UCL	2.016
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.304
95% Adjusted-CLT UCL (Chen-1995)	1.792	97.5% Chebyshev (MVUE) UCL	2.742
95% Modified-t UCL (Johnson-1978)	1.771	99% Chebyshev (MVUE) UCL	3.601
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.745	Data appear Normal at 5% Significance Level	
Theta Star	0.474		

MLE of Mean	1.302
MLE of Standard Deviation	0.786
nu star	49.41
Approximate Chi Square Value (.05)	34.27
Adjusted Level of Significance	0.0231
Adjusted Chi Square Value	31.63
Anderson-Darling Test Statistic	0.477
Anderson-Darling 5% Critical Value	0.725
Kolmogorov-Smirnov Test Statistic	0.228
Kolmogorov-Smirnov 5% Critical Value	0.28

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.877
95% Adjusted Gamma UCL	2.034

Nonparametric Statistics

95% CLT UCL	1.705
95% Jackknife UCL	1.757
95% Standard Bootstrap UCL	1.677
95% Bootstrap-t UCL	2.126
95% Hall's Bootstrap UCL	1.916
95% Percentile Bootstrap UCL	1.714
95% BCA Bootstrap UCL	1.782
95% Chebyshev(Mean, Sd) UCL	2.368
97.5% Chebyshev(Mean, Sd) UCL	2.83
99% Chebyshev(Mean, Sd) UCL	3.736

Potential UCL to Use

Use 95% Student's-t UCL 1.757

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

RIPARIAN VEGETATION – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Rip Veg Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Cadmium

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
Tolerance Factor	3.031		

Raw Statistics		Log-Transformed Statistics	
Minimum	0.1	Minimum	-2.303
Maximum	0.9	Maximum	-0.105
Second Largest	0.6	Second Largest	-0.511
First Quartile	0.12	First Quartile	-2.12
Median	0.18	Median	-1.715
Third Quartile	0.35	Third Quartile	-1.05
Mean	0.316	Mean	-1.451
SD	0.274	SD	0.796
Coefficient of Variation	0.868		
Skewness	1.474		

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.803	Shapiro Wilk Test Statistic	0.902
Shapiro Wilk Critical Value	0.829	Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	1.146	95% UTL with 95% Coverage	2.62
95% UPL (t)	0.853	95% UPL (t)	1.117
90% Percentile (z)	0.667	90% Percentile (z)	0.651
95% Percentile (z)	0.766	95% Percentile (z)	0.869
99% Percentile (z)	0.953	99% Percentile (z)	1.495

Gamma Distribution Test		Data Distribution Test
k star	1.295	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.244	
MLE of Mean	0.316	
MLE of Standard Deviation	0.277	

nu star	23.31

A-D Test Statistic	0.519
5% A-D Critical Value	0.731
K-S Test Statistic	0.224
5% K-S Critical Value	0.283

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.66
95% Percentile	0.78
99% Percentile	0.876

Assuming Gamma Distribution

90% Percentile	0.682
95% Percentile	0.864
99% Percentile	1.28
95% WH Approx. Gamma UPL	0.958
95% HW Approx. Gamma UPL	0.986
95% WH Approx. Gamma UTL with 95% Coverage	1.628
95% HW Approx. Gamma UTL with 95% Coverage	1.772

95% UTL with 95% Coverage	0.9
95% Percentile Bootstrap UTL with 95% Coverage	0.9
95% BCA Bootstrap UTL with 95% Coverage	0.9
95% UPL	0.9
95% Chebyshev UPL	1.574
Upper Threshold Limit Based upon IQR	0.695

Molybdenum

General Statistics

Total Number of Observations	9
Tolerance Factor	3.031

Number of Distinct Observations	9

Raw Statistics

Minimum	0.63
Maximum	2.58
Second Largest	2.37
First Quartile	0.72
Median	0.94
Third Quartile	1.57
Mean	1.302
SD	0.734
Coefficient of Variation	0.564
Skewness	1.006

Log-Transformed Statistics

Minimum	-0.462
Maximum	0.948
Second Largest	0.863
First Quartile	-0.329
Median	-0.0619
Third Quartile	0.451
Mean	0.134
SD	0.53

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.841
Shapiro Wilk Critical Value	0.829

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.904
Shapiro Wilk Critical Value	0.829

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	3.526

Assuming Lognormal Distribution

95% UTL with 95% Coverage	5.695

95% UPL (t)	2.741
90% Percentile (z)	2.243
95% Percentile (z)	2.509
99% Percentile (z)	3.009

95% UPL (t)	3.23
90% Percentile (z)	2.254
95% Percentile (z)	2.733
99% Percentile (z)	3.921

Gamma Distribution Test

k star	2.745
Theta Star	0.474
MLE of Mean	1.302
MLE of Standard Deviation	0.786
nu star	49.41

A-D Test Statistic	0.477
5% A-D Critical Value	0.725
K-S Test Statistic	0.228
5% K-S Critical Value	0.28

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	2.412
95% Percentile	2.496
99% Percentile	2.563

Assuming Gamma Distribution

90% Percentile	2.356
95% Percentile	2.804
99% Percentile	3.781

95% WH Approx. Gamma UPL	2.983
95% HW Approx. Gamma UPL	3.032
95% WH Approx. Gamma UTL with 95% Coverage	4.463
95% HW Approx. Gamma UTL with 95% Coverage	4.683

95% UTL with 95% Coverage	2.58
95% Percentile Bootstrap UTL with 95% Coverage	2.58
95% BCA Bootstrap UTL with 95% Coverage	2.58
95% UPL	2.58
95% Chebyshev UPL	4.674
Upper Threshold Limit Based upon IQR	2.845

RIPARIAN VEGETATION – USL OUTPUTS

Robust Simultaneous Intervals/Limits (SLs)

Date/Time of Computation	8/20/2012 6:27:31 PM
User Selected Options	
From File	C:\Documents and Settings\Valerie C Chen\My Documents\Val's documents from C\Monsanto\Background TM\Fr
Full Precision	OFF
Confidence Coefficient	0.9
PROP Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	PROP SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Huber Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	Huber SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Tukey Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Tukey Biweight SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
Lax/Kafadar Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Lax/Kafadar SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
MVT Method	Triming Percentage of 10.08%
	MVT SLs derived using 10 Iterations and initial estimates of median/1.48MAD.

D2Max represents unsquared critical value of Max-MD (Mahalanobis Distances) computed based upon Wsum Values

Cadmium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	9	0.316	0.18	0.274	0.119	2.11	-0.262	0.893

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.18	0.119	0.197	0.109	7.097	1.948	-0.0157	0.41
Huber	0.18	0.119	0.304	0.252	8.824	2.097	-0.224	0.832
Tukey Biweight	0.18	0.119	0.187	0.169	6.463	1.879	-0.13	0.505
Lax Kafadar Biweight	0.18	0.119	0.204	0.142	6.831	1.92	-0.0685	0.476
MVT	0.18	0.119	0.316	0.274	9	2.11	-0.262	0.893

Molybdenum

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	9	1.302	0.94	0.734	0.46	2.11	-0.246	2.85

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.94	0.46	0.99	0.357	7.111	1.949	0.294	1.686
Huber	0.94	0.46	1.302	0.734	9	2.11	-0.246	2.85
Tukey Biweight	0.94	0.46	1.021	0.735	6.849	1.922	-0.393	2.434
Lax Kafadar Biweight	0.94	0.46	1.119	0.541	7.356	1.974	0.0516	2.185
MVT	0.94	0.46	1.302	0.734	9	2.11	-0.246	2.85

UPLAND SOIL– OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options	
From File	Upland Soil values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	2

Rosner's Outlier Test for Chromium, Total

Mean	**20.1**
Standard Deviation	**8.235**
Number of data	**30**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	20.1	8.096	44.8	20	3.051	2.91	3.24
2	19.25	6.906	43	16	3.44	2.89	3.22

For 5% significance level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

44.8, 43

For 1% Significance Level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

44.8, 43

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Soil values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Rosner's Outlier Test for Mercury

Mean	**0.0289**
Standard Deviation	**0.0117**
Number of data	**30**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.0289	0.0115	0.0746	16	3.971	2.91	3.24

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 0.0746 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 0.0746 is a Potential Statistical Outlier

Rosner's Outlier Test for Nickel

Mean	**23.04**
Standard Deviation	**9.548**
Number of data	**30**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	23.04	9.388	63.2	16	4.278	2.91	3.24

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 63.2 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 63.2 is a Potential Statistical Outlier

Rosner's Outlier Test for Selenium

Mean	**0.918**
Standard Deviation	**1.193**
Number of data	**30**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.918	1.173	6.89	16	5.09	2.91	3.24

For 5% Significance Level, there is 1 Potential Outlier
Therefore, Observation 6.89 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier
Therefore, Observation 6.89 is a Potential Statistical Outlier

Dixon's Outlier Test for Silver

Number of data = 22
10% critical value: 0.382
5% critical value: 0.43
1% critical value: 0.514

1. Data Value 0.423 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.639

For 10% significance level, 0.423 is an outlier.
For 5% significance level, 0.423 is an outlier.
For 1% significance level, 0.423 is an outlier.

2. Data Value 0.0703 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.097

For 10% significance level, 0.0703 is not an outlier.
For 5% significance level, 0.0703 is not an outlier.
For 1% significance level, 0.0703 is not an outlier.

Rosner's Outlier Test for Thallium

Mean	**0.182**
Standard Deviation	**0.0704**
Number of data	**30**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.182	0.0693	0.481	16	4.322	2.91	3.24

For 5% Significance Level, there is 1 Potential Outlier
Therefore, Observation 0.481 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier
Therefore, Observation 0.481 is a Potential Statistical Outlier

Rosner's Outlier Test for Vanadium

Mean	**22.76**
Standard Deviation	**8.163**
Number of data	**30**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	22.76	8.026	52.2	16	3.668	2.91	3.24

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 52.2 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 52.2 is a Potential Statistical Outlier

Rosner's Outlier Test for Zinc

Mean	**103.3**
Standard Deviation	**37.22**
Number of data	**30**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	103.3	36.59	241	16	3.764	2.91	3.24

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 241 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 241 is a Potential Statistical Outlier

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Soil values_b.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	4

Rosner's Outlier Test for Uranium, Total

Mean	**1.719**
Standard Deviation	**2.523**
Number of data	**26**
Number of suspected outliers	**4**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	1.719	2.474	10.2	16	3.429	2.84	3.16
2	1.38	1.874	9.21	20	4.179	2.82	3.14
3	1.053	0.942	4.89	17	4.073	2.8	3.11
4	0.887	0.479	2.55	18	3.474	2.78	3.09

For 5% significance level, there are 4 Potential Outliers

Therefore, Potential Statistical Outliers are

10.2, 9.21, 4.89, 2.55

For 1% Significance Level, there are 4 Potential Outliers

Therefore, Potential Statistical Outliers are

10.2, 9.21, 4.89, 2.55

UPLAND SOIL – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Upland Soil values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	30	Number of Detected Data	10
Number of Distinct Detected Data	10	Number of Non-Detect Data	20
		Percent Non-Detects	66.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.419	Minimum Detected	-0.87
Maximum Detected	0.854	Maximum Detected	-0.158
Mean of Detected	0.553	Mean of Detected	-0.62
SD of Detected	0.146	SD of Detected	0.237
Minimum Non-Detect	0.343	Minimum Non-Detect	-1.07
Maximum Non-Detect	0.755	Maximum Non-Detect	-0.281

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	28
Number treated as Detected	2
Single DL Non-Detect Percentage	93.33%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.793	Shapiro Wilk Test Statistic	0.849
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.321	Mean	-1.281
SD	0.191	SD	0.524
95% DL/2 (t) UCL	0.38	95% H-Stat (DL/2) UCL	0.386
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-1.072
		SD in Log Scale	0.362
		Mean in Original Scale	0.367
		SD in Original Scale	0.158
		95% t UCL	0.416
		95% Percentile Bootstrap UCL	0.417
		95% BCA Bootstrap UCL	0.426
		95% H-UCL	0.414

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	13.04	Data appear Lognormal at 5% Significance Level
Theta Star	0.0424	
nu star	260.8	

A-D Test Statistic	0.806
5% A-D Critical Value	0.725
K-S Test Statistic	0.725
5% K-S Critical Value	0.266

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.854
Mean	0.186
Median	0.000001
SD	0.276
k star	0.127
Theta star	1.46
Nu star	7.643
AppChi2	2.53
95% Gamma Approximate UCL	0.562
95% Adjusted Gamma UCL	0.601

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.465
SD	0.102
SE of Mean	0.0197
95% KM (t) UCL	0.499
95% KM (z) UCL	0.497
95% KM (jackknife) UCL	0.495
95% KM (bootstrap t) UCL	0.533
95% KM (BCA) UCL	0.528
95% KM (Percentile Bootstrap) UCL	0.514
95% KM (Chebyshev) UCL	0.551
97.5% KM (Chebyshev) UCL	0.588
99% KM (Chebyshev) UCL	0.661

Potential UCLs to Use

95% KM (t) UCL	0.499
95% KM (% Bootstrap) UCL	0.514

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Arsenic

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	30

Raw Statistics

Minimum	2.55
Maximum	9.01
Mean	5.572
Median	5.67
SD	2.154
Std. Error of Mean	0.393
Coefficient of Variation	0.386
Skewness	0.0198

Log-transformed Statistics

Minimum of Log Data	0.936
Maximum of Log Data	2.198
Mean of log Data	1.637
SD of log Data	0.422

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.907
Shapiro Wilk Critical Value	0.927

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.896
Shapiro Wilk Critical Value	0.927

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	6.24

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	6.221
95% Modified-t UCL (Johnson-1978)	6.241

Assuming Lognormal Distribution

95% H-UCL	6.514
95% Chebyshev (MVUE) UCL	7.539
97.5% Chebyshev (MVUE) UCL	8.378
99% Chebyshev (MVUE) UCL	10.03

Gamma Distribution Test	
k star (bias corrected)	5.717
Theta Star	0.975
MLE of Mean	5.572
MLE of Standard Deviation	2.331
nu star	343
Approximate Chi Square Value (.05)	301.1
Adjusted Level of Significance	0.041
Adjusted Chi Square Value	298.8
Anderson-Darling Test Statistic	1.01
Anderson-Darling 5% Critical Value	0.746
Kolmogorov-Smirnov Test Statistic	0.151
Kolmogorov-Smirnov 5% Critical Value	0.16

Data follow Appr. Gamma Distribution at 5% Significance Level

Data Distribution

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	6.219
95% Jackknife UCL	6.24
95% Standard Bootstrap UCL	6.213
95% Bootstrap-t UCL	6.216
95% Hall's Bootstrap UCL	6.183
95% Percentile Bootstrap UCL	6.212
95% BCA Bootstrap UCL	6.21
95% Chebyshev(Mean, Sd) UCL	7.286
97.5% Chebyshev(Mean, Sd) UCL	8.028
99% Chebyshev(Mean, Sd) UCL	9.485

Assuming Gamma Distribution

95% Approximate Gamma UCL	6.348
95% Adjusted Gamma UCL	6.396

Potential UCL to Use

Use 95% Approximate Gamma UCL 6.348

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Boron

General Statistics

Number of Valid Data	30	Number of Detected Data	29
Number of Distinct Detected Data	29	Number of Non-Detect Data	1
		Percent Non-Detects	3.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.92	Minimum Detected	0.652
Maximum Detected	22.3	Maximum Detected	3.105
Mean of Detected	9.125	Mean of Detected	1.954
SD of Detected	6.315	SD of Detected	0.754
Minimum Non-Detect	1.89	Minimum Non-Detect	0.637
Maximum Non-Detect	1.89	Maximum Non-Detect	0.637

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.887	Shapiro Wilk Test Statistic	0.933
5% Shapiro Wilk Critical Value	0.926	5% Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	8.852	Mean	1.887

SD	6.383
95% DL/2 (t) UCL	10.83

SD	0.827
95% H-Stat (DL/2) UCL	13.17

Maximum Likelihood Estimate(MLE) Method

Mean	8.775
SD	6.406
95% MLE (t) UCL	10.76
95% MLE (Tiku) UCL	10.68

Log ROS Method

Mean in Log Scale	1.891
SD in Log Scale	0.817
Mean in Original Scale	8.856
SD in Original Scale	6.377
95% t UCL	10.83
95% Percentile Bootstrap UCL	10.8
95% BCA Bootstrap UCL	10.94
95% H UCL	13.04

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.902
Theta Star	4.798
nu star	110.3
A-D Test Statistic	0.701
5% A-D Critical Value	0.757
K-S Test Statistic	0.757
5% K-S Critical Value	0.165

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	22.3
Mean	8.821
Median	6.84
SD	6.425
k star	0.736
Theta star	11.98
Nu star	44.17
AppChi2	29.93
95% Gamma Approximate UCL	13.02
95% Adjusted Gamma UCL	13.32

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	8.885
SD	6.237
SE of Mean	1.159
95% KM (t) UCL	10.85
95% KM (z) UCL	10.79
95% KM (jackknife) UCL	10.84
95% KM (bootstrap t) UCL	11.01
95% KM (BCA) UCL	10.77
95% KM (Percentile Bootstrap) UCL	10.71
95% KM (Chebyshev) UCL	13.94
97.5% KM (Chebyshev) UCL	16.12
99% KM (Chebyshev) UCL	20.41

Potential UCLs to Use

95% KM (Chebyshev) UCL	13.94

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cadmium

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	30

Raw Statistics

Minimum	0.538
Maximum	9.66
Mean	2.27

Log-transformed Statistics

Minimum of Log Data	-0.62
Maximum of Log Data	2.268
Mean of log Data	0.494

Median	1.45	SD of log Data	0.754
SD	2.309		
Std. Error of Mean	0.422		
Coefficient of Variation	1.017		
Skewness	2.267		

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.673
Shapiro Wilk Critical Value	0.927

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.926
Shapiro Wilk Critical Value	0.927

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	2.986
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	3.15
95% Modified-t UCL (Johnson-1978)	3.015

Assuming Lognormal Distribution

95% H-UCL	2.959
95% Chebyshev (MVUE) UCL	3.563
97.5% Chebyshev (MVUE) UCL	4.173
99% Chebyshev (MVUE) UCL	5.372

Gamma Distribution Test

k star (bias corrected)	1.538
Theta Star	1.476
MLE of Mean	2.27
MLE of Standard Deviation	1.83
nu star	92.27
Approximate Chi Square Value (.05)	71.12
Adjusted Level of Significance	0.041
Adjusted Chi Square Value	70.05
Anderson-Darling Test Statistic	1.551
Anderson-Darling 5% Critical Value	0.761
Kolmogorov-Smirnov Test Statistic	0.18
Kolmogorov-Smirnov 5% Critical Value	0.163

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	2.945
95% Adjusted Gamma UCL	2.99

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	2.963
95% Jackknife UCL	2.986
95% Standard Bootstrap UCL	2.935
95% Bootstrap-t UCL	3.303
95% Hall's Bootstrap UCL	3.259
95% Percentile Bootstrap UCL	3.012
95% BCA Bootstrap UCL	3.105
95% Chebyshev(Mean, Sd) UCL	4.108
97.5% Chebyshev(Mean, Sd) UCL	4.903
99% Chebyshev(Mean, Sd) UCL	6.465

Potential UCL to Use

Use 95% Chebyshev (Mean, Sd) UCL 4.108

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium, Total_out

General Statistics

Number of Valid Observations	28	Number of Distinct Observations	26
Number of Missing Values	2		

Raw Statistics

Minimum	9.87

Log-transformed Statistics

Minimum of Log Data	2.289

Maximum	32.1	Maximum of Log Data	3.469
Mean	18.4	Mean of log Data	2.87
Median	20.3	SD of log Data	0.303
SD	5.274		
Std. Error of Mean	0.997		
Coefficient of Variation	0.287		
Skewness	0.205		

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.942
Shapiro Wilk Critical Value	0.924

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical Value	0.924

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	20.1

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	20.08
95% Modified-t UCL (Johnson-1978)	20.1

Assuming Lognormal Distribution

95% H-UCL	20.52
95% Chebyshev (MVUE) UCL	23.12
97.5% Chebyshev (MVUE) UCL	25.14
99% Chebyshev (MVUE) UCL	29.12

Gamma Distribution Test

k star (bias corrected)	10.7
Theta Star	1.719
MLE of Mean	18.4
MLE of Standard Deviation	5.624
nu star	599.4
Approximate Chi Square Value (.05)	543.6
Adjusted Level of Significance	0.0404
Adjusted Chi Square Value	540.3
Anderson-Darling Test Statistic	0.803
Anderson-Darling 5% Critical Value	0.745
Kolmogorov-Smirnov Test Statistic	0.193
Kolmogorov-Smirnov 5% Critical Value	0.165

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	20.29
95% Adjusted Gamma UCL	20.41

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	20.04
95% Jackknife UCL	20.1
95% Standard Bootstrap UCL	20.01
95% Bootstrap-t UCL	20.03
95% Hall's Bootstrap UCL	20.09
95% Percentile Bootstrap UCL	20.02
95% BCA Bootstrap UCL	20.15
95% Chebyshev(Mean, Sd) UCL	22.74
97.5% Chebyshev(Mean, Sd) UCL	24.62
99% Chebyshev(Mean, Sd) UCL	28.32

Potential UCL to Use

Use 95% Student's-t UCL 20.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cobalt

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	27

Raw Statistics

Log-transformed Statistics

Minimum	3.37	Minimum of Log Data	1.215
Maximum	13.3	Maximum of Log Data	2.588
Mean	8.634	Mean of log Data	2.07
Median	9.165	SD of log Data	0.444
SD	3.308		
Std. Error of Mean	0.604		
Coefficient of Variation	0.383		
Skewness	-0.24		

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.902
Shapiro Wilk Critical Value	0.927

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.873
Shapiro Wilk Critical Value	0.927

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	9.66

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	9.599
95% Modified-t UCL (Johnson-1978)	9.656

Assuming Lognormal Distribution

95% H-UCL	10.23
95% Chebyshev (MVUE) UCL	11.89
97.5% Chebyshev (MVUE) UCL	13.27
99% Chebyshev (MVUE) UCL	15.98

Gamma Distribution Test

k star (bias corrected)	5.391
Theta Star	1.602
MLE of Mean	8.634
MLE of Standard Deviation	3.719
nu star	323.4
Approximate Chi Square Value (.05)	282.8
Adjusted Level of Significance	0.041
Adjusted Chi Square Value	280.6
Anderson-Darling Test Statistic	1.287
Anderson-Darling 5% Critical Value	0.746
Kolmogorov-Smirnov Test Statistic	0.151
Kolmogorov-Smirnov 5% Critical Value	0.16

Data follow Appr. Gamma Distribution at 5% Significance Level

Data Distribution

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	9.627
95% Jackknife UCL	9.66
95% Standard Bootstrap UCL	9.597
95% Bootstrap-t UCL	9.728
95% Hall's Bootstrap UCL	9.562
95% Percentile Bootstrap UCL	9.647
95% BCA Bootstrap UCL	9.561
95% Chebyshev(Mean, Sd) UCL	11.27
97.5% Chebyshev(Mean, Sd) UCL	12.41
99% Chebyshev(Mean, Sd) UCL	14.64

Assuming Gamma Distribution

95% Approximate Gamma UCL	9.876
95% Adjusted Gamma UCL	9.953

Potential UCL to Use

Use 95% Approximate Gamma UCL 9.876

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Copper

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	26

Raw Statistics

Minimum	8.6
Maximum	30.6
Mean	18.62
Median	21.2
SD	6.886
Std. Error of Mean	1.257
Coefficient of Variation	0.37
Skewness	-0.0962

Log-transformed Statistics

Minimum of Log Data	2.152
Maximum of Log Data	3.421
Mean of log Data	2.848
SD of log Data	0.41

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.899
Shapiro Wilk Critical Value	0.927

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.87
Shapiro Wilk Critical Value	0.927

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	20.76

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	20.66
95% Modified-t UCL (Johnson-1978)	20.75

Assuming Lognormal Distribution

95% H-UCL	21.67
95% Chebyshev (MVUE) UCL	25.01
97.5% Chebyshev (MVUE) UCL	27.74
99% Chebyshev (MVUE) UCL	33.09

Gamma Distribution Test

k star (bias corrected)	6.097
Theta Star	3.054
MLE of Mean	18.62
MLE of Standard Deviation	7.541
nu star	365.8
Approximate Chi Square Value (.05)	322.5
Adjusted Level of Significance	0.041
Adjusted Chi Square Value	320.1
Anderson-Darling Test Statistic	1.503
Anderson-Darling 5% Critical Value	0.746
Kolmogorov-Smirnov Test Statistic	0.215
Kolmogorov-Smirnov 5% Critical Value	0.16

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	21.12
95% Adjusted Gamma UCL	21.28

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	20.69
95% Jackknife UCL	20.76
95% Standard Bootstrap UCL	20.66
95% Bootstrap-t UCL	20.62
95% Hall's Bootstrap UCL	20.71
95% Percentile Bootstrap UCL	20.69
95% BCA Bootstrap UCL	20.65
95% Chebyshev(Mean, Sd) UCL	24.1
97.5% Chebyshev(Mean, Sd) UCL	26.47
99% Chebyshev(Mean, Sd) UCL	31.13

Potential UCL to Use

Use 95% Student's-t UCL	20.76
or 95% Modified-t UCL	20.75

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Manganese

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	30

Raw Statistics

Minimum	337
Maximum	3990
Mean	1595
Median	1540
SD	1093
Std. Error of Mean	199.5
Coefficient of Variation	0.685
Skewness	0.346

Log-transformed Statistics

Minimum of Log Data	5.82
Maximum of Log Data	8.292
Mean of log Data	7.071
SD of log Data	0.854

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.894
Shapiro Wilk Critical Value	0.927

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.855
Shapiro Wilk Critical Value	0.927

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	1934

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	1936
95% Modified-t UCL (Johnson-1978)	1936

Assuming Lognormal Distribution

95% H-UCL	2443
95% Chebyshev (MVUE) UCL	2934
97.5% Chebyshev (MVUE) UCL	3481
99% Chebyshev (MVUE) UCL	4556

Gamma Distribution Test

k star (bias corrected)	1.639
Theta Star	972.8
MLE of Mean	1595
MLE of Standard Deviation	1246
nu star	98.37
Approximate Chi Square Value (.05)	76.49
Adjusted Level of Significance	0.041
Adjusted Chi Square Value	75.37
Anderson-Darling Test Statistic	1.471
Anderson-Darling 5% Critical Value	0.76
Kolmogorov-Smirnov Test Statistic	0.2
Kolmogorov-Smirnov 5% Critical Value	0.162

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	2051
95% Adjusted Gamma UCL	2081

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	1923
95% Jackknife UCL	1934
95% Standard Bootstrap UCL	1927
95% Bootstrap-t UCL	1947
95% Hall's Bootstrap UCL	1943
95% Percentile Bootstrap UCL	1913
95% BCA Bootstrap UCL	1944
95% Chebyshev(Mean, Sd) UCL	2465
97.5% Chebyshev(Mean, Sd) UCL	2841
99% Chebyshev(Mean, Sd) UCL	3580

Potential UCL to Use | Use 95% Chebyshev (Mean, Sd) UCL 2465

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mercury_Out

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	26
Number of Missing Values	1		

Raw Statistics

Minimum	0.015
Maximum	0.0507
Mean	0.0273
Median	0.0249
SD	0.00805
Std. Error of Mean	0.0015
Coefficient of Variation	0.295
Skewness	1.43

Log-transformed Statistics

Minimum of Log Data	-4.2
Maximum of Log Data	-2.982
Mean of log Data	-3.638
SD of log Data	0.268

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.868
Shapiro Wilk Critical Value	0.926

Data not Normal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.0298

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.0302
95% Modified-t UCL (Johnson-1978)	0.0299

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.949
Shapiro Wilk Critical Value	0.926

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL	0.0298
95% Chebyshev (MVUE) UCL	0.0332
97.5% Chebyshev (MVUE) UCL	0.0358
99% Chebyshev (MVUE) UCL	0.0409

Gamma Distribution Test

k star (bias corrected)	12.44
Theta Star	0.00219
MLE of Mean	0.0273
MLE of Standard Deviation	0.00774
nu star	721.3
Approximate Chi Square Value (.05)	660
Adjusted Level of Significance	0.0407
Adjusted Chi Square Value	656.5
Anderson-Darling Test Statistic	0.905
Anderson-Darling 5% Critical Value	0.745
Kolmogorov-Smirnov Test Statistic	0.171
Kolmogorov-Smirnov 5% Critical Value	0.162

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Data Distribution

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.0297
95% Jackknife UCL	0.0298
95% Standard Bootstrap UCL	0.0297
95% Bootstrap-t UCL	0.0305
95% Hall's Bootstrap UCL	0.0305
95% Percentile Bootstrap UCL	0.0298
95% BCA Bootstrap UCL	0.0301
95% Chebyshev(Mean, Sd) UCL	0.0338
97.5% Chebyshev(Mean, Sd) UCL	0.0366
99% Chebyshev(Mean, Sd) UCL	0.0422

95% Approximate Gamma UCL 0.0298

95% Adjusted Gamma UCL 0.03

Potential UCL to Use

Use 95% Student's-t UCL 0.0298

or 95% Modified-t UCL 0.0299

or 95% H-UCL 0.0298

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Molybdenum

General Statistics

Number of Valid Data	30	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	28
		Percent Non-Detects	93.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.62	Minimum Detected	0.482
Maximum Detected	3.45	Maximum Detected	1.238
Mean of Detected	2.535	Mean of Detected	0.86
SD of Detected	1.294	SD of Detected	0.535
Minimum Non-Detect	1.03	Minimum Non-Detect	0.0296
Maximum Non-Detect	1.15	Maximum Non-Detect	0.14

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	28
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	93.33%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A

5% Shapiro Wilk Critical Value	N/A

Data not Normal at 5% Significance Level

5% Shapiro Wilk Critical Value	N/A

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.692
SD	0.556
95% DL/2 (t) UCL	0.864
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-0.484
SD	0.38
95% H-Stat (DL/2) UCL	0.755
Log ROS Method	
Mean in Log Scale	N/A
SD in Log Scale	N/A
Mean in Original Scale	N/A
SD in Original Scale	N/A
95% t UCL	N/A
95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A
95% H-UCL	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	1.681
SD	0.328
SE of Mean	0.0848
95% KM (t) UCL	1.825
95% KM (z) UCL	1.821
95% KM (jackknife) UCL	2.881
95% KM (bootstrap t) UCL	N/A
95% KM (BCA) UCL	3.45
95% KM (Percentile Bootstrap) UCL	3.45
95% KM (Chebyshev) UCL	2.051
97.5% KM (Chebyshev) UCL	2.211
99% KM (Chebyshev) UCL	2.525
Potential UCLs to Use	
95% KM (t) UCL	1.825
95% KM (% Bootstrap) UCL	3.45

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Nickel_Out

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	28
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	12.5	Minimum of Log Data	2.526
Maximum	32.2	Maximum of Log Data	3.472
Mean	21.66	Mean of log Data	3.035
Median	22.8	SD of log Data	0.298
SD	5.903		
Std. Error of Mean	1.096		
Coefficient of Variation	0.273		
Skewness	-0.308		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Test Statistic	0.866
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	23.52	95% H-UCL	24.08
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	27.04
95% Adjusted-CLT UCL (Chen-1995)	23.39	97.5% Chebyshev (MVUE) UCL	29.35
95% Modified-t UCL (Johnson-1978)	23.51	99% Chebyshev (MVUE) UCL	33.88

Gamma Distribution Test		Data Distribution
k star (bias corrected)	11.25	Data do not follow a Discernable Distribution (0.05)
Theta Star	1.924	
MLE of Mean	21.66	
MLE of Standard Deviation	6.456	
nu star	652.8	
Approximate Chi Square Value (.05)	594.5	**Nonparametric Statistics**
Adjusted Level of Significance	0.0407	95% CLT UCL 23.46
Adjusted Chi Square Value	591.2	95% Jackknife UCL 23.52
		95% Standard Bootstrap UCL 23.48
Anderson-Darling Test Statistic	1.444	95% Bootstrap-t UCL 23.47
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL 23.35
Kolmogorov-Smirnov Test Statistic	0.163	95% Percentile Bootstrap UCL 23.49
Kolmogorov-Smirnov 5% Critical Value	0.162	95% BCA Bootstrap UCL 23.37
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 26.44
		97.5% Chebyshev(Mean, Sd) UCL 28.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 32.57
95% Approximate Gamma UCL	23.78	
95% Adjusted Gamma UCL	23.91	

Potential UCL to Use	Use 95% Student's-t UCL 23.52
	or 95% Modified-t UCL 23.51

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits

(e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Selenium_OutR

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	29
Number of Missing Values	1		

Raw Statistics

Minimum	0.25
Maximum	2
Mean	0.712
Median	0.643
SD	0.397
Std. Error of Mean	0.0737
Coefficient of Variation	0.557
Skewness	1.695

Log-transformed Statistics

Minimum of Log Data	-1.386
Maximum of Log Data	0.693
Mean of log Data	-0.465
SD of log Data	0.499

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.845
Shapiro Wilk Critical Value	0.926

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.973
Shapiro Wilk Critical Value	0.926

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.838

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.858
95% Modified-t UCL (Johnson-1978)	0.842

Assuming Lognormal Distribution

95% H-UCL	0.855
95% Chebyshev (MVUE) UCL	1.007
97.5% Chebyshev (MVUE) UCL	1.136
99% Chebyshev (MVUE) UCL	1.39

Gamma Distribution Test

k star (bias corrected)	3.733
Theta Star	0.191
MLE of Mean	0.712
MLE of Standard Deviation	0.369
nu star	216.5
Approximate Chi Square Value (.05)	183.5
Adjusted Level of Significance	0.0407
Adjusted Chi Square Value	181.7
Anderson-Darling Test Statistic	0.442
Anderson-Darling 5% Critical Value	0.75
Kolmogorov-Smirnov Test Statistic	0.106
Kolmogorov-Smirnov 5% Critical Value	0.163

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.841
95% Adjusted Gamma UCL	0.849

Nonparametric Statistics

95% CLT UCL	0.834
95% Jackknife UCL	0.838
95% Standard Bootstrap UCL	0.831
95% Bootstrap-t UCL	0.878
95% Hall's Bootstrap UCL	0.903
95% Percentile Bootstrap UCL	0.841
95% BCA Bootstrap UCL	0.866
95% Chebyshev(Mean, Sd) UCL	1.034
97.5% Chebyshev(Mean, Sd) UCL	1.173
99% Chebyshev(Mean, Sd) UCL	1.446

Potential UCL to Use | Use 95% Approximate Gamma UCL 0.841

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Silver_Out

General Statistics

Number of Valid Data	29	Number of Detected Data	21
Number of Distinct Detected Data	21	Number of Non-Detect Data	8
Number of Missing Values	1	Percent Non-Detects	27.59%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0703	Minimum Detected	-2.655
Maximum Detected	0.251	Maximum Detected	-1.382
Mean of Detected	0.118	Mean of Detected	-2.187
SD of Detected	0.0437	SD of Detected	0.314
Minimum Non-Detect	0.242	Minimum Non-Detect	-1.419
Maximum Non-Detect	0.25	Maximum Non-Detect	-1.386

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	28
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	1
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	96.55%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.813	Shapiro Wilk Test Statistic	0.926
5% Shapiro Wilk Critical Value	0.908	5% Shapiro Wilk Critical Value	0.908
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.12	Mean	-2.16
SD	0.037	SD	0.269
95% DL/2 (t) UCL	0.131	95% H-Stat (DL/2) UCL	0.131
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.195
		SD in Log Scale	0.274
		Mean in Original Scale	0.116
		SD in Original Scale	0.0378
		95% t UCL	0.128
		95% Percentile Bootstrap UCL	0.128
		95% BCA Bootstrap UCL	0.131
		95% H-UCL	0.127

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	8.435	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	0.014	
nu star	354.3	

A-D Test Statistic	0.77
5% A-D Critical Value	0.743
K-S Test Statistic	0.743
5% K-S Critical Value	0.189

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.0703
Maximum	0.251
Mean	0.119
Median	0.11
SD	0.0378
k star	11.43
Theta star	0.0104
Nu star	662.7
AppChi2	604
95% Gamma Approximate UCL	0.131
95% Adjusted Gamma UCL	0.131

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.116
SD	0.0399
SE of Mean	0.00845
95% KM (t) UCL	0.131
95% KM (z) UCL	0.13
95% KM (jackknife) UCL	0.131
95% KM (bootstrap t) UCL	0.135
95% KM (BCA) UCL	0.129
95% KM (Percentile Bootstrap) UCL	0.131
95% KM (Chebyshev) UCL	0.153
97.5% KM (Chebyshev) UCL	0.169
99% KM (Chebyshev) UCL	0.2

Potential UCLs to Use

95% KM (Percentile Bootstrap) UCL	0.131

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Thallium_Out

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	23
Number of Missing Values	1		

Raw Statistics

Minimum	0.118
Maximum	0.293
Mean	0.171
Median	0.158
SD	0.0428
Std. Error of Mean	0.00794
Coefficient of Variation	0.25
Skewness	1.873

Log-transformed Statistics

Minimum of Log Data	-2.137
Maximum of Log Data	-1.228
Mean of log Data	-1.789
SD of log Data	0.216

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.777
Shapiro Wilk Critical Value	0.926

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.869
Shapiro Wilk Critical Value	0.926

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.185

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.187
95% Modified-t UCL (Johnson-1978)	0.185

Assuming Lognormal Distribution

95% H-UCL	0.184
95% Chebyshev (MVUE) UCL	0.201
97.5% Chebyshev (MVUE) UCL	0.214
99% Chebyshev (MVUE) UCL	0.24

Gamma Distribution Test	
k star (bias corrected)	18.31
Theta Star	0.00936
MLE of Mean	0.171
MLE of Standard Deviation	0.04
nu star	1062
Approximate Chi Square Value (.05)	987.4
Adjusted Level of Significance	0.0407
Adjusted Chi Square Value	983.1
Anderson-Darling Test Statistic	1.699
Anderson-Darling 5% Critical Value	0.744
Kolmogorov-Smirnov Test Statistic	0.193
Kolmogorov-Smirnov 5% Critical Value	0.162

Data not Gamma Distributed at 5% Significance Level

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	0.184
95% Jackknife UCL	0.185
95% Standard Bootstrap UCL	0.184
95% Bootstrap-t UCL	0.189
95% Hall's Bootstrap UCL	0.19
95% Percentile Bootstrap UCL	0.184
95% BCA Bootstrap UCL	0.188
95% Chebyshev(Mean, Sd) UCL	0.206
97.5% Chebyshev(Mean, Sd) UCL	0.221
99% Chebyshev(Mean, Sd) UCL	0.25

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.184
95% Adjusted Gamma UCL	0.185

Potential UCL to Use

Use 95% Student's-t UCL 0.185

or 95% Modified-t UCL 0.185

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Uranium, Total_Out

General Statistics

Number of Valid Data	26	Number of Detected Data	22
Number of Distinct Detected Data	22	Number of Non-Detect Data	4
Number of Missing Values	4	Percent Non-Detects	15.38%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.395	Minimum Detected	-0.929
Maximum Detected	1.61	Maximum Detected	0.476
Mean of Detected	0.811	Mean of Detected	-0.275
SD of Detected	0.32	SD of Detected	0.362
Minimum Non-Detect	0.484	Minimum Non-Detect	-0.726
Maximum Non-Detect	0.5	Maximum Non-Detect	-0.693

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	6
Number treated as Detected	20
Single DL Non-Detect Percentage	23.08%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.866	Shapiro Wilk Test Statistic	0.962
5% Shapiro Wilk Critical Value	0.911	5% Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.724
SD	0.359
95% DL/2 (t) UCL	0.845

Maximum Likelihood Estimate(MLE) Method	
Mean	0.718
SD	0.37
95% MLE (t) UCL	0.842
95% MLE (Tiku) UCL	0.845

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-0.448
SD	0.531
95% H-Stat (DL/2) UCL	0.909

Log ROS Method	
Mean in Log Scale	-0.373
SD in Log Scale	0.406
Mean in Original Scale	0.748
SD in Original Scale	0.33
95% t UCL	0.859
95% Percentile Bootstrap UCL	0.857
95% BCA Bootstrap UCL	0.88
95% H UCL	0.872

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	6.788
Theta Star	0.119
nu star	298.7
A-D Test Statistic	0.464
5% A-D Critical Value	0.745
K-S Test Statistic	0.745
5% K-S Critical Value	0.186

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.236
Maximum	1.61
Mean	0.722
Median	0.689
SD	0.362
k star	3.573
Theta star	0.202
Nu star	185.8
AppChi2	155.3
95% Gamma Approximate UCL	0.865
95% Adjusted Gamma UCL	0.875

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.749
SD	0.323
SE of Mean	0.0648
95% KM (t) UCL	0.859
95% KM (z) UCL	0.855
95% KM (jackknife) UCL	0.859
95% KM (bootstrap t) UCL	0.878
95% KM (BCA) UCL	0.875
95% KM (Percentile Bootstrap) UCL	0.861
95% KM (Chebyshev) UCL	1.031
97.5% KM (Chebyshev) UCL	1.153
99% KM (Chebyshev) UCL	1.393

Potential UCLs to Use

95% KM (BCA) UCL	0.875

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium_Out

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	29
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	10.7	Minimum of Log Data	2.37
Maximum	36.8	Maximum of Log Data	3.605
Mean	21.74	Mean of log Data	3.04
Median	22.4	SD of log Data	0.293
SD	6.082		
Std. Error of Mean	1.129		
Coefficient of Variation	0.28		
Skewness	0.257		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.973	Shapiro Wilk Test Statistic	0.967
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	23.67	95% H-UCL	24.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	27.02
95% Adjusted-CLT UCL (Chen-1995)	23.66	97.5% Chebyshev (MVUE) UCL	29.28
95% Modified-t UCL (Johnson-1978)	23.68	99% Chebyshev (MVUE) UCL	33.74

Gamma Distribution Test		Data Distribution
k star (bias corrected)	11.43	Data appear Normal at 5% Significance Level
Theta Star	1.902	
MLE of Mean	21.74	
MLE of Standard Deviation	6.431	
nu star	663.2	
Approximate Chi Square Value (.05)	604.4	**Nonparametric Statistics**
Adjusted Level of Significance	0.0407	95% CLT UCL 23.6
Adjusted Chi Square Value	601.1	95% Jackknife UCL 23.67
		95% Standard Bootstrap UCL 23.55
Anderson-Darling Test Statistic	0.412	95% Bootstrap-t UCL 23.75
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL 23.77
Kolmogorov-Smirnov Test Statistic	0.146	95% Percentile Bootstrap UCL 23.51
Kolmogorov-Smirnov 5% Critical Value	0.162	95% BCA Bootstrap UCL 23.63
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 26.67
		97.5% Chebyshev(Mean, Sd) UCL 28.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 32.98
95% Approximate Gamma UCL	23.86	
95% Adjusted Gamma UCL	23.99	

Potential UCL to Use	Use 95% Student's-t UCL 23.67

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zinc_Out

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	26
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	57.7	Minimum of Log Data	4.055
Maximum	148	Maximum of Log Data	4.997
Mean	98.51	Mean of log Data	4.553
Median	97	SD of log Data	0.279
SD	27.08		
Std. Error of Mean	5.03		
Coefficient of Variation	0.275		
Skewness	0.313		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	107.1	95% H-UCL	108.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	121.1
95% Adjusted-CLT UCL (Chen-1995)	107.1	97.5% Chebyshev (MVUE) UCL	130.8
95% Modified-t UCL (Johnson-1978)	107.1	99% Chebyshev (MVUE) UCL	150

Gamma Distribution Test		Data Distribution
k star (bias corrected)	12.27	Data appear Normal at 5% Significance Level
Theta Star	8.026	
MLE of Mean	98.51	
MLE of Standard Deviation	28.12	
nu star	711.9	
Approximate Chi Square Value (.05)	651	**Nonparametric Statistics**
Adjusted Level of Significance	0.0407	95% CLT UCL 106.8
Adjusted Chi Square Value	647.5	95% Jackknife UCL 107.1
		95% Standard Bootstrap UCL 106.7
Anderson-Darling Test Statistic	0.393	95% Bootstrap-t UCL 107.3
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL 106.9
Kolmogorov-Smirnov Test Statistic	0.119	95% Percentile Bootstrap UCL 106.8
Kolmogorov-Smirnov 5% Critical Value	0.162	95% BCA Bootstrap UCL 106.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 120.4
		97.5% Chebyshev(Mean, Sd) UCL 129.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 148.6
95% Approximate Gamma UCL	107.7	
95% Adjusted Gamma UCL	108.3	

Potential UCL to Use	Use 95% Student's-t UCL 107.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

UPLAND SOIL – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Upland Soil values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	30	Number of Detected Data	10
Number of Distinct Detected Data	10	Number of Non-Detect Data	20
Tolerance Factor	2.22	Percent Non-Detects	66.67%

Raw Statistics

Minimum Detected	0.419
Maximum Detected	0.854
Mean of Detected	0.553
SD of Detected	0.146
Minimum Non-Detect	0.343
Maximum Non-Detect	0.755

Log-transformed Statistics

Minimum Detected	-0.87
Maximum Detected	-0.158
Mean of Detected	-0.62
SD of Detected	0.237
Minimum Non-Detect	-1.07
Maximum Non-Detect	-0.281

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	28
Number treated as Detected with Single DL	2
Single DL Non-Detect Percentage	93.33%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.793
5% Shapiro Wilk Critical Value	0.842

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.849
5% Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.321
SD		0.191
95% UTL	95% Coverage	0.746
	95% UPL (t)	0.652
	90% Percentile (z)	0.566
	95% Percentile (z)	0.636
	99% Percentile (z)	0.766

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-1.281
SD (Log Scale)		0.524
95% UTL	95% Coverage	0.889
	95% UPL (t)	0.687
	90% Percentile (z)	0.544
	95% Percentile (z)	0.658
	99% Percentile (z)	0.94

Log ROS Method

Mean in Original Scale		0.367
SD in Original Scale		0.158
Mean in Log Scale		-1.072
SD in Log Scale		0.362
95% UTL	95% Coverage	0.765
	95% UPL (t)	0.64

90% Percentile (z)	0.545
95% Percentile (z)	0.621
99% Percentile (z)	0.795

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	13.04
Theta Star	0.0424
nu star	260.8
A-D Test Statistic	0.806
5% A-D Critical Value	0.725
K-S Test Statistic	0.29
5% K-S Critical Value	0.266

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.465
SD	0.102
SE of Mean	0.0197
95% KM UTL with 95% Coverage	0.691
95% KM Chebyshev UPL	0.917
95% KM UPL (t)	0.641
90% Percentile (z)	0.596
95% Percentile (z)	0.633
99% Percentile (z)	0.702

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.186
Median	0.000001
SD	0.276
k star	0.127
Theta star	1.46
Nu star	7.643
95% Percentile of Chisquare (2k)	1.442
90% Percentile	0.535
95% Percentile	1.052
99% Percentile	2.609

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.871
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.02
95% WH Approx. Gamma UTL with 95% Coverage	1.488
95% HW Approx. Gamma UTL with 95% Coverage	2.044

Note: DL/2 is not a recommended method.

Arsenic

General Statistics

Total Number of Observations	30
Tolerance Factor	2.22
Number of Distinct Observations	30

Raw Statistics

Minimum	2.55
Maximum	9.01
Second Largest	8.6
First Quartile	3.405
Median	5.67
Third Quartile	7.413
Mean	5.572
SD	2.154
Coefficient of Variation	0.386
Skewness	0.0198

Log-Transformed Statistics

Minimum	0.936
Maximum	2.198
Second Largest	2.152
First Quartile	1.225
Median	1.735
Third Quartile	2.003
Mean	1.637
SD	0.422

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.907

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.896

Shapiro Wilk Critical Value	0.927

Data not Normal at 5% Significance Level

Shapiro Wilk Critical Value	0.927

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	10.35
95% UPL (t)	9.292
90% Percentile (z)	8.332
95% Percentile (z)	9.115
99% Percentile (z)	10.58

Assuming Lognormal Distribution

95% UTL with 95% Coverage	13.11
95% UPL (t)	10.65
90% Percentile (z)	8.824
95% Percentile (z)	10.29
99% Percentile (z)	13.71

Gamma Distribution Test

k star	5.717
Theta Star	0.975
MLE of Mean	5.572
MLE of Standard Deviation	2.331
nu star	343

A-D Test Statistic	1.01
5% A-D Critical Value	0.746
K-S Test Statistic	0.151
5% K-S Critical Value	0.16

Data follow Appx. Gamma Distribution at 5% Significance Level

Data Distribution Test

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

90% Percentile	8.283
95% Percentile	8.591
99% Percentile	8.891

Assuming Gamma Distribution

90% Percentile	8.689
95% Percentile	9.876
99% Percentile	12.37
95% WH Approx. Gamma UPL	10.01
95% HW Approx. Gamma UPL	10.15
95% WH Approx. Gamma UTL with 95% Coverage	11.75
95% HW Approx. Gamma UTL with 95% Coverage	12.02

95% UTL with 95% Coverage	9.01
95% Percentile Bootstrap UTL with 95% Coverage	9.01
95% BCA Bootstrap UTL with 95% Coverage	9.01
95% UPL	8.785
95% Chebyshev UPL	15.11
Upper Threshold Limit Based upon IQR	13.42

Boron

General Statistics

Number of Valid Data	30
Number of Distinct Detected Data	29
Tolerance Factor	2.22

Number of Detected Data	29
Number of Non-Detect Data	1
Percent Non-Detects	3.33%

Raw Statistics

Minimum Detected	1.92
Maximum Detected	22.3
Mean of Detected	9.125
SD of Detected	6.315
Minimum Non-Detect	1.89
Maximum Non-Detect	1.89

Log-transformed Statistics

Minimum Detected	0.652
Maximum Detected	3.105
Mean of Detected	1.954
SD of Detected	0.754
Minimum Non-Detect	0.637
Maximum Non-Detect	0.637

Background Statistics

Normal Distribution Test with Detected Values Only

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.887
5% Shapiro Wilk Critical Value	0.926

Data not Normal at 5% Significance Level

Shapiro Wilk Test Statistic	0.933
5% Shapiro Wilk Critical Value	0.926

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	8.852
SD	6.383
95% UTL 95% Coverage	23.02
95% UPL (t)	19.88
90% Percentile (z)	17.03
95% Percentile (z)	19.35
99% Percentile (z)	23.7

Maximum Likelihood Estimate(MLE) Method

Mean	8.775
SD	6.406
95% UTL with 95% Coverage	23
95% UPL (t)	19.84
90% Percentile (z)	16.98
95% Percentile (z)	19.31
99% Percentile (z)	23.68

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	1.887
SD (Log Scale)	0.827
95% UTL 95% Coverage	41.39
95% UPL (t)	27.54
90% Percentile (z)	19.05
95% Percentile (z)	25.72
99% Percentile (z)	45.2

Log ROS Method

Mean in Original Scale	8.856
SD in Original Scale	6.377
95% UTL with 95% Coverage	40.66
95% BCA UTL with 95% Coverage	22.3
95% Bootstrap (%) UTL with 95% Coverage	22.3
95% UPL (t)	27.18
90% Percentile (z)	18.88
95% Percentile (z)	25.41
99% Percentile (z)	44.36

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.902
Theta Star	4.798
nu star	110.3
A-D Test Statistic	0.701
5% A-D Critical Value	0.757
K-S Test Statistic	0.145
5% K-S Critical Value	0.165

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	8.821
Median	6.84
SD	6.425
k star	0.736
Theta star	11.98
Nu star	44.17
95% Percentile of Chisquare (2k)	4.921
90% Percentile	21.88
95% Percentile	29.48
99% Percentile	47.56

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	8.885
SD	6.237
SE of Mean	1.159
95% KM UTL with 95% Coverage	22.73
95% KM Chebyshev UPL	36.52
95% KM UPL (t)	19.66
90% Percentile (z)	16.88
95% Percentile (z)	19.14
99% Percentile (z)	23.39

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	25.66
95% Hawkins Wixley (HW) Approx. Gamma UPL	29.9
95% WH Approx. Gamma UTL with 95% Coverage	34.19
95% HW Approx. Gamma UTL with 95% Coverage	42.15

Note: DL/2 is not a recommended method.

Cadmium

General Statistics

Total Number of Observations	30	Number of Distinct Observations	30
Tolerance Factor	2.22		

Raw Statistics

Minimum	0.538
Maximum	9.66
Second Largest	8.9
First Quartile	0.969
Median	1.45
Third Quartile	2.29
Mean	2.27
SD	2.309
Coefficient of Variation	1.017
Skewness	2.267

Log-Transformed Statistics

Minimum	-0.62
Maximum	2.268
Second Largest	2.186
First Quartile	-0.0314
Median	0.371
Third Quartile	0.829
Mean	0.494
SD	0.754

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.673
Shapiro Wilk Critical Value	0.927

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.926
Shapiro Wilk Critical Value	0.927

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	7.397
95% UPL (t)	6.259
90% Percentile (z)	5.229
95% Percentile (z)	6.069
99% Percentile (z)	7.642

Assuming Lognormal Distribution

95% UTL with 95% Coverage	8.735
95% UPL (t)	6.025
90% Percentile (z)	4.306
95% Percentile (z)	5.663
99% Percentile (z)	9.463

Gamma Distribution Test

k star	1.538
Theta Star	1.476
MLE of Mean	2.27
MLE of Standard Deviation	1.83
nu star	92.27
A-D Test Statistic	1.551
5% A-D Critical Value	0.761
K-S Test Statistic	0.18
5% K-S Critical Value	0.163

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

90% Percentile	5.213
95% Percentile	7.82
99% Percentile	9.44
95% UTL with 95% Coverage	9.66
95% Percentile Bootstrap UTL with 95% Coverage	9.66
95% BCA Bootstrap UTL with 95% Coverage	9.66
95% UPL	9.242
95% Chebyshev UPL	12.5
Upper Threshold Limit Based upon IQR	4.271

Assuming Gamma Distribution

90% Percentile	4.701
95% Percentile	5.864
99% Percentile	8.484
95% WH Approx. Gamma UPL	5.905
95% HW Approx. Gamma UPL	5.904
95% WH Approx. Gamma UTL with 95% Coverage	7.71
95% HW Approx. Gamma UTL with 95% Coverage	7.867

Chromium, Total_out

General Statistics

Total Number of Observations	28	Number of Distinct Observations	26
Tolerance Factor	2.246	Number of Missing Values	2

Raw Statistics		Log-Transformed Statistics	
Minimum	9.87	Minimum	2.289
Maximum	32.1	Maximum	3.469
Second Largest	24.7	Second Largest	3.207
First Quartile	14.15	First Quartile	2.65
Median	20.3	Median	3.011
Third Quartile	21.83	Third Quartile	3.083
Mean	18.4	Mean	2.87
SD	5.274	SD	0.303
Coefficient of Variation	0.287		
Skewness	0.205		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.942	Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical Value	0.924	Shapiro Wilk Critical Value	0.924
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	30.24	95% UTL with 95% Coverage	34.85
95% UPL (t)	27.54	95% UPL (t)	29.84
90% Percentile (z)	25.16	90% Percentile (z)	26.01
95% Percentile (z)	27.07	95% Percentile (z)	29.04
99% Percentile (z)	30.67	99% Percentile (z)	35.71

Gamma Distribution Test		Data Distribution Test
k star	10.7	Data appear Normal at 5% Significance Level
Theta Star	1.719	
MLE of Mean	18.4	
MLE of Standard Deviation	5.624	
nu star	599.4	
A-D Test Statistic	0.803	
5% A-D Critical Value	0.745	
K-S Test Statistic	0.193	
5% K-S Critical Value	0.165	
Data not Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
90% Percentile	23.19
95% Percentile	24.25
99% Percentile	30.1

Assuming Gamma Distribution			
90% Percentile	25.87	95% UTL with 95% Coverage	32.1
95% Percentile	28.52	95% Percentile Bootstrap UTL with 95% Coverage	32.1
99% Percentile	33.94	95% BCA Bootstrap UTL with 95% Coverage	32.1
		95% UPL	28.77
		95% Chebyshev UPL	41.79
95% WH Approx. Gamma UPL	28.79	Upper Threshold Limit Based upon IQR	33.34

95% HW Approx. Gamma UPL	29.02
95% WH Approx. Gamma UTL with 95% Coverage	32.7
95% HW Approx. Gamma UTL with 95% Coverage	33.16

Cobalt

General Statistics

Total Number of Observations	30	Number of Distinct Observations	27
Tolerance Factor	2.22		

Raw Statistics		Log-Transformed Statistics	
Minimum	3.37	Minimum	1.215
Maximum	13.3	Maximum	2.588
Second Largest	13.1	Second Largest	2.573
First Quartile	5.283	First Quartile	1.664
Median	9.165	Median	2.215
Third Quartile	11.48	Third Quartile	2.44
Mean	8.634	Mean	2.07
SD	3.308	SD	0.444
Coefficient of Variation	0.383		
Skewness	-0.24		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.902	Shapiro Wilk Test Statistic	0.873
Shapiro Wilk Critical Value	0.927	Shapiro Wilk Critical Value	0.927
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	15.98	95% UTL with 95% Coverage	21.22
95% UPL (t)	14.35	95% UPL (t)	17.05
90% Percentile (z)	12.87	90% Percentile (z)	13.99
95% Percentile (z)	14.08	95% Percentile (z)	16.44
99% Percentile (z)	16.33	99% Percentile (z)	22.24

Gamma Distribution Test		Data Distribution Test
k star	5.391	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	1.602	
MLE of Mean	8.634	
MLE of Standard Deviation	3.719	
nu star	323.4	
A-D Test Statistic	1.287	
5% A-D Critical Value	0.746	
K-S Test Statistic	0.151	
5% K-S Critical Value	0.16	
Data follow Appx. Gamma Distribution at 5% Significance Level		

Nonparametric Statistics	
90% Percentile	12.47
95% Percentile	13.1
99% Percentile	13.24

Assuming Gamma Distribution			
90% Percentile	13.61	95% UTL with 95% Coverage	13.3
95% Percentile	15.52	95% Percentile Bootstrap UTL with 95% Coverage	13.3
		95% BCA Bootstrap UTL with 95% Coverage	13.21

99% Percentile	19.54	95% UPL	13.19
		95% Chebyshev UPL	23.29
95% WH Approx. Gamma UPL	15.75	Upper Threshold Limit Based upon IQR	20.76
95% HW Approx. Gamma UPL	16.02		
95% WH Approx. Gamma UTL with 95% Coverage	18.55		
95% HW Approx. Gamma UTL with 95% Coverage	19.07		

Copper

General Statistics

Total Number of Observations	30	Number of Distinct Observations	26
Tolerance Factor	2.22		

Raw Statistics		Log-Transformed Statistics	
Minimum	8.6	Minimum	2.152
Maximum	30.6	Maximum	3.421
Second Largest	28.7	Second Largest	3.357
First Quartile	10.83	First Quartile	2.382
Median	21.2	Median	3.054
Third Quartile	23.9	Third Quartile	3.174
Mean	18.62	Mean	2.848
SD	6.886	SD	0.41
Coefficient of Variation	0.37		
Skewness	-0.0962		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Test Statistic	0.87
Shapiro Wilk Critical Value	0.927	Shapiro Wilk Critical Value	0.927
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	33.91	95% UTL with 95% Coverage	42.91
95% UPL (t)	30.51	95% UPL (t)	35.06
90% Percentile (z)	27.44	90% Percentile (z)	29.2
95% Percentile (z)	29.95	95% Percentile (z)	33.89
99% Percentile (z)	34.64	99% Percentile (z)	44.83

Gamma Distribution Test		Data Distribution Test
k star	6.097	Data do not follow a Discernable Distribution (0.05)
Theta Star	3.054	
MLE of Mean	18.62	
MLE of Standard Deviation	7.541	
nu star	365.8	
A-D Test Statistic	1.503	**Nonparametric Statistics**
5% A-D Critical Value	0.746	90% Percentile 27.23
K-S Test Statistic	0.215	95% Percentile 28.16
5% K-S Critical Value	0.16	99% Percentile 30.05
Data not Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution

90% Percentile	28.7
95% Percentile	32.5
99% Percentile	40.47
95% WH Approx. Gamma UPL	32.94
95% HW Approx. Gamma UPL	33.39
95% WH Approx. Gamma UTL with 95% Coverage	38.49
95% HW Approx. Gamma UTL with 95% Coverage	39.39
95% UTL with 95% Coverage	30.6
95% Percentile Bootstrap UTL with 95% Coverage	30.6
95% BCA Bootstrap UTL with 95% Coverage	30.6
95% UPL	29.56
95% Chebyshev UPL	49.13
Upper Threshold Limit Based upon IQR	43.51

Manganese

General Statistics

Total Number of Observations	30
Number of Distinct Observations	30
Tolerance Factor	2.22

Raw Statistics

Minimum	337
Maximum	3990
Second Largest	3460
First Quartile	445.3
Median	1540
Third Quartile	2515
Mean	1595
SD	1093
Coefficient of Variation	0.685
Skewness	0.346

Log-Transformed Statistics

Minimum	5.82
Maximum	8.292
Second Largest	8.149
First Quartile	6.099
Median	7.339
Third Quartile	7.83
Mean	7.071
SD	0.854

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.894
Shapiro Wilk Critical Value	0.927

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.855
Shapiro Wilk Critical Value	0.927

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	4021
95% UPL (t)	3483
90% Percentile (z)	2995
95% Percentile (z)	3393
99% Percentile (z)	4137

Assuming Lognormal Distribution

95% UTL with 95% Coverage	7843
95% UPL (t)	5148
90% Percentile (z)	3518
95% Percentile (z)	4799
99% Percentile (z)	8589

Gamma Distribution Test

k star	1.639
Theta Star	972.8
MLE of Mean	1595
MLE of Standard Deviation	1246
nu star	98.37
A-D Test Statistic	1.471
5% A-D Critical Value	0.76
K-S Test Statistic	0.2

Data Distribution Test

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

90% Percentile	2848
95% Percentile	3217

5% K-S Critical Value	0.162	99% Percentile	3836

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

90% Percentile	3252	95% UTL with 95% Coverage	3990
95% Percentile	4034	95% Percentile Bootstrap UTL with 95% Coverage	3990
99% Percentile	5788	95% BCA Bootstrap UTL with 95% Coverage	3752
		95% UPL	3699
		95% Chebyshev UPL	6438
95% WH Approx. Gamma UPL	4155	Upper Threshold Limit Based upon IQR	5620
95% HW Approx. Gamma UPL	4328		
95% WH Approx. Gamma UTL with 95% Coverage	5392		
95% HW Approx. Gamma UTL with 95% Coverage	5776		

Mercury_Out

General Statistics

Total Number of Observations	29	Number of Distinct Observations	26
Tolerance Factor	2.232	Number of Missing Values	1

Raw Statistics		Log-Transformed Statistics	
Minimum	0.015	Minimum	-4.2
Maximum	0.0507	Maximum	-2.982
Second Largest	0.0456	Second Largest	-3.088
First Quartile	0.0229	First Quartile	-3.777
Median	0.0249	Median	-3.693
Third Quartile	0.0303	Third Quartile	-3.497
Mean	0.0273	Mean	-3.638
SD	0.00805	SD	0.268
Coefficient of Variation	0.295		
Skewness	1.43		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.868	Shapiro Wilk Test Statistic	0.949
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	0.0453	95% UTL with 95% Coverage	0.0478
95% UPL (t)	0.0412	95% UPL (t)	0.0418
90% Percentile (z)	0.0376	90% Percentile (z)	0.0371
95% Percentile (z)	0.0405	95% Percentile (z)	0.0408
99% Percentile (z)	0.046	99% Percentile (z)	0.049

Gamma Distribution Test		Data Distribution Test
k star	12.44	Data appear Lognormal at 5% Significance Level
Theta Star	0.00219	
MLE of Mean	0.0273	
MLE of Standard Deviation	0.00774	
nu star	721.3	

A-D Test Statistic	0.905
5% A-D Critical Value	0.745
K-S Test Statistic	0.171
5% K-S Critical Value	0.162

Data not Gamma Distributed at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.0367
95% Percentile	0.0444
99% Percentile	0.0493

Assuming Gamma Distribution

90% Percentile	0.0375
95% Percentile	0.0411
99% Percentile	0.0484
95% WH Approx. Gamma UPL	0.0414
95% HW Approx. Gamma UPL	0.0415
95% WH Approx. Gamma UTL with 95% Coverage	0.0466
95% HW Approx. Gamma UTL with 95% Coverage	0.0468

95% UTL with 95% Coverage	0.0507
95% Percentile Bootstrap UTL with 95% Coverage	0.0507
95% BCA Bootstrap UTL with 95% Coverage	0.0507
95% UPL	0.0482
95% Chebyshev UPL	0.063
Upper Threshold Limit Based upon IQR	0.0414

Molybdenum

General Statistics

Number of Valid Data	30	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	28

Warning: Data set has only 2 Detected Values.

This is not enough to compute meaningful and reliable test statistics and estimates.

No statistics will be produced!

Tolerance Factor	2.22	Percent Non-Detects	93.33%

Raw Statistics

Minimum Detected	1.62
Maximum Detected	3.45
Mean of Detected	2.535
SD of Detected	1.294
Minimum Non-Detect	1.03
Maximum Non-Detect	1.15

Log-transformed Statistics

Minimum Detected	0.482
Maximum Detected	1.238
Mean of Detected	0.86
SD of Detected	0.535
Minimum Non-Detect	0.0296
Maximum Non-Detect	0.14

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	28
Number treated as Detected with Single DL	2
Single DL Non-Detect Percentage	93.33%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.692
SD		0.556
95% UTL	95% Coverage	1.926
95% UPL (t)		1.652
90% Percentile (z)		1.404
95% Percentile (z)		1.606
99% Percentile (z)		1.985

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-0.484
SD (Log Scale)		0.38
95% UTL	95% Coverage	1.431
95% UPL (t)		1.187
90% Percentile (z)		1.003
95% Percentile (z)		1.151
99% Percentile (z)		1.49

Log ROS Method

Mean in Original Scale		N/A
SD in Original Scale		N/A
Mean in Log Scale		N/A
SD in Log Scale		N/A
95% UTL	95% Coverage	N/A
95% UPL (t)		N/A
90% Percentile (z)		N/A
95% Percentile (z)		N/A
99% Percentile (z)		N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean		1.681
SD		0.328
SE of Mean		0.0848
95% KM UTL with	95% Coverage	2.41
95% KM Chebyshev UPL		3.137
95% KM UPL (t)		2.248
90% Percentile (z)		2.102
95% Percentile (z)		2.221
99% Percentile (z)		2.445

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
95% Percentile of Chisquare (2k)	N/A
90% Percentile	N/A
95% Percentile	N/A

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		N/A
95% Hawkins Wixley (HW) Approx. Gamma UPL		N/A
95% WH Approx. Gamma UTL with	95% Coverage	N/A
95% HW Approx. Gamma UTL with	95% Coverage	N/A

99% Percentile	N/A

Note: DL/2 is not a recommended method.

Nickel_Out

General Statistics

Total Number of Observations	29	Number of Distinct Observations	28
Tolerance Factor	2.232	Number of Missing Values	1

Raw Statistics		Log-Transformed Statistics	
Minimum	12.5	Minimum	2.526
Maximum	32.2	Maximum	3.472
Second Largest	28.4	Second Largest	3.346
First Quartile	14.9	First Quartile	2.701
Median	22.8	Median	3.127
Third Quartile	26.6	Third Quartile	3.281
Mean	21.66	Mean	3.035
SD	5.903	SD	0.298
Coefficient of Variation	0.273		
Skewness	-0.308		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Test Statistic	0.866
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	34.83	95% UTL with 95% Coverage	40.49
95% UPL (t)	31.87	95% UPL (t)	34.86
90% Percentile (z)	29.22	90% Percentile (z)	30.49
95% Percentile (z)	31.37	95% Percentile (z)	33.98
99% Percentile (z)	35.39	99% Percentile (z)	41.65

Gamma Distribution Test		Data Distribution Test
k star	11.25	Data do not follow a Discernable Distribution (0.05)
Theta Star	1.924	
MLE of Mean	21.66	
MLE of Standard Deviation	6.456	
nu star	652.8	
A-D Test Statistic	1.444	
5% A-D Critical Value	0.745	
K-S Test Statistic	0.163	
5% K-S Critical Value	0.162	
Data not Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
90% Percentile	27.38
95% Percentile	28.12
99% Percentile	31.14

Assuming Gamma Distribution			
90% Percentile	30.23	95% UTL with 95% Coverage	32.2
95% Percentile	33.25	95% Percentile Bootstrap UTL with 95% Coverage	32.2
99% Percentile	39.43	95% BCA Bootstrap UTL with 95% Coverage	32.2
		95% UPL	30.3

95% Chebyshev UPL	47.83
Upper Threshold Limit Based upon IQR	44.15
95% WH Approx. Gamma UPL	33.56
95% HW Approx. Gamma UPL	33.85
95% WH Approx. Gamma UTL with 95% Coverage	37.93
95% HW Approx. Gamma UTL with 95% Coverage	38.48

Selenium_OutR

General Statistics

Total Number of Observations	29	Number of Distinct Observations	29
Tolerance Factor	2.232	Number of Missing Values	1

Raw Statistics		Log-Transformed Statistics	
Minimum	0.25	Minimum	-1.386
Maximum	2	Maximum	0.693
Second Largest	1.66	Second Largest	0.507
First Quartile	0.414	First Quartile	-0.882
Median	0.643	Median	-0.442
Third Quartile	0.863	Third Quartile	-0.147
Mean	0.712	Mean	-0.465
SD	0.397	SD	0.499
Coefficient of Variation	0.557		
Skewness	1.695		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.845	Shapiro Wilk Test Statistic	0.973
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	1.598	95% UTL with 95% Coverage	1.915
95% UPL (t)	1.399	95% UPL (t)	1.491
90% Percentile (z)	1.221	90% Percentile (z)	1.192
95% Percentile (z)	1.365	95% Percentile (z)	1.429
99% Percentile (z)	1.636	99% Percentile (z)	2.008

Gamma Distribution Test		Data Distribution Test
k star	3.733	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.191	
MLE of Mean	0.712	
MLE of Standard Deviation	0.369	
nu star	216.5	
A-D Test Statistic	0.442	Nonparametric Statistics
5% A-D Critical Value	0.75	90% Percentile 1.068
K-S Test Statistic	0.106	95% Percentile 1.5
5% K-S Critical Value	0.163	99% Percentile 1.905
Data appear Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution		
		95% UTL with 95% Coverage 2

90% Percentile	1.207	95% Percentile Bootstrap UTL with 95% Coverage	2
95% Percentile	1.407	95% BCA Bootstrap UTL with 95% Coverage	2
99% Percentile	1.835	95% UPL	1.83
		95% Chebyshev UPL	2.472
95% WH Approx. Gamma UPL	1.427	Upper Threshold Limit Based upon IQR	1.537
95% HW Approx. Gamma UPL	1.438		
95% WH Approx. Gamma UTL with 95% Coverage	1.73		
95% HW Approx. Gamma UTL with 95% Coverage	1.764		

Silver_Out

General Statistics

Number of Valid Data	29	Number of Detected Data	21
Number of Distinct Detected Data	21	Number of Non-Detect Data	8
Tolerance Factor	2.232	Percent Non-Detects	27.59%
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0703	Minimum Detected	-2.655
Maximum Detected	0.251	Maximum Detected	-1.382
Mean of Detected	0.118	Mean of Detected	-2.187
SD of Detected	0.0437	SD of Detected	0.314
Minimum Non-Detect	0.242	Minimum Non-Detect	-1.419
Maximum Non-Detect	0.25	Maximum Non-Detect	-1.386

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	28
Number treated as Detected with Single DL	1
Single DL Non-Detect Percentage	96.55%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.813
5% Shapiro Wilk Critical Value	0.908

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.926
5% Shapiro Wilk Critical Value	0.908

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.12
SD		0.037
95% UTL	95% Coverage	0.202
95% UPL (t)		0.184
90% Percentile (z)		0.167
95% Percentile (z)		0.181
99% Percentile (z)		0.206

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-2.16
SD (Log Scale)		0.269
95% UTL	95% Coverage	0.21
95% UPL (t)		0.184
90% Percentile (z)		0.163
95% Percentile (z)		0.18
99% Percentile (z)		0.216

Log ROS Method

Mean in Original Scale	0.116
SD in Original Scale	0.0378
Mean in Log Scale	-2.195
SD in Log Scale	0.274

95% UTL 95% Coverage	0.205
95% UPL (t)	0.179
90% Percentile (z)	0.158
95% Percentile (z)	0.175
99% Percentile (z)	0.211

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	8.435
Theta Star	0.014
nu star	354.3
A-D Test Statistic	0.77
5% A-D Critical Value	0.743
K-S Test Statistic	0.165
5% K-S Critical Value	0.189

Data follow Appx. Gamma Distribution at 5% Significance Level

Data Distribution Test with Detected Values Only

Data follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.116
SD	0.0399
SE of Mean	0.00845
95% KM UTL with 95% Coverage	0.205
95% KM Chebyshev UPL	0.293
95% KM UPL (t)	0.185
90% Percentile (z)	0.168
95% Percentile (z)	0.182
99% Percentile (z)	0.209

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.119
Median	0.11
SD	0.0378
k star	11.43
Theta star	0.0104
Nu star	662.7
95% Percentile of Chisquare (2k)	34.99
90% Percentile	0.166
95% Percentile	0.182
99% Percentile	0.216

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.184
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.184
95% WH Approx. Gamma UTL with 95% Coverage	0.207
95% HW Approx. Gamma UTL with 95% Coverage	0.208

Note: DL/2 is not a recommended method.

Thallium_Out

General Statistics

Total Number of Observations	29
Tolerance Factor	2.232
Number of Distinct Observations	23
Number of Missing Values	1

Raw Statistics

Minimum	0.118
Maximum	0.293
Second Largest	0.292
First Quartile	0.15
Median	0.158
Third Quartile	0.176
Mean	0.171
SD	0.0428
Coefficient of Variation	0.25
Skewness	1.873

Log-Transformed Statistics

Minimum	-2.137
Maximum	-1.228
Second Largest	-1.231
First Quartile	-1.897
Median	-1.845
Third Quartile	-1.737
Mean	-1.789
SD	0.216

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.777
Shapiro Wilk Critical Value	0.926

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.869
Shapiro Wilk Critical Value	0.926

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	0.267
95% UPL (t)	0.245
90% Percentile (z)	0.226
95% Percentile (z)	0.242
99% Percentile (z)	0.271

Assuming Lognormal Distribution

95% UTL with 95% Coverage	0.271
95% UPL (t)	0.243
90% Percentile (z)	0.221
95% Percentile (z)	0.239
99% Percentile (z)	0.276

Gamma Distribution Test

k star	18.31
Theta Star	0.00936
MLE of Mean	0.171
MLE of Standard Deviation	0.04
nu star	1062
A-D Test Statistic	1.699
5% A-D Critical Value	0.744
K-S Test Statistic	0.193
5% K-S Critical Value	0.162

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

90% Percentile	0.218
95% Percentile	0.278
99% Percentile	0.293
95% UTL with 95% Coverage	0.293
95% Percentile Bootstrap UTL with 95% Coverage	0.293
95% BCA Bootstrap UTL with 95% Coverage	0.293
95% UPL	0.293
95% Chebyshev UPL	0.361
Upper Threshold Limit Based upon IQR	0.215

Assuming Gamma Distribution

90% Percentile	0.224
95% Percentile	0.242
99% Percentile	0.278
95% WH Approx. Gamma UPL	0.243
95% HW Approx. Gamma UPL	0.243
95% WH Approx. Gamma UTL with 95% Coverage	0.269
95% HW Approx. Gamma UTL with 95% Coverage	0.269

Uranium, Total_Out

General Statistics

Number of Valid Data	26
Number of Detected Data	22
Number of Distinct Detected Data	22
Number of Non-Detect Data	4
Tolerance Factor	2.275
Percent Non-Detects	15.38%
Number of Missing Values	4

Raw Statistics

Minimum Detected	0.395
Maximum Detected	1.61
Mean of Detected	0.811
SD of Detected	0.32
Minimum Non-Detect	0.484
Maximum Non-Detect	0.5

Log-transformed Statistics

Minimum Detected	-0.929
Maximum Detected	0.476
Mean of Detected	-0.275
SD of Detected	0.362
Minimum Non-Detect	-0.726
Maximum Non-Detect	-0.693

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	6
Number treated as Detected with Single DL	20
Single DL Non-Detect Percentage	23.08%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.866
5% Shapiro Wilk Critical Value	0.911

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.962
5% Shapiro Wilk Critical Value	0.911

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.724
SD		0.359
95% UTL	95% Coverage	1.542
95% UPL (t)		1.35
90% Percentile (z)		1.185
95% Percentile (z)		1.315
99% Percentile (z)		1.56

Maximum Likelihood Estimate(MLE) Method

Mean		0.718
SD		0.37
95% UTL with	95% Coverage	1.558
95% UPL (t)		1.361
90% Percentile (z)		1.191
95% Percentile (z)		1.326
99% Percentile (z)		1.577

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-0.448
SD (Log Scale)		0.531
95% UTL	95% Coverage	2.138
95% UPL (t)		1.61
90% Percentile (z)		1.262
95% Percentile (z)		1.53
99% Percentile (z)		2.197

Log ROS Method

Mean in Original Scale		0.748
SD in Original Scale		0.33
95% UTL with	95% Coverage	1.736
95% BCA UTL with	95% Coverage	1.61
95% Bootstrap (%) UTL with	95% Coverage	1.61
95% UPL (t)		1.397
90% Percentile (z)		1.16
95% Percentile (z)		1.344
99% Percentile (z)		1.773

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	6.788
Theta Star	0.119
nu star	298.7
A-D Test Statistic	0.464
5% A-D Critical Value	0.745
K-S Test Statistic	0.168
5% K-S Critical Value	0.186

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.722
Median	0.689
SD	0.362
k star	3.573
Theta star	0.202
Nu star	185.8
95% Percentile of Chisquare (2k)	14.28

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean		0.749
SD		0.323
SE of Mean		0.0648
95% KM UTL with	95% Coverage	1.483
95% KM Chebyshev UPL		2.182
95% KM UPL (t)		1.311
90% Percentile (z)		1.162
95% Percentile (z)		1.28
99% Percentile (z)		1.5

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		1.472
95% Hawkins Wixley (HW) Approx. Gamma UPL		1.502
95% WH Approx. Gamma UTL with	95% Coverage	1.81

90% Percentile	1.235	95% HW Approx. Gamma UTL with 95% Coverage	1.878
95% Percentile	1.444		
99% Percentile	1.892		

Note: DL/2 is not a recommended method.

Vanadium_Out

General Statistics

Total Number of Observations	29	Number of Distinct Observations	29
Tolerance Factor	2.232	Number of Missing Values	1

Raw Statistics		Log-Transformed Statistics	
Minimum	10.7	Minimum	2.37
Maximum	36.8	Maximum	3.605
Second Largest	31.2	Second Largest	3.44
First Quartile	16.3	First Quartile	2.791
Median	22.4	Median	3.109
Third Quartile	26.2	Third Quartile	3.266
Mean	21.74	Mean	3.04
SD	6.082	SD	0.293
Coefficient of Variation	0.28		
Skewness	0.257		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.973	Shapiro Wilk Test Statistic	0.967
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	35.32	95% UTL with 95% Coverage	40.16
95% UPL (t)	32.27	95% UPL (t)	34.68
90% Percentile (z)	29.54	90% Percentile (z)	30.41
95% Percentile (z)	31.75	95% Percentile (z)	33.82
99% Percentile (z)	35.89	99% Percentile (z)	41.29

Gamma Distribution Test		Data Distribution Test
k star	11.43	Data appear Normal at 5% Significance Level
Theta Star	1.902	
MLE of Mean	21.74	
MLE of Standard Deviation	6.431	
nu star	663.2	
A-D Test Statistic	0.412	Nonparametric Statistics
5% A-D Critical Value	0.745	90% Percentile 27.64
K-S Test Statistic	0.146	95% Percentile 30.64
5% K-S Critical Value	0.162	99% Percentile 35.23
Data appear Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution			
90% Percentile	30.29	95% UTL with 95% Coverage	36.8
		95% Percentile Bootstrap UTL with 95% Coverage	36.8

95% Percentile	33.29
99% Percentile	39.42
95% WH Approx. Gamma UPL	33.58
95% HW Approx. Gamma UPL	33.82
95% WH Approx. Gamma UTL with 95% Coverage	37.91
95% HW Approx. Gamma UTL with 95% Coverage	38.39
95% BCA Bootstrap UTL with 95% Coverage	34.56
95% UPL	34
95% Chebyshev UPL	48.71
Upper Threshold Limit Based upon IQR	41.05

Zinc_Out

General Statistics

Total Number of Observations	29	Number of Distinct Observations	26
Tolerance Factor	2.232	Number of Missing Values	1

Raw Statistics		Log-Transformed Statistics	
Minimum	57.7	Minimum	4.055
Maximum	148	Maximum	4.997
Second Largest	141	Second Largest	4.949
First Quartile	78.3	First Quartile	4.361
Median	97	Median	4.575
Third Quartile	115	Third Quartile	4.745
Mean	98.51	Mean	4.553
SD	27.08	SD	0.279
Coefficient of Variation	0.275		
Skewness	0.313		

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	159	95% UTL with 95% Coverage	176.8
95% UPL (t)	145.4	95% UPL (t)	153.7
90% Percentile (z)	133.2	90% Percentile (z)	135.7
95% Percentile (z)	143.1	95% Percentile (z)	150.1
99% Percentile (z)	161.5	99% Percentile (z)	181.5

Gamma Distribution Test		Data Distribution Test
k star	12.27	Data appear Normal at 5% Significance Level
Theta Star	8.026	
MLE of Mean	98.51	
MLE of Standard Deviation	28.12	
nu star	711.9	
A-D Test Statistic	0.393	**Nonparametric Statistics**
5% A-D Critical Value	0.745	90% Percentile 139
K-S Test Statistic	0.119	95% Percentile 140.2
5% K-S Critical Value	0.162	99% Percentile 146
Data appear Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution

90% Percentile	135.8
95% Percentile	148.9
99% Percentile	175.4
95% WH Approx. Gamma UPL	150.1
95% HW Approx. Gamma UPL	150.9
95% WH Approx. Gamma UTL with 95% Coverage	168.9
95% HW Approx. Gamma UTL with 95% Coverage	170.6
95% UTL with 95% Coverage	148
95% Percentile Bootstrap UTL with 95% Coverage	148
95% BCA Bootstrap UTL with 95% Coverage	145.2
95% UPL	144.5
95% Chebyshev UPL	218.6
Upper Threshold Limit Based upon IQR	170.1

UPLAND SOIL – USL OUTPUTS

Robust Simultaneous Intervals/Limits (SLs)

Date/Time of Computation	6/20/2012 6:20:06 PM
User Selected Options	
From File	C:\Documents and Settings\Valerie C Chen\My Documents\Val's documents from C\Monsanto\Background TM\I
Full Precision	OFF
Confidence Coefficient	0.9
PROP Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	PROP SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Huber Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	Huber SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Tukey Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Tukey Biweight SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
Lax/Kafadar Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Lax/Kafadar SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
MVT Method	Triming Percentage of 10.08%
	MVT SLs derived using 10 Iterations and initial estimates of median/1.48MAD.

D2Max represents unsquared critical value of Max-MD (Mahalanobis Distances) computed based upon Wsum Values

Arsenic

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	30	5.572	5.67	2.154	3.113	2.745	-0.34	11.48

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	5.67	3.113	5.572	2.154	30	2.745	-0.34	11.48
Huber	5.67	3.113	5.572	2.154	30	2.745	-0.34	11.48
Tukey Biweight	5.67	3.113	5.57	2.24	28.3	2.719	-0.521	11.66
Lax Kafadar Biweight	5.67	3.113	5.568	2.327	27.02	2.698	-0.71	11.85
MVT	5.67	3.113	5.666	2.007	27	2.698	0.251	11.08

Cadmium

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	30	2.27	1.45	2.309	0.876	2.745	-4.07	8.61

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	1.45	0.876	1.379	0.596	24.85	2.66	-0.208	2.965
Huber	1.45	0.876	1.955	1.507	28.61	2.724	-2.15	6.061
Tukey Biweight	1.45	0.876	1.397	0.839	23.98	2.644	-0.822	3.616
Lax Kafadar Biweight	1.45	0.876	1.376	0.768	23.43	2.633	-0.646	3.399
MVT	1.45	0.876	1.594	0.997	27	2.698	-1.097	4.285

Chromium, Total_out

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	28	18.4	20.3	5.274	4.596	2.714	4.083	32.71

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	20.3	4.596	18.05	4.7	27.31	2.703	5.35	30.76
Huber	20.3	4.596	18.3	5.052	27.79	2.711	4.6	31.99

Tukey Biweight	20.3	4.596	18.32	5.417	24.07	2.645	3.993	32.65
Lax Kafadar Biweight	20.3	4.596	18.33	6.012	25.58	2.673	2.255	34.4
MVT	20.3	4.596	18.2	4.425	26	2.681	6.338	30.06

Cobalt

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	30	8.634	9.165	3.308	4.129	2.745	-0.447	17.72

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	9.165	4.129	8.634	3.308	30	2.745	-0.447	17.72
Huber	9.165	4.129	8.634	3.308	30	2.745	-0.447	17.72
Tukey Biweight	9.165	4.129	8.704	3.479	27.75	2.71	-0.725	18.13
Lax Kafadar Biweight	9.165	4.129	8.727	3.67	27.17	2.701	-1.186	18.64
MVT	9.165	4.129	9.181	3.014	27	2.698	1.048	17.31

Copper

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	30	18.62	21.2	6.886	7.784	2.745	-0.283	37.52

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	21.2	7.784	18.62	6.886	30	2.745	-0.283	37.52
Huber	21.2	7.784	18.62	6.886	30	2.745	-0.283	37.52
Tukey Biweight	21.2	7.784	18.7	7.328	27.27	2.703	-1.104	38.5
Lax Kafadar Biweight	21.2	7.784	18.69	8.206	27.54	2.707	-3.523	40.9
MVT	21.2	7.784	18.17	6.276	27	2.698	1.24	35.11

Manganese

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	30	1595	1540	1093	1612	2.745	-1406	4595

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	1540	1612	1588	1082	29.92	2.744	-1380	4557
Huber	1540	1612	1594	1091	29.98	2.745	-1400	4588
Tukey Biweight	1540	1612	1574	1124	28.38	2.72	-1483	4630
Lax Kafadar Biweight	1540	1612	1549	1148	26.89	2.696	-1546	4645
MVT	1540	1612	1388	930.6	27	2.698	-1123	3899

Mercury_Out

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	29	0.0273	0.0249	0.00805	0.00356	2.73	0.0053	0.0493

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.0249	0.00356	0.0253	0.00483	26.23	2.685	0.0123	0.0382
Huber	0.0249	0.00356	0.0269	0.00709	28.44	2.721	0.00756	0.0461
Tukey Biweight	0.0249	0.00356	0.0245	0.00528	21.25	2.586	0.0109	0.0382

Lax Kafadar Biweight	0.0249	0.00356	0.0249	0.00507	23.49	2.634	0.0116	0.0383
MVT	0.0249	0.00356	0.0257	0.00577	27	2.698	0.0102	0.0413

Nickel_Out

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	29	21.66	22.8	5.903	6.523	2.73	5.542	37.78

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	22.8	6.523	21.66	5.903	29	2.73	5.542	37.78
Huber	22.8	6.523	21.66	5.903	29	2.73	5.542	37.78
Tukey Biweight	22.8	6.523	21.88	6.253	26.26	2.685	5.086	38.67
Lax Kafadar Biweight	22.8	6.523	21.87	6.631	26.34	2.687	4.053	39.68
MVT	22.8	6.523	21.61	5.48	27	2.698	6.823	36.39

Selenium_OutR

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	29	0.712	0.643	0.397	0.34	2.73	-0.371	1.796

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.643	0.34	0.618	0.23	26.46	2.689	-0.000644	1.236
Huber	0.643	0.34	0.68	0.316	28.21	2.718	-0.178	1.538
Tukey Biweight	0.643	0.34	0.629	0.32	25.45	2.671	-0.226	1.485
Lax Kafadar Biweight	0.643	0.34	0.618	0.286	24.63	2.656	-0.141	1.378
MVT	0.643	0.34	0.63	0.253	27	2.698	-0.0537	1.313

Thallium_Out

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	29	0.171	0.158	0.0428	0.0208	2.73	0.0546	0.288

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.158	0.0208	0.158	0.0187	25.47	2.671	0.108	0.208
Huber	0.158	0.0208	0.167	0.0316	27.85	2.712	0.081	0.252
Tukey Biweight	0.158	0.0208	0.157	0.0225	23.22	2.628	0.0982	0.217
Lax Kafadar Biweight	0.158	0.0208	0.157	0.0212	23.32	2.631	0.102	0.213
MVT	0.158	0.0208	0.162	0.0275	27	2.698	0.0882	0.237

Vanadium_Out

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	29	21.74	22.4	6.082	6.227	2.73	5.14	38.35

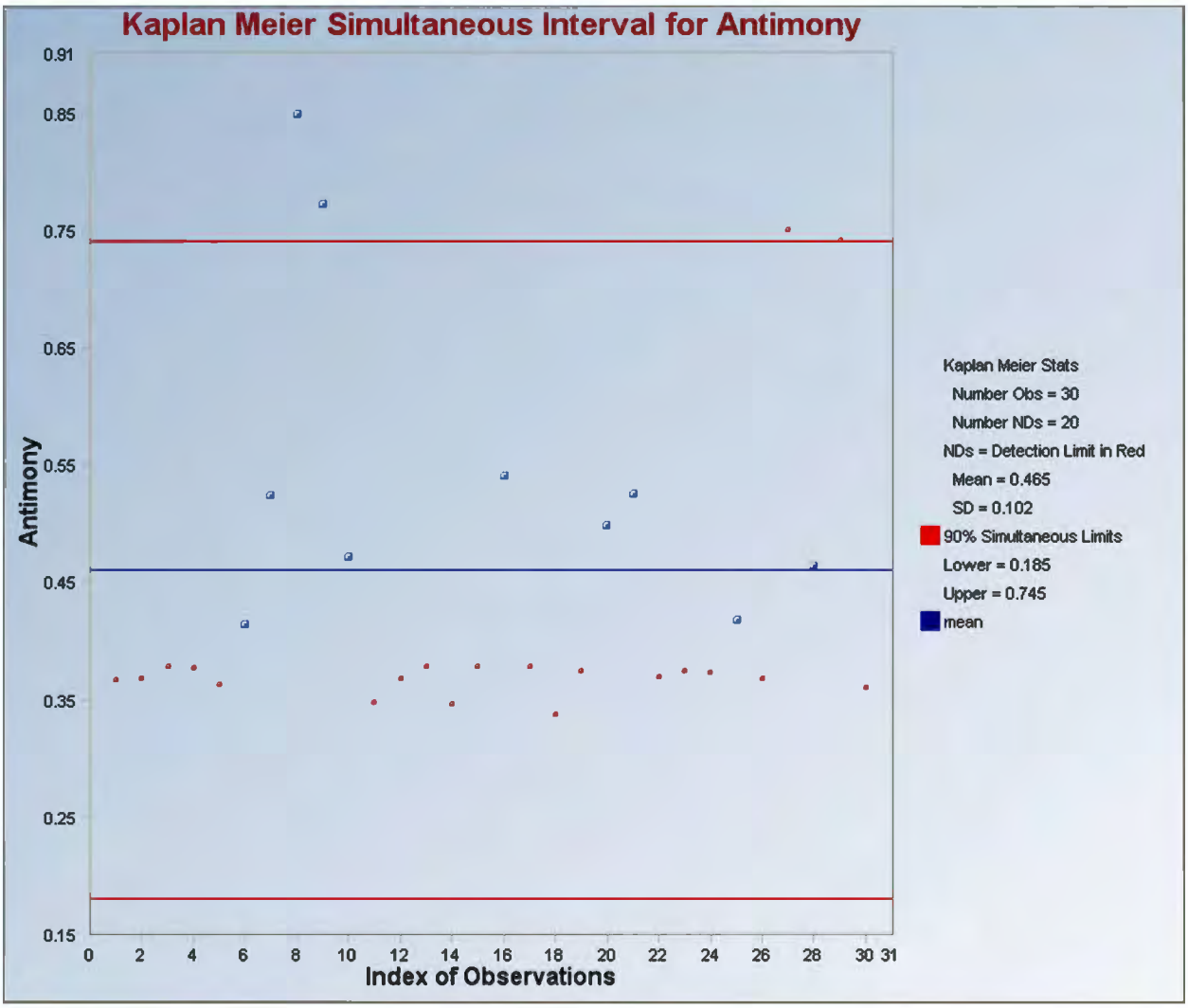
Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	22.4	6.227	21.45	5.582	28.44	2.721	6.255	36.64
Huber	22.4	6.227	21.66	5.917	28.84	2.728	5.524	37.8
Tukey Biweight	22.4	6.227	21.58	6.219	25.92	2.68	4.919	38.24
Lax Kafadar Biweight	22.4	6.227	21.59	6.501	26.16	2.684	4.148	39.04

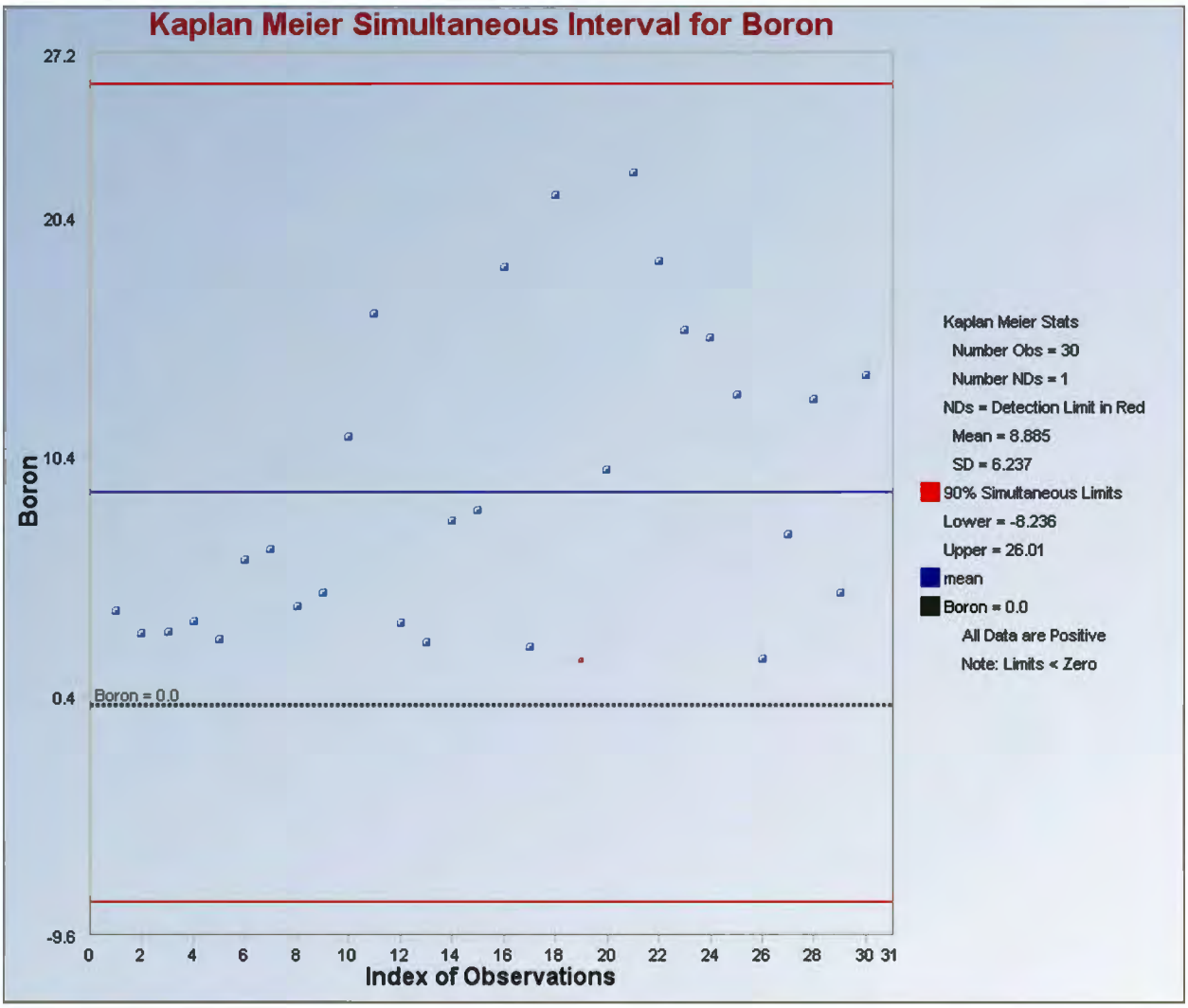
MVT	22.4	6.227	21.6	5.139	27	2.698	7.732	35.46

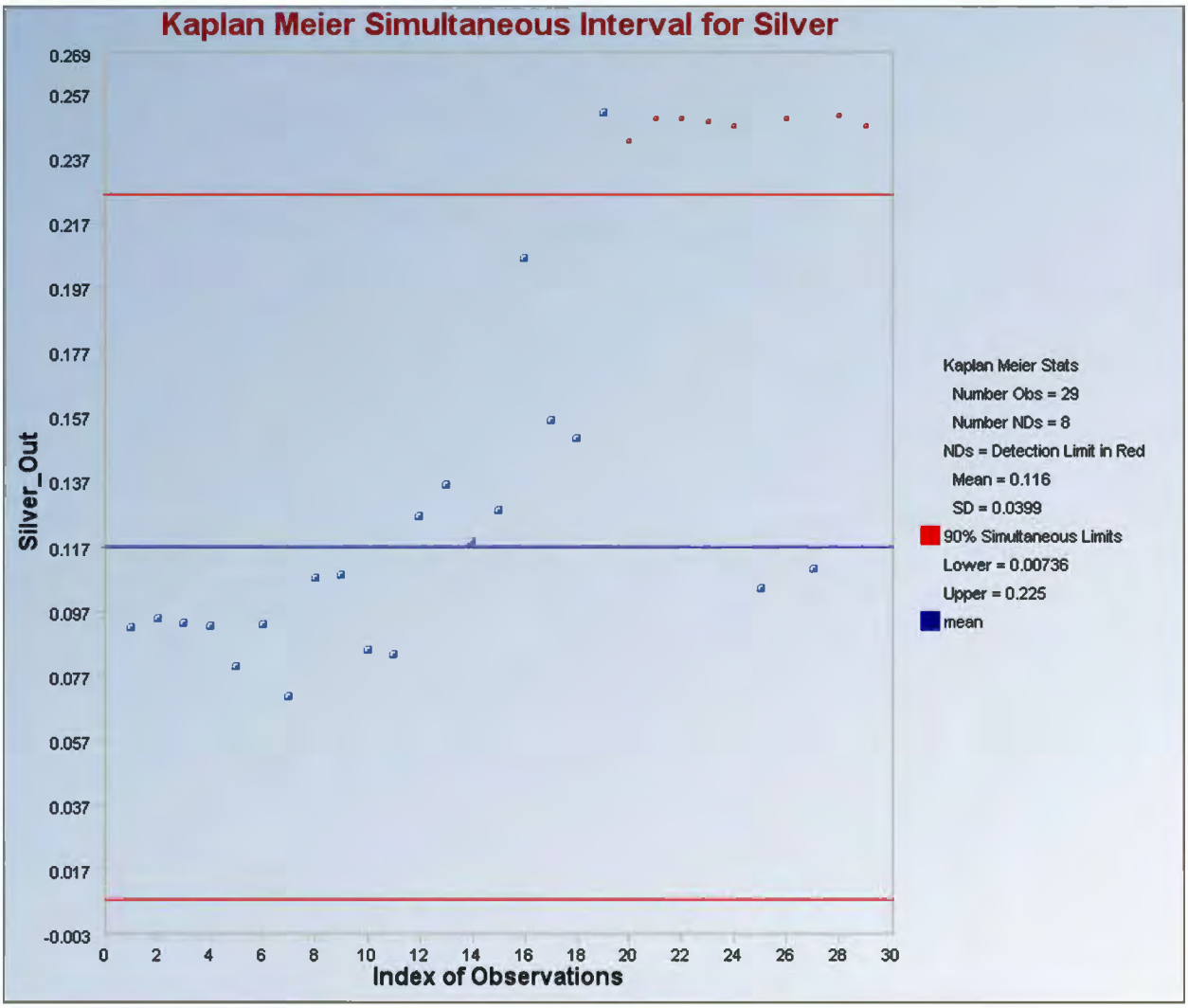
Zinc_Out

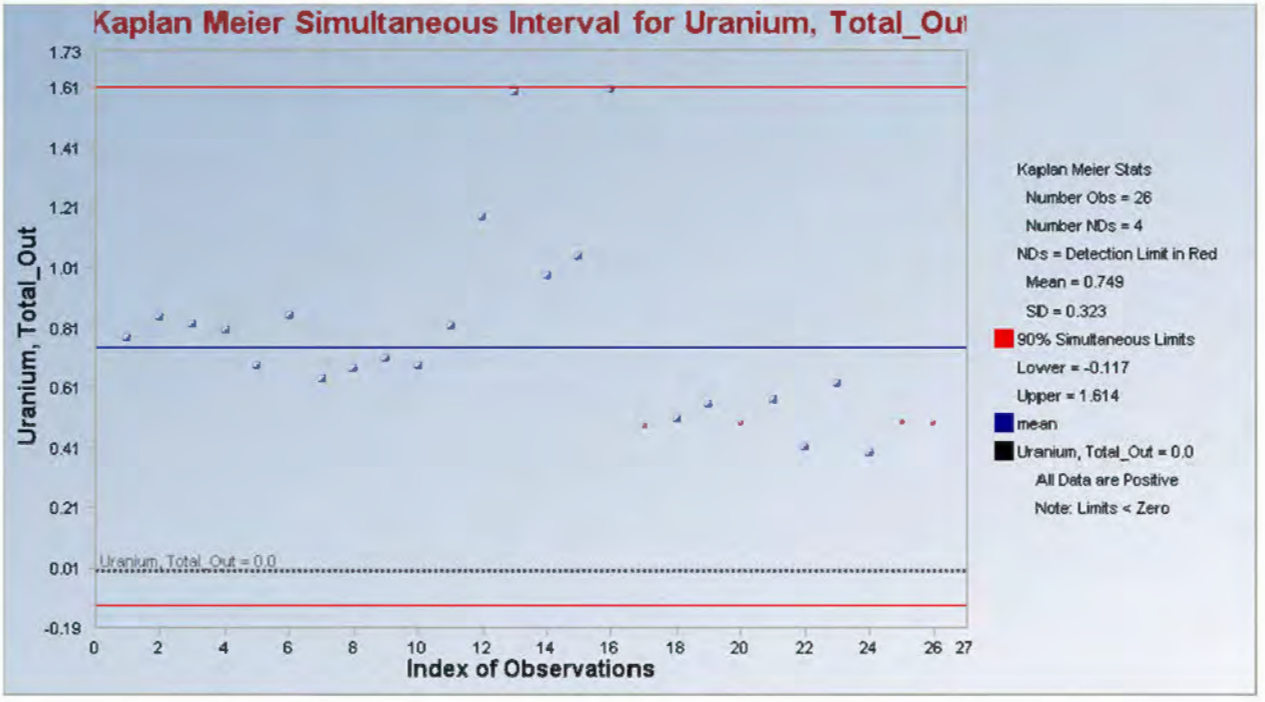
	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	29	98.51	97	27.08	27.72	2.73	24.57	172.5

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	97	27.72	98.51	27.08	29	2.73	24.57	172.5
Huber	97	27.72	98.51	27.08	29	2.73	24.57	172.5
Tukey Biweight	97	27.72	97.33	28.71	25.84	2.678	20.43	174.2
Lax Kafadar Biweight	97	27.72	97.6	30.75	26.41	2.688	14.95	180.2
MVT	97	27.72	95.1	24.79	27	2.698	28.23	162


Kaplan Meier Simultaneous Interval for Antimony
Antimony
0.91
0.85
0.75
0.65
0.55
0.45
0.35
0.25
0.15
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 31
Index of Observations
Kaplan Meier Stats
Number Obs = 30
Number NDs = 20
NDs = Detection Limit in Red
Mean = 0.465
SD = 0.102
90% Simultaneous Limits
Lower = 0.185
Upper = 0.745
mean


Kaplan Meier Simultaneous Interval for Boron
27.2
20.4
10.4
0.4
-9.6
Boron
Boron = 0.0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
31
Index of Observations
Kaplan Meier Stats
Number Obs = 30
Number NDs = 1
NDs = Detection Limit in Red
Mean = 8.885
SD = 6.237
90% Simultaneous Limits
Lower = -8.236
Upper = 26.01
mean
Boron = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Silver
Silver_Out
0.269
0.257
0.237
0.217
0.197
0.177
0.157
0.137
0.117
0.097
0.077
0.057
0.037
0.017
-0.003
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Index of Observations
Kaplan Meier Stats
Number Obs = 29
Number NDs = 8
NDs = Detection Limit in Red
Mean = 0.116
SD = 0.0399
90% Simultaneous Limits
Lower = 0.00736
Upper = 0.225
mean


Kaplan Meier Simultaneous Interval for Uranium, Total_Out
Uranium, Total_Out
Index of Observations
1.73
1.61
1.41
1.21
1.01
0.81
0.61
0.41
0.21
0.01
-0.19
0
2
4
6
8
10
12
14
16
18
20
22
24
26
27
Uranium, Total_Out = 0.0
Kaplan Meier Stats
Number Obs = 26
Number NDs = 4
NDs = Detection Limit in Red
Mean = 0.749
SD = 0.323
90% Simultaneous Limits
Lower = -0.117
Upper = 1.614
mean
Uranium, Total_Out = 0.0
All Data are Positive
Note: Limits < Zero

CULTURALLY SIGNIFICANT UPLAND VEGETATION – OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Veg Values_CS.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Rosner's Outlier Test for Boron

Mean	**26.2**
Standard Deviation	**41.15**
Number of data	**75**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	26.2	40.87	364	22	8.265	3.285	3.645

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 364 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 364 is a Potential Statistical Outlier

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Veg Values_CS.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Molybdenum_1

Number of data = 9
10% critical value: 0.441
5% critical value: 0.512
1% critical value: 0.635

1. Data Value 10.4 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.877

For 10% significance level, 10.4 is an outlier.
For 5% significance level, 10.4 is an outlier.
For 1% significance level, 10.4 is an outlier.

2. Data Value 1.54 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.077

For 10% significance level, 1.54 is not an outlier.
For 5% significance level, 1.54 is not an outlier.
For 1% significance level, 1.54 is not an outlier.

Dixon's Outlier Test for Silver_1

Number of data = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Data Value 10.5 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.980

For 10% significance level, 10.5 is an outlier.
For 5% significance level, 10.5 is an outlier.
For 1% significance level, 10.5 is an outlier.

2. Data Value 0.0925 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.001

For 10% significance level, 0.0925 is not an outlier.
For 5% significance level, 0.0925 is not an outlier.

For 1% significance level, 0.0925 is not an outlier.

CULTURALLY SIGNIFICANT UPLAND VEGETATION – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Upland Veg Values_CS.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Boron_1

General Statistics

Number of Valid Data	75	Number of Detected Data	74
Number of Distinct Detected Data	67	Number of Non-Detect Data	1
Number of Missing Values	1	Percent Non-Detects	1.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	6.32	Minimum Detected	1.844
Maximum Detected	52	Maximum Detected	3.951
Mean of Detected	21.63	Mean of Detected	2.933
SD of Detected	11.49	SD of Detected	0.545
Minimum Non-Detect	43.1	Minimum Non-Detect	3.764
Maximum Non-Detect	43.1	Maximum Non-Detect	3.764

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.113	Lilliefors Test Statistic	0.0682
5% Lilliefors Critical Value	0.103	5% Lilliefors Critical Value	0.103
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	21.63	Mean	2.934
SD	11.41	SD	0.542
95% DL/2 (t) UCL	23.83	95% H-Stat (DL/2) UCL	24.52
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	48.39	Mean in Log Scale	2.932
SD	3.416	SD in Log Scale	0.541
95% MLE (t) UCL	49.05	Mean in Original Scale	21.59
95% MLE (Tiku) UCL	51.16	SD in Original Scale	11.42
		95% t UCL	23.78
		95% Percentile Bootstrap UCL	23.84
		95% BCA Bootstrap UCL	24.01
		95% H UCL	24.46

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	3.547	Data appear Gamma Distributed at 5% Significance Level
Theta Star	6.1	
nu star	524.9	
A-D Test Statistic	0.635	Nonparametric Statistics
5% A-D Critical Value	0.757	Kaplan-Meier (KM) Method

K-S Test Statistic	0.757	Mean	21.62
5% K-S Critical Value	0.104	SD	11.4
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	1.332
		95% KM (t) UCL	23.83
Assuming Gamma Distribution		95% KM (z) UCL	23.81
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	23.83
Minimum	6.32	95% KM (bootstrap t) UCL	23.93
Maximum	52	95% KM (BCA) UCL	23.87
Mean	21.65	95% KM (Percentile Bootstrap) UCL	23.75
Median	20	95% KM (Chebyshev) UCL	27.42
SD	11.41	97.5% KM (Chebyshev) UCL	29.93
k star	3.594	99% KM (Chebyshev) UCL	34.87
Theta star	6.025		
Nu star	539.1	Potential UCLs to Use	
AppChi2	486.2	95% KM (BCA) UCL	23.87
95% Gamma Approximate UCL	24.01		
95% Adjusted Gamma UCL	24.05		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cadmium

General Statistics

Number of Valid Data	76	Number of Detected Data	69
Number of Distinct Detected Data	66	Number of Non-Detect Data	7
		Percent Non-Detects	9.21%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0262	Minimum Detected	-3.642
Maximum Detected	1.95	Maximum Detected	0.668
Mean of Detected	0.401	Mean of Detected	-1.624
SD of Detected	0.527	SD of Detected	1.179
Minimum Non-Detect	0.0225	Minimum Non-Detect	-3.794
Maximum Non-Detect	0.0248	Maximum Non-Detect	-3.697

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	7
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	69
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	9.21%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.304	Lilliefors Test Statistic	0.0914
5% Lilliefors Critical Value	0.107	5% Lilliefors Critical Value	0.107
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.365	Mean	-1.882
SD	0.515	SD	1.387

95% DL/2 (t) UCL	0.464	95% H-Stat (DL/2) UCL	0.611

Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.335	Mean in Log Scale	-1.866
SD	0.547	SD in Log Scale	1.358
95% MLE (t) UCL	0.44	Mean in Original Scale	0.366
95% MLE (Tiku) UCL	0.434	SD in Original Scale	0.515
		95% t UCL	0.464
		95% Percentile Bootstrap UCL	0.47
		95% BCA Bootstrap UCL	0.475
		95% H UCL	0.589

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.804	Data appear Lognormal at 5% Significance Level	
Theta Star	0.499		
nu star	111		
A-D Test Statistic	3.158	**Nonparametric Statistics**	
5% A-D Critical Value	0.789	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.789	Mean	0.367
5% K-S Critical Value	0.111	SD	0.511
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.059
		95% KM (t) UCL	0.465
Assuming Gamma Distribution		95% KM (z) UCL	0.464
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.465
Minimum	0.000001	95% KM (bootstrap t) UCL	0.484
Maximum	1.95	95% KM (BCA) UCL	0.465
Mean	0.364	95% KM (Percentile Bootstrap) UCL	0.464
Median	0.145	95% KM (Chebyshev) UCL	0.624
SD	0.516	97.5% KM (Chebyshev) UCL	0.735
k star	0.375	99% KM (Chebyshev) UCL	0.954
Theta star	0.971		
Nu star	57.05	Potential UCLs to Use	
AppChi2	40.69	95% KM (Chebyshev) UCL	0.624
95% Gamma Approximate UCL	0.511		
95% Adjusted Gamma UCL	0.514		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Mercury

General Statistics

Number of Valid Data	70	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	58
Number of Missing Values	6	Percent Non-Detects	82.86%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00946	Minimum Detected	-4.661
Maximum Detected	0.0876	Maximum Detected	-2.435

Mean of Detected	0.0373	Mean of Detected	-3.527
SD of Detected	0.0264	SD of Detected	0.735
Minimum Non-Detect	0.00867	Minimum Non-Detect	-4.748
Maximum Non-Detect	0.0487	Maximum Non-Detect	-3.022

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	67
Number treated as Detected	3
Single DL Non-Detect Percentage	95.71%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.878
5% Shapiro Wilk Critical Value	0.859

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.953
5% Shapiro Wilk Critical Value	0.859

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0128
SD	0.016
95% DL/2 (t) UCL	0.016
Maximum Likelihood Estimate(MLE) Method	N/A

MLE yields a negative mean

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-4.743
SD	0.764
95% H-Stat (DL/2) UCL	0.0141
Log ROS Method	
Mean in Log Scale	-5.649
SD in Log Scale	1.097
Mean in Original Scale	0.00847
SD in Original Scale	0.0169
95% t UCL	0.0118
95% Percentile Bootstrap UCL	0.0117
95% BCA Bootstrap UCL	0.0128
95% H-UCL	0.00863

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.743
Theta Star	0.0214
nu star	41.82
A-D Test Statistic	0.332
5% A-D Critical Value	0.741
K-S Test Statistic	0.741
5% K-S Critical Value	0.248

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.0876
Mean	0.0064
Median	0.000001
SD	0.0177
k star	0.119
Theta star	0.0539
Nu star	16.62
AppChi2	8.4

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0144
SD	0.0148
SE of Mean	0.00186
95% KM (t) UCL	0.0175
95% KM (z) UCL	0.0175
95% KM (jackknife) UCL	0.0169
95% KM (bootstrap t) UCL	0.0188
95% KM (BCA) UCL	0.0245
95% KM (Percentile Bootstrap) UCL	0.0226
95% KM (Chebyshev) UCL	0.0225
97.5% KM (Chebyshev) UCL	0.0261
99% KM (Chebyshev) UCL	0.033

Potential UCLs to Use

95% KM (t) UCL	0.0175

95% Gamma Approximate UCL	0.0127	95% KM (Percentile Bootstrap) UCL	0.0226
95% Adjusted Gamma UCL	0.0128		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Molybdenum_2

General Statistics

Number of Valid Data	74	Number of Detected Data	8
Number of Distinct Detected Data	8	Number of Non-Detect Data	66
Number of Missing Values	2	Percent Non-Detects	89.19%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.54	Minimum Detected	0.432
Maximum Detected	2.71	Maximum Detected	0.997
Mean of Detected	2.063	Mean of Detected	0.707
SD of Detected	0.401	SD of Detected	0.198
Minimum Non-Detect	1.39	Minimum Non-Detect	0.329
Maximum Non-Detect	25.9	Maximum Non-Detect	3.254

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	74
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 8 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.921	Shapiro Wilk Test Statistic	0.914
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.257	Mean	-0.0227
SD	1.655	SD	0.554
95% DL/2 (t) UCL	1.577	95% H-Stat (DL/2) UCL	1.288
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.0148
		SD in Log Scale	0.368
		Mean in Original Scale	1.057
		SD in Original Scale	0.439
		95% t UCL	1.142

95% Percentile Bootstrap UCL	1.137
95% BCA Bootstrap UCL	1.154
95% H-UCL	1.138

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	18.66
Theta Star	0.111
nu star	298.5
A-D Test Statistic	0.447
5% A-D Critical Value	0.716
K-S Test Statistic	0.716
5% K-S Critical Value	0.294

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	1.606
SD	0.218
SE of Mean	0.0292
95% KM (t) UCL	1.654
95% KM (z) UCL	1.654
95% KM (jackknife) UCL	1.668
95% KM (bootstrap t) UCL	1.66
95% KM (BCA) UCL	2.19
95% KM (Percentile Bootstrap) UCL	1.792
95% KM (Chebyshev) UCL	1.733
97.5% KM (Chebyshev) UCL	1.788
99% KM (Chebyshev) UCL	1.896

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	2.71
Mean	0.259
Median	0.000001
SD	0.663
k star	0.0886
Theta star	2.929
Nu star	13.11
AppChi2	5.965
95% Gamma Approximate UCL	0.57
95% Adjusted Gamma UCL	0.579

Potential UCLs to Use

95% KM (t) UCL	1.654
95% KM (Percentile Bootstrap) UCL	1.792

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Selenium

General Statistics

Number of Valid Data	76	Number of Detected Data	67
Number of Distinct Detected Data	67	Number of Non-Detect Data	9
		Percent Non-Detects	11.84%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0992	Minimum Detected	-2.311
Maximum Detected	3.18	Maximum Detected	1.157
Mean of Detected	0.435	Mean of Detected	-1.163
SD of Detected	0.474	SD of Detected	0.753
Minimum Non-Detect	0.0933	Minimum Non-Detect	-2.372
Maximum Non-Detect	0.379	Maximum Non-Detect	-0.97

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	55
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	21
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	72.37%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.26
5% Lilliefors Critical Value	0.108

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.391
SD	0.461
95% DL/2 (t) UCL	0.479
Maximum Likelihood Estimate(MLE) Method	N/A

MLE yields a negative mean

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.11
5% Lilliefors Critical Value	0.108

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-1.366
SD	0.913
95% H-Stat (DL/2) UCL	0.487
Log ROS Method	
Mean in Log Scale	-1.345
SD in Log Scale	0.876
Mean in Original Scale	0.392
SD in Original Scale	0.46
95% t UCL	0.48
95% Percentile Bootstrap UCL	0.486
95% BCA Bootstrap UCL	0.506
95% H-UCL	0.475

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.598
Theta Star	0.272
nu star	214.1
A-D Test Statistic	2.336
5% A-D Critical Value	0.767
K-S Test Statistic	0.767
5% K-S Critical Value	0.111

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	3.18
Mean	0.386
Median	0.253
SD	0.465
k star	0.414
Theta star	0.933
Nu star	62.87
AppChi2	45.63
95% Gamma Approximate UCL	0.532
95% Adjusted Gamma UCL	0.535

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.396
SD	0.454
SE of Mean	0.0525
95% KM (t) UCL	0.484
95% KM (z) UCL	0.483
95% KM (jackknife) UCL	0.484
95% KM (bootstrap t) UCL	0.522
95% KM (BCA) UCL	0.493
95% KM (Percentile Bootstrap) UCL	0.488
95% KM (Chebyshev) UCL	0.625
97.5% KM (Chebyshev) UCL	0.724
99% KM (Chebyshev) UCL	0.919

Potential UCLs to Use

95% KM (BCA) UCL	0.493

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Silver_2

General Statistics

Number of Valid Data	74	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	68
Number of Missing Values	2	Percent Non-Detects	91.89%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0925	Minimum Detected	-2.381
Maximum Detected	0.299	Maximum Detected	-1.207
Mean of Detected	0.174	Mean of Detected	-1.871
SD of Detected	0.0969	SD of Detected	0.527
Minimum Non-Detect	0.0433	Minimum Non-Detect	-3.14
Maximum Non-Detect	0.189	Maximum Non-Detect	-1.666

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	72
Number treated as Detected	2
Single DL Non-Detect Percentage	97.30%

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.76	Shapiro Wilk Test Statistic	0.821
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0381	Mean	-3.53
SD	0.0487	SD	0.552
95% DL/2 (t) UCL	0.0475	95% H-Stat (DL/2) UCL	0.0385
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.457
		SD in Log Scale	0.974
		Mean in Original Scale	0.0242
		SD in Original Scale	0.0518
		95% t UCL	0.0342
		95% Percentile Bootstrap UCL	0.0346
		95% BCA Bootstrap UCL	0.0383
		95% H-UCL	0.024

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	2.251	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.0772	
nu star	27.01	

A-D Test Statistic	0.68
5% A-D Critical Value	0.699
K-S Test Statistic	0.699
5% K-S Critical Value	0.333

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.299
Mean	0.0141
Median	0.000001
SD	0.0541
k star	0.1
Theta star	0.141
Nu star	14.85
AppChi2	7.156
95% Gamma Approximate UCL	0.0292
95% Adjusted Gamma UCL	0.0297

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0991
SD	0.0336
SE of Mean	0.00428
95% KM (t) UCL	0.106
95% KM (z) UCL	0.106
95% KM (jackknife) UCL	0.105
95% KM (bootstrap t) UCL	0.121
95% KM (BCA) UCL	0.145
95% KM (Percentile Bootstrap) UCL	0.136
95% KM (Chebyshev) UCL	0.118
97.5% KM (Chebyshev) UCL	0.126
99% KM (Chebyshev) UCL	0.142

Potential UCLs to Use

95% KM (t) UCL	0.106

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Thallium

General Statistics

Number of Valid Data	76	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	75
		Percent Non-Detects	98.68%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Thallium was not processed!

Uranium, Total

General Statistics

Number of Valid Data	76	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	74
		Percent Non-Detects	97.37%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.101	Minimum Detected	-2.293
Maximum Detected	0.162	Maximum Detected	-1.82
Mean of Detected	0.132	Mean of Detected	-2.056
SD of Detected	0.0431	SD of Detected	0.334

Minimum Non-Detect	0.0867	Minimum Non-Detect	-2.445
Maximum Non-Detect	0.379	Maximum Non-Detect	-0.97

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	76
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.054
SD	0.0227
95% DL/2 (t) UCL	0.0583
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-2.963
SD	0.25
95% H-Stat (DL/2) UCL	0.056
Log ROS Method	
Mean in Log Scale	N/A
SD in Log Scale	N/A
Mean in Original Scale	N/A
SD in Original Scale	N/A
95% t UCL	N/A
95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A
95% H-UCL	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.102
SD	0.00709
SE of Mean	0.00117

95% KM (t) UCL	0.104
95% KM (z) UCL	0.104
95% KM (jackknife) UCL	0.141
95% KM (bootstrap t) UCL	0.102
95% KM (BCA) UCL	0.162
95% KM (Percentile Bootstrap) UCL	0.162
95% KM (Chebyshev) UCL	0.107
97.5% KM (Chebyshev) UCL	0.109
99% KM (Chebyshev) UCL	0.114

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Potential UCLs to Use

95% KM (t) UCL	0.104
95% KM (% Bootstrap) UCL	0.162

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

CULTURALLY SIGNIFICANT UPLAND VEGETATION – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Upland Veg Values_CS.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Boron_1

General Statistics

Number of Valid Data	75	Number of Detected Data	74
Number of Distinct Detected Data	67	Number of Non-Detect Data	1
Tolerance Factor	1.972	Percent Non-Detects	1.33%
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	6.32	Minimum Detected	1.844
Maximum Detected	52	Maximum Detected	3.951
Mean of Detected	21.63	Mean of Detected	2.933
SD of Detected	11.49	SD of Detected	0.545
Minimum Non-Detect	43.1	Minimum Non-Detect	3.764
Maximum Non-Detect	43.1	Maximum Non-Detect	3.764

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.113	Lilliefors Test Statistic	0.0682
5% Lilliefors Critical Value	0.103	5% Lilliefors Critical Value	0.103
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	21.63	Mean (Log Scale)	2.934
SD	11.41	SD (Log Scale)	0.542
95% UTL 95% Coverage	44.14	95% UTL 95% Coverage	54.75
95% UPL (t)	40.77	95% UPL (t)	46.65
90% Percentile (z)	36.26	90% Percentile (z)	37.66
95% Percentile (z)	40.41	95% Percentile (z)	45.85
99% Percentile (z)	48.19	99% Percentile (z)	66.32
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	48.39	Mean in Original Scale	21.59
SD	3.416	SD in Original Scale	11.42
95% UTL with 95% Coverage	55.13	95% UTL with 95% Coverage	54.59
		95% BCA UTL with 95% Coverage	46.33
		95% Bootstrap (%) UTL with 95% Coverage	46.33
95% UPL (t)	54.12	95% UPL (t)	46.52
90% Percentile (z)	52.77	90% Percentile (z)	37.56
95% Percentile (z)	54.01	95% Percentile (z)	45.73
99% Percentile (z)	56.34	99% Percentile (z)	66.13

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	3.547
Theta Star	6.1
nu star	524.9
A-D Test Statistic	0.635
5% A-D Critical Value	0.757
K-S Test Statistic	0.0824
5% K-S Critical Value	0.104

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	21.65
Median	20
SD	11.41
k star	3.594
Theta star	6.025
Nu star	539.1
95% Percentile of Chisquare (2k)	14.34
90% Percentile	36.97
95% Percentile	43.2
99% Percentile	56.58

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	21.62
SD	11.4
SE of Mean	1.332
95% KM UTL with 95% Coverage	44.09
95% KM Chebyshev UPL	71.62
95% KM UPL (t)	40.72
90% Percentile (z)	36.22
95% Percentile (z)	40.36
99% Percentile (z)	48.13

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	43.45
95% Hawkins Wixley (HW) Approx. Gamma UPL	44.08
95% WH Approx. Gamma UTL with 95% Coverage	48.97
95% HW Approx. Gamma UTL with 95% Coverage	50.08

Note: DL/2 is not a recommended method.

Cadmium

General Statistics

Number of Valid Data	76
Number of Distinct Detected Data	66
Tolerance Factor	1.97
Number of Detected Data	69
Number of Non-Detect Data	7
Percent Non-Detects	9.21%

Raw Statistics

Minimum Detected	0.0262
Maximum Detected	1.95
Mean of Detected	0.401
SD of Detected	0.527
Minimum Non-Detect	0.0225
Maximum Non-Detect	0.0248

Log-transformed Statistics

Minimum Detected	-3.642
Maximum Detected	0.668
Mean of Detected	-1.624
SD of Detected	1.179
Minimum Non-Detect	-3.794
Maximum Non-Detect	-3.697

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	7
Number treated as Detected with Single DL	69
Single DL Non-Detect Percentage	9.21%

Background Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.304
5% Lilliefors Critical Value	0.107

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0914
5% Lilliefors Critical Value	0.107

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.365
SD	0.515
95% UTL 95% Coverage	1.38
95% UPL (t)	1.229
90% Percentile (z)	1.025
95% Percentile (z)	1.212
99% Percentile (z)	1.563

Maximum Likelihood Estimate(MLE) Method

Mean	0.335
SD	0.547
95% UTL with 95% Coverage	1.412
95% UPL (t)	1.252
90% Percentile (z)	1.036
95% Percentile (z)	1.235
99% Percentile (z)	1.607

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.804
Theta Star	0.499
nu star	111
A-D Test Statistic	3.158
5% A-D Critical Value	0.789
K-S Test Statistic	0.177
5% K-S Critical Value	0.111

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.364
Median	0.145
SD	0.516
k star	0.375
Theta star	0.971
Nu star	57.05
95% Percentile of Chisquare (2k)	3.188
90% Percentile	1.04
95% Percentile	1.547
99% Percentile	2.831

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-1.882
SD (Log Scale)	1.387
95% UTL 95% Coverage	2.34
95% UPL (t)	1.558
90% Percentile (z)	0.901
95% Percentile (z)	1.491
99% Percentile (z)	3.838

Log ROS Method

Mean in Original Scale	0.366
SD in Original Scale	0.515
95% UTL with 95% Coverage	2.247
95% BCA UTL with 95% Coverage	1.89
95% Bootstrap (%) UTL with 95% Coverage	1.89
95% UPL (t)	1.508
90% Percentile (z)	0.882
95% Percentile (z)	1.445
99% Percentile (z)	3.647

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.367
SD	0.511
SE of Mean	0.059
95% KM UTL with 95% Coverage	1.372
95% KM Chebyshev UPL	2.607
95% KM UPL (t)	1.223
90% Percentile (z)	1.021
95% Percentile (z)	1.207
99% Percentile (z)	1.555

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	1.314
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.52
95% WH Approx. Gamma UTL with 95% Coverage	1.672
95% HW Approx. Gamma UTL with 95% Coverage	2.03

Note: DL/2 is not a recommended method.

Mercury

General Statistics

Number of Valid Data	70	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	58
Tolerance Factor	1.985	Percent Non-Detects	82.86%
Number of Missing Values	6		

Raw Statistics

Minimum Detected	0.00946
Maximum Detected	0.0876
Mean of Detected	0.0373
SD of Detected	0.0264
Minimum Non-Detect	0.00867
Maximum Non-Detect	0.0487

Log-transformed Statistics

Minimum Detected	-4.661
Maximum Detected	-2.435
Mean of Detected	-3.527
SD of Detected	0.735
Minimum Non-Detect	-4.748
Maximum Non-Detect	-3.022

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	67
Number treated as Detected with Single DL	3
Single DL Non-Detect Percentage	95.71%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.878
5% Shapiro Wilk Critical Value	0.859

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.953
5% Shapiro Wilk Critical Value	0.859

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0128
	SD	0.016
95% UTL	95% Coverage	0.0446
	95% UPL (t)	0.0397
	90% Percentile (z)	0.0334
	95% Percentile (z)	0.0392
	99% Percentile (z)	0.0501

Maximum Likelihood Estimate(MLE) Method

	Mean	-0.0562
	SD	0.0614
95% UTL with	95% Coverage	0.0656
	95% UPL (t)	0.0469
	90% Percentile (z)	0.0225
	95% Percentile (z)	0.0448
	99% Percentile (z)	0.0866

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-4.743
	SD (Log Scale)	0.764
95% UTL	95% Coverage	0.0397
	95% UPL (t)	0.0314
	90% Percentile (z)	0.0232
	95% Percentile (z)	0.0306
	99% Percentile (z)	0.0515

Log ROS Method

	Mean in Original Scale	0.00847
	SD in Original Scale	0.0169
95% UTL with	95% Coverage	0.0311
95% BCA UTL with	95% Coverage	0.0714
95% Bootstrap (%) UTL with	95% Coverage	0.0714
	95% UPL (t)	0.0222
	90% Percentile (z)	0.0144
	95% Percentile (z)	0.0214
	99% Percentile (z)	0.0452

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.743
Theta Star	0.0214
nu star	41.82
A-D Test Statistic	0.332
5% A-D Critical Value	0.741

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

K-S Test Statistic	0.169
5% K-S Critical Value	0.248

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0064
Median	0.000001
SD	0.0177
k star	0.119
Theta star	0.0539
Nu star	16.62
95% Percentile of Chisquare (2k)	1.357
90% Percentile	0.0181
95% Percentile	0.0365
99% Percentile	0.0931

Mean	0.0144
SD	0.0148
SE of Mean	0.00186
95% KM UTL with 95% Coverage	0.0439
95% KM Chebyshev UPL	0.0796
95% KM UPL (t)	0.0393
90% Percentile (z)	0.0334
95% Percentile (z)	0.0388
99% Percentile (z)	0.049

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.0187
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0153
95% WH Approx. Gamma UTL with 95% Coverage	0.0276
95% HW Approx. Gamma UTL with 95% Coverage	0.025

Note: DL/2 is not a recommended method.

Molybdenum_2

General Statistics

Number of Valid Data	74
Number of Distinct Detected Data	8
Tolerance Factor	1.975
Number of Missing Values	2
Number of Detected Data	8
Number of Non-Detect Data	66
Percent Non-Detects	89.19%

Raw Statistics

Minimum Detected	1.54
Maximum Detected	2.71
Mean of Detected	2.063
SD of Detected	0.401
Minimum Non-Detect	1.39
Maximum Non-Detect	25.9

Log-transformed Statistics

Minimum Detected	0.432
Maximum Detected	0.997
Mean of Detected	0.707
SD of Detected	0.198
Minimum Non-Detect	0.329
Maximum Non-Detect	3.254

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	74
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 8 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.921
5% Shapiro Wilk Critical Value	0.818

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.914
5% Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	1.257
SD	1.655
95% UTL 95% Coverage	4.524
95% UPL (t)	4.032
90% Percentile (z)	3.377
95% Percentile (z)	3.978
99% Percentile (z)	5.106

Maximum Likelihood Estimate(MLE) Method N/A

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-0.0227
SD (Log Scale)	0.554
95% UTL 95% Coverage	2.921
95% UPL (t)	2.477
90% Percentile (z)	1.989
95% Percentile (z)	2.433
99% Percentile (z)	3.55

Log ROS Method

Mean in Original Scale	1.057
SD in Original Scale	0.439
Mean in Log Scale	-0.0148
SD in Log Scale	0.368
95% UTL 95% Coverage	2.037
95% UPL (t)	1.826
90% Percentile (z)	1.579
95% Percentile (z)	1.804
99% Percentile (z)	2.319

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	18.66
Theta Star	0.111
nu star	298.5
A-D Test Statistic	0.447
5% A-D Critical Value	0.716
K-S Test Statistic	0.258
5% K-S Critical Value	0.294

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.259
Median	0.000001
SD	0.663
k star	0.0886
Theta star	2.929
Nu star	13.11
95% Percentile of Chisquare (2k)	1.032
90% Percentile	0.652
95% Percentile	1.512
99% Percentile	4.376

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	1.606
SD	0.218
SE of Mean	0.0292
95% KM UTL with 95% Coverage	2.036
95% KM Chebyshev UPL	2.563
95% KM UPL (t)	1.972
90% Percentile (z)	1.885
95% Percentile (z)	1.965
99% Percentile (z)	2.113

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.756
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.607
95% WH Approx. Gamma UTL with 95% Coverage	1.117
95% HW Approx. Gamma UTL with 95% Coverage	1.007

Note: DL/2 is not a recommended method.

Selenium

General Statistics

Number of Valid Data	76	Number of Detected Data	67
Number of Distinct Detected Data	67	Number of Non-Detect Data	9
Tolerance Factor	1.97	Percent Non-Detects	11.84%

Raw Statistics

Minimum Detected	0.0992
Maximum Detected	3.18
Mean of Detected	0.435
SD of Detected	0.474
Minimum Non-Detect	0.0933
Maximum Non-Detect	0.379

Log-transformed Statistics

Minimum Detected	-2.311
Maximum Detected	1.157
Mean of Detected	-1.163
SD of Detected	0.753
Minimum Non-Detect	-2.372
Maximum Non-Detect	-0.97

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	55
Number treated as Detected with Single DL	21
Single DL Non-Detect Percentage	72.37%

Background Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.26
5% Lilliefors Critical Value	0.108

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.11
5% Lilliefors Critical Value	0.108

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.391
SD		0.461
95% UTL	95% Coverage	1.299
	95% UPL (t)	1.164
	90% Percentile (z)	0.982
	95% Percentile (z)	1.149
	99% Percentile (z)	1.464

Maximum Likelihood Estimate(MLE) Method

Mean		-0.246
SD		0.988
95% UTL with	95% Coverage	1.699
	95% UPL (t)	1.41
	90% Percentile (z)	1.02
	95% Percentile (z)	1.379
	99% Percentile (z)	2.052

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-1.366
SD (Log Scale)		0.913
95% UTL	95% Coverage	1.541
	95% UPL (t)	1.179
	90% Percentile (z)	0.822
	95% Percentile (z)	1.145
	99% Percentile (z)	2.134

Log ROS Method

Mean in Original Scale		0.392
SD in Original Scale		0.46
95% UTL with	95% Coverage	1.463
95% BCA UTL with	95% Coverage	1.65
95% Bootstrap (%) UTL with	95% Coverage	1.65
	95% UPL (t)	1.132
	90% Percentile (z)	0.801
	95% Percentile (z)	1.101
	99% Percentile (z)	2

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.598
Theta Star	0.272
nu star	214.1
A-D Test Statistic	2.336
5% A-D Critical Value	0.767
K-S Test Statistic	0.175

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.396

5% K-S Critical Value	0.111

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.386
Median	0.253
SD	0.465
k star	0.414
Theta star	0.933
Nu star	62.87
95% Percentile of Chisquare (2k)	3.397
90% Percentile	1.084
95% Percentile	1.586
99% Percentile	2.843

SD	0.454
SE of Mean	0.0525
95% KM UTL with 95% Coverage	1.292
95% KM Chebyshev UPL	2.39
95% KM UPL (t)	1.158
90% Percentile (z)	0.979
95% Percentile (z)	1.144
99% Percentile (z)	1.454

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	1.327
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.647
95% WH Approx. Gamma UTL with 95% Coverage	1.649
95% HW Approx. Gamma UTL with 95% Coverage	2.154

Note: DL/2 is not a recommended method.

Silver_2

General Statistics

Number of Valid Data	74
Number of Distinct Detected Data	6
Tolerance Factor	1.975
Number of Missing Values	2

Number of Detected Data	6
Number of Non-Detect Data	68
Percent Non-Detects	91.89%

Raw Statistics

Minimum Detected	0.0925
Maximum Detected	0.299
Mean of Detected	0.174
SD of Detected	0.0969
Minimum Non-Detect	0.0433
Maximum Non-Detect	0.189

Log-transformed Statistics

Minimum Detected	-2.381
Maximum Detected	-1.207
Mean of Detected	-1.871
SD of Detected	0.527
Minimum Non-Detect	-3.14
Maximum Non-Detect	-1.666

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	72
Number treated as Detected with Single DL	2
Single DL Non-Detect Percentage	97.30%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.76
5% Shapiro Wilk Critical Value	0.788

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.821
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0381
	SD	0.0487
95% UTL	95% Coverage	0.134
	95% UPL (t)	0.12
	90% Percentile (z)	0.101
	95% Percentile (z)	0.118
	99% Percentile (z)	0.151

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-3.53
	SD (Log Scale)	0.552
95% UTL	95% Coverage	0.0871
	95% UPL (t)	0.0739
	90% Percentile (z)	0.0594
	95% Percentile (z)	0.0726
	99% Percentile (z)	0.106

Log ROS Method

	Mean in Original Scale	0.0242
	SD in Original Scale	0.0518
	Mean in Log Scale	-4.457
	SD in Log Scale	0.974
95% UTL	95% Coverage	0.0794
	95% UPL (t)	0.0594
	90% Percentile (z)	0.0404
	95% Percentile (z)	0.0576
	99% Percentile (z)	0.112

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.251
Theta Star	0.0772
nu star	27.01

A-D Test Statistic	0.68
5% A-D Critical Value	0.699
K-S Test Statistic	0.304
5% K-S Critical Value	0.333

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0141
Median	0.000001
SD	0.0541
k star	0.1
Theta star	0.141
Nu star	14.85
95% Percentile of Chisquare (2k)	1.164
90% Percentile	0.0376
95% Percentile	0.0818
99% Percentile	0.224

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0991
	SD	0.0336
	SE of Mean	0.00428
95% KM UTL with	95% Coverage	0.165
	95% KM Chebyshev UPL	0.247
	95% KM UPL (t)	0.155
	90% Percentile (z)	0.142
	95% Percentile (z)	0.154
	99% Percentile (z)	0.177

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		0.0277
95% Hawkins Wixley (HW) Approx. Gamma UPL		0.0166
95% WH Approx. Gamma UTL with	95% Coverage	0.0418
95% HW Approx. Gamma UTL with	95% Coverage	0.0279

Note: DL/2 is not a recommended method.

Thallium

General Statistics

Number of Valid Data	76	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	75

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Thallium was not processed!

Uranium, Total

General Statistics

Number of Valid Data	76	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	74

Warning: Data set has only 2 Detected Values.

This is not enough to compute meaningful and reliable test statistics and estimates.

No statistics will be produced!

Tolerance Factor	1.97	Percent Non-Detects	97.37%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.101	Minimum Detected	-2.293
Maximum Detected	0.162	Maximum Detected	-1.82
Mean of Detected	0.132	Mean of Detected	-2.056
SD of Detected	0.0431	SD of Detected	0.334
Minimum Non-Detect	0.0867	Minimum Non-Detect	-2.445
Maximum Non-Detect	0.379	Maximum Non-Detect	-0.97

Data with Multiple Detection Limits	Single Detection Limit Scenario	
Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect with Single DL	76
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected with Single DL	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.054
	SD	0.0227
95% UTL	95% Coverage	0.0988
	95% UPL (t)	0.0921
	90% Percentile (z)	0.0831
	95% Percentile (z)	0.0914
	99% Percentile (z)	0.107

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-2.963
	SD (Log Scale)	0.25
95% UTL	95% Coverage	0.0845
	95% UPL (t)	0.0786
	90% Percentile (z)	0.0712
	95% Percentile (z)	0.0779
	99% Percentile (z)	0.0924

Log ROS Method

	Mean in Original Scale	N/A
	SD in Original Scale	N/A
	Mean in Log Scale	N/A
	SD in Log Scale	N/A
95% UTL	95% Coverage	N/A
	95% UPL (t)	N/A
	90% Percentile (z)	N/A
	95% Percentile (z)	N/A
	99% Percentile (z)	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
95% Percentile of Chisquare (2k)	N/A
90% Percentile	N/A
95% Percentile	N/A
99% Percentile	N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

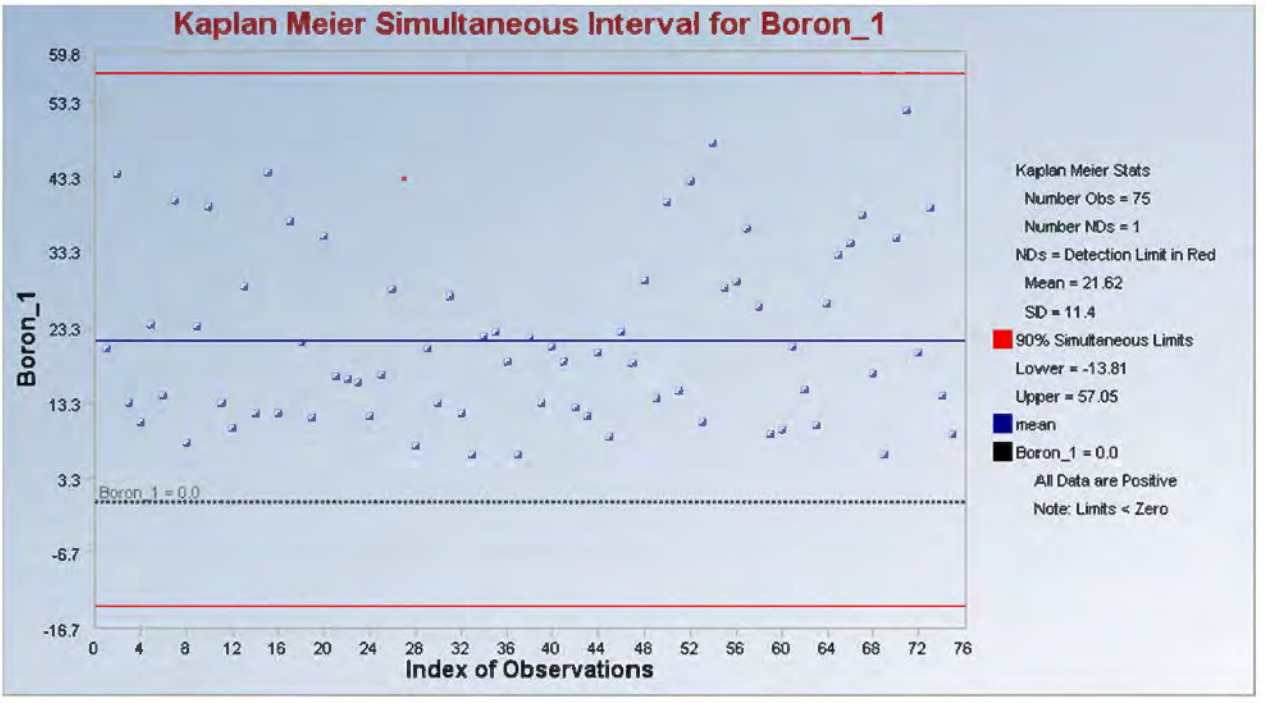
	Mean	0.102
	SD	0.00709
	SE of Mean	0.00117
95% KM UTL with	95% Coverage	0.116
	95% KM Chebyshev UPL	0.133
	95% KM UPL (t)	0.114
	90% Percentile (z)	0.111
	95% Percentile (z)	0.113
	99% Percentile (z)	0.118

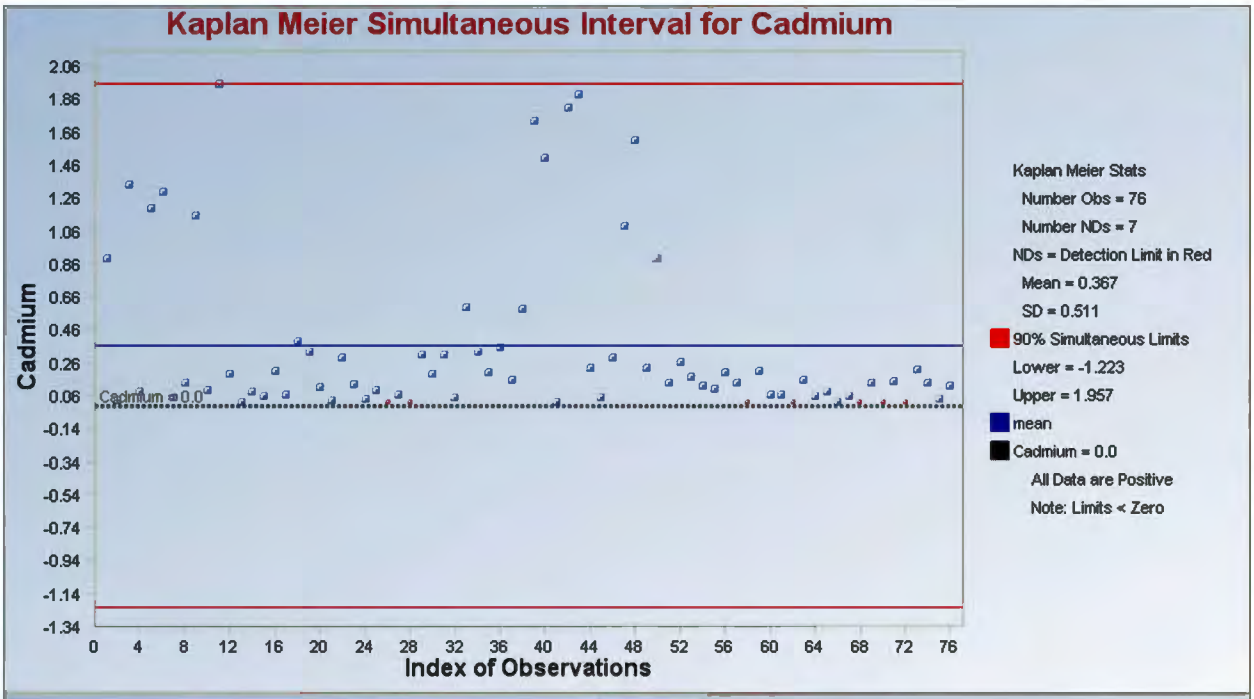
Gamma ROS Limits with Extrapolated Data

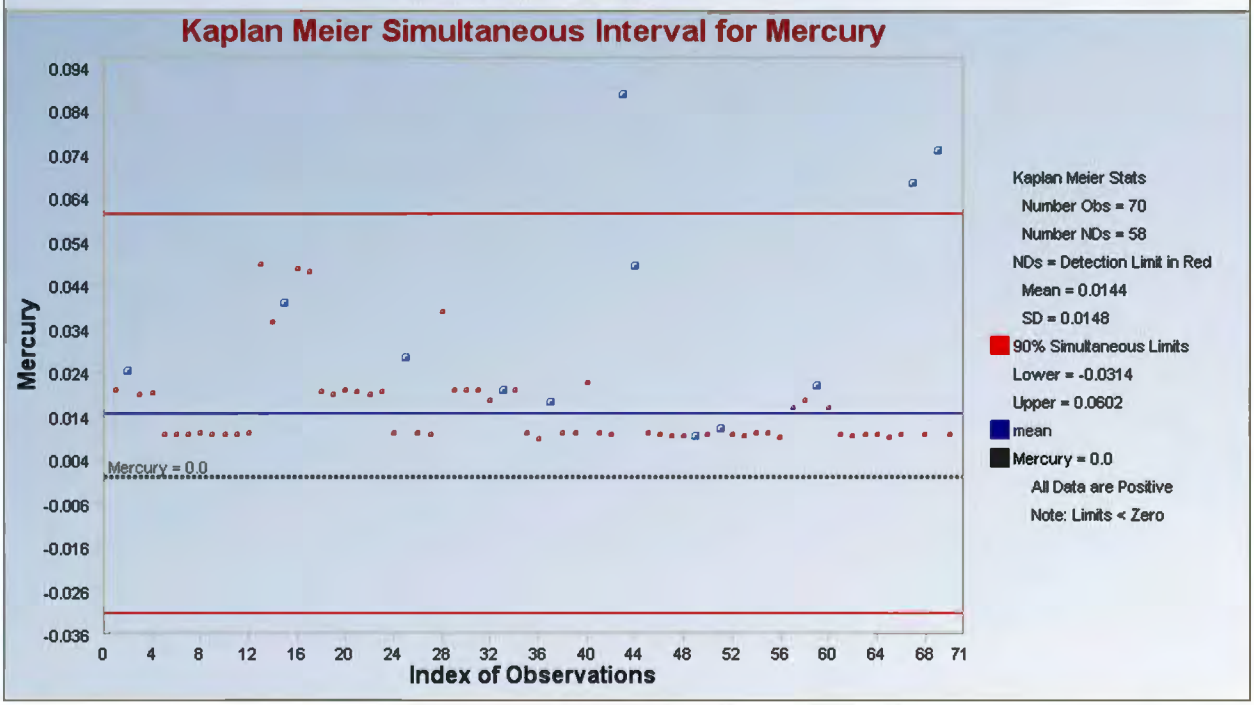
95% Wilson Hilferty (WH) Approx. Gamma UPL		N/A
95% Hawkins Wixley (HW) Approx. Gamma UPL		N/A
95% WH Approx. Gamma UTL with	95% Coverage	N/A
95% HW Approx. Gamma UTL with	95% Coverage	N/A

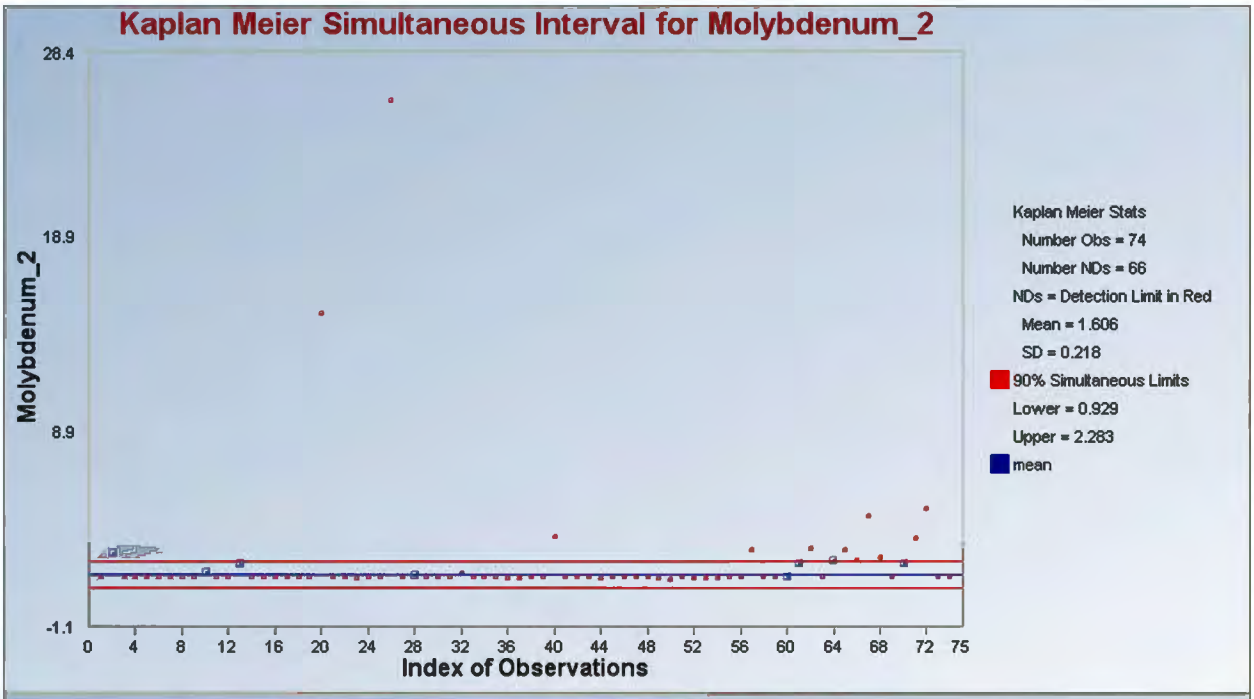
Note: DL/2 is not a recommended method.

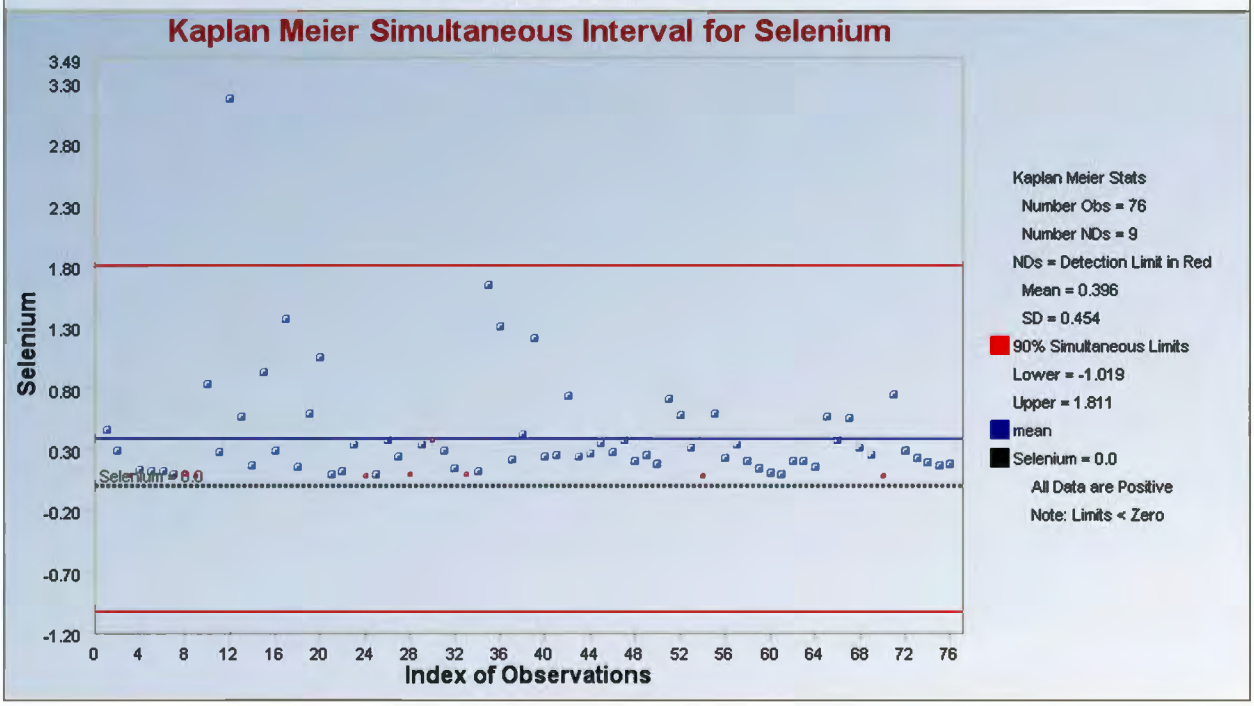
CULTURALLY SIGNIFICANT UPLAND VEGETATION – USL OUTPUTS

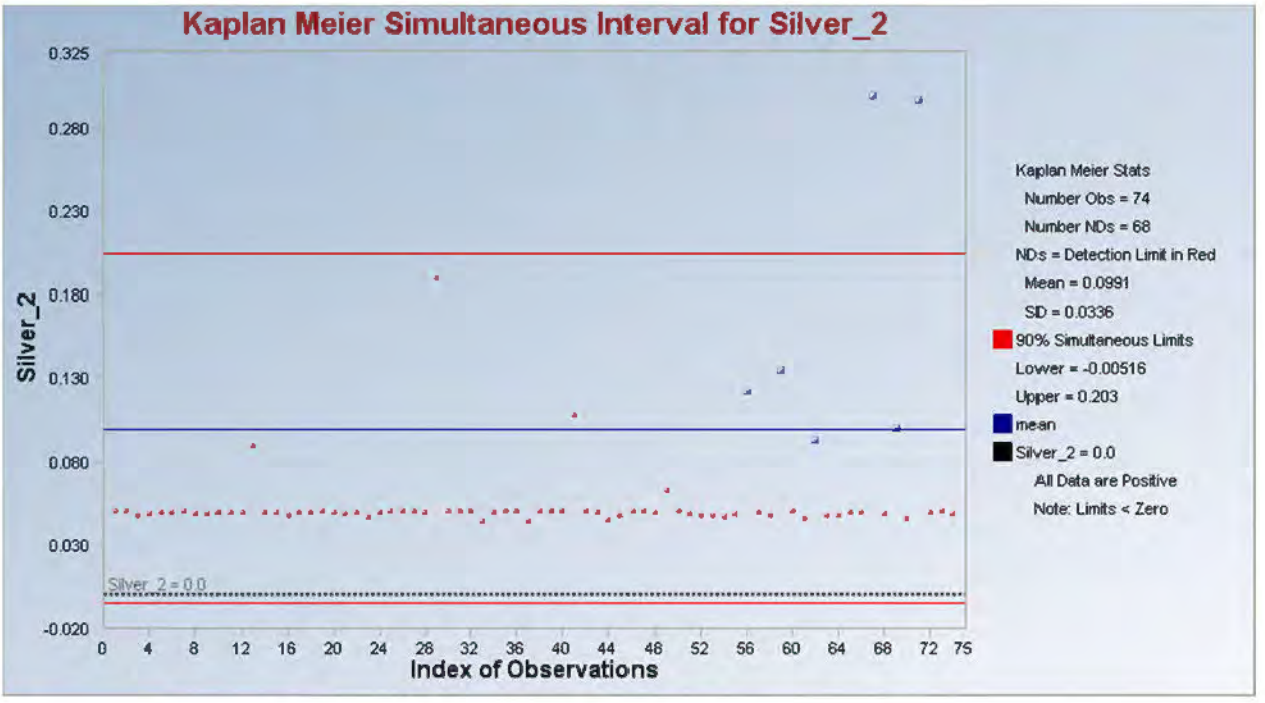

Kaplan Meier Simultaneous Interval for Boron_1
Boron_1
Index of Observations
Boron_1 = 0.0
Kaplan Meier Stats
Number Obs = 75
Number NDs = 1
NDs = Detection Limit in Red
Mean = 21.62
SD = 11.4
90% Simultaneous Limits
Lower = -13.81
Upper = 57.05
mean
Boron_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Cadmium
Cadmium
Index of Observations
Cadmium = 0.0
Kaplan Meier Stats
Number Obs = 76
Number NDs = 7
NDs = Detection Limit in Red
Mean = 0.367
SD = 0.511
90% Simultaneous Limits
Lower = -1.223
Upper = 1.957
mean
Cadmium = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Mercury
Mercury
Index of Observations
Mercury = 0.0
Kaplan Meier Stats
Number Obs = 70
Number NDs = 58
NDs = Detection Limit in Red
Mean = 0.0144
SD = 0.0148
90% Simultaneous Limits
Lower = -0.0314
Upper = 0.0602
mean
Mercury = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Molybdenum_2
Molybdenum_2
28.4
18.9
8.9
-1.1
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 75
Index of Observations
Kaplan Meier Stats
Number Obs = 74
Number NDs = 66
NDs = Detection Limit in Red
Mean = 1.606
SD = 0.218
90% Simultaneous Limits
Lower = 0.929
Upper = 2.283
mean


Kaplan Meier Simultaneous Interval for Selenium
Selenium
3.49
3.30
2.80
2.30
1.80
1.30
0.80
0.30
-0.20
-0.70
-1.20
Selenium = 0.0
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76
Index of Observations
Kaplan Meier Stats
Number Obs = 76
Number NDs = 9
NDs = Detection Limit in Red
Mean = 0.396
SD = 0.454
90% Simultaneous Limits
Lower = -1.019
Upper = 1.811
mean
Selenium = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Silver_2
Silver_2
0.325
0.280
0.230
0.180
0.130
0.080
0.030
-0.020
Silver_2 = 0.0
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 75
Index of Observations
Kaplan Meier Stats
Number Obs = 74
Number NDs = 68
NDs = Detection Limit in Red
Mean = 0.0991
SD = 0.0336
90% Simultaneous Limits
Lower = -0.00516
Upper = 0.203
mean
Silver_2 = 0.0
All Data are Positive
Note: Limits < Zero

NON-CULTURALLY SIGNIFICANT UPLAND VEGETATION – OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Veg Values_Non-CS.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Rosner's Outlier Test for Cadmium

Mean	**0.319**
Standard Deviation	**0.378**
Number of data	**79**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.319	0.375	2.52	41	5.863	3.305	3.665

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 2.52 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 2.52 is a Potential Statistical Outlier

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Veg Values_Non-CS.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	6

Rosner's Outlier Test for Molybdenum

Mean	**17.77**
Standard Deviation	**49.49**
Number of data	**42**
Number of suspected outliers	**6**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	17.77	48.9	240	20	4.545	3.06	3.4
2	12.35	35.29	206	10	5.487	3.05	3.39
3	7.506	17.09	99.6	12	5.39	3.04	3.38
4	5.144	8.409	50.2	13	5.358	3.03	3.37
5	3.959	4.039	20.6	9	4.12	3.01	3.36
6	3.509	2.978	17.3	29	4.631	2.998	3.346

For 5% significance level, there are 6 Potential Outliers

Therefore, Potential Statistical Outliers are

240, 206, 99.6, 50.2, 20.6, 17.3

For 1% Significance Level, there are 6 Potential Outliers

Therefore, Potential Statistical Outliers are

240, 206, 99.6, 50.2, 20.6, 17.3

NON-CULTURALLY SIGNIFICANT UPLAND VEGETATION – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Upland Veg Values_Non-CS.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Boron

General Statistics

Number of Valid Data	84	Number of Detected Data	81
Number of Distinct Detected Data	74	Number of Non-Detect Data	3
		Percent Non-Detects	3.57%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2.76	Minimum Detected	1.015
Maximum Detected	68.3	Maximum Detected	4.224
Mean of Detected	20.77	Mean of Detected	2.837
SD of Detected	12.67	SD of Detected	0.673
Minimum Non-Detect	2.5	Minimum Non-Detect	0.916
Maximum Non-Detect	8.06	Maximum Non-Detect	2.087

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	12
Number treated as Detected	72
Single DL Non-Detect Percentage	14.29%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.115	Lilliefors Test Statistic	0.0909
5% Lilliefors Critical Value	0.0984	5% Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	20.12	Mean	2.766
SD	12.9	SD	0.764
95% DL/2 (t) UCL	22.47	95% H-Stat (DL/2) UCL	25.26
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	19.59	Mean in Log Scale	2.788
SD	13.74	SD in Log Scale	0.711
95% MLE (t) UCL	22.08	Mean in Original Scale	20.19
95% MLE (Tiku) UCL	22.07	SD in Original Scale	12.81
		95% t UCL	22.52
		95% Percentile Bootstrap UCL	22.49
		95% BCA Bootstrap UCL	22.71
		95% H UCL	24.49

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	2.611	Data appear Gamma Distributed at 5% Significance Level
Theta Star	7.957	
nu star	422.9	

A-D Test Statistic	0.305
5% A-D Critical Value	0.76
K-S Test Statistic	0.76
5% K-S Critical Value	0.1

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	68.3
Mean	20.03
Median	18.55
SD	13.03
k star	0.768
Theta star	26.09
Nu star	129
AppChi2	103.8
95% Gamma Approximate UCL	24.9
95% Adjusted Gamma UCL	25

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	20.16
SD	12.78
SE of Mean	1.403
95% KM (t) UCL	22.49
95% KM (z) UCL	22.47
95% KM (jackknife) UCL	22.49
95% KM (bootstrap t) UCL	22.76
95% KM (BCA) UCL	22.5
95% KM (Percentile Bootstrap) UCL	22.49
95% KM (Chebyshev) UCL	26.27
97.5% KM (Chebyshev) UCL	28.92
99% KM (Chebyshev) UCL	34.12

Potential UCLs to Use

95% KM (BCA) UCL	22.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cadmium_1

General Statistics

Number of Valid Data	83	Number of Detected Data	78
Number of Distinct Detected Data	73	Number of Non-Detect Data	5
Number of Missing Values	1	Percent Non-Detects	6.02%

Raw Statistics

Minimum Detected	0.0248
Maximum Detected	1.58
Mean of Detected	0.291
SD of Detected	0.284
Minimum Non-Detect	0.0234
Maximum Non-Detect	0.0496

Log-transformed Statistics

Minimum Detected	-3.697
Maximum Detected	0.457
Mean of Detected	-1.674
SD of Detected	0.994
Minimum Non-Detect	-3.755
Maximum Non-Detect	-3.004

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	13
Number treated as Detected	70
Single DL Non-Detect Percentage	15.66%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.175
5% Lilliefors Critical Value	0.1

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.089
5% Lilliefors Critical Value	0.1

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	0.274
SD	0.283
95% DL/2 (t) UCL	0.326

Maximum Likelihood Estimate(MLE) Method	
Mean	0.248
SD	0.316
95% MLE (t) UCL	0.306
95% MLE (Tiku) UCL	0.305

DL/2 Substitution Method	
Mean	-1.831
SD	1.15
95% H-Stat (DL/2) UCL	0.42

Log ROS Method	
Mean in Log Scale	-1.808
SD in Log Scale	1.102
Mean in Original Scale	0.275
SD in Original Scale	0.283
95% t UCL	0.326
95% Percentile Bootstrap UCL	0.327
95% BCA Bootstrap UCL	0.335
95% H UCL	0.4

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.238
Theta Star	0.235
nu star	193.1
A-D Test Statistic	0.522
5% A-D Critical Value	0.775
K-S Test Statistic	0.775
5% K-S Critical Value	0.103

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	1.58
Mean	0.274
Median	0.18
SD	0.284
k star	0.55
Theta star	0.497
Nu star	91.35
AppChi2	70.31
95% Gamma Approximate UCL	0.355
95% Adjusted Gamma UCL	0.357

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.275
SD	0.281
SE of Mean	0.031
95% KM (t) UCL	0.327
95% KM (z) UCL	0.326
95% KM (jackknife) UCL	0.327
95% KM (bootstrap t) UCL	0.336
95% KM (BCA) UCL	0.33
95% KM (Percentile Bootstrap) UCL	0.327
95% KM (Chebyshev) UCL	0.41
97.5% KM (Chebyshev) UCL	0.469
99% KM (Chebyshev) UCL	0.584

Potential UCLs to Use

95% KM (Chebyshev) UCL	0.41

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Mercury

General Statistics

Number of Valid Data	75	Number of Detected Data	10
Number of Distinct Detected Data	10	Number of Non-Detect Data	65
Number of Missing Values	9	Percent Non-Detects	86.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0117	Minimum Detected	-4.448
Maximum Detected	0.0589	Maximum Detected	-2.832
Mean of Detected	0.0268	Mean of Detected	-3.74
SD of Detected	0.0145	SD of Detected	0.513
Minimum Non-Detect	0.00921	Minimum Non-Detect	-4.687
Maximum Non-Detect	0.0498	Maximum Non-Detect	-3

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	74
Number treated as Detected	1
Single DL Non-Detect Percentage	98.67%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.889	Shapiro Wilk Test Statistic	0.963
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0108	Mean	-4.768
SD	0.00946	SD	0.629
95% DL/2 (t) UCL	0.0126	95% H-Stat (DL/2) UCL	0.0119
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-5.443
		SD in Log Scale	0.791
		Mean in Original Scale	0.0067
		SD in Original Scale	0.00951
		95% t UCL	0.00853
		95% Percentile Bootstrap UCL	0.00867
		95% BCA Bootstrap UCL	0.0093
		95% H-UCL	0.00715

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	3.08	Data appear Normal at 5% Significance Level
Theta Star	0.0087	
nu star	61.6	
A-D Test Statistic	0.253	
5% A-D Critical Value	0.729	
K-S Test Statistic	0.729	
5% K-S Critical Value	0.268	
Data appear Gamma Distributed at 5% Significance Level		

Assuming Gamma Distribution		Nonparametric Statistics	
Gamma ROS Statistics using Extrapolated Data		Kaplan-Meier (KM) Method	
Minimum	0.000001	Mean	0.0139
Maximum	0.0589	SD	0.00727
Mean	0.00358	SE of Mean	0.0009022
Median	0.000001	95% KM (t) UCL	0.0154
SD	0.0105	95% KM (z) UCL	0.0153
k star	0.121	95% KM (jackknife) UCL	0.0153
		95% KM (bootstrap t) UCL	0.0156
		95% KM (BCA) UCL	0.0224
		95% KM (Percentile Bootstrap) UCL	0.0173
		95% KM (Chebyshev) UCL	0.0178
		97.5% KM (Chebyshev) UCL	0.0195
		99% KM (Chebyshev) UCL	0.0228

Theta star	0.0296		
Nu star	18.1	Potential UCLs to Use	
AppChi2	9.463	95% KM (t) UCL	0.0154
95% Gamma Approximate UCL	0.00684	95% KM (Percentile Bootstrap) UCL	0.0173
95% Adjusted Gamma UCL	0.00693		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Molybdenum_2

General Statistics

Number of Valid Data	78	Number of Detected Data	36
Number of Distinct Detected Data	33	Number of Non-Detect Data	42
Number of Missing Values	6	Percent Non-Detects	53.85%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.48	Minimum Detected	0.392
Maximum Detected	8.91	Maximum Detected	2.187
Mean of Detected	3.126	Mean of Detected	1.011
SD of Detected	1.88	SD of Detected	0.481
Minimum Non-Detect	1.4	Minimum Non-Detect	0.336
Maximum Non-Detect	4.84	Maximum Non-Detect	1.577

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	73
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	5
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	93.59%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.748	Shapiro Wilk Test Statistic	0.879
5% Shapiro Wilk Critical Value	0.935	5% Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.949	Mean	0.4
SD	1.7	SD	0.697
95% DL/2 (t) UCL	2.27	95% H-Stat (DL/2) UCL	2.226
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	0.414
		SD in Log Scale	0.692
		Mean in Original Scale	1.959
		SD in Original Scale	1.684
		95% t UCL	2.276
		95% Percentile Bootstrap UCL	2.288
		95% BCA Bootstrap UCL	2.347
		95% H-UCL	2.247

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	3.712
Theta Star	0.842
nu star	267.3
A-D Test Statistic	2.068
5% A-D Critical Value	0.753
K-S Test Statistic	0.753
5% K-S Critical Value	0.148

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only
Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	2.277
SD	1.496
SE of Mean	0.173
95% KM (t) UCL	2.565
95% KM (z) UCL	2.561
95% KM (jackknife) UCL	2.519
95% KM (bootstrap t) UCL	2.608
95% KM (BCA) UCL	2.701
95% KM (Percentile Bootstrap) UCL	2.615
95% KM (Chebyshev) UCL	3.031
97.5% KM (Chebyshev) UCL	3.357
99% KM (Chebyshev) UCL	3.998
Potential UCLs to Use	
95% KM (t) UCL	2.565
95% KM (% Bootstrap) UCL	2.615

Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	8.91
Mean	1.444
Median	0.000001
SD	2.016
k star	0.116
Theta star	12.49
Nu star	18.04
AppChi2	9.418
95% Gamma Approximate UCL	2.766
95% Adjusted Gamma UCL	2.801

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Selenium

General Statistics

Number of Valid Data	84	Number of Detected Data	74
Number of Distinct Detected Data	71	Number of Non-Detect Data	10
		Percent Non-Detects	11.90%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.109	Minimum Detected	-2.216
Maximum Detected	7.28	Maximum Detected	1.985
Mean of Detected	0.773	Mean of Detected	-0.69
SD of Detected	1.126	SD of Detected	0.806
Minimum Non-Detect	0.0911	Minimum Non-Detect	-2.396
Maximum Non-Detect	0.198	Maximum Non-Detect	-1.619

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	16
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	68
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	19.05%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.303	Lilliefors Test Statistic	0.0927

5% Lilliefors Critical Value	0.103

Data not Normal at 5% Significance Level

5% Lilliefors Critical Value	0.103

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.687
SD	1.082
95% DL/2 (t) UCL	0.883
Maximum Likelihood Estimate(MLE) Method	
Mean	0.542
SD	1.226
95% MLE (t) UCL	0.765
95% MLE (Tiku) UCL	0.759

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-0.959
SD	1.057
95% H-Stat (DL/2) UCL	0.875
Log ROS Method	
Mean in Log Scale	-0.897
SD in Log Scale	0.946
Mean in Original Scale	0.691
SD in Original Scale	1.079
95% t UCL	0.887
95% Percentile Bootstrap UCL	0.902
95% BCA Bootstrap UCL	0.958
95% H UCL	0.8

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.255
Theta Star	0.615
nu star	185.8
A-D Test Statistic	4.293
5% A-D Critical Value	0.774
K-S Test Statistic	0.774
5% K-S Critical Value	0.106

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.694
SD	1.071
SE of Mean	0.118
95% KM (t) UCL	0.89
95% KM (z) UCL	0.887
95% KM (jackknife) UCL	0.885
95% KM (bootstrap t) UCL	1.02
95% KM (BCA) UCL	0.92
95% KM (Percentile Bootstrap) UCL	0.889
95% KM (Chebyshev) UCL	1.207
97.5% KM (Chebyshev) UCL	1.429
99% KM (Chebyshev) UCL	1.865

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	7.28
Mean	0.681
Median	0.392
SD	1.086
k star	0.354
Theta star	1.924
Nu star	59.43
AppChi2	42.7
95% Gamma Approximate UCL	0.947
95% Adjusted Gamma UCL	0.953

Potential UCLs to Use

95% KM (BCA) UCL	0.92

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Silver

General Statistics

Number of Valid Data	84	Number of Detected Data	13
Number of Distinct Detected Data	13	Number of Non-Detect Data	71
		Percent Non-Detects	84.52%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0505	Minimum Detected	-2.986
Maximum Detected	0.598	Maximum Detected	-0.514
Mean of Detected	0.168	Mean of Detected	-2.092
SD of Detected	0.158	SD of Detected	0.776
Minimum Non-Detect	0.0447	Minimum Non-Detect	-3.108
Maximum Non-Detect	0.245	Maximum Non-Detect	-1.406

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	82
Number treated as Detected	2
Single DL Non-Detect Percentage	97.62%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.749	Shapiro Wilk Test Statistic	0.928
5% Shapiro Wilk Critical Value	0.866	5% Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0482	Mean	-3.432
SD	0.0801	SD	0.676
95% DL/2 (t) UCL	0.0627	95% H-Stat (DL/2) UCL	0.047
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.801
		SD in Log Scale	1.439
		Mean in Original Scale	0.0319
		SD in Original Scale	0.0842
		95% t UCL	0.0472
		95% Percentile Bootstrap UCL	0.0496
		95% BCA Bootstrap UCL	0.0532
		95% H-UCL	0.0354

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	1.409	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.119	
nu star	36.63	
A-D Test Statistic	0.58	Nonparametric Statistics
5% A-D Critical Value	0.747	Kaplan-Meier (KM) Method
K-S Test Statistic	0.747	Mean 0.0688
5% K-S Critical Value	0.24	SD 0.0735
Data appear Gamma Distributed at 5% Significance Level		SE of Mean 0.00835
		95% KM (t) UCL 0.0827
Assuming Gamma Distribution		95% KM (z) UCL 0.0826
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 0.0808
Minimum	0.000001	95% KM (bootstrap t) UCL 0.0958
Maximum	0.598	95% KM (BCA) UCL 0.0921

Mean	0.026	95% KM (Percentile Bootstrap) UCL	0.087
Median	0.000001	95% KM (Chebyshev) UCL	0.105
SD	0.0858	97.5% KM (Chebyshev) UCL	0.121
k star	0.102	99% KM (Chebyshev) UCL	0.152
Theta star	0.255		
Nu star	17.13	Potential UCLs to Use	
AppChi2	8.767	95% KM (t) UCL	0.0827
95% Gamma Approximate UCL	0.0509		
95% Adjusted Gamma UCL	0.0515		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Thallium

General Statistics

Number of Valid Data	84	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	78
		Percent Non-Detects	92.86%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0109	Minimum Detected	-4.519
Maximum Detected	0.0257	Maximum Detected	-3.661
Mean of Detected	0.0166	Mean of Detected	-4.147
SD of Detected	0.00601	SD of Detected	0.343
Minimum Non-Detect	0.00894	Minimum Non-Detect	-4.717
Maximum Non-Detect	0.049	Maximum Non-Detect	-3.016

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	84
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.858	Shapiro Wilk Test Statistic	0.897
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00602	Mean	-5.21
SD	0.00398	SD	0.364
95% DL/2 (t) UCL	0.00674	95% H-Stat (DL/2) UCL	0.00626

Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Log ROS Method	
Mean in Log Scale	-5.984
SD in Log Scale	0.716
Mean in Original Scale	0.00349
SD in Original Scale	0.00413
95% t UCL	0.00424
95% Percentile Bootstrap UCL	0.00425
95% BCA Bootstrap UCL	0.0044
95% H-UCL	0.00381

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.11
Theta Star	0.00325
nu star	61.32
A-D Test Statistic	0.458
5% A-D Critical Value	0.698
K-S Test Statistic	0.698
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.0257
Mean	0.00119
Median	0.000001
SD	0.00455
k star	0.127
Theta star	0.00935
Nu star	21.36
AppChi2	11.86
95% Gamma Approximate UCL	0.00214
95% Adjusted Gamma UCL	0.00216

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0113
SD	0.00209
SE of Mean	0.0002519
95% KM (t) UCL	0.0117
95% KM (z) UCL	0.0117
95% KM (jackknife) UCL	0.0122
95% KM (bootstrap t) UCL	0.0122
95% KM (BCA) UCL	0.0148
95% KM (Percentile Bootstrap) UCL	0.0146
95% KM (Chebyshev) UCL	0.0124
97.5% KM (Chebyshev) UCL	0.0129
99% KM (Chebyshev) UCL	0.0138

Potential UCLs to Use

95% KM (t) UCL	0.0117
95% KM (Percentile Bootstrap) UCL	0.0146

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Uranium, Total

General Statistics

Number of Valid Data	84	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	83
		Percent Non-Detects	98.81%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Uranium, Total was not processed!

NON-CULTURALLY SIGNIFICANT UPLAND VEGETATION – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Upland Veg Values_Non-CS.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Boron

General Statistics

Number of Valid Data	84	Number of Detected Data	81
Number of Distinct Detected Data	74	Number of Non-Detect Data	3
Tolerance Factor	1.952	Percent Non-Detects	3.57%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2.76	Minimum Detected	1.015
Maximum Detected	68.3	Maximum Detected	4.224
Mean of Detected	20.77	Mean of Detected	2.837
SD of Detected	12.67	SD of Detected	0.673
Minimum Non-Detect	2.5	Minimum Non-Detect	0.916
Maximum Non-Detect	8.06	Maximum Non-Detect	2.087

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	12
Number treated as Detected with Single DL	72
Single DL Non-Detect Percentage	14.29%

Background Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.115
5% Lilliefors Critical Value	0.0984

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0909
5% Lilliefors Critical Value	0.0984

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		20.12
SD		12.9
95% UTL	95% Coverage	45.3
	95% UPL (t)	41.71
	90% Percentile (z)	36.65
	95% Percentile (z)	41.34
	99% Percentile (z)	50.13

Maximum Likelihood Estimate(MLE) Method

Mean		19.59
SD		13.74
95% UTL with	95% Coverage	46.41
	95% UPL (t)	42.58

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		2.766
SD (Log Scale)		0.764
95% UTL	95% Coverage	70.61
	95% UPL (t)	57.07
	90% Percentile (z)	42.31
	95% Percentile (z)	55.85
	99% Percentile (z)	93.99

Log ROS Method

Mean in Original Scale		20.19
SD in Original Scale		12.81
95% UTL with	95% Coverage	65.14
95% BCA UTL with	95% Coverage	50.9
95% Bootstrap (%) UTL with	95% Coverage	50.9
	95% UPL (t)	53.43

90% Percentile (z)	37.19
95% Percentile (z)	42.19
99% Percentile (z)	51.55

90% Percentile (z)	40.44
95% Percentile (z)	52.36
99% Percentile (z)	85.01

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.611
Theta Star	7.957
nu star	422.9

A-D Test Statistic	0.305
5% A-D Critical Value	0.76
K-S Test Statistic	0.0641
5% K-S Critical Value	0.1

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	20.03
Median	18.55
SD	13.03
k star	0.768
Theta star	26.09
Nu star	129
95% Percentile of Chisquare (2k)	5.056
90% Percentile	49.19
95% Percentile	65.95
99% Percentile	105.6

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	20.16
SD	12.78
SE of Mean	1.403
95% KM UTL with 95% Coverage	45.1
95% KM Chebyshev UPL	76.18
95% KM UPL (t)	41.54
90% Percentile (z)	36.53
95% Percentile (z)	41.17
99% Percentile (z)	49.88

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	53.76
95% Hawkins Wixley (HW) Approx. Gamma UPL	63.54
95% WH Approx. Gamma UTL with 95% Coverage	63.01
95% HW Approx. Gamma UTL with 95% Coverage	77.02

Note: DL/2 is not a recommended method.

Cadmium_1

General Statistics

Number of Valid Data	83
Number of Distinct Detected Data	73
Tolerance Factor	1.954
Number of Missing Values	1

Number of Detected Data	78
Number of Non-Detect Data	5
Percent Non-Detects	6.02%

Raw Statistics

Minimum Detected	0.0248
Maximum Detected	1.58
Mean of Detected	0.291
SD of Detected	0.284
Minimum Non-Detect	0.0234
Maximum Non-Detect	0.0496

Log-transformed Statistics

Minimum Detected	-3.697
Maximum Detected	0.457
Mean of Detected	-1.674
SD of Detected	0.994
Minimum Non-Detect	-3.755
Maximum Non-Detect	-3.004

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	13
Number treated as Detected with Single DL	70
Single DL Non-Detect Percentage	15.66%

Background Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.175
5% Lilliefors Critical Value	0.1

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.089
5% Lilliefors Critical Value	0.1

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.274
SD		0.283
95% UTL	95% Coverage	0.828
95% UPL (t)		0.749
90% Percentile (z)		0.638
95% Percentile (z)		0.74
99% Percentile (z)		0.934

Maximum Likelihood Estimate(MLE) Method

Mean		0.248
SD		0.316
95% UTL with	95% Coverage	0.866
95% UPL (t)		0.777
90% Percentile (z)		0.653
95% Percentile (z)		0.768
99% Percentile (z)		0.984

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-1.831
SD (Log Scale)		1.15
95% UTL	95% Coverage	1.515
95% UPL (t)		1.097
90% Percentile (z)		0.699
95% Percentile (z)		1.062
99% Percentile (z)		2.324

Log ROS Method

Mean in Original Scale		0.275
SD in Original Scale		0.283
95% UTL with	95% Coverage	1.413
95% BCA UTL with	95% Coverage	0.971
95% Bootstrap (%) UTL with	95% Coverage	1.168
95% UPL (t)		1.037
90% Percentile (z)		0.673
95% Percentile (z)		1.005
99% Percentile (z)		2.129

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.238
Theta Star	0.235
nu star	193.1
A-D Test Statistic	0.522
5% A-D Critical Value	0.775
K-S Test Statistic	0.0927
5% K-S Critical Value	0.103

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.274
Median	0.18
SD	0.284
k star	0.55
Theta star	0.497
Nu star	91.35
95% Percentile of Chisquare (2k)	4.085
90% Percentile	0.725
95% Percentile	1.015
99% Percentile	1.723

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean		0.275
SD		0.281
SE of Mean		0.031
95% KM UTL with	95% Coverage	0.824
95% KM Chebyshev UPL		1.507
95% KM UPL (t)		0.745
90% Percentile (z)		0.635
95% Percentile (z)		0.737
99% Percentile (z)		0.929

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		0.894
95% Hawkins Wixley (HW) Approx. Gamma UPL		1.047
95% WH Approx. Gamma UTL with	95% Coverage	1.091
95% HW Approx. Gamma UTL with	95% Coverage	1.33

Note: DL/2 is not a recommended method.

Mercury

General Statistics

Number of Valid Data	75	Number of Detected Data	10
Number of Distinct Detected Data	10	Number of Non-Detect Data	65
Tolerance Factor	1.972	Percent Non-Detects	86.67%
Number of Missing Values	9		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0117	Minimum Detected	-4.448
Maximum Detected	0.0589	Maximum Detected	-2.832
Mean of Detected	0.0268	Mean of Detected	-3.74
SD of Detected	0.0145	SD of Detected	0.513
Minimum Non-Detect	0.00921	Minimum Non-Detect	-4.687
Maximum Non-Detect	0.0498	Maximum Non-Detect	-3

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	74
Number treated as Detected with Single DL	1
Single DL Non-Detect Percentage	98.67%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.889
5% Shapiro Wilk Critical Value	0.842

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.963
5% Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0108
	SD	0.00946
95% UTL	95% Coverage	0.0294
	95% UPL (t)	0.0266
	90% Percentile (z)	0.0229
	95% Percentile (z)	0.0263
	99% Percentile (z)	0.0328

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-4.768
	SD (Log Scale)	0.629
95% UTL	95% Coverage	0.0294
	95% UPL (t)	0.0244
	90% Percentile (z)	0.019
	95% Percentile (z)	0.0239
	99% Percentile (z)	0.0367

Log ROS Method

	Mean in Original Scale	0.0067
	SD in Original Scale	0.00951
	Mean in Log Scale	-5.443
	SD in Log Scale	0.791
95% UTL	95% Coverage	0.0206
	95% UPL (t)	0.0163
	90% Percentile (z)	0.0119
	95% Percentile (z)	0.0159
	99% Percentile (z)	0.0272

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	3.08
Theta Star	0.0087

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

nu star	61.6

A-D Test Statistic	0.253
5% A-D Critical Value	0.729
K-S Test Statistic	0.147
5% K-S Critical Value	0.268

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.00358
Median	0.000001
SD	0.0105
k star	0.121
Theta star	0.0296
Nu star	18.1
95% Percentile of Chisquare (2k)	1.376
90% Percentile	0.0101
95% Percentile	0.0204
99% Percentile	0.0516

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0139
SD	0.00727
SE of Mean	0.0009022
95% KM UTL with 95% Coverage	0.0282
95% KM Chebyshev UPL	0.0458
95% KM UPL (t)	0.0261
90% Percentile (z)	0.0232
95% Percentile (z)	0.0258
99% Percentile (z)	0.0308

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00948
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00719
95% WH Approx. Gamma UTL with 95% Coverage	0.0139
95% HW Approx. Gamma UTL with 95% Coverage	0.0116

Note: DL/2 is not a recommended method.

Molybdenum_2

General Statistics

Number of Valid Data	78
Number of Distinct Detected Data	33
Tolerance Factor	1.965
Number of Missing Values	6
Number of Detected Data	36
Number of Non-Detect Data	42
Percent Non-Detects	53.85%

Raw Statistics

Minimum Detected	1.48
Maximum Detected	8.91
Mean of Detected	3.126
SD of Detected	1.88
Minimum Non-Detect	1.4
Maximum Non-Detect	4.84

Log-transformed Statistics

Minimum Detected	0.392
Maximum Detected	2.187
Mean of Detected	1.011
SD of Detected	0.481
Minimum Non-Detect	0.336
Maximum Non-Detect	1.577

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	73
Number treated as Detected with Single DL	5
Single DL Non-Detect Percentage	93.59%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.748
5% Shapiro Wilk Critical Value	0.935

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.879
5% Shapiro Wilk Critical Value	0.935

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	1.949
SD	1.7
95% UTL 95% Coverage	5.29
95% UPL (t)	4.798
90% Percentile (z)	4.128
95% Percentile (z)	4.746
99% Percentile (z)	5.904

DL/2 Substitution Method	
Mean (Log Scale)	0.4
SD (Log Scale)	0.697
95% UTL 95% Coverage	5.868
95% UPL (t)	4.796
90% Percentile (z)	3.645
95% Percentile (z)	4.695
99% Percentile (z)	7.548

Maximum Likelihood Estimate(MLE) Method	
Mean	-2.456
SD	4.814
95% UTL with 95% Coverage	7.004
95% UPL (t)	5.61
90% Percentile (z)	3.713
95% Percentile (z)	5.462
99% Percentile (z)	8.743

Log ROS Method	
Mean in Original Scale	1.959
SD in Original Scale	1.684
95% UTL with 95% Coverage	5.894
95% BCA UTL with 95% Coverage	7.617
95% Bootstrap (%) UTL with 95% Coverage	8.11
95% UPL (t)	4.824
90% Percentile (z)	3.673
95% Percentile (z)	4.722
99% Percentile (z)	7.567

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	3.712
Theta Star	0.842
nu star	267.3
A-D Test Statistic	2.068
5% A-D Critical Value	0.753
K-S Test Statistic	0.197
5% K-S Critical Value	0.148

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	1.444
Median	0.000001
SD	2.016
k star	0.116
Theta star	12.49
Nu star	18.04
95% Percentile of Chisquare (2k)	1.325
90% Percentile	4.048
95% Percentile	8.277
99% Percentile	21.31

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	2.277
SD	1.496
SE of Mean	0.173
95% KM UTL with 95% Coverage	5.217
95% KM Chebyshev UPL	8.841
95% KM UPL (t)	4.784
90% Percentile (z)	4.195
95% Percentile (z)	4.738
99% Percentile (z)	5.758

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	6.613
95% Hawkins Wixley (HW) Approx. Gamma UPL	8.284
95% WH Approx. Gamma UTL with 95% Coverage	9.081
95% HW Approx. Gamma UTL with 95% Coverage	12.55

Note: DL/2 is not a recommended method.

Selenium

General Statistics

Number of Valid Data	84	Number of Detected Data	74
Number of Distinct Detected Data	71	Number of Non-Detect Data	10

Tolerance Factor	1.952	Percent Non-Detects	11.90%

Raw Statistics

Minimum Detected	0.109
Maximum Detected	7.28
Mean of Detected	0.773
SD of Detected	1.126
Minimum Non-Detect	0.0911
Maximum Non-Detect	0.198

Log-transformed Statistics

Minimum Detected	-2.216
Maximum Detected	1.985
Mean of Detected	-0.69
SD of Detected	0.806
Minimum Non-Detect	-2.396
Maximum Non-Detect	-1.619

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	16
Number treated as Detected with Single DL	68
Single DL Non-Detect Percentage	19.05%

Background Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.303
5% Lilliefors Critical Value	0.103

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0927
5% Lilliefors Critical Value	0.103

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.687
	SD	1.082
95% UTL	95% Coverage	2.798
	95% UPL (t)	2.497
	90% Percentile (z)	2.073
	95% Percentile (z)	2.466
	99% Percentile (z)	3.203

Maximum Likelihood Estimate(MLE) Method

	Mean	0.542
	SD	1.226
95% UTL with	95% Coverage	2.936
	95% UPL (t)	2.594
	90% Percentile (z)	2.114
	95% Percentile (z)	2.559
	99% Percentile (z)	3.395

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-0.959
	SD (Log Scale)	1.057
95% UTL	95% Coverage	3.019
	95% UPL (t)	2.249
	90% Percentile (z)	1.486
	95% Percentile (z)	2.182
	99% Percentile (z)	4.485

Log ROS Method

	Mean in Original Scale	0.691
	SD in Original Scale	1.079
95% UTL with	95% Coverage	2.584
95% BCA UTL with	95% Coverage	4.41
95% Bootstrap (%) UTL with	95% Coverage	4.41
	95% UPL (t)	1.986
	90% Percentile (z)	1.371
	95% Percentile (z)	1.933
	99% Percentile (z)	3.683

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.255
Theta Star	0.615
nu star	185.8
A-D Test Statistic	4.293
5% A-D Critical Value	0.774
K-S Test Statistic	0.178
5% K-S Critical Value	0.106

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.694
	SD	1.071
	SE of Mean	0.118
95% KM UTL with	95% Coverage	2.785

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.681
Median	0.392
SD	1.086
k star	0.354
Theta star	1.924
Nu star	59.43
95% Percentile of Chisquare (2k)	3.065
90% Percentile	1.962
95% Percentile	2.949
99% Percentile	5.464

95% KM Chebyshev UPL	5.391
95% KM UPL (t)	2.486
90% Percentile (z)	2.067
95% Percentile (z)	2.456
99% Percentile (z)	3.186

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	2.39
95% Hawkins Wixley (HW) Approx. Gamma UPL	2.925
95% WH Approx. Gamma UTL with 95% Coverage	2.975
95% HW Approx. Gamma UTL with 95% Coverage	3.829

Note: DL/2 is not a recommended method.

Silver

General Statistics

Number of Valid Data	84
Number of Distinct Detected Data	13
Tolerance Factor	1.952

Number of Detected Data	13
Number of Non-Detect Data	71
Percent Non-Detects	84.52%

Raw Statistics

Minimum Detected	0.0505
Maximum Detected	0.598
Mean of Detected	0.168
SD of Detected	0.158
Minimum Non-Detect	0.0447
Maximum Non-Detect	0.245

Log-transformed Statistics

Minimum Detected	-2.986
Maximum Detected	-0.514
Mean of Detected	-2.092
SD of Detected	0.776
Minimum Non-Detect	-3.108
Maximum Non-Detect	-1.406

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	82
Number treated as Detected with Single DL	2
Single DL Non-Detect Percentage	97.62%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.749
5% Shapiro Wilk Critical Value	0.866

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.928
5% Shapiro Wilk Critical Value	0.866

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0482
SD	0.0801
95% UTL 95% Coverage	0.205
95% UPL (t)	0.182
90% Percentile (z)	0.151
95% Percentile (z)	0.18
99% Percentile (z)	0.234

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-3.432
SD (Log Scale)	0.676
95% UTL 95% Coverage	0.121
95% UPL (t)	0.1
90% Percentile (z)	0.0769
95% Percentile (z)	0.0983
99% Percentile (z)	0.156

Maximum Likelihood Estimate(MLE) Method N/A

Log ROS Method

Mean in Original Scale	0.0319
SD in Original Scale	0.0842
Mean in Log Scale	-4.801
SD in Log Scale	1.439
95% UTL 95% Coverage	0.136
95% UPL (t)	0.0913
90% Percentile (z)	0.052
95% Percentile (z)	0.0876
99% Percentile (z)	0.234

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.409
Theta Star	0.119
nu star	36.63
A-D Test Statistic	0.58
5% A-D Critical Value	0.747
K-S Test Statistic	0.189
5% K-S Critical Value	0.24

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.026
Median	0.000001
SD	0.0858
k star	0.102
Theta star	0.255
Nu star	17.13
95% Percentile of Chisquare (2k)	1.182
90% Percentile	0.0699
95% Percentile	0.151
99% Percentile	0.41

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0688
SD	0.0735
SE of Mean	0.00835
95% KM UTL with 95% Coverage	0.212
95% KM Chebyshev UPL	0.391
95% KM UPL (t)	0.192
90% Percentile (z)	0.163
95% Percentile (z)	0.19
99% Percentile (z)	0.24

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.0682
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0519
95% WH Approx. Gamma UTL with 95% Coverage	0.0985
95% HW Approx. Gamma UTL with 95% Coverage	0.083

Note: DL/2 is not a recommended method.

Thallium

General Statistics

Number of Valid Data	84
Number of Detected Data	6
Number of Distinct Detected Data	6
Number of Non-Detect Data	78
Tolerance Factor	1.952
Percent Non-Detects	92.86%

Raw Statistics

Minimum Detected	0.0109
Maximum Detected	0.0257
Mean of Detected	0.0166
SD of Detected	0.00601
Minimum Non-Detect	0.00894
Maximum Non-Detect	0.049

Log-transformed Statistics

Minimum Detected	-4.519
Maximum Detected	-3.661
Mean of Detected	-4.147
SD of Detected	0.343
Minimum Non-Detect	-4.717
Maximum Non-Detect	-3.016

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	84
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.858
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.897
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.00602
	SD	0.00398
95% UTL	95% Coverage	0.0138
	95% UPL (t)	0.0127
	90% Percentile (z)	0.0111
	95% Percentile (z)	0.0126
	99% Percentile (z)	0.0153

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-5.21
	SD (Log Scale)	0.364
95% UTL	95% Coverage	0.0111
	95% UPL (t)	0.01
	90% Percentile (z)	0.0087
	95% Percentile (z)	0.00993
	99% Percentile (z)	0.0127

Log ROS Method

	Mean in Original Scale	0.00349
	SD in Original Scale	0.00413
	Mean in Log Scale	-5.984
	SD in Log Scale	0.716
95% UTL	95% Coverage	0.0102
	95% UPL (t)	0.00834
	90% Percentile (z)	0.0063
	95% Percentile (z)	0.00817
	99% Percentile (z)	0.0133

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.11
Theta Star	0.00325
nu star	61.32

A-D Test Statistic	0.458
5% A-D Critical Value	0.698
K-S Test Statistic	0.291
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0113
	SD	0.00209
	SE of Mean	0.0002519
95% KM UTL with	95% Coverage	0.0154
	95% KM Chebyshev UPL	0.0205
	95% KM UPL (t)	0.0148

Mean	0.00119	90% Percentile (z)	0.014
Median	0.000001	95% Percentile (z)	0.0148
SD	0.00455	99% Percentile (z)	0.0162
k star	0.127		
Theta star	0.00935	**Gamma ROS Limits with Extrapolated Data**	
Nu star	21.36	95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00236
95% Percentile of Chisquare (2k)	1.439	95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00147
		95% WH Approx. Gamma UTL with 95% Coverage	0.00342
90% Percentile	0.00342	95% HW Approx. Gamma UTL with 95% Coverage	0.00231
95% Percentile	0.00673		
99% Percentile	0.0167		

Note: DL/2 is not a recommended method.

Uranium, Total

General Statistics

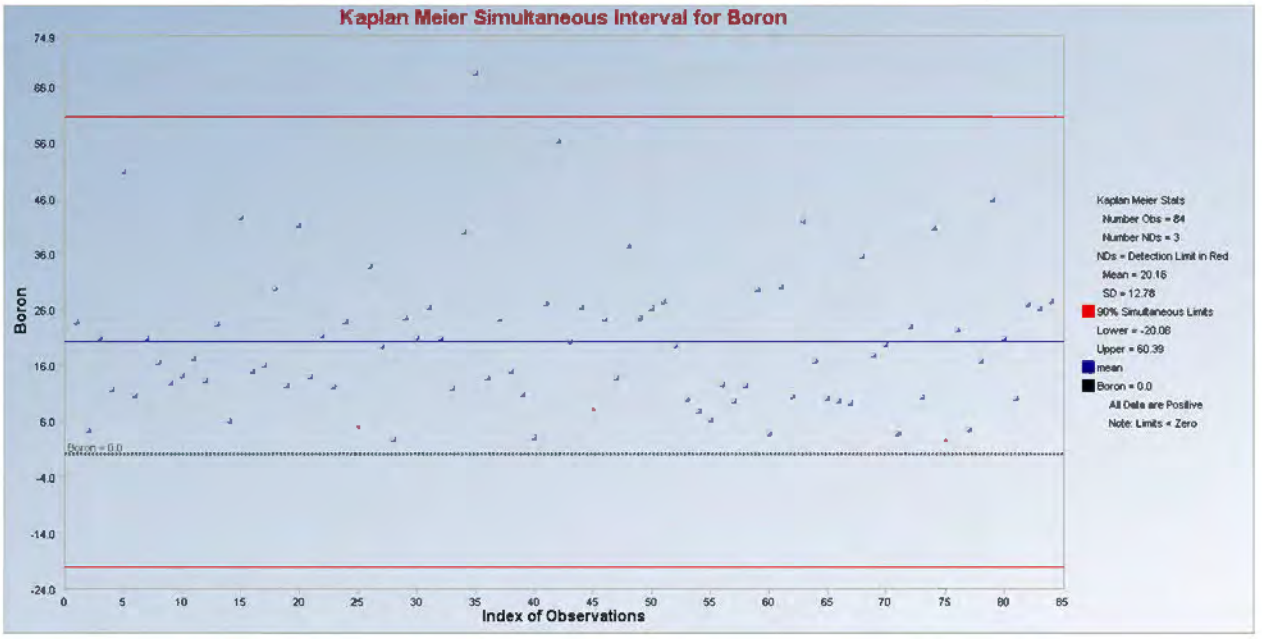
Number of Valid Data	84	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	83

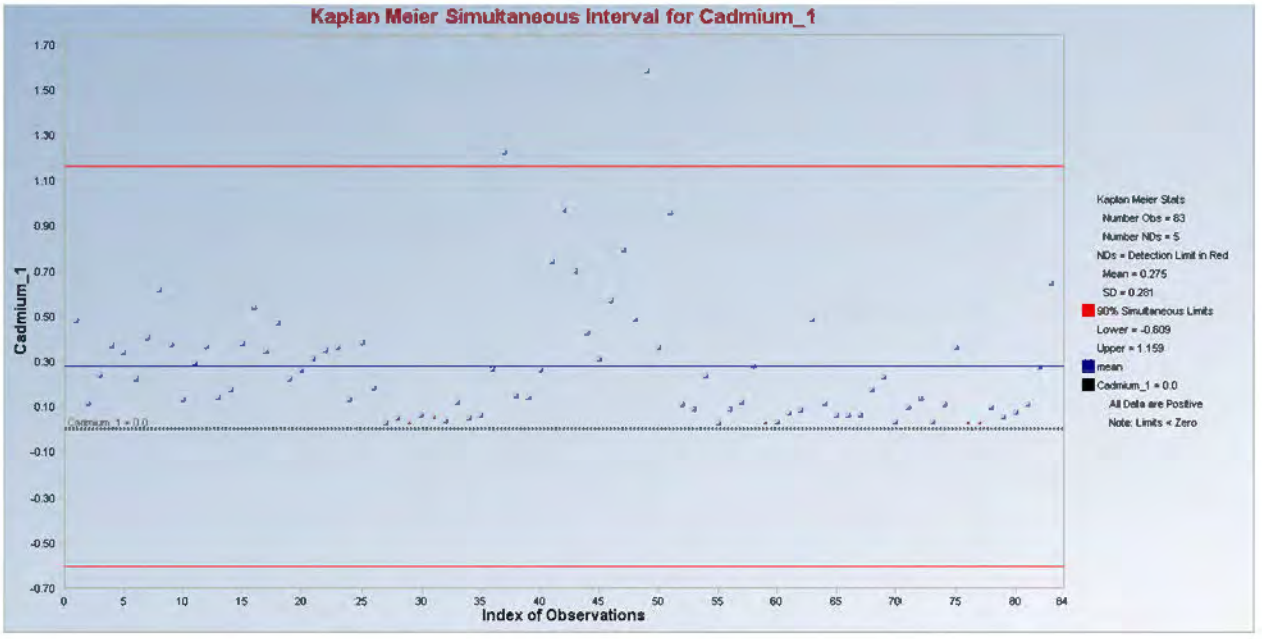
Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

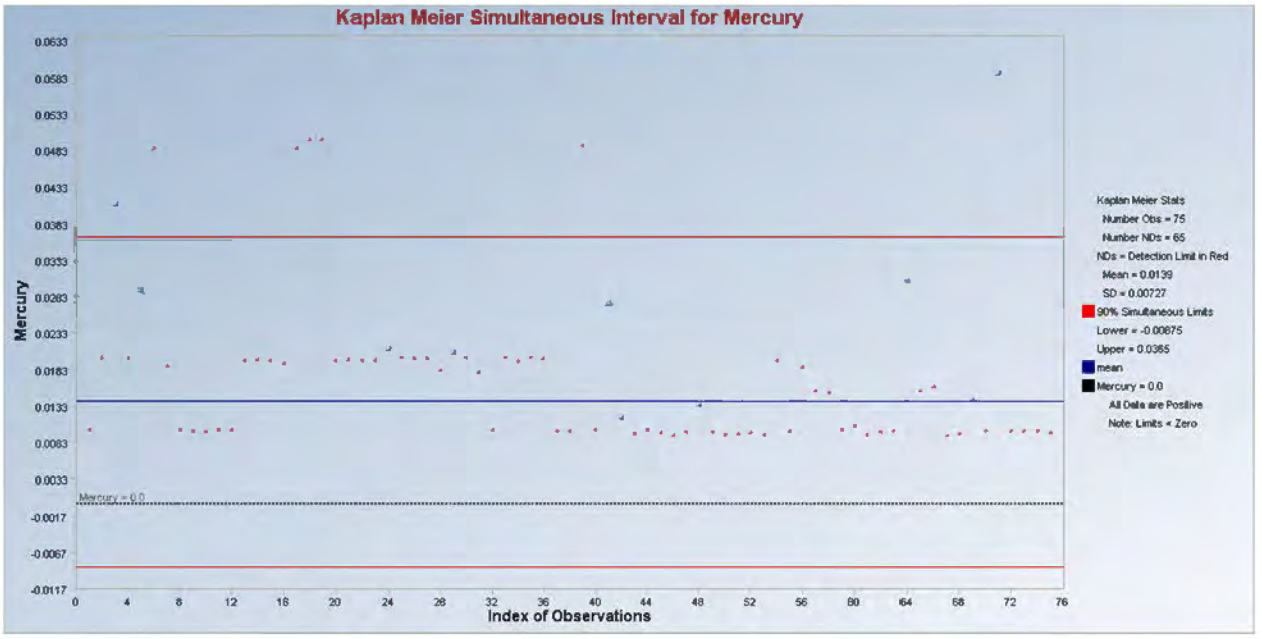
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

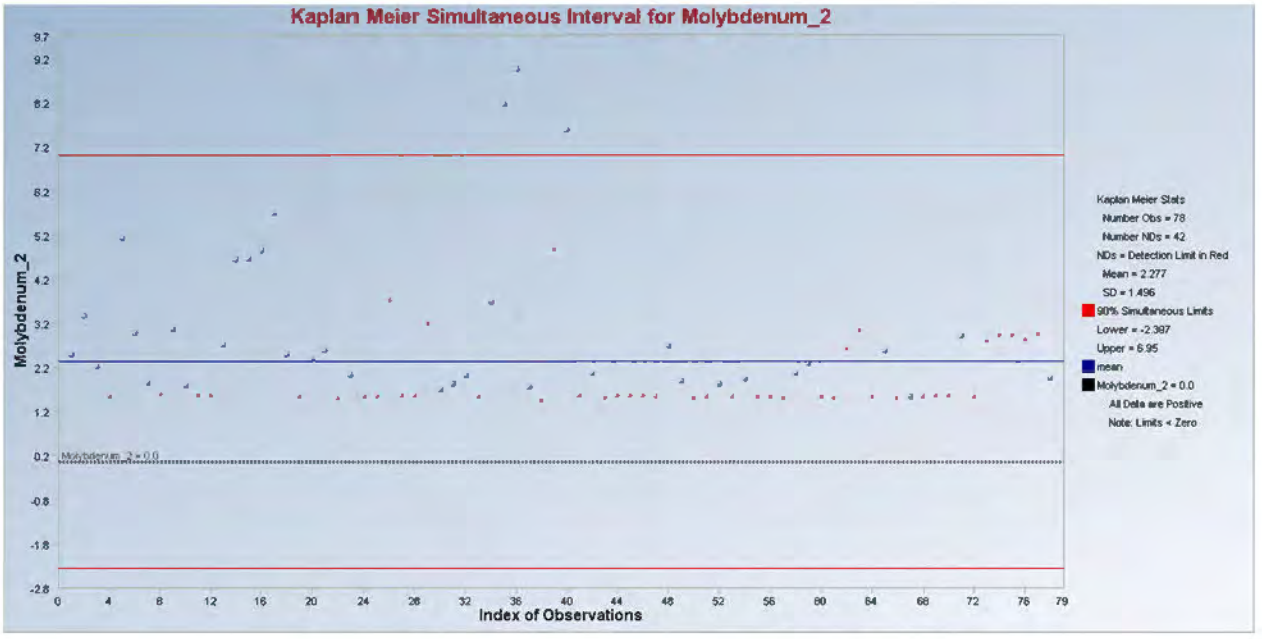
The data set for variable Uranium, Total was not processed!

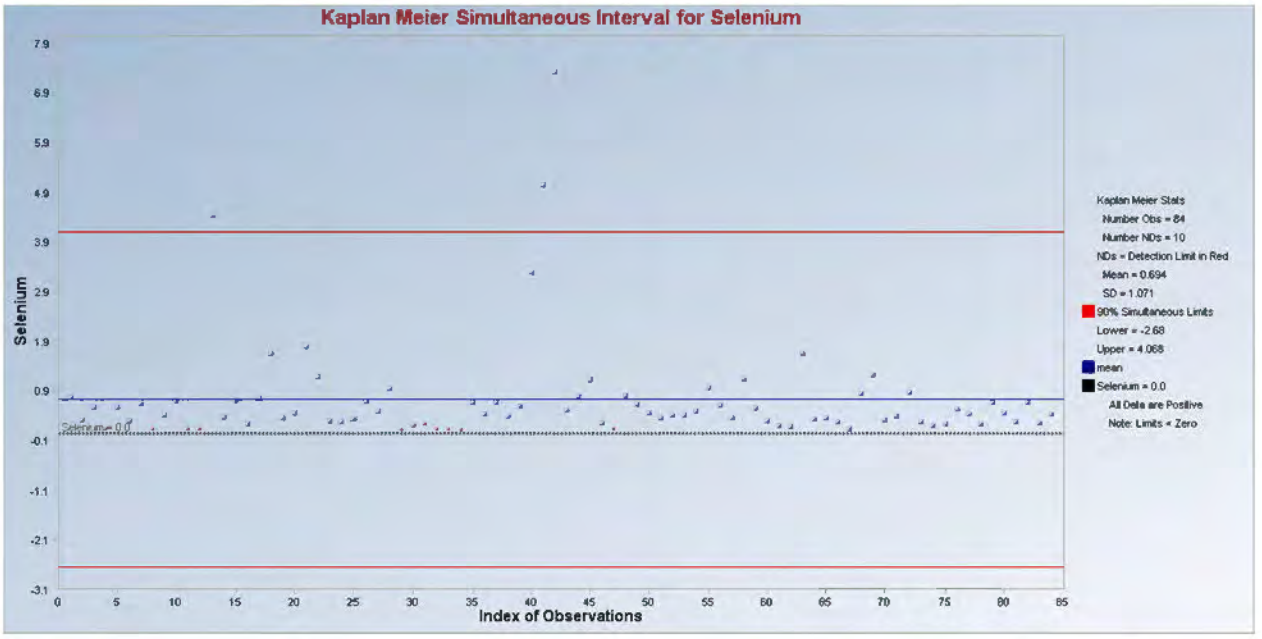
NON-CULTURALLY SIGNIFICANT UPLAND VEGETATION – USL OUTPUTS

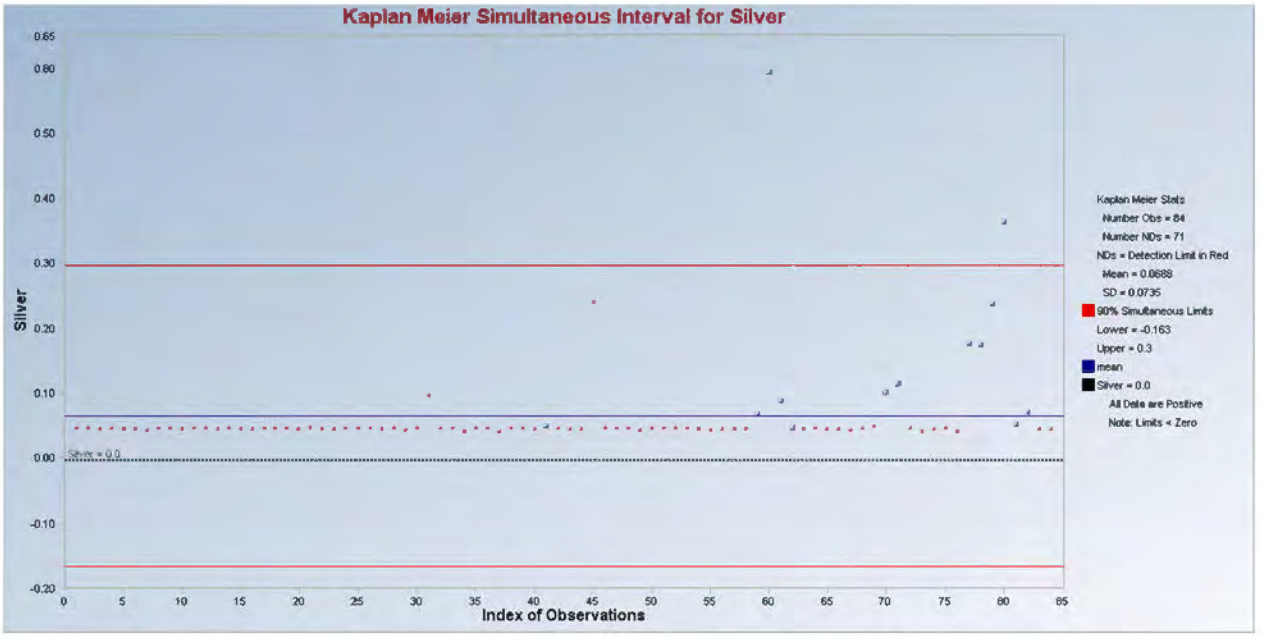

Kaplan Meier Simultaneous Interval for Boron
Boron
Index of Observations
Kaplan Meier Stats
Number Obs = 84
Number NDs = 3
NDs = Detection Limit in Red
Mean = 20.16
SD = 12.78
90% Simultaneous Limits
Lower = -20.08
Upper = 60.39
mean
Boron = 0.0
All Data are Positive
Note: Limits < Zero

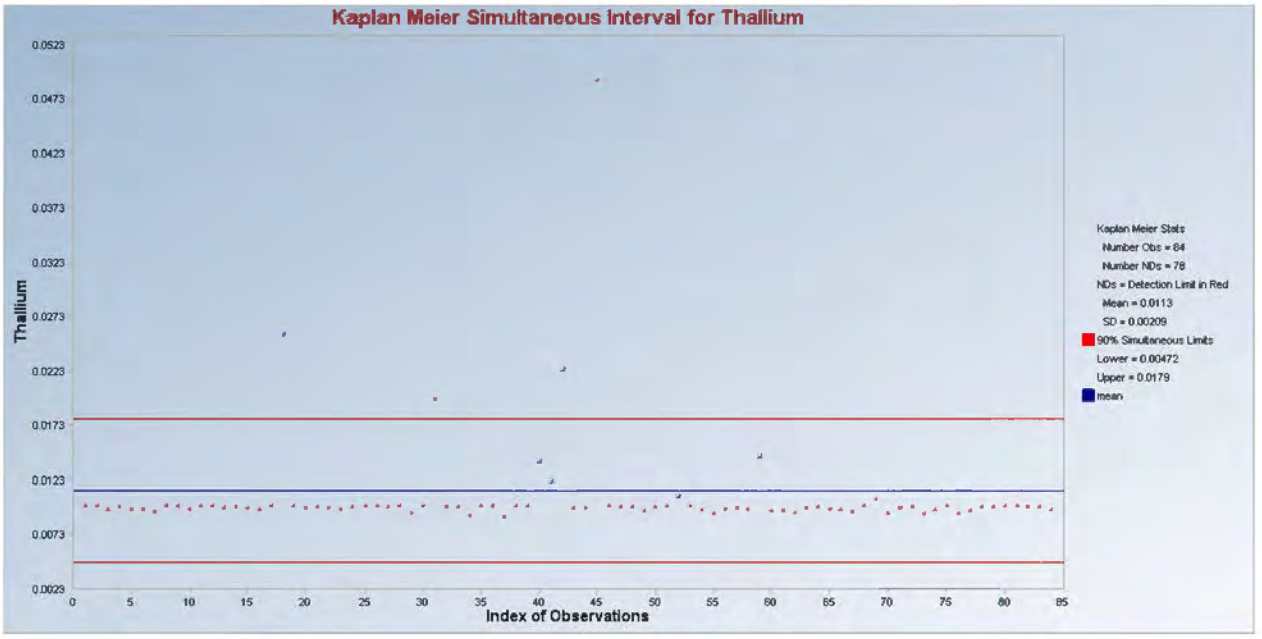

Kaplan Meier Simultaneous Interval for Cadmium_1
Cadmium_1
Index of Observations
Kaplan Meier Stats
Number Obs = 83
Number NDs = 5
NDs = Detection Limit in Red
Mean = 0.275
SD = 0.281
90% Simultaneous Limits
Lower = -0.609
Upper = 1.159
mean
Cadmium_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Mercury
Mercury
Index of Observations
Mercury = 0.0
Kaplan Meier Stats
Number Obs = 75
Number NDs = 65
NDs = Detection Limit in Red
Mean = 0.0139
SD = 0.00727
90% Simultaneous Limits
Lower = -0.00675
Upper = 0.0365
mean
Mercury = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Molybdenum_2
Molybdenum_2
Index of Observations
Molybdenum_2 = 0.0
Kaplan Meier Stats
Number Obs = 78
Number NDs = 42
NDs = Detection Limit in Red
Mean = 2.277
SD = 1.496
90% Simultaneous Limits
Lower = -2.387
Upper = 6.95
mean
Molybdenum_2 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Selenium
Selenium
Index of Observations
Kaplan Meier Stats
Number Obs = 84
Number NDs = 10
NDs = Detection Limit in Red
Mean = 0.694
SD = 1.071
90% Simultaneous Limits
Lower = -2.68
Upper = 4.068
mean
Selenium = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Silver
Silver
Index of Observations
Kaplan Meier Stats
Number Obs = 84
Number NDs = 71
NDs = Detection Limit in Red
Mean = 0.0688
SD = 0.0735
90% Simultaneous Limits
Lower = -0.163
Upper = 0.3
mean
Silver = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Thallium
Thallium
0.0523
0.0473
0.0423
0.0373
0.0323
0.0273
0.0223
0.0173
0.0123
0.0073
0.0023
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Index of Observations
Kaplan Meier Stats
Number Obs = 84
Number NDs = 78
NDs = Detection Limit in Red
Mean = 0.0113
SD = 0.00209
90% Simultaneous Limits
Lower = 0.00472
Upper = 0.0179
mean

COMBINED UPLAND VEGETATION – OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Veg Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	2

Dixon's Outlier Test for Silver_out1

Number of data = 20

10% critical value: 0.401

5% critical value: 0.45

1% critical value: 0.535

1. Data Value 10.5 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.970

For 10% significance level, 10.5 is an outlier.

For 5% significance level, 10.5 is an outlier.

For 1% significance level, 10.5 is an outlier.

2. Data Value 0.0505 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.018

For 10% significance level, 0.0505 is not an outlier.

For 5% significance level, 0.0505 is not an outlier.

For 1% significance level, 0.0505 is not an outlier.

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Veg Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Rosner's Outlier Test for Boron

Mean	**23.38**
Standard Deviation	**29.98**
Number of data	**156**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	23.38	29.88	364	23	11.4	3.531	3.901

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 364 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 364 is a Potential Statistical Outlier

Rosner's Outlier Test for Cadmium

Mean	**0.358**
Standard Deviation	**0.454**
Number of data	**148**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.358	0.452	2.52	97	4.78	3.514	3.884

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 2.52 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 2.52 is a Potential Statistical Outlier

Outlier Tests for Selected Variables

User Selected Options

From File	Upland Veg Values_combined.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	8

Rosner's Outlier Test for Molybdenum

Mean	**15.34**
Standard Deviation	**44.76**
Number of data	**52**
Number of suspected outliers	**8**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	15.34	44.33	240	14	5.068	3.144	3.496
2	10.93	31.85	206	17	6.125	3.134	3.486
3	7.031	15.59	99.6	2	5.938	3.126	3.478
4	5.141	8.117	50.2	38	5.551	3.116	3.476
5	4.203	4.816	24.4	1	4.194	3.106	3.466
6	3.773	3.826	20.6	50	4.398	3.098	3.455
7	3.407	2.922	17.3	52	4.755	3.091	3.444
8	3.098	2.061	10.4	31	3.544	3.083	3.432

For 5% significance level, there are 8 Potential Outliers

Therefore, Potential Statistical Outliers are

240, 206, 99.6, 50.2, 24.4, 20.6, 17.3, 10.4

For 1% Significance Level, there are 8 Potential Outliers

Therefore, Potential Statistical Outliers are

240, 206, 99.6, 50.2, 24.4, 20.6, 17.3, 10.4

COMBINED UPLAND VEGETATION – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Upland Veg Values_combined.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	160	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	159
		Percent Non-Detects	99.38%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Antimony was not processed!

Boron_1

General Statistics

Number of Valid Data	159	Number of Detected Data	155
Number of Distinct Detected Data	125	Number of Non-Detect Data	4
Number of Missing Values	1	Percent Non-Detects	2.52%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2.76	Minimum Detected	1.015
Maximum Detected	68.3	Maximum Detected	4.224
Mean of Detected	21.18	Mean of Detected	2.883
SD of Detected	12.09	SD of Detected	0.615
Minimum Non-Detect	2.5	Minimum Non-Detect	0.916
Maximum Non-Detect	43.1	Maximum Non-Detect	3.764

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	151
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	8
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	94.97%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.0965	Lilliefors Test Statistic	0.0632
5% Lilliefors Critical Value	0.0712	5% Lilliefors Critical Value	0.0712
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	20.84	Mean	2.846
SD	12.21	SD	0.672
95% DL/2 (t) UCL	22.44	95% H-Stat (DL/2) UCL	23.92

Maximum Likelihood Estimate(MLE) Method	
Mean	11.31
SD	19.34
95% MLE (t) UCL	13.85
95% MLE (Tiku) UCL	29.47

Log ROS Method	
Mean in Log Scale	2.857
SD in Log Scale	0.636
Mean in Original Scale	20.85
SD in Original Scale	12.15
95% t UCL	22.44
95% Percentile Bootstrap UCL	22.35
95% BCA Bootstrap UCL	22.62
95% H UCL	23.48

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	3.035
Theta Star	6.98
nu star	940.9
A-D Test Statistic	0.365
5% A-D Critical Value	0.759
K-S Test Statistic	0.759
5% K-S Critical Value	0.0757

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	68.3
Mean	20.79
Median	19.3
SD	12.28
k star	1.195
Theta star	17.39
Nu star	380.1
AppChi2	335.9
95% Gamma Approximate UCL	23.53
95% Adjusted Gamma UCL	23.55

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	20.84
SD	12.16
SE of Mean	0.97
95% KM (t) UCL	22.45
95% KM (z) UCL	22.44
95% KM (jackknife) UCL	22.45
95% KM (bootstrap t) UCL	22.58
95% KM (BCA) UCL	22.27
95% KM (Percentile Bootstrap) UCL	22.4
95% KM (Chebyshev) UCL	25.07
97.5% KM (Chebyshev) UCL	26.9
99% KM (Chebyshev) UCL	30.49

Potential UCLs to Use

95% KM (BCA) UCL	22.27

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cadmium_1

General Statistics

Number of Valid Data	159	Number of Detected Data	147
Number of Distinct Detected Data	136	Number of Non-Detect Data	12
Number of Missing Values	1	Percent Non-Detects	7.55%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0248	Minimum Detected	-3.697
Maximum Detected	1.95	Maximum Detected	0.668
Mean of Detected	0.343	Mean of Detected	-1.651
SD of Detected	0.419	SD of Detected	1.081

Minimum Non-Detect	0.0225	Minimum Non-Detect	-3.794
Maximum Non-Detect	0.0496	Maximum Non-Detect	-3.004

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	27
Number treated as Detected	132
Single DL Non-Detect Percentage	16.98%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.24
5% Lilliefors Critical Value	0.0731

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0513
5% Lilliefors Critical Value	0.0731

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.318
SD	0.412
95% DL/2 (t) UCL	0.372

Maximum Likelihood Estimate(MLE) Method

Mean	0.271
SD	0.466
95% MLE (t) UCL	0.332
95% MLE (Tiku) UCL	0.331

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-1.855
SD	1.265
95% H-Stat (DL/2) UCL	0.446

Log ROS Method

Mean in Log Scale	-1.833
SD in Log Scale	1.221
Mean in Original Scale	0.318
SD in Original Scale	0.412
95% t UCL	0.372
95% Percentile Bootstrap UCL	0.372
95% BCA Bootstrap UCL	0.376
95% H UCL	0.427

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.98
Theta Star	0.35
nu star	288.1
A-D Test Statistic	3.026
5% A-D Critical Value	0.784
K-S Test Statistic	0.784
5% K-S Critical Value	0.0796

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	1.95
Mean	0.317
Median	0.158
SD	0.413
k star	0.45
Theta star	0.705
Nu star	143.1
AppChi2	116.4
95% Gamma Approximate UCL	0.389
95% Adjusted Gamma UCL	0.39

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.319
SD	0.41
SE of Mean	0.0326
95% KM (t) UCL	0.373
95% KM (z) UCL	0.372
95% KM (jackknife) UCL	0.373
95% KM (bootstrap t) UCL	0.383
95% KM (BCA) UCL	0.374
95% KM (Percentile Bootstrap) UCL	0.374
95% KM (Chebyshev) UCL	0.461
97.5% KM (Chebyshev) UCL	0.522
99% KM (Chebyshev) UCL	0.643

Potential UCLs to Use

95% KM (Chebyshev) UCL	0.461

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Mercury

General Statistics

Number of Valid Data	145	Number of Detected Data	22
Number of Distinct Detected Data	21	Number of Non-Detect Data	123
Number of Missing Values	15	Percent Non-Detects	84.83%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.00946	Minimum Detected	-4.661
Maximum Detected	0.0876	Maximum Detected	-2.435
Mean of Detected	0.0325	Mean of Detected	-3.624
SD of Detected	0.022	SD of Detected	0.639
Minimum Non-Detect	0.00867	Minimum Non-Detect	-4.748
Maximum Non-Detect	0.0498	Maximum Non-Detect	-3

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	141
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	4
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	97.24%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.858	Shapiro Wilk Test Statistic	0.968
5% Shapiro Wilk Critical Value	0.911	5% Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0117	Mean	-4.756
SD	0.013	SD	0.695
95% DL/2 (t) UCL	0.0135	95% H-Stat (DL/2) UCL	0.0123
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-5.63
		SD in Log Scale	1.034
		Mean in Original Scale	0.00743
		SD in Original Scale	0.0137
		95% t UCL	0.00931
		95% Percentile Bootstrap UCL	0.00935
		95% BCA Bootstrap UCL	0.00967
		95% H-UCL	0.00742

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	2.342	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.0139	
nu star	103.1	

A-D Test Statistic	0.445
5% A-D Critical Value	0.752
K-S Test Statistic	0.752
5% K-S Critical Value	0.187

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.0876
Mean	0.00494
Median	0.000001
SD	0.0144
k star	0.117
Theta star	0.0422
Nu star	33.9
AppChi2	21.58
95% Gamma Approximate UCL	0.00775
95% Adjusted Gamma UCL	0.00779

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0132
SD	0.0118
SE of Mean	0.00102
95% KM (t) UCL	0.0149
95% KM (z) UCL	0.0148
95% KM (jackknife) UCL	0.0146
95% KM (bootstrap t) UCL	0.0151
95% KM (BCA) UCL	0.0175
95% KM (Percentile Bootstrap) UCL	0.0163
95% KM (Chebyshev) UCL	0.0176
97.5% KM (Chebyshev) UCL	0.0195
99% KM (Chebyshev) UCL	0.0233

Potential UCLs to Use

95% KM (t) UCL	0.0149

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Molybdenum_2

General Statistics

Number of Valid Data	152	Number of Detected Data	44
Number of Distinct Detected Data	39	Number of Non-Detect Data	108
Number of Missing Values	7	Percent Non-Detects	71.05%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.48	Minimum Detected	0.392
Maximum Detected	8.91	Maximum Detected	2.187
Mean of Detected	2.933	Mean of Detected	0.955
SD of Detected	1.754	SD of Detected	0.456
Minimum Non-Detect	1.39	Minimum Non-Detect	0.329
Maximum Non-Detect	25.9	Maximum Non-Detect	3.254

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	152
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.714	Shapiro Wilk Test Statistic	0.863
5% Shapiro Wilk Critical Value	0.944	5% Shapiro Wilk Critical Value	0.944
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution	Assuming Lognormal Distribution
DL/2 Substitution Method	DL/2 Substitution Method

Mean	1.612
SD	1.708
95% DL/2 (t) UCL	1.841

Mean	0.194
SD	0.664
95% H-Stat (DL/2) UCL	1.681

Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Log ROS Method	
Mean in Log Scale	0.0185
SD in Log Scale	0.757
Mean in Original Scale	1.391
SD in Original Scale	1.383
95% t UCL	1.577
95% Percentile Bootstrap UCL	1.588
95% BCA Bootstrap UCL	1.622
95% H-UCL	1.534

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	4.029
Theta Star	0.728
nu star	354.6
A-D Test Statistic	2.811
5% A-D Critical Value	0.753
K-S Test Statistic	0.753
5% K-S Critical Value	0.134

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	8.91
Mean	0.852
Median	0.000001
SD	1.629
k star	0.092
Theta star	9.263
Nu star	27.96
AppChi2	16.89
95% Gamma Approximate UCL	1.41
95% Adjusted Gamma UCL	1.416

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	1.928
SD	1.15
SE of Mean	0.0957
95% KM (t) UCL	2.087
95% KM (z) UCL	2.086
95% KM (jackknife) UCL	2.061
95% KM (bootstrap t) UCL	2.122
95% KM (BCA) UCL	2.178
95% KM (Percentile Bootstrap) UCL	2.14
95% KM (Chebyshev) UCL	2.346
97.5% KM (Chebyshev) UCL	2.526
99% KM (Chebyshev) UCL	2.881

Potential UCLs to Use

95% KM (t) UCL	2.087
95% KM (% Bootstrap) UCL	2.14

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Selenium

General Statistics

Number of Valid Data	160	Number of Detected Data	141
Number of Distinct Detected Data	132	Number of Non-Detect Data	19
		Percent Non-Detects	11.88%

Raw Statistics

Log-transformed Statistics

Minimum Detected	0.0992	Minimum Detected	-2.311
Maximum Detected	7.28	Maximum Detected	1.985
Mean of Detected	0.612	Mean of Detected	-0.915
SD of Detected	0.892	SD of Detected	0.814
Minimum Non-Detect	0.0911	Minimum Non-Detect	-2.396
Maximum Non-Detect	0.379	Maximum Non-Detect	-0.97

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	93
Number treated as Detected	67
Single DL Non-Detect Percentage	58.13%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.283
5% Lilliefors Critical Value	0.0746

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.091
5% Lilliefors Critical Value	0.0746

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.546
SD	0.856
95% DL/2 (t) UCL	0.658

Maximum Likelihood Estimate(MLE) Method	N/A

MLE yields a negative mean

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-1.152
SD	1.009
95% H-Stat (DL/2) UCL	0.628

Log ROS Method

Mean in Log Scale	-1.118
SD in Log Scale	0.95
Mean in Original Scale	0.548
SD in Original Scale	0.855
95% t UCL	0.66
95% Percentile Bootstrap UCL	0.671
95% BCA Bootstrap UCL	0.692
95% H-UCL	0.604

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.298
Theta Star	0.471
nu star	366.1

A-D Test Statistic	5.803
5% A-D Critical Value	0.775
K-S Test Statistic	0.775
5% K-S Critical Value	0.0807

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	7.28
Mean	0.54
Median	0.318
SD	0.86
k star	0.375
Theta star	1.441

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.552
SD	0.85
SE of Mean	0.0675
95% KM (t) UCL	0.664
95% KM (z) UCL	0.663
95% KM (jackknife) UCL	0.663
95% KM (bootstrap t) UCL	0.716
95% KM (BCA) UCL	0.684
95% KM (Percentile Bootstrap) UCL	0.669
95% KM (Chebyshev) UCL	0.846
97.5% KM (Chebyshev) UCL	0.973
99% KM (Chebyshev) UCL	1.223

Nu star	119.9	**Potential UCLs to Use**	
AppChi2	95.59	95% KM (BCA) UCL	0.684
95% Gamma Approximate UCL	0.677		
95% Adjusted Gamma UCL	0.678		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Silver_2

General Statistics

Number of Valid Data	158	Number of Detected Data	19
Number of Distinct Detected Data	19	Number of Non-Detect Data	139
Number of Missing Values	2	Percent Non-Detects	87.97%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0505	Minimum Detected	-2.986
Maximum Detected	0.598	Maximum Detected	-0.514
Mean of Detected	0.17	Mean of Detected	-2.022
SD of Detected	0.139	SD of Detected	0.7
Minimum Non-Detect	0.0433	Minimum Non-Detect	-3.14
Maximum Non-Detect	0.245	Maximum Non-Detect	-1.406

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	154
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	4
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	97.47%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.787	Shapiro Wilk Test Statistic	0.954
5% Shapiro Wilk Critical Value	0.901	5% Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0435	Mean	-3.478
SD	0.0672	SD	0.621
95% DL/2 (t) UCL	0.0523	95% H-Stat (DL/2) UCL	0.0411
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-4.82
		SD in Log Scale	1.379
		Mean in Original Scale	0.0276
		SD in Original Scale	0.0711
		95% t UCL	0.0369
		95% Percentile Bootstrap UCL	0.0375
		95% BCA Bootstrap UCL	0.0396
		95% H-UCL	0.0277

Gamma Distribution Test with Detected Values Only	**Data Distribution Test with Detected Values Only**

k star (bias corrected)	1.847
Theta Star	0.0921
nu star	70.17

Data appear Gamma Distributed at 5% Significance Level

A-D Test Statistic	0.579
5% A-D Critical Value	0.751
K-S Test Statistic	0.751
5% K-S Critical Value	0.201

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.598
Mean	0.0204
Median	0.000001
SD	0.0727
k star	0.0984
Theta star	0.208
Nu star	31.08
AppChi2	19.34
95% Gamma Approximate UCL	0.0329
95% Adjusted Gamma UCL	0.033

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.065
SD	0.061
SE of Mean	0.00499
95% KM (t) UCL	0.0732
95% KM (z) UCL	0.0732
95% KM (jackknife) UCL	0.0717
95% KM (bootstrap t) UCL	0.0768
95% KM (BCA) UCL	0.0859
95% KM (Percentile Bootstrap) UCL	0.0786
95% KM (Chebyshev) UCL	0.0867
97.5% KM (Chebyshev) UCL	0.0961
99% KM (Chebyshev) UCL	0.115

Potential UCLs to Use

95% KM (t) UCL	0.0732

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Thallium

General Statistics

Number of Valid Data	160	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	153
		Percent Non-Detects	95.63%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0109	Minimum Detected	-4.519
Maximum Detected	0.0257	Maximum Detected	-3.661
Mean of Detected	0.0159	Mean of Detected	-4.19
SD of Detected	0.0058	SD of Detected	0.333
Minimum Non-Detect	0.00867	Minimum Non-Detect	-4.748
Maximum Non-Detect	0.049	Maximum Non-Detect	-3.016

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	160
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 7 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.816
5% Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.861
5% Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.00566
SD	0.00319
95% DL/2 (t) UCL	0.00608
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-5.243
SD	0.305
95% H-Stat (DL/2) UCL	0.00577
Log ROS Method	
Mean in Log Scale	-6.277
SD in Log Scale	0.737
Mean in Original Scale	0.00263
SD in Original Scale	0.00329
95% t UCL	0.00306
95% Percentile Bootstrap UCL	0.00308
95% BCA Bootstrap UCL	0.00316
95% H-UCL	0.00277

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.842
Theta Star	0.00273
nu star	81.78
A-D Test Statistic	0.603
5% A-D Critical Value	0.708
K-S Test Statistic	0.708
5% K-S Critical Value	0.312

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.0257
Mean	0.0006978
Median	0.000001
SD	0.00346
k star	0.13
Theta star	0.00537
Nu star	41.61
AppChi2	27.82
95% Gamma Approximate UCL	0.00104
95% Adjusted Gamma UCL	0.00105

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0111
SD	0.00153
SE of Mean	0.0001318
95% KM (t) UCL	0.0113
95% KM (z) UCL	0.0113
95% KM (jackknife) UCL	0.0116
95% KM (bootstrap t) UCL	0.0117
95% KM (BCA) UCL	0.0141
95% KM (Percentile Bootstrap) UCL	0.0141
95% KM (Chebyshev) UCL	0.0117
97.5% KM (Chebyshev) UCL	0.0119
99% KM (Chebyshev) UCL	0.0124

Potential UCLs to Use

95% KM (t) UCL	0.0113
95% KM (Percentile Bootstrap) UCL	0.0141

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Uranium, Total

General Statistics

Number of Valid Data	160	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	157
		Percent Non-Detects	98.13%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.101	Minimum Detected	-2.293
Maximum Detected	0.162	Maximum Detected	-1.82
Mean of Detected	0.124	Mean of Detected	-2.113
SD of Detected	0.0334	SD of Detected	0.256
Minimum Non-Detect	0.0867	Minimum Non-Detect	-2.445
Maximum Non-Detect	0.49	Maximum Non-Detect	-0.713

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	160
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.835	Shapiro Wilk Test Statistic	0.854
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0532	Mean	-2.973
SD	0.0228	SD	0.229
95% DL/2 (t) UCL	0.0562	95% H-Stat (DL/2) UCL	0.0542
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.118
		SD in Log Scale	0.581
		Mean in Original Scale	0.0198
		SD in Original Scale	0.0175
		95% t UCL	0.0221
		95% Percentile Bootstrap UCL	0.0222
		95% BCA Bootstrap UCL	0.0228
		95% H-UCL	0.021

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.101
SD	0.00491
SE of Mean	0.0004833
95% KM (t) UCL	0.102
95% KM (z) UCL	0.102
95% KM (jackknife) UCL	0.106
95% KM (bootstrap t) UCL	0.104
95% KM (BCA) UCL	0.162
95% KM (Percentile Bootstrap) UCL	N/A
95% KM (Chebyshev) UCL	0.104
97.5% KM (Chebyshev) UCL	0.104
99% KM (Chebyshev) UCL	0.106

Potential UCLs to Use

95% KM (t) UCL	0.102
95% KM (Percentile Bootstrap) UCL	N/A

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

COMBINED UPLAND VEGETATION – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Upland Veg Values_combined.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	160	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	159

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Antimony was not processed!

Boron_1

General Statistics

Number of Valid Data	159	Number of Detected Data	155
Number of Distinct Detected Data	125	Number of Non-Detect Data	4
Tolerance Factor	1.861	Percent Non-Detects	2.52%
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2.76	Minimum Detected	1.015
Maximum Detected	68.3	Maximum Detected	4.224
Mean of Detected	21.18	Mean of Detected	2.883
SD of Detected	12.09	SD of Detected	0.615
Minimum Non-Detect	2.5	Minimum Non-Detect	0.916
Maximum Non-Detect	43.1	Maximum Non-Detect	3.764

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	151
Number treated as Detected with Single DL	8
Single DL Non-Detect Percentage	94.97%

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.0965	Lilliefors Test Statistic	0.0632
5% Lilliefors Critical Value	0.0712	5% Lilliefors Critical Value	0.0712
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	20.84	Mean (Log Scale)	2.846

SD	12.21
95% UTL 95% Coverage	43.55
95% UPL (t)	41.09
90% Percentile (z)	36.48
95% Percentile (z)	40.91
99% Percentile (z)	49.23

SD (Log Scale)	0.672
95% UTL 95% Coverage	60.06
95% UPL (t)	52.47
90% Percentile (z)	40.7
95% Percentile (z)	51.95
99% Percentile (z)	82.1

Maximum Likelihood Estimate(MLE) Method

Mean	11.31
SD	19.34
95% UTL with 95% Coverage	47.3
95% UPL (t)	43.41
90% Percentile (z)	36.1
95% Percentile (z)	43.13
99% Percentile (z)	56.31

Log ROS Method

Mean in Original Scale	20.85
SD in Original Scale	12.15
95% UTL with 95% Coverage	56.83
95% BCA UTL with 95% Coverage	47.8
95% Bootstrap (%) UTL with 95% Coverage	47.8
95% UPL (t)	50.01
90% Percentile (z)	39.32
95% Percentile (z)	49.53
99% Percentile (z)	76.39

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	3.035
Theta Star	6.98
nu star	940.9
A-D Test Statistic	0.365
5% A-D Critical Value	0.759
K-S Test Statistic	0.0525
5% K-S Critical Value	0.0757

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	20.79
Median	19.3
SD	12.28
k star	1.195
Theta star	17.39
Nu star	380.1
95% Percentile of Chisquare (2k)	6.728
90% Percentile	45.81
95% Percentile	58.52
99% Percentile	87.64

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	20.84
SD	12.16
SE of Mean	0.97
95% KM UTL with 95% Coverage	43.48
95% KM Chebyshev UPL	74.02
95% KM UPL (t)	41.03
90% Percentile (z)	36.43
95% Percentile (z)	40.85
99% Percentile (z)	49.14

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	49.39
95% Hawkins Wixley (HW) Approx. Gamma UPL	55.49
95% WH Approx. Gamma UTL with 95% Coverage	54.71
95% HW Approx. Gamma UTL with 95% Coverage	62.58

Note: DL/2 is not a recommended method.

Cadmium_1

General Statistics

Number of Valid Data	159
Number of Detected Data	147
Number of Distinct Detected Data	136
Number of Non-Detect Data	12
Tolerance Factor	1.861
Percent Non-Detects	7.55%
Number of Missing Values	1

Raw Statistics

Minimum Detected	0.0248
Maximum Detected	1.95
Mean of Detected	0.343
SD of Detected	0.419
Minimum Non-Detect	0.0225
Maximum Non-Detect	0.0496

Log-transformed Statistics

Minimum Detected	-3.697
Maximum Detected	0.668
Mean of Detected	-1.651
SD of Detected	1.081
Minimum Non-Detect	-3.794
Maximum Non-Detect	-3.004

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	27
Number treated as Detected with Single DL	132
Single DL Non-Detect Percentage	16.98%

Background Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.24
5% Lilliefors Critical Value	0.0731

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0513
5% Lilliefors Critical Value	0.0731

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.318
	SD	0.412
95% UTL	95% Coverage	1.084
	95% UPL (t)	1.001
	90% Percentile (z)	0.846
	95% Percentile (z)	0.995
	99% Percentile (z)	1.276

Maximum Likelihood Estimate(MLE) Method

	Mean	0.271
	SD	0.466
95% UTL with	95% Coverage	1.138
	95% UPL (t)	1.044
	90% Percentile (z)	0.868
	95% Percentile (z)	1.037
	99% Percentile (z)	1.354

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-1.855
	SD (Log Scale)	1.265
95% UTL	95% Coverage	1.646
	95% UPL (t)	1.276
	90% Percentile (z)	0.791
	95% Percentile (z)	1.253
	99% Percentile (z)	2.966

Log ROS Method

	Mean in Original Scale	0.318
	SD in Original Scale	0.412
95% UTL with	95% Coverage	1.552
95% BCA UTL with	95% Coverage	1.61
95% Bootstrap (%) UTL with	95% Coverage	1.61
	95% UPL (t)	1.214
	90% Percentile (z)	0.765
	95% Percentile (z)	1.192
	99% Percentile (z)	2.741

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.98
Theta Star	0.35
nu star	288.1
A-D Test Statistic	3.026
5% A-D Critical Value	0.784
K-S Test Statistic	0.105
5% K-S Critical Value	0.0796

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.319
	SD	0.41
	SE of Mean	0.0326
95% KM UTL with	95% Coverage	1.081
	95% KM Chebyshev UPL	2.111

Gamma ROS Statistics with Extrapolated Data	
Mean	0.317
Median	0.158
SD	0.413
k star	0.45
Theta star	0.705
Nu star	143.1
95% Percentile of Chisquare (2k)	3.588
90% Percentile	0.876
95% Percentile	1.264
99% Percentile	2.228

95% KM UPL (t)	0.999
90% Percentile (z)	0.844
95% Percentile (z)	0.993
99% Percentile (z)	1.272

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	1.077
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.247
95% WH Approx. Gamma UTL with 95% Coverage	1.26
95% HW Approx. Gamma UTL with 95% Coverage	1.504

Note: DL/2 is not a recommended method.

Mercury

General Statistics

Number of Valid Data	145
Number of Distinct Detected Data	21
Tolerance Factor	1.872
Number of Missing Values	15

Number of Detected Data	22
Number of Non-Detect Data	123
Percent Non-Detects	84.83%

Raw Statistics

Minimum Detected	0.00946
Maximum Detected	0.0876
Mean of Detected	0.0325
SD of Detected	0.022
Minimum Non-Detect	0.00867
Maximum Non-Detect	0.0498

Log-transformed Statistics

Minimum Detected	-4.661
Maximum Detected	-2.435
Mean of Detected	-3.624
SD of Detected	0.639
Minimum Non-Detect	-4.748
Maximum Non-Detect	-3

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	141
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	97.24%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.858
5% Shapiro Wilk Critical Value	0.911

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.968
5% Shapiro Wilk Critical Value	0.911

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.0117
SD		0.013
95% UTL	95% Coverage	0.0362
95% UPL (t)		0.0334
90% Percentile (z)		0.0285
95% Percentile (z)		0.0332
99% Percentile (z)		0.0421

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-4.756
SD (Log Scale)		0.695
95% UTL	95% Coverage	0.0316
95% UPL (t)		0.0273
90% Percentile (z)		0.021
95% Percentile (z)		0.027
99% Percentile (z)		0.0433

Maximum Likelihood Estimate(MLE) Method	
Mean	-0.0534
SD	0.054
95% UTL with 95% Coverage	0.0476
95% UPL (t)	0.0363
90% Percentile (z)	0.0158
95% Percentile (z)	0.0354
99% Percentile (z)	0.0722

Log ROS Method	
Mean in Original Scale	0.00743
SD in Original Scale	0.0137
95% UTL with 95% Coverage	0.0249
95% BCA UTL with 95% Coverage	0.0482
95% Bootstrap (%) UTL with 95% Coverage	0.0482
95% UPL (t)	0.02
90% Percentile (z)	0.0135
95% Percentile (z)	0.0197
99% Percentile (z)	0.0398

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.342
Theta Star	0.0139
nu star	103.1
A-D Test Statistic	0.445
5% A-D Critical Value	0.752
K-S Test Statistic	0.139
5% K-S Critical Value	0.187

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data	
Mean	0.00494
Median	0.000001
SD	0.0144
k star	0.117
Theta star	0.0422
Nu star	33.9
95% Percentile of Chisquare (2k)	1.338
90% Percentile	0.0139
95% Percentile	0.0283
99% Percentile	0.0724

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0132
SD	0.0118
SE of Mean	0.00102
95% KM UTL with 95% Coverage	0.0353
95% KM Chebyshev UPL	0.0649
95% KM UPL (t)	0.0328
90% Percentile (z)	0.0283
95% Percentile (z)	0.0326
99% Percentile (z)	0.0407

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.0132
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0103
95% WH Approx. Gamma UTL with 95% Coverage	0.0175
95% HW Approx. Gamma UTL with 95% Coverage	0.0146

Note: DL/2 is not a recommended method.

Molybdenum_2

General Statistics

Number of Valid Data	152
Number of Detected Data	44
Number of Distinct Detected Data	39
Number of Non-Detect Data	108
Tolerance Factor	1.866
Percent Non-Detects	71.05%
Number of Missing Values	7

Raw Statistics

Minimum Detected	1.48
Maximum Detected	8.91
Mean of Detected	2.933
SD of Detected	1.754
Minimum Non-Detect	1.39

Log-transformed Statistics

Minimum Detected	0.392
Maximum Detected	2.187
Mean of Detected	0.955
SD of Detected	0.456
Minimum Non-Detect	0.329

Maximum Non-Detect 25.9

Maximum Non-Detect 3.254

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL 152

Number treated as Detected with Single DL 0

Single DL Non-Detect Percentage 100.00%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic 0.714

5% Shapiro Wilk Critical Value 0.944

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic 0.863

5% Shapiro Wilk Critical Value 0.944

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean 1.612

SD 1.708

95% UTL 95% Coverage 4.8

95% UPL (t) 4.448

90% Percentile (z) 3.801

95% Percentile (z) 4.422

99% Percentile (z) 5.586

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale) 0.194

SD (Log Scale) 0.664

95% UTL 95% Coverage 4.195

95% UPL (t) 3.659

90% Percentile (z) 2.845

95% Percentile (z) 3.621

99% Percentile (z) 5.694

Log ROS Method

Mean in Original Scale 1.391

SD in Original Scale 1.383

Mean in Log Scale 0.0185

SD in Log Scale 0.757

95% UTL 95% Coverage 4.18

95% UPL (t) 3.578

90% Percentile (z) 2.686

95% Percentile (z) 3.536

99% Percentile (z) 5.921

Gamma Distribution Test with Detected Values Only

k star (bias corrected) 4.029

Theta Star 0.728

nu star 354.6

A-D Test Statistic 2.811

5% A-D Critical Value 0.753

K-S Test Statistic 0.204

5% K-S Critical Value 0.134

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean 0.852

Median 0.000001

SD 1.629

k star 0.092

Theta star 9.263

Nu star 27.96

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean 1.928

SD 1.15

SE of Mean 0.0957

95% KM UTL with 95% Coverage 4.075

95% KM Chebyshev UPL 6.957

95% KM UPL (t) 3.838

90% Percentile (z) 3.402

95% Percentile (z) 3.82

99% Percentile (z) 4.604

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL 3.238

95% Percentile of Chisquare (2k)	1.071	95% Hawkins Wixley (HW) Approx. Gamma UPL	3.342
		95% WH Approx. Gamma UTL with 95% Coverage	4.181
90% Percentile	2.183	95% HW Approx. Gamma UTL with 95% Coverage	4.669
95% Percentile	4.961		
99% Percentile	14.1		

Note: DL/2 is not a recommended method.

Selenium

General Statistics

Number of Valid Data	160	Number of Detected Data	141
Number of Distinct Detected Data	132	Number of Non-Detect Data	19
Tolerance Factor	1.86	Percent Non-Detects	11.88%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0992	Minimum Detected	-2.311
Maximum Detected	7.28	Maximum Detected	1.985
Mean of Detected	0.612	Mean of Detected	-0.915
SD of Detected	0.892	SD of Detected	0.814
Minimum Non-Detect	0.0911	Minimum Non-Detect	-2.396
Maximum Non-Detect	0.379	Maximum Non-Detect	-0.97

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	93
Number treated as Detected with Single DL	67
Single DL Non-Detect Percentage	58.13%

Background Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.283
5% Lilliefors Critical Value	0.0746

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.091
5% Lilliefors Critical Value	0.0746

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.546
SD		0.856
95% UTL	95% Coverage	2.139
95% UPL (t)		1.967
90% Percentile (z)		1.644
95% Percentile (z)		1.955
99% Percentile (z)		2.538

Maximum Likelihood Estimate(MLE) Method

Mean		-0.141
SD		1.444
95% UTL with	95% Coverage	2.546
95% UPL (t)		2.256
90% Percentile (z)		1.71

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-1.152
SD (Log Scale)		1.009
95% UTL	95% Coverage	2.065
95% UPL (t)		1.686
90% Percentile (z)		1.151
95% Percentile (z)		1.661
99% Percentile (z)		3.305

Log ROS Method

Mean in Original Scale		0.548
SD in Original Scale		0.855
95% UTL with	95% Coverage	1.913
95% BCA UTL with	95% Coverage	1.84
95% Bootstrap (%) UTL with	95% Coverage	3.18
95% UPL (t)		1.582
90% Percentile (z)		1.104

95% Percentile (z)	2.235
99% Percentile (z)	3.219

95% Percentile (z)	1.56
99% Percentile (z)	2.98

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.298
Theta Star	0.471
nu star	366.1
A-D Test Statistic	5.803
5% A-D Critical Value	0.775
K-S Test Statistic	0.15
5% K-S Critical Value	0.0807

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.552
SD	0.85
SE of Mean	0.0675
95% KM UTL with 95% Coverage	2.134
95% KM Chebyshev UPL	4.271
95% KM UPL (t)	1.963
90% Percentile (z)	1.642
95% Percentile (z)	1.951
99% Percentile (z)	2.53

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.54
Median	0.318
SD	0.86
k star	0.375
Theta star	1.441
Nu star	119.9
95% Percentile of Chisquare (2k)	3.184
90% Percentile	1.542
95% Percentile	2.294
99% Percentile	4.199

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	1.852
95% Hawkins Wixley (HW) Approx. Gamma UPL	2.251
95% WH Approx. Gamma UTL with 95% Coverage	2.168
95% HW Approx. Gamma UTL with 95% Coverage	2.731

Note: DL/2 is not a recommended method.

Silver_2

General Statistics

Number of Valid Data	158
Number of Distinct Detected Data	19
Tolerance Factor	1.862
Number of Missing Values	2

Number of Detected Data	19
Number of Non-Detect Data	139
Percent Non-Detects	87.97%

Raw Statistics

Minimum Detected	0.0505
Maximum Detected	0.598
Mean of Detected	0.17
SD of Detected	0.139
Minimum Non-Detect	0.0433
Maximum Non-Detect	0.245

Log-transformed Statistics

Minimum Detected	-2.986
Maximum Detected	-0.514
Mean of Detected	-2.022
SD of Detected	0.7
Minimum Non-Detect	-3.14
Maximum Non-Detect	-1.406

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	154
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	97.47%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.787
5% Shapiro Wilk Critical Value	0.901

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.954
5% Shapiro Wilk Critical Value	0.901

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0435
	SD	0.0672
95% UTL	95% Coverage	0.169
	95% UPL (t)	0.155
	90% Percentile (z)	0.13
	95% Percentile (z)	0.154
	99% Percentile (z)	0.2

Maximum Likelihood Estimate(MLE) Method

	Mean	-0.496
	SD	0.379
95% UTL with	95% Coverage	0.21
	95% UPL (t)	0.133
	90% Percentile (z)	-0.0101
	95% Percentile (z)	0.128
	99% Percentile (z)	0.386

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-3.478
	SD (Log Scale)	0.621
95% UTL	95% Coverage	0.0981
	95% UPL (t)	0.0865
	90% Percentile (z)	0.0684
	95% Percentile (z)	0.0857
	99% Percentile (z)	0.131

Log ROS Method

	Mean in Original Scale	0.0276
	SD in Original Scale	0.0711
95% UTL with	95% Coverage	0.105
95% BCA UTL with	95% Coverage	0.242
95% Bootstrap (%) UTL with	95% Coverage	0.242
	95% UPL (t)	0.0795
	90% Percentile (z)	0.0472
	95% Percentile (z)	0.0779
	99% Percentile (z)	0.199

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.847
Theta Star	0.0921
nu star	70.17
A-D Test Statistic	0.579
5% A-D Critical Value	0.751
K-S Test Statistic	0.172
5% K-S Critical Value	0.201

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

	Mean	0.0204
	Median	0.000001
	SD	0.0727
	k star	0.0984
	Theta star	0.208
	Nu star	31.08
95% Percentile of Chisquare (2k)		1.143
	90% Percentile	0.054
	95% Percentile	0.119
	99% Percentile	0.327

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.065
	SD	0.061
	SE of Mean	0.00499
95% KM UTL with	95% Coverage	0.178
	95% KM Chebyshev UPL	0.332
	95% KM UPL (t)	0.166
	90% Percentile (z)	0.143
	95% Percentile (z)	0.165
	99% Percentile (z)	0.207

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		0.0463
95% Hawkins Wixley (HW) Approx. Gamma UPL		0.0318
95% WH Approx. Gamma UTL with	95% Coverage	0.0612
95% HW Approx. Gamma UTL with	95% Coverage	0.0452

Note: DL/2 is not a recommended method.

Thallium

General Statistics

Number of Valid Data	160	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	153
Tolerance Factor	1.86	Percent Non-Detects	95.63%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0109	Minimum Detected	-4.519
Maximum Detected	0.0257	Maximum Detected	-3.661
Mean of Detected	0.0159	Mean of Detected	-4.19
SD of Detected	0.0058	SD of Detected	0.333
Minimum Non-Detect	0.00867	Minimum Non-Detect	-4.748
Maximum Non-Detect	0.049	Maximum Non-Detect	-3.016

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	160
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.816
5% Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.861
5% Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.00566
	SD	0.00319
95% UTL	95% Coverage	0.0116
	95% UPL (t)	0.011
	90% Percentile (z)	0.00975
	95% Percentile (z)	0.0109
	99% Percentile (z)	0.0131

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-5.243
	SD (Log Scale)	0.305
95% UTL	95% Coverage	0.00931
	95% UPL (t)	0.00876
	90% Percentile (z)	0.00781
	95% Percentile (z)	0.00872
	99% Percentile (z)	0.0107

Log ROS Method

	Mean in Original Scale	0.00263
	SD in Original Scale	0.00329
	Mean in Log Scale	-6.277
	SD in Log Scale	0.737
95% UTL	95% Coverage	0.0074
	95% UPL (t)	0.00638
	90% Percentile (z)	0.00483
	95% Percentile (z)	0.00631

99% Percentile (z)	0.0104

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.842
Theta Star	0.00273
nu star	81.78
A-D Test Statistic	0.603
5% A-D Critical Value	0.708
K-S Test Statistic	0.289
5% K-S Critical Value	0.312

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0111
SD	0.00153
SE of Mean	0.0001318
95% KM UTL with 95% Coverage	0.014
95% KM Chebyshev UPL	0.0178
95% KM UPL (t)	0.0137
90% Percentile (z)	0.0131
95% Percentile (z)	0.0136
99% Percentile (z)	0.0147

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0006978
Median	0.000001
SD	0.00346
k star	0.13
Theta star	0.00537
Nu star	41.61
95% Percentile of Chisquare (2k)	1.467
90% Percentile	0.00202
95% Percentile	0.00394
99% Percentile	0.00969

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00107
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0005789
95% WH Approx. Gamma UTL with 95% Coverage	0.00141
95% HW Approx. Gamma UTL with 95% Coverage	0.0008031

Note: DL/2 is not a recommended method.

Uranium, Total

General Statistics

Number of Valid Data	160	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	157

Warning: Data set has only 3 Detected Values.

This is not enough to compute meaningful and reliable test statistics and estimates.

No statistics will be produced!

Tolerance Factor	1.86	Percent Non-Detects	98.13%

Raw Statistics

Minimum Detected	0.101
Maximum Detected	0.162
Mean of Detected	0.124
SD of Detected	0.0334
Minimum Non-Detect	0.0867
Maximum Non-Detect	0.49

Log-transformed Statistics

Minimum Detected	-2.293
Maximum Detected	-1.82
Mean of Detected	-2.113
SD of Detected	0.256
Minimum Non-Detect	-2.445
Maximum Non-Detect	-0.713

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	160
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.835
5% Shapiro Wilk Critical Value	0.767

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.854
5% Shapiro Wilk Critical Value	0.767

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0532
	SD	0.0228
95% UTL	95% Coverage	0.0955
	95% UPL (t)	0.091
	90% Percentile (z)	0.0824
	95% Percentile (z)	0.0906
	99% Percentile (z)	0.106

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-2.973
	SD (Log Scale)	0.229
95% UTL	95% Coverage	0.0784
	95% UPL (t)	0.0749
	90% Percentile (z)	0.0686
	95% Percentile (z)	0.0746
	99% Percentile (z)	0.0872

Log ROS Method

	Mean in Original Scale	0.0198
	SD in Original Scale	0.0175
	Mean in Log Scale	-4.118
	SD in Log Scale	0.581
95% UTL	95% Coverage	0.048
	95% UPL (t)	0.0427
	90% Percentile (z)	0.0343
	95% Percentile (z)	0.0423
	99% Percentile (z)	0.0629

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	N/A
Median	N/A
SD	N/A

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.101
	SD	0.00491
	SE of Mean	0.0004833
95% KM UTL with	95% Coverage	0.111
	95% KM Chebyshev UPL	0.123
	95% KM UPL (t)	0.11
	90% Percentile (z)	0.108
	95% Percentile (z)	0.11
	99% Percentile (z)	0.113

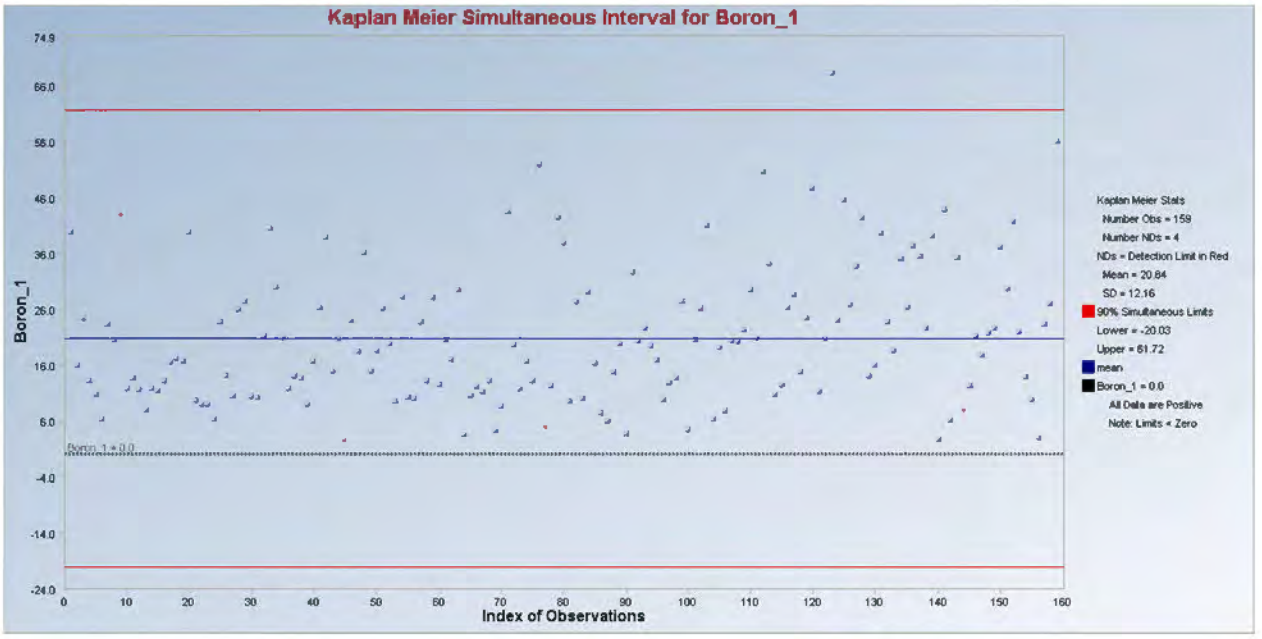
k star	N/A
Theta star	N/A
Nu star	N/A
95% Percentile of Chisquare (2k)	N/A
90% Percentile	N/A
95% Percentile	N/A
99% Percentile	N/A

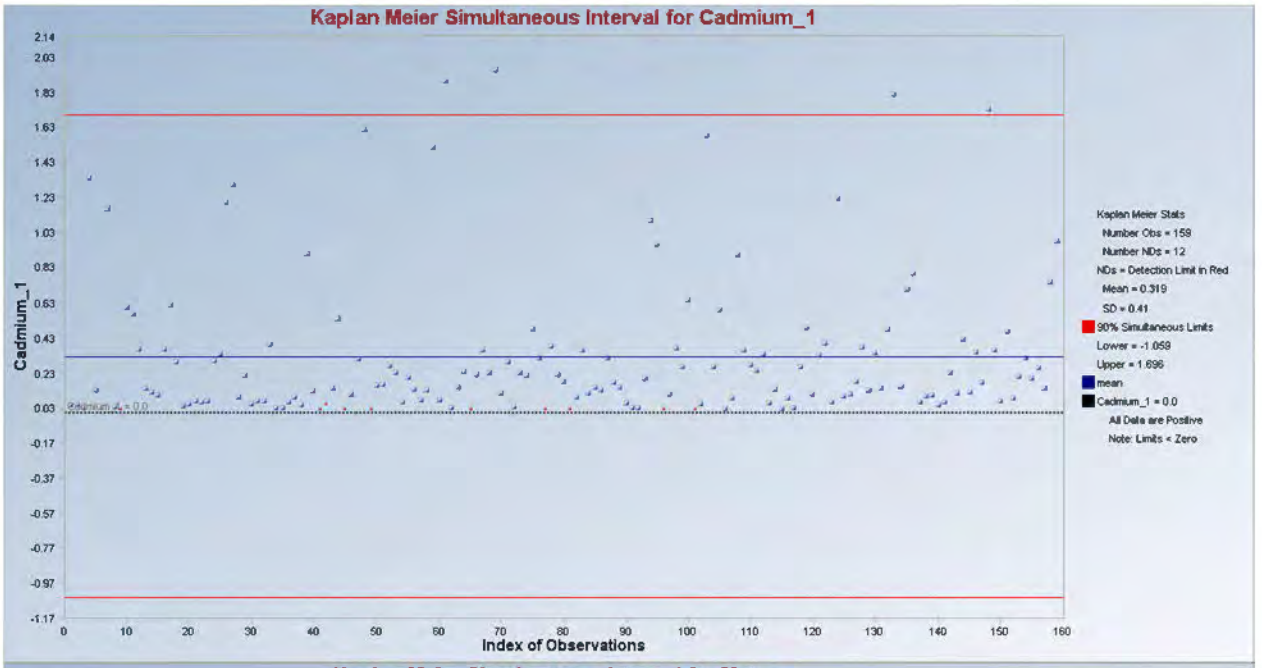
Gamma ROS Limits with Extrapolated Data

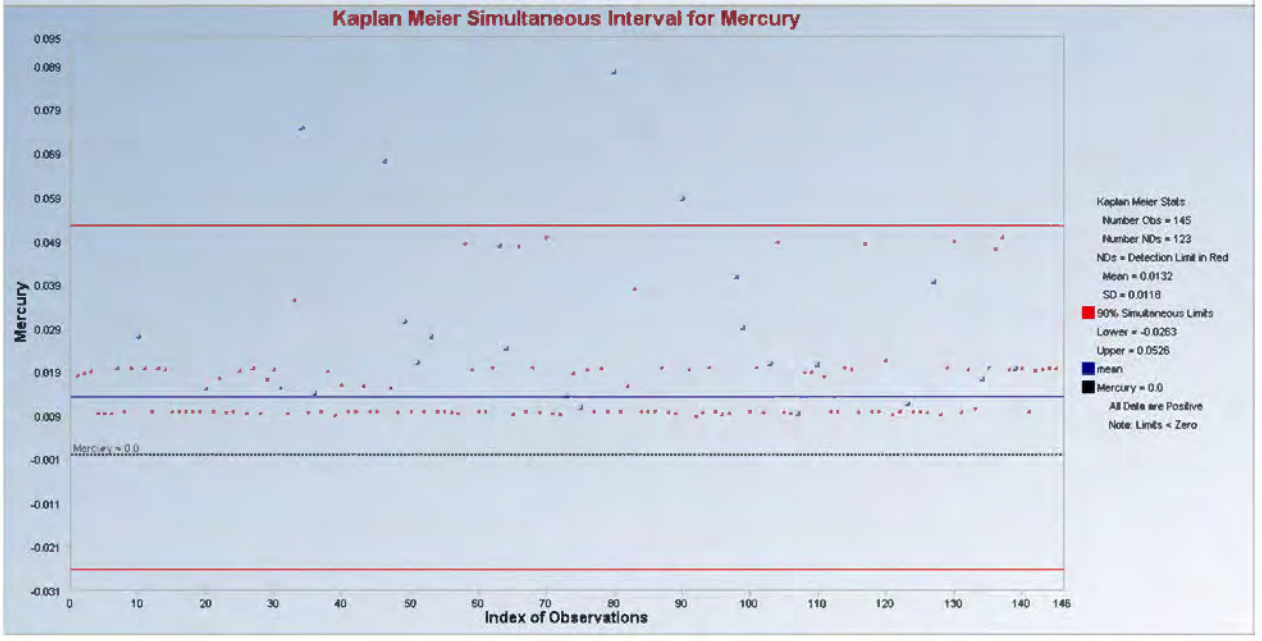
95% Wilson Hilferty (WH) Approx. Gamma UPL	N/A
95% Hawkins Wixley (HW) Approx. Gamma UPL	N/A
95% WH Approx. Gamma UTL with 95% Coverage	N/A
95% HW Approx. Gamma UTL with 95% Coverage	N/A

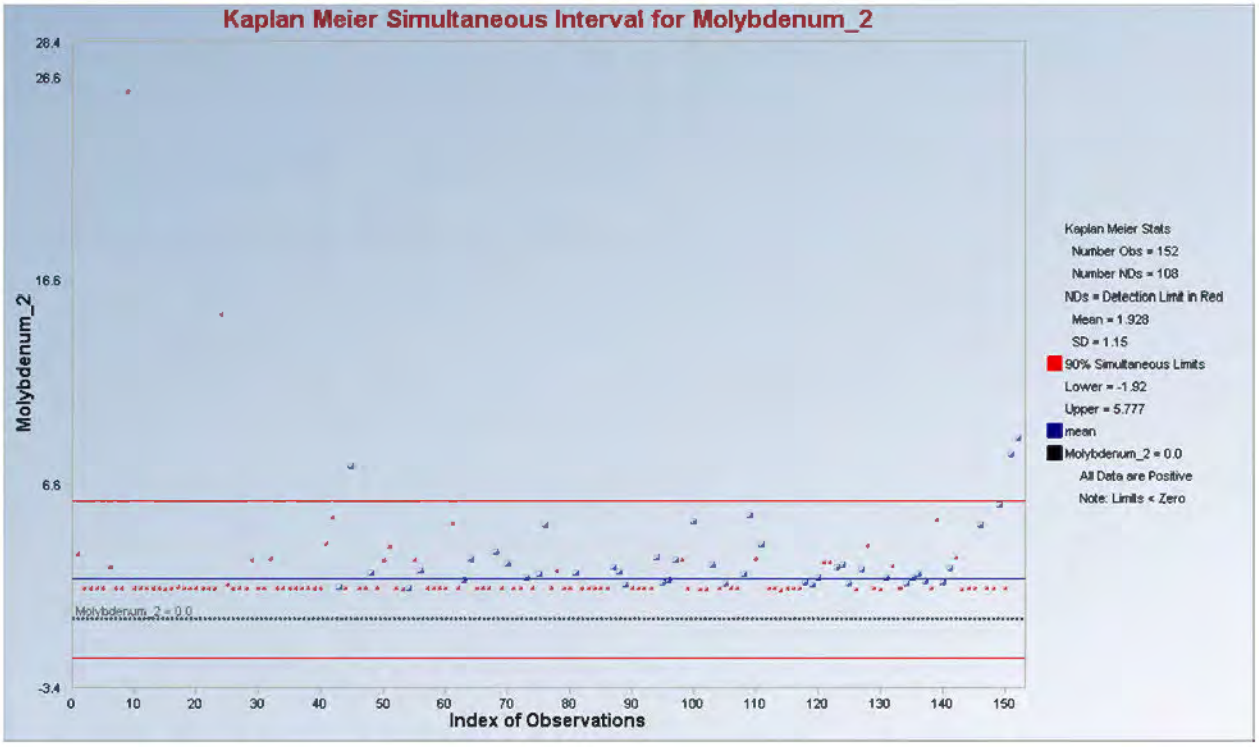
Note: DL/2 is not a recommended method.

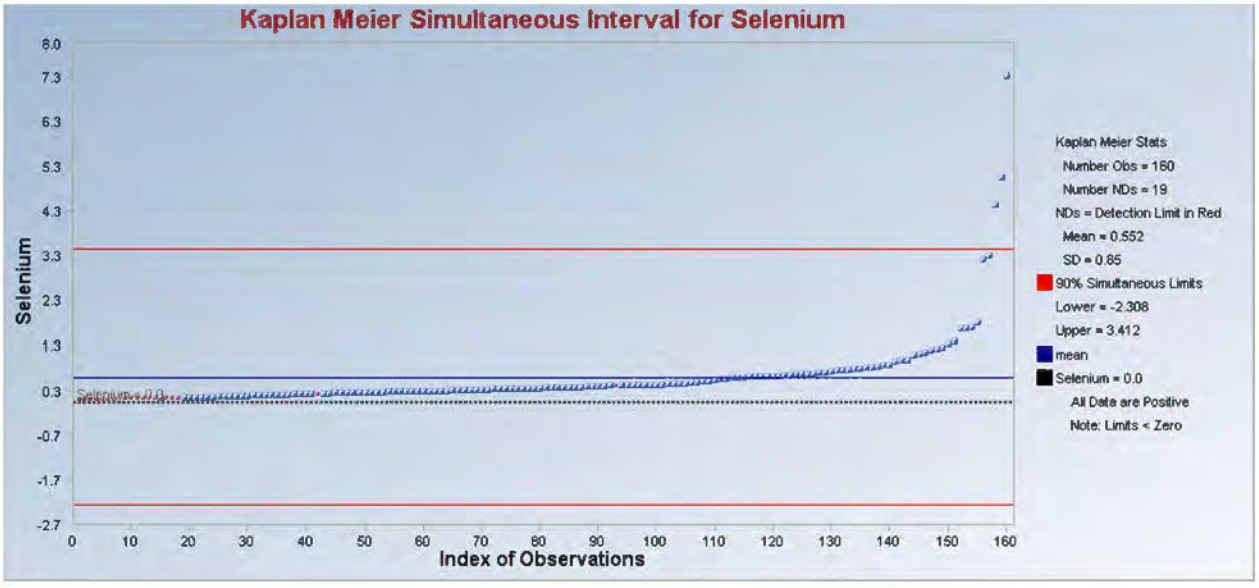
COMBINED UPLAND VEGETATION – USL OUTPUTS

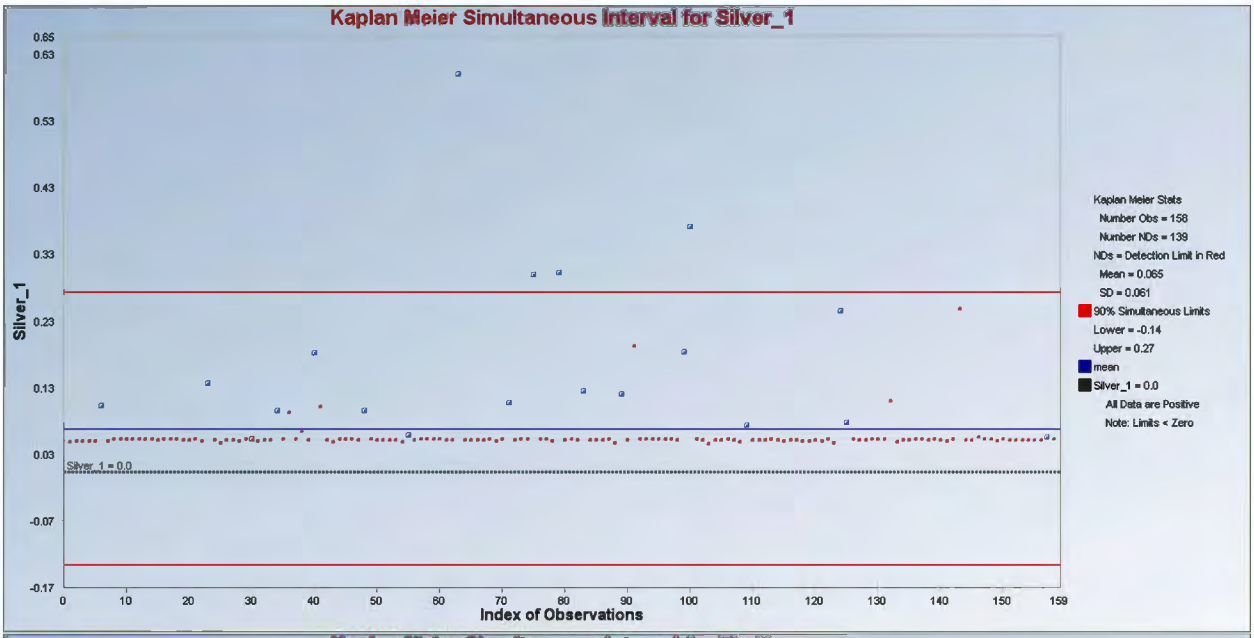

Kaplan Meier Simultaneous Interval for Boron_1
Boron_1
Index of Observations
74.9
66.0
56.0
46.0
36.0
26.0
16.0
6.0
-4.0
-14.0
-24.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Boron_1 = 0.0
Kaplan Meier Stats
Number Obs = 159
Number NDs = 4
NDs = Detection Limit in Red
Mean = 20.84
SD = 12.16
90% Simultaneous Limits
Lower = -20.03
Upper = 61.72
mean
Boron_1 = 0.0
All Data are Positive
Note: Limits < Zero

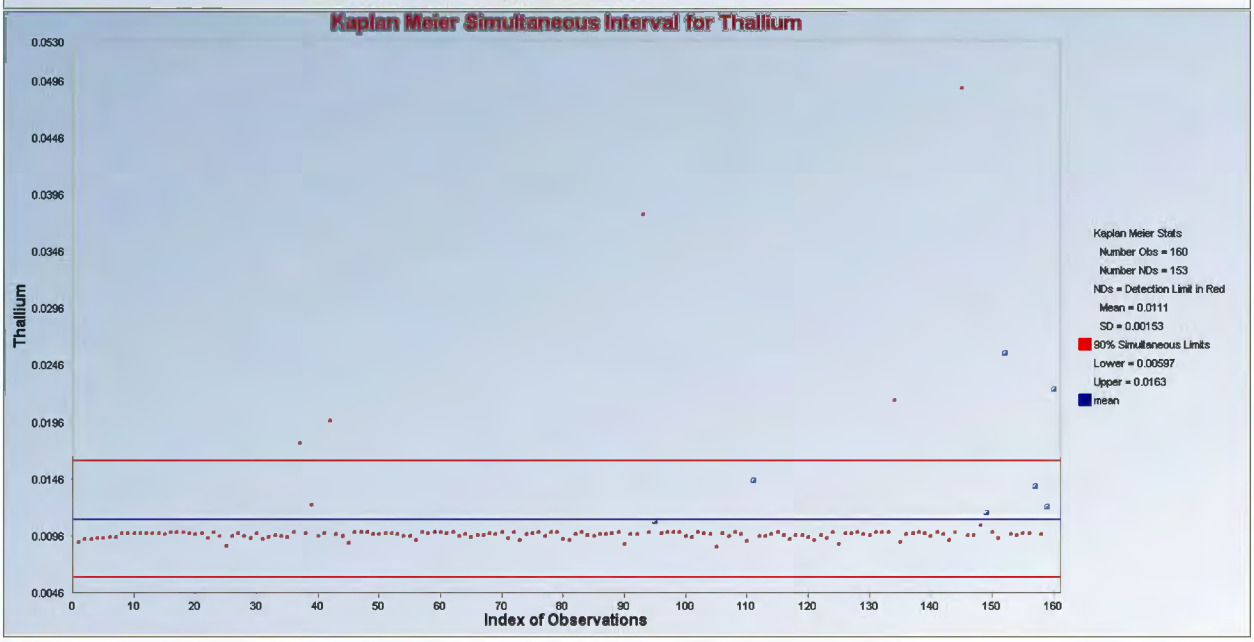

Kaplan Meier Simultaneous Interval for Cadmium_1
Cadmium_1
Index of Observations
Kaplan Meier Stats
Number Obs = 159
Number NDs = 12
NDs = Detection Limit in Red
Mean = 0.319
SD = 0.41
90% Simultaneous Limits
Lower = -1.058
Upper = 1.696
mean
Cadmium_1 = 0.0
All Data are Positive
Note: Limits < Zero

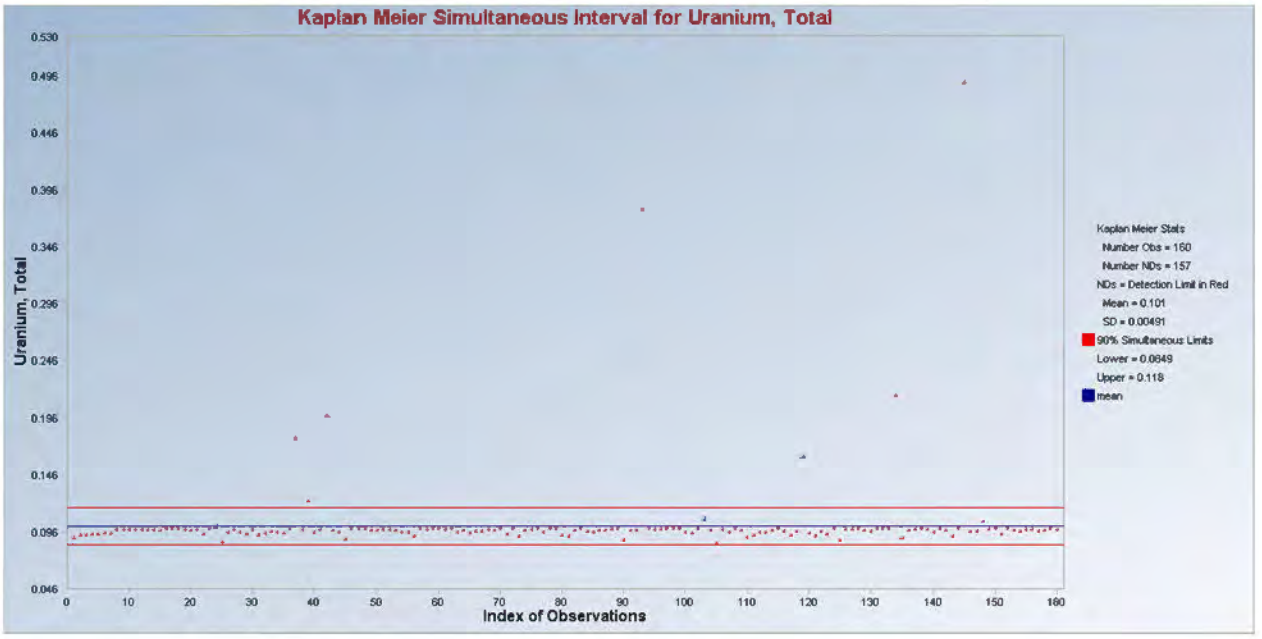

Kaplan Meier Simultaneous Interval for Mercury
Mercury
Index of Observations
Kaplan Meier Stats
Number Obs = 145
Number NDs = 123
NDs = Detection Limit in Red
Mean = 0.0132
SD = 0.0118
90% Simultaneous Limits
Lower = -0.0263
Upper = 0.0526
mean
Mercury = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Molybdenum_2
Molybdenum_2
Index of Observations
Kaplan Meier Stats
Number Obs = 152
Number NDs = 108
NDs = Detection Limit in Red
Mean = 1.928
SD = 1.15
90% Simultaneous Limits
Lower = -1.92
Upper = 5.777
mean
Molybdenum_2 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Selenium
Selenium
Index of Observations
Kaplan Meier Stats
Number Obs = 160
Number NDs = 19
NDs = Detection Limit in Red
Mean = 0.552
SD = 0.85
90% Simultaneous Limits
Lower = -2.308
Upper = 3.412
mean
Selenium = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Silver_1
Silver_1
Index of Observations
Silver_1 = 0.0
Kaplan Meier Stats
Number Obs = 158
Number NDs = 139
NDs = Detection Limit in Red
Mean = 0.065
SD = 0.061
90% Simultaneous Limits
Lower = -0.14
Upper = 0.27
mean
Silver_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Thallium
Thallium
Index of Observations
Kaplan Meier Stats
Number Obs = 160
Number NDs = 153
NDs = Detection Limit in Red
Mean = 0.0111
SD = 0.00153
90% Simultaneous Limits
Lower = 0.00597
Upper = 0.0163
mean


Kaplan Meier Simultaneous Interval for Uranium, Total
Uranium, Total
0.530
0.496
0.446
0.396
0.346
0.296
0.246
0.196
0.146
0.096
0.046
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Index of Observations
Kaplan Meier Stats
Number Obs = 160
Number NDs = 157
NDs = Detection Limit in Red
Mean = 0.101
SD = 0.00491
90% Simultaneous Limits
Lower = 0.0849
Upper = 0.118
mean

GROUNDWATER – OUTLIER OUTPUTS

Outlier Tests for Selected Variables

User Selected Options	
From File	Input Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Arsenic_1

Number of data = 6

10% critical value: 0.482

5% critical value: 0.56

1% critical value: 0.698

1. Data Value 0.0149 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.951

For 10% significance level, 0.0149 is an outlier.

For 5% significance level, 0.0149 is an outlier.

For 1% significance level, 0.0149 is an outlier.

2. Data Value 0.000266 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.013

For 10% significance level, 0.000266 is not an outlier.

For 5% significance level, 0.000266 is not an outlier.

For 1% significance level, 0.000266 is not an outlier.

Dixon's Outlier Test for Cadmium

Number of data = 7

10% critical value: 0.434

5% critical value: 0.507

1% critical value: 0.637

1. Data Value 0.0016 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.770

For 10% significance level, 0.0016 is an outlier.

For 5% significance level, 0.0016 is an outlier.

For 1% significance level, 0.0016 is an outlier.

2. Data Value 0.0002 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.000

For 10% significance level, 0.0002 is not an outlier.

For 5% significance level, 0.0002 is not an outlier.

For 1% significance level, 0.0002 is not an outlier.

Dixon's Outlier Test for Lead

Number of data = 6

10% critical value: 0.482

5% critical value: 0.56

1% critical value: 0.698

1. Data Value 0.00432 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.719

For 10% significance level, 0.00432 is an outlier.

For 5% significance level, 0.00432 is an outlier.

For 1% significance level, 0.00432 is an outlier.

2. Data Value 0.0004 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.031

For 10% significance level, 0.0004 is not an outlier.

For 5% significance level, 0.0004 is not an outlier.

For 1% significance level, 0.0004 is not an outlier.

Outlier Tests for Selected Variables

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for Chromium_shallow_1

Number of data = 7

10% critical value: 0.434

5% critical value: 0.507

1% critical value: 0.637

1. Data Value 0.0103 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.562

For 10% significance level, 0.0103 is an outlier.

For 5% significance level, 0.0103 is an outlier.

For 1% significance level, 0.0103 is not an outlier.

2. Data Value 0.0004 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.030

For 10% significance level, 0.0004 is not an outlier.

For 5% significance level, 0.0004 is not an outlier.

For 1% significance level, 0.0004 is not an outlier.

Dixon's Outlier Test for Manganese_inter

Number of data = 8

10% critical value: 0.479

5% critical value: 0.554

1% critical value: 0.683

1. Data Value 0.344 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.848

For 10% significance level, 0.344 is an outlier.

For 5% significance level, 0.344 is an outlier.

For 1% significance level, 0.344 is an outlier.

2. Data Value 0.0006 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.293

For 10% significance level, 0.0006 is not an outlier.

For 5% significance level, 0.0006 is not an outlier.

For 1% significance level, 0.0006 is not an outlier.

Dixon's Outlier Test for Selenium_Inter

Number of data = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Data Value 0.00577 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.771

For 10% significance level, 0.00577 is an outlier.
For 5% significance level, 0.00577 is an outlier.
For 1% significance level, 0.00577 is an outlier.

2. Data Value 0.000879 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.025

For 10% significance level, 0.000879 is not an outlier.
For 5% significance level, 0.000879 is not an outlier.
For 1% significance level, 0.000879 is not an outlier.

Dixon's Outlier Test for Selenium_Shallow

Number of data = 11
10% critical value: 0.517
5% critical value: 0.576
1% critical value: 0.679

1. Data Value 0.005 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.690

For 10% significance level, 0.005 is an outlier.
For 5% significance level, 0.005 is an outlier.
For 1% significance level, 0.005 is an outlier.

2. Data Value 0.000606 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.351

For 10% significance level, 0.000606 is not an outlier.
For 5% significance level, 0.000606 is not an outlier.
For 1% significance level, 0.000606 is not an outlier.

Dixon's Outlier Test for Vanadium_shallow_1

Number of data = 9

10% critical value: 0.441

5% critical value: 0.512

1% critical value: 0.635

1. Data Value 0.0026 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.227

For 10% significance level, 0.0026 is not an outlier.

For 5% significance level, 0.0026 is not an outlier.

For 1% significance level, 0.0026 is not an outlier.

2. Data Value 0.0003 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.056

For 10% significance level, 0.0003 is not an outlier.

For 5% significance level, 0.0003 is not an outlier.

For 1% significance level, 0.0003 is not an outlier.

Dixon's Outlier Test for Zinc_shallow

Number of data = 16

10% critical value: 0.454

5% critical value: 0.507

1% critical value: 0.595

1. Data Value 0.326 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.781

For 10% significance level, 0.326 is an outlier.

For 5% significance level, 0.326 is an outlier.

For 1% significance level, 0.326 is an outlier.

2. Data Value 0.00526 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.077

For 10% significance level, 0.00526 is not an outlier.

For 5% significance level, 0.00526 is not an outlier.

For 1% significance level, 0.00526 is not an outlier.

Outlier Tests for Selected Variables

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	2

Rosner's Outlier Test for Chromium, total

Mean	**0.00319**
Standard Deviation	**0.00431**
Number of data	**28**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.00319	0.00423	0.0224	12	4.537	2.88	3.2
2	0.00248	0.00214	0.0103	21	3.651	2.86	3.18

For 5% significance level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.0224, 0.0103

For 1% Significance Level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.0224, 0.0103

Rosner's Outlier Test for Manganese

Mean	**0.135**
Standard Deviation	**0.207**
Number of data	**33**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.135	0.204	0.915	10	3.832	2.95	3.29
2	0.111	0.154	0.61	15	3.233	2.94	3.27

For 5% significance level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.915, 0.61

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 0.915 is a Potential Statistical Outlier

Rosner's Outlier Test for Selenium

Mean	**0.00175**
Standard Deviation	**0.00115**
Number of data	**29**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.00175	0.00113	0.00577	25	3.567	2.89	3.22
2	0.00161	0.0008627	0.005	9	3.933	2.88	3.2

For 5% significance level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.00577, 0.005

For 1% Significance Level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.00577, 0.005

Rosner's Outlier Test for Zinc

Mean	**0.721**
Standard Deviation	**3.453**
Number of data	**38**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.721	3.407	21.3	9	6.039	3.01	3.36
2	0.165	0.417	2.48	10	5.552	3	3.34

For 5% significance level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

21.3, 2.48

For 1% Significance Level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

21.3, 2.48

Outlier Tests for Selected Variables

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	2

Rosner's Outlier Test for Chromium, total

Mean	**0.00319**
Standard Deviation	**0.00431**
Number of data	**28**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.00319	0.00423	0.0224	12	4.537	2.88	3.2
2	0.00248	0.00214	0.0103	21	3.651	2.86	3.18

For 5% significance level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.0224, 0.0103

For 1% Significance Level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.0224, 0.0103

Rosner's Outlier Test for Selenium

Mean	**0.00175**
Standard Deviation	**0.00115**
Number of data	**29**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.00175	0.00113	0.00577	25	3.567	2.89	3.22
2	0.00161	0.0008627	0.005	9	3.933	2.88	3.2

For 5% significance level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.00577, 0.005

For 1% Significance Level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

0.00577, 0.005

Rosner's Outlier Test for Zinc

Mean	**0.721**
Standard Deviation	**3.453**
Number of data	**38**
Number of suspected outliers	**2**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.721	3.407	21.3	9	6.039	3.01	3.36
2	0.165	0.417	2.48	10	5.552	3	3.34

For 5% significance level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

21.3, 2.48

For 1% Significance Level, there are 2 Potential Outliers

Therefore, Potential Statistical Outliers are

21.3, 2.48

GROUNDWATER – UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic_2

General Statistics

Number of Valid Data	8	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	3
Number of Missing Values	45	Percent Non-Detects	37.50%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000266	Minimum Detected	-8.232
Maximum Detected	0.000989	Maximum Detected	-6.919
Mean of Detected	0.0006252	Mean of Detected	-7.475
SD of Detected	0.0002858	SD of Detected	0.516
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.985	Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0004845	Mean	-7.782
SD	0.0002905	SD	0.576
95% DL/2 (t) UCL	0.0006791	95% H-Stat (DL/2) UCL	0.0008466
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0008123	Mean in Log Scale	-7.671
SD	0.0001591	SD in Log Scale	0.497
95% MLE (t) UCL	0.0009189	Mean in Original Scale	0.0005202
95% MLE (Tiku) UCL	0.0009844	SD in Original Scale	0.0002649
		95% t UCL	0.0006976
		95% Percentile Bootstrap UCL	0.0006743
		95% BCA Bootstrap UCL	0.0006896
		95% H UCL	0.0008202

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.249
Theta Star	0.000278
nu star	22.49
A-D Test Statistic	0.195
5% A-D Critical Value	0.681
K-S Test Statistic	0.681
5% K-S Critical Value	0.358

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.0001544
Maximum	0.000989
Mean	0.0005193
Median	0.0004867
SD	0.0002784
k star	2.352
Theta star	0.0002207
Nu star	37.64
AppChi2	24.59
95% Gamma Approximate UCL	0.0007948
95% Adjusted Gamma UCL	0.00089

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0005261
SD	0.0002461
SE of Mean	0.0001039
95% KM (t) UCL	0.0007229
95% KM (z) UCL	0.000697
95% KM (jackknife) UCL	0.0007422
95% KM (bootstrap t) UCL	0.0007286
95% KM (BCA) UCL	0.000751
95% KM (Percentile Bootstrap) UCL	0.0007456
95% KM (Chebyshev) UCL	0.0009789
97.5% KM (Chebyshev) UCL	0.00117
99% KM (Chebyshev) UCL	0.00156

Potential UCLs to Use

95% KM (t) UCL	0.0007229
95% KM (Percentile Bootstrap) UCL	0.0007456

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cadmium_1

General Statistics

Number of Valid Data	51	Number of Detected Data	6
Number of Distinct Detected Data	5	Number of Non-Detect Data	45
Number of Missing Values	6	Percent Non-Detects	88.24%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.000522	Maximum Detected	-7.558
Mean of Detected	0.000345	Mean of Detected	-8.037
SD of Detected	0.0001304	SD of Detected	0.406
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.0003	Maximum Non-Detect	-8.112

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	47
Number treated as Detected	4
Single DL Non-Detect Percentage	92.16%

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.921
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0001073
SD	0.0001017
95% DL/2 (t) UCL	0.0001311

Maximum Likelihood Estimate(MLE) Method	N/A

MLE yields a negative mean

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.888
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-9.388
SD	0.626
95% H-Stat (DL/2) UCL	0.0001212

Log ROS Method

Mean in Log Scale	-9.866
SD in Log Scale	1.016
Mean in Original Scale	8.808E-05
SD in Original Scale	0.0001095
95% t UCL	0.0001138
95% Percentile Bootstrap UCL	0.0001151
95% BCA Bootstrap UCL	0.0001214
95% H-UCL	0.0001213

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	4.017
Theta Star	8.588E-05
nu star	48.21

A-D Test Statistic	0.375
5% A-D Critical Value	0.698
K-S Test Statistic	0.698
5% K-S Critical Value	0.333

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.000522
Mean	4.147E-05
Median	0.000001
SD	0.0001193
k star	0.235
Theta star	0.0001767
Nu star	23.94
AppChi2	13.8
95% Gamma Approximate UCL	7.193E-05
95% Adjusted Gamma UCL	7.312E-05

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0002171
SD	6.205E-05
SE of Mean	9.518E-06
95% KM (t) UCL	0.000233
95% KM (z) UCL	0.0002327
95% KM (jackknife) UCL	0.0002318
95% KM (bootstrap t) UCL	0.0002348
95% KM (BCA) UCL	0.0004048
95% KM (Percentile Bootstrap) UCL	0.0004
95% KM (Chebyshev) UCL	0.0002586
97.5% KM (Chebyshev) UCL	0.0002765
99% KM (Chebyshev) UCL	0.0003118

Potential UCLs to Use

95% KM (t) UCL	0.000233
95% KM (Percentile Bootstrap) UCL	0.0004

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Chromium, total_1

General Statistics

Number of Valid Data	32	Number of Detected Data	26
Number of Distinct Detected Data	25	Number of Non-Detect Data	6
Number of Missing Values	24	Percent Non-Detects	18.75%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.00524	Maximum Detected	-5.251
Mean of Detected	0.00218	Mean of Detected	-6.416
SD of Detected	0.00149	SD of Detected	0.858
Minimum Non-Detect	0.0002	Minimum Non-Detect	-8.517
Maximum Non-Detect	0.001	Maximum Non-Detect	-6.908

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Number treated as Non-Detect	13
Number treated as Detected	19
Single DL Non-Detect Percentage	40.63%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Test Statistic	0.939
5% Shapiro Wilk Critical Value	0.92	5% Shapiro Wilk Critical Value	0.92
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00181	Mean	-6.861
SD	0.00156	SD	1.247
95% DL/2 (t) UCL	0.00227	95% H-Stat (DL/2) UCL	0.00422
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.00146	Mean in Log Scale	-6.745
SD	0.00199	SD in Log Scale	1.051
95% MLE (t) UCL	0.00205	Mean in Original Scale	0.00183
95% MLE (Tiku) UCL	0.00213	SD in Original Scale	0.00153
		95% t UCL	0.00229
		95% Percentile Bootstrap UCL	0.00229
		95% BCA Bootstrap UCL	0.00232
		95% H UCL	0.00327

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	1.702	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.00128	
nu star	88.48	
A-D Test Statistic	0.221	**Nonparametric Statistics**
5% A-D Critical Value	0.758	Kaplan-Meier (KM) Method
K-S Test Statistic	0.758	Mean 0.00182

5% K-S Critical Value	0.174

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.00524
Mean	0.00177
Median	0.00142
SD	0.0016
k star	0.421
Theta star	0.0042
Nu star	26.95
AppChi2	16.11
95% Gamma Approximate UCL	0.00296
95% Adjusted Gamma UCL	0.00304

SD	0.00152
SE of Mean	0.0002745
95% KM (t) UCL	0.00228
95% KM (z) UCL	0.00227
95% KM (jackknife) UCL	0.00227
95% KM (bootstrap t) UCL	0.00232
95% KM (BCA) UCL	0.00232
95% KM (Percentile Bootstrap) UCL	0.00228
95% KM (Chebyshev) UCL	0.00301
97.5% KM (Chebyshev) UCL	0.00353
99% KM (Chebyshev) UCL	0.00455

Potential UCLs to Use

95% KM (BCA) UCL	0.00232

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cobalt

General Statistics

Number of Valid Data	10	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	8
Number of Missing Values	43	Percent Non-Detects	80.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000281	Minimum Detected	-8.177
Maximum Detected	0.000436	Maximum Detected	-7.738
Mean of Detected	0.0003585	Mean of Detected	-7.958
SD of Detected	0.0001096	SD of Detected	0.311
Minimum Non-Detect	0.00025	Minimum Non-Detect	-8.294
Maximum Non-Detect	0.01	Maximum Non-Detect	-4.605

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	10
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.00215
SD	0.00246
95% DL/2 (t) UCL	0.00357
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-7.167
SD	1.649
95% H-Stat (DL/2) UCL	0.0368
Log ROS Method	
Mean in Log Scale	N/A
SD in Log Scale	N/A
Mean in Original Scale	N/A
SD in Original Scale	N/A
95% t UCL	N/A
95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A
95% H-UCL	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0003198
SD	6.712E-05
SE of Mean	4.746E-05
95% KM (t) UCL	0.0004068
95% KM (z) UCL	0.0003978
95% KM (jackknife) UCL	0.0004346
95% KM (bootstrap t) UCL	N/A
95% KM (BCA) UCL	0.000436
95% KM (Percentile Bootstrap) UCL	0.000436
95% KM (Chebyshev) UCL	0.0005266
97.5% KM (Chebyshev) UCL	0.0006161
99% KM (Chebyshev) UCL	0.000792

Potential UCLs to Use

95% KM (t) UCL	0.0004068
95% KM (% Bootstrap) UCL	0.000436

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Lead_1

General Statistics

Number of Valid Data	9	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	4
Number of Missing Values	44	Percent Non-Detects	44.44%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0004	Minimum Detected	-7.824
Maximum Detected	0.0015	Maximum Detected	-6.502
Mean of Detected	0.0008334	Mean of Detected	-7.225
SD of Detected	0.0004865	SD of Detected	0.576
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.00025	Maximum Non-Detect	-8.294

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	4
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	5
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	44.44%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.845	Shapiro Wilk Test Statistic	0.878
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0005102	Mean	-8.11
SD	0.0005155	SD	1.16
95% DL/2 (t) UCL	0.0008298	95% H-Stat (DL/2) UCL	0.00258
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0003445	Mean in Log Scale	-7.959
SD	0.0006889	SD in Log Scale	0.988
95% MLE (t) UCL	0.0007715	Mean in Original Scale	0.0005282
95% MLE (Tiku) UCL	0.000843	SD in Original Scale	0.0005003
		95% t UCL	0.0008383
		95% Percentile Bootstrap UCL	0.0008052
		95% BCA Bootstrap UCL	0.0008602
		95% H UCL	0.00175

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	1.68	Data appear Normal at 5% Significance Level

Theta Star	0.0004961
nu star	16.8

A-D Test Statistic	0.486
5% A-D Critical Value	0.681
K-S Test Statistic	0.681
5% K-S Critical Value	0.359

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.0015
Mean	0.0004634
Median	0.0004
SD	0.0005575
k star	0.262
Theta star	0.00177
Nu star	4.709
AppChi2	1.02
95% Gamma Approximate UCL	0.00214
95% Adjusted Gamma UCL	0.00308

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0006408
SD	0.0003893
SE of Mean	0.0001451
95% KM (t) UCL	0.0009106
95% KM (z) UCL	0.0008794
95% KM (jackknife) UCL	0.0008815
95% KM (bootstrap t) UCL	0.00178
95% KM (BCA) UCL	0.00101
95% KM (Percentile Bootstrap) UCL	0.0009262
95% KM (Chebyshev) UCL	0.00127
97.5% KM (Chebyshev) UCL	0.00155
99% KM (Chebyshev) UCL	0.00208

Potential UCLs to Use

95% KM (t) UCL	0.0009106
95% KM (Percentile Bootstrap) UCL	0.0009262

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Selenium_1

General Statistics

Number of Valid Data	52	Number of Detected Data	27
Number of Distinct Detected Data	19	Number of Non-Detect Data	25
Number of Missing Values	5	Percent Non-Detects	48.08%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.000606	Minimum Detected	-7.409
Maximum Detected	0.00267	Maximum Detected	-5.926
Mean of Detected	0.00148	Mean of Detected	-6.589
SD of Detected	0.0005602	SD of Detected	0.404
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.001	Maximum Non-Detect	-6.908

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	30
Number treated as Detected	22
Single DL Non-Detect Percentage	57.69%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Test Statistic	0.942
5% Shapiro Wilk Critical Value	0.923	5% Shapiro Wilk Critical Value	0.923
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0009953
SD	0.0006509
95% DL/2 (t) UCL	0.00115

Maximum Likelihood Estimate(MLE) Method	
Mean	0.0008413
SD	0.0008617
95% MLE (t) UCL	0.00104
95% MLE (Tiku) UCL	0.00111

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-7.116
SD	0.643
95% H-Stat (DL/2) UCL	0.00119

Log ROS Method	
Mean in Log Scale	-6.992
SD in Log Scale	0.564
Mean in Original Scale	0.00107
SD in Original Scale	0.000604
95% t UCL	0.00121
95% Percentile Bootstrap UCL	0.00121
95% BCA Bootstrap UCL	0.00123
95% H UCL	0.00126

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	6.121
Theta Star	0.0002421
nu star	330.5
A-D Test Statistic	0.658
5% A-D Critical Value	0.746
K-S Test Statistic	0.746
5% K-S Critical Value	0.168

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.00267
Mean	0.0009245
Median	0.0008873
SD	0.0007599
k star	0.411
Theta star	0.00225
Nu star	42.76
AppChi2	28.76
95% Gamma Approximate UCL	0.00137
95% Adjusted Gamma UCL	0.00139

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0011
SD	0.0005646
SE of Mean	8.227E-05
95% KM (t) UCL	0.00124
95% KM (z) UCL	0.00124
95% KM (jackknife) UCL	0.00123
95% KM (bootstrap t) UCL	0.00124
95% KM (BCA) UCL	0.00129
95% KM (Percentile Bootstrap) UCL	0.00126
95% KM (Chebyshev) UCL	0.00146
97.5% KM (Chebyshev) UCL	0.00162
99% KM (Chebyshev) UCL	0.00192

Potential UCLs to Use

95% KM (t) UCL	0.00124
95% KM (Percentile Bootstrap) UCL	0.00126

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium

General Statistics

Number of Valid Data	48	Number of Detected Data	29
Number of Distinct Detected Data	24	Number of Non-Detect Data	19

Number of Missing Values	9	Percent Non-Detects	39.58%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.0147	Maximum Detected	-4.22
Mean of Detected	0.00373	Mean of Detected	-6.326
SD of Detected	0.00453	SD of Detected	1.276
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.025	Maximum Non-Detect	-3.689

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	48
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.73	Shapiro Wilk Test Statistic	0.946
5% Shapiro Wilk Critical Value	0.926	5% Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00315	Mean	-6.577
SD	0.00395	SD	1.474
95% DL/2 (t) UCL	0.00411	95% H-Stat (DL/2) UCL	0.00768
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-6.951
		SD in Log Scale	1.483
		Mean in Original Scale	0.00255
		SD in Original Scale	0.00383
		95% t UCL	0.00348
		95% Percentile Bootstrap UCL	0.00352
		95% BCA Bootstrap UCL	0.00368
		95% H-UCL	0.00539

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.746	Data appear Lognormal at 5% Significance Level
Theta Star	0.00499	
nu star	43.3	
A-D Test Statistic	1.022	Nonparametric Statistics
5% A-D Critical Value	0.782	Kaplan-Meier (KM) Method
K-S Test Statistic	0.782	Mean 0.00262
5% K-S Critical Value	0.169	SD 0.00382
Data not Gamma Distributed at 5% Significance Level		SE of Mean 0.0005742
		95% KM (t) UCL 0.00358
Assuming Gamma Distribution		95% KM (z) UCL 0.00356
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 0.00356
Minimum	0.000001	95% KM (bootstrap t) UCL 0.00377
Maximum	0.0147	95% KM (BCA) UCL 0.00355
Mean	0.00274	95% KM (Percentile Bootstrap) UCL 0.00356
Median	0.00101	95% KM (Chebyshev) UCL 0.00512

SD	0.00391	97.5% KM (Chebyshev) UCL	0.0062
k star	0.313	99% KM (Chebyshev) UCL	0.00833
Theta star	0.00877		
Nu star	30.01	**Potential UCLs to Use**	
AppChi2	18.5	95% KM (Chebyshev) UCL	0.00512
95% Gamma Approximate UCL	0.00445		
95% Adjusted Gamma UCL	0.00452		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium (shallow)

General Statistics

Number of Valid Data	19	Number of Detected Data	5
Number of Distinct Detected Data	4	Number of Non-Detect Data	14
Number of Missing Values	2	Percent Non-Detects	73.68%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.000522	Maximum Detected	-7.558
Mean of Detected	0.000334	Mean of Detected	-8.08
SD of Detected	0.0001427	SD of Detected	0.438
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.0003	Maximum Non-Detect	-8.112

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	16
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	84.21%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.897	Shapiro Wilk Test Statistic	0.884
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0001412	Mean	-9.208
SD	0.0001388	SD	0.795
95% DL/2 (t) UCL	0.0001964	95% H-Stat (DL/2) UCL	0.0002131
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	7.845E-05	Mean in Log Scale	-9.277
SD	0.000223	SD in Log Scale	0.888
95% MLE (t) UCL	0.0001672	Mean in Original Scale	0.0001386
95% MLE (Tiku) UCL	0.0003361	SD in Original Scale	0.0001404
		95% t UCL	0.0001945

95% Percentile Bootstrap UCL	0.0001935
95% BCA Bootstrap UCL	0.0002086
95% H UCL	0.0002319

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.843
Theta Star	0.0001175
nu star	28.43

A-D Test Statistic	0.378
5% A-D Critical Value	0.68
K-S Test Statistic	0.68
5% K-S Critical Value	0.358

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.000522
Mean	8.863E-05
Median	0.000001
SD	0.000165
k star	0.237
Theta star	0.0003733
Nu star	9.022
AppChi2	3.34
95% Gamma Approximate UCL	0.0002394
95% Adjusted Gamma UCL	0.0002627

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0002353
SD	8.813E-05
SE of Mean	2.261E-05
95% KM (t) UCL	0.0002745
95% KM (z) UCL	0.0002724
95% KM (jackknife) UCL	0.0002713
95% KM (bootstrap t) UCL	0.0002913
95% KM (BCA) UCL	0.000433
95% KM (Percentile Bootstrap) UCL	0.0003492
95% KM (Chebyshev) UCL	0.0003338
97.5% KM (Chebyshev) UCL	0.0003764
99% KM (Chebyshev) UCL	0.0004602

Potential UCLs to Use

95% KM (t) UCL	0.0002745
95% KM (Percentile Bootstrap) UCL	0.0003492

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Chromium, total (deep)

General Statistics

Number of Valid Observations	6	Number of Distinct Observations	6
Number of Missing Values	2		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.00154	Minimum of Log Data	-6.476
Maximum	0.00442	Maximum of Log Data	-5.422
Mean	0.0026	Mean of log Data	-6.008
Median	0.00235	SD of log Data	0.356
SD	0.0009989		
Std. Error of Mean	0.0004078		
Coefficient of Variation	0.384		
Skewness	1.404		

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.00342	95% H-UCL	0.00379
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.00423
95% Adjusted-CLT UCL (Chen-1995)	0.00352	97.5% Chebyshev (MVUE) UCL	0.00494
95% Modified-t UCL (Johnson-1978)	0.00346	99% Chebyshev (MVUE) UCL	0.00634

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	4.726	Data appear Normal at 5% Significance Level
Theta Star	0.0005498	
MLE of Mean	0.0026	

MLE of Standard Deviation	0.0012
nu star	56.71
Approximate Chi Square Value (.05)	40.4
Adjusted Level of Significance	0.0122
Adjusted Chi Square Value	35.49
Anderson-Darling Test Statistic	0.271
Anderson-Darling 5% Critical Value	0.698
Kolmogorov-Smirnov Test Statistic	0.203
Kolmogorov-Smirnov 5% Critical Value	0.333

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.00365
95% Adjusted Gamma UCL	0.00415

Nonparametric Statistics

95% CLT UCL	0.00327
95% Jackknife UCL	0.00342
95% Standard Bootstrap UCL	0.00321
95% Bootstrap-t UCL	0.0042
95% Hall's Bootstrap UCL	0.00746
95% Percentile Bootstrap UCL	0.00329
95% BCA Bootstrap UCL	0.00348
95% Chebyshev(Mean, Sd) UCL	0.00438
97.5% Chebyshev(Mean, Sd) UCL	0.00514
99% Chebyshev(Mean, Sd) UCL	0.00666

Potential UCL to Use

Use 95% Student's-t UCL 0.00342

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium, total (intermediate)

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Number of Missing Values	6		

Raw Statistics

Minimum	0.0003
Maximum	0.00524
Mean	0.00236
Median	0.00184
SD	0.00172
Std. Error of Mean	0.0006088
Coefficient of Variation	0.73
Skewness	0.731

Log-transformed Statistics

Minimum of Log Data	-8.112
Maximum of Log Data	-5.251
Mean of log Data	-6.349
SD of log Data	0.916

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.913
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.925
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% Student's-t UCL	0.00351	95% H-UCL	0.00811
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.00607
95% Adjusted-CLT UCL (Chen-1995)	0.00353	97.5% Chebyshev (MVUE) UCL	0.00762
95% Modified-t UCL (Johnson-1978)	0.00354	99% Chebyshev (MVUE) UCL	0.0107

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	1.222	Data appear Normal at 5% Significance Level
Theta Star	0.00193	
MLE of Mean	0.00236	
MLE of Standard Deviation	0.00213	
nu star	19.56	
Approximate Chi Square Value (.05)	10.53	**Nonparametric Statistics**
Adjusted Level of Significance	0.0195	95% CLT UCL 0.00336
Adjusted Chi Square Value	8.899	95% Jackknife UCL 0.00351
		95% Standard Bootstrap UCL 0.00333
Anderson-Darling Test Statistic	0.262	95% Bootstrap-t UCL 0.00399
Anderson-Darling 5% Critical Value	0.726	95% Hall's Bootstrap UCL 0.00403
Kolmogorov-Smirnov Test Statistic	0.182	95% Percentile Bootstrap UCL 0.00333
Kolmogorov-Smirnov 5% Critical Value	0.298	95% BCA Bootstrap UCL 0.00345
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.00501
		97.5% Chebyshev(Mean, Sd) UCL 0.00616
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.00842
95% Approximate Gamma UCL	0.00438	
95% Adjusted Gamma UCL	0.00518	

Potential UCL to Use	Use 95% Student's-t UCL 0.00351

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium, total_1 (shallow)

General Statistics

Number of Valid Data	10	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	4
Number of Missing Values	11	Percent Non-Detects	40.00%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0004	Minimum Detected	-7.824
Maximum Detected	0.00474	Maximum Detected	-5.352
Mean of Detected	0.00196	Mean of Detected	-6.583
SD of Detected	0.00168	SD of Detected	0.944
Minimum Non-Detect	0.0002	Minimum Non-Detect	-8.517
Maximum Non-Detect	0.001	Maximum Non-Detect	-6.908

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	7
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	70.00%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.89
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.00127
SD	0.00154
95% DL/2 (t) UCL	0.00216

Maximum Likelihood Estimate(MLE) Method

Mean	0.00334
SD	0.00116
95% MLE (t) UCL	0.00401
95% MLE (Tiku) UCL	0.00456

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-7.381
SD	1.327
95% H-Stat (DL/2) UCL	0.00812

Log ROS Method

Mean in Log Scale	-7.39
SD in Log Scale	1.295
Mean in Original Scale	0.00126
SD in Original Scale	0.00155
95% t UCL	0.00215
95% Percentile Bootstrap UCL	0.00207
95% BCA Bootstrap UCL	0.00231
95% H UCL	0.00718

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.907
Theta Star	0.00216
nu star	10.88
A-D Test Statistic	0.248
5% A-D Critical Value	0.707
K-S Test Statistic	0.707
5% K-S Critical Value	0.337

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.00474
Mean	0.00117
Median	0.00055
SD	0.00161
k star	0.248
Theta star	0.00474
Nu star	4.957
AppChi2	1.132
95% Gamma Approximate UCL	0.00514
95% Adjusted Gamma UCL	0.00685

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.00135
SD	0.00141
SE of Mean	0.000488
95% KM (t) UCL	0.00224
95% KM (z) UCL	0.00215
95% KM (jackknife) UCL	0.00217
95% KM (bootstrap t) UCL	0.0033
95% KM (BCA) UCL	0.00249
95% KM (Percentile Bootstrap) UCL	0.00231
95% KM (Chebyshev) UCL	0.00347
97.5% KM (Chebyshev) UCL	0.00439
99% KM (Chebyshev) UCL	0.0062

Potential UCLs to Use

95% KM (t) UCL	0.00224
95% KM (Percentile Bootstrap) UCL	0.00231

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Manganese_1

General Statistics

Number of Valid Data	32	Number of Detected Data	31
Number of Distinct Detected Data	30	Number of Non-Detect Data	1
Number of Missing Values	25	Percent Non-Detects	3.13%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0006	Minimum Detected	-7.419
Maximum Detected	0.456	Maximum Detected	-0.785
Mean of Detected	0.0945	Mean of Detected	-3.682
SD of Detected	0.127	SD of Detected	2.061
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.74	Shapiro Wilk Test Statistic	0.915
5% Shapiro Wilk Critical Value	0.929	5% Shapiro Wilk Critical Value	0.929
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0915	Mean	-3.826
SD	0.126	SD	2.185
95% DL/2 (t) UCL	0.129	95% H-Stat (DL/2) UCL	1.194
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0892	Mean in Log Scale	-3.841
SD	0.127	SD in Log Scale	2.218
95% MLE (t) UCL	0.127	Mean in Original Scale	0.0915
95% MLE (Tiku) UCL	0.124	SD in Original Scale	0.126
		95% t UCL	0.129
		95% Percentile Bootstrap UCL	0.128
		95% BCA Bootstrap UCL	0.134
		95% H UCL	1.323

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.458	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.206	
nu star	28.37	
A-D Test Statistic	0.492	Nonparametric Statistics
5% A-D Critical Value	0.814	Kaplan-Meier (KM) Method

K-S Test Statistic	0.814
5% K-S Critical Value	0.167

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.456
Mean	0.0915
Median	0.0452
SD	0.126
k star	0.391
Theta star	0.234
Nu star	25
AppChi2	14.61
95% Gamma Approximate UCL	0.157
95% Adjusted Gamma UCL	0.161

Mean	0.0915
SD	0.124
SE of Mean	0.0223
95% KM (t) UCL	0.129
95% KM (z) UCL	0.128
95% KM (jackknife) UCL	0.129
95% KM (bootstrap t) UCL	0.138
95% KM (BCA) UCL	0.13
95% KM (Percentile Bootstrap) UCL	0.13
95% KM (Chebyshev) UCL	0.189
97.5% KM (Chebyshev) UCL	0.231
99% KM (Chebyshev) UCL	0.313

Potential UCLs to Use

95% KM (Chebyshev) UCL	0.189

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Zinc_final

General Statistics

Number of Valid Data	46	Number of Detected Data	36
Number of Distinct Detected Data	35	Number of Non-Detect Data	10
Number of Missing Values	11	Percent Non-Detects	21.74%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.005	Minimum Detected	-5.298
Maximum Detected	0.699	Maximum Detected	-0.358
Mean of Detected	0.101	Mean of Detected	-3.106
SD of Detected	0.146	SD of Detected	1.322
Minimum Non-Detect	0.002	Minimum Non-Detect	-6.215
Maximum Non-Detect	0.0125	Maximum Non-Detect	-4.382

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	17
Number treated as Detected	29
Single DL Non-Detect Percentage	36.96%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.656
5% Shapiro Wilk Critical Value	0.935

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.959
5% Shapiro Wilk Critical Value	0.935

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0797
SD	0.135

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-3.734
SD	1.697

95% DL/2 (t) UCL	0.113

Maximum Likelihood Estimate(MLE) Method	
Mean	0.031
SD	0.183
95% MLE (t) UCL	0.0763
95% MLE (Tiku) UCL	0.0806

95% H-Stat (DL/2) UCL	0.225

Log ROS Method	
Mean in Log Scale	-3.74
SD in Log Scale	1.707
Mean in Original Scale	0.0796
SD in Original Scale	0.135
95% t UCL	0.113
95% Percentile Bootstrap UCL	0.113
95% BCA Bootstrap UCL	0.12
95% H UCL	0.229

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.695
Theta Star	0.145
nu star	50.02
A-D Test Statistic	1.142
5% A-D Critical Value	0.789
K-S Test Statistic	0.789
5% K-S Critical Value	0.153

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.699
Mean	0.079
Median	0.0345
SD	0.136
k star	0.244
Theta star	0.323
Nu star	22.48
AppChi2	12.7
95% Gamma Approximate UCL	0.14
95% Adjusted Gamma UCL	0.143

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0801
SD	0.134
SE of Mean	0.02
95% KM (t) UCL	0.114
95% KM (z) UCL	0.113
95% KM (jackknife) UCL	0.114
95% KM (bootstrap t) UCL	0.131
95% KM (BCA) UCL	0.116
95% KM (Percentile Bootstrap) UCL	0.113
95% KM (Chebyshev) UCL	0.167
97.5% KM (Chebyshev) UCL	0.205
99% KM (Chebyshev) UCL	0.279
Potential UCLs to Use	
95% KM (Chebyshev) UCL	0.167

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Manganese (deep)

General Statistics

Number of Valid Data	6	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	1
Number of Missing Values	2	Percent Non-Detects	16.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.00149	Minimum Detected	-6.509
Maximum Detected	0.0923	Maximum Detected	-2.383
Mean of Detected	0.0456	Mean of Detected	-3.94
SD of Detected	0.0426	SD of Detected	1.835
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.869	Shapiro Wilk Test Statistic	0.86
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.038	Mean	-4.666
SD	0.0424	SD	2.42
95% DL/2 (t) UCL	0.0729	95% H-Stat (DL/2) UCL	3905
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0338	Mean in Log Scale	-4.682
SD	0.0446	SD in Log Scale	2.45
95% MLE (t) UCL	0.0704	Mean in Original Scale	0.038
95% MLE (Tiku) UCL	0.0704	SD in Original Scale	0.0424
		95% t UCL	0.0729
		95% Percentile Bootstrap UCL	0.0633
		95% BCA Bootstrap UCL	0.0672
		95% H UCL	5303

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.417
Theta Star	0.109
nu star	4.168
A-D Test Statistic	0.429
5% A-D Critical Value	0.7
K-S Test Statistic	0.7
5% K-S Critical Value	0.367

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.0923
Mean	0.038
Median	0.0247
SD	0.0424
k star	0.26
Theta star	0.146
Nu star	3.122
AppChi2	0.41
95% Gamma Approximate UCL	0.289
95% Adjusted Gamma UCL	0.642

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0382
SD	0.0385
SE of Mean	0.0176
95% KM (t) UCL	0.0736
95% KM (z) UCL	0.0671
95% KM (jackknife) UCL	0.0728
95% KM (bootstrap t) UCL	0.0808
95% KM (BCA) UCL	0.072
95% KM (Percentile Bootstrap) UCL	0.0669
95% KM (Chebyshev) UCL	0.115
97.5% KM (Chebyshev) UCL	0.148
99% KM (Chebyshev) UCL	0.213

Potential UCLs to Use

95% KM (t) UCL	0.0736
95% KM (Percentile Bootstrap) UCL	0.0669

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Manganese (shallow)

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	8		

Raw Statistics

Minimum	0.0013
Maximum	0.61
Mean	0.192
Median	0.114
SD	0.199
Std. Error of Mean	0.0552
Coefficient of Variation	1.038
Skewness	0.865

Log-transformed Statistics

Minimum of Log Data	-6.645
Maximum of Log Data	-0.494
Mean of log Data	-2.845
SD of log Data	2.217

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.881
Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.852
Shapiro Wilk Critical Value	0.866

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL	0.29

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.297
95% Modified-t UCL (Johnson-1978)	0.293

95% H-UCL	19.96
95% Chebyshev (MVUE) UCL	1.681
97.5% Chebyshev (MVUE) UCL	2.224
99% Chebyshev (MVUE) UCL	3.289

Gamma Distribution Test

k star (bias corrected)	0.457
Theta Star	0.42
MLE of Mean	0.192
MLE of Standard Deviation	0.284
nu star	11.88
Approximate Chi Square Value (.05)	5.149
Adjusted Level of Significance	0.0301
Adjusted Chi Square Value	4.533
Anderson-Darling Test Statistic	0.426
Anderson-Darling 5% Critical Value	0.788
Kolmogorov-Smirnov Test Statistic	0.148
Kolmogorov-Smirnov 5% Critical Value	0.249

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.443
95% Adjusted Gamma UCL	0.503

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.283
95% Jackknife UCL	0.29
95% Standard Bootstrap UCL	0.276
95% Bootstrap-t UCL	0.308
95% Hall's Bootstrap UCL	0.301
95% Percentile Bootstrap UCL	0.284
95% BCA Bootstrap UCL	0.296
95% Chebyshev(Mean, Sd) UCL	0.433
97.5% Chebyshev(Mean, Sd) UCL	0.537
99% Chebyshev(Mean, Sd) UCL	0.741

Potential UCL to Use

Use 95% Student's-t UCL 0.29

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Manganese_inter_1

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7
Number of Missing Values	48		

Raw Statistics		Log-transformed Statistics	
Minimum	0.0006	Minimum of Log Data	-7.419
Maximum	0.0699	Maximum of Log Data	-2.661
Mean	0.0403	Mean of log Data	-3.739
Median	0.0464	SD of log Data	1.668
SD	0.0234		
Std. Error of Mean	0.00884		
Coefficient of Variation	0.58		
Skewness	-0.7		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.962	Shapiro Wilk Test Statistic	0.659
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.0575	95% H-UCL	4.655
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.249
95% Adjusted-CLT UCL (Chen-1995)	0.0524	97.5% Chebyshev (MVUE) UCL	0.327
95% Modified-t UCL (Johnson-1978)	0.0571	99% Chebyshev (MVUE) UCL	0.48

Gamma Distribution Test		Data Distribution
k star (bias corrected)	0.714	Data appear Normal at 5% Significance Level
Theta Star	0.0565	
MLE of Mean	0.0403	

MLE of Standard Deviation	0.0477
nu star	9.998
Approximate Chi Square Value (.05)	3.941
Adjusted Level of Significance	0.0158
Adjusted Chi Square Value	2.88
Anderson-Darling Test Statistic	0.87
Anderson-Darling 5% Critical Value	0.726
Kolmogorov-Smirnov Test Statistic	0.298
Kolmogorov-Smirnov 5% Critical Value	0.319

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.102
95% Adjusted Gamma UCL	0.14

Nonparametric Statistics

95% CLT UCL	0.0549
95% Jackknife UCL	0.0575
95% Standard Bootstrap UCL	0.0539
95% Bootstrap-t UCL	0.0547
95% Hall's Bootstrap UCL	0.0526
95% Percentile Bootstrap UCL	0.0531
95% BCA Bootstrap UCL	0.0517
95% Chebyshev(Mean, Sd) UCL	0.0789
97.5% Chebyshev(Mean, Sd) UCL	0.0955
99% Chebyshev(Mean, Sd) UCL	0.128

Potential UCL to Use

Use 95% Student's-t UCL 0.0575

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Zinc_shallow_1

General Statistics

Number of Valid Data	17	Number of Detected Data	15
Number of Distinct Detected Data	15	Number of Non-Detect Data	2
Number of Missing Values	29	Percent Non-Detects	11.76%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.00526	Minimum Detected	-5.248
Maximum Detected	0.087	Maximum Detected	-2.442
Mean of Detected	0.0416	Mean of Detected	-3.485
SD of Detected	0.0277	SD of Detected	0.917
Minimum Non-Detect	0.002	Minimum Non-Detect	-6.215
Maximum Non-Detect	0.0125	Maximum Non-Detect	-4.382

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	5
Number treated as Detected	12
Single DL Non-Detect Percentage	29.41%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.932	Shapiro Wilk Test Statistic	0.9
5% Shapiro Wilk Critical Value	0.881	5% Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0372
SD	0.0288
95% DL/2 (t) UCL	0.0494

Maximum Likelihood Estimate(MLE) Method	
Mean	0.0329
SD	0.0343
95% MLE (t) UCL	0.0474
95% MLE (Tiku) UCL	0.0484

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-3.78
SD	1.239
95% H-Stat (DL/2) UCL	0.126

Log ROS Method	
Mean in Log Scale	-3.694
SD in Log Scale	1.051
Mean in Original Scale	0.0374
SD in Original Scale	0.0285
95% t UCL	0.0495
95% Percentile Bootstrap UCL	0.0488
95% BCA Bootstrap UCL	0.0495
95% H UCL	0.089

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.472
Theta Star	0.0283
nu star	44.15
A-D Test Statistic	0.369
5% A-D Critical Value	0.75
K-S Test Statistic	0.75
5% K-S Critical Value	0.225

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.087
Mean	0.0367
Median	0.036
SD	0.0293
k star	0.419
Theta star	0.0877
Nu star	14.24
AppChi2	6.734
95% Gamma Approximate UCL	0.0776
95% Adjusted Gamma UCL	0.0843

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0374
SD	0.0276
SE of Mean	0.00693
95% KM (t) UCL	0.0495
95% KM (z) UCL	0.0488
95% KM (jackknife) UCL	0.0495
95% KM (bootstrap t) UCL	0.0505
95% KM (BCA) UCL	0.05
95% KM (Percentile Bootstrap) UCL	0.0492
95% KM (Chebyshev) UCL	0.0677
97.5% KM (Chebyshev) UCL	0.0807
99% KM (Chebyshev) UCL	0.106

Potential UCLs to Use

95% KM (t) UCL	0.0495
95% KM (Percentile Bootstrap) UCL	0.0492

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Selenium_deep

General Statistics

Number of Valid Data	8	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	2
Number of Missing Values	36	Percent Non-Detects	25.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000683	Minimum Detected	-7.289
Maximum Detected	0.0013	Maximum Detected	-6.645
Mean of Detected	0.00101	Mean of Detected	-6.914
SD of Detected	0.0002171	SD of Detected	0.227
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.991	Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0008234	Mean	-7.259
SD	0.0003986	SD	0.667
95% DL/2 (t) UCL	0.00109	95% H-Stat (DL/2) UCL	0.00172
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0008372	Mean in Log Scale	-7.056
SD	0.0003612	SD in Log Scale	0.329
95% MLE (t) UCL	0.00108	Mean in Original Scale	0.0009018
95% MLE (Tiku) UCL	0.0011	SD in Original Scale	0.0002788
		95% t UCL	0.00109
		95% Percentile Bootstrap UCL	0.00105
		95% BCA Bootstrap UCL	0.00105
		95% H UCL	0.00118

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	12.3
Theta Star	8.246E-05
nu star	147.6
A-D Test Statistic	0.193
5% A-D Critical Value	0.697
K-S Test Statistic	0.697
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	5.709E-05
Maximum	0.0013
Mean	0.0008098
Median	0.000937
SD	0.0004276
k star	1.26
Theta star	0.0006428
Nu star	20.16
AppChi2	10.97
95% Gamma Approximate UCL	0.00149
95% Adjusted Gamma UCL	0.00176

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0009316
SD	0.0002237
SE of Mean	8.665E-05
95% KM (t) UCL	0.0011
95% KM (z) UCL	0.00107
95% KM (jackknife) UCL	0.0011
95% KM (bootstrap t) UCL	0.00109
95% KM (BCA) UCL	0.00113
95% KM (Percentile Bootstrap) UCL	0.00111
95% KM (Chebyshev) UCL	0.00131
97.5% KM (Chebyshev) UCL	0.00147
99% KM (Chebyshev) UCL	0.00179

Potential UCLs to Use

95% KM (t) UCL	0.0011
95% KM (Percentile Bootstrap) UCL	0.00111

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Selenium_Inter_1

General Statistics

Number of Valid Data	10	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	4
Number of Missing Values	45	Percent Non-Detects	40.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000879	Minimum Detected	-7.037
Maximum Detected	0.002	Maximum Detected	-6.215
Mean of Detected	0.00134	Mean of Detected	-6.659
SD of Detected	0.0004496	SD of Detected	0.333
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.001	Maximum Non-Detect	-6.908

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	5
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	50.00%

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.9
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.905
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0009809
SD	0.0005799
95% DL/2 (t) UCL	0.00132

Maximum Likelihood Estimate(MLE) Method

Mean	0.0009779
SD	0.0005918
95% MLE (t) UCL	0.00132
95% MLE (Tiku) UCL	0.0014

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-7.105
SD	0.658
95% H-Stat (DL/2) UCL	0.00175

Log ROS Method

Mean in Log Scale	-6.954
SD in Log Scale	0.471
Mean in Original Scale	0.00106
SD in Original Scale	0.0005063
95% t UCL	0.00135
95% Percentile Bootstrap UCL	0.00132
95% BCA Bootstrap UCL	0.00134
95% H UCL	0.0015

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.579
Theta Star	0.0002407
nu star	66.95
A-D Test Statistic	0.406
5% A-D Critical Value	0.698
K-S Test Statistic	0.698
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.002
Mean	0.0009005
Median	0.0009395
SD	0.000687
k star	0.411
Theta star	0.00219
Nu star	8.212
AppChi2	2.858
95% Gamma Approximate UCL	0.00259
95% Adjusted Gamma UCL	0.00316

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.00116
SD	0.0003909
SE of Mean	0.0001354
95% KM (t) UCL	0.00141
95% KM (z) UCL	0.00138
95% KM (jackknife) UCL	0.00138
95% KM (bootstrap t) UCL	0.00146
95% KM (BCA) UCL	0.00151
95% KM (Percentile Bootstrap) UCL	0.00145
95% KM (Chebyshev) UCL	0.00175
97.5% KM (Chebyshev) UCL	0.002
99% KM (Chebyshev) UCL	0.0025

Potential UCLs to Use

95% KM (t) UCL	0.00141
95% KM (Percentile Bootstrap) UCL	0.00145

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Selenium_Shallow_1

General Statistics

Number of Valid Data	20	Number of Detected Data	10
Number of Distinct Detected Data	8	Number of Non-Detect Data	10
Number of Missing Values	26	Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000606	Minimum Detected	-7.409
Maximum Detected	0.00267	Maximum Detected	-5.926
Mean of Detected	0.00171	Mean of Detected	-6.443
SD of Detected	0.0006126	SD of Detected	0.429
Minimum Non-Detect	0.001	Minimum Non-Detect	-6.908
Maximum Non-Detect	0.001	Maximum Non-Detect	-6.908

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.97	Shapiro Wilk Test Statistic	0.902
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0011	Mean	-7.022
SD	0.0007502	SD	0.663
95% DL/2 (t) UCL	0.00139	95% H-Stat (DL/2) UCL	0.00155
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0009246	Mean in Log Scale	-6.89
SD	0.0009901	SD in Log Scale	0.595
95% MLE (t) UCL	0.00131	Mean in Original Scale	0.0012
95% MLE (Tiku) UCL	0.00142	SD in Original Scale	0.0006905
		95% t UCL	0.00146
		95% Percentile Bootstrap UCL	0.00144
		95% BCA Bootstrap UCL	0.00146
		95% H UCL	0.00162

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	5.044	Data appear Normal at 5% Significance Level
Theta Star	0.0003389	
nu star	100.9	
A-D Test Statistic	0.336	Nonparametric Statistics
5% A-D Critical Value	0.728	Kaplan-Meier (KM) Method
K-S Test Statistic	0.728	Mean 0.00116
5% K-S Critical Value	0.267	SD 0.000688
Data appear Gamma Distributed at 5% Significance Level		SE of Mean 0.0001622
		95% KM (t) UCL 0.00144

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.00267
Mean	0.00106
Median	0.00106
SD	0.000843
k star	0.433
Theta star	0.00246
Nu star	17.31
AppChi2	8.896
95% Gamma Approximate UCL	0.00207
95% Adjusted Gamma UCL	0.00219

95% KM (z) UCL	0.00142
95% KM (jackknife) UCL	0.00148
95% KM (bootstrap t) UCL	0.00144
95% KM (BCA) UCL	0.00172
95% KM (Percentile Bootstrap) UCL	0.00166
95% KM (Chebyshev) UCL	0.00186
97.5% KM (Chebyshev) UCL	0.00217
99% KM (Chebyshev) UCL	0.00277

Potential UCLs to Use

95% KM (t) UCL	0.00144
95% KM (Percentile Bootstrap) UCL	0.00166

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Vanadium (intermediate)

General Statistics

Number of Valid Data	10	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	5
Number of Missing Values	4	Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.013	Maximum Detected	-4.343
Mean of Detected	0.00434	Mean of Detected	-6.532
SD of Detected	0.0056	SD of Detected	1.853
Minimum Non-Detect	0.0002	Minimum Non-Detect	-8.517
Maximum Non-Detect	0.005	Maximum Non-Detect	-5.298

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	8
Number treated as Detected	2
Single DL Non-Detect Percentage	80.00%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.817	Shapiro Wilk Test Statistic	0.91
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00318	Mean	-6.584
SD	0.00399	SD	1.565
95% DL/2 (t) UCL	0.00549	95% H-Stat (DL/2) UCL	0.0457
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-7.725
		SD in Log Scale	2.055
		Mean in Original Scale	0.00233
		SD in Original Scale	0.0043
		95% t UCL	0.00482
		95% Percentile Bootstrap UCL	0.00471

95% BCA Bootstrap UCL	0.00543
95% H-UCL	0.161

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.361
Theta Star	0.012
nu star	3.614
A-D Test Statistic	0.363
5% A-D Critical Value	0.707
K-S Test Statistic	0.707
5% K-S Critical Value	0.37

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.00238
SD	0.00406
SE of Mean	0.00144
95% KM (t) UCL	0.00502
95% KM (z) UCL	0.00475
95% KM (jackknife) UCL	0.00486
95% KM (bootstrap t) UCL	0.0137
95% KM (BCA) UCL	0.00556
95% KM (Percentile Bootstrap) UCL	0.00542
95% KM (Chebyshev) UCL	0.00866
97.5% KM (Chebyshev) UCL	0.0114
99% KM (Chebyshev) UCL	0.0167

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.013
Mean	0.00243
Median	0.00025
SD	0.00431
k star	0.232
Theta star	0.0105
Nu star	4.645
AppChi2	0.992
95% Gamma Approximate UCL	0.0114
95% Adjusted Gamma UCL	0.0154

Potential UCLs to Use

95% KM (t) UCL	0.00502
95% KM (Percentile Bootstrap) UCL	0.00542

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium (shallow)

General Statistics

Number of Valid Data	18	Number of Detected Data	13
Number of Distinct Detected Data	11	Number of Non-Detect Data	5
Number of Missing Values	3	Percent Non-Detects	27.78%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0003	Minimum Detected	-8.112
Maximum Detected	0.0147	Maximum Detected	-4.22
Mean of Detected	0.00466	Mean of Detected	-6.213
SD of Detected	0.0056	SD of Detected	1.419
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.005	Maximum Non-Detect	-5.298

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	14
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	4
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	77.78%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.728
5% Shapiro Wilk Critical Value	0.866

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.89
5% Shapiro Wilk Critical Value	0.866

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.00366
SD	0.00503
95% DL/2 (t) UCL	0.00572

Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-6.726
SD	1.734
95% H-Stat (DL/2) UCL	0.0271

Log ROS Method

Mean in Log Scale	-6.88
SD in Log Scale	1.724
Mean in Original Scale	0.00346
SD in Original Scale	0.00512
95% t UCL	0.00556
95% Percentile Bootstrap UCL	0.00551
95% BCA Bootstrap UCL	0.00594
95% H-UCL	0.0224

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.6
Theta Star	0.00777
nu star	15.61

A-D Test Statistic	0.909
5% A-D Critical Value	0.773
K-S Test Statistic	0.773
5% K-S Critical Value	0.246

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.0147
Mean	0.00348
Median	0.00095
SD	0.00512
k star	0.293
Theta star	0.0119
Nu star	10.54
AppChi2	4.279
95% Gamma Approximate UCL	0.00858
95% Adjusted Gamma UCL	0.00941

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.00352
SD	0.00494
SE of Mean	0.00121
95% KM (t) UCL	0.00563
95% KM (z) UCL	0.00552
95% KM (jackknife) UCL	0.00559
95% KM (bootstrap t) UCL	0.00681
95% KM (BCA) UCL	0.00551
95% KM (Percentile Bootstrap) UCL	0.00555
95% KM (Chebyshev) UCL	0.00881
97.5% KM (Chebyshev) UCL	0.0111
99% KM (Chebyshev) UCL	0.0156

Potential UCLs to Use

95% KM (Chebyshev) UCL	0.00881

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Zinc (intermediate)

General Statistics

Number of Valid Data	10	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	3
Number of Missing Values	4	Percent Non-Detects	30.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.014	Minimum Detected	-4.269
Maximum Detected	0.699	Maximum Detected	-0.358
Mean of Detected	0.206	Mean of Detected	-2.329
SD of Detected	0.248	SD of Detected	1.411
Minimum Non-Detect	0.005	Minimum Non-Detect	-5.298
Maximum Non-Detect	0.0125	Maximum Non-Detect	-4.382

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	3
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	7
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	30.00%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.791	Shapiro Wilk Test Statistic	0.946
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.145	Mean	-3.336
SD	0.225	SD	2.004
95% DL/2 (t) UCL	0.275	95% H-Stat (DL/2) UCL	9.828
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0899	Mean in Log Scale	-3.407
SD	0.274	SD in Log Scale	2.097
95% MLE (t) UCL	0.249	Mean in Original Scale	0.145
95% MLE (Tiku) UCL	0.256	SD in Original Scale	0.225
		95% t UCL	0.275

95% Percentile Bootstrap UCL	0.263
95% BCA Bootstrap UCL	0.307
95% H UCL	15.34

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.549
Theta Star	0.374
nu star	7.69
A-D Test Statistic	0.369
5% A-D Critical Value	0.735
K-S Test Statistic	0.735
5% K-S Critical Value	0.322

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.699
Mean	0.144
Median	0.0382
SD	0.226
k star	0.202
Theta star	0.714
Nu star	4.034
AppChi2	0.735
95% Gamma Approximate UCL	0.79
95% Adjusted Gamma UCL	1.097

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.148
SD	0.211
SE of Mean	0.0721
95% KM (t) UCL	0.28
95% KM (z) UCL	0.267
95% KM (jackknife) UCL	0.274
95% KM (bootstrap t) UCL	0.393
95% KM (BCA) UCL	0.282
95% KM (Percentile Bootstrap) UCL	0.272
95% KM (Chebyshev) UCL	0.463
97.5% KM (Chebyshev) UCL	0.599
99% KM (Chebyshev) UCL	0.866

Potential UCLs to Use

95% KM (BCA) UCL	0.282

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

GROUNDWATER – UTL AND UPL OUTPUTS

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Arsenic_2

General Statistics

Number of Valid Data	8	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	3
Tolerance Factor	3.187	Percent Non-Detects	37.50%
Number of Missing Values	45		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000266	Minimum Detected	-8.232
Maximum Detected	0.000989	Maximum Detected	-6.919
Mean of Detected	0.0006252	Mean of Detected	-7.475
SD of Detected	0.0002858	SD of Detected	0.516
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.985	Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0004845	Mean (Log Scale)	-7.782
SD	0.0002905	SD (Log Scale)	0.576
95% UTL 95% Coverage	0.00141	95% UTL 95% Coverage	0.00262
95% UPL (t)	0.00107	95% UPL (t)	0.00133
90% Percentile (z)	0.0008568	90% Percentile (z)	0.0008727
95% Percentile (z)	0.0009623	95% Percentile (z)	0.00108
99% Percentile (z)	0.00116	99% Percentile (z)	0.00159
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0008123	Mean in Original Scale	0.0005202
SD	0.0001591	SD in Original Scale	0.0002649

95% UTL with 95% Coverage	0.00132
95% UPL (t)	0.00113
90% Percentile (z)	0.00102
95% Percentile (z)	0.00107
99% Percentile (z)	0.00118

95% UTL with 95% Coverage	0.00227
95% BCA UTL with 95% Coverage	0.000989
95% Bootstrap (%) UTL with 95% Coverage	0.000989
95% UPL (t)	0.00127
90% Percentile (z)	0.0008817
95% Percentile (z)	0.00106
99% Percentile (z)	0.00148

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.249
Theta Star	0.000278
nu star	22.49
A-D Test Statistic	0.195
5% A-D Critical Value	0.681
K-S Test Statistic	0.182
5% K-S Critical Value	0.358

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0005193
Median	0.0004867
SD	0.0002784
k star	2.352
Theta star	0.0002207
Nu star	37.64
95% Percentile of Chisquare (2k)	10.61
90% Percentile	0.0009726
95% Percentile	0.00117
99% Percentile	0.00161

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0005261
SD	0.0002461
SE of Mean	0.0001039
95% KM UTL with 95% Coverage	0.00131
95% KM Chebyshev UPL	0.00166
95% KM UPL (t)	0.00102
90% Percentile (z)	0.0008416
95% Percentile (z)	0.000931
99% Percentile (z)	0.0011

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00126
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00131
95% WH Approx. Gamma UTL with 95% Coverage	0.00199
95% HW Approx. Gamma UTL with 95% Coverage	0.00216

Note: DL/2 is not a recommended method.

Cadmium_1

General Statistics

Number of Valid Data	51
Number of Distinct Detected Data	5
Tolerance Factor	2.054
Number of Missing Values	6
Number of Detected Data	6
Number of Non-Detect Data	45
Percent Non-Detects	88.24%

Raw Statistics

Minimum Detected	0.0002
Maximum Detected	0.000522
Mean of Detected	0.000345
SD of Detected	0.0001304
Minimum Non-Detect	0.0001
Maximum Non-Detect	0.0003

Log-transformed Statistics

Minimum Detected	-8.517
Maximum Detected	-7.558
Mean of Detected	-8.037
SD of Detected	0.406
Minimum Non-Detect	-9.21
Maximum Non-Detect	-8.112

Data with Multiple Detection Limits

Single Detection Limit Scenario

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Number treated as Non-Detect with Single DL	47
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	92.16%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.921
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.888
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0001073
	SD	0.0001017
95% UTL	95% Coverage	0.0003161
	95% UPL (t)	0.0002793
	90% Percentile (z)	0.0002376
	95% Percentile (z)	0.0002745
	99% Percentile (z)	0.0003438

Maximum Likelihood Estimate(MLE) Method

	Mean	-4.43E-05
	SD	0.0002444
95% UTL with	95% Coverage	0.0004578
	95% UPL (t)	0.0003694
	90% Percentile (z)	0.000269
	95% Percentile (z)	0.0003578
	99% Percentile (z)	0.0005244

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-9.388
	SD (Log Scale)	0.626
95% UTL	95% Coverage	0.0003029
	95% UPL (t)	0.0002415
	90% Percentile (z)	0.0001868
	95% Percentile (z)	0.0002345
	99% Percentile (z)	0.0003592

Log ROS Method

	Mean in Original Scale	8.808E-05
	SD in Original Scale	0.0001095
95% UTL with	95% Coverage	0.0004179
95% BCA UTL with	95% Coverage	0.0004775
95% Bootstrap (%) UTL with	95% Coverage	0.000461
	95% UPL (t)	0.0002895
	90% Percentile (z)	0.0001907
	95% Percentile (z)	0.0002759
	99% Percentile (z)	0.0005513

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	4.017
Theta Star	8.588E-05
nu star	48.21
A-D Test Statistic	0.375
5% A-D Critical Value	0.698
K-S Test Statistic	0.232
5% K-S Critical Value	0.333

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	4.147E-05
Median	0.000001

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0002171
	SD	6.205E-05
	SE of Mean	9.518E-06
95% KM UTL with	95% Coverage	0.0003445
	95% KM Chebyshev UPL	0.0004902
	95% KM UPL (t)	0.0003221
	90% Percentile (z)	0.0002966
	95% Percentile (z)	0.0003191

SD	0.0001193
k star	0.235
Theta star	0.0001767
Nu star	23.94
95% Percentile of Chisquare (2k)	2.315
90% Percentile	0.000125
95% Percentile	0.0002045
99% Percentile	0.0004181

99% Percentile (z)	0.0003614

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.0001242
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0001038
95% WH Approx. Gamma UTL with 95% Coverage	0.0001845
95% HW Approx. Gamma UTL with 95% Coverage	0.0001639

Note: DL/2 is not a recommended method.

Chromium, total_1

General Statistics

Number of Valid Data	32
Number of Distinct Detected Data	25
Tolerance Factor	2.186
Number of Missing Values	24

Number of Detected Data	26
Number of Non-Detect Data	6
Percent Non-Detects	18.75%

Raw Statistics

Minimum Detected	0.0002
Maximum Detected	0.00524
Mean of Detected	0.00218
SD of Detected	0.00149
Minimum Non-Detect	0.0002
Maximum Non-Detect	0.001

Log-transformed Statistics

Minimum Detected	-8.517
Maximum Detected	-5.251
Mean of Detected	-6.416
SD of Detected	0.858
Minimum Non-Detect	-8.517
Maximum Non-Detect	-6.908

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	13
Number treated as Detected with Single DL	19
Single DL Non-Detect Percentage	40.63%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.913
5% Shapiro Wilk Critical Value	0.92

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.939
5% Shapiro Wilk Critical Value	0.92

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.00181
SD	0.00156
95% UTL 95% Coverage	0.00521
95% UPL (t)	0.00449
90% Percentile (z)	0.0038
95% Percentile (z)	0.00437
99% Percentile (z)	0.00543

Maximum Likelihood Estimate(MLE) Method

Mean	0.00146
SD	0.00199

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-6.861
SD (Log Scale)	1.247
95% UTL 95% Coverage	0.016
95% UPL (t)	0.00897
90% Percentile (z)	0.00518
95% Percentile (z)	0.00815
99% Percentile (z)	0.0191

Log ROS Method

Mean in Original Scale	0.00183
SD in Original Scale	0.00153

95% UTL with 95% Coverage	0.0058
95% UPL (t)	0.00488
90% Percentile (z)	0.004
95% Percentile (z)	0.00473
99% Percentile (z)	0.00608

95% UTL with 95% Coverage	0.0117
95% BCA UTL with 95% Coverage	0.00524
95% Bootstrap (%) UTL with 95% Coverage	0.00524
95% UPL (t)	0.00719
90% Percentile (z)	0.00452
95% Percentile (z)	0.00663
99% Percentile (z)	0.0136

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.702
Theta Star	0.00128
nu star	88.48
A-D Test Statistic	0.221
5% A-D Critical Value	0.758
K-S Test Statistic	0.0998
5% K-S Critical Value	0.174

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.00177
Median	0.00142
SD	0.0016
k star	0.421
Theta star	0.0042
Nu star	26.95
95% Percentile of Chisquare (2k)	3.437
90% Percentile	0.00495
95% Percentile	0.00722
99% Percentile	0.0129

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.00182
SD	0.00152
SE of Mean	0.0002745
95% KM UTL with 95% Coverage	0.00514
95% KM Chebyshev UPL	0.00855
95% KM UPL (t)	0.00444
90% Percentile (z)	0.00377
95% Percentile (z)	0.00432
99% Percentile (z)	0.00536

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.0071
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00891
95% WH Approx. Gamma UTL with 95% Coverage	0.0102
95% HW Approx. Gamma UTL with 95% Coverage	0.0139

Note: DL/2 is not a recommended method.

Lead_1

General Statistics

Number of Valid Data	9
Number of Distinct Detected Data	5
Tolerance Factor	3.031
Number of Missing Values	44

Number of Detected Data	5
Number of Non-Detect Data	4
Percent Non-Detects	44.44%

Raw Statistics

Minimum Detected	0.0004
Maximum Detected	0.0015
Mean of Detected	0.0008334
SD of Detected	0.0004865
Minimum Non-Detect	0.0001
Maximum Non-Detect	0.00025

Log-transformed Statistics

Minimum Detected	-7.824
Maximum Detected	-6.502
Mean of Detected	-7.225
SD of Detected	0.576
Minimum Non-Detect	-9.21
Maximum Non-Detect	-8.294

Data with Multiple Detection Limits

Single Detection Limit Scenario

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect with Single DL	4
Number treated as Detected with Single DL	5
Single DL Non-Detect Percentage	44.44%

Warning: There are only 5 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.845
5% Shapiro Wilk Critical Value	0.762

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.878
5% Shapiro Wilk Critical Value	0.762

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0005102
	SD	0.0005155
95% UTL	95% Coverage	0.00207
	95% UPL (t)	0.00152
	90% Percentile (z)	0.00117
	95% Percentile (z)	0.00136
	99% Percentile (z)	0.00171

Maximum Likelihood Estimate(MLE) Method

	Mean	0.0003445
	SD	0.0006889
95% UTL with	95% Coverage	0.00243
	95% UPL (t)	0.00169
	90% Percentile (z)	0.00123
	95% Percentile (z)	0.00148
	99% Percentile (z)	0.00195

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-8.11
	SD (Log Scale)	1.16
95% UTL	95% Coverage	0.0101
	95% UPL (t)	0.00292
	90% Percentile (z)	0.00133
	95% Percentile (z)	0.00203
	99% Percentile (z)	0.00447

Log ROS Method

	Mean in Original Scale	0.0005282
	SD in Original Scale	0.0005003
95% UTL with	95% Coverage	0.00698
95% BCA UTL with	95% Coverage	0.0015
95% Bootstrap (%) UTL with	95% Coverage	0.0015
	95% UPL (t)	0.00242
	90% Percentile (z)	0.00124
	95% Percentile (z)	0.00177
	99% Percentile (z)	0.00348

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.68
Theta Star	0.0004961
nu star	16.8
A-D Test Statistic	0.486
5% A-D Critical Value	0.681
K-S Test Statistic	0.328
5% K-S Critical Value	0.359

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0004634
Median	0.0004

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0006408
	SD	0.0003893
	SE of Mean	0.0001451
95% KM UTL with	95% Coverage	0.00182
	95% KM Chebyshev UPL	0.00243
	95% KM UPL (t)	0.0014
	90% Percentile (z)	0.00114
	95% Percentile (z)	0.00128

SD	0.0005575
k star	0.262
Theta star	0.00177
Nu star	4.709
95% Percentile of Chisquare (2k)	2.498
90% Percentile	0.00139
95% Percentile	0.00221
99% Percentile	0.0044

99% Percentile (z)	0.00155

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00291
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00382
95% WH Approx. Gamma UTL with 95% Coverage	0.00693
95% HW Approx. Gamma UTL with 95% Coverage	0.0114

Note: DL/2 is not a recommended method.

Selenium_1

General Statistics

Number of Valid Data	52
Number of Distinct Detected Data	19
Tolerance Factor	2.049
Number of Missing Values	5

Number of Detected Data	27
Number of Non-Detect Data	25
Percent Non-Detects	48.08%

Raw Statistics

Minimum Detected	0.000606
Maximum Detected	0.00267
Mean of Detected	0.00148
SD of Detected	0.0005602
Minimum Non-Detect	0.0005
Maximum Non-Detect	0.001

Log-transformed Statistics

Minimum Detected	-7.409
Maximum Detected	-5.926
Mean of Detected	-6.589
SD of Detected	0.404
Minimum Non-Detect	-7.601
Maximum Non-Detect	-6.908

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	30
Number treated as Detected with Single DL	22
Single DL Non-Detect Percentage	57.69%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.935
5% Shapiro Wilk Critical Value	0.923

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.942
5% Shapiro Wilk Critical Value	0.923

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0009953
SD	0.0006509
95% UTL 95% Coverage	0.00233
95% UPL (t)	0.0021
90% Percentile (z)	0.00183
95% Percentile (z)	0.00207
99% Percentile (z)	0.00251

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-7.116
SD (Log Scale)	0.643
95% UTL 95% Coverage	0.00303
95% UPL (t)	0.00241
90% Percentile (z)	0.00185
95% Percentile (z)	0.00234
99% Percentile (z)	0.00362

Maximum Likelihood Estimate(MLE) Method

Mean	0.0008413
SD	0.0008617

Log ROS Method

Mean in Original Scale	0.00107
SD in Original Scale	0.000604

95% UTL with 95% Coverage	0.00261
95% UPL (t)	0.0023
90% Percentile (z)	0.00195
95% Percentile (z)	0.00226
99% Percentile (z)	0.00285

95% UTL with 95% Coverage	0.00292
95% BCA UTL with 95% Coverage	0.00152
95% Bootstrap (%) UTL with 95% Coverage	0.00251
95% UPL (t)	0.00239
90% Percentile (z)	0.0019
95% Percentile (z)	0.00233
99% Percentile (z)	0.00342

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	6.121
Theta Star	0.0002421
nu star	330.5
A-D Test Statistic	0.658
5% A-D Critical Value	0.746
K-S Test Statistic	0.2
5% K-S Critical Value	0.168

Data follow Appx. Gamma Distribution at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0011
SD	0.0005646
SE of Mean	8.227E-05
95% KM UTL with 95% Coverage	0.00226
95% KM Chebyshev UPL	0.00359
95% KM UPL (t)	0.00206
90% Percentile (z)	0.00183
95% Percentile (z)	0.00203
99% Percentile (z)	0.00242

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0009245
Median	0.0008873
SD	0.0007599
k star	0.411
Theta star	0.00225
Nu star	42.76
95% Percentile of Chisquare (2k)	3.384
90% Percentile	0.0026
95% Percentile	0.0038
99% Percentile	0.00683

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00371
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00466
95% WH Approx. Gamma UTL with 95% Coverage	0.00496
95% HW Approx. Gamma UTL with 95% Coverage	0.00668

Note: DL/2 is not a recommended method.

Vanadium

General Statistics

Number of Valid Data	48
Number of Distinct Detected Data	24
Tolerance Factor	2.069
Number of Missing Values	9
Number of Detected Data	29
Number of Non-Detect Data	19
Percent Non-Detects	39.58%

Raw Statistics

Minimum Detected	0.0002
Maximum Detected	0.0147
Mean of Detected	0.00373
SD of Detected	0.00453
Minimum Non-Detect	0.0001
Maximum Non-Detect	0.025

Log-transformed Statistics

Minimum Detected	-8.517
Maximum Detected	-4.22
Mean of Detected	-6.326
SD of Detected	1.276
Minimum Non-Detect	-9.21
Maximum Non-Detect	-3.689

Data with Multiple Detection Limits

Single Detection Limit Scenario

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect with Single DL	48
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.73
5% Shapiro Wilk Critical Value	0.926

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.946
5% Shapiro Wilk Critical Value	0.926

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.00315
	SD	0.00395
95% UTL	95% Coverage	0.0113
	95% UPL (t)	0.00984
	90% Percentile (z)	0.00821
	95% Percentile (z)	0.00964
	99% Percentile (z)	0.0123

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-6.577
	SD (Log Scale)	1.474
95% UTL	95% Coverage	0.0293
	95% UPL (t)	0.0169
	90% Percentile (z)	0.0092
	95% Percentile (z)	0.0157
	99% Percentile (z)	0.0429

Log ROS Method

	Mean in Original Scale	0.00255
	SD in Original Scale	0.00383
	Mean in Log Scale	-6.951
	SD in Log Scale	1.483
95% UTL	95% Coverage	0.0206
	95% UPL (t)	0.0118
	90% Percentile (z)	0.00641
	95% Percentile (z)	0.011
	99% Percentile (z)	0.0302

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.746
Theta Star	0.00499
nu star	43.3

A-D Test Statistic	1.022
5% A-D Critical Value	0.782
K-S Test Statistic	0.17
5% K-S Critical Value	0.169

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.00274
Median	0.00101
SD	0.00391
k star	0.313
Theta star	0.00877
Nu star	30.01
95% Percentile of Chisquare (2k)	2.822
90% Percentile	0.00805

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.00262
	SD	0.00382
	SE of Mean	0.0005742
95% KM UTL with	95% Coverage	0.0105
	95% KM Chebyshev UPL	0.0194
	95% KM UPL (t)	0.00909
	90% Percentile (z)	0.00751
	95% Percentile (z)	0.00889
	99% Percentile (z)	0.0115

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		0.0112
95% Hawkins Wixley (HW) Approx. Gamma UPL		0.0134
95% WH Approx. Gamma UTL with	95% Coverage	0.0157
95% HW Approx. Gamma UTL with	95% Coverage	0.0201

95% Percentile	0.0124
99% Percentile	0.0236

Note: DL/2 is not a recommended method.

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Cadmium (shallow)

General Statistics

Number of Valid Data	19	Number of Detected Data	5
Number of Distinct Detected Data	4	Number of Non-Detect Data	14
Tolerance Factor	2.423	Percent Non-Detects	73.68%
Number of Missing Values	2		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.000522	Maximum Detected	-7.558
Mean of Detected	0.000334	Mean of Detected	-8.08
SD of Detected	0.0001427	SD of Detected	0.438
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.0003	Maximum Non-Detect	-8.112

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	16
Number treated as Detected with Single DL	3
Single DL Non-Detect Percentage	84.21%

Warning: There are only 4 Distinct Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.897
5% Shapiro Wilk Critical Value	0.762

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.884
5% Shapiro Wilk Critical Value	0.762

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0001412
	SD	0.0001388
95% UTL	95% Coverage	0.0004775
	95% UPL (t)	0.0003882
	90% Percentile (z)	0.0003191
	95% Percentile (z)	0.0003695

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-9.208
	SD (Log Scale)	0.795
95% UTL	95% Coverage	0.0006884
	95% UPL (t)	0.0004125
	90% Percentile (z)	0.0002777
	95% Percentile (z)	0.0003708

99% Percentile (z)	0.0004641

Maximum Likelihood Estimate(MLE) Method

Mean	7.845E-05
SD	0.000223
95% UTL with 95% Coverage	0.0006188
95% UPL (t)	0.0004752
90% Percentile (z)	0.0003642
95% Percentile (z)	0.0004452
99% Percentile (z)	0.0005972

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.843
Theta Star	0.0001175
nu star	28.43
A-D Test Statistic	0.378
5% A-D Critical Value	0.68
K-S Test Statistic	0.264
5% K-S Critical Value	0.358

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	8.863E-05
Median	0.000001
SD	0.000165
k star	0.237
Theta star	0.0003733
Nu star	9.022
95% Percentile of Chisquare (2k)	2.334
90% Percentile	0.0002669
95% Percentile	0.0004356
99% Percentile	0.0008879

99% Percentile (z)	0.0006375

Log ROS Method

Mean in Original Scale	0.0001386
SD in Original Scale	0.0001404
95% UTL with 95% Coverage	0.0008037
95% BCA UTL with 95% Coverage	0.000522
95% Bootstrap (%) UTL with 95% Coverage	0.000522
95% UPL (t)	0.0004538
90% Percentile (z)	0.0002918
95% Percentile (z)	0.0004028
99% Percentile (z)	0.0007376

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0002353
SD	8.813E-05
SE of Mean	2.261E-05
95% KM UTL with 95% Coverage	0.0004488
95% KM Chebyshev UPL	0.0006294
95% KM UPL (t)	0.0003921
90% Percentile (z)	0.0003482
95% Percentile (z)	0.0003802
99% Percentile (z)	0.0004403

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.000388
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0003966
95% WH Approx. Gamma UTL with 95% Coverage	0.000733
95% HW Approx. Gamma UTL with 95% Coverage	0.0008564

Note: DL/2 is not a recommended method.

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Chromium, total (deep)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
Tolerance Factor	3.708	Number of Missing Values	2

Raw Statistics		Log-Transformed Statistics	
Minimum	0.00154	Minimum	-6.476
Maximum	0.00442	Maximum	-5.422
Second Largest	0.0029	Second Largest	-5.843
First Quartile	0.00209	First Quartile	-6.172
Median	0.00235	Median	-6.054
Third Quartile	0.00278	Third Quartile	-5.887
Mean	0.0026	Mean	-6.008
SD	0.0009989	SD	0.356
Coefficient of Variation	0.384		
Skewness	1.404		

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	0.0063	95% UTL with 95% Coverage	0.0092
95% UPL (t)	0.00477	95% UPL (t)	0.00534
90% Percentile (z)	0.00388	90% Percentile (z)	0.00388
95% Percentile (z)	0.00424	95% Percentile (z)	0.00442
99% Percentile (z)	0.00492	99% Percentile (z)	0.00563

Gamma Distribution Test

k star	4.726
Theta Star	0.0005498
MLE of Mean	0.0026
MLE of Standard Deviation	0.0012
nu star	56.71

A-D Test Statistic	0.271
5% A-D Critical Value	0.698
K-S Test Statistic	0.203
5% K-S Critical Value	0.333

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.00366
95% Percentile	0.00404
99% Percentile	0.00434

Assuming Gamma Distribution

90% Percentile	0.0042
95% Percentile	0.00482
99% Percentile	0.00615
95% WH Approx. Gamma UPL	0.00507
95% HW Approx. Gamma UPL	0.00512
95% WH Approx. Gamma UTL with 95% Coverage	0.00765
95% HW Approx. Gamma UTL with 95% Coverage	0.00795

95% UTL with 95% Coverage	0.00442
95% Percentile Bootstrap UTL with 95% Coverage	0.00442
95% BCA Bootstrap UTL with 95% Coverage	0.00442
95% UPL	0.00442
95% Chebyshev UPL	0.0073
Upper Threshold Limit Based upon IQR	0.00382

Chromium, total (intermediate)

General Statistics

Total Number of Observations	8
Tolerance Factor	3.187
Number of Distinct Observations	8
Number of Missing Values	6

Raw Statistics

Minimum	0.0003
Maximum	0.00524
Second Largest	0.0044
First Quartile	0.00122
Median	0.00184
Third Quartile	0.00324
Mean	0.00236
SD	0.00172
Coefficient of Variation	0.73
Skewness	0.731

Log-Transformed Statistics

Minimum	-8.112
Maximum	-5.251
Second Largest	-5.426
First Quartile	-6.713
Median	-6.345
Third Quartile	-5.752
Mean	-6.349
SD	0.916

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.913
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Shapiro Wilk Test Statistic	0.925
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	0.00785
95% UPL (t)	0.00582
90% Percentile (z)	0.00456
95% Percentile (z)	0.00519
99% Percentile (z)	0.00636

Assuming Lognormal Distribution

95% UTL with 95% Coverage	0.0324
95% UPL (t)	0.011
90% Percentile (z)	0.00565
95% Percentile (z)	0.00788
99% Percentile (z)	0.0147

Gamma Distribution Test

k star	1.222
Theta Star	0.00193
MLE of Mean	0.00236
MLE of Standard Deviation	0.00213
nu star	19.56

A-D Test Statistic	0.262
5% A-D Critical Value	0.726
K-S Test Statistic	0.182
5% K-S Critical Value	0.298

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.00465
95% Percentile	0.00495
99% Percentile	0.00518

Assuming Gamma Distribution

90% Percentile	0.00517
95% Percentile	0.00658
99% Percentile	0.00983
95% WH Approx. Gamma UPL	0.00746
95% HW Approx. Gamma UPL	0.00798
95% WH Approx. Gamma UTL with 95% Coverage	0.0132
95% HW Approx. Gamma UTL with 95% Coverage	0.0153

95% UTL with 95% Coverage	0.00524
95% Percentile Bootstrap UTL with 95% Coverage	0.00524
95% BCA Bootstrap UTL with 95% Coverage	0.00524
95% UPL	0.00524
95% Chebyshev UPL	0.0103
Upper Threshold Limit Based upon IQR	0.00627

Chromium, total_1 (shallow)

General Statistics

Number of Valid Data	10
Number of Distinct Detected Data	6
Tolerance Factor	2.911
Number of Missing Values	11

Number of Detected Data	6
Number of Non-Detect Data	4
Percent Non-Detects	40.00%

Raw Statistics

Minimum Detected	0.0004
Maximum Detected	0.00474
Mean of Detected	0.00196
SD of Detected	0.00168
Minimum Non-Detect	0.0002
Maximum Non-Detect	0.001

Log-transformed Statistics

Minimum Detected	-7.824
Maximum Detected	-5.352
Mean of Detected	-6.583
SD of Detected	0.944
Minimum Non-Detect	-8.517
Maximum Non-Detect	-6.908

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	7
Number treated as Detected with Single DL	3
Single DL Non-Detect Percentage	70.00%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.89
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.00127
	SD	0.00154
95% UTL	95% Coverage	0.00576
	95% UPL (t)	0.00423
	90% Percentile (z)	0.00324
	95% Percentile (z)	0.0038
	99% Percentile (z)	0.00485

Maximum Likelihood Estimate(MLE) Method

	Mean	0.00334
	SD	0.00116
95% UTL with	95% Coverage	0.00673
	95% UPL (t)	0.00558
	90% Percentile (z)	0.00483
	95% Percentile (z)	0.00525
	99% Percentile (z)	0.00605

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-7.381
	SD (Log Scale)	1.327
95% UTL	95% Coverage	0.0297
	95% UPL (t)	0.00799
	90% Percentile (z)	0.00341
	95% Percentile (z)	0.00553
	99% Percentile (z)	0.0137

Log ROS Method

	Mean in Original Scale	0.00126
	SD in Original Scale	0.00155
95% UTL with	95% Coverage	0.0268
95% BCA UTL with	95% Coverage	0.00474
95% Bootstrap (%) UTL with	95% Coverage	0.00474
	95% UPL (t)	0.00745
	90% Percentile (z)	0.00325
	95% Percentile (z)	0.0052
	99% Percentile (z)	0.0126

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.907
Theta Star	0.00216
nu star	10.88
A-D Test Statistic	0.248
5% A-D Critical Value	0.707
K-S Test Statistic	0.222
5% K-S Critical Value	0.337

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

	Mean	0.00117

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.00135
	SD	0.00141
	SE of Mean	0.000488
95% KM UTL with	95% Coverage	0.00544
	95% KM Chebyshev UPL	0.00778
	95% KM UPL (t)	0.00405
	90% Percentile (z)	0.00315

Median	0.00055
SD	0.00161
k star	0.248
Theta star	0.00474
Nu star	4.957
95% Percentile of Chisquare (2k)	2.406
90% Percentile	0.00353
95% Percentile	0.0057
99% Percentile	0.0115

95% Percentile (z)	0.00366
99% Percentile (z)	0.00462

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00698
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00907
95% WH Approx. Gamma UTL with 95% Coverage	0.0159
95% HW Approx. Gamma UTL with 95% Coverage	0.0256

Note: DL/2 is not a recommended method.

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Manganese (deep)

General Statistics

Number of Valid Data	6	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	1
Tolerance Factor	3.708	Percent Non-Detects	16.67%
Number of Missing Values	2		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.00149	Minimum Detected	-6.509
Maximum Detected	0.0923	Maximum Detected	-2.383
Mean of Detected	0.0456	Mean of Detected	-3.94
SD of Detected	0.0426	SD of Detected	1.835
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.869	Shapiro Wilk Test Statistic	0.86
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.038	Mean (Log Scale)	-4.666
SD	0.0424	SD (Log Scale)	2.42
95% UTL 95% Coverage	0.195	95% UTL 95% Coverage	74.2
95% UPL (t)	0.13	95% UPL (t)	1.824
90% Percentile (z)	0.0923	90% Percentile (z)	0.209
95% Percentile (z)	0.108	95% Percentile (z)	0.504
99% Percentile (z)	0.137	99% Percentile (z)	2.621
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0338	Mean in Original Scale	0.038
SD	0.0446	SD in Original Scale	0.0424

95% UTL with 95% Coverage	0.199
95% UPL (t)	0.131
90% Percentile (z)	0.0908
95% Percentile (z)	0.107
99% Percentile (z)	0.137

95% UTL with 95% Coverage	81.66
95% BCA UTL with 95% Coverage	0.0923
95% Bootstrap (%) UTL with 95% Coverage	0.0923
95% UPL (t)	1.916
90% Percentile (z)	0.214
95% Percentile (z)	0.521
99% Percentile (z)	2.766

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.417
Theta Star	0.109
nu star	4.168
A-D Test Statistic	0.429
5% A-D Critical Value	0.7
K-S Test Statistic	0.245
5% K-S Critical Value	0.367

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.038
Median	0.0247
SD	0.0424
k star	0.26
Theta star	0.146
Nu star	3.122
95% Percentile of Chisquare (2k)	2.489
90% Percentile	0.114
95% Percentile	0.182
99% Percentile	0.362

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0382
SD	0.0385
SE of Mean	0.0176
95% KM UTL with 95% Coverage	0.181
95% KM Chebyshev UPL	0.219
95% KM UPL (t)	0.122
90% Percentile (z)	0.0875
95% Percentile (z)	0.102
99% Percentile (z)	0.128

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.283
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.402
95% WH Approx. Gamma UTL with 95% Coverage	0.824
95% HW Approx. Gamma UTL with 95% Coverage	1.555

Note: DL/2 is not a recommended method.

Manganese (shallow)

General Statistics

Total Number of Observations	13
Tolerance Factor	2.671
Number of Distinct Observations	13
Number of Missing Values	8

Raw Statistics

Minimum	0.0013
Maximum	0.61
Second Largest	0.456
First Quartile	0.0216
Median	0.114
Third Quartile	0.339
Mean	0.192
SD	0.199
Coefficient of Variation	1.038
Skewness	0.865

Log-Transformed Statistics

Minimum	-6.645
Maximum	-0.494
Second Largest	-0.785
First Quartile	-3.835
Median	-2.172
Third Quartile	-1.082
Mean	-2.845
SD	2.217

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.881
Shapiro Wilk Critical Value	0.866

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.852
Shapiro Wilk Critical Value	0.866

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	0.724
95% UPL (t)	0.56
90% Percentile (z)	0.447
95% Percentile (z)	0.519
99% Percentile (z)	0.655

Assuming Lognormal Distribution

95% UTL with 95% Coverage	21.7
95% UPL (t)	3.51
90% Percentile (z)	0.996
95% Percentile (z)	2.229
99% Percentile (z)	10.1

Gamma Distribution Test

k star	0.457
Theta Star	0.42
MLE of Mean	0.192
MLE of Standard Deviation	0.284
nu star	11.88
A-D Test Statistic	0.426
5% A-D Critical Value	0.788
K-S Test Statistic	0.148
5% K-S Critical Value	0.249

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.436
95% Percentile	0.518
99% Percentile	0.592
95% UTL with 95% Coverage	0.61
95% Percentile Bootstrap UTL with 95% Coverage	0.61
95% BCA Bootstrap UTL with 95% Coverage	0.61
95% UPL	0.61
95% Chebyshev UPL	1.093
Upper Threshold Limit Based upon IQR	0.815

Assuming Gamma Distribution

90% Percentile	0.529
95% Percentile	0.761
99% Percentile	1.337
95% WH Approx. Gamma UPL	0.863
95% HW Approx. Gamma UPL	1.025
95% WH Approx. Gamma UTL with 95% Coverage	1.579
95% HW Approx. Gamma UTL with 95% Coverage	2.122

Zinc (intermediate)

General Statistics

Number of Valid Data	10
Number of Detected Data	7
Number of Distinct Detected Data	7
Number of Non-Detect Data	3
Tolerance Factor	2.911
Percent Non-Detects	30.00%
Number of Missing Values	4

Raw Statistics

Minimum Detected	0.014
Maximum Detected	0.699
Mean of Detected	0.206
SD of Detected	0.248
Minimum Non-Detect	0.005
Maximum Non-Detect	0.0125

Log-transformed Statistics

Minimum Detected	-4.269
Maximum Detected	-0.358
Mean of Detected	-2.329
SD of Detected	1.411
Minimum Non-Detect	-5.298
Maximum Non-Detect	-4.382

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	3
Number treated as Detected with Single DL	7
Single DL Non-Detect Percentage	30.00%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.791
5% Shapiro Wilk Critical Value	0.803

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.946
5% Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.145
	SD	0.225
95% UTL	95% Coverage	0.799
	95% UPL (t)	0.577
	90% Percentile (z)	0.433
	95% Percentile (z)	0.515
	99% Percentile (z)	0.668

Maximum Likelihood Estimate(MLE) Method

	Mean	0.0899
	SD	0.274
95% UTL with	95% Coverage	0.887
	95% UPL (t)	0.617
	90% Percentile (z)	0.441
	95% Percentile (z)	0.541
	99% Percentile (z)	0.727

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-3.336
	SD (Log Scale)	2.004
95% UTL	95% Coverage	12.17
	95% UPL (t)	1.678
	90% Percentile (z)	0.464
	95% Percentile (z)	0.962
	99% Percentile (z)	3.769

Log ROS Method

	Mean in Original Scale	0.145
	SD in Original Scale	0.225
95% UTL with	95% Coverage	14.86
95% BCA UTL with	95% Coverage	0.699
95% Bootstrap (%) UTL with	95% Coverage	0.699
	95% UPL (t)	1.869
	90% Percentile (z)	0.487
	95% Percentile (z)	1.044
	99% Percentile (z)	4.36

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.549
Theta Star	0.374
nu star	7.69
A-D Test Statistic	0.369
5% A-D Critical Value	0.735
K-S Test Statistic	0.233
5% K-S Critical Value	0.322

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.148
	SD	0.211
	SE of Mean	0.0721
95% KM UTL with	95% Coverage	0.763
	95% KM Chebyshev UPL	1.114
	95% KM UPL (t)	0.554

Mean	0.144
Median	0.0382
SD	0.226
k star	0.202
Theta star	0.714
Nu star	4.034
95% Percentile of Chisquare (2k)	2.074
90% Percentile	0.435
95% Percentile	0.74
99% Percentile	1.578

90% Percentile (z)	0.419
95% Percentile (z)	0.496
99% Percentile (z)	0.639

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.847
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.139
95% WH Approx. Gamma UTL with 95% Coverage	1.95
95% HW Approx. Gamma UTL with 95% Coverage	3.296

Note: DL/2 is not a recommended method.

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Manganese_inter_1

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
Tolerance Factor	3.399	Number of Missing Values	48

Raw Statistics		Log-Transformed Statistics	
Minimum	0.0006	Minimum	-7.419
Maximum	0.0699	Maximum	-2.661
Second Largest	0.0561	Second Largest	-2.881
First Quartile	0.0285	First Quartile	-3.596
Median	0.0464	Median	-3.07
Third Quartile	0.0543	Third Quartile	-2.915
Mean	0.0403	Mean	-3.739
SD	0.0234	SD	1.668
Coefficient of Variation	0.58		
Skewness	-0.7		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.962	Shapiro Wilk Test Statistic	0.659
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 95% Coverage	0.12	95% UTL with 95% Coverage	6.901
95% UPL (t)	0.0889	95% UPL (t)	0.761
90% Percentile (z)	0.0703	90% Percentile (z)	0.202
95% Percentile (z)	0.0788	95% Percentile (z)	0.37
99% Percentile (z)	0.0947	99% Percentile (z)	1.153

Gamma Distribution Test

k star	0.714
Theta Star	0.0565
MLE of Mean	0.0403
MLE of Standard Deviation	0.0477
nu star	9.998

A-D Test Statistic	0.87
5% A-D Critical Value	0.726
K-S Test Statistic	0.298
5% K-S Critical Value	0.319

Data follow Appx. Gamma Distribution at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	0.0616
95% Percentile	0.0658
99% Percentile	0.0691

Assuming Gamma Distribution

90% Percentile	0.101
95% Percentile	0.136
99% Percentile	0.221
95% WH Approx. Gamma UPL	0.165
95% HW Approx. Gamma UPL	0.202
95% WH Approx. Gamma UTL with 95% Coverage	0.336
95% HW Approx. Gamma UTL with 95% Coverage	0.48

95% UTL with 95% Coverage	0.0699
95% Percentile Bootstrap UTL with 95% Coverage	0.0699
95% BCA Bootstrap UTL with 95% Coverage	0.0699
95% UPL	0.0699
95% Chebyshev UPL	0.149
Upper Threshold Limit Based upon IQR	0.093

Manganese_1

General Statistics

Number of Valid Data	32
Number of Distinct Detected Data	30
Tolerance Factor	2.186
Number of Missing Values	25

Number of Detected Data	31
Number of Non-Detect Data	1
Percent Non-Detects	3.13%

Raw Statistics

Minimum Detected	0.0006
Maximum Detected	0.456
Mean of Detected	0.0945
SD of Detected	0.127
Minimum Non-Detect	0.0005
Maximum Non-Detect	0.0005

Log-transformed Statistics

Minimum Detected	-7.419
Maximum Detected	-0.785
Mean of Detected	-3.682
SD of Detected	2.061
Minimum Non-Detect	-7.601
Maximum Non-Detect	-7.601

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.74
5% Shapiro Wilk Critical Value	0.929

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.915
5% Shapiro Wilk Critical Value	0.929

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0915
SD	0.126

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-3.826
SD (Log Scale)	2.185

95% UTL 95% Coverage	0.367
95% UPL (t)	0.308
90% Percentile (z)	0.253
95% Percentile (z)	0.299
99% Percentile (z)	0.384

95% UTL 95% Coverage	2.588
95% UPL (t)	0.938
90% Percentile (z)	0.358
95% Percentile (z)	0.793
99% Percentile (z)	3.515

Maximum Likelihood Estimate(MLE) Method

Mean	0.0892
SD	0.127
95% UTL with 95% Coverage	0.366
95% UPL (t)	0.307
90% Percentile (z)	0.252
95% Percentile (z)	0.298
99% Percentile (z)	0.384

Log ROS Method

Mean in Original Scale	0.0915
SD in Original Scale	0.126
95% UTL with 95% Coverage	2.742
95% BCA UTL with 95% Coverage	0.456
95% Bootstrap (%) UTL with 95% Coverage	0.456
95% UPL (t)	0.978
90% Percentile (z)	0.368
95% Percentile (z)	0.825
99% Percentile (z)	3.741

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.458
Theta Star	0.206
nu star	28.37
A-D Test Statistic	0.492
5% A-D Critical Value	0.814
K-S Test Statistic	0.119
5% K-S Critical Value	0.167

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0915
Median	0.0452
SD	0.126
k star	0.391
Theta star	0.234
Nu star	25
95% Percentile of Chisquare (2k)	3.273
90% Percentile	0.26
95% Percentile	0.383
99% Percentile	0.695

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0915
SD	0.124
SE of Mean	0.0223
95% KM UTL with 95% Coverage	0.362
95% KM Chebyshev UPL	0.64
95% KM UPL (t)	0.305
90% Percentile (z)	0.25
95% Percentile (z)	0.295
99% Percentile (z)	0.38

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.367
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.416
95% WH Approx. Gamma UTL with 95% Coverage	0.542
95% HW Approx. Gamma UTL with 95% Coverage	0.663

Note: DL/2 is not a recommended method.

Zinc_shallow_1

General Statistics

Number of Valid Data	17
Number of Distinct Detected Data	15
Tolerance Factor	2.486
Number of Missing Values	29
Number of Detected Data	15
Number of Non-Detect Data	2
Percent Non-Detects	11.76%

Raw Statistics

Minimum Detected	0.00526
Maximum Detected	0.087
Mean of Detected	0.0416
SD of Detected	0.0277
Minimum Non-Detect	0.002
Maximum Non-Detect	0.0125

Log-transformed Statistics

Minimum Detected	-5.248
Maximum Detected	-2.442
Mean of Detected	-3.485
SD of Detected	0.917
Minimum Non-Detect	-6.215
Maximum Non-Detect	-4.382

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	5
Number treated as Detected with Single DL	12
Single DL Non-Detect Percentage	29.41%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.932
5% Shapiro Wilk Critical Value	0.881

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.9
5% Shapiro Wilk Critical Value	0.881

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0372
	SD	0.0288
95% UTL	95% Coverage	0.109
	95% UPL (t)	0.0889
	90% Percentile (z)	0.0741
	95% Percentile (z)	0.0845
	99% Percentile (z)	0.104

Maximum Likelihood Estimate(MLE) Method

	Mean	0.0329
	SD	0.0343
95% UTL with	95% Coverage	0.118
	95% UPL (t)	0.0945
	90% Percentile (z)	0.0769
	95% Percentile (z)	0.0893
	99% Percentile (z)	0.113

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-3.78
	SD (Log Scale)	1.239
95% UTL	95% Coverage	0.496
	95% UPL (t)	0.211
	90% Percentile (z)	0.112
	95% Percentile (z)	0.175
	99% Percentile (z)	0.407

Log ROS Method

	Mean in Original Scale	0.0374
	SD in Original Scale	0.0285
95% UTL with	95% Coverage	0.339
95% BCA UTL with	95% Coverage	0.087
95% Bootstrap (%) UTL with	95% Coverage	0.087
	95% UPL (t)	0.164
	90% Percentile (z)	0.0957
	95% Percentile (z)	0.14
	99% Percentile (z)	0.287

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.472
Theta Star	0.0283
nu star	44.15
A-D Test Statistic	0.369
5% A-D Critical Value	0.75
K-S Test Statistic	0.126
5% K-S Critical Value	0.225

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.0374
	SD	0.0276
	SE of Mean	0.00693
95% KM UTL with	95% Coverage	0.106
	95% KM Chebyshev UPL	0.161
	95% KM UPL (t)	0.087

Mean	0.0367
Median	0.036
SD	0.0293
k star	0.419
Theta star	0.0877
Nu star	14.24
95% Percentile of Chisquare (2k)	3.425
90% Percentile	0.103
95% Percentile	0.15
99% Percentile	0.269

90% Percentile (z)	0.0728
95% Percentile (z)	0.0828
99% Percentile (z)	0.102

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.148
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.193
95% WH Approx. Gamma UTL with 95% Coverage	0.241
95% HW Approx. Gamma UTL with 95% Coverage	0.353

Note: DL/2 is not a recommended method.

Zinc_final

General Statistics

Number of Valid Data	46
Number of Distinct Detected Data	35
Tolerance Factor	2.079
Number of Missing Values	11

Number of Detected Data	36
Number of Non-Detect Data	10
Percent Non-Detects	21.74%

Raw Statistics

Minimum Detected	0.005
Maximum Detected	0.699
Mean of Detected	0.101
SD of Detected	0.146
Minimum Non-Detect	0.002
Maximum Non-Detect	0.0125

Log-transformed Statistics

Minimum Detected	-5.298
Maximum Detected	-0.358
Mean of Detected	-3.106
SD of Detected	1.322
Minimum Non-Detect	-6.215
Maximum Non-Detect	-4.382

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	17
Number treated as Detected with Single DL	29
Single DL Non-Detect Percentage	36.96%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.656
5% Shapiro Wilk Critical Value	0.935

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.959
5% Shapiro Wilk Critical Value	0.935

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0797
SD	0.135
95% UTL 95% Coverage	0.361
95% UPL (t)	0.309
90% Percentile (z)	0.253
95% Percentile (z)	0.302
99% Percentile (z)	0.395

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-3.734
SD (Log Scale)	1.697
95% UTL 95% Coverage	0.816
95% UPL (t)	0.427
90% Percentile (z)	0.211
95% Percentile (z)	0.39
99% Percentile (z)	1.24

Maximum Likelihood Estimate(MLE) Method

Log ROS Method

Mean	0.031
SD	0.183
95% UTL with 95% Coverage	0.412
95% UPL (t)	0.342
90% Percentile (z)	0.266
95% Percentile (z)	0.332
99% Percentile (z)	0.457

Mean in Original Scale	0.0796
SD in Original Scale	0.135
95% UTL with 95% Coverage	0.827
95% BCA UTL with 95% Coverage	0.606
95% Bootstrap (%) UTL with 95% Coverage	0.623
95% UPL (t)	0.431
90% Percentile (z)	0.212
95% Percentile (z)	0.394
99% Percentile (z)	1.26

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.695
Theta Star	0.145
nu star	50.02
A-D Test Statistic	1.142
5% A-D Critical Value	0.789
K-S Test Statistic	0.171
5% K-S Critical Value	0.153

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0801
SD	0.134
SE of Mean	0.02
95% KM UTL with 95% Coverage	0.358
95% KM Chebyshev UPL	0.669
95% KM UPL (t)	0.307
90% Percentile (z)	0.251
95% Percentile (z)	0.3
99% Percentile (z)	0.391

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.079
Median	0.0345
SD	0.136
k star	0.244
Theta star	0.323
Nu star	22.48
95% Percentile of Chisquare (2k)	2.382
90% Percentile	0.238
95% Percentile	0.385
99% Percentile	0.779

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.324
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.392
95% WH Approx. Gamma UTL with 95% Coverage	0.46
95% HW Approx. Gamma UTL with 95% Coverage	0.606

Note: DL/2 is not a recommended method.

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Selenium_deep

General Statistics

Number of Valid Data	8	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	2
Tolerance Factor	3.187	Percent Non-Detects	25.00%
Number of Missing Values	36		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000683	Minimum Detected	-7.289
Maximum Detected	0.0013	Maximum Detected	-6.645
Mean of Detected	0.00101	Mean of Detected	-6.914
SD of Detected	0.0002171	SD of Detected	0.227
Minimum Non-Detect	0.0005	Minimum Non-Detect	-7.601
Maximum Non-Detect	0.0005	Maximum Non-Detect	-7.601

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.991	Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0008234	Mean (Log Scale)	-7.259
SD	0.0003986	SD (Log Scale)	0.667
95% UTL 95% Coverage	0.00209	95% UTL 95% Coverage	0.0059
95% UPL (t)	0.00162	95% UPL (t)	0.00269
90% Percentile (z)	0.00133	90% Percentile (z)	0.00165
95% Percentile (z)	0.00148	95% Percentile (z)	0.00211
99% Percentile (z)	0.00175	99% Percentile (z)	0.00332
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0008372	Mean in Original Scale	0.0009018
SD	0.0003612	SD in Original Scale	0.0002788

95% UTL with 95% Coverage	0.00199
95% UPL (t)	0.00156
90% Percentile (z)	0.0013
95% Percentile (z)	0.00143
99% Percentile (z)	0.00168

95% UTL with 95% Coverage	0.00246
95% BCA UTL with 95% Coverage	0.0013
95% Bootstrap (%) UTL with 95% Coverage	0.0013
95% UPL (t)	0.00167
90% Percentile (z)	0.00131
95% Percentile (z)	0.00148
99% Percentile (z)	0.00185

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	12.3
Theta Star	8.246E-05
nu star	147.6
A-D Test Statistic	0.193
5% A-D Critical Value	0.697
K-S Test Statistic	0.165
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0009316
SD	0.0002237
SE of Mean	8.665E-05
95% KM UTL with 95% Coverage	0.00164
95% KM Chebyshev UPL	0.00197
95% KM UPL (t)	0.00138
90% Percentile (z)	0.00122
95% Percentile (z)	0.0013
99% Percentile (z)	0.00145

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0008098
Median	0.000937
SD	0.0004276
k star	1.26
Theta star	0.0006428
Nu star	20.16
95% Percentile of Chisquare (2k)	6.963
90% Percentile	0.00176
95% Percentile	0.00224
99% Percentile	0.00333

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00252
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00282
95% WH Approx. Gamma UTL with 95% Coverage	0.00442
95% HW Approx. Gamma UTL with 95% Coverage	0.0054

Note: DL/2 is not a recommended method.

Selenium_Inter_1

General Statistics

Number of Valid Data	10
Number of Distinct Detected Data	6
Tolerance Factor	2.911
Number of Missing Values	45
Number of Detected Data	6
Number of Non-Detect Data	4
Percent Non-Detects	40.00%

Raw Statistics

Minimum Detected	0.000879
Maximum Detected	0.002
Mean of Detected	0.00134
SD of Detected	0.0004496
Minimum Non-Detect	0.0005
Maximum Non-Detect	0.001

Log-transformed Statistics

Minimum Detected	-7.037
Maximum Detected	-6.215
Mean of Detected	-6.659
SD of Detected	0.333
Minimum Non-Detect	-7.601
Maximum Non-Detect	-6.908

Data with Multiple Detection Limits

Single Detection Limit Scenario

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Number treated as Non-Detect with Single DL	5
Number treated as Detected with Single DL	5
Single DL Non-Detect Percentage	50.00%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.9
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.905
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.0009809
	SD	0.0005799
95% UTL	95% Coverage	0.00267
	95% UPL (t)	0.0021
	90% Percentile (z)	0.00172
	95% Percentile (z)	0.00193
	99% Percentile (z)	0.00233

Maximum Likelihood Estimate(MLE) Method

	Mean	0.0009779
	SD	0.0005918
95% UTL with	95% Coverage	0.0027
	95% UPL (t)	0.00212
	90% Percentile (z)	0.00174
	95% Percentile (z)	0.00195
	99% Percentile (z)	0.00235

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-7.105
	SD (Log Scale)	0.658
95% UTL	95% Coverage	0.00558
	95% UPL (t)	0.00291
	90% Percentile (z)	0.00191
	95% Percentile (z)	0.00242
	99% Percentile (z)	0.0038

Log ROS Method

	Mean in Original Scale	0.00106
	SD in Original Scale	0.0005063
95% UTL with	95% Coverage	0.00376
95% BCA UTL with	95% Coverage	0.002
95% Bootstrap (%) UTL with	95% Coverage	0.002
	95% UPL (t)	0.00236
	90% Percentile (z)	0.00175
	95% Percentile (z)	0.00207
	99% Percentile (z)	0.00286

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.579
Theta Star	0.0002407
nu star	66.95
A-D Test Statistic	0.406
5% A-D Critical Value	0.698
K-S Test Statistic	0.287
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.0009005
Median	0.0009395

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.00116
	SD	0.0003909
	SE of Mean	0.0001354
95% KM UTL with	95% Coverage	0.0023
	95% KM Chebyshev UPL	0.00294
	95% KM UPL (t)	0.00191
	90% Percentile (z)	0.00166
	95% Percentile (z)	0.0018

SD	0.000687
k star	0.411
Theta star	0.00219
Nu star	8.212
95% Percentile of Chisquare (2k)	3.381
90% Percentile	0.00253
95% Percentile	0.00371
99% Percentile	0.00666

99% Percentile (z)	0.00207

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00437
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00582
95% WH Approx. Gamma UTL with 95% Coverage	0.00861
95% HW Approx. Gamma UTL with 95% Coverage	0.0136

Note: DL/2 is not a recommended method.

Selenium_Shallow_1

General Statistics

Number of Valid Data	20
Number of Distinct Detected Data	8
Tolerance Factor	2.396
Number of Missing Values	26

Number of Detected Data	10
Number of Non-Detect Data	10
Percent Non-Detects	50.00%

Raw Statistics

Minimum Detected	0.000606
Maximum Detected	0.00267
Mean of Detected	0.00171
SD of Detected	0.0006126
Minimum Non-Detect	0.001
Maximum Non-Detect	0.001

Log-transformed Statistics

Minimum Detected	-7.409
Maximum Detected	-5.926
Mean of Detected	-6.443
SD of Detected	0.429
Minimum Non-Detect	-6.908
Maximum Non-Detect	-6.908

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.97
5% Shapiro Wilk Critical Value	0.842

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.902
5% Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0011
SD	0.0007502
95% UTL 95% Coverage	0.0029
95% UPL (t)	0.00243
90% Percentile (z)	0.00207
95% Percentile (z)	0.00234
99% Percentile (z)	0.00285

Maximum Likelihood Estimate(MLE) Method

Mean	0.0009246
SD	0.0009901
95% UTL with 95% Coverage	0.0033
95% UPL (t)	0.00268

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-7.022
SD (Log Scale)	0.663
95% UTL 95% Coverage	0.00437
95% UPL (t)	0.00289
90% Percentile (z)	0.00209
95% Percentile (z)	0.00265
99% Percentile (z)	0.00417

Log ROS Method

Mean in Original Scale	0.0012
SD in Original Scale	0.0006905
95% UTL with 95% Coverage	0.00423
95% BCA UTL with 95% Coverage	0.00267
95% Bootstrap (%) UTL with 95% Coverage	0.00267
95% UPL (t)	0.00292

90% Percentile (z)	0.00219
95% Percentile (z)	0.00255
99% Percentile (z)	0.00323

90% Percentile (z)	0.00218
95% Percentile (z)	0.00271
99% Percentile (z)	0.00406

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.044
Theta Star	0.0003389
nu star	100.9

A-D Test Statistic	0.336
5% A-D Critical Value	0.728
K-S Test Statistic	0.21
5% K-S Critical Value	0.267

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.00116
SD	0.000688
SE of Mean	0.0001622
95% KM UTL with 95% Coverage	0.00281
95% KM Chebyshev UPL	0.00423
95% KM UPL (t)	0.00238
90% Percentile (z)	0.00204
95% Percentile (z)	0.00229
99% Percentile (z)	0.00276

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.00106
Median	0.00106
SD	0.000843
k star	0.433
Theta star	0.00246
Nu star	17.31
95% Percentile of Chisquare (2k)	3.499
90% Percentile	0.00296
95% Percentile	0.0043
99% Percentile	0.00764

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.00447
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.00573
95% WH Approx. Gamma UTL with 95% Coverage	0.00711
95% HW Approx. Gamma UTL with 95% Coverage	0.0102

Note: DL/2 is not a recommended method.

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Input Values.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Vanadium (intermediate)

General Statistics

Number of Valid Data	10	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	5
Tolerance Factor	2.911	Percent Non-Detects	50.00%
Number of Missing Values	4		

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.013	Maximum Detected	-4.343
Mean of Detected	0.00434	Mean of Detected	-6.532
SD of Detected	0.0056	SD of Detected	1.853
Minimum Non-Detect	0.0002	Minimum Non-Detect	-8.517
Maximum Non-Detect	0.005	Maximum Non-Detect	-5.298

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	8
Number treated as Detected with Single DL	2
Single DL Non-Detect Percentage	80.00%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.817
5% Shapiro Wilk Critical Value	0.762

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.91
5% Shapiro Wilk Critical Value	0.762

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.00318
	SD	0.00399
95% UTL	95% Coverage	0.0148
	95% UPL (t)	0.0109
	90% Percentile (z)	0.0083
	95% Percentile (z)	0.00975
	99% Percentile (z)	0.0125

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-6.584
	SD (Log Scale)	1.565
95% UTL	95% Coverage	0.132
	95% UPL (t)	0.028
	90% Percentile (z)	0.0103
	95% Percentile (z)	0.0182
	99% Percentile (z)	0.0527

Maximum Likelihood Estimate(MLE) Method N/A

Log ROS Method

Mean in Original Scale	0.00233
SD in Original Scale	0.0043
Mean in Log Scale	-7.725
SD in Log Scale	2.055
95% UTL 95% Coverage	0.175
95% UPL (t)	0.0229
90% Percentile (z)	0.00615
95% Percentile (z)	0.013
99% Percentile (z)	0.0526

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.361
Theta Star	0.012
nu star	3.614
A-D Test Statistic	0.363
5% A-D Critical Value	0.707
K-S Test Statistic	0.23
5% K-S Critical Value	0.37

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.00243
Median	0.00025
SD	0.00431
k star	0.232
Theta star	0.0105
Nu star	4.645
95% Percentile of Chisquare (2k)	2.297
90% Percentile	0.00733
95% Percentile	0.012
99% Percentile	0.0247

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.00238
SD	0.00406
SE of Mean	0.00144
95% KM UTL with 95% Coverage	0.0142
95% KM Chebyshev UPL	0.0209
95% KM UPL (t)	0.0102
90% Percentile (z)	0.00758
95% Percentile (z)	0.00905
99% Percentile (z)	0.0118

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	0.0138
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0166
95% WH Approx. Gamma UTL with 95% Coverage	0.0325
95% HW Approx. Gamma UTL with 95% Coverage	0.0481

Note: DL/2 is not a recommended method.

Vanadium (shallow)

General Statistics

Number of Valid Data	18	Number of Detected Data	13
Number of Distinct Detected Data	11	Number of Non-Detect Data	5
Tolerance Factor	2.453	Percent Non-Detects	27.78%
Number of Missing Values	3		

Raw Statistics

Minimum Detected	0.0003
Maximum Detected	0.0147
Mean of Detected	0.00466

Log-transformed Statistics

Minimum Detected	-8.112
Maximum Detected	-4.22
Mean of Detected	-6.213

SD of Detected	0.0056
Minimum Non-Detect	0.0001
Maximum Non-Detect	0.005

SD of Detected	1.419
Minimum Non-Detect	-9.21
Maximum Non-Detect	-5.298

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	14
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	77.78%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.728
5% Shapiro Wilk Critical Value	0.866

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.89
5% Shapiro Wilk Critical Value	0.866

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

	Mean	0.00366
	SD	0.00503
95% UTL	95% Coverage	0.016
	95% UPL (t)	0.0127
	90% Percentile (z)	0.0101
	95% Percentile (z)	0.0119
	99% Percentile (z)	0.0154

Maximum Likelihood Estimate(MLE) Method

	Mean	N/A
	SD	N/A
95% UTL with	95% Coverage	N/A
	95% UPL (t)	N/A
	90% Percentile (z)	N/A
	95% Percentile (z)	N/A
	99% Percentile (z)	N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

	Mean (Log Scale)	-6.726
	SD (Log Scale)	1.734
95% UTL	95% Coverage	0.0843
	95% UPL (t)	0.0266
	90% Percentile (z)	0.0111
	95% Percentile (z)	0.0208
	99% Percentile (z)	0.0677

Log ROS Method

	Mean in Original Scale	0.00346
	SD in Original Scale	0.00512
95% UTL with	95% Coverage	0.0705
95% BCA UTL with	95% Coverage	0.0147
95% Bootstrap (%) UTL with	95% Coverage	0.0147
	95% UPL (t)	0.0224
	90% Percentile (z)	0.00936
	95% Percentile (z)	0.0175
	99% Percentile (z)	0.0567

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.6
Theta Star	0.00777
nu star	15.61
A-D Test Statistic	0.909
5% A-D Critical Value	0.773
K-S Test Statistic	0.207
5% K-S Critical Value	0.246

Data follow Appx. Gamma Distribution at 5% Significance Level

Data Distribution Test with Detected Values Only

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.00348
Median	0.00095
SD	0.00512
k star	0.293

Nonparametric Statistics

Kaplan-Meier (KM) Method

	Mean	0.00352
	SD	0.00494
	SE of Mean	0.00121
95% KM UTL with	95% Coverage	0.0156
	95% KM Chebyshev UPL	0.0256
	95% KM UPL (t)	0.0123
	90% Percentile (z)	0.00985
	95% Percentile (z)	0.0116
	99% Percentile (z)	0.015

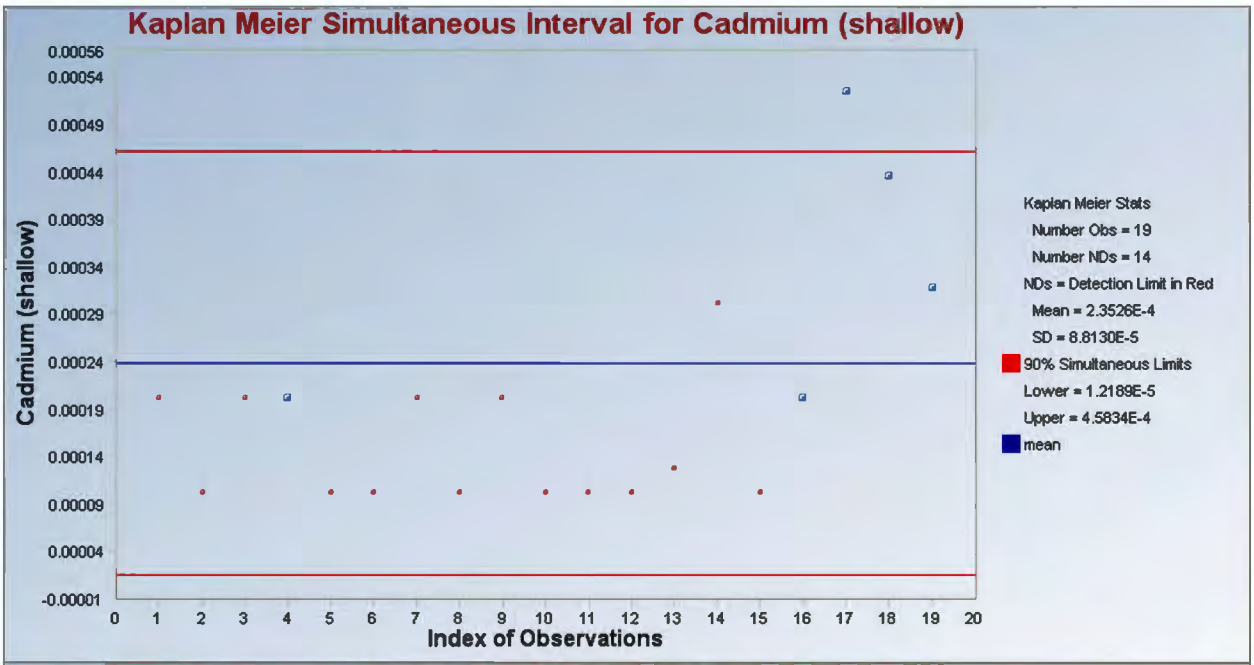
Theta star	0.0119
Nu star	10.54
95% Percentile of Chisquare (2k)	2.699
90% Percentile	0.0103
95% Percentile	0.0161
99% Percentile	0.0311

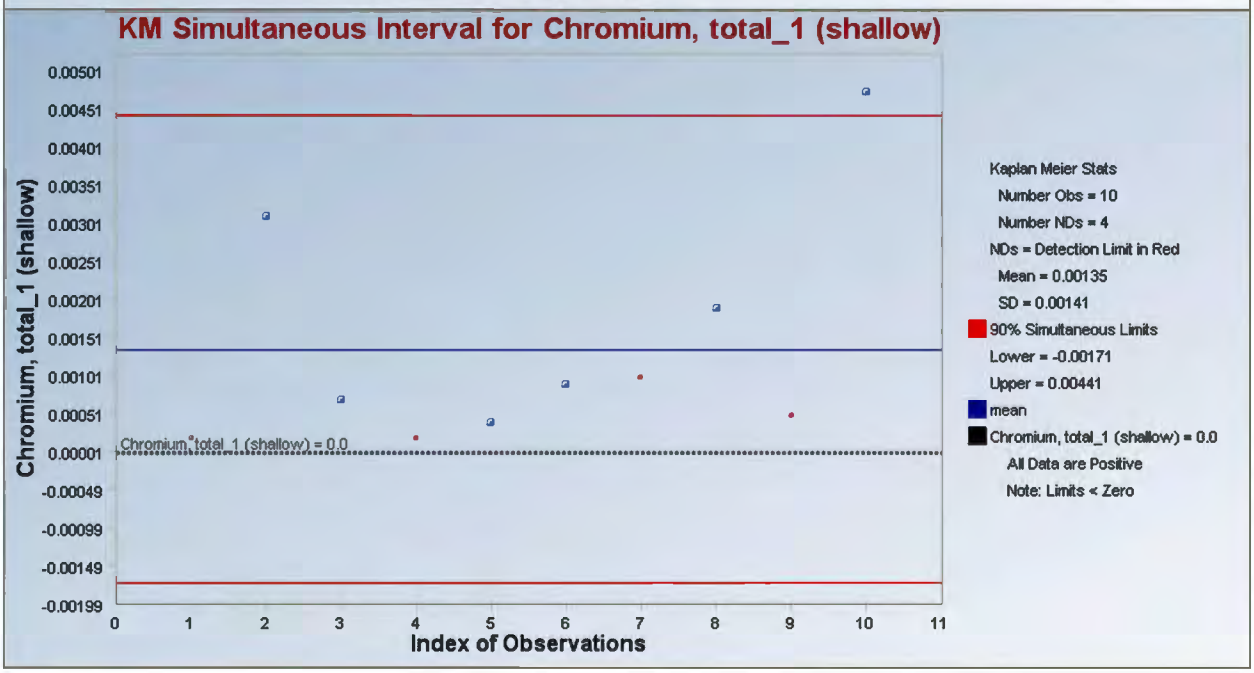
Gamma ROS Limits with Extrapolated Data

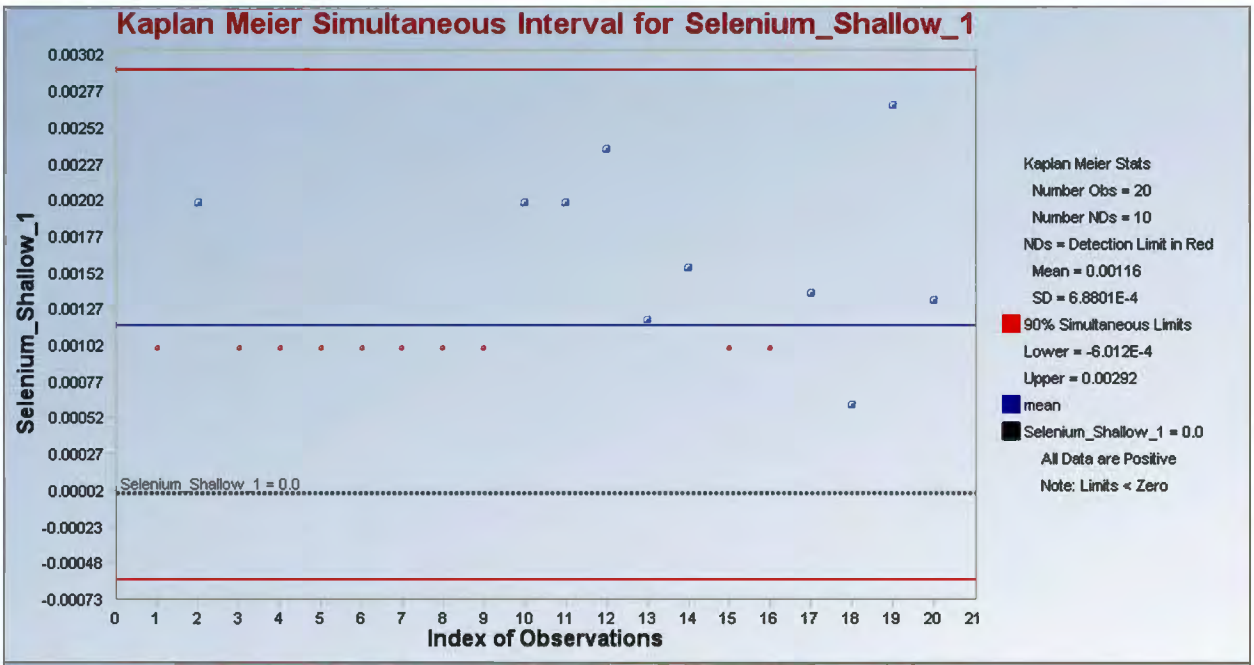
95% Wilson Hilferty (WH) Approx. Gamma UPL	0.016
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.0192
95% WH Approx. Gamma UTL with 95% Coverage	0.0283
95% HW Approx. Gamma UTL with 95% Coverage	0.0386

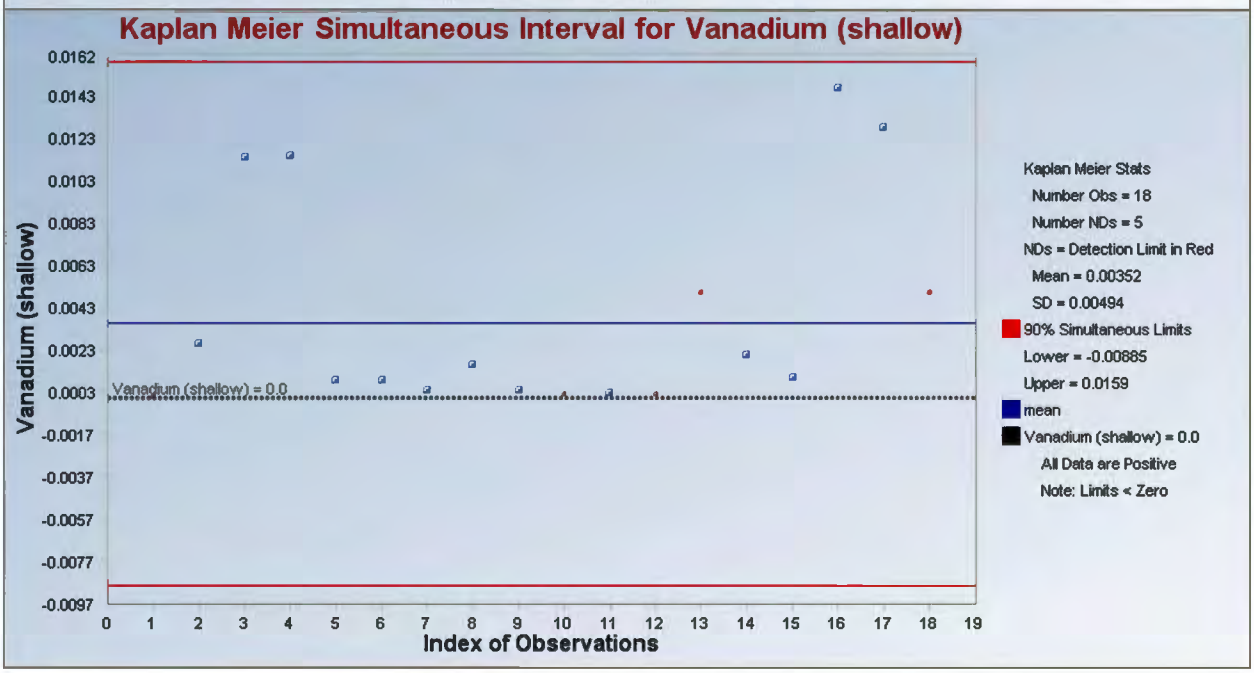
Note: DL/2 is not a recommended method.

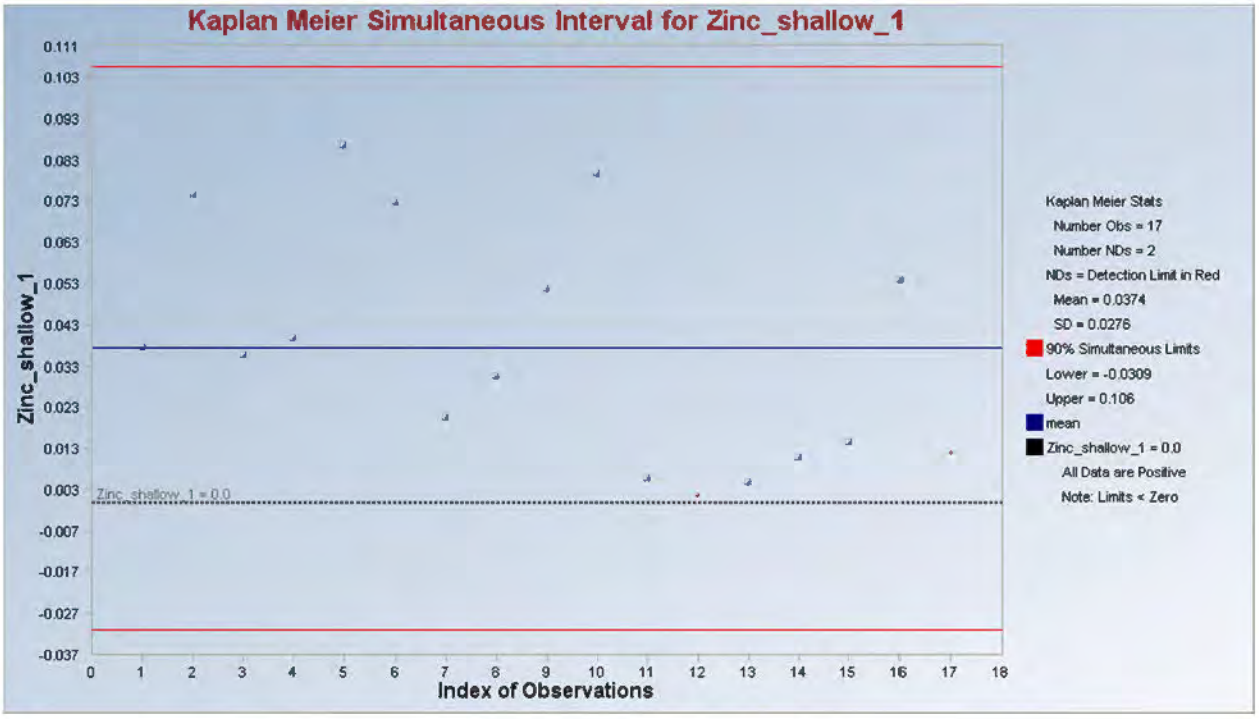
GROUNDWATER – USL OUTPUTS


Kaplan Meier Simultaneous Interval for Cadmium (shallow)
Cadmium (shallow)
Index of Observations
Kaplan Meier Stats
Number Obs = 19
Number NDs = 14
NDs = Detection Limit in Red
Mean = 2.3526E-4
SD = 8.8130E-5
90% Simultaneous Limits
Lower = 1.2189E-5
Upper = 4.5834E-4
mean


KM Simultaneous Interval for Chromium, total_1 (shallow)
Chromium, total_1 (shallow)
Chromium, total_1 (shallow) = 0.0
Index of Observations
Kaplan Meier Stats
Number Obs = 10
Number NDs = 4
NDs = Detection Limit in Red
Mean = 0.00135
SD = 0.00141
90% Simultaneous Limits
Lower = -0.00171
Upper = 0.00441
mean
Chromium, total_1 (shallow) = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Selenium_Shallow_1
Selenium_Shallow_1
Index of Observations
Selenium_Shallow_1 = 0.0
Kaplan Meier Stats
Number Obs = 20
Number NDs = 10
NDs = Detection Limit in Red
Mean = 0.00116
SD = 6.8801E-4
90% Simultaneous Limits
Lower = -6.012E-4
Upper = 0.00292
mean
Selenium_Shallow_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Vanadium (shallow)
Vanadium (shallow)
Index of Observations
Vanadium (shallow) = 0.0
Kaplan Meier Stats
Number Obs = 18
Number NDs = 5
NDs = Detection Limit in Red
Mean = 0.00352
SD = 0.00494
90% Simultaneous Limits
Lower = -0.00885
Upper = 0.0159
mean
Vanadium (shallow) = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Zinc_shallow_1
Zinc_shallow_1
Index of Observations
Zinc_shallow_1 = 0.0
Kaplan Meier Stats
Number Obs = 17
Number NDs = 2
NDs = Detection Limit in Red
Mean = 0.0374
SD = 0.0276
90% Simultaneous Limits
Lower = -0.0309
Upper = 0.106
mean
Zinc_shallow_1 = 0.0
All Data are Positive
Note: Limits < Zero

Robust Simultaneous Intervals/Limits (SLs)

Date/Time of Computation	8/30/2012 9:00:42 PM
User Selected Options	
From File	C:\Documents and Settings\Valerie C Chen\My Documents\Val's documents from C\Monsanto\Background TM\Fr
Full Precision	OFF
Confidence Coefficient	0.9
PROP Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	PROP SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Huber Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	Huber SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Tukey Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Tukey Biweight SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
Lax/Kafadar Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Lax/Kafadar SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
MVT Method	Triming Percentage of 10.08%
	MVT SLs derived using 10 Iterations and initial estimates of median/1.48MAD.

D2Max represents unsquared critical value of Max-MD (Mahalanobis Distances) computed based upon Wsum Values

Manganese (deep)

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	6	0.0381	0.0247	0.0423	0.0352	1.822	-0.0391	0.115

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.0247	0.0352	0.0381	0.0423	6	1.822	-0.0391	0.115
Huber	0.0247	0.0352	0.0381	0.0423	6	1.822	-0.0391	0.115
Tukey Biweight	0.0247	0.0352	0.0349	0.0475	5.141	1.695	-0.0457	0.115
Lax Kafadar Biweight	0.0247	0.0352	0.0368	0.0504	5.57	1.763	-0.052	0.126
MVT	0.0247	0.0352	0.0381	0.0423	6	1.822	-0.0391	0.115

Manganese (intermediate)

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	0.0783	0.0494	0.11	0.0251	2.032	-0.144	0.301

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.0494	0.0251	0.0403	0.0234	7	1.938	-0.00499	0.0856
Huber	0.0494	0.0251	0.0516	0.0413	7.269	1.965	-0.0295	0.133
Tukey Biweight	0.0494	0.0251	0.0416	0.0255	6.385	1.87	-0.00599	0.0893
Lax Kafadar Biweight	0.0494	0.0251	0.0417	0.025	6.379	1.869	-0.00509	0.0884
MVT	0.0494	0.0251	0.0783	0.11	8	2.032	-0.144	0.301

Manganese (na)

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	7	0.158	0.0063	0.339	0.00845	1.938	-0.499	0.815

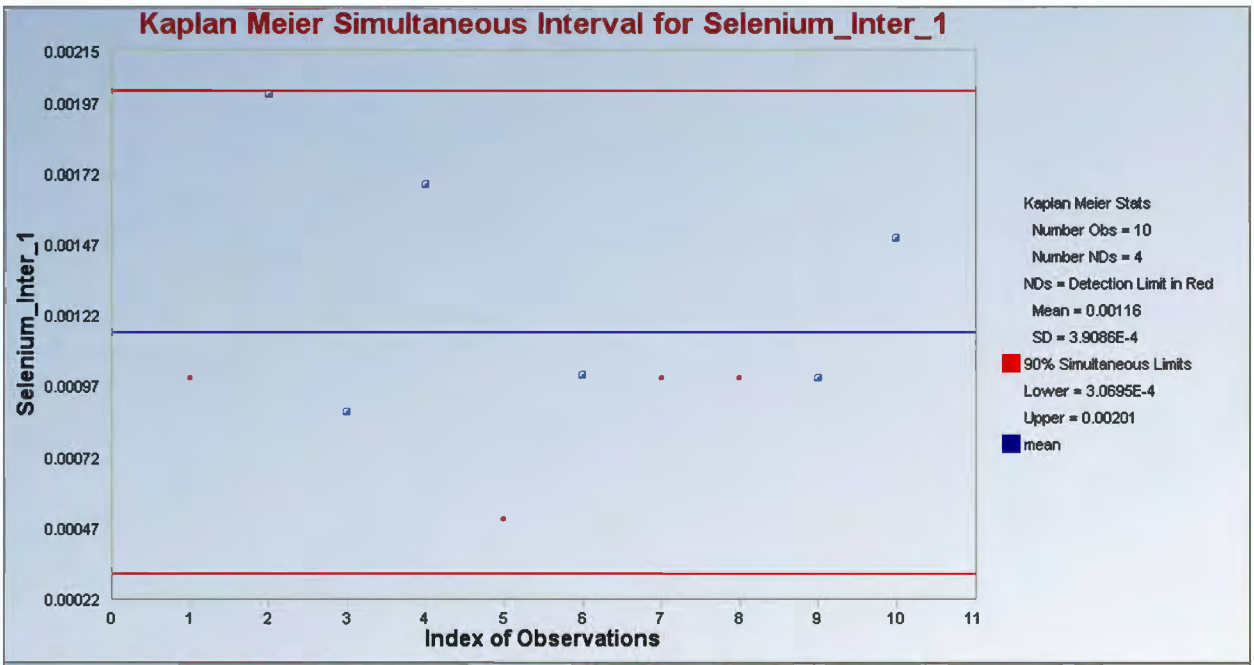
Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.0063	0.00845	0.00589	0.00737	5	1.671	-0.00643	0.0182
Huber	0.0063	0.00845	0.0687	0.124	6.263	1.855	-0.161	0.299
Tukey Biweight	0.0063	0.00845	0.00518	0.00837	4.64	1.605	-0.00825	0.0186

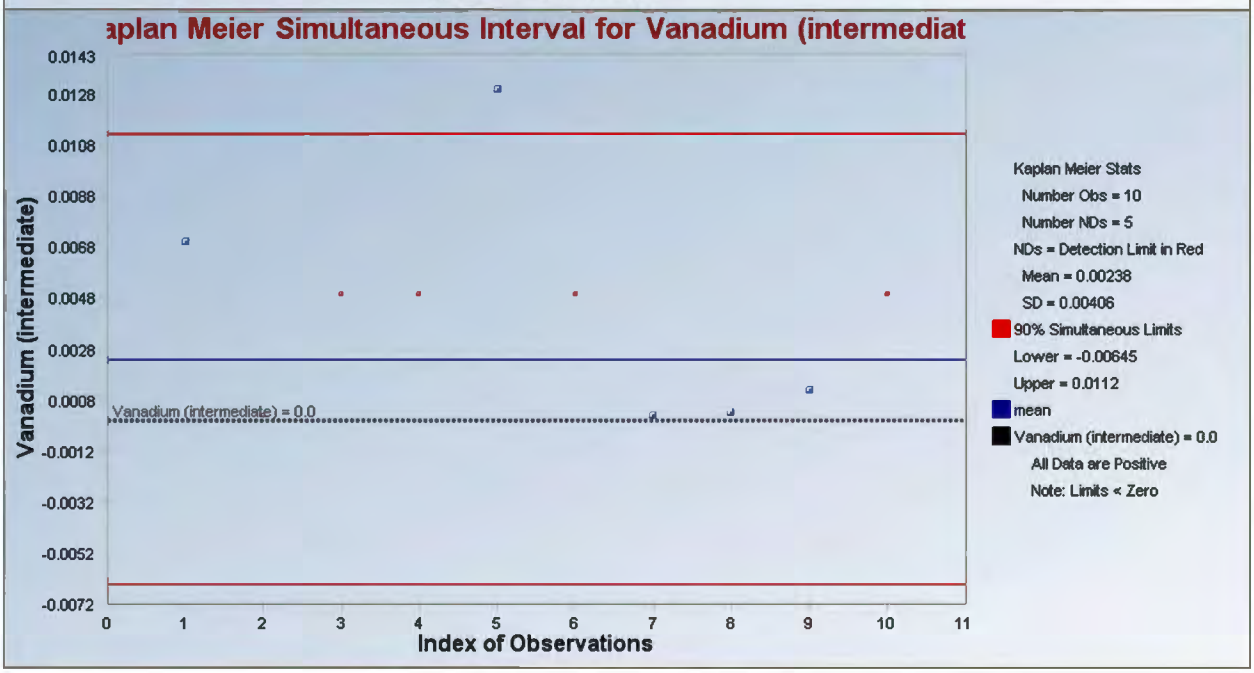
Lax Kafadar Biweight	0.0063	0.00845	0.00512	0.00817	4.616	1.6	-0.00795	0.0182
MVT	0.0063	0.00845	0.158	0.339	7	1.938	-0.499	0.815

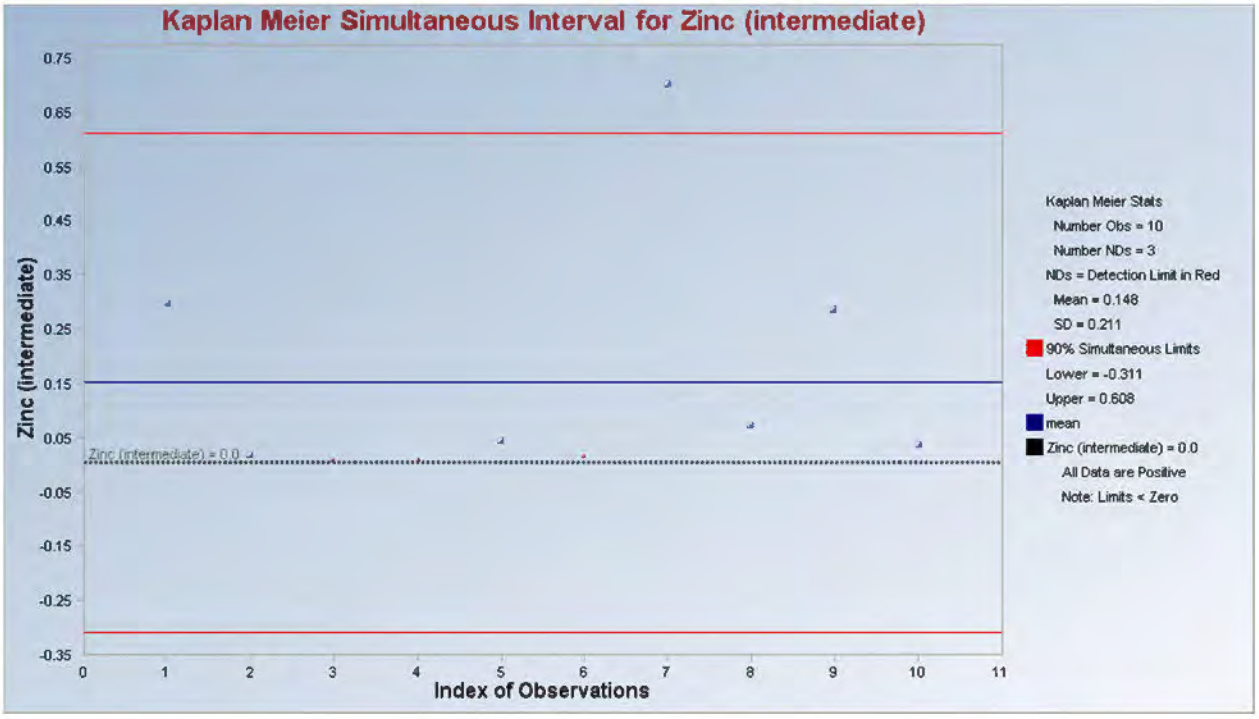
Manganese (shallow)

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	13	0.192	0.114	0.199	0.167	2.331	-0.272	0.656

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.114	0.167	0.177	0.175	12.54	2.31	-0.228	0.581
Huber	0.114	0.167	0.191	0.197	12.96	2.329	-0.268	0.65
Tukey Biweight	0.114	0.167	0.16	0.206	11.07	2.238	-0.301	0.621
Lax Kafadar Biweight	0.114	0.167	0.172	0.202	11.65	2.268	-0.287	0.631
MVT	0.114	0.167	0.157	0.161	12	2.285	-0.212	0.526


Kaplan Meier Simultaneous Interval for Selenium_Inter_1
Selenium_Inter_1
0.00215
0.00197
0.00172
0.00147
0.00122
0.00097
0.00072
0.00047
0.00022
0 1 2 3 4 5 6 7 8 9 10 11
Index of Observations
Kaplan Meier Stats
Number Obs = 10
Number NDs = 4
NDs = Detection Limit in Red
Mean = 0.00116
SD = 3.9086E-4
90% Simultaneous Limits
Lower = 3.0695E-4
Upper = 0.00201
mean


aplan Meier Simultaneous Interval for Vanadium (intermediat
Vanadium (intermediate)
0.0143
0.0128
0.0108
0.0088
0.0068
0.0048
0.0028
0.0008
-0.0012
-0.0032
-0.0052
-0.0072
Vanadium (intermediate) = 0.0
0 1 2 3 4 5 6 7 8 9 10 11
Index of Observations
Kaplan Meier Stats
Number Obs = 10
Number NDs = 5
NDs = Detection Limit in Red
Mean = 0.00238
SD = 0.00406
90% Simultaneous Limits
Lower = -0.00645
Upper = 0.0112
mean
Vanadium (intermediate) = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Zinc (intermediate)
Zinc (intermediate)
Index of Observations
0.75
0.65
0.55
0.45
0.35
0.25
0.15
0.05
-0.05
-0.15
-0.25
-0.35
0
1
2
3
4
5
6
7
8
9
10
11
Zinc (intermediate) = 0.0
Kaplan Meier Stats
Number Obs = 10
Number NDs = 3
NDs = Detection Limit in Red
Mean = 0.148
SD = 0.211
90% Simultaneous Limits
Lower = -0.311
Upper = 0.608
mean
Zinc (intermediate) = 0.0
All Data are Positive
Note: Limits < Zero

Robust Simultaneous Intervals/Limits (SLs)

Date/Time of Computation	8/30/2012 9:20:31 PM
User Selected Options	
From File	C:\Documents and Settings\Valerie C Chen\My Documents\Val's documents from C\Monsanto\Background TM\I
Full Precision	OFF
Confidence Coefficient	0.9
PROP Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	PROP SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Huber Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	Huber SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Tukey Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Tukey Biweight SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
Lax/Kafadar Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Lax/Kafadar SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
MVT Method	Triming Percentage of 10.08%
	MVT SLs derived using 10 Iterations and initial estimates of median/1.48MAD.

D2Max represents unsquared critical value of Max-MD (Mahalanobis Distances) computed based upon Wsum Values

Manganese_inter_1

	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	7	0.0403	0.0464	0.0234	0.0154	1.938	-0.00499	0.0856

Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.0464	0.0154	0.0403	0.0234	7	1.938	-0.00499	0.0856
Huber	0.0464	0.0154	0.0403	0.0234	7	1.938	-0.00499	0.0856
Tukey Biweight	0.0464	0.0154	0.0451	0.025	5.514	1.754	0.00128	0.0888
Lax Kafadar Biweight	0.0464	0.0154	0.0417	0.0249	6.372	1.869	-0.00478	0.0881
MVT	0.0464	0.0154	0.0403	0.0234	7	1.938	-0.00499	0.0856

Robust Simultaneous Intervals/Limits (SLs)

Date/Time of Computation	12/13/2012 6:23:56 PM
User Selected Options	
From File	C:\Documents and Settings\Valerie C Chen\My Documents\Val's documents from C\Monsanto\Background TM\Fr
Full Precision	OFF
Confidence Coefficient	0.9
PROP Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	PROP SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Huber Method	Influence Function Alpha of 0.025 with MDs following Beta Distribution.
	Huber SLs derived using 10 Iterations and initial estimates of median/1.48MAD.
Tukey Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Tukey Biweight SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
Lax/Kafadar Biweight Method	Location Tuning Constant of 4 and a Scale Tuning Constant of 6
	Lax/Kafadar SLs derived using a Maximum of 10 Iterations and initial estimates of median/1.48MAD.
MVT Method	Triming Percentage of 10.08%
	MVT SLs derived using 10 Iterations and initial estimates of median/1.48MAD.

D2Max represents unsquared critical value of Max-MD (Mahalanobis Distances) computed based upon Wsum Values

Chromium, total (deep)

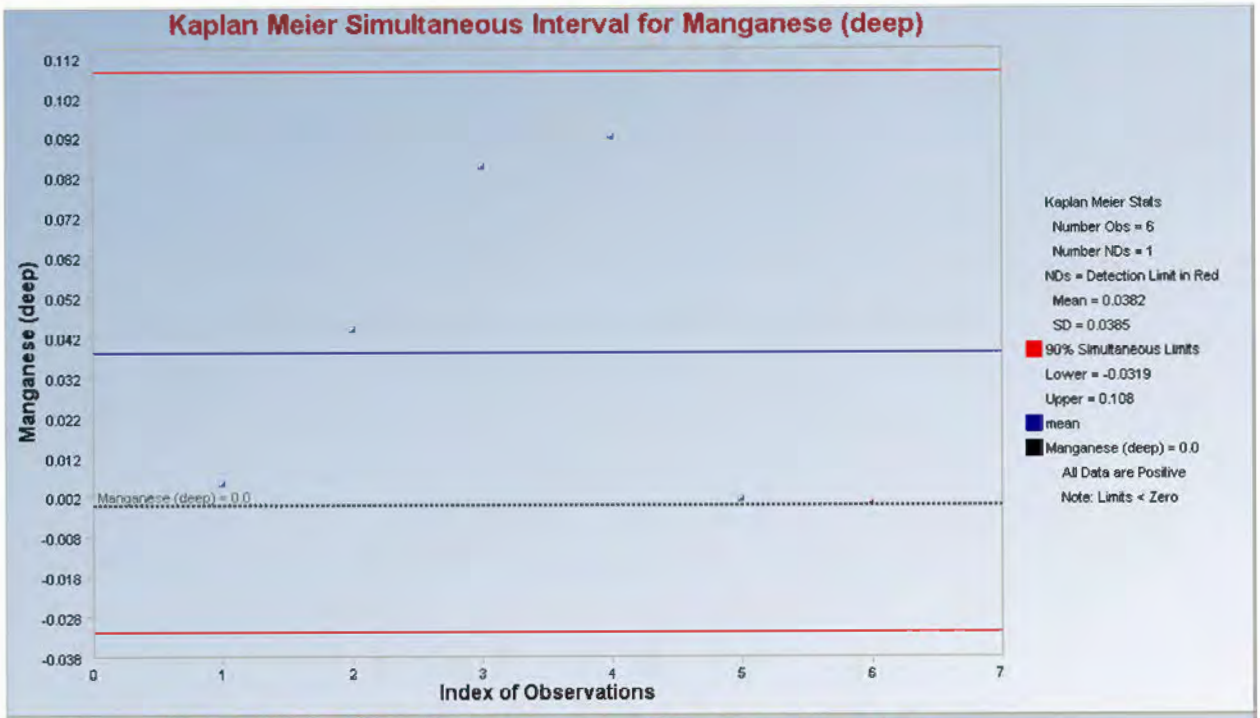
	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	6	0.0026	0.00235	0.0009989	0.0006449	1.822	0.0007783	0.00442

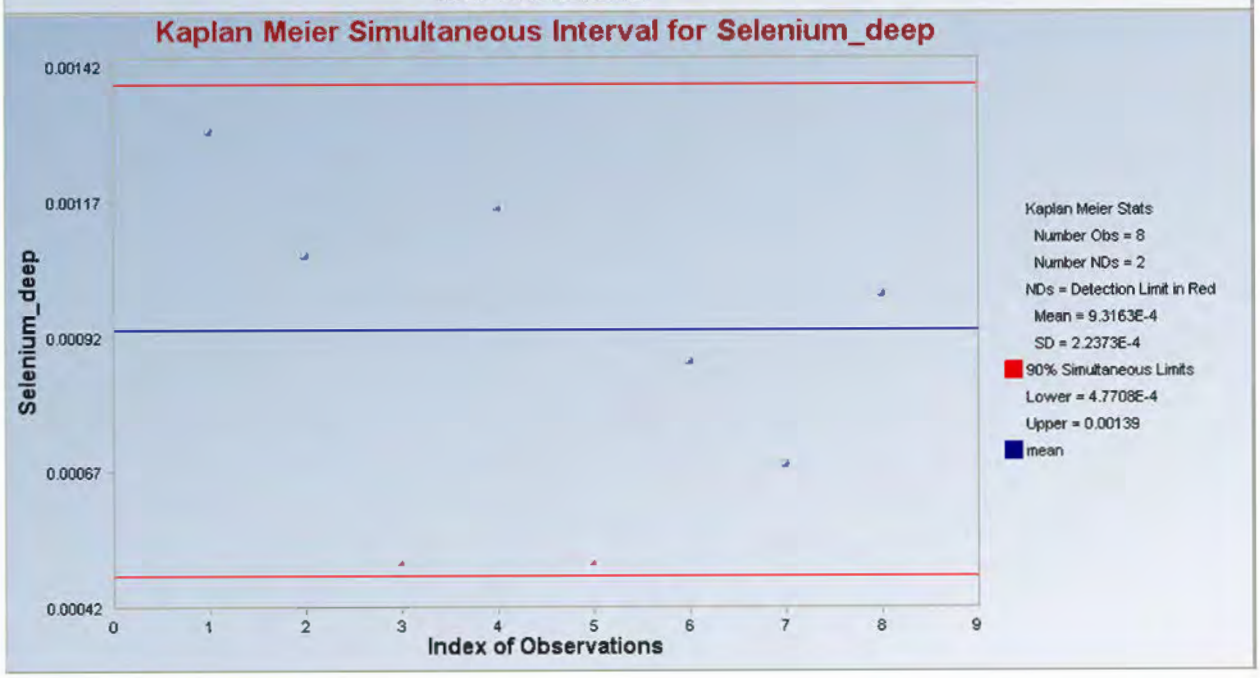
Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.00235	0.00102	0.00225	0.000503	5.032	1.677	0.0014	0.00309
Huber	0.00235	0.00102	0.00257	0.0009614	5.922	1.812	0.0008325	0.00432
Tukey Biweight	0.00235	0.00102	0.00249	0.000983	5.442	1.743	0.0007724	0.0042
Lax Kafadar Biweight	0.00235	0.00102	0.00242	0.0008335	5.203	1.706	0.0009982	0.00384
MVT	0.00235	0.00102	0.0026	0.0009989	6	1.822	0.0007783	0.00442

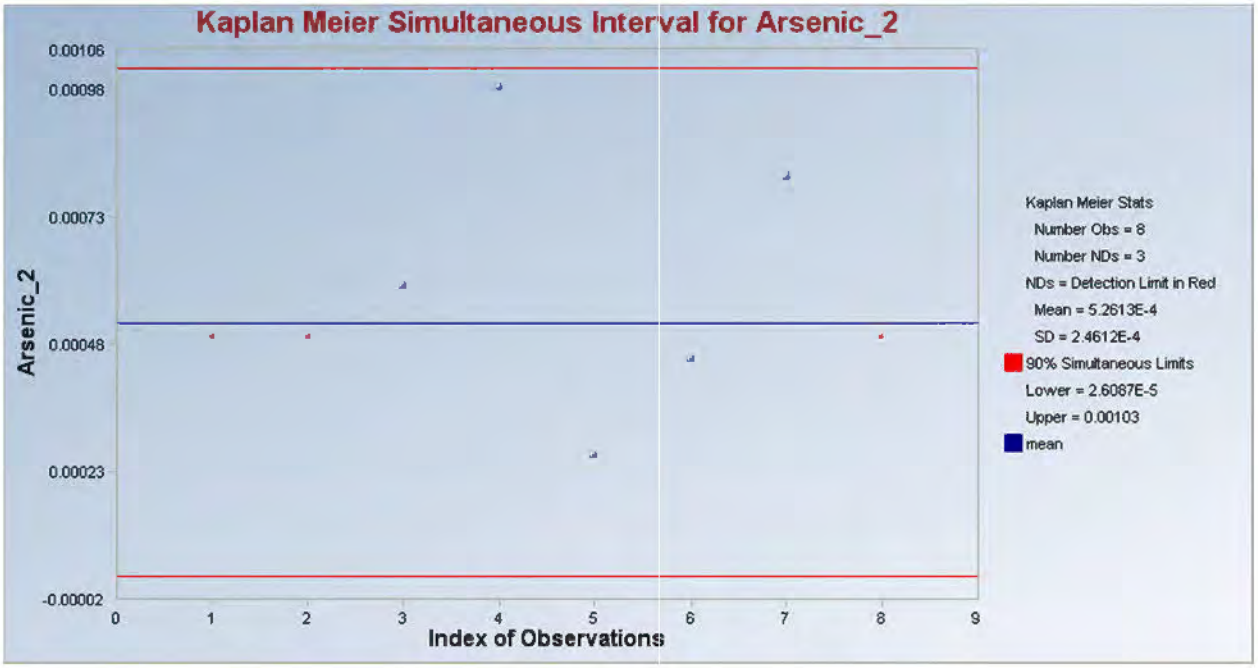
Chromium, total (intermediate)

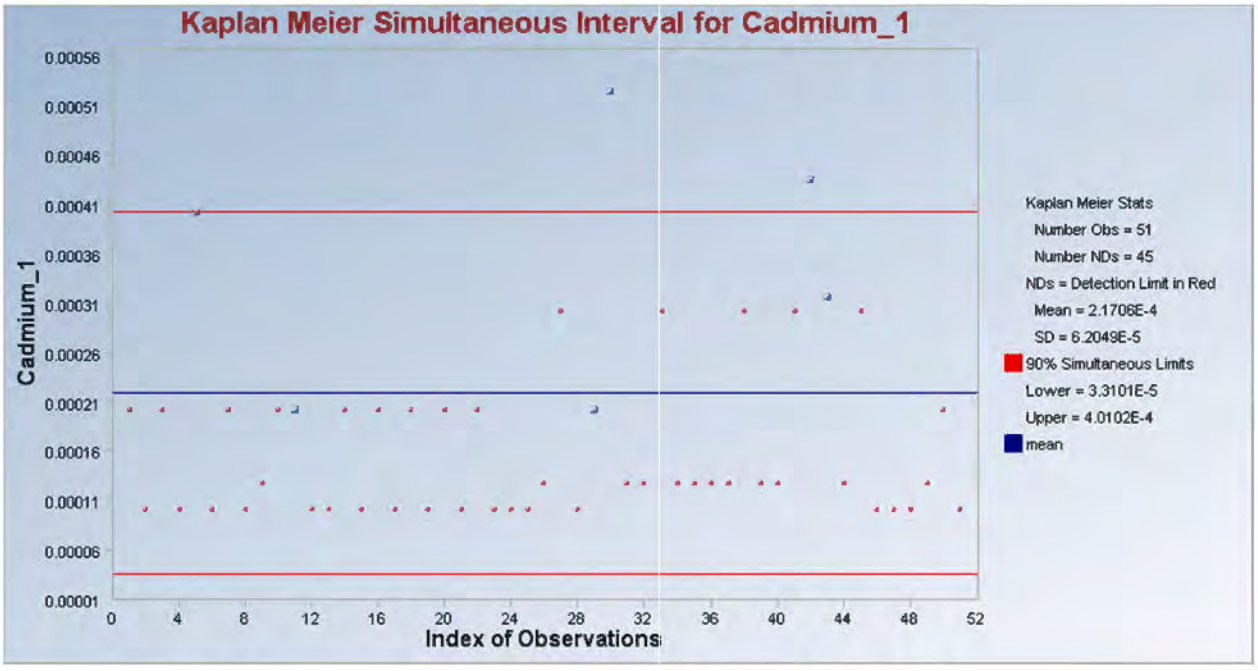
	Number Obs.	Mean	Median	Standard Deviation	MAD/ 0.6745	D2Max	LSL	USL
Classical	8	0.00236	0.00184	0.00172	0.00125	2.032	-0.00114	0.00586

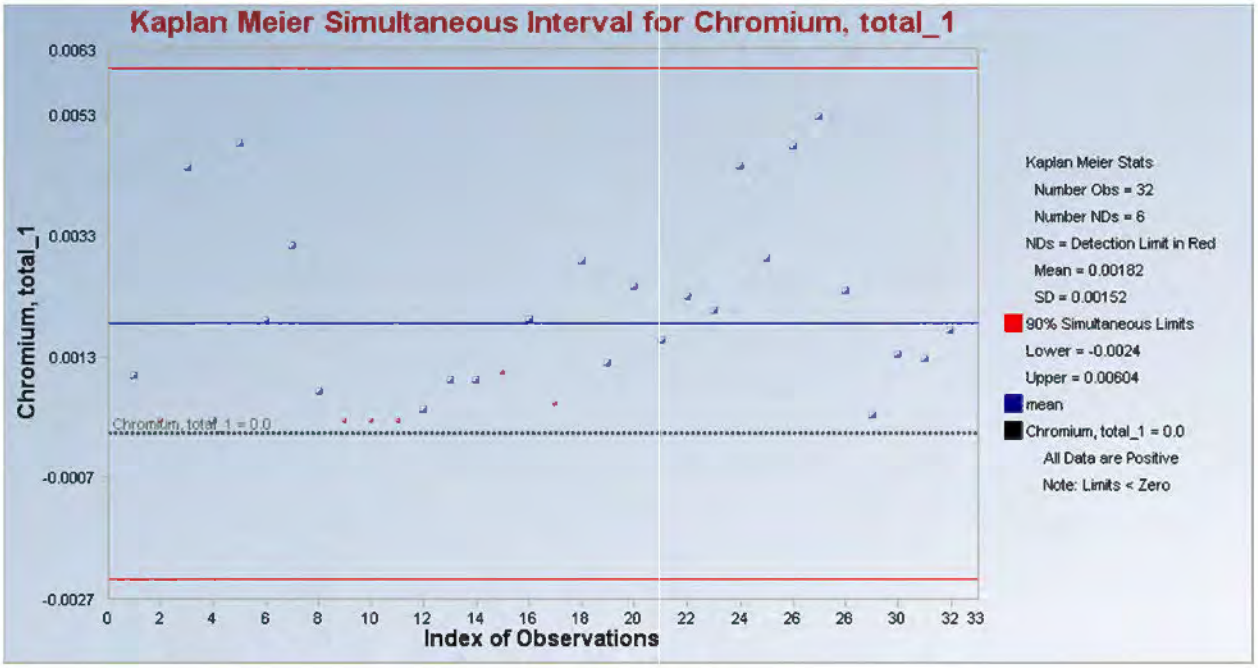
Method	Initial Location	Initial Scale	Final Mean	Final Stdv	Wsum	D2Max	LSL	USL
PROP	0.00184	0.00125	0.00236	0.00172	8	2.032	-0.00114	0.00586
Huber	0.00184	0.00125	0.00236	0.00172	8	2.032	-0.00114	0.00586
Tukey Biweight	0.00184	0.00125	0.00204	0.00186	6.5	1.884	-0.00146	0.00554
Lax Kafadar Biweight	0.00184	0.00125	0.00225	0.00184	7.27	1.965	-0.00137	0.00586
MVT	0.00184	0.00125	0.00236	0.00172	8	2.032	-0.00114	0.00586

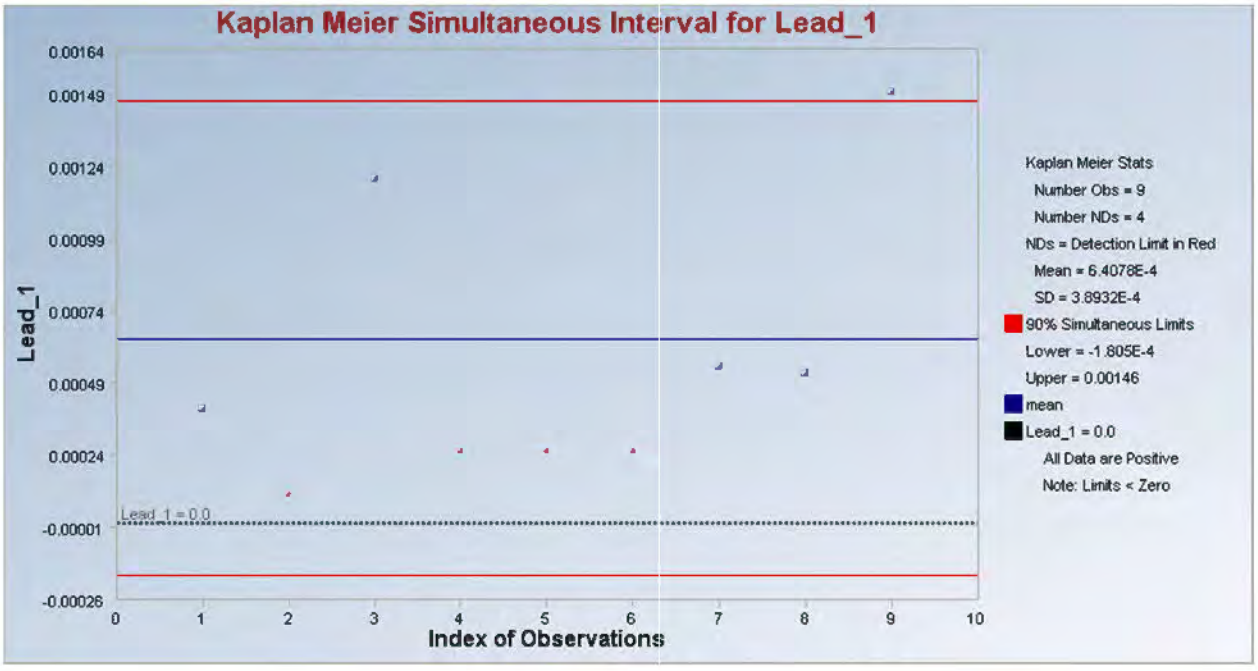

Kaplan Meier Simultaneous Interval for Manganese (deep)
Manganese (deep)
0.112
0.102
0.092
0.082
0.072
0.062
0.052
0.042
0.032
0.022
0.012
0.002
-0.008
-0.018
-0.028
-0.038
Manganese (deep) = 0.0
0
1
2
3
4
5
6
7
Index of Observations
Kaplan Meier Stats
Number Obs = 6
Number NDs = 1
NDs = Detection Limit in Red
Mean = 0.0382
SD = 0.0385
90% Simultaneous Limits
Lower = -0.0319
Upper = 0.108
mean
Manganese (deep) = 0.0
All Data are Positive
Note: Limits < Zero

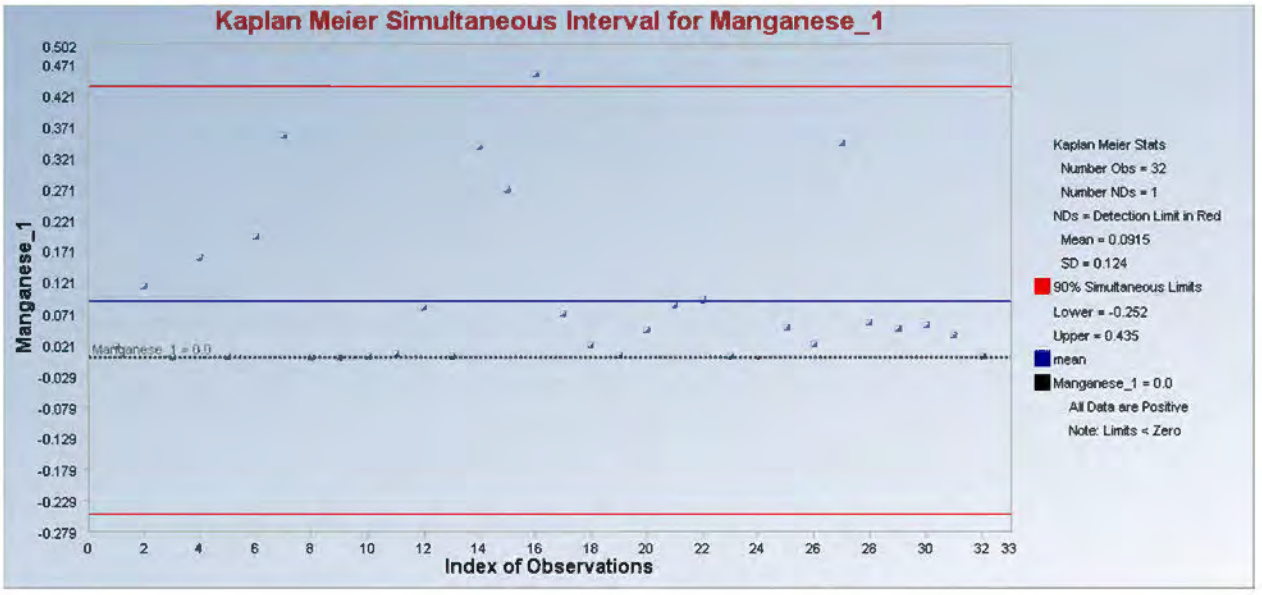

Kaplan Meier Simultaneous Interval for Selenium_deep
Selenium_deep
0.00142
0.00117
0.00092
0.00067
0.00042
0
1
2
3
4
5
6
7
8
9
Index of Observations
Kaplan Meier Stats
Number Obs = 8
Number NDs = 2
NDs = Detection Limit in Red
Mean = 9.3163E-4
SD = 2.2373E-4
90% Simultaneous Limits
Lower = 4.7708E-4
Upper = 0.00139
mean

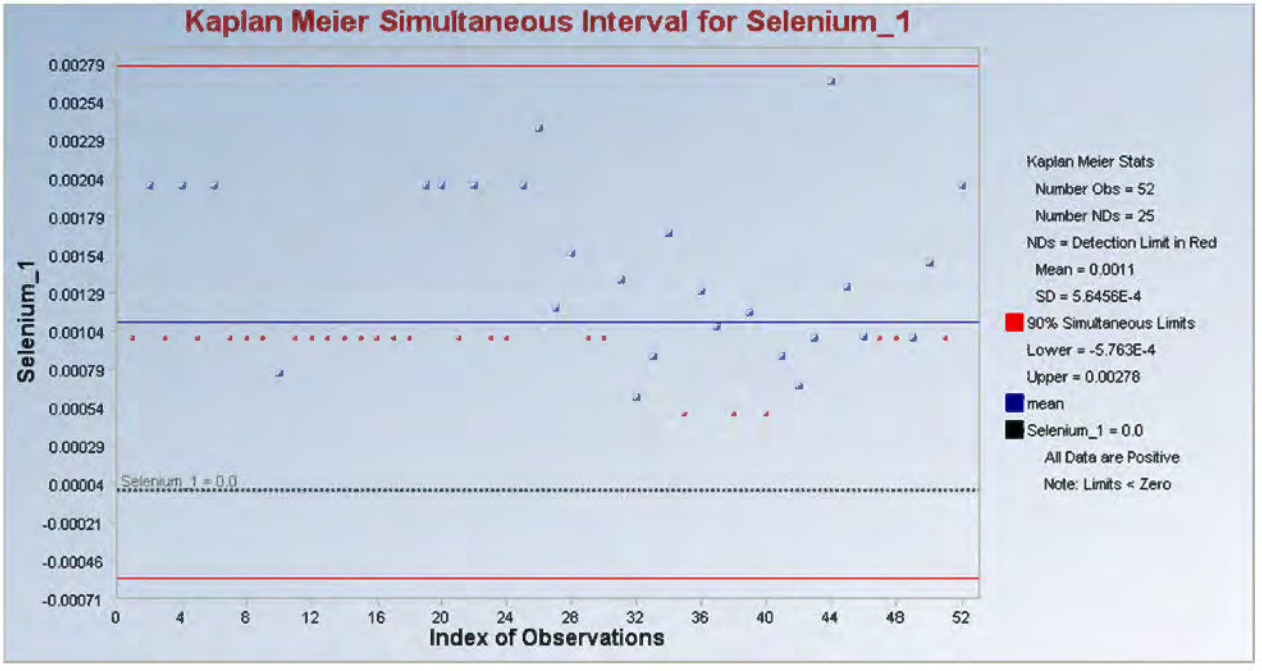

Kaplan Meier Simultaneous Interval for Arsenic_2
Arsenic_2
0.00106
0.00098
0.00073
0.00048
0.00023
-0.00002
0
1
2
3
4
5
6
7
8
9
Index of Observations
Kaplan Meier Stats
Number Obs = 8
Number NDs = 3
NDs = Detection Limit in Red
Mean = 5.2613E-4
SD = 2.4612E-4
90% Simultaneous Limits
Lower = 2.6087E-5
Upper = 0.00103
mean

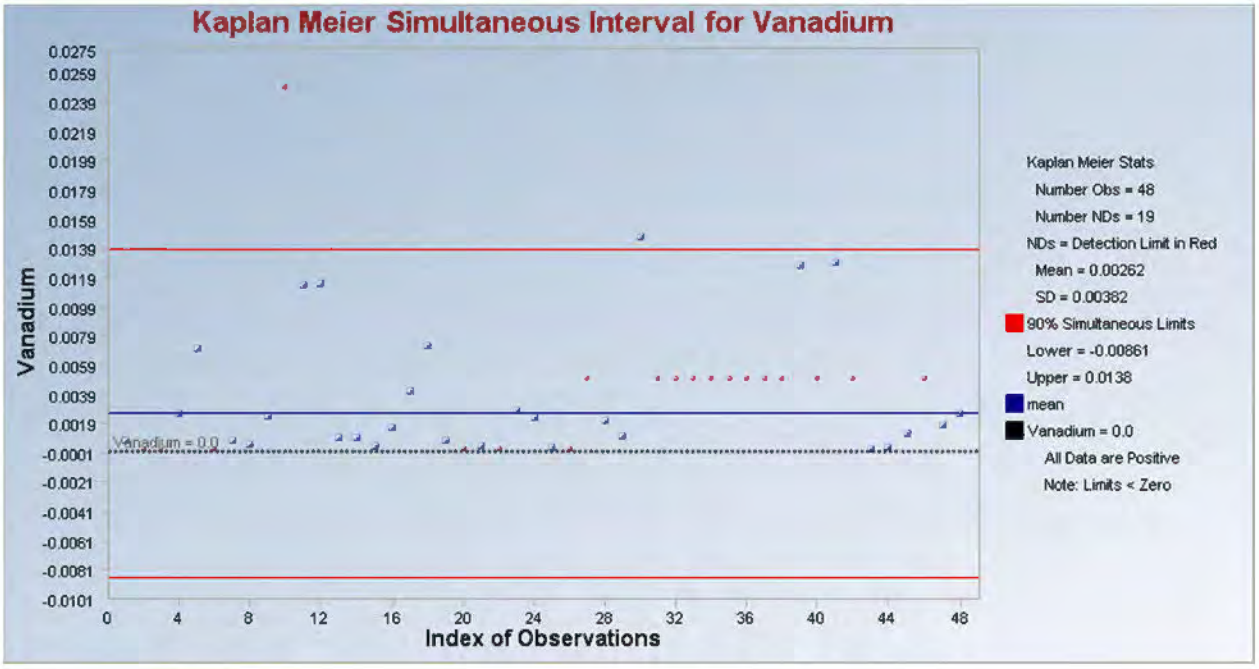

Kaplan Meier Simultaneous Interval for Cadmium_1
Cadmium_1
0.00056
0.00051
0.00046
0.00041
0.00036
0.00031
0.00026
0.00021
0.00016
0.00011
0.00006
0.00001
0
4
8
12
16
20
24
28
32
36
40
44
48
52
Index of Observations
Kaplan Meier Stats
Number Obs = 51
Number NDs = 45
NDs = Detection Limit in Red
Mean = 2.1706E-4
SD = 6.2049E-5
90% Simultaneous Limits
Lower = 3.3101E-5
Upper = 4.0102E-4
mean

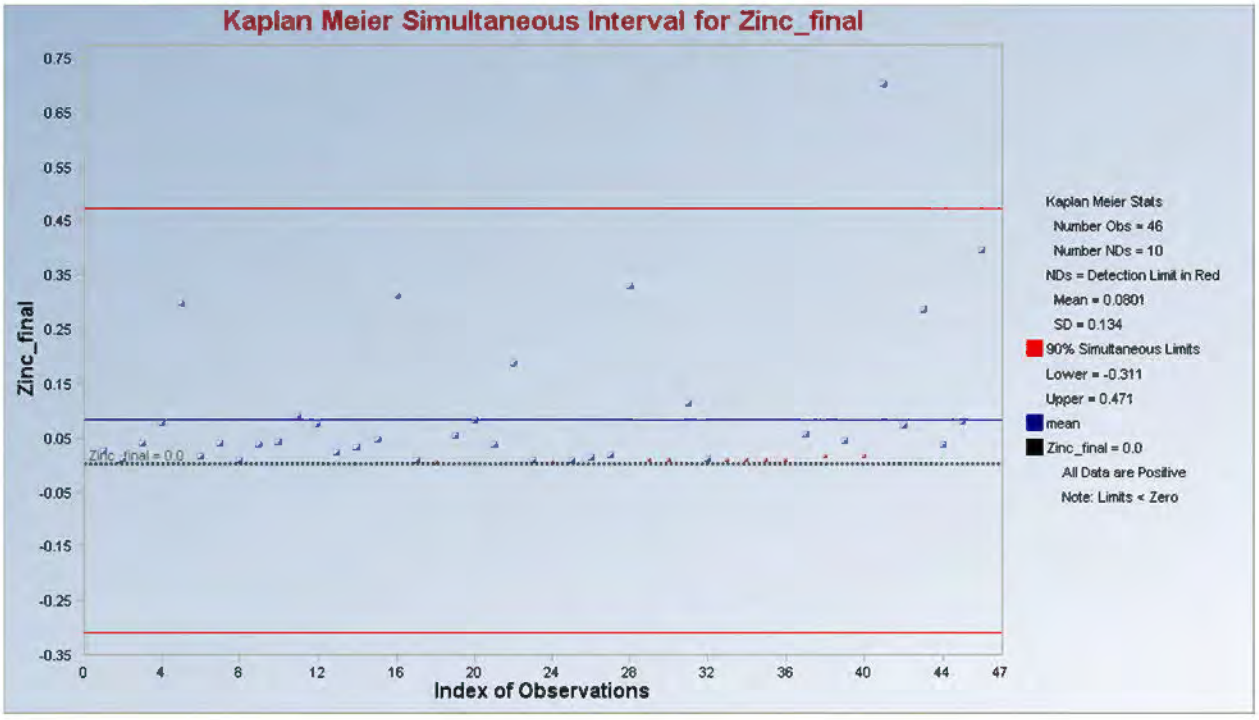

Kaplan Meier Simultaneous Interval for Chromium, total_1
Chromium, total_1
Index of Observations
Chromium, total_1 = 0.0
Kaplan Meier Stats
Number Obs = 32
Number NDs = 6
NDs = Detection Limit in Red
Mean = 0.00182
SD = 0.00152
90% Simultaneous Limits
Lower = -0.0024
Upper = 0.00604
mean
Chromium, total_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Lead_1
Lead_1
Index of Observations
Lead_1 = 0.0
Kaplan Meier Stats
Number Obs = 9
Number NDs = 4
NDs = Detection Limit in Red
Mean = 6.4078E-4
SD = 3.8932E-4
90% Simultaneous Limits
Lower = -1.805E-4
Upper = 0.00146
mean
Lead_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Manganese_1
Manganese_1
Index of Observations
Manganese_1 = 0.0
Kaplan Meier Stats
Number Obs = 32
Number NDs = 1
NDs = Detection Limit in Red
Mean = 0.0915
SD = 0.124
90% Simultaneous Limits
Lower = -0.252
Upper = 0.435
mean
Manganese_1 = 0.0
All Data are Positive
Note: Limits < Zero


Kaplan Meier Simultaneous Interval for Selenium_1
Selenium_1
Index of Observations
Selenium_1 = 0.0
Kaplan Meier Stats
Number Obs = 52
Number NDs = 25
NDs = Detection Limit in Red
Mean = 0.0011
SD = 5.6456E-4
90% Simultaneous Limits
Lower = -5.763E-4
Upper = 0.00278
mean
Selenium_1 = 0.0
All Data are Positive
Note: Limits < Zero

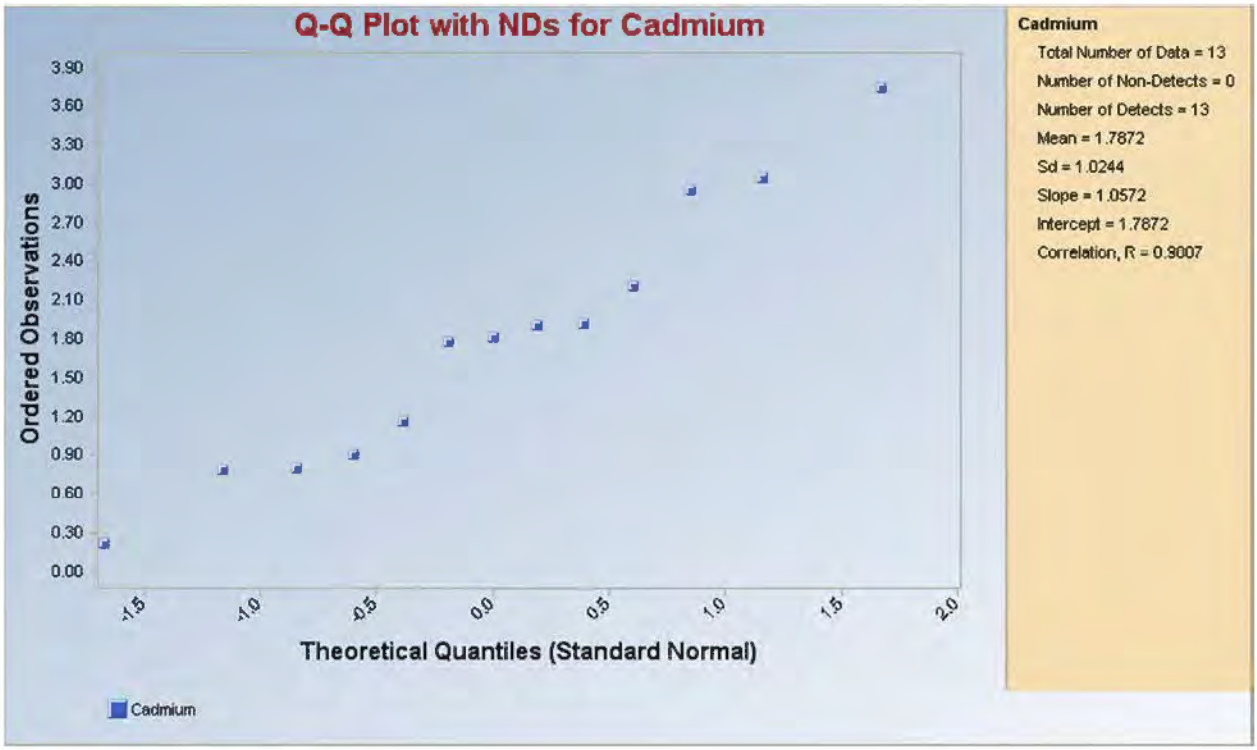

Kaplan Meier Simultaneous Interval for Vanadium
Vanadium
Index of Observations
Vanadium = 0.0
Kaplan Meier Stats
Number Obs = 48
Number NDs = 19
NDs = Detection Limit in Red
Mean = 0.00262
SD = 0.00382
90% Simultaneous Limits
Lower = -0.00861
Upper = 0.0138
mean
Vanadium = 0.0
All Data are Positive
Note: Limits < Zero

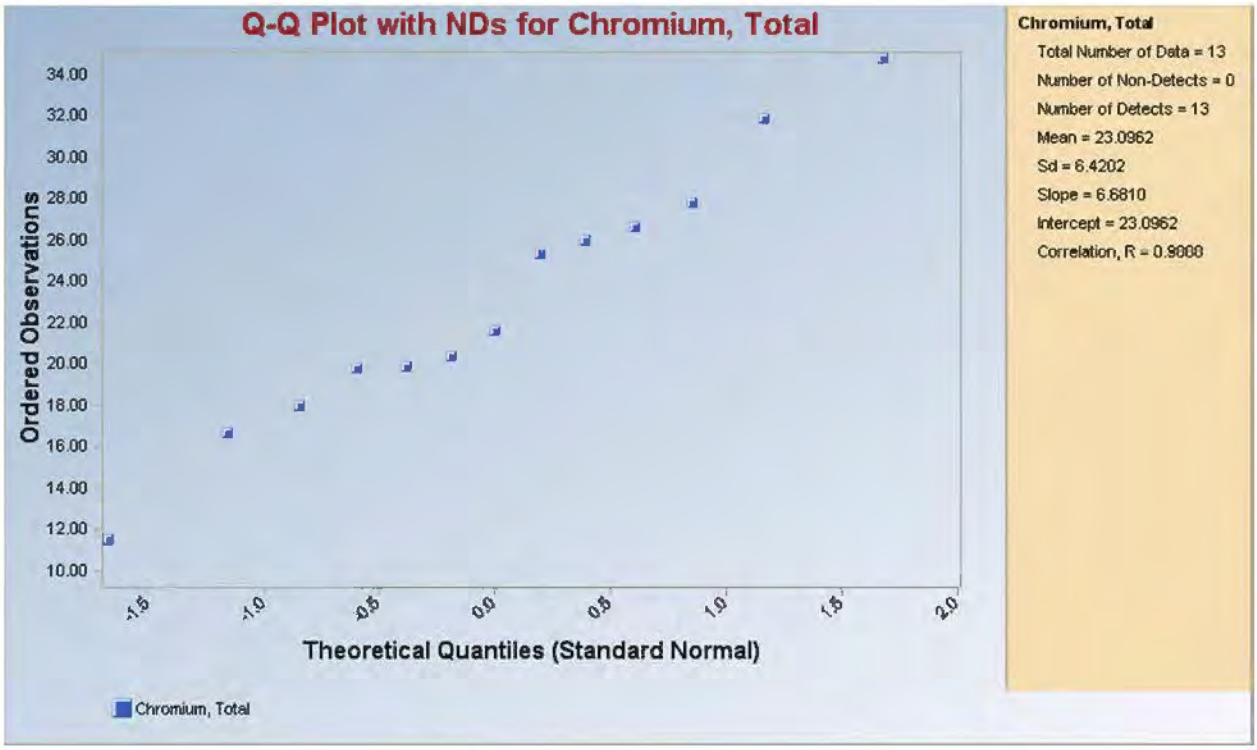

Kaplan Meier Simultaneous Interval for Zinc_final
Zinc_final
Index of Observations
Zinc_final = 0.0
Kaplan Meier Stats
Number Obs = 46
Number NDs = 10
NDs = Detection Limit in Red
Mean = 0.0801
SD = 0.134
90% Simultaneous Limits
Lower = -0.311
Upper = 0.471
mean
Zinc_final = 0.0
All Data are Positive
Note: Limits < Zero

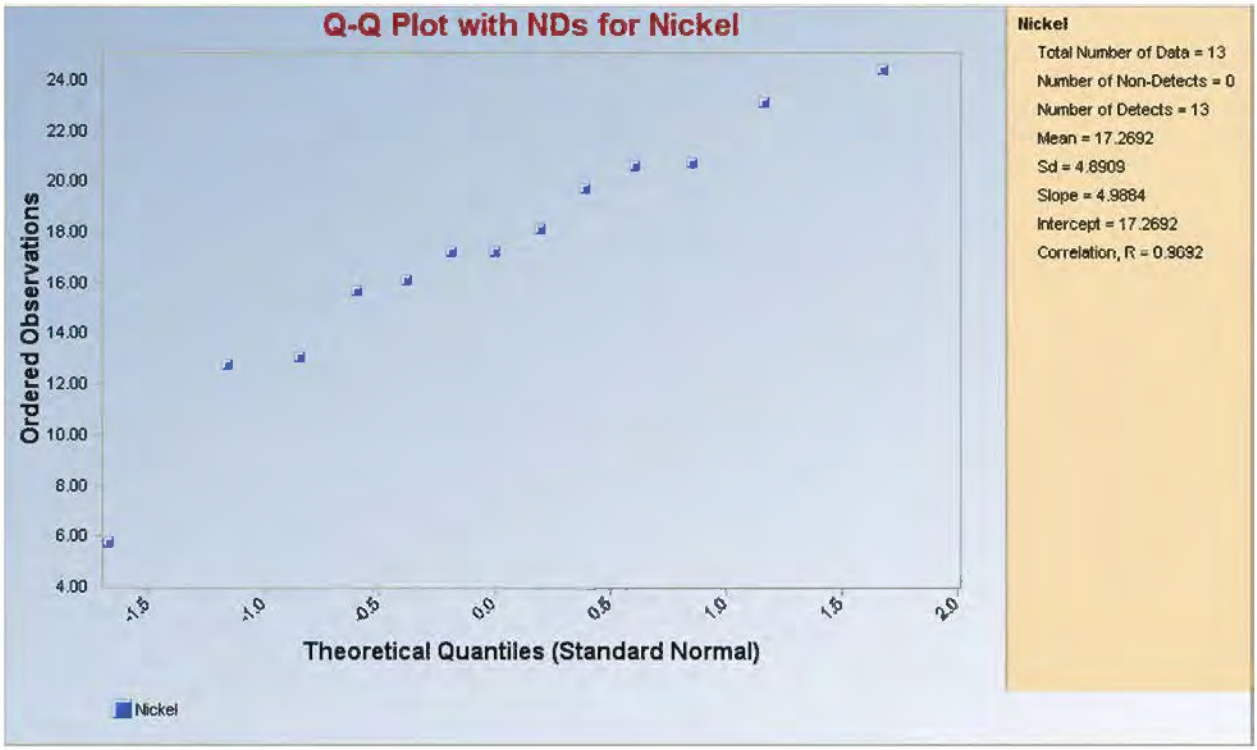
APPENDIX D

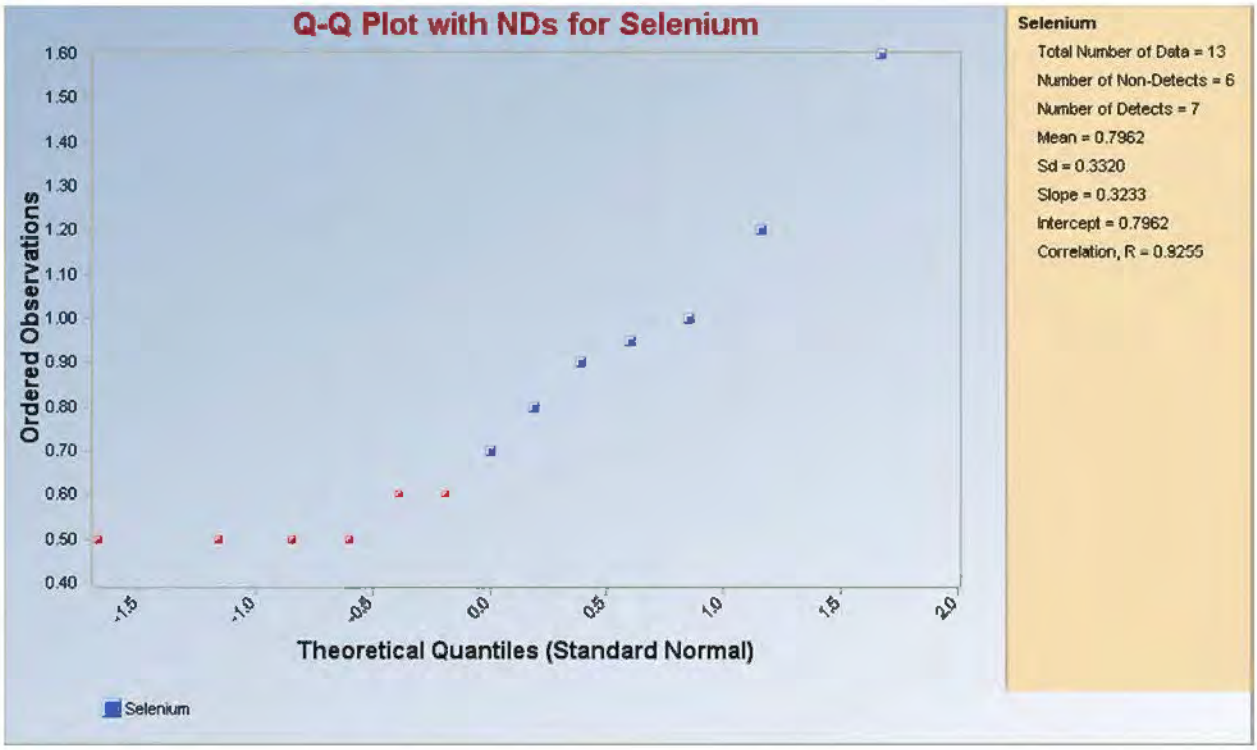
QUANTILE-QUANTILE PLOTS FOR METALS IN BACKGROUND DATASETS

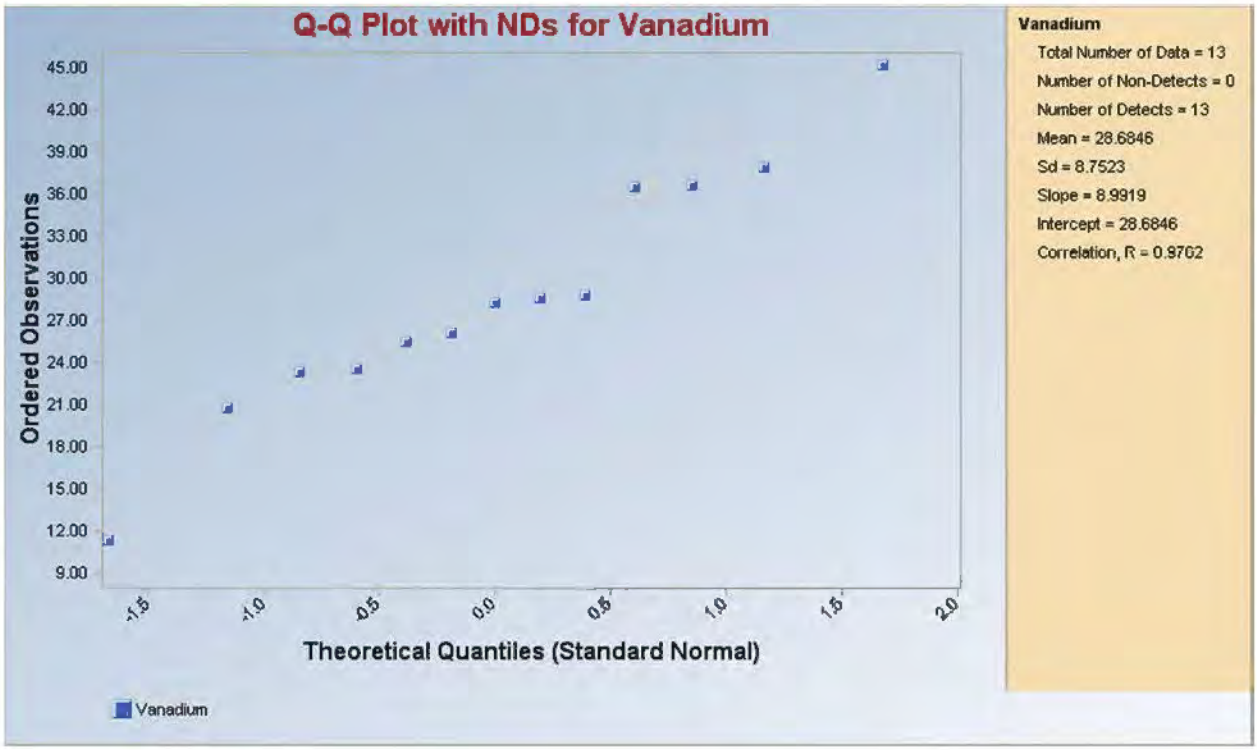
SEDIMENT – QQ PLOTS

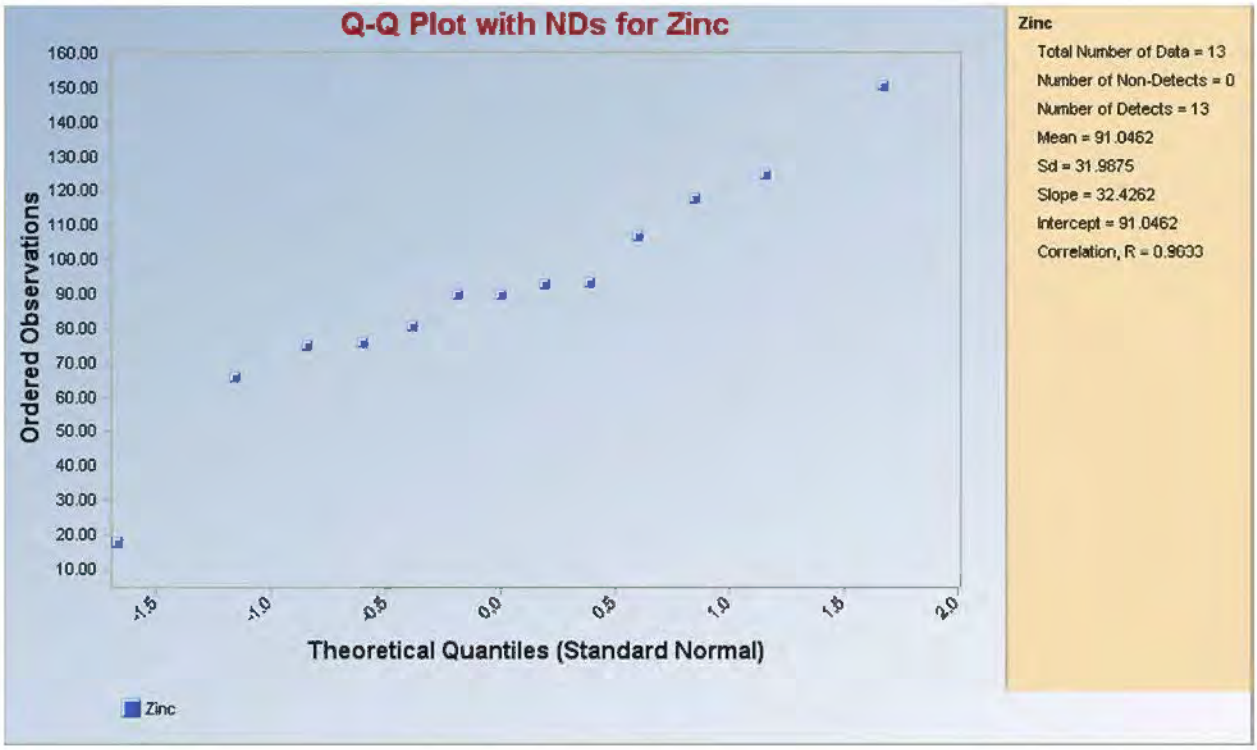

Q-Q Plot with NDs for Cadmium
Ordered Observations
3.90
3.60
3.30
3.00
2.70
2.40
2.10
1.80
1.50
1.20
0.90
0.60
0.30
0.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Cadmium
Cadmium
Total Number of Data = 13
Number of Non-Detects = 0
Number of Detects = 13
Mean = 1.7872
Sd = 1.0244
Slope = 1.0572
Intercept = 1.7872
Correlation, R = 0.9007


Q-Q Plot with NDs for Chromium, Total
Ordered Observations
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Chromium, Total
Chromium, Total
Total Number of Data = 13
Number of Non-Detects = 0
Number of Detects = 13
Mean = 23.0962
Sd = 6.4202
Slope = 6.6810
Intercept = 23.0962
Correlation, R = 0.9008

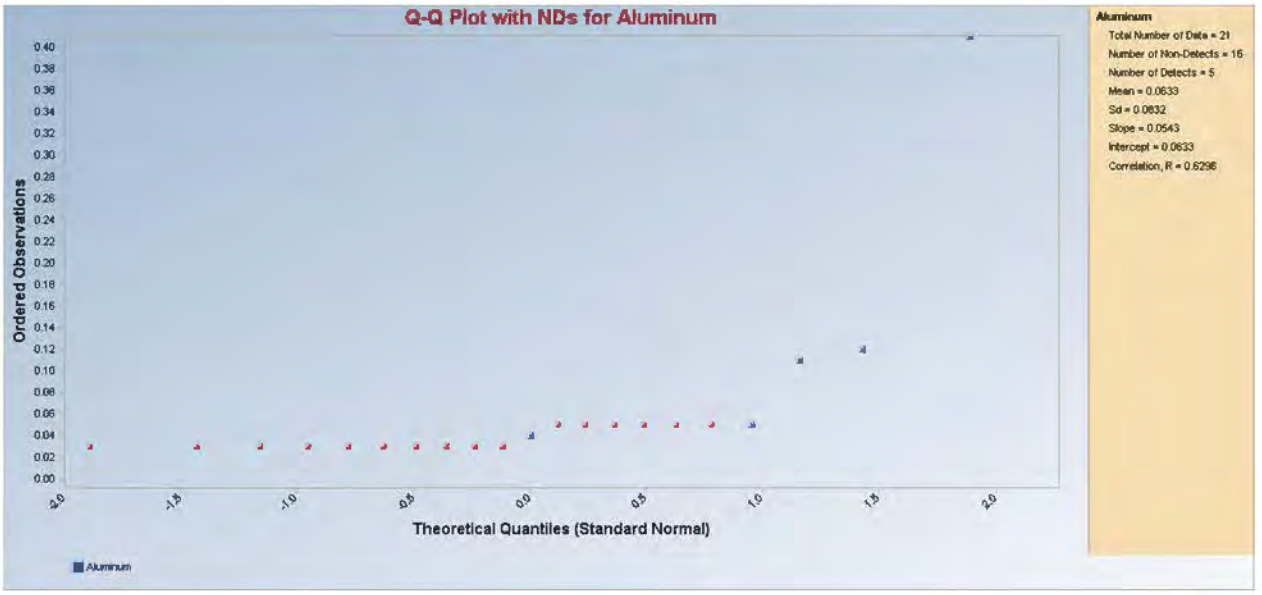

Q-Q Plot with NDs for Nickel
Ordered Observations
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Nickel
Nickel
Total Number of Data = 13
Number of Non-Detects = 0
Number of Detects = 13
Mean = 17.2692
Sd = 4.8909
Slope = 4.9884
Intercept = 17.2692
Correlation, R = 0.9692

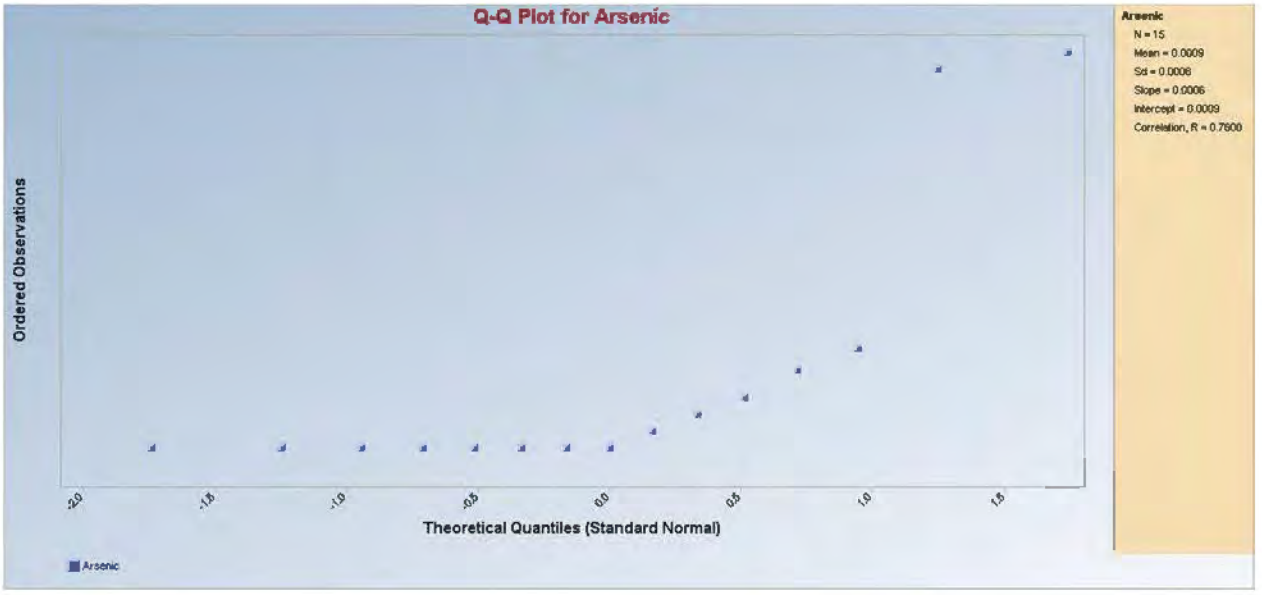

Q-Q Plot with NDs for Selenium
Ordered Observations
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Selenium
Selenium
Total Number of Data = 13
Number of Non-Detects = 6
Number of Detects = 7
Mean = 0.7962
Sd = 0.3320
Slope = 0.3233
Intercept = 0.7962
Correlation, R = 0.9255

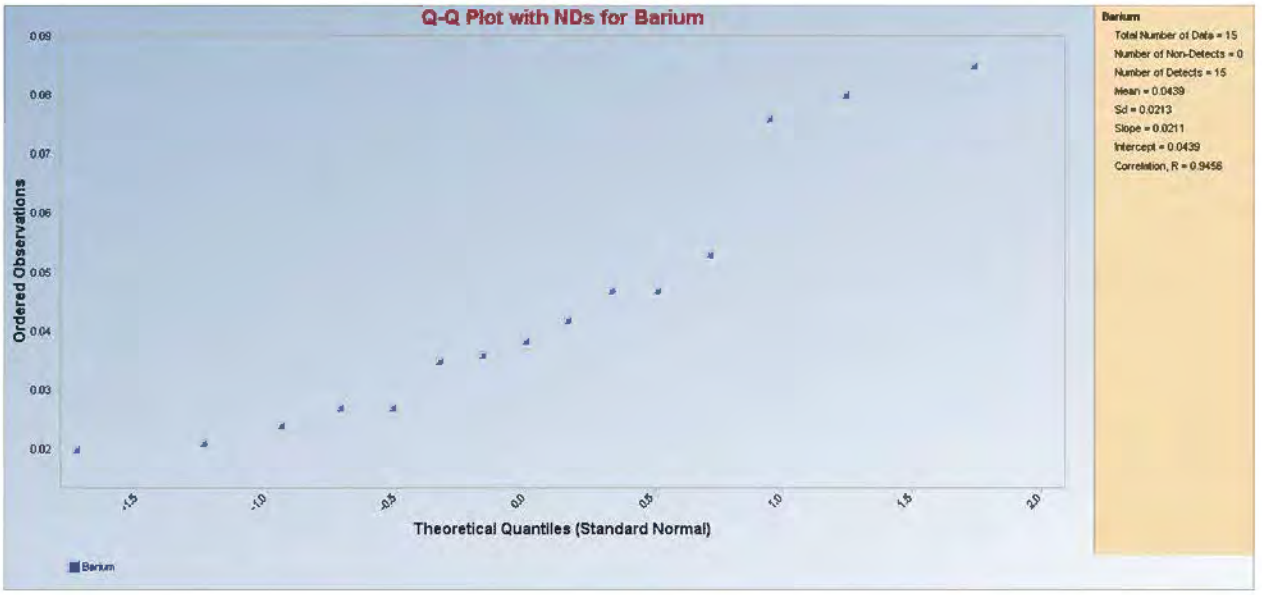

Q-Q Plot with NDs for Vanadium
Ordered Observations
45.00
42.00
39.00
36.00
33.00
30.00
27.00
24.00
21.00
18.00
15.00
12.00
9.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Vanadium
Vanadium
Total Number of Data = 13
Number of Non-Detects = 0
Number of Detects = 13
Mean = 28.6846
Sd = 8.7523
Slope = 8.9919
Intercept = 28.6846
Correlation, R = 0.9762

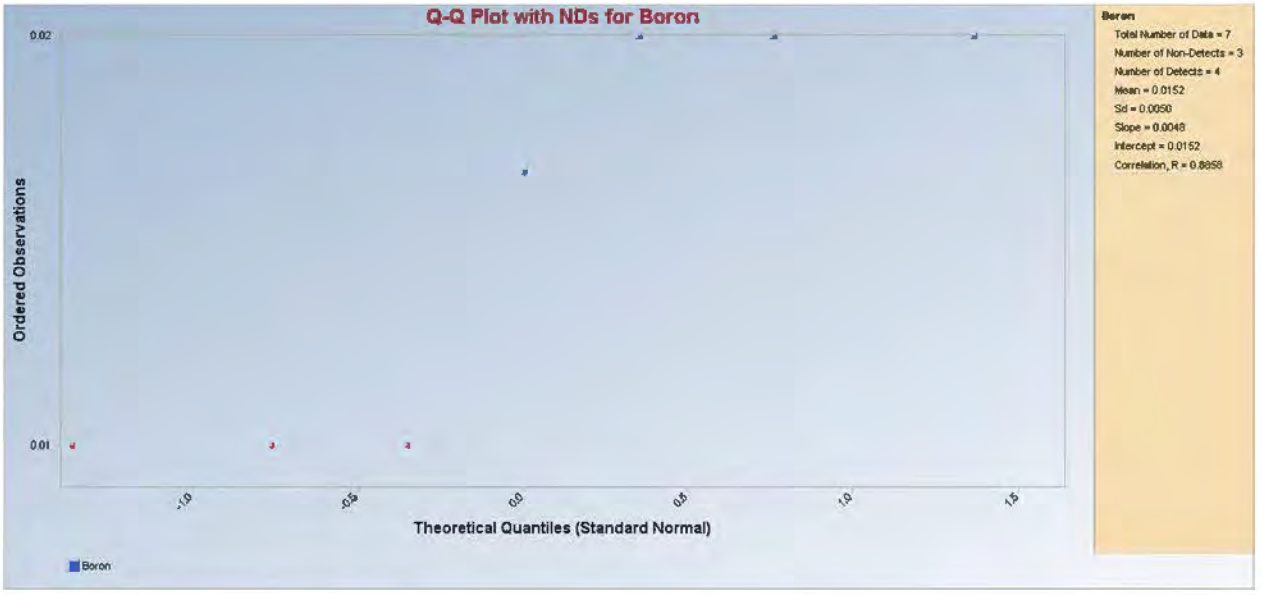

Q-Q Plot with NDs for Zinc
Ordered Observations
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Zinc
Zinc
Total Number of Data = 13
Number of Non-Detects = 0
Number of Detects = 13
Mean = 91.0462
Sd = 31.9875
Slope = 32.4262
Intercept = 91.0462
Correlation, R = 0.9633

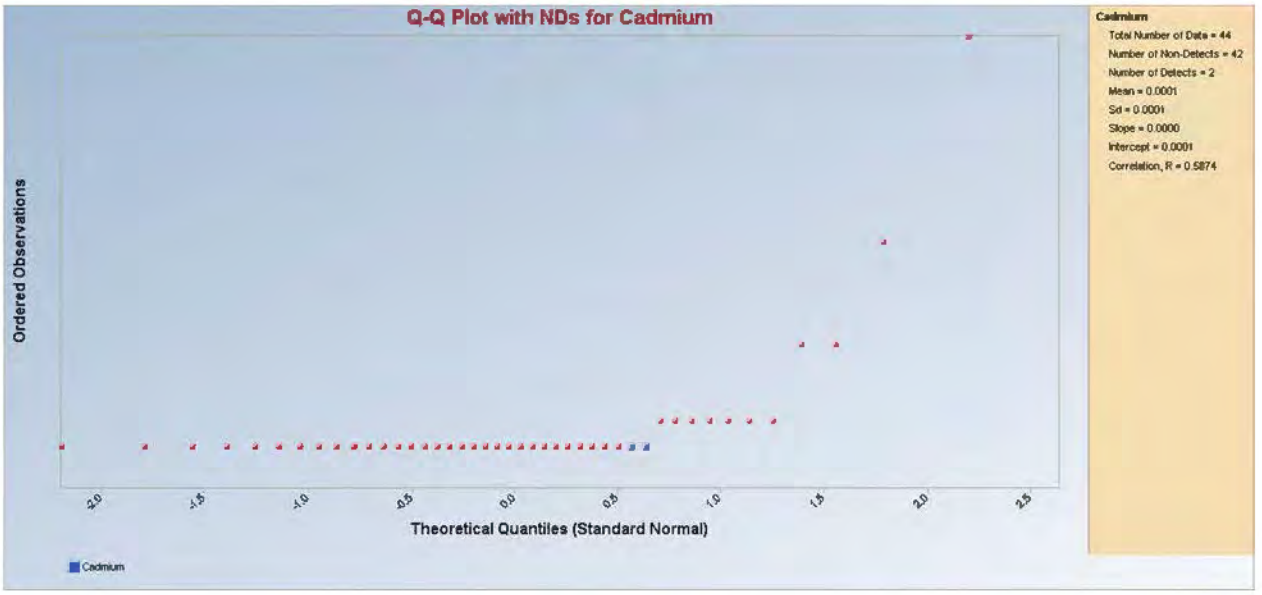
SURFACE WATER – QQ PLOTS

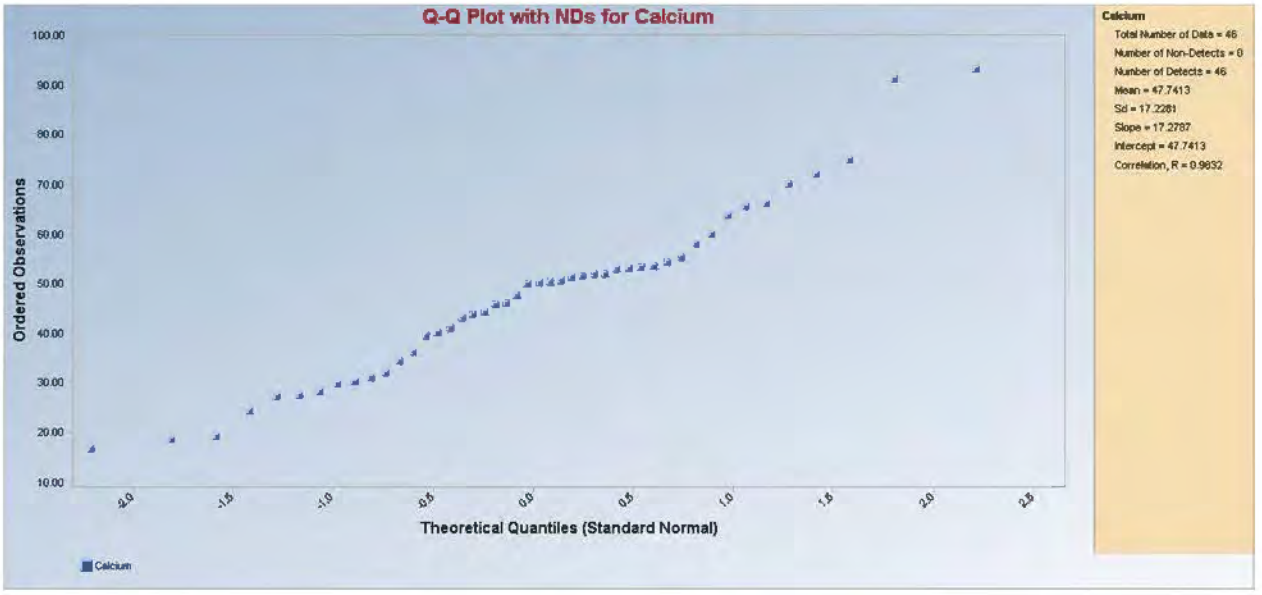

Q-Q Plot with NDs for Aluminum
Ordered Observations
Theoretical Quantiles (Standard Normal)
Aluminum
Aluminum
Total Number of Data = 21
Number of Non-Detects = 16
Number of Detects = 5
Mean = 0.0633
Sd = 0.0832
Slope = 0.0543
Intercept = 0.0633
Correlation, R = 0.6298

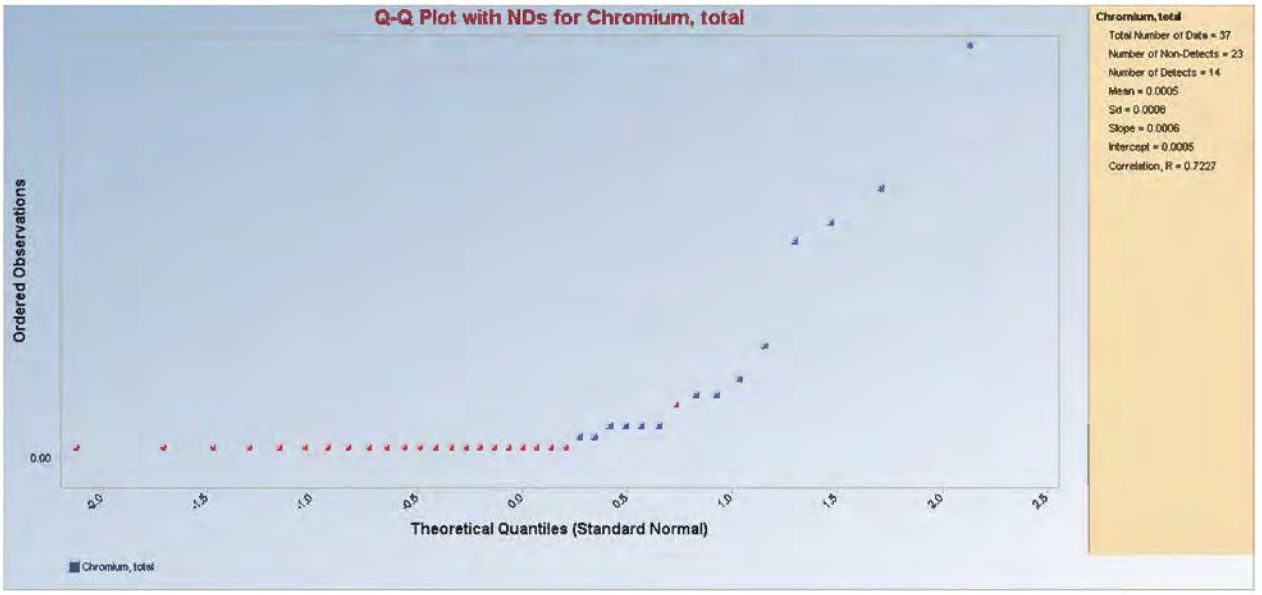

Q-Q Plot for Arsenic
Ordered Observations
Theoretical Quantiles (Standard Normal)
Arsenic
Arsenic
N = 15
Mean = 0.0009
Sd = 0.0006
Slope = 0.0006
Intercept = 0.0009
Correlation, R = 0.7600

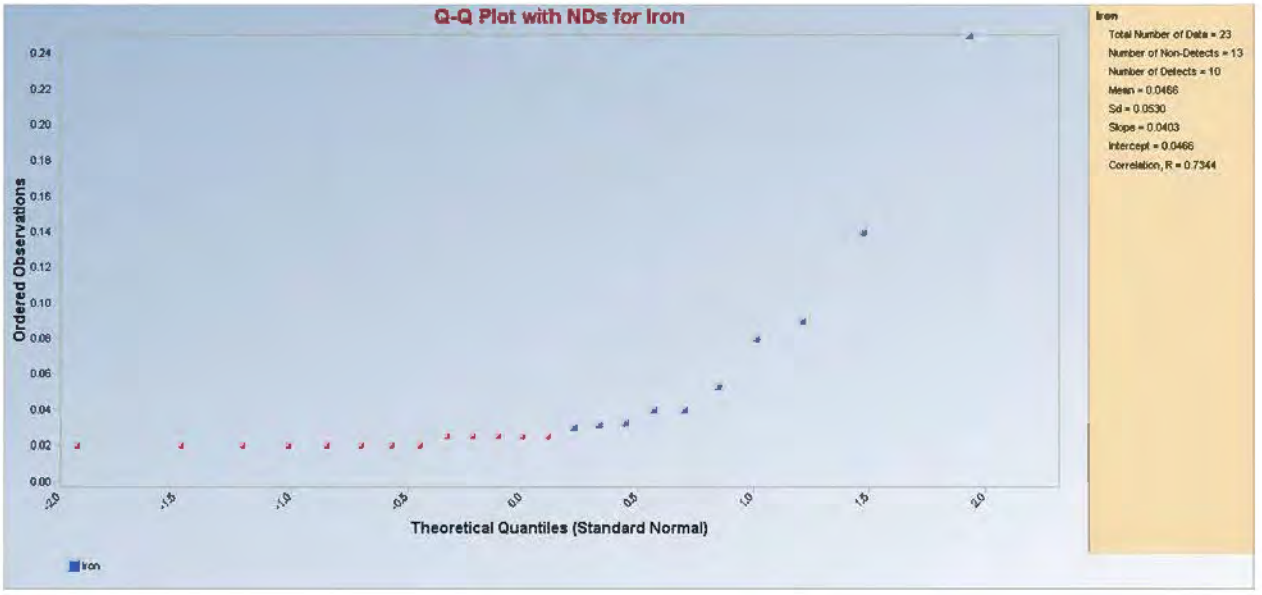

Q-Q Plot with NDs for Barium
Ordered Observations
Theoretical Quantiles (Standard Normal)
Barium
Barium
Total Number of Data = 15
Number of Non-Detects = 0
Number of Detects = 15
Mean = 0.0439
Sd = 0.0213
Slope = 0.0211
Intercept = 0.0439
Correlation, R = 0.9458

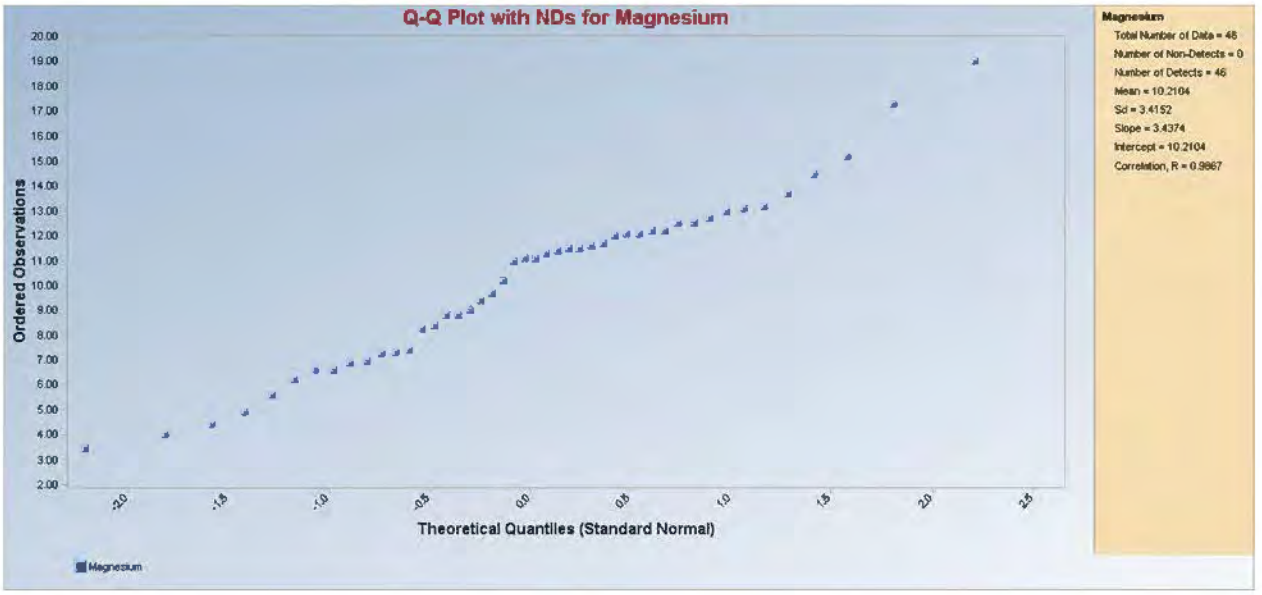

Q-Q Plot with NDs for Boron
Ordered Observations
Theoretical Quantiles (Standard Normal)
Boron
Boron
Total Number of Data = 7
Number of Non-Detects = 3
Number of Detects = 4
Mean = 0.0152
Sd = 0.0050
Slope = 0.0048
Intercept = 0.0152
Correlation, R = 0.8858

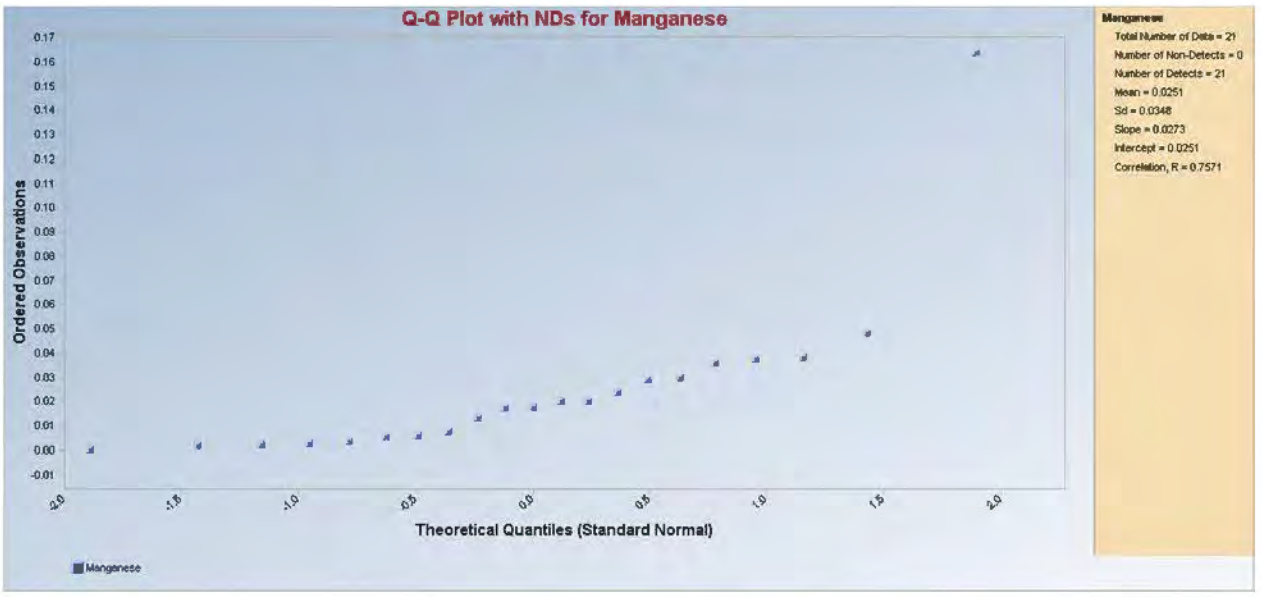

Q-Q Plot with NDs for Cadmium
Ordered Observations
Theoretical Quantiles (Standard Normal)
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Cadmium
Cadmium
Total Number of Data = 44
Number of Non-Detects = 42
Number of Detects = 2
Mean = 0.0001
Sd = 0.0001
Slope = 0.0000
Intercept = 0.0001
Correlation, R = 0.5874

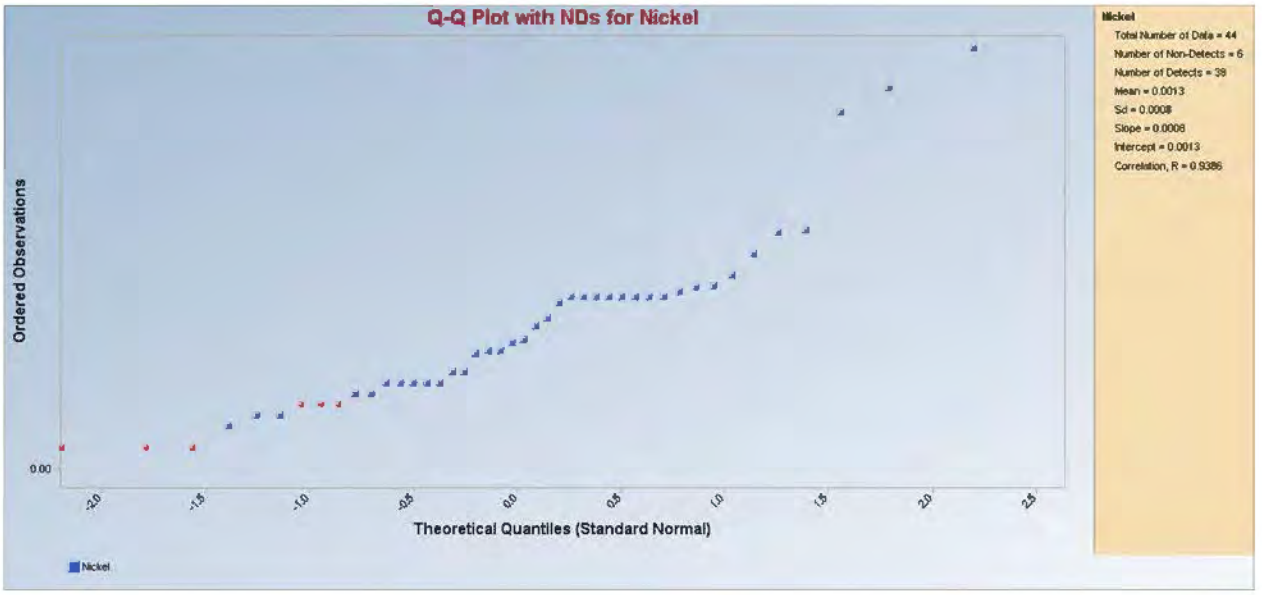

Q-Q Plot with NDs for Calcium
Ordered Observations
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
Theoretical Quantiles (Standard Normal)
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Calcium
Calcium
Total Number of Data = 46
Number of Non-Detects = 0
Number of Detects = 46
Mean = 47.7413
Sd = 17.2281
Slope = 17.2787
Intercept = 47.7413
Correlation, R = 0.9832

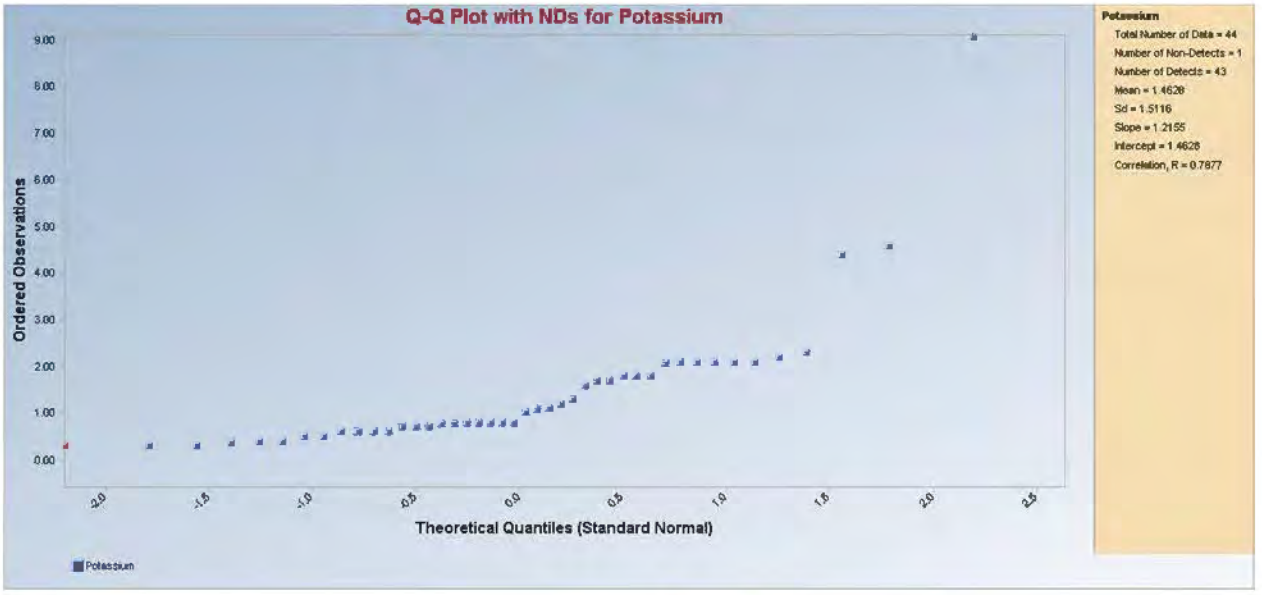

Q-Q Plot with NDs for Chromium, total
Ordered Observations
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Chromium, total
Chromium, total
Total Number of Data = 37
Number of Non-Detects = 23
Number of Detects = 14
Mean = 0.0005
Sd = 0.0008
Slope = 0.0006
Intercept = 0.0005
Correlation, R = 0.7227

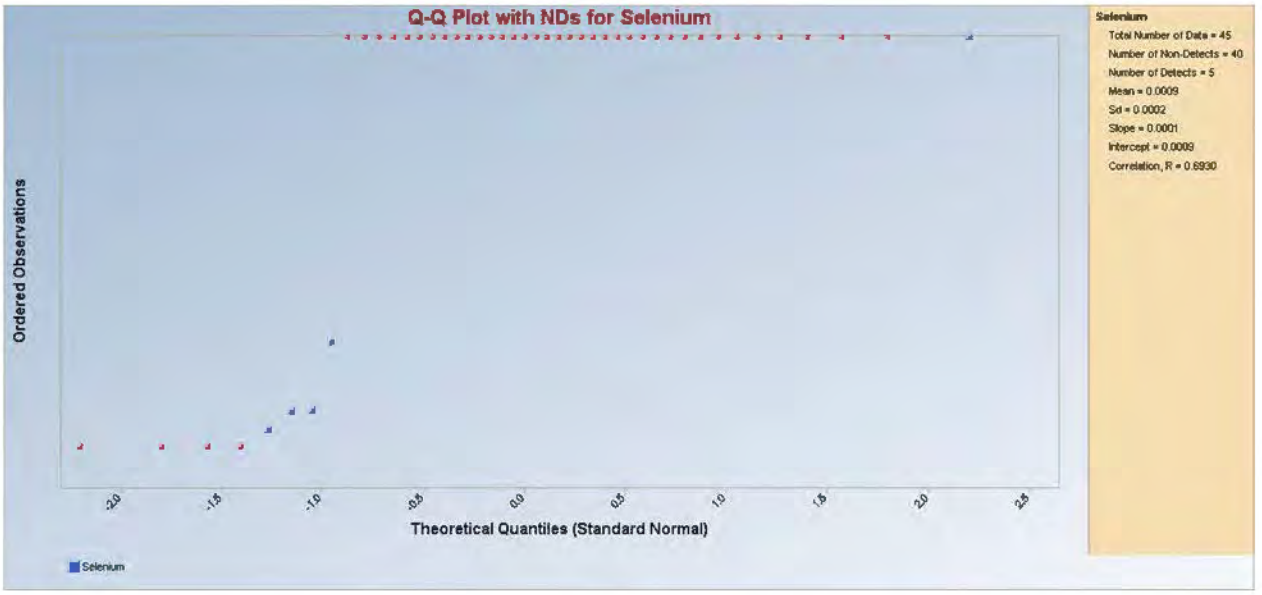

Q-Q Plot with NDs for Iron
Ordered Observations
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Iron
Iron
Total Number of Data = 23
Number of Non-Detects = 13
Number of Detects = 10
Mean = 0.0466
Sd = 0.0530
Slope = 0.0403
Intercept = 0.0466
Correlation, R = 0.7344

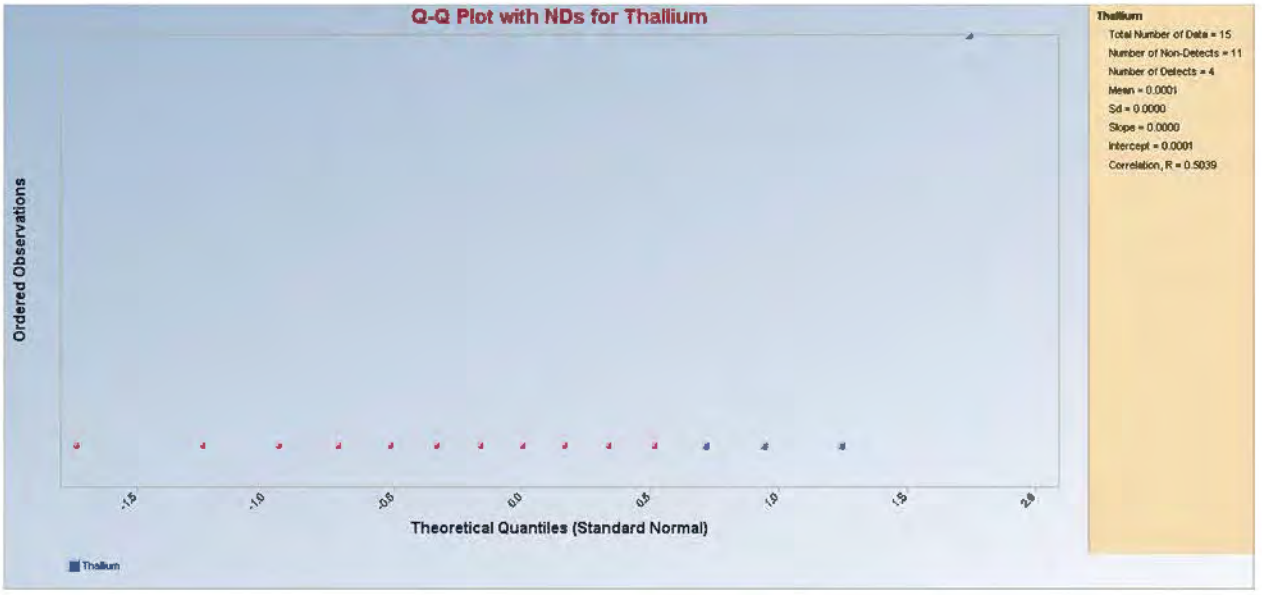

Q-Q Plot with NDs for Magnesium
Ordered Observations
Theoretical Quantiles (Standard Normal)
Magnesium
Magnesium
Total Number of Data = 46
Number of Non-Detects = 0
Number of Detects = 46
Mean = 10.2104
Sd = 3.4152
Slope = 3.4374
Intercept = 10.2104
Correlation, R = 0.9867

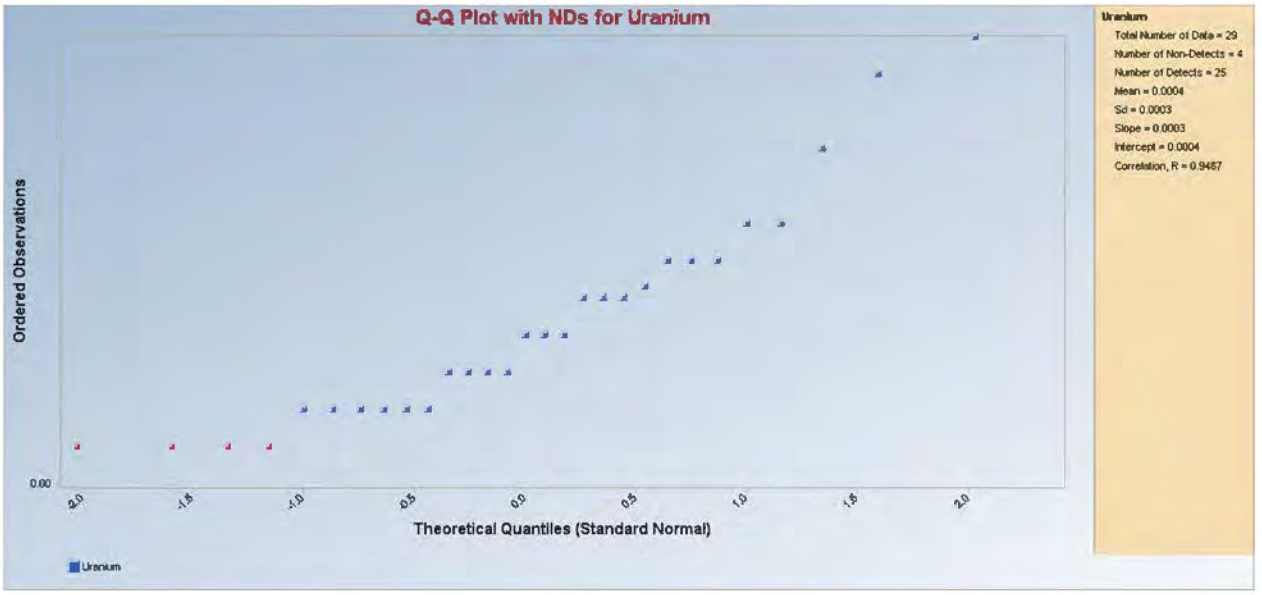

Q-Q Plot with NDs for Manganese
Ordered Observations
Theoretical Quantiles (Standard Normal)
Manganese
Manganese
Total Number of Data = 21
Number of Non-Detects = 0
Number of Detects = 21
Mean = 0.0251
Sd = 0.0348
Slope = 0.0273
Intercept = 0.0251
Correlation, R = 0.7571

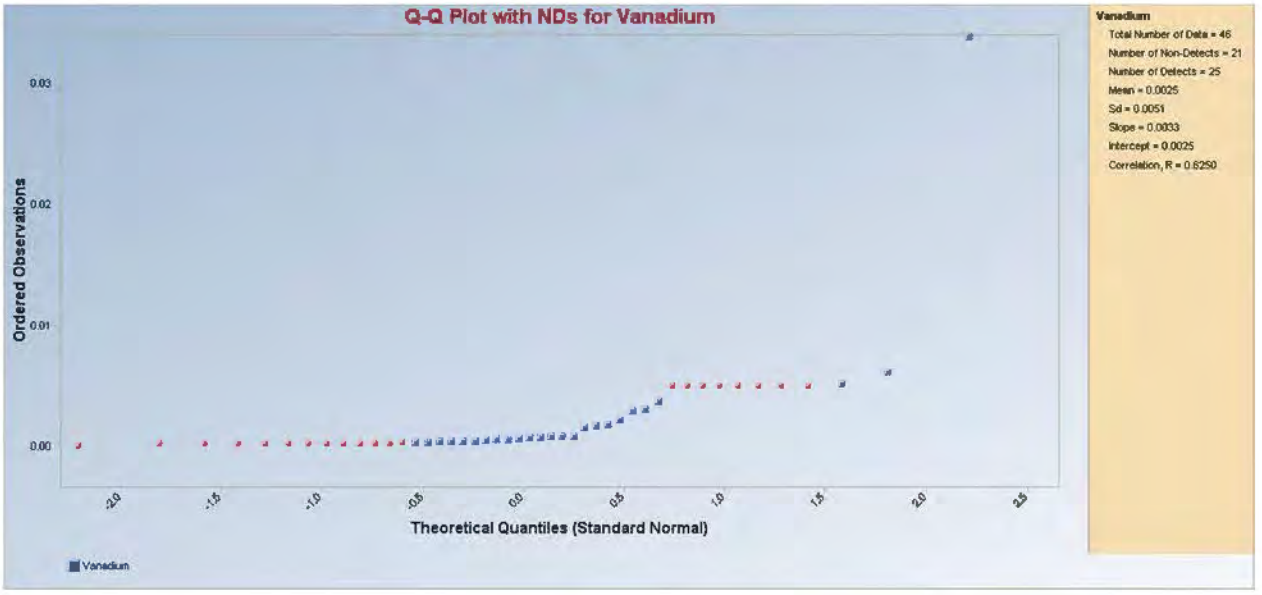

Q-Q Plot with NDs for Nickel
Ordered Observations
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Nickel
Nickel
Total Number of Data = 44
Number of Non-Detects = 5
Number of Detects = 39
Mean = 0.0013
Sd = 0.0008
Slope = 0.0008
Intercept = 0.0013
Correlation, R = 0.9386

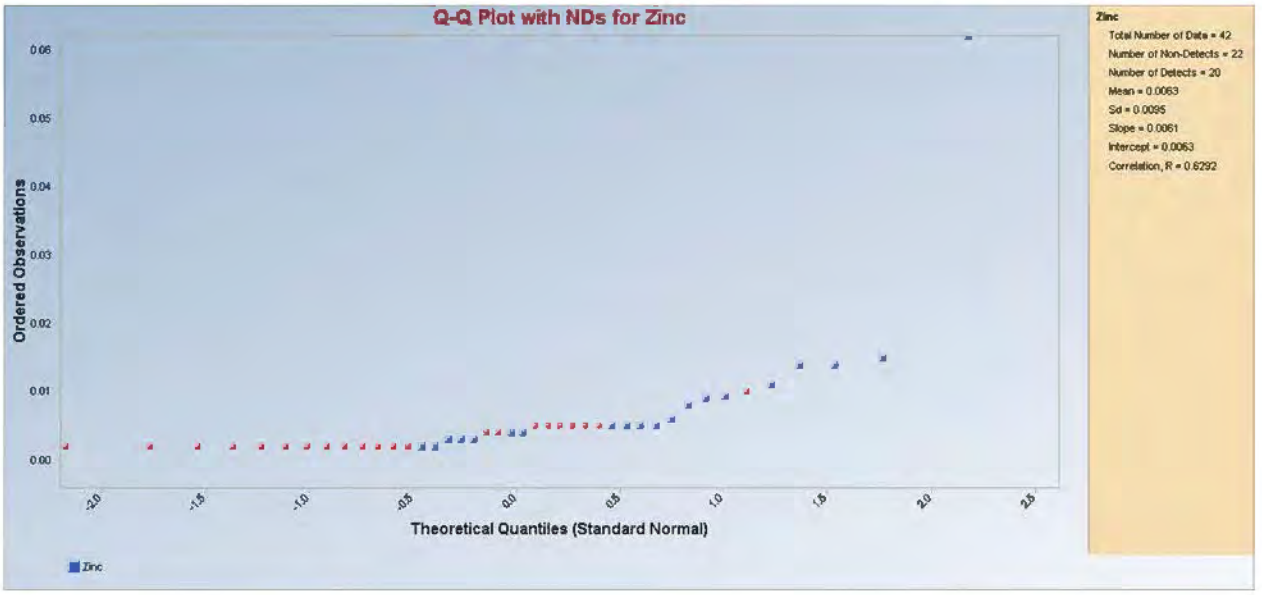

Q-Q Plot with NDs for Potassium
Ordered Observations
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Potassium
Potassium
Total Number of Data = 44
Number of Non-Detects = 1
Number of Detects = 43
Mean = 1.4628
Sd = 1.5116
Slope = 1.2155
Intercept = 1.4628
Correlation, R = 0.7877

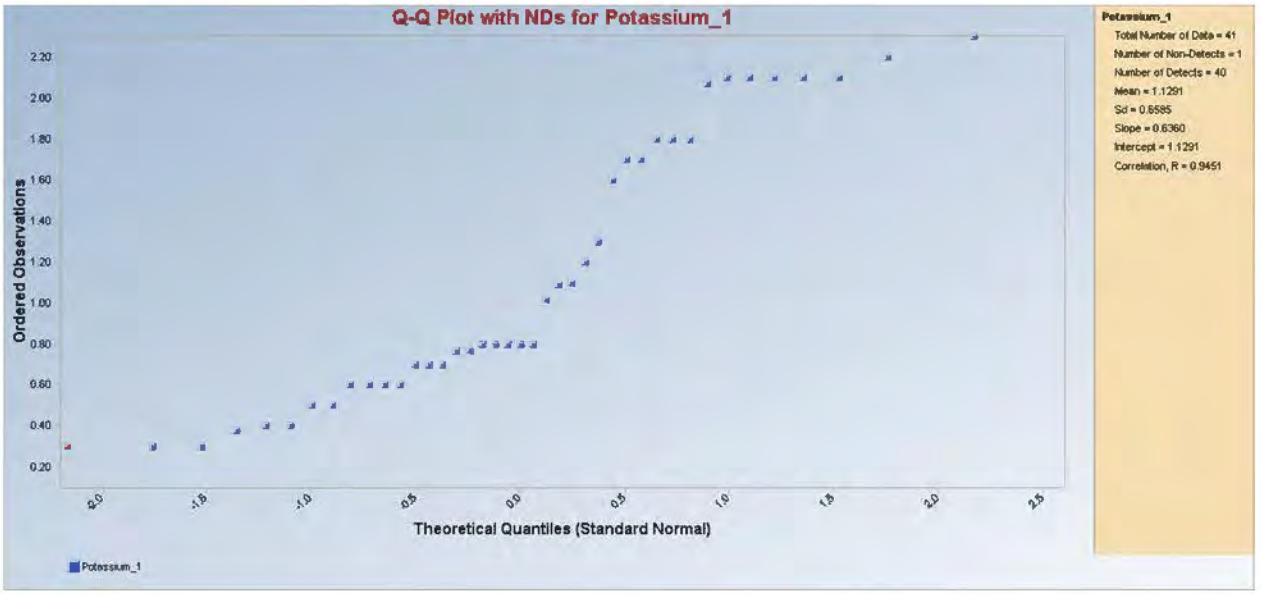

Q-Q Plot with NDs for Selenium
Ordered Observations
Theoretical Quantiles (Standard Normal)
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Selenium
Selenium
Total Number of Data = 45
Number of Non-Detects = 40
Number of Detects = 5
Mean = 0.0009
Sd = 0.0002
Slope = 0.0001
Intercept = 0.0009
Correlation, R = 0.6930


Q-Q Plot with NDs for Thallium
Ordered Observations
Theoretical Quantiles (Standard Normal)
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Thallium
Thallium
Total Number of Data = 15
Number of Non-Detects = 11
Number of Detects = 4
Mean = 0.0001
Sd = 0.0000
Slope = 0.0000
Intercept = 0.0001
Correlation, R = 0.5039

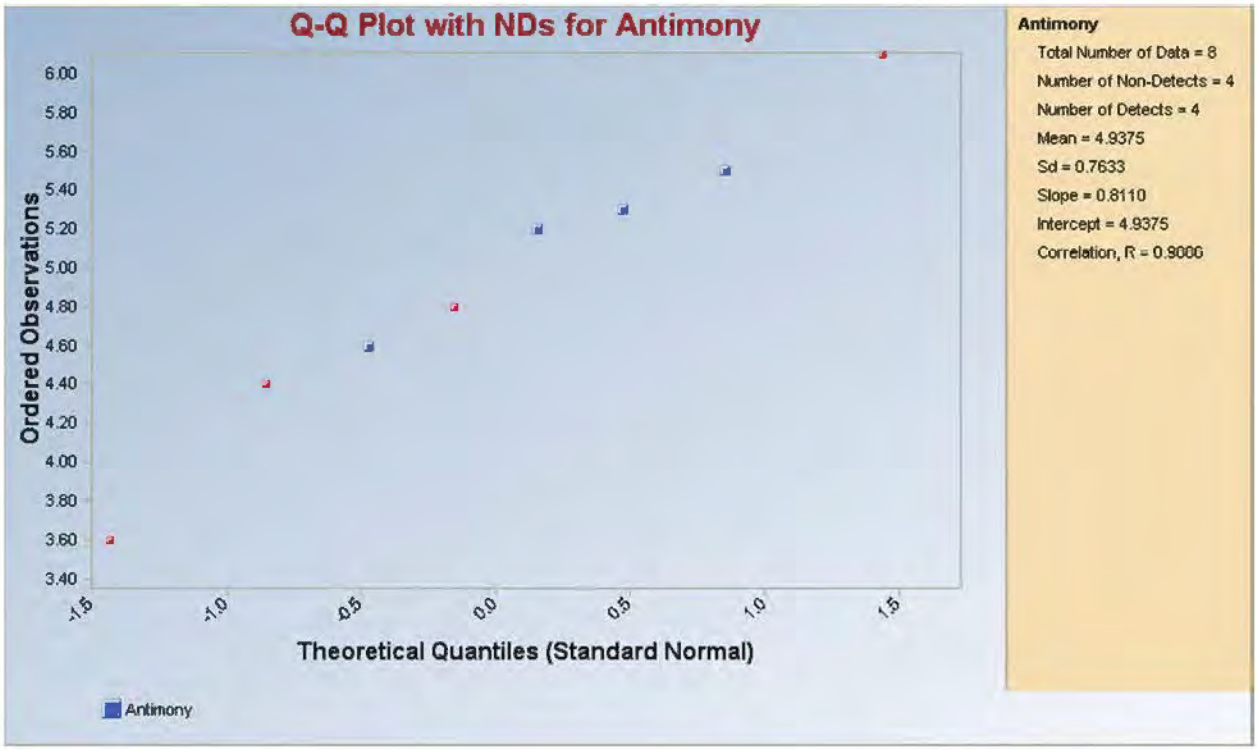

Q-Q Plot with NDs for Uranium
Ordered Observations
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Uranium
Uranium
Total Number of Data = 29
Number of Non-Detects = 4
Number of Detects = 25
Mean = 0.0004
Sd = 0.0003
Slope = 0.0003
Intercept = 0.0004
Correlation, R = 0.9487

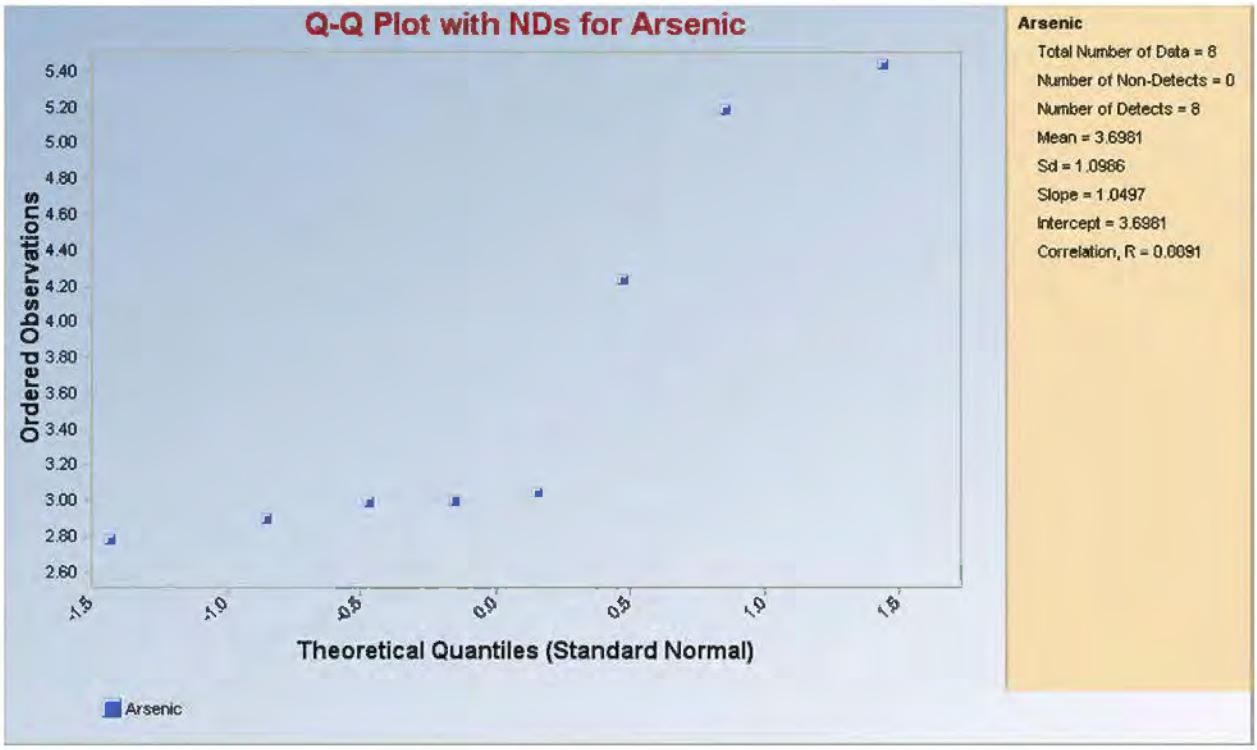

Q-Q Plot with NDs for Vanadium
Ordered Observations
0.03
0.02
0.01
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Vanadium
Vanadium
Total Number of Data = 46
Number of Non-Detects = 21
Number of Detects = 25
Mean = 0.0025
Sd = 0.0051
Slope = 0.0033
Intercept = 0.0025
Correlation, R = 0.6250

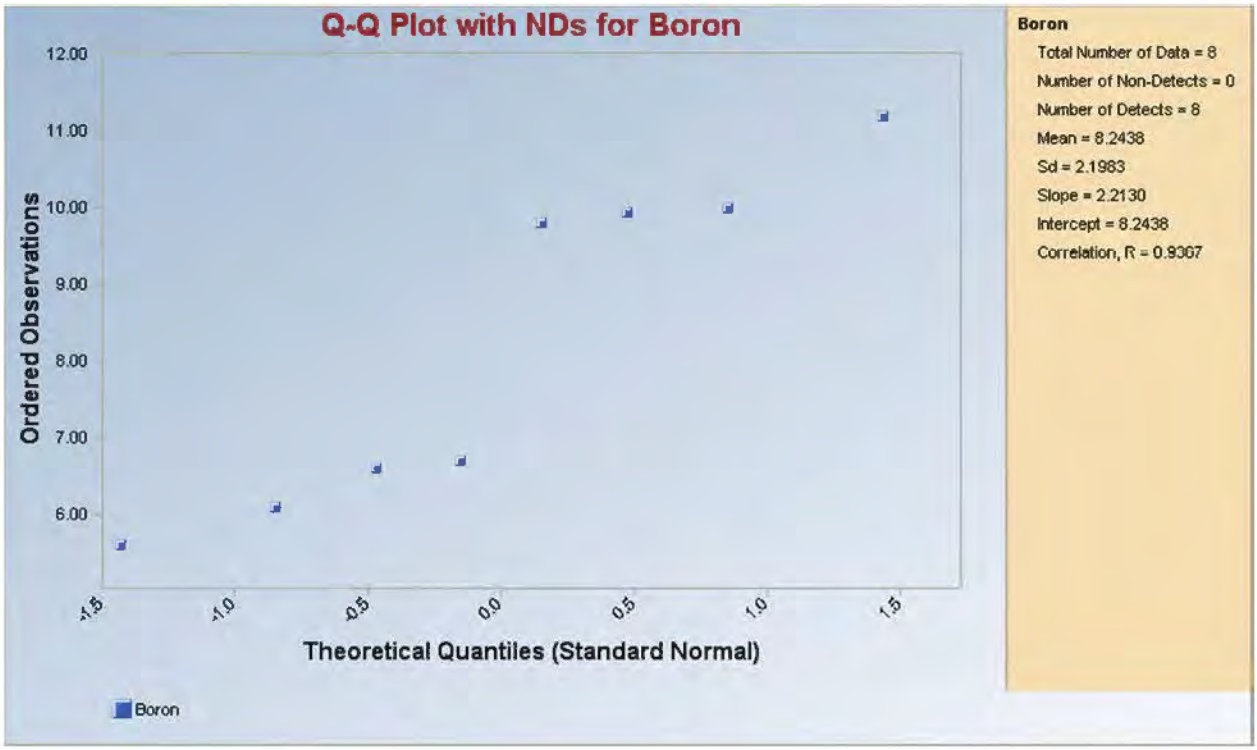

Q-Q Plot with NDs for Zinc
Ordered Observations
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Zinc
Zinc
Total Number of Data = 42
Number of Non-Detects = 22
Number of Detects = 20
Mean = 0.0063
Sd = 0.0095
Slope = 0.0061
Intercept = 0.0063
Correlation, R = 0.6292

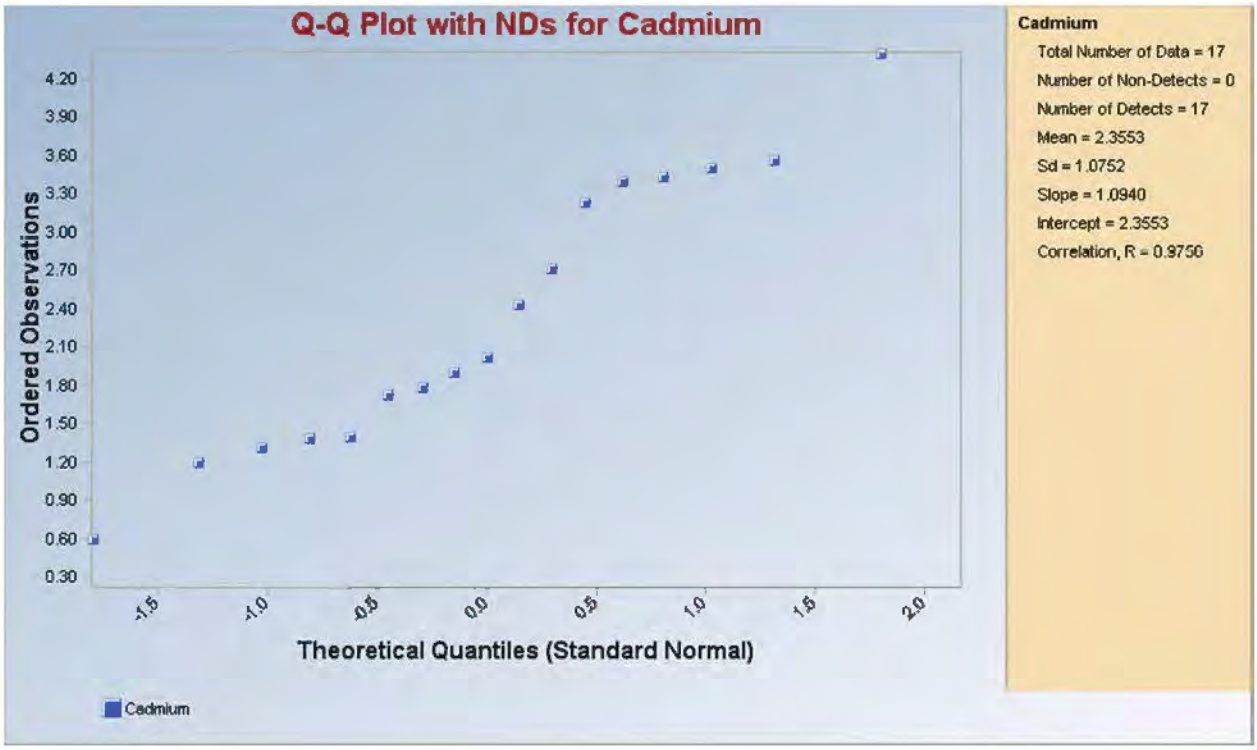

Q-Q Plot with NDs for Potassium_1
Ordered Observations
Theoretical Quantiles (Standard Normal)
Potassium_1
Potassium_1
Total Number of Data = 41
Number of Non-Detects = 1
Number of Detects = 40
Mean = 1.1291
Sd = 0.6585
Slope = 0.6360
Intercept = 1.1291
Correlation, R = 0.9451

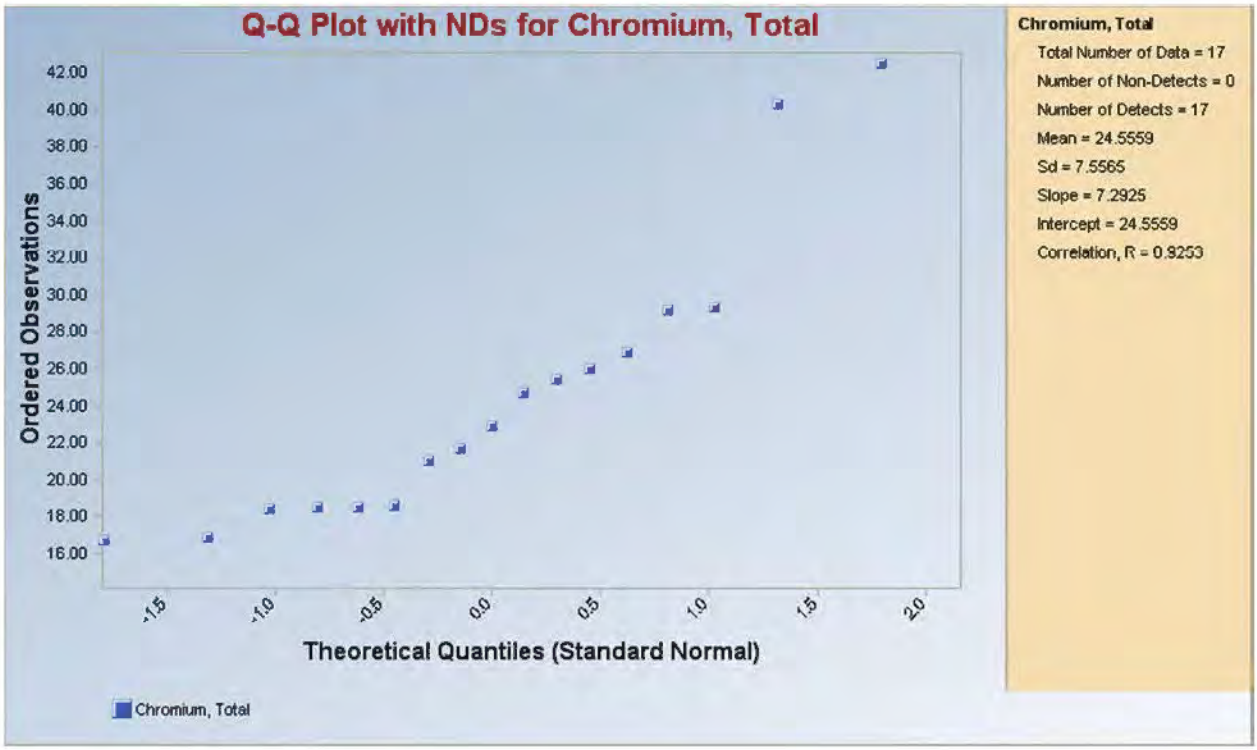
RIPARIAN SOIL – QQ PLOTS

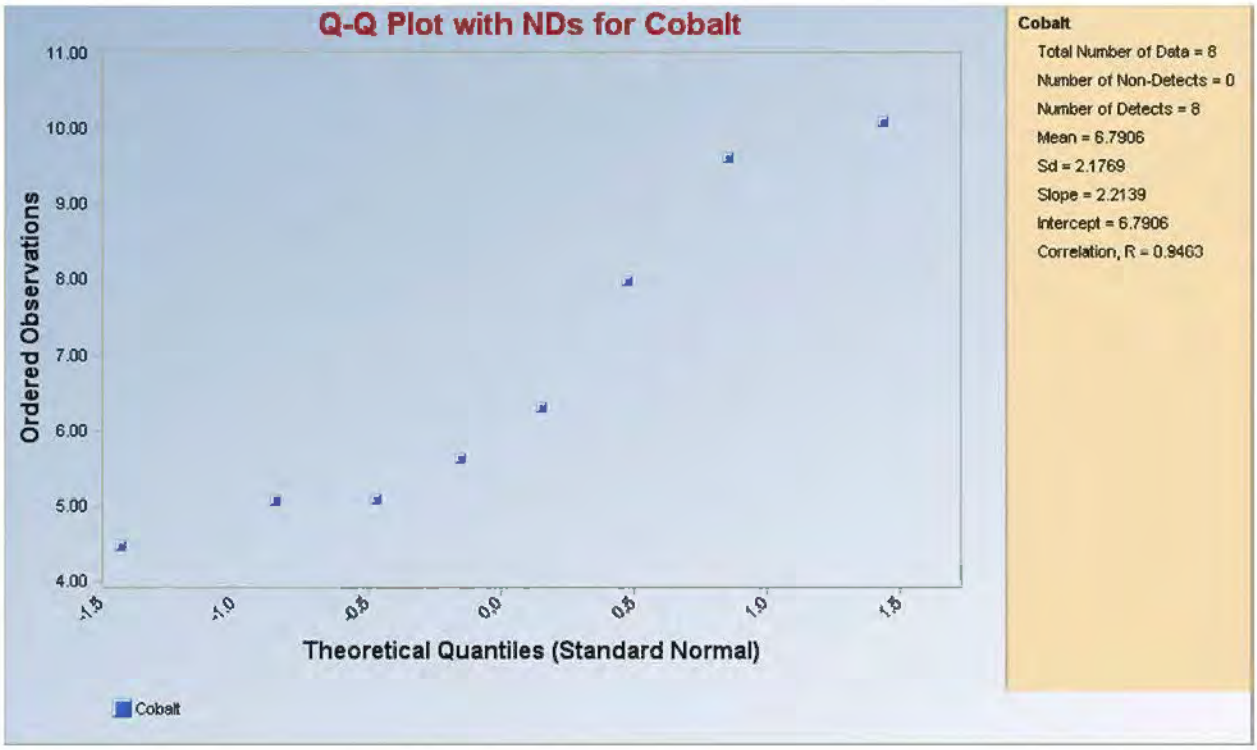

Q-Q Plot with NDs for Antimony
Ordered Observations
6.00
5.80
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Antimony
Antimony
Total Number of Data = 8
Number of Non-Detects = 4
Number of Detects = 4
Mean = 4.9375
Sd = 0.7633
Slope = 0.8110
Intercept = 4.9375
Correlation, R = 0.9006

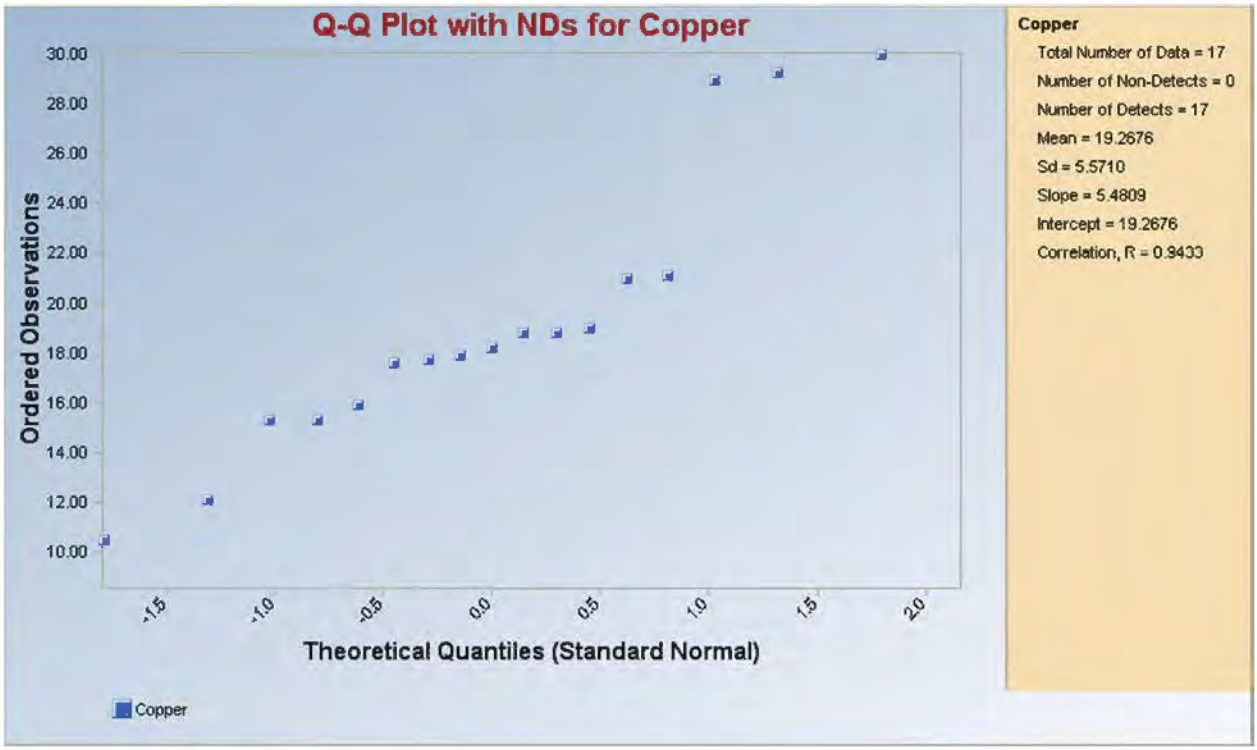

Q-Q Plot with NDs for Arsenic
Ordered Observations
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Arsenic
Arsenic
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 3.6981
Sd = 1.0986
Slope = 1.0497
Intercept = 3.6981
Correlation, R = 0.0091

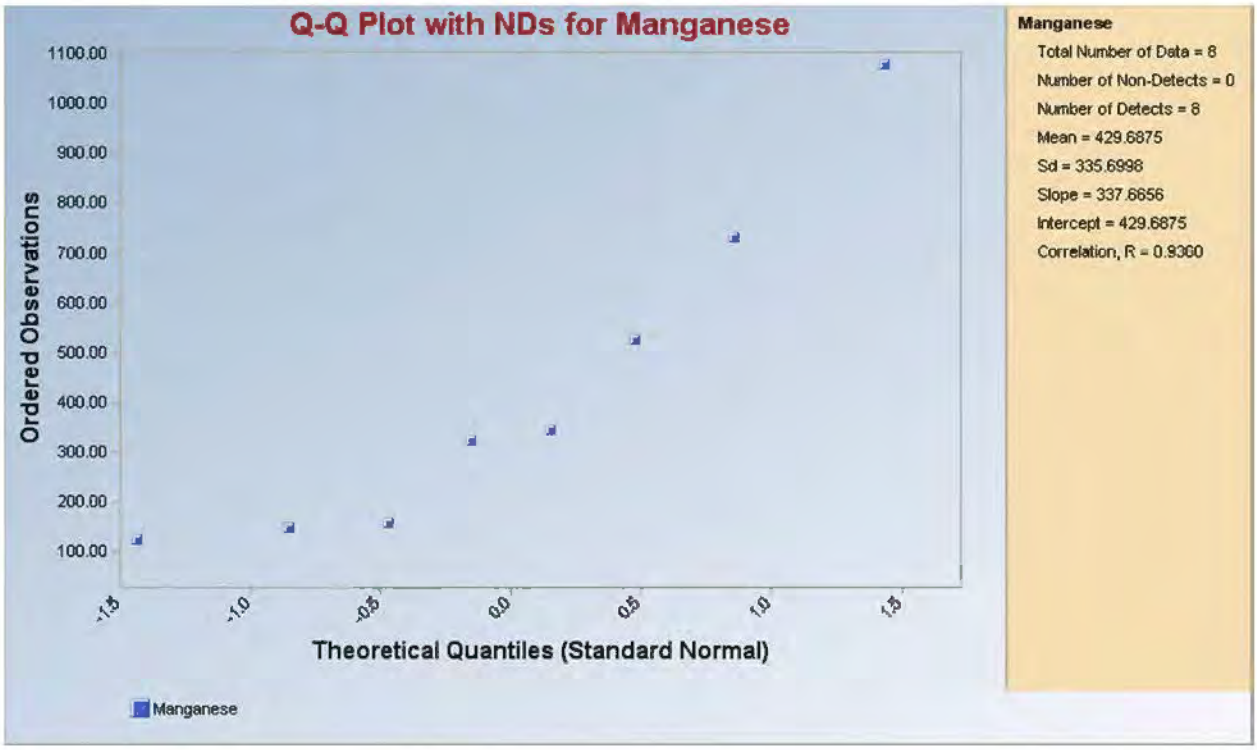

Q-Q Plot with NDs for Boron
Ordered Observations
12.00
11.00
10.00
9.00
8.00
7.00
6.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Boron
Boron
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 8.2438
Sd = 2.1983
Slope = 2.2130
Intercept = 8.2438
Correlation, R = 0.9367

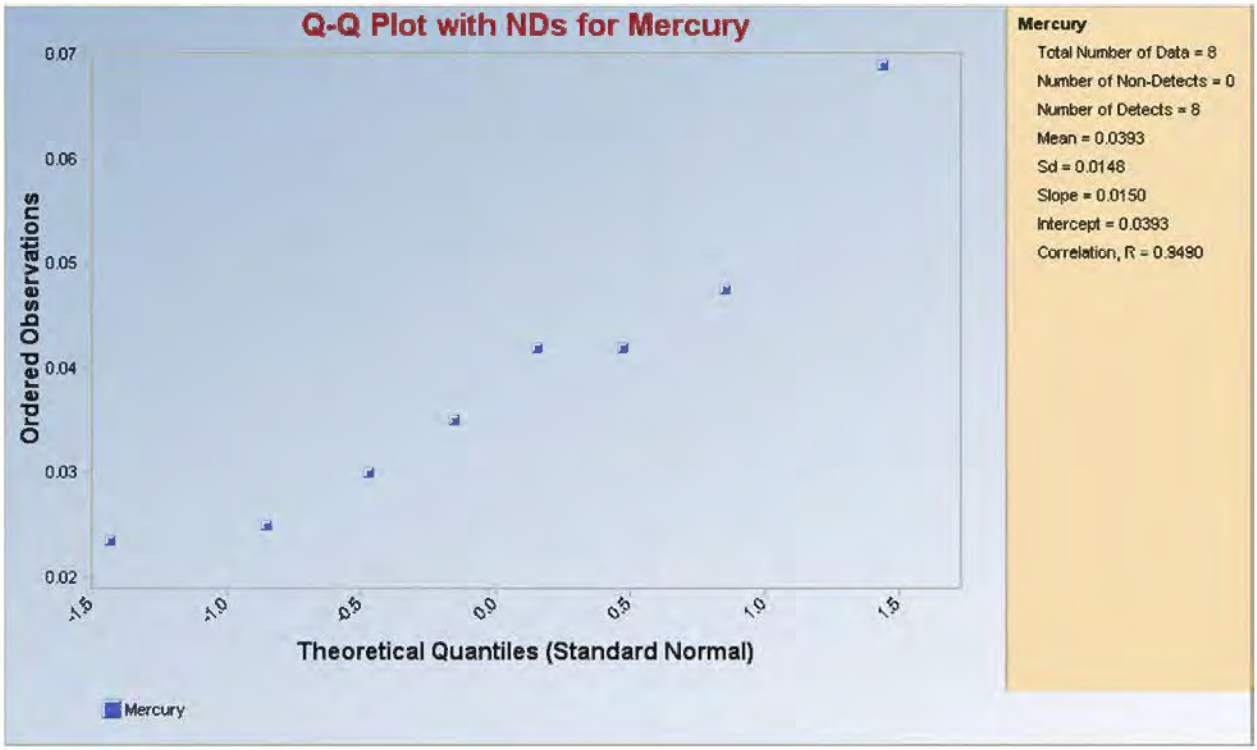

Q-Q Plot with NDs for Cadmium
Ordered Observations
4.20
3.90
3.60
3.30
3.00
2.70
2.40
2.10
1.80
1.50
1.20
0.90
0.60
0.30
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Cadmium
Cadmium
Total Number of Data = 17
Number of Non-Detects = 0
Number of Detects = 17
Mean = 2.3553
Sd = 1.0752
Slope = 1.0940
Intercept = 2.3553
Correlation, R = 0.9750

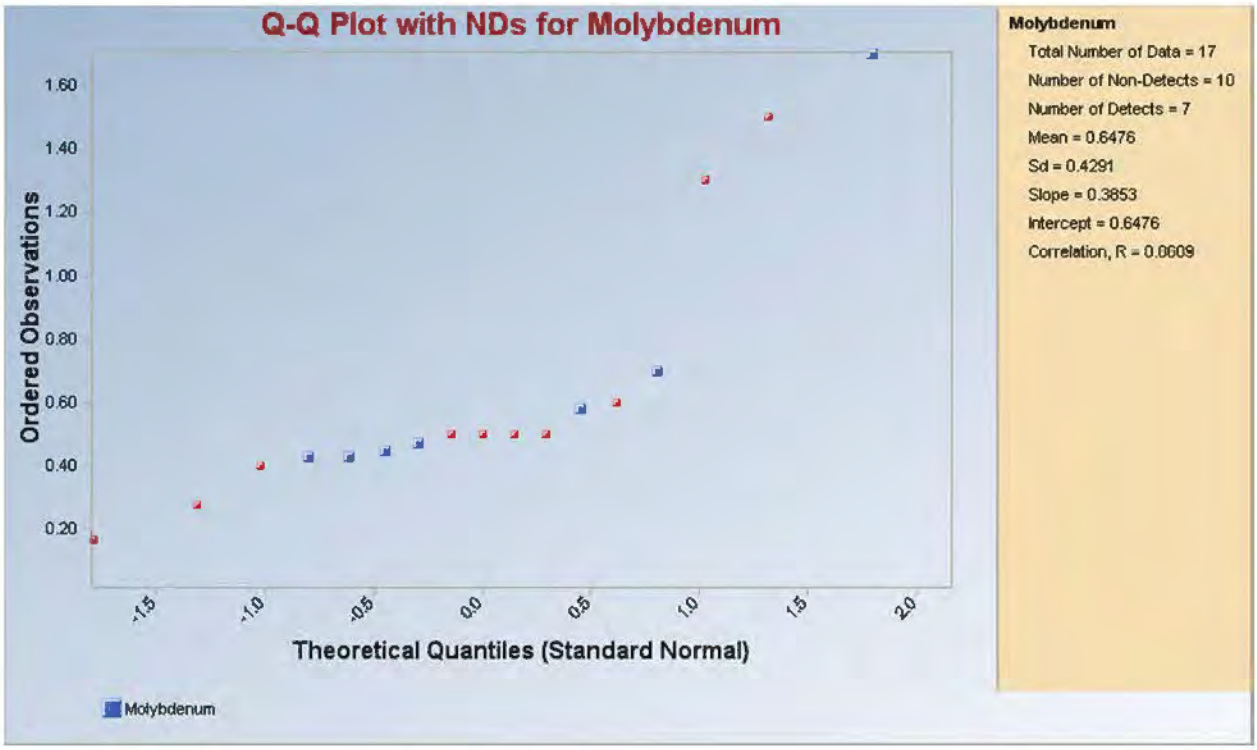

Q-Q Plot with NDs for Chromium, Total
Ordered Observations
42.00
40.00
38.00
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Chromium, Total
Chromium, Total
Total Number of Data = 17
Number of Non-Detects = 0
Number of Detects = 17
Mean = 24.5559
Sd = 7.5565
Slope = 7.2925
Intercept = 24.5559
Correlation, R = 0.9253

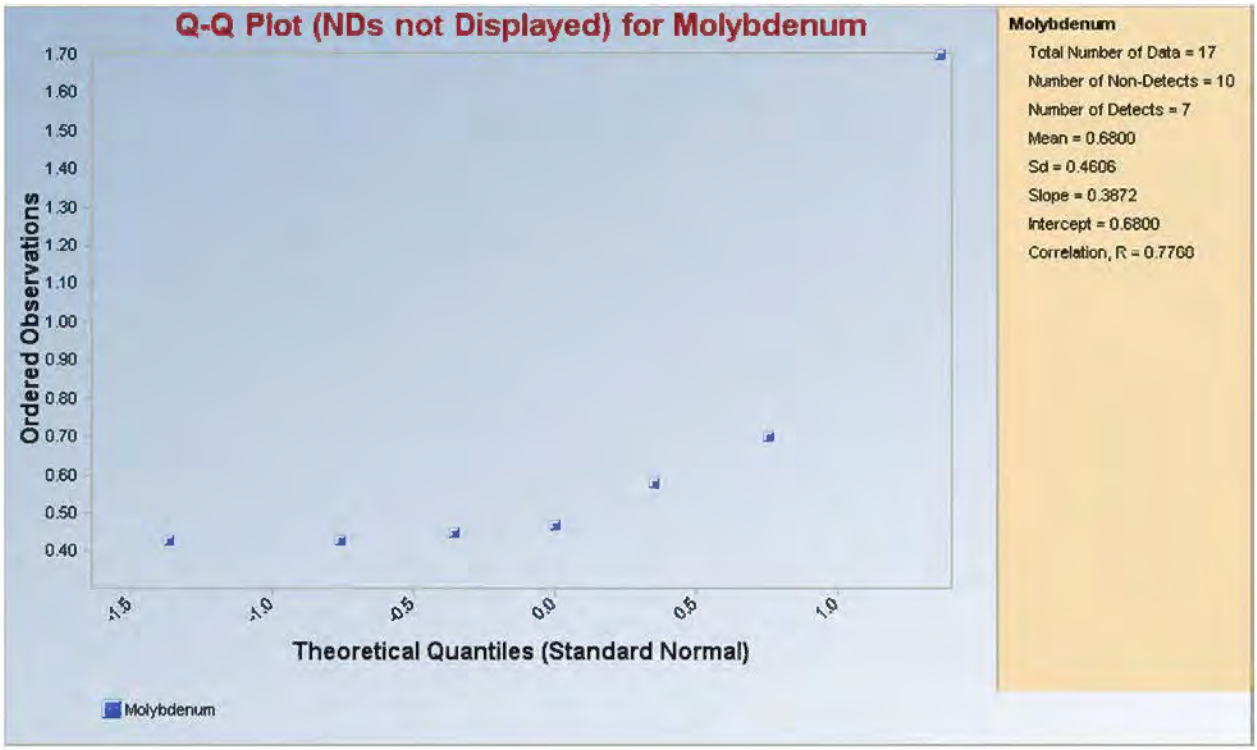

Q-Q Plot with NDs for Cobalt
Ordered Observations
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Cobalt
Cobalt
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 6.7906
Sd = 2.1769
Slope = 2.2139
Intercept = 6.7906
Correlation, R = 0.9463

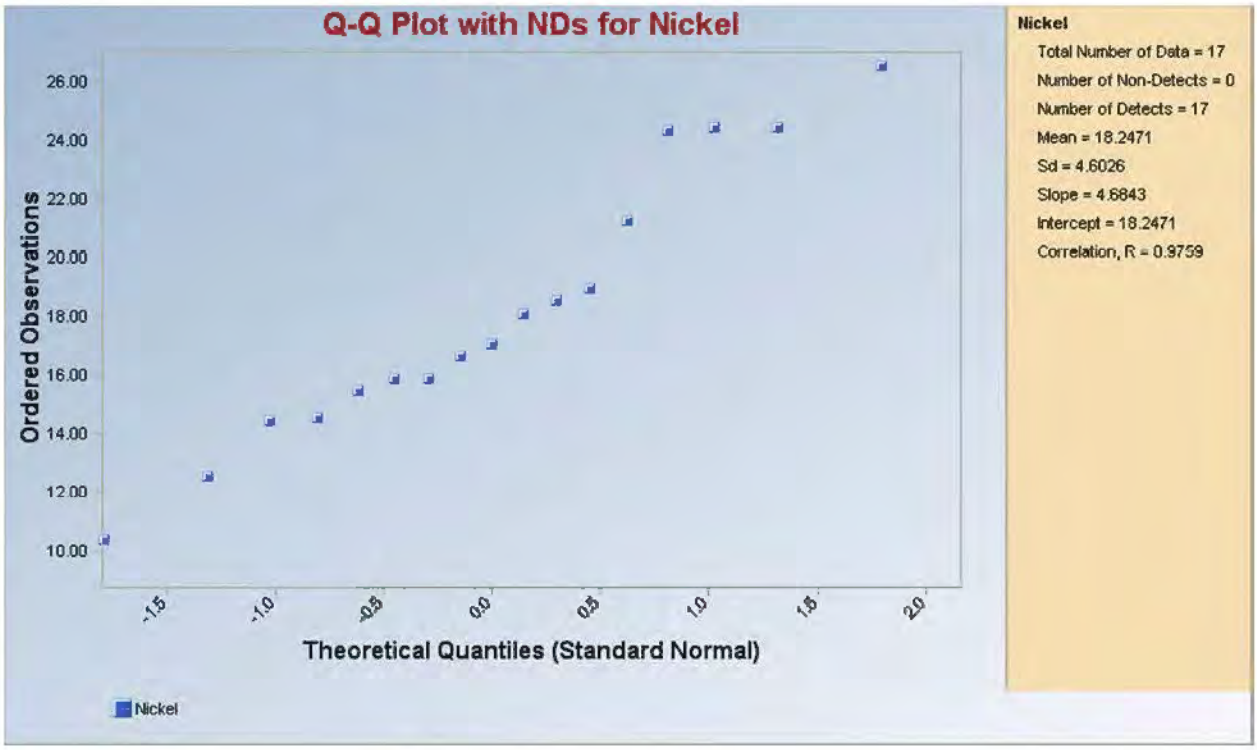

Q-Q Plot with NDs for Copper
Ordered Observations
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Copper
Copper
Total Number of Data = 17
Number of Non-Detects = 0
Number of Detects = 17
Mean = 19.2676
Sd = 5.5710
Slope = 5.4809
Intercept = 19.2676
Correlation, R = 0.9433

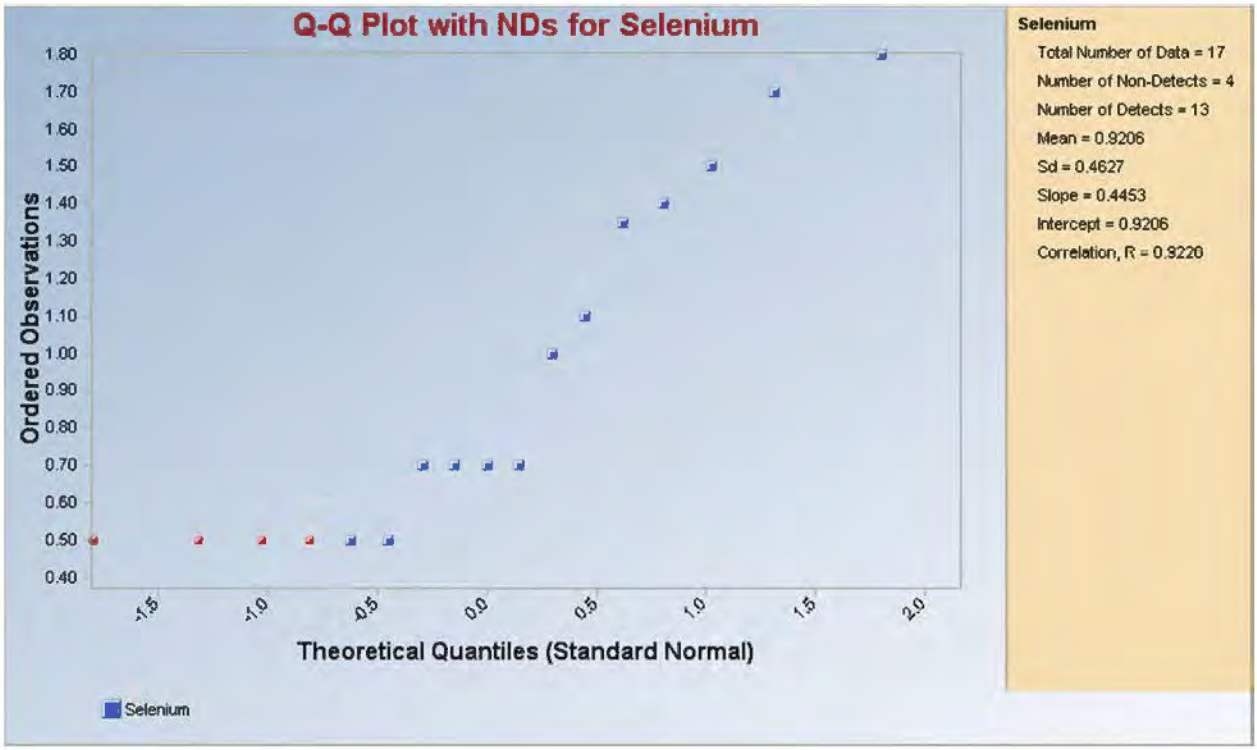

Q-Q Plot with NDs for Manganese
Ordered Observations
1100.00
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Manganese
Manganese
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 429.6875
Sd = 335.6998
Slope = 337.6656
Intercept = 429.6875
Correlation, R = 0.9360

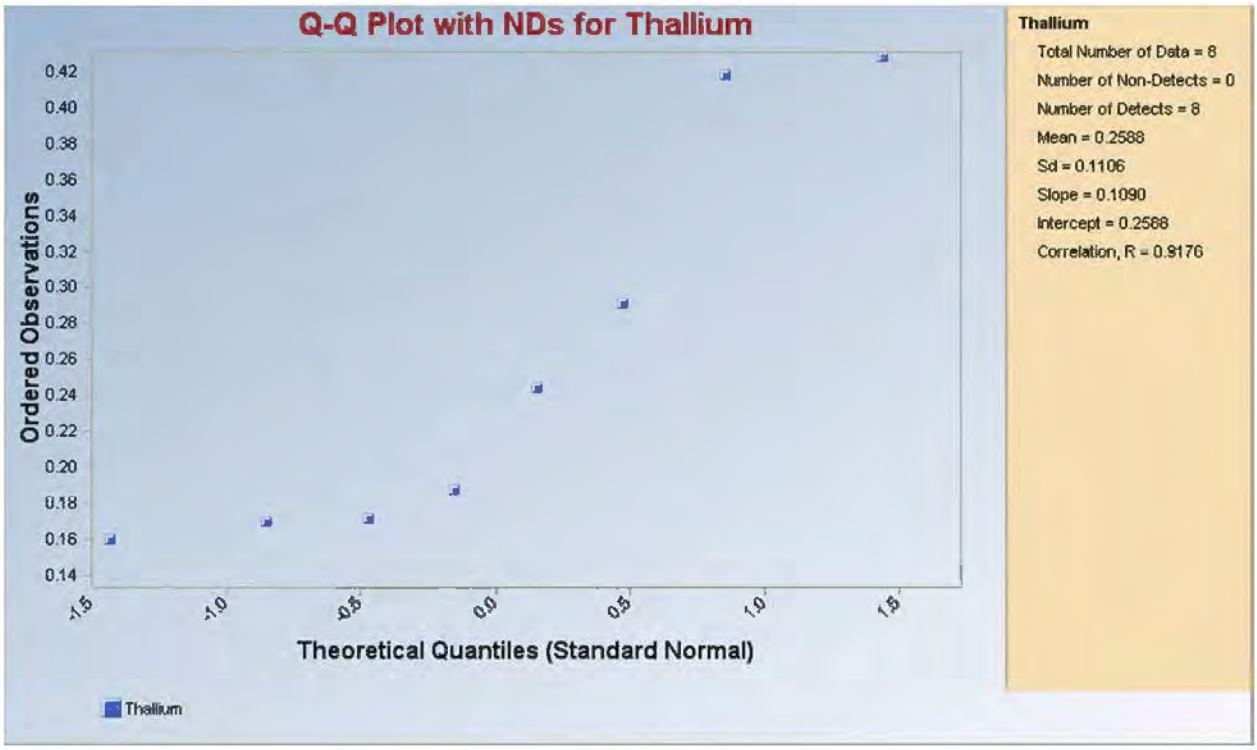

Q-Q Plot with NDs for Mercury
Ordered Observations
0.07
0.06
0.05
0.04
0.03
0.02
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Mercury
Mercury
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 0.0393
Sd = 0.0148
Slope = 0.0150
Intercept = 0.0393
Correlation, R = 0.9490

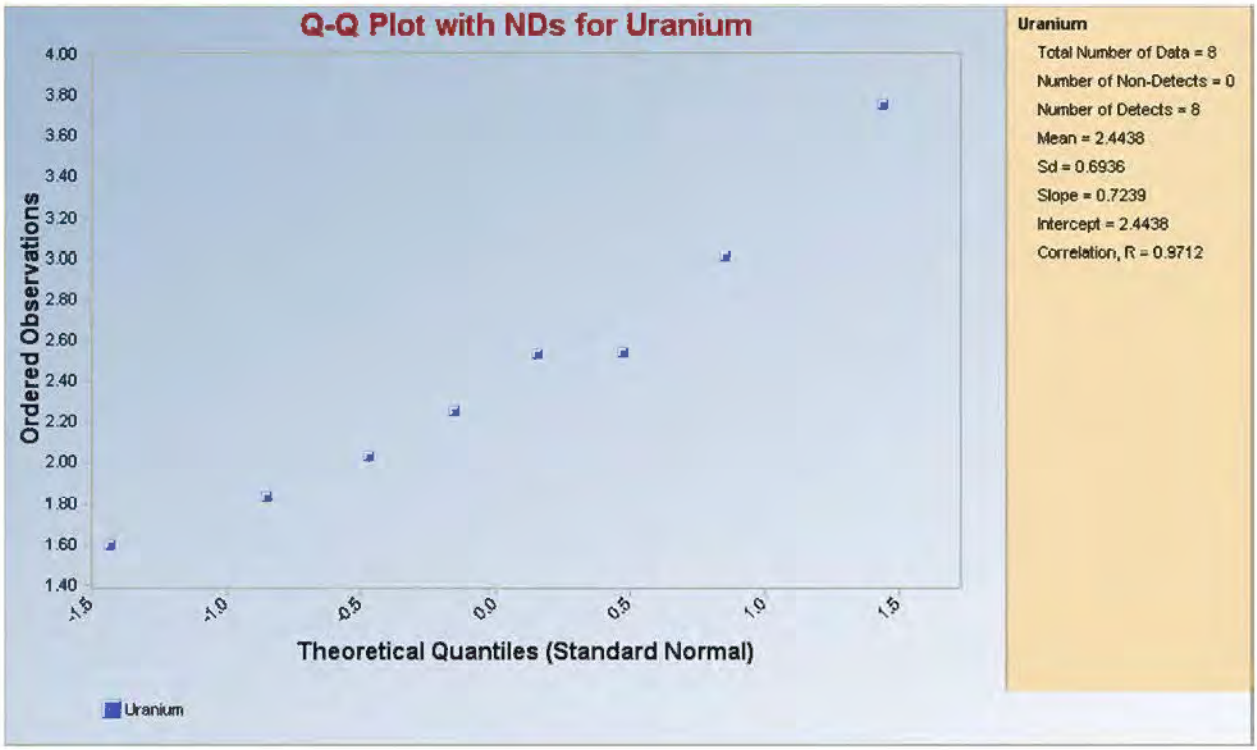

Q-Q Plot with NDs for Molybdenum
Ordered Observations
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 17
Number of Non-Detects = 10
Number of Detects = 7
Mean = 0.6476
Sd = 0.4291
Slope = 0.3853
Intercept = 0.6476
Correlation, R = 0.0609

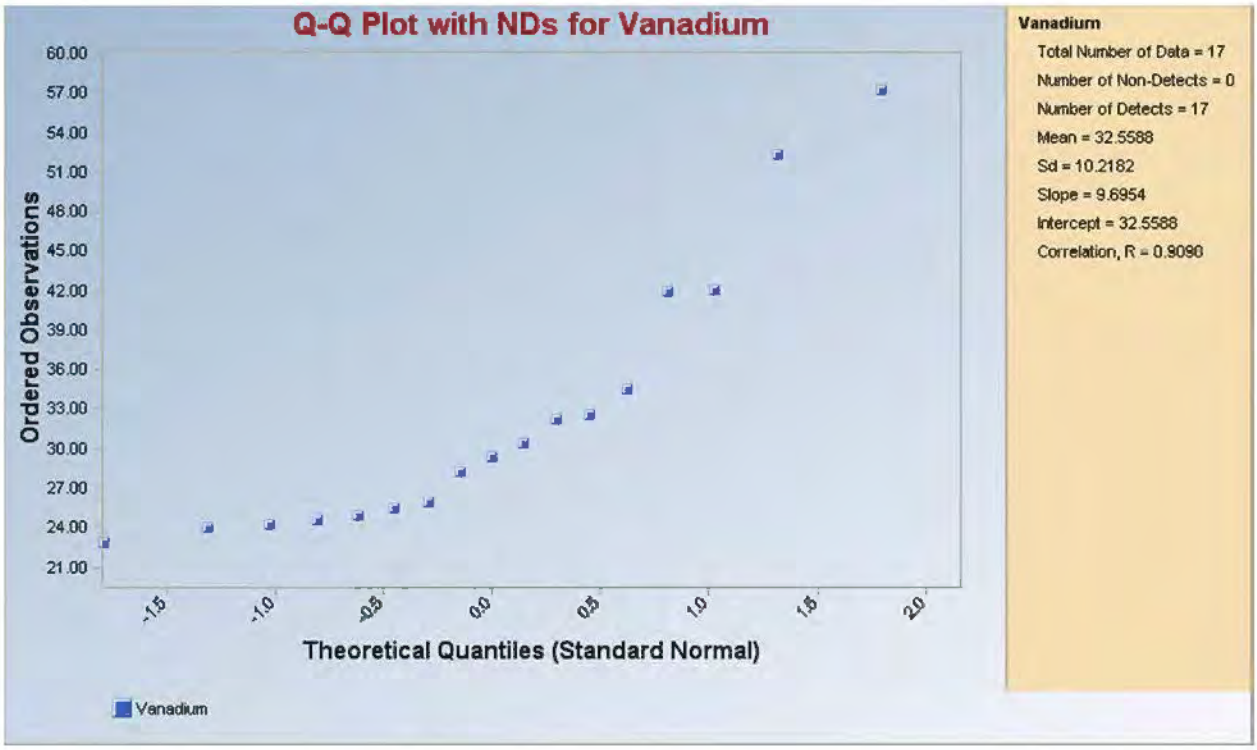

Q-Q Plot (NDs not Displayed) for Molybdenum
Ordered Observations
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
-1.5
-1.0
-0.5
0.0
0.5
1.0
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 17
Number of Non-Detects = 10
Number of Detects = 7
Mean = 0.6800
Sd = 0.4606
Slope = 0.3872
Intercept = 0.6800
Correlation, R = 0.7760

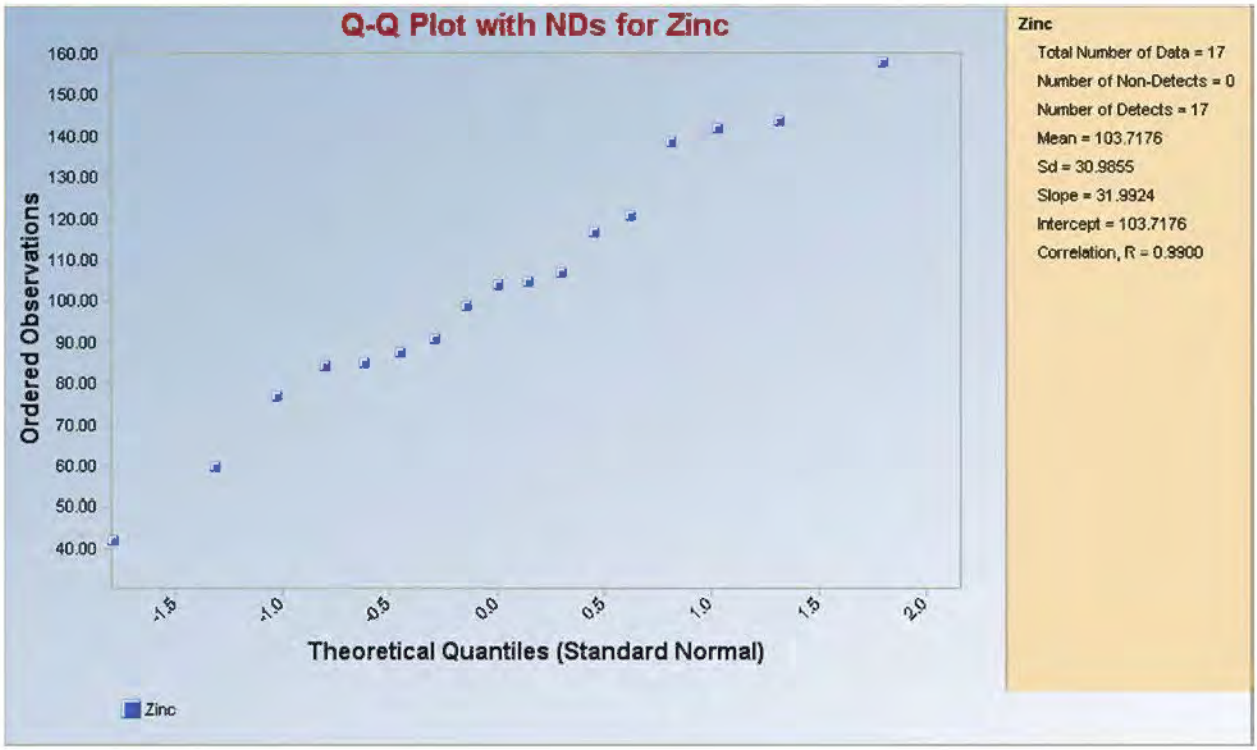

Q-Q Plot with NDs for Nickel
Ordered Observations
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Nickel
Nickel
Total Number of Data = 17
Number of Non-Detects = 0
Number of Detects = 17
Mean = 18.2471
Sd = 4.6026
Slope = 4.6843
Intercept = 18.2471
Correlation, R = 0.9759


Q-Q Plot with NDs for Selenium
Ordered Observations
Theoretical Quantiles (Standard Normal)
Selenium
Selenium
Total Number of Data = 17
Number of Non-Detects = 4
Number of Detects = 13
Mean = 0.9206
Sd = 0.4627
Slope = 0.4453
Intercept = 0.9206
Correlation, R = 0.9220

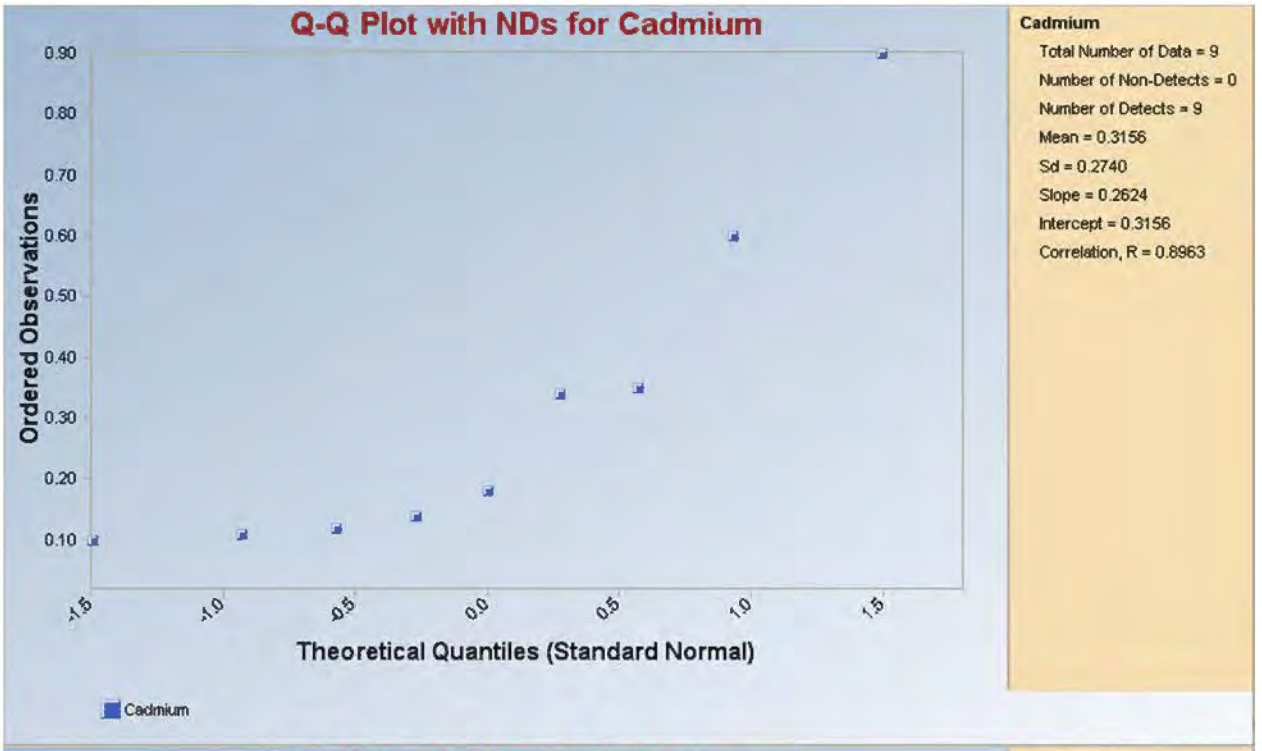

Q-Q Plot with NDs for Thallium
Ordered Observations
Theoretical Quantiles (Standard Normal)
Thallium
Thallium
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 0.2588
Sd = 0.1106
Slope = 0.1090
Intercept = 0.2588
Correlation, R = 0.9176

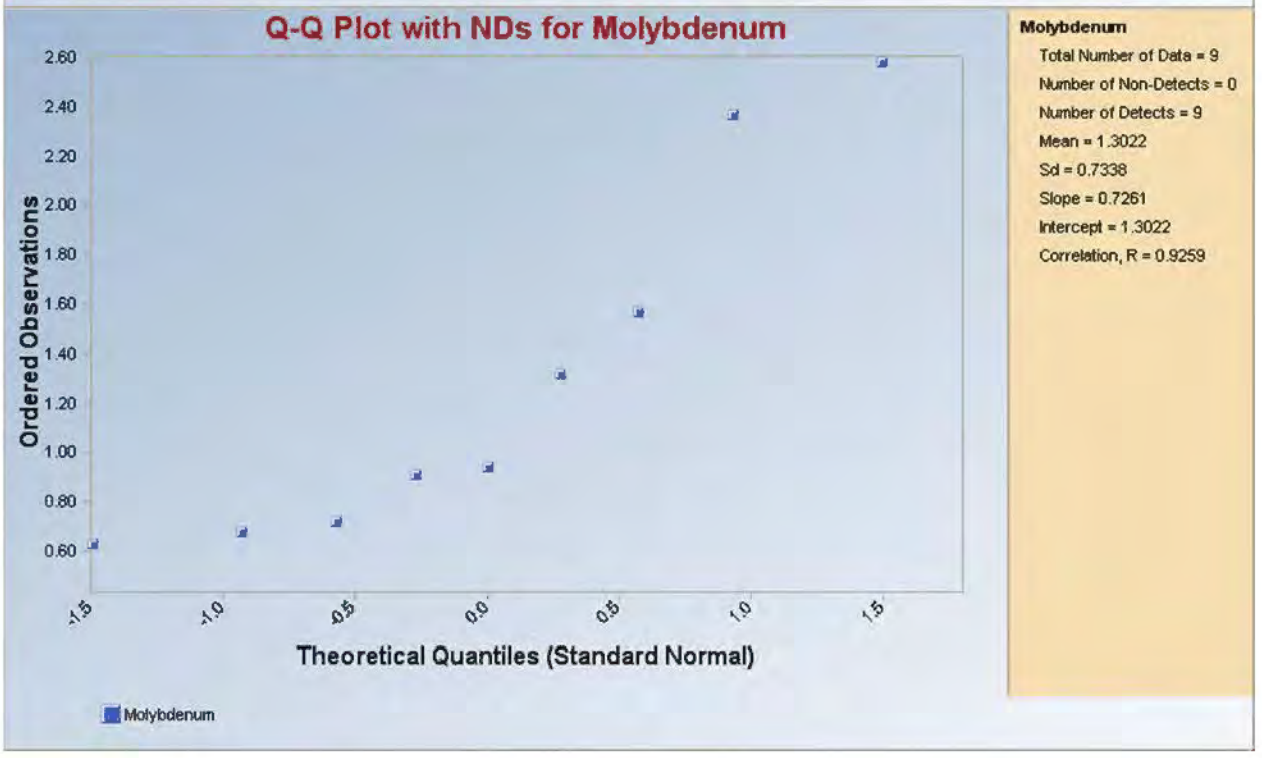

Q-Q Plot with NDs for Uranium
Ordered Observations
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Uranium
Uranium
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 2.4438
Sd = 0.6936
Slope = 0.7239
Intercept = 2.4438
Correlation, R = 0.9712


Q-Q Plot with NDs for Vanadium
Ordered Observations
60.00
57.00
54.00
51.00
48.00
45.00
42.00
39.00
36.00
33.00
30.00
27.00
24.00
21.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Vanadium
Vanadium
Total Number of Data = 17
Number of Non-Detects = 0
Number of Detects = 17
Mean = 32.5588
Sd = 10.2182
Slope = 9.6954
Intercept = 32.5588
Correlation, R = 0.9090

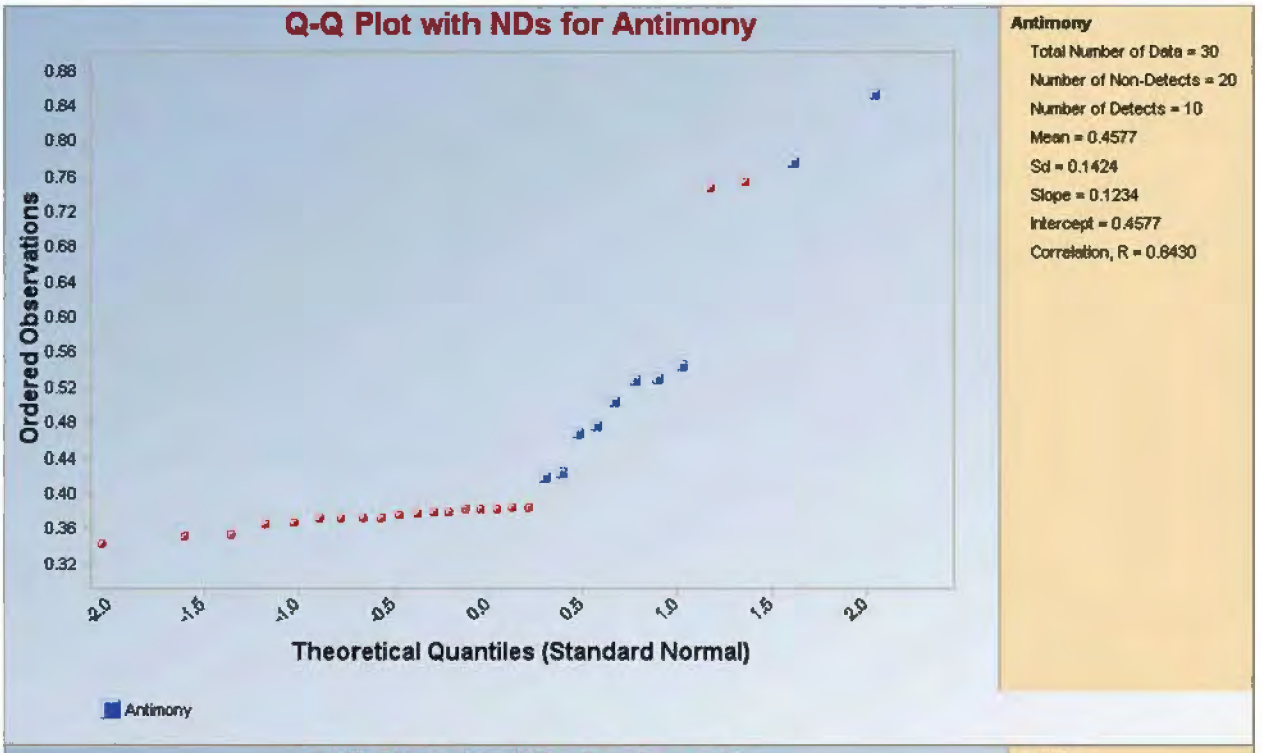

Q-Q Plot with NDs for Zinc
Ordered Observations
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Zinc
Zinc
Total Number of Data = 17
Number of Non-Detects = 0
Number of Detects = 17
Mean = 103.7176
Sd = 30.9855
Slope = 31.9924
Intercept = 103.7176
Correlation, R = 0.9900

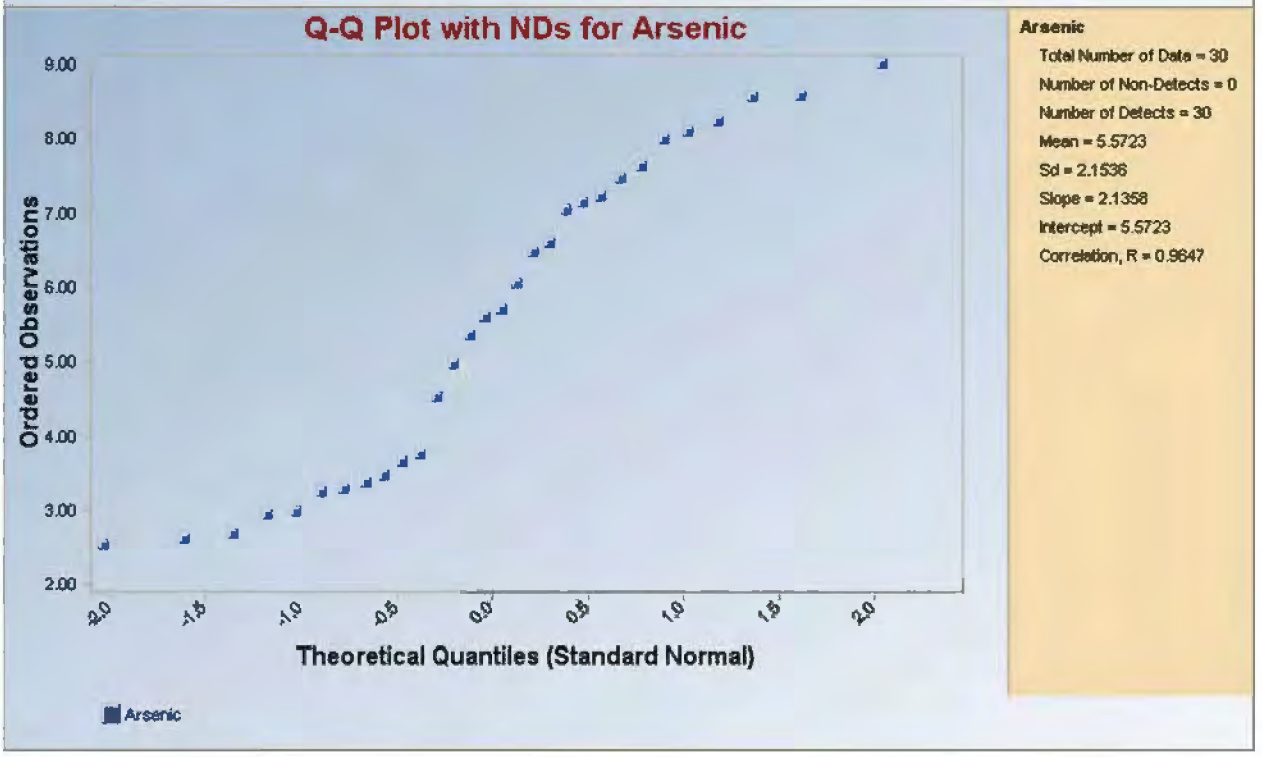
RIPARIAN VEGETATION – QQ PLOTS

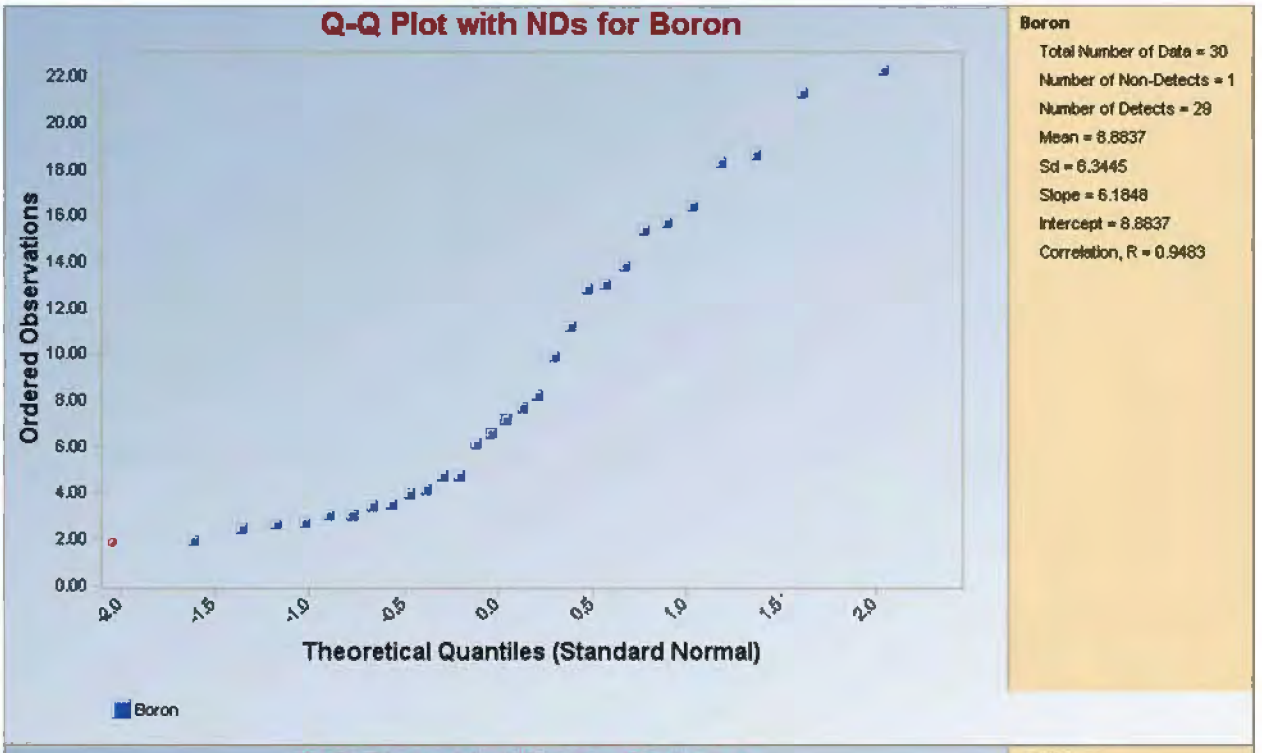

Q-Q Plot with NDs for Cadmium
Ordered Observations
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Cadmium
Cadmium
Total Number of Data = 9
Number of Non-Detects = 0
Number of Detects = 9
Mean = 0.3156
Sd = 0.2740
Slope = 0.2624
Intercept = 0.3156
Correlation, R = 0.8963

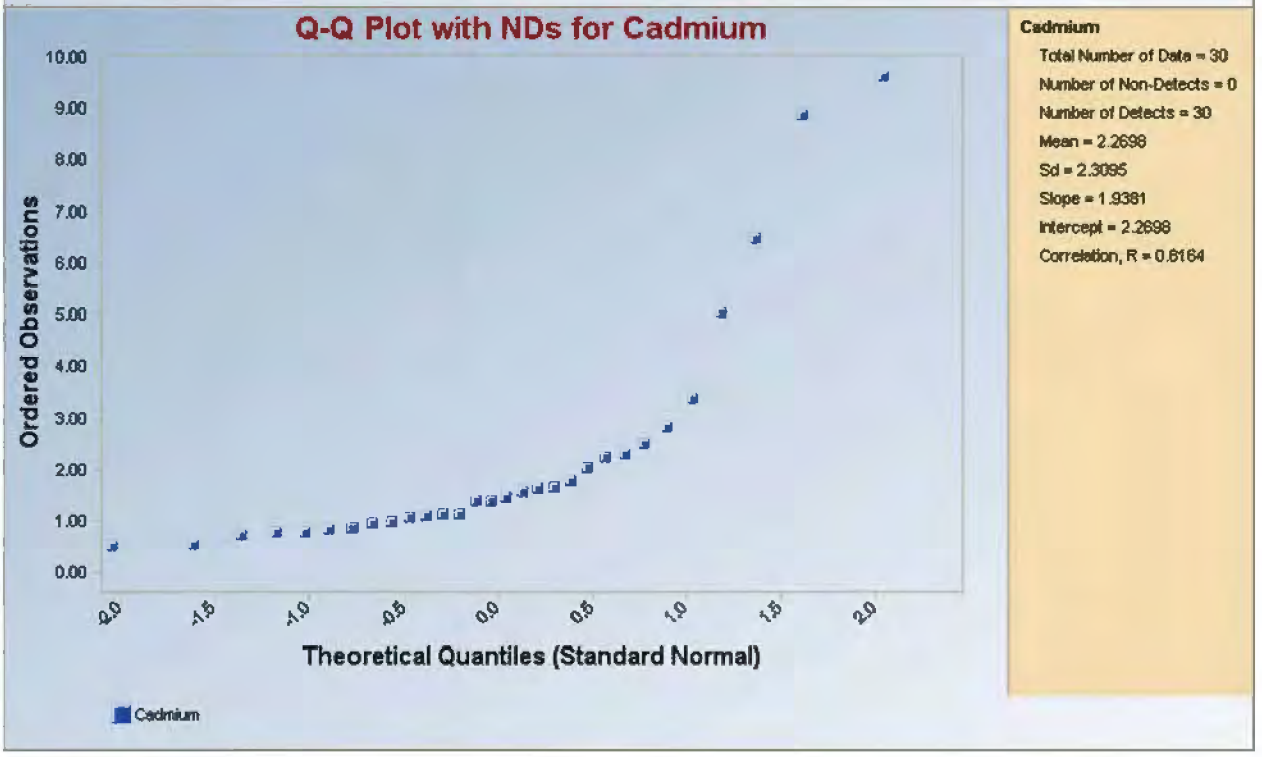

Q-Q Plot with NDs for Molybdenum
Ordered Observations
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 9
Number of Non-Detects = 0
Number of Detects = 9
Mean = 1.3022
Sd = 0.7338
Slope = 0.7261
Intercept = 1.3022
Correlation, R = 0.9259

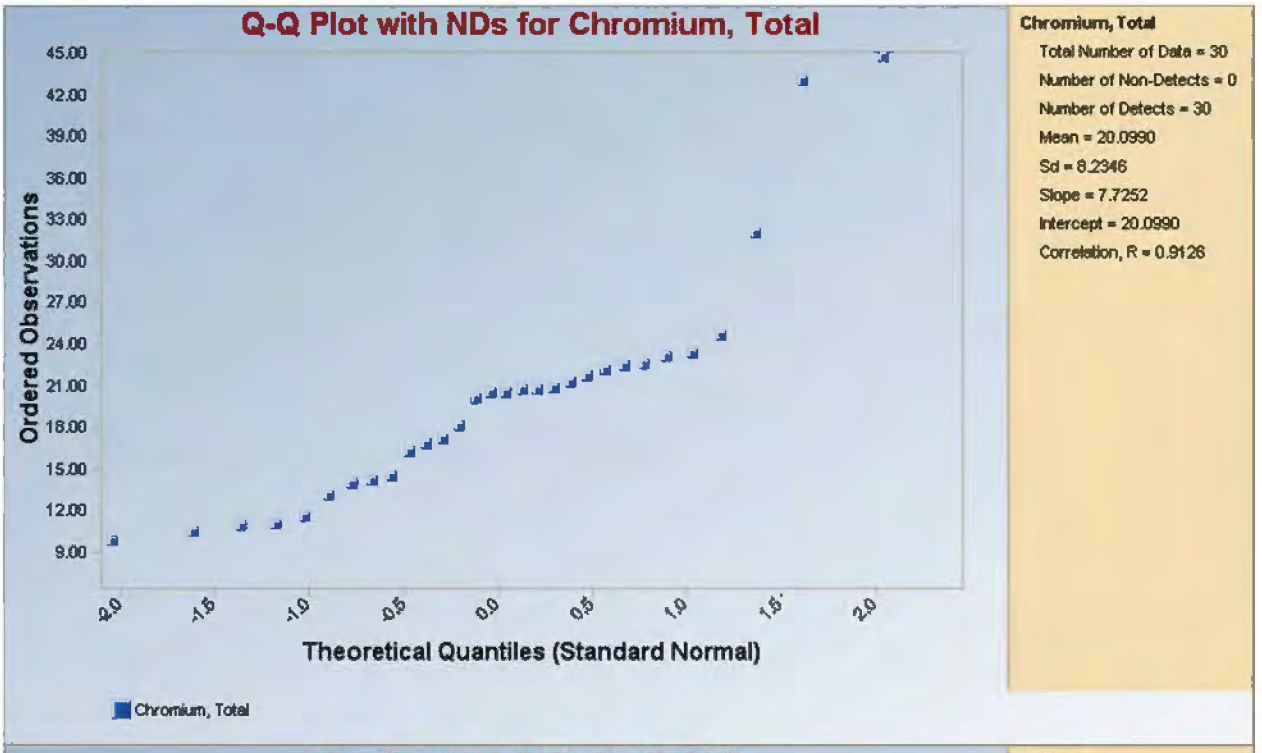
UPLAND SOIL – QQ PLOTS

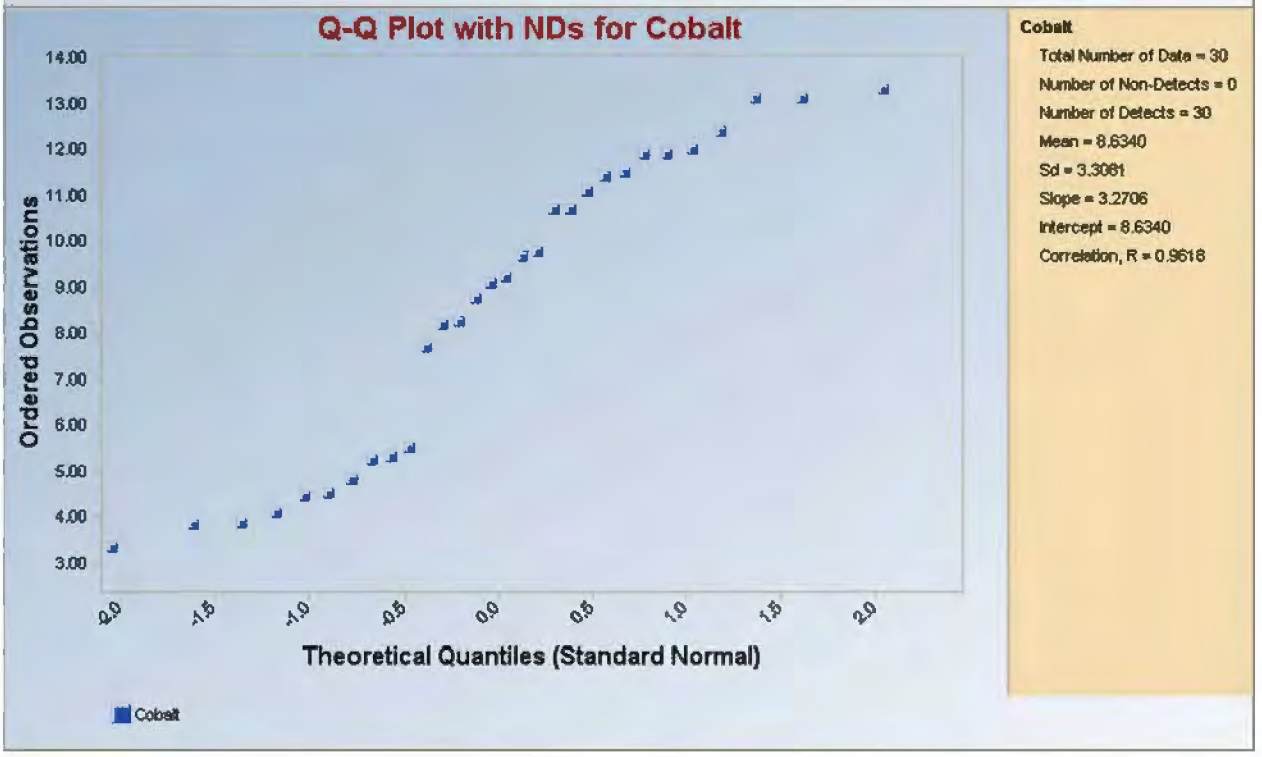

Q-Q Plot with NDs for Antimony
Ordered Observations
0.88
0.84
0.80
0.76
0.72
0.68
0.64
0.60
0.56
0.52
0.48
0.44
0.40
0.36
0.32
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Antimony
Antimony
Total Number of Data = 30
Number of Non-Detects = 20
Number of Detects = 10
Mean = 0.4577
Sd = 0.1424
Slope = 0.1234
Intercept = 0.4577
Correlation, R = 0.8430

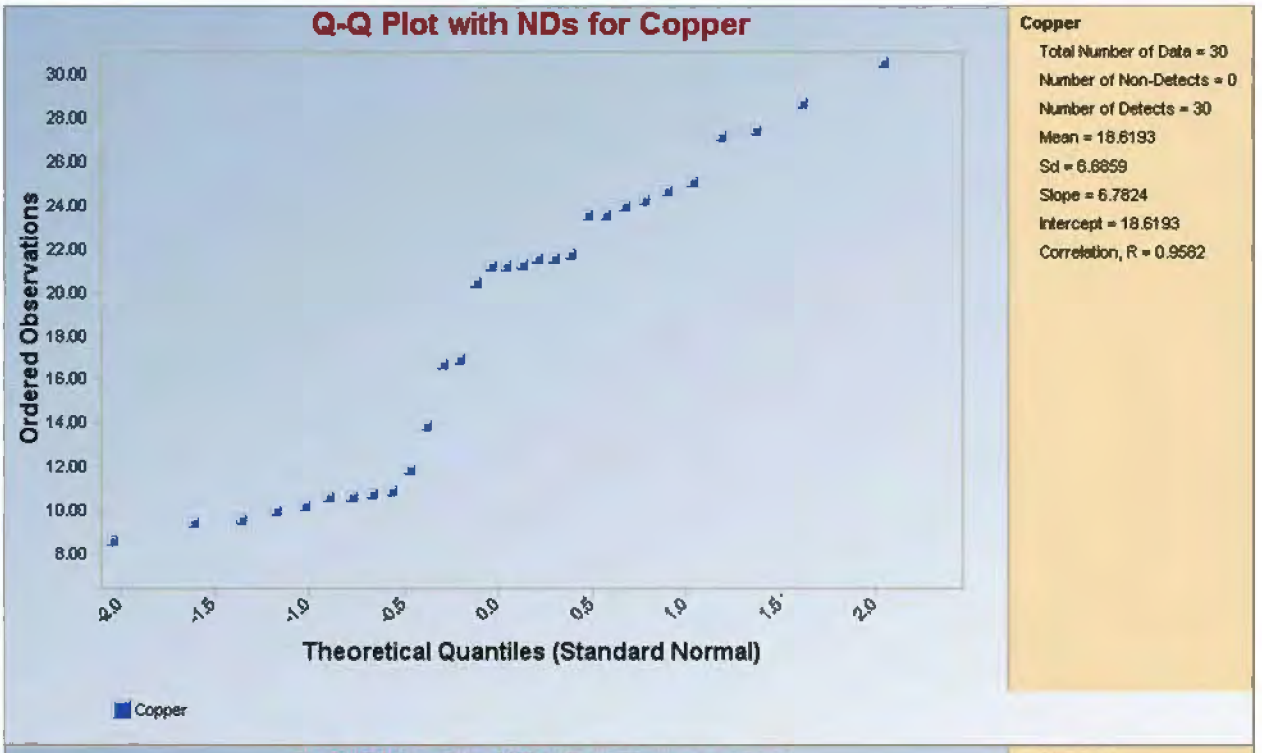

Q-Q Plot with NDs for Arsenic
Ordered Observations
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Arsenic
Arsenic
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 5.5723
Sd = 2.1536
Slope = 2.1358
Intercept = 5.5723
Correlation, R = 0.9647

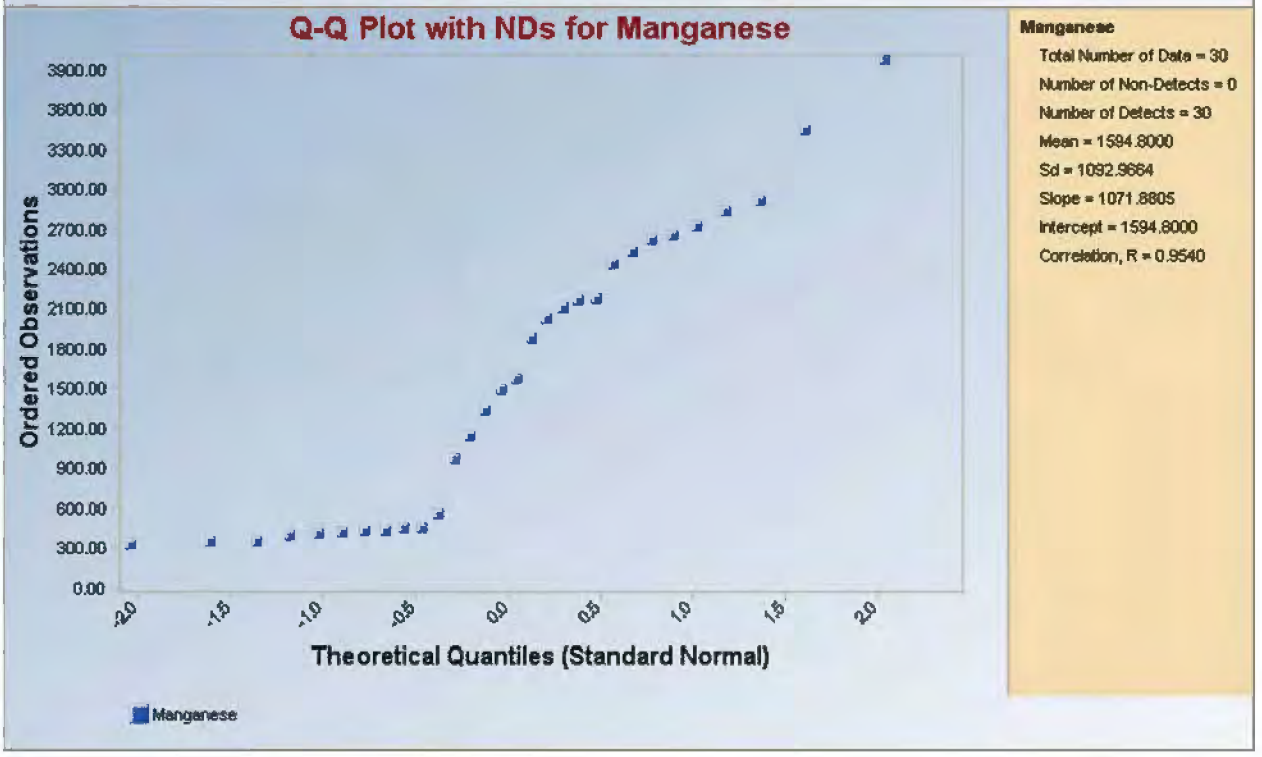

Q-Q Plot with NDs for Boron
Ordered Observations
Theoretical Quantiles (Standard Normal)
Boron
Total Number of Data = 30
Number of Non-Detects = 1
Number of Detects = 29
Mean = 8.8837
Sd = 6.3445
Slope = 6.1848
Intercept = 8.8837
Correlation, R = 0.9483

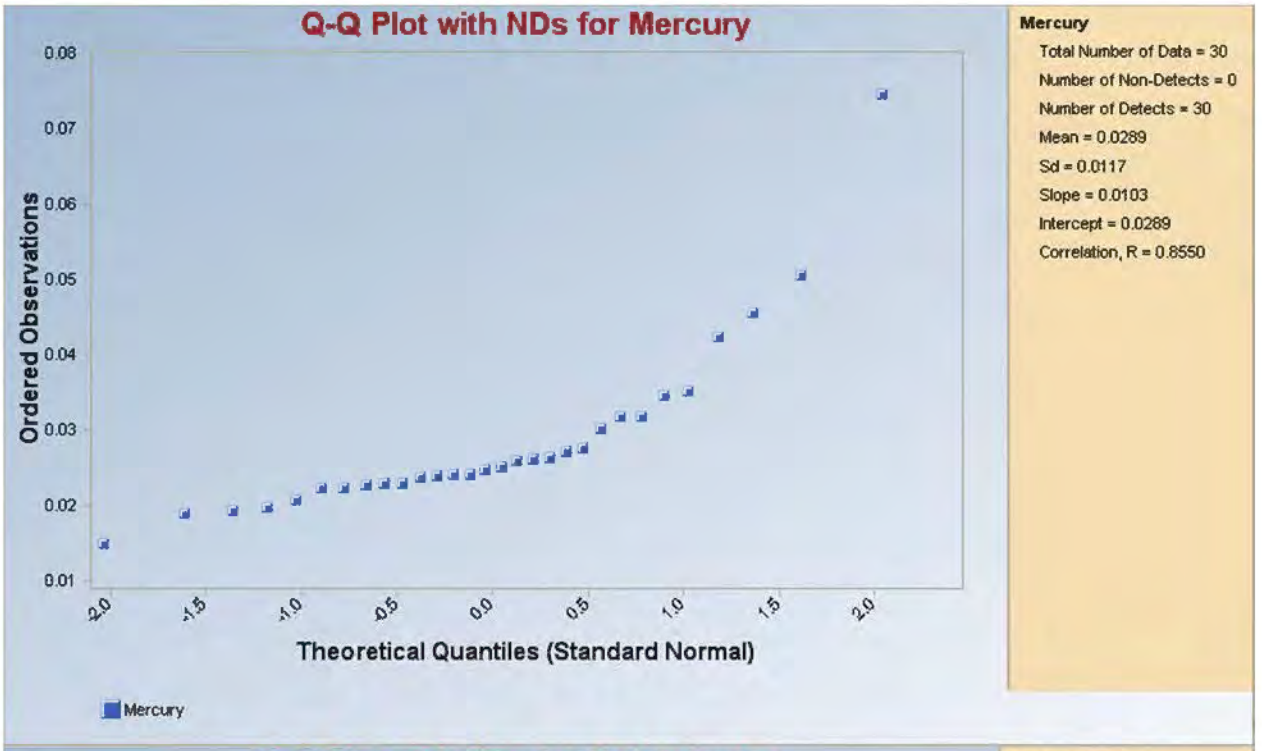

Q-Q Plot with NDs for Cadmium
Ordered Observations
Theoretical Quantiles (Standard Normal)
Cadmium
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 2.2698
Sd = 2.3095
Slope = 1.9381
Intercept = 2.2698
Correlation, R = 0.6164

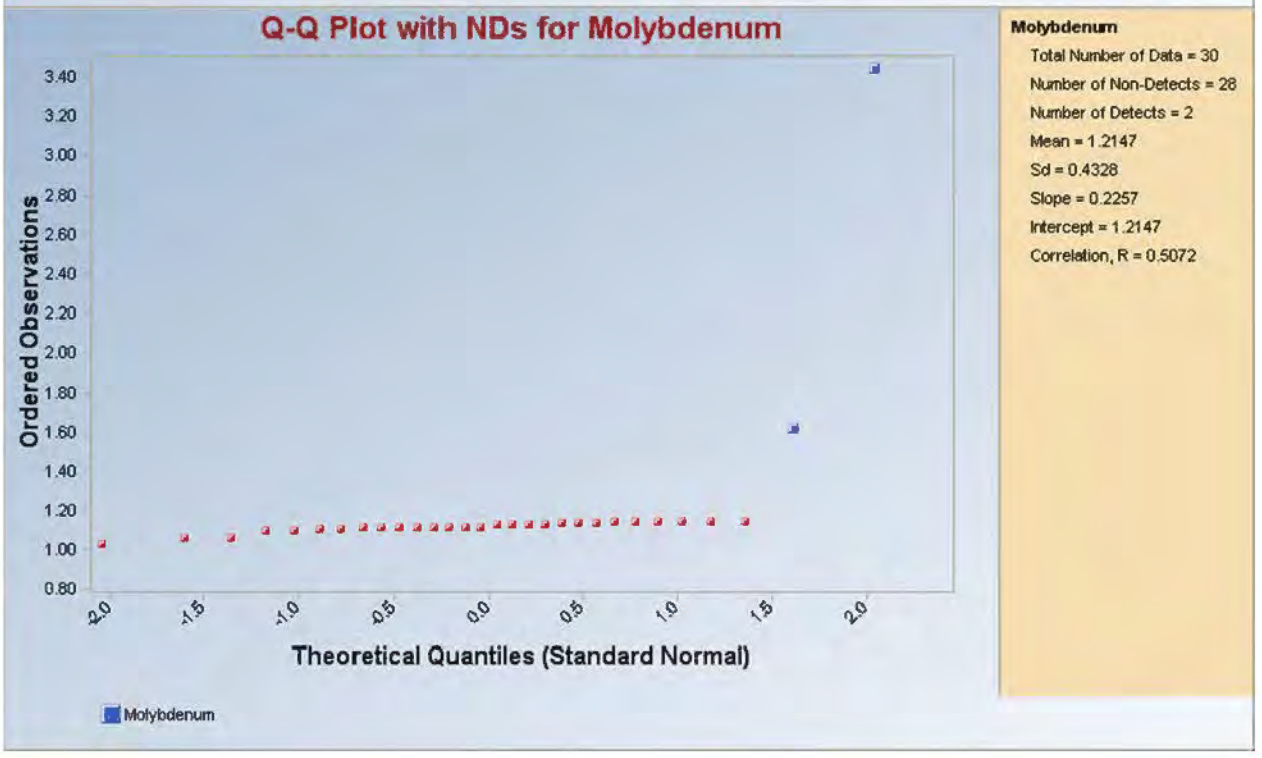

Q-Q Plot with NDs for Chromium, Total
Ordered Observations
Theoretical Quantiles (Standard Normal)
Chromium, Total
Chromium, Total
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 20.0990
Sd = 8.2346
Slope = 7.7252
Intercept = 20.0990
Correlation, R = 0.9126

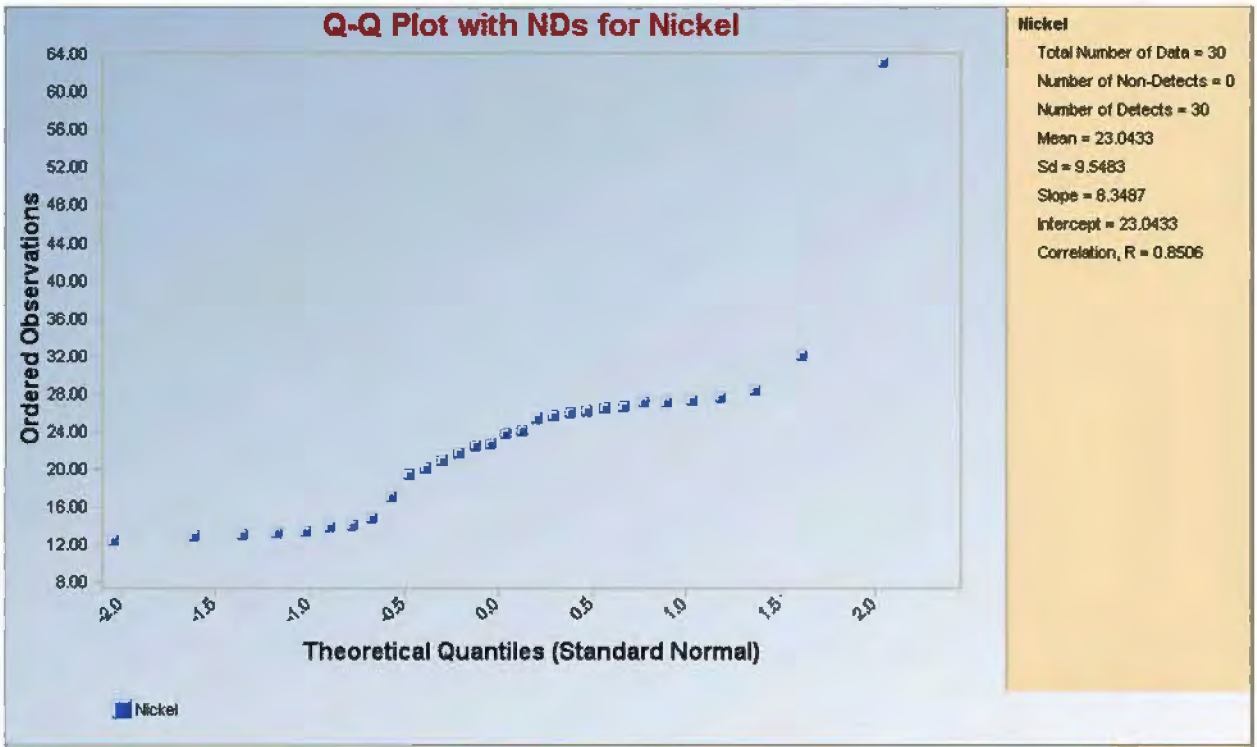

Q-Q Plot with NDs for Cobalt
Ordered Observations
Theoretical Quantiles (Standard Normal)
Cobalt
Cobalt
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 8.6340
Sd = 3.3061
Slope = 3.2706
Intercept = 8.6340
Correlation, R = 0.9618

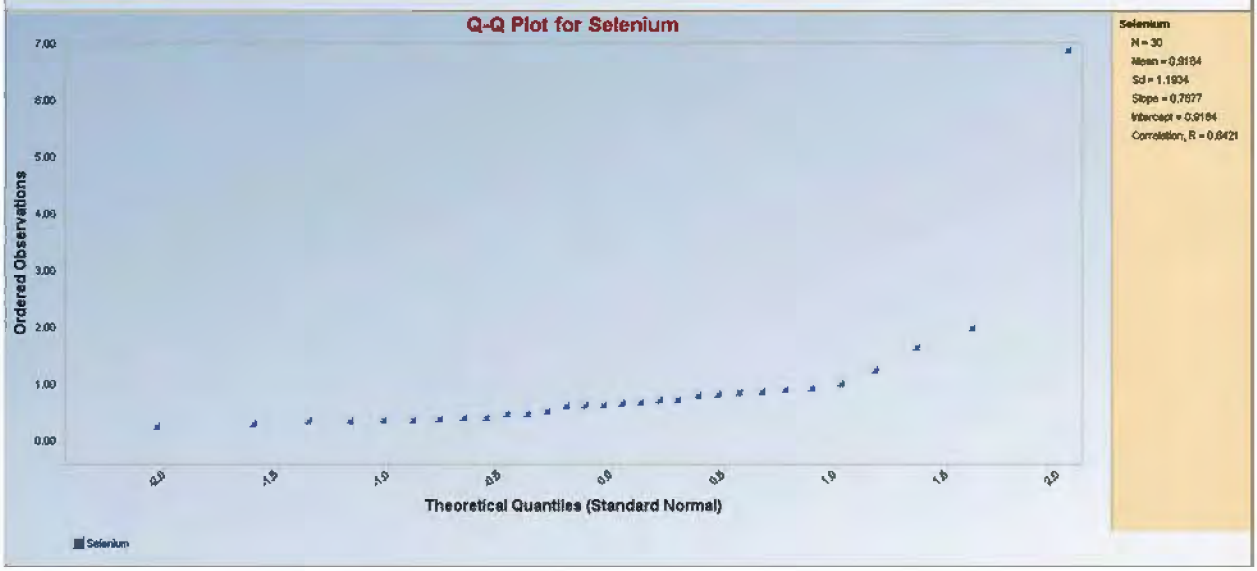

Q-Q Plot with NDs for Copper
Ordered Observations
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Copper
Copper
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 18.6193
Sd = 6.6859
Slope = 6.7824
Intercept = 18.6193
Correlation, R = 0.9582

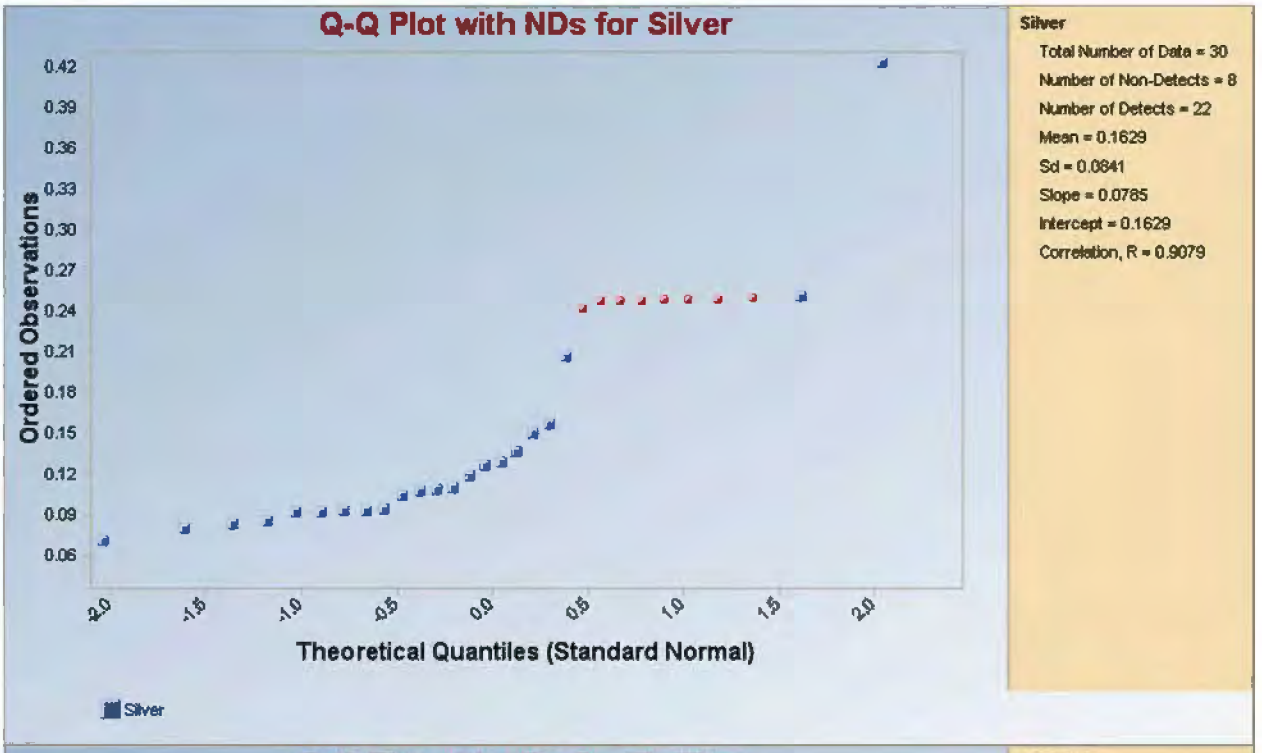

Q-Q Plot with NDs for Manganese
Ordered Observations
3900.00
3600.00
3300.00
3000.00
2700.00
2400.00
2100.00
1800.00
1500.00
1200.00
900.00
600.00
300.00
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Manganese
Manganese
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 1594.8000
Sd = 1092.9664
Slope = 1071.8805
Intercept = 1594.8000
Correlation, R = 0.9540

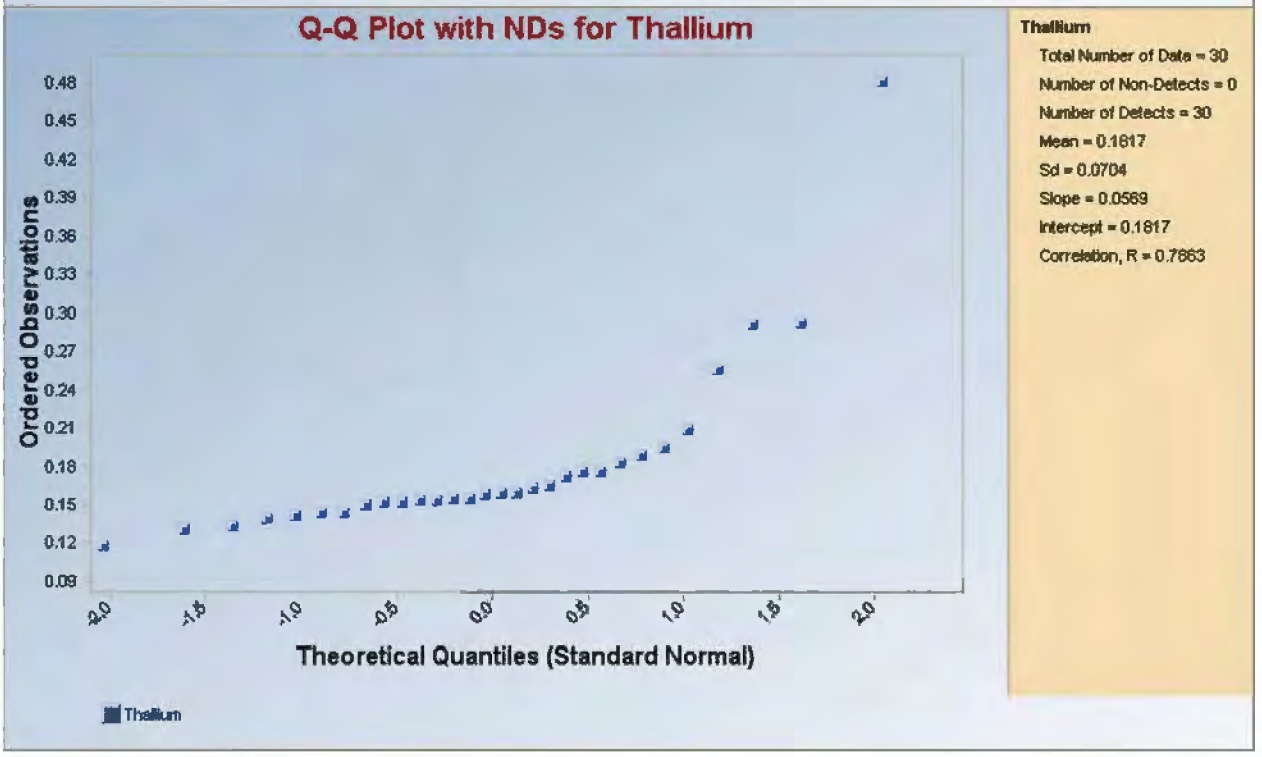

Q-Q Plot with NDs for Mercury
Ordered Observations
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Mercury
Mercury
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 0.0289
Sd = 0.0117
Slope = 0.0103
Intercept = 0.0289
Correlation, R = 0.8550

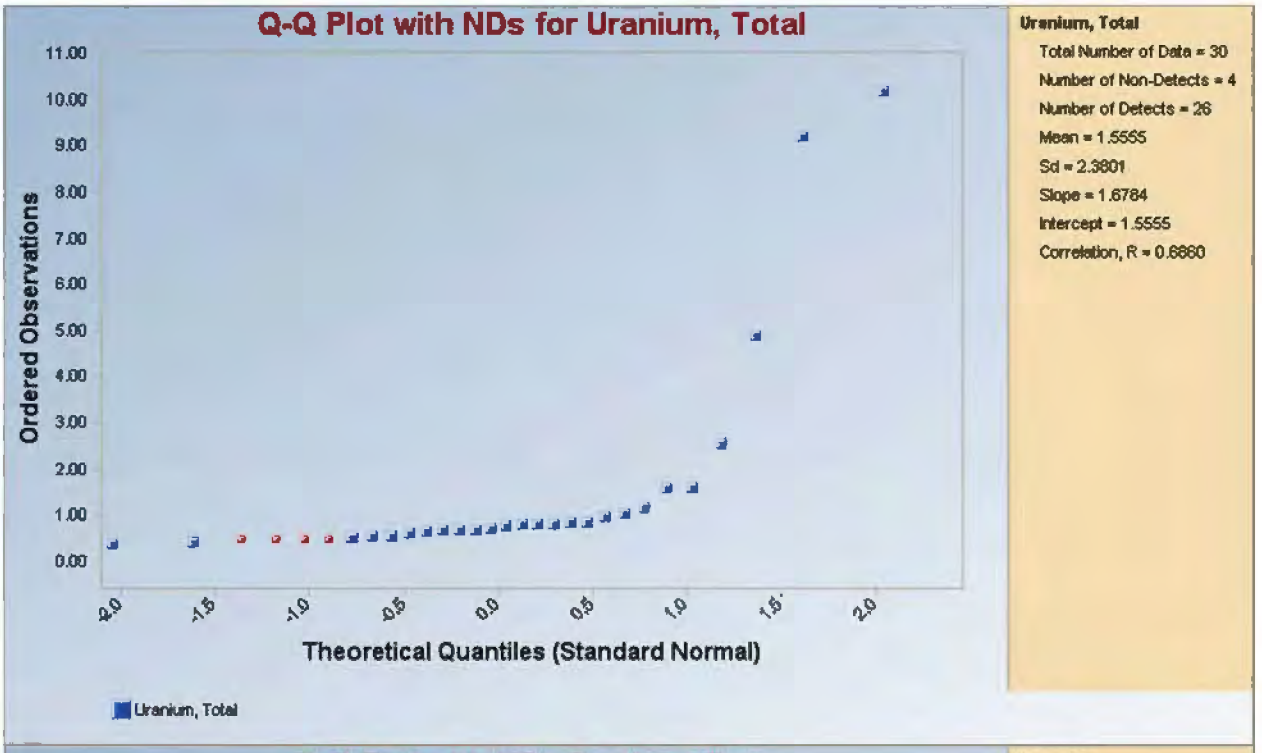

Q-Q Plot with NDs for Molybdenum
Ordered Observations
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 30
Number of Non-Detects = 28
Number of Detects = 2
Mean = 1.2147
Sd = 0.4328
Slope = 0.2257
Intercept = 1.2147
Correlation, R = 0.5072

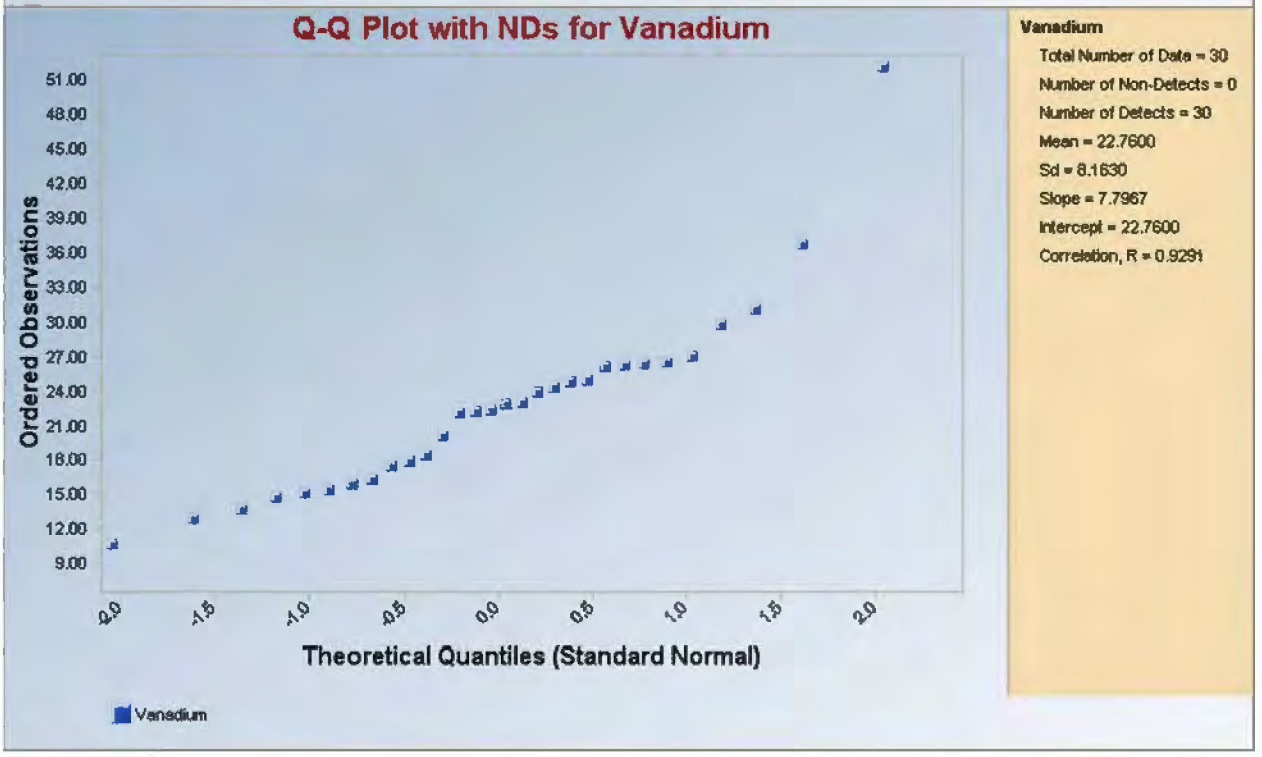

Q-Q Plot with NDs for Nickel
Ordered Observations
64.00
60.00
56.00
52.00
48.00
44.00
40.00
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Nickel
Nickel
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 23.0433
Sd = 9.5483
Slope = 8.3487
Intercept = 23.0433
Correlation, R = 0.8506

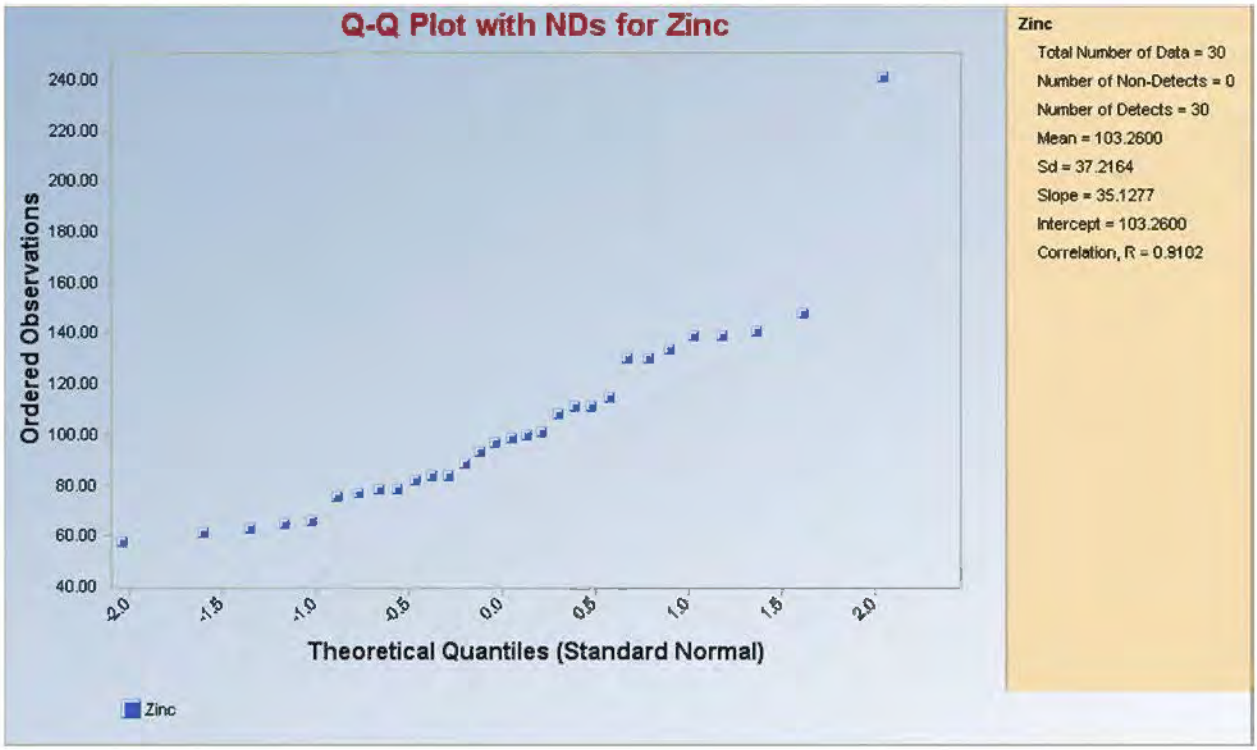

Q-Q Plot for Selenium
Ordered Observations
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Selenium
Selenium
N = 30
Mean = 0.9184
Sd = 1.1934
Slope = 0.7677
Intercept = 0.9184
Correlation, R = 0.8421

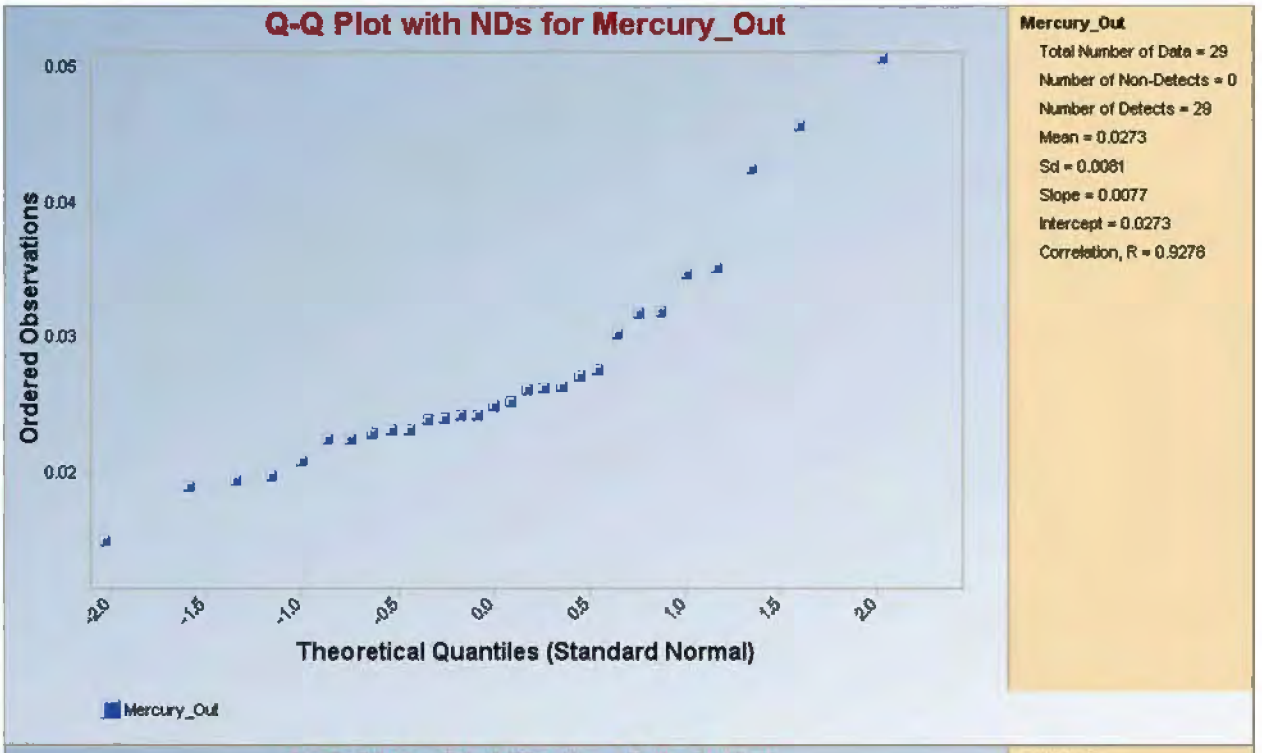

Q-Q Plot with NDs for Silver
Ordered Observations
0.42
0.39
0.36
0.33
0.30
0.27
0.24
0.21
0.18
0.15
0.12
0.09
0.06
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Silver
Silver
Total Number of Data = 30
Number of Non-Detects = 8
Number of Detects = 22
Mean = 0.1629
Sd = 0.0841
Slope = 0.0785
Intercept = 0.1629
Correlation, R = 0.9079

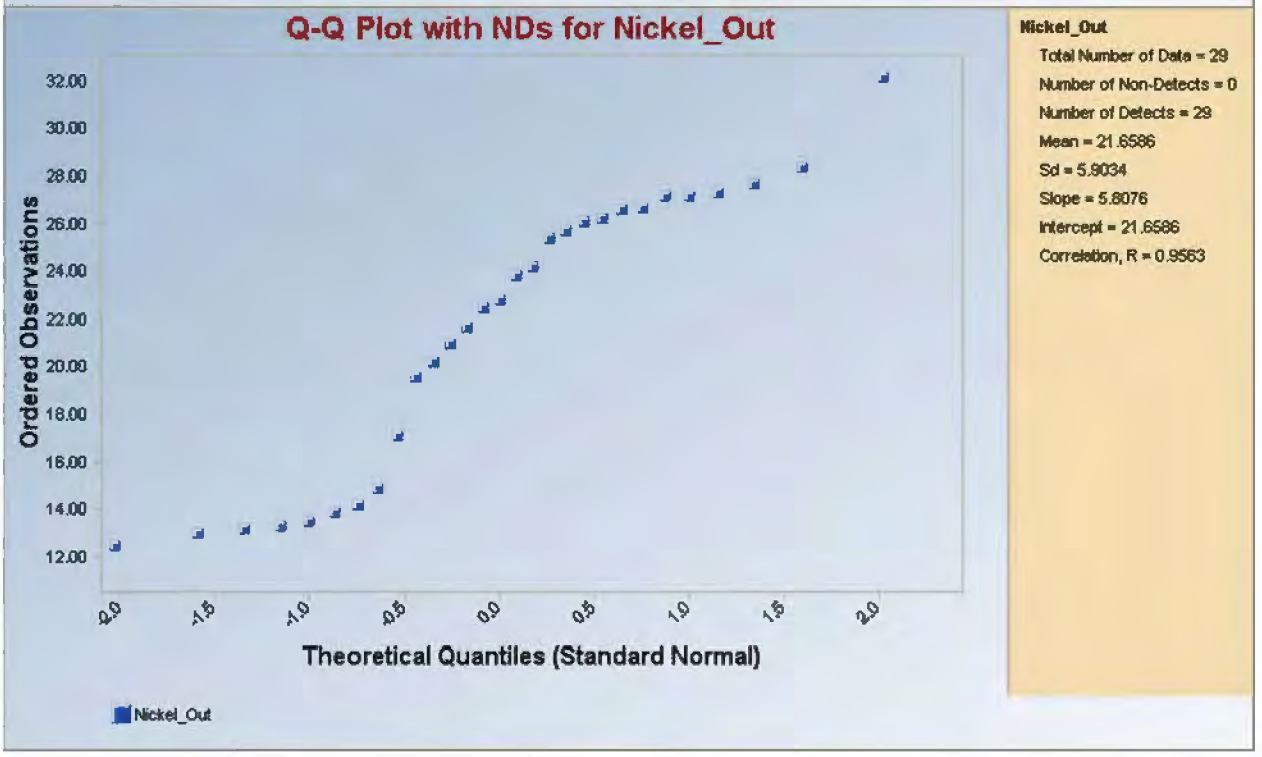

Q-Q Plot with NDs for Thallium
Ordered Observations
0.48
0.45
0.42
0.39
0.36
0.33
0.30
0.27
0.24
0.21
0.18
0.15
0.12
0.09
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Thallium
Thallium
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 0.1817
Sd = 0.0704
Slope = 0.0569
Intercept = 0.1817
Correlation, R = 0.7863

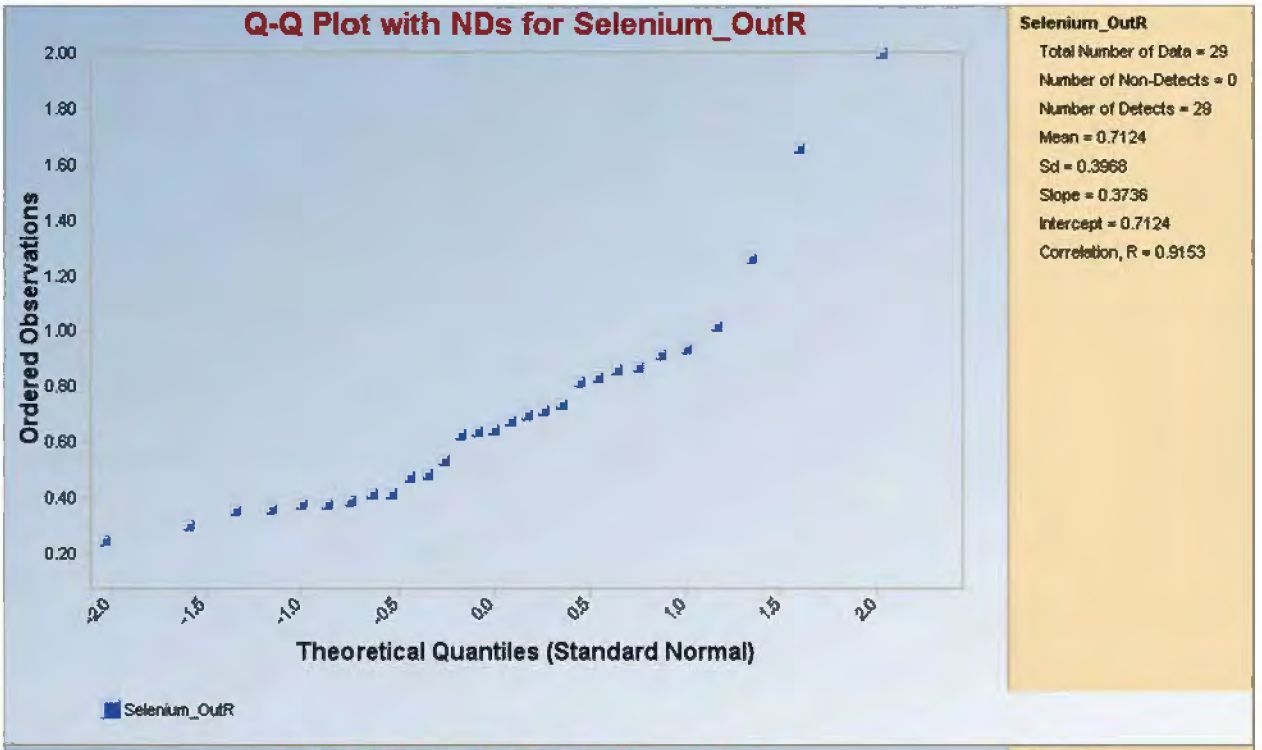

Q-Q Plot with NDs for Uranium, Total
Ordered Observations
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Uranium, Total
Uranium, Total
Total Number of Data = 30
Number of Non-Detects = 4
Number of Detects = 26
Mean = 1.5555
Sd = 2.3801
Slope = 1.6784
Intercept = 1.5555
Correlation, R = 0.6860

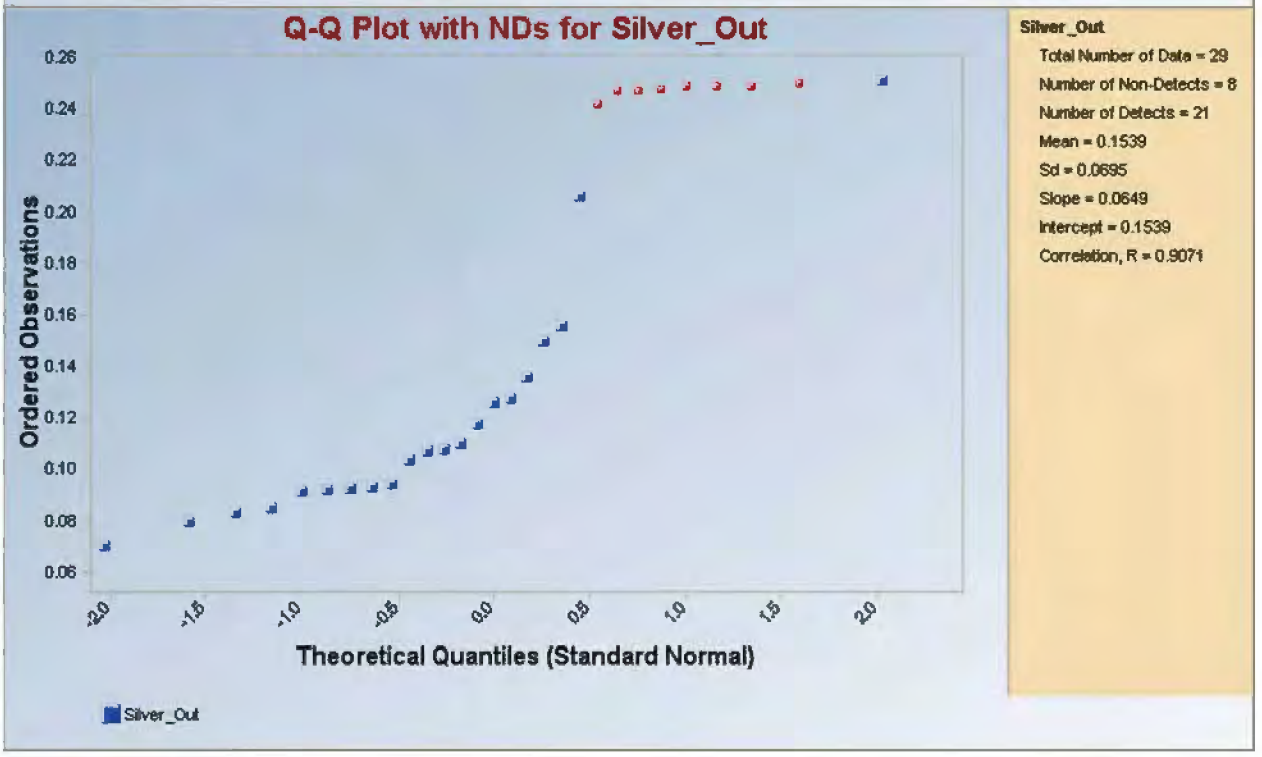

Q-Q Plot with NDs for Vanadium
Ordered Observations
51.00
48.00
45.00
42.00
39.00
36.00
33.00
30.00
27.00
24.00
21.00
18.00
15.00
12.00
9.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Vanadium
Vanadium
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 22.7600
Sd = 8.1630
Slope = 7.7967
Intercept = 22.7600
Correlation, R = 0.9291

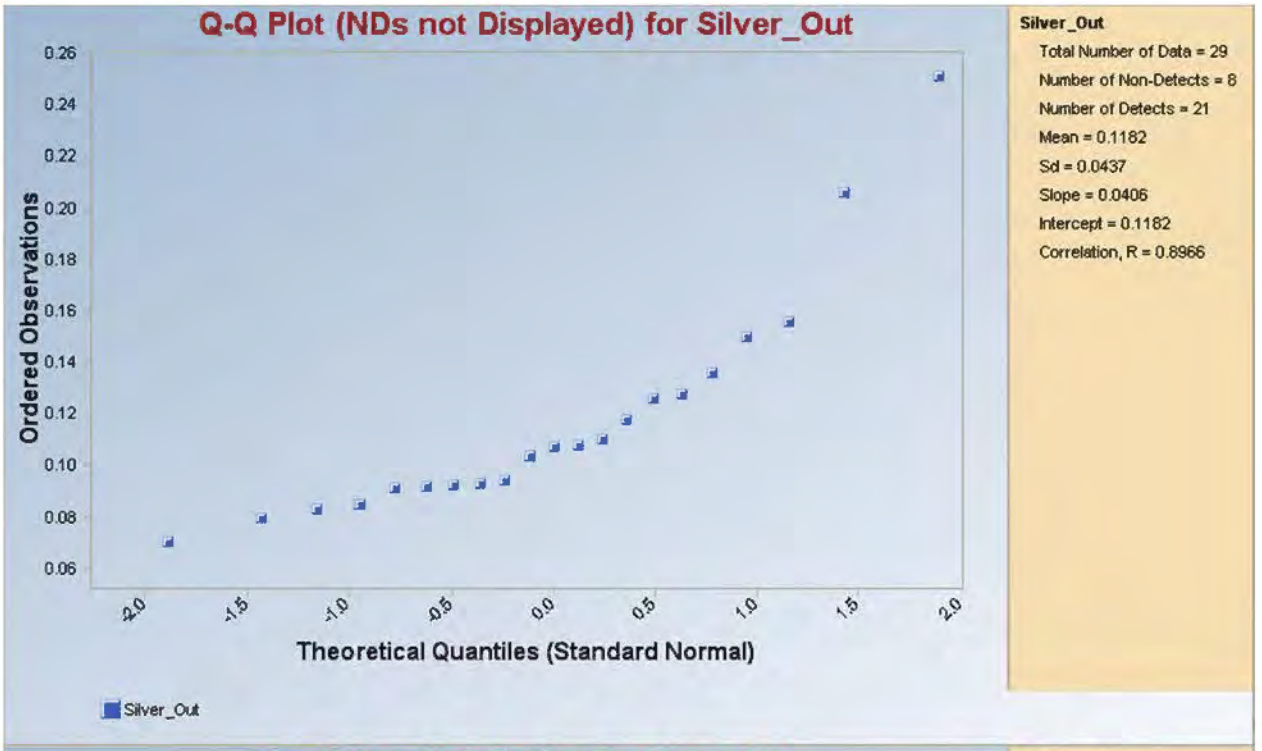

Q-Q Plot with NDs for Zinc
Ordered Observations
240.00
220.00
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Zinc
Zinc
Total Number of Data = 30
Number of Non-Detects = 0
Number of Detects = 30
Mean = 103.2600
Sd = 37.2164
Slope = 35.1277
Intercept = 103.2600
Correlation, R = 0.9102

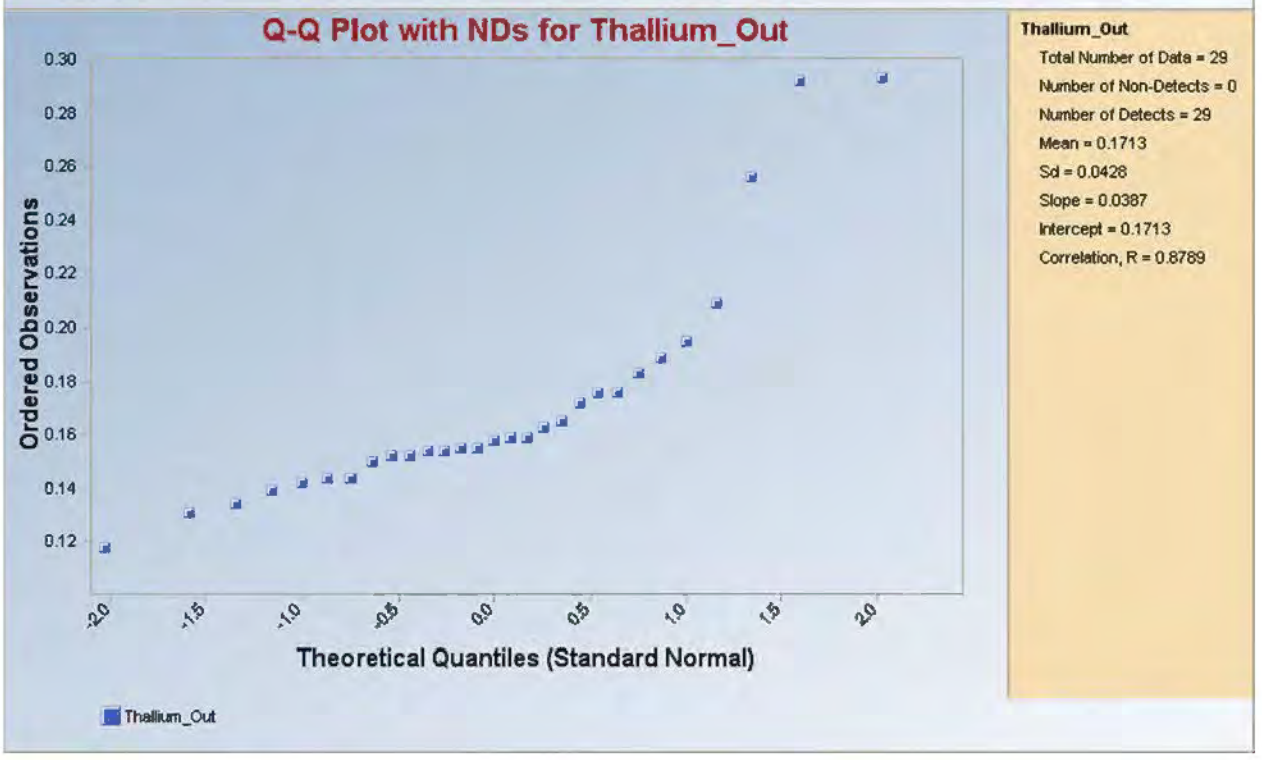

Q-Q Plot with NDs for Mercury_Out
Ordered Observations
0.05
0.04
0.03
0.02
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Mercury_Out
Mercury_Out
Total Number of Data = 29
Number of Non-Detects = 0
Number of Detects = 29
Mean = 0.0273
Sd = 0.0081
Slope = 0.0077
Intercept = 0.0273
Correlation, R = 0.9276

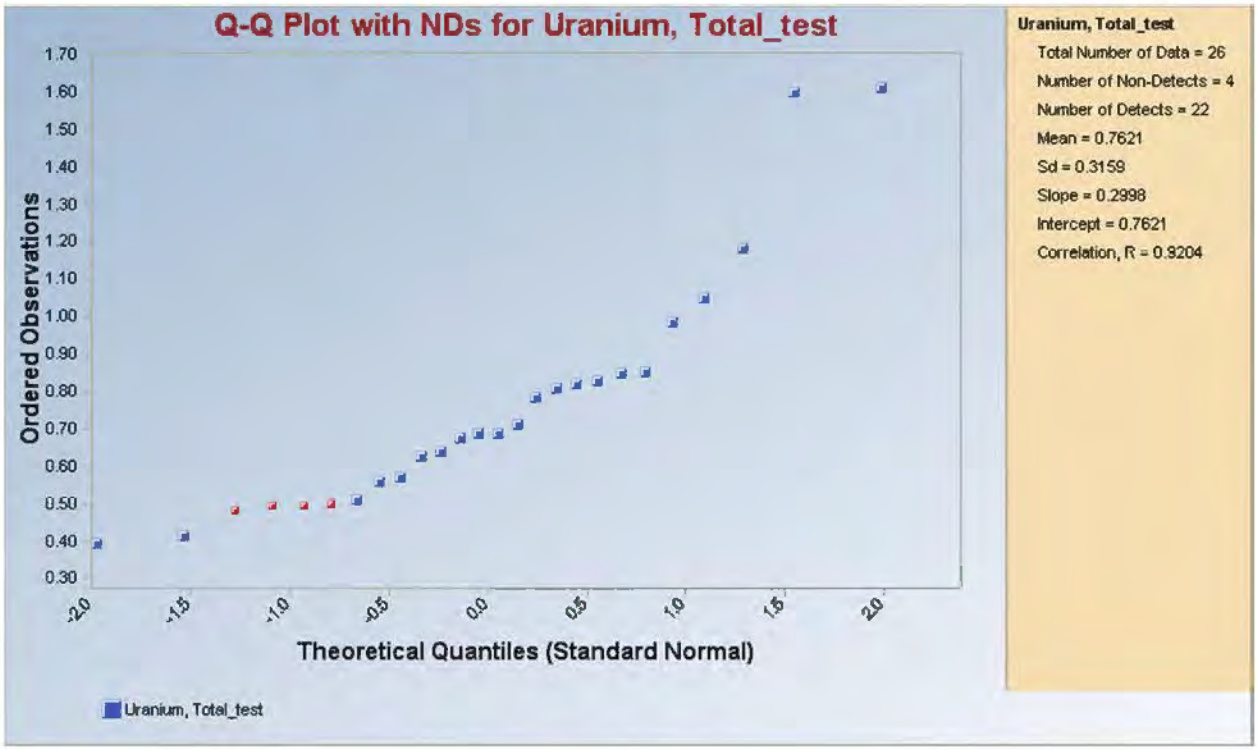

Q-Q Plot with NDs for Nickel_Out
Ordered Observations
32.00
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Nickel_Out
Nickel_Out
Total Number of Data = 29
Number of Non-Detects = 0
Number of Detects = 29
Mean = 21.6586
Sd = 5.9034
Slope = 5.8076
Intercept = 21.6586
Correlation, R = 0.9563


Q-Q Plot with NDs for Selenium_OutR
Ordered Observations
Theoretical Quantiles (Standard Normal)
Selenium_OutR
Selenium_OutR
Total Number of Data = 29
Number of Non-Detects = 0
Number of Detects = 29
Mean = 0.7124
Sd = 0.3968
Slope = 0.3736
Intercept = 0.7124
Correlation, R = 0.9153

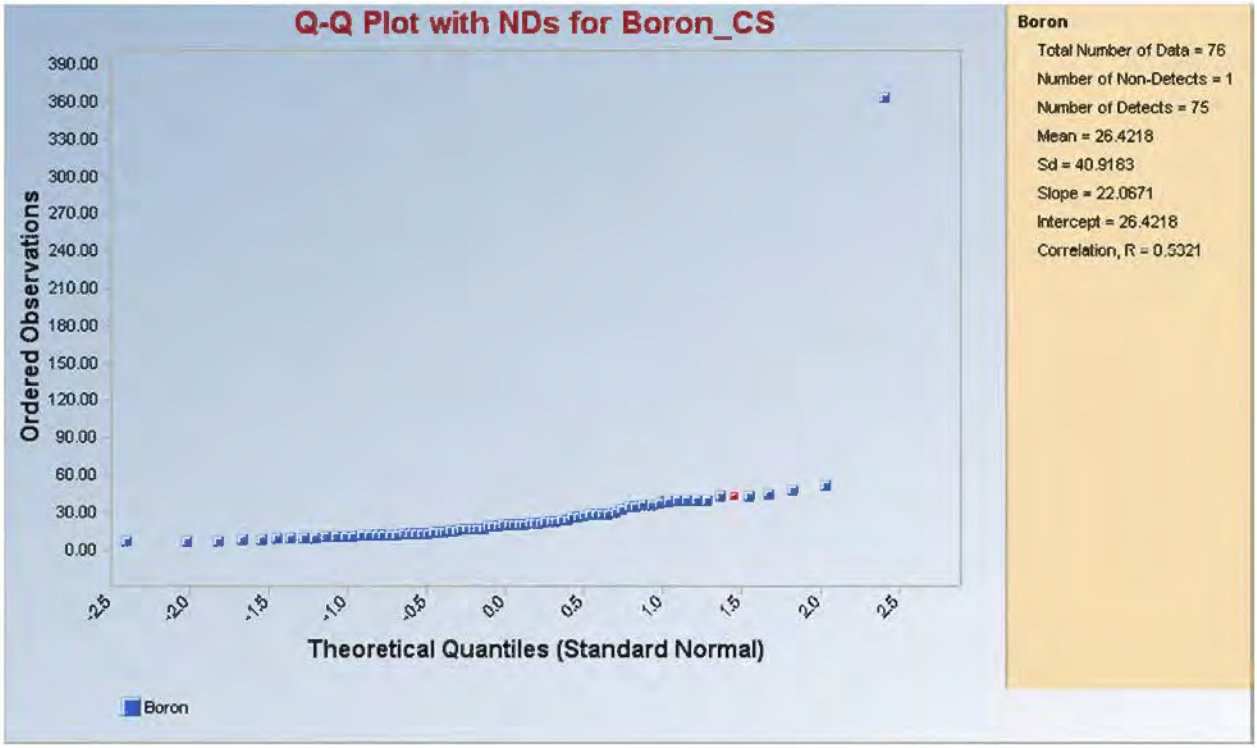

Q-Q Plot with NDs for Silver_Out
Ordered Observations
Theoretical Quantiles (Standard Normal)
Silver_Out
Silver_Out
Total Number of Data = 29
Number of Non-Detects = 8
Number of Detects = 21
Mean = 0.1539
Sd = 0.0695
Slope = 0.0649
Intercept = 0.1539
Correlation, R = 0.9071

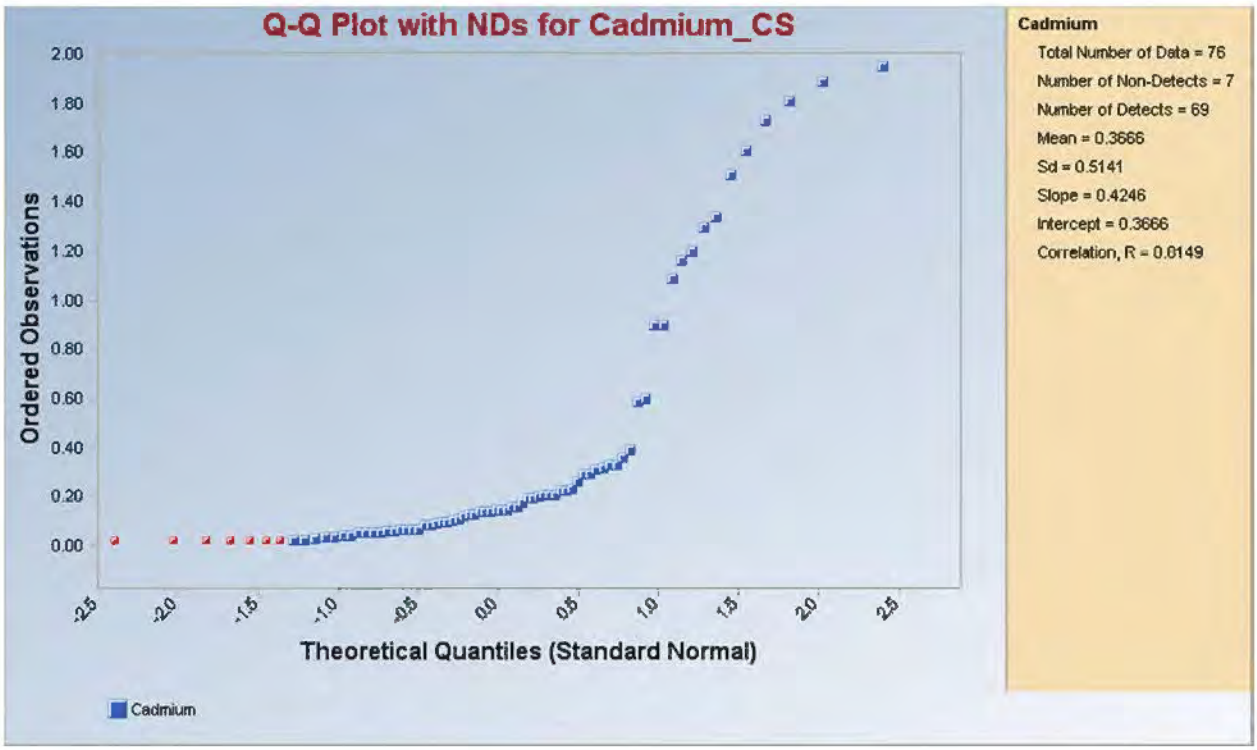

Q-Q Plot (NDs not Displayed) for Silver_Out
Ordered Observations
Theoretical Quantiles (Standard Normal)
Silver_Out
Silver_Out
Total Number of Data = 29
Number of Non-Detects = 8
Number of Detects = 21
Mean = 0.1182
Sd = 0.0437
Slope = 0.0406
Intercept = 0.1182
Correlation, R = 0.8966

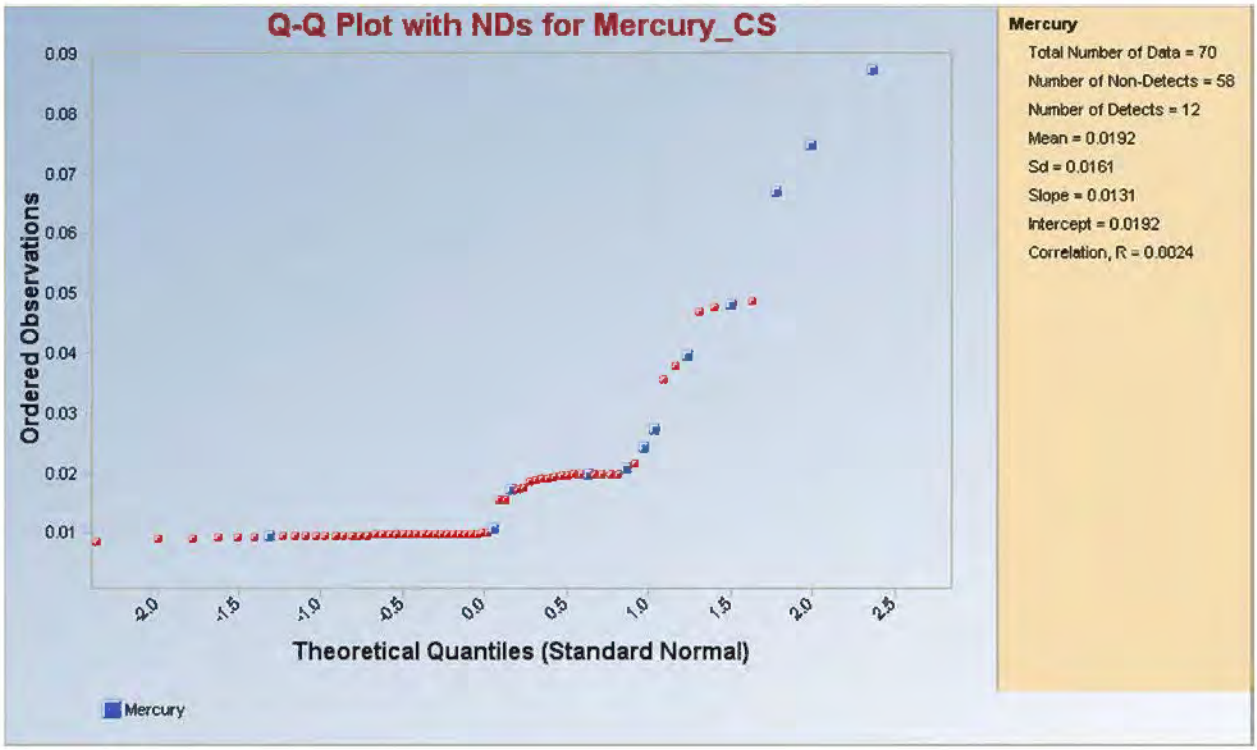

Q-Q Plot with NDs for Thallium_Out
Ordered Observations
Theoretical Quantiles (Standard Normal)
Thallium_Out
Thallium_Out
Total Number of Data = 29
Number of Non-Detects = 0
Number of Detects = 29
Mean = 0.1713
Sd = 0.0428
Slope = 0.0387
Intercept = 0.1713
Correlation, R = 0.8789

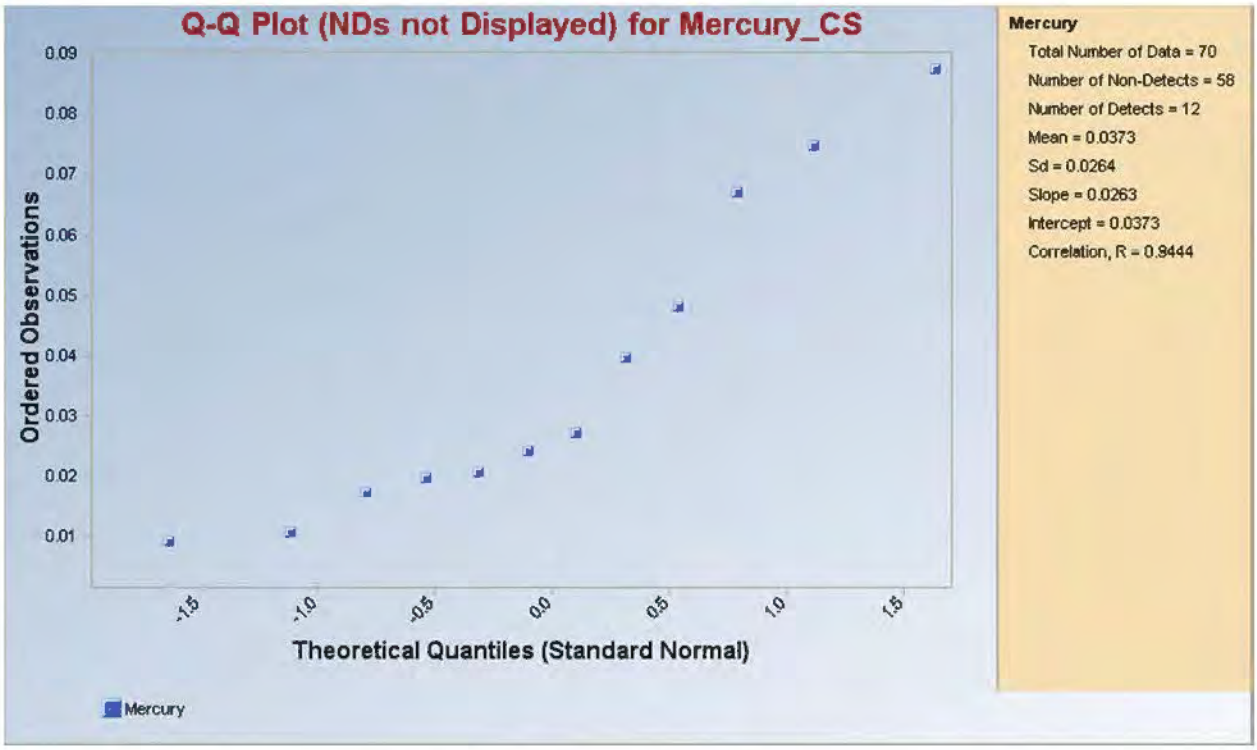

Q-Q Plot with NDs for Uranium, Total_test
Ordered Observations
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Uranium, Total_test
Uranium, Total_test
Total Number of Data = 26
Number of Non-Detects = 4
Number of Detects = 22
Mean = 0.7621
Sd = 0.3159
Slope = 0.2998
Intercept = 0.7621
Correlation, R = 0.9204

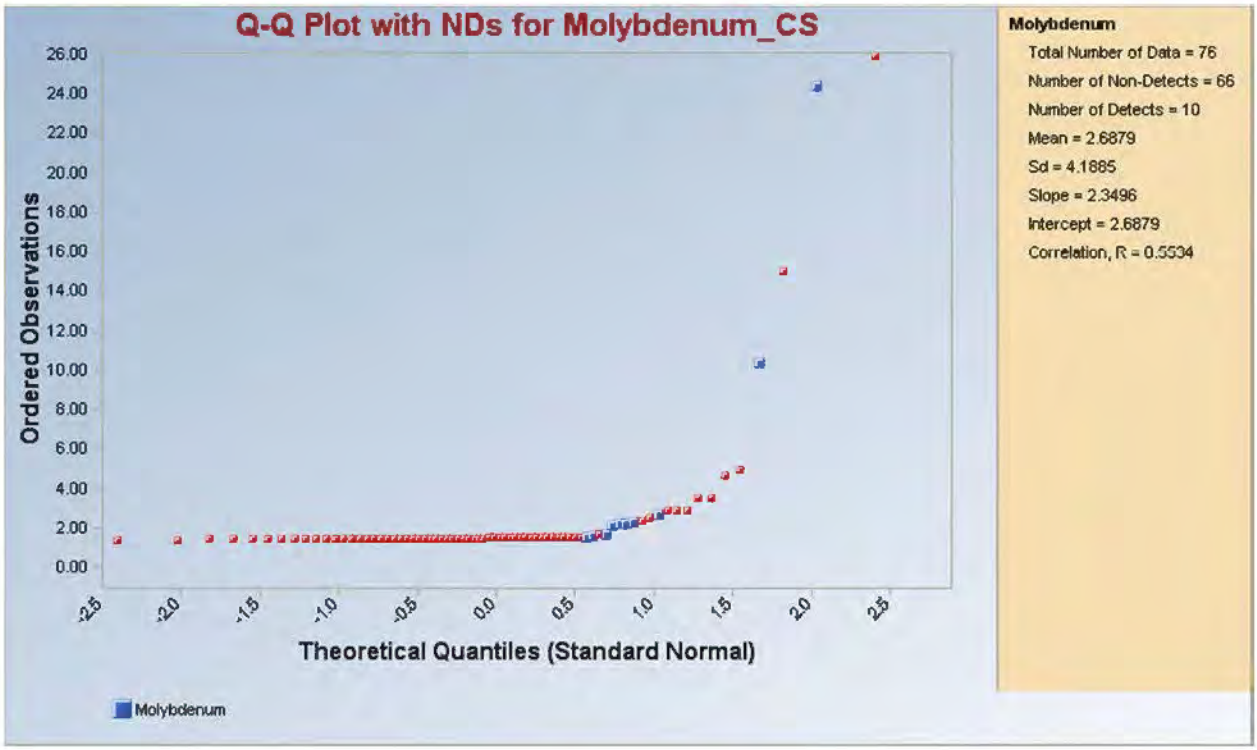
CULTURALLY SIGNIFICANT UPLAND VEGETATION – QQ PLOTS

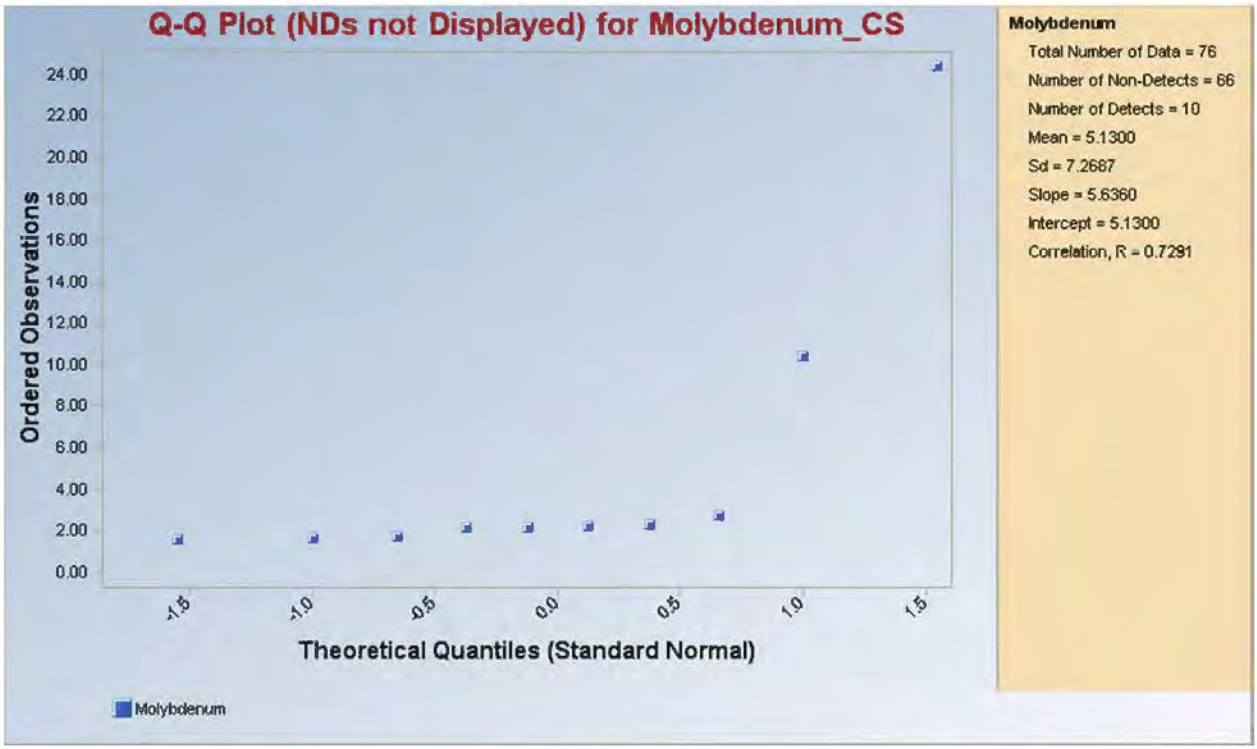

Q-Q Plot with NDs for Boron_CS
Ordered Observations
390.00
360.00
330.00
300.00
270.00
240.00
210.00
180.00
150.00
120.00
90.00
60.00
30.00
0.00
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Boron
Boron
Total Number of Data = 76
Number of Non-Detects = 1
Number of Detects = 75
Mean = 26.4218
Sd = 40.9183
Slope = 22.0671
Intercept = 26.4218
Correlation, R = 0.5321

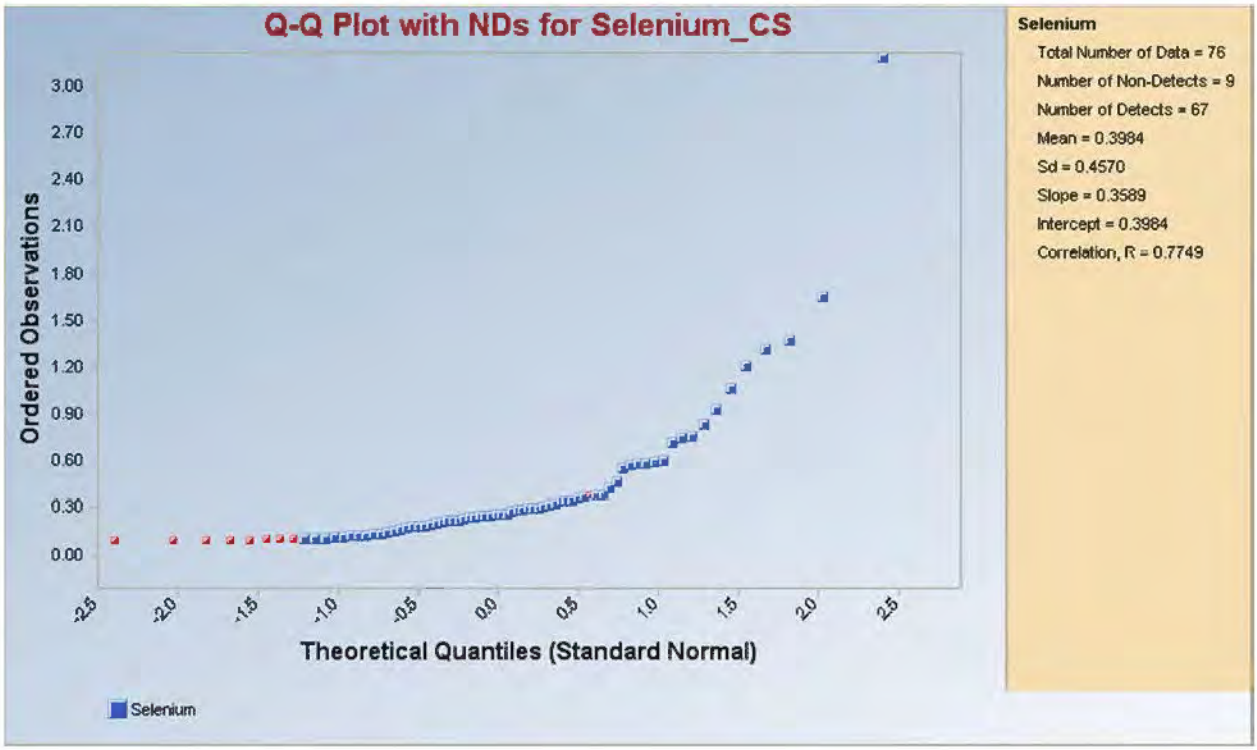

Q-Q Plot with NDs for Cadmium_CS
Ordered Observations
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Cadmium
Cadmium
Total Number of Data = 76
Number of Non-Detects = 7
Number of Detects = 69
Mean = 0.3666
Sd = 0.5141
Slope = 0.4246
Intercept = 0.3666
Correlation, R = 0.0149

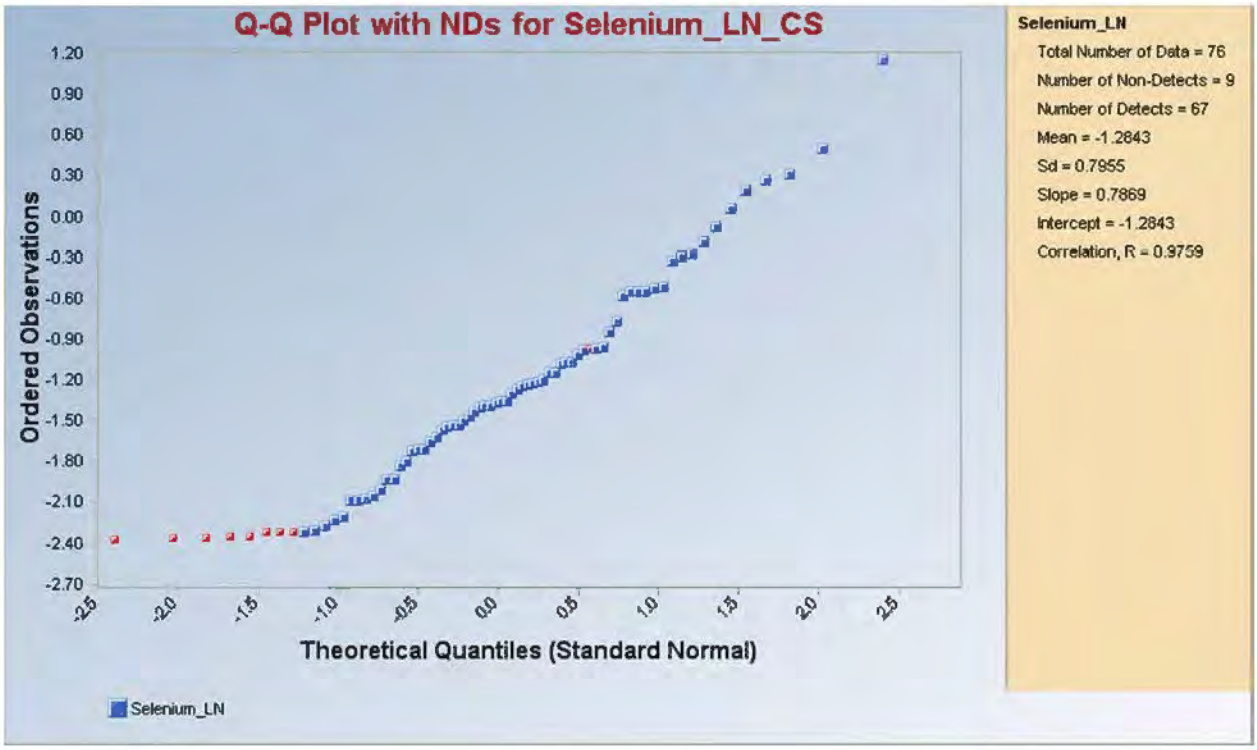

Q-Q Plot with NDs for Mercury_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Mercury
Mercury
Total Number of Data = 70
Number of Non-Detects = 58
Number of Detects = 12
Mean = 0.0192
Sd = 0.0161
Slope = 0.0131
Intercept = 0.0192
Correlation, R = 0.0024

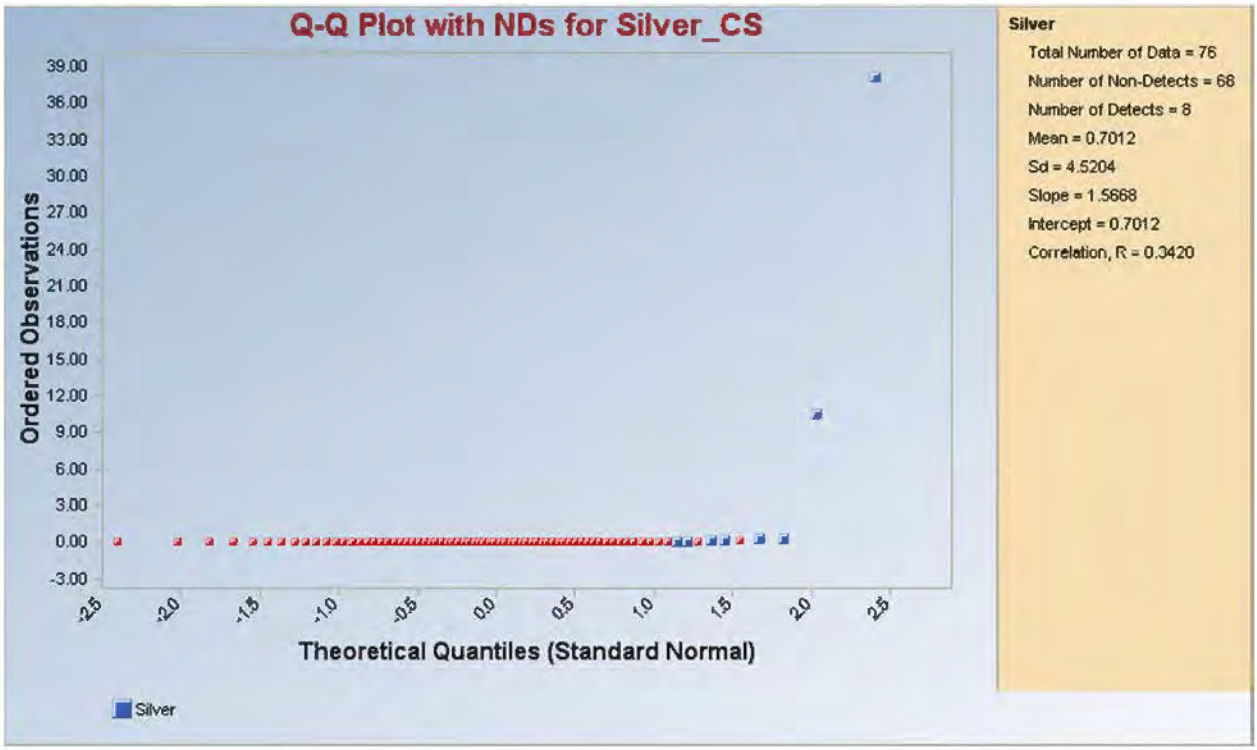

Q-Q Plot (NDs not Displayed) for Mercury_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Mercury
Mercury
Total Number of Data = 70
Number of Non-Detects = 58
Number of Detects = 12
Mean = 0.0373
Sd = 0.0264
Slope = 0.0263
Intercept = 0.0373
Correlation, R = 0.9444

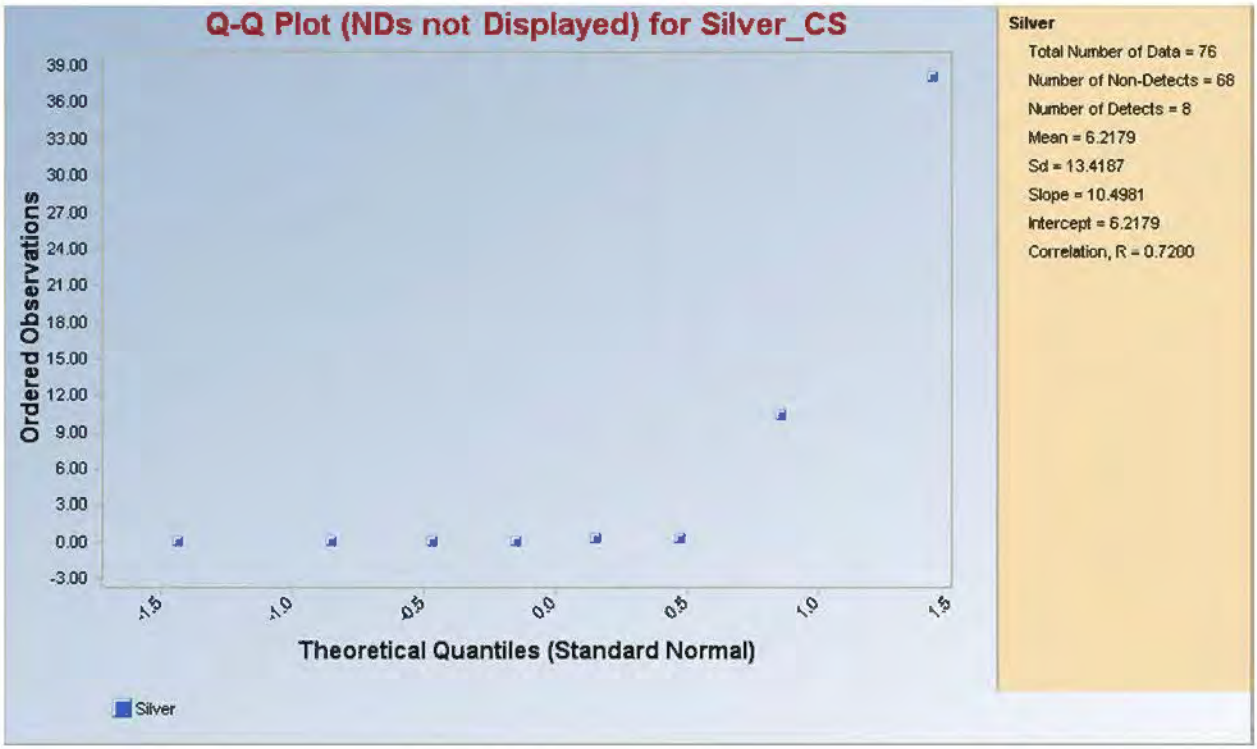

Q-Q Plot with NDs for Molybdenum_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 76
Number of Non-Detects = 66
Number of Detects = 10
Mean = 2.6879
Sd = 4.1885
Slope = 2.3496
Intercept = 2.6879
Correlation, R = 0.5534

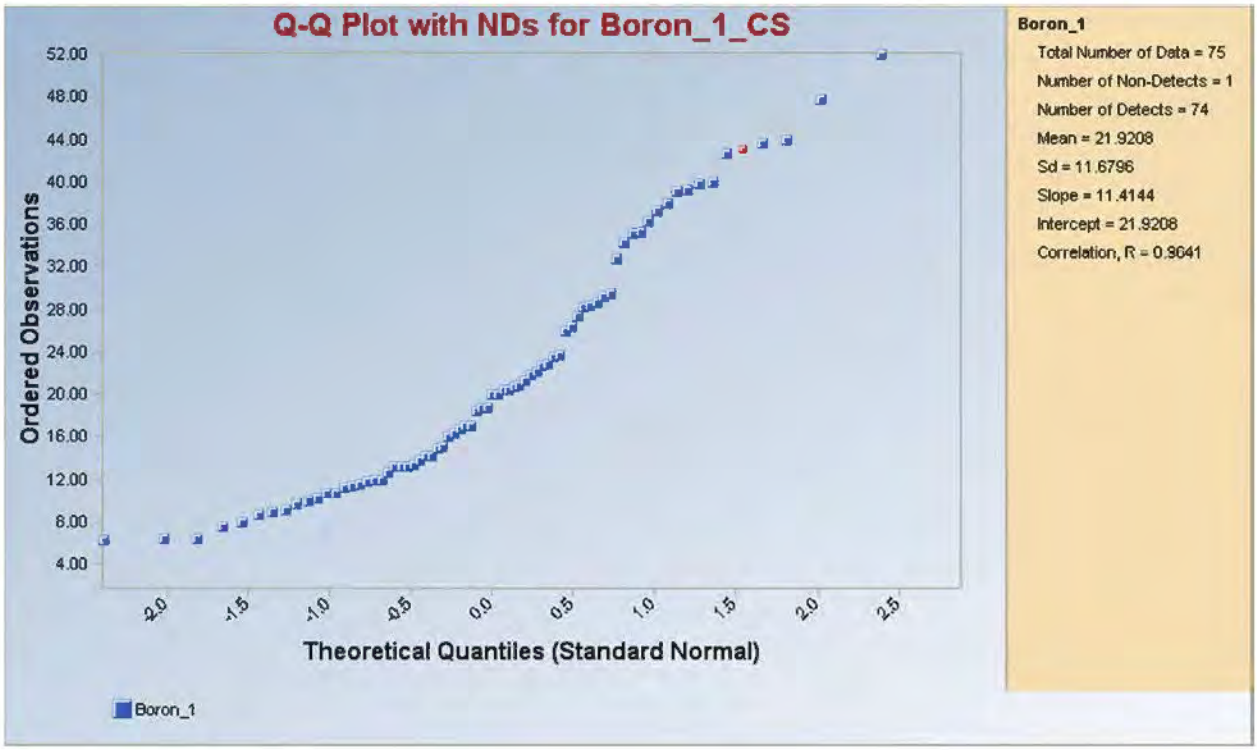

Q-Q Plot (NDs not Displayed) for Molybdenum_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 76
Number of Non-Detects = 66
Number of Detects = 10
Mean = 5.1300
Sd = 7.2687
Slope = 5.6360
Intercept = 5.1300
Correlation, R = 0.7291

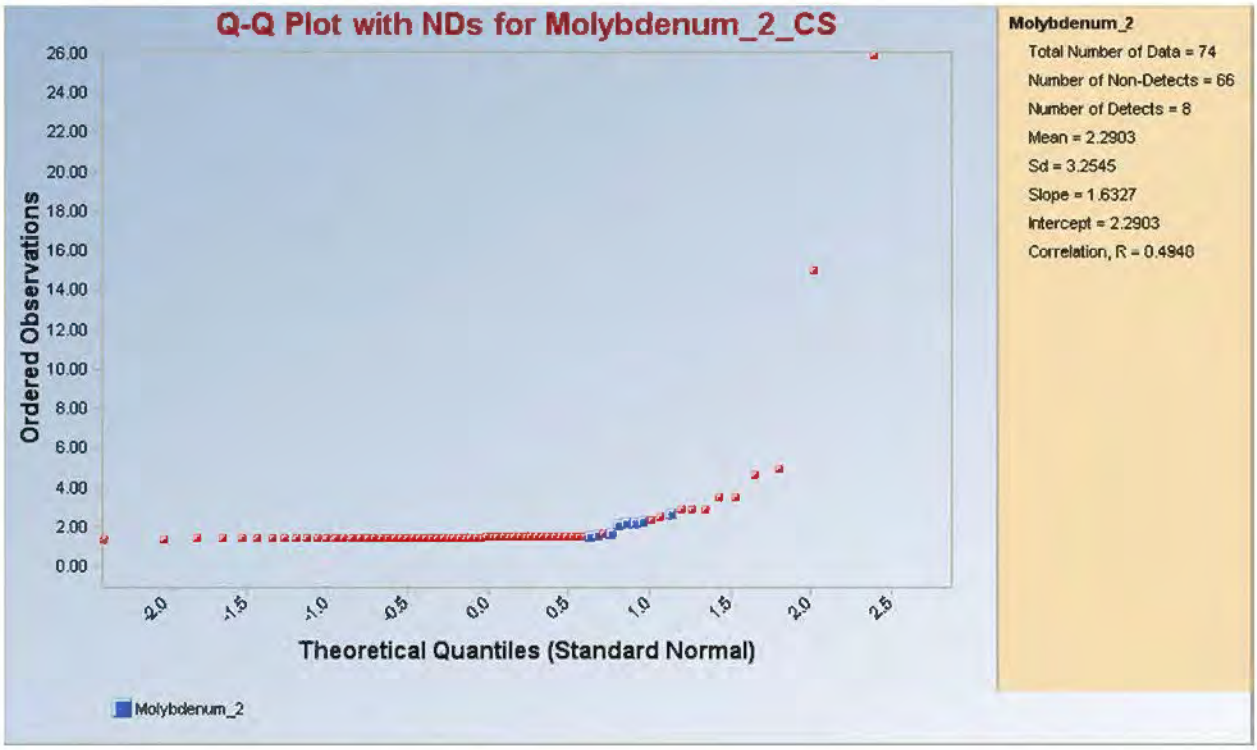

Q-Q Plot with NDs for Selenium_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Selenium
Selenium
Total Number of Data = 76
Number of Non-Detects = 9
Number of Detects = 67
Mean = 0.3984
Sd = 0.4570
Slope = 0.3589
Intercept = 0.3984
Correlation, R = 0.7749

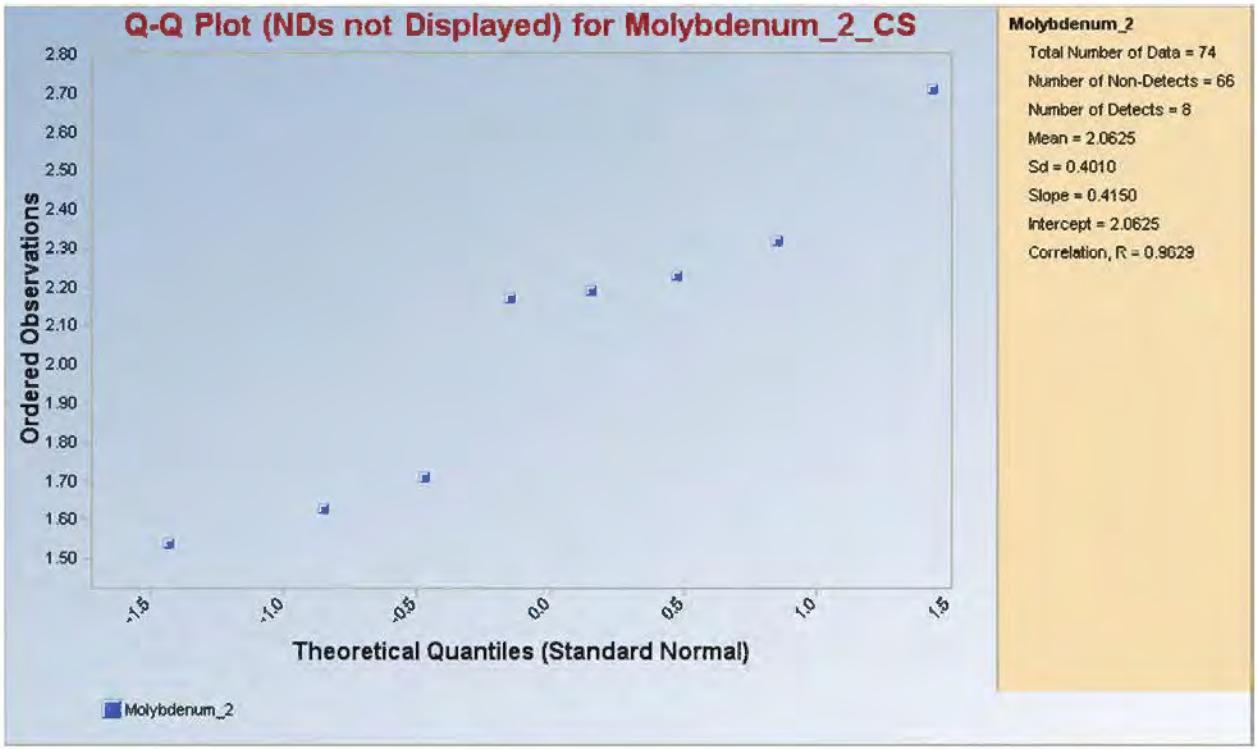

Q-Q Plot with NDs for Selenium_LN_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Selenium_LN
Selenium_LN
Total Number of Data = 76
Number of Non-Detects = 9
Number of Detects = 67
Mean = -1.2843
Sd = 0.7955
Slope = 0.7869
Intercept = -1.2843
Correlation, R = 0.9759


Q-Q Plot with NDs for Silver_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Silver
Silver
Total Number of Data = 76
Number of Non-Detects = 68
Number of Detects = 8
Mean = 0.7012
Sd = 4.5204
Slope = 1.5668
Intercept = 0.7012
Correlation, R = 0.3420

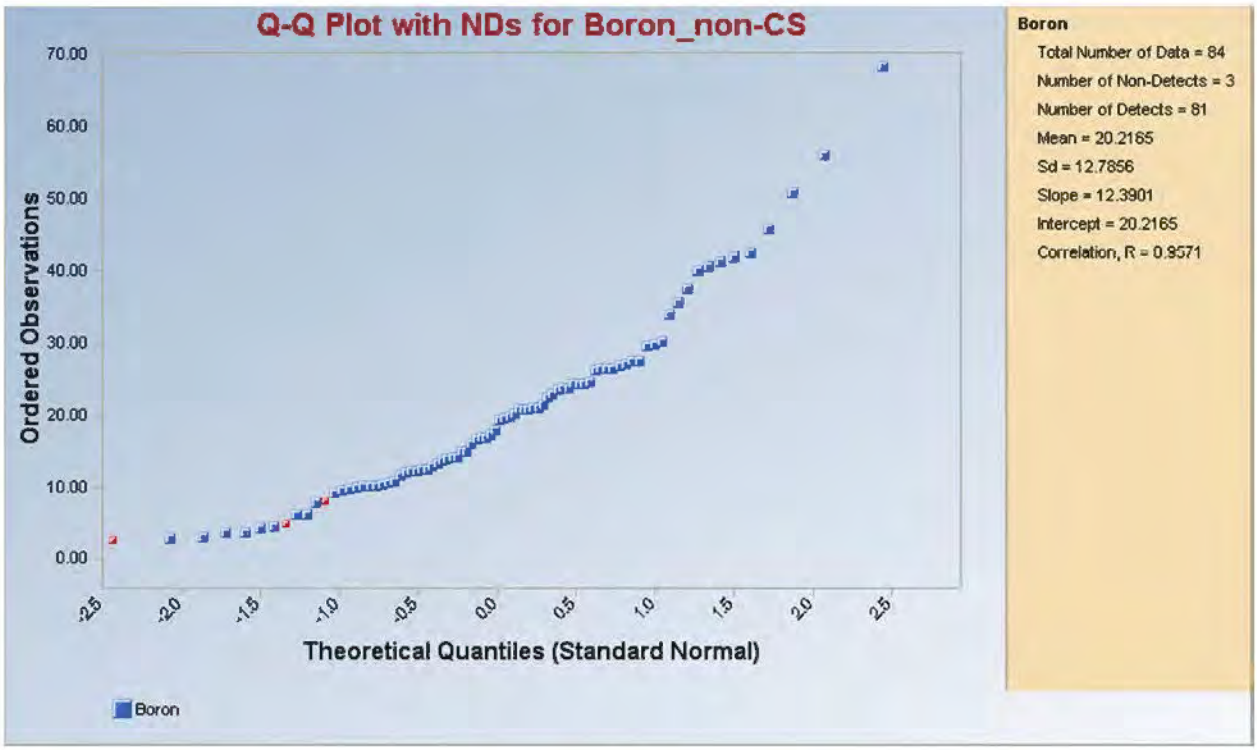

Q-Q Plot (NDs not Displayed) for Silver_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Silver
Silver
Total Number of Data = 76
Number of Non-Detects = 68
Number of Detects = 8
Mean = 6.2179
Sd = 13.4187
Slope = 10.4981
Intercept = 6.2179
Correlation, R = 0.7200

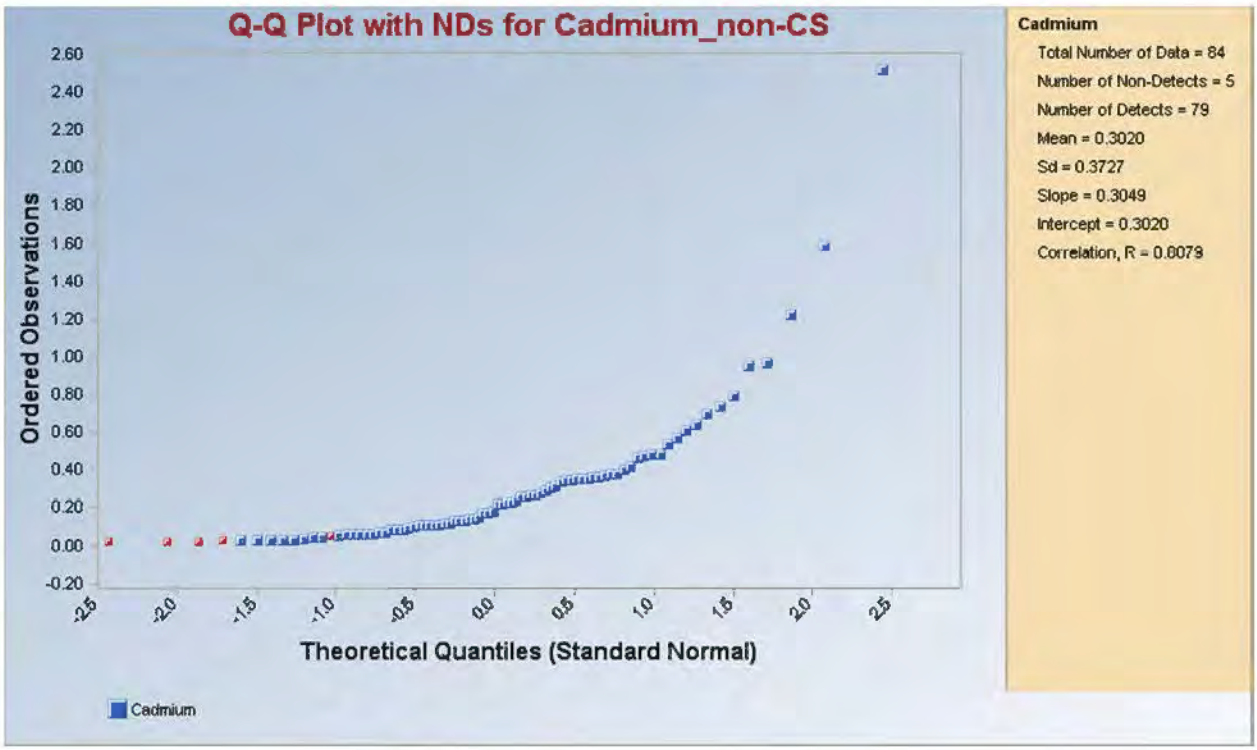

Q-Q Plot with NDs for Boron_1_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Boron_1
Boron_1
Total Number of Data = 75
Number of Non-Detects = 1
Number of Detects = 74
Mean = 21.9208
Sd = 11.6796
Slope = 11.4144
Intercept = 21.9208
Correlation, R = 0.9641

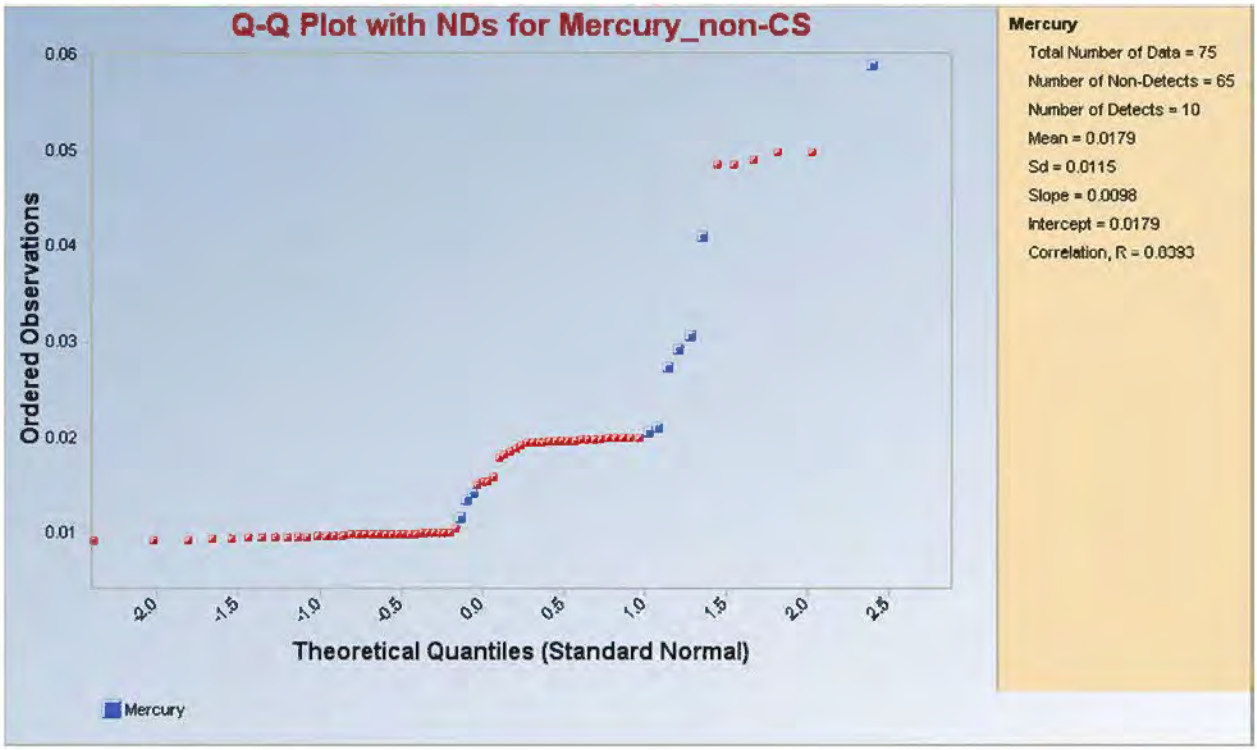

Q-Q Plot with NDs for Molybdenum_2_CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Molybdenum_2
Molybdenum_2
Total Number of Data = 74
Number of Non-Detects = 66
Number of Detects = 8
Mean = 2.2903
Sd = 3.2545
Slope = 1.6327
Intercept = 2.2903
Correlation, R = 0.4940

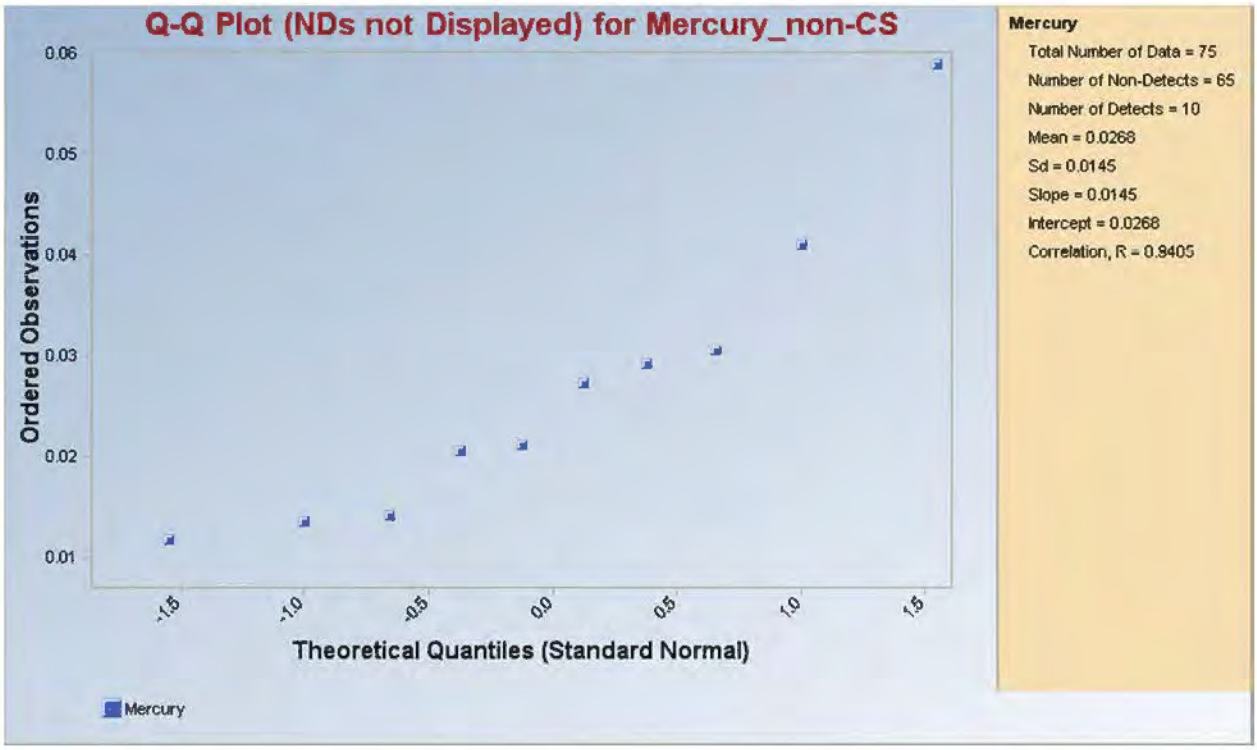

Q-Q Plot (NDs not Displayed) for Molybdenum_2_CS
Ordered Observations
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Molybdenum_2
Molybdenum_2
Total Number of Data = 74
Number of Non-Detects = 66
Number of Detects = 8
Mean = 2.0625
Sd = 0.4010
Slope = 0.4150
Intercept = 2.0625
Correlation, R = 0.9629

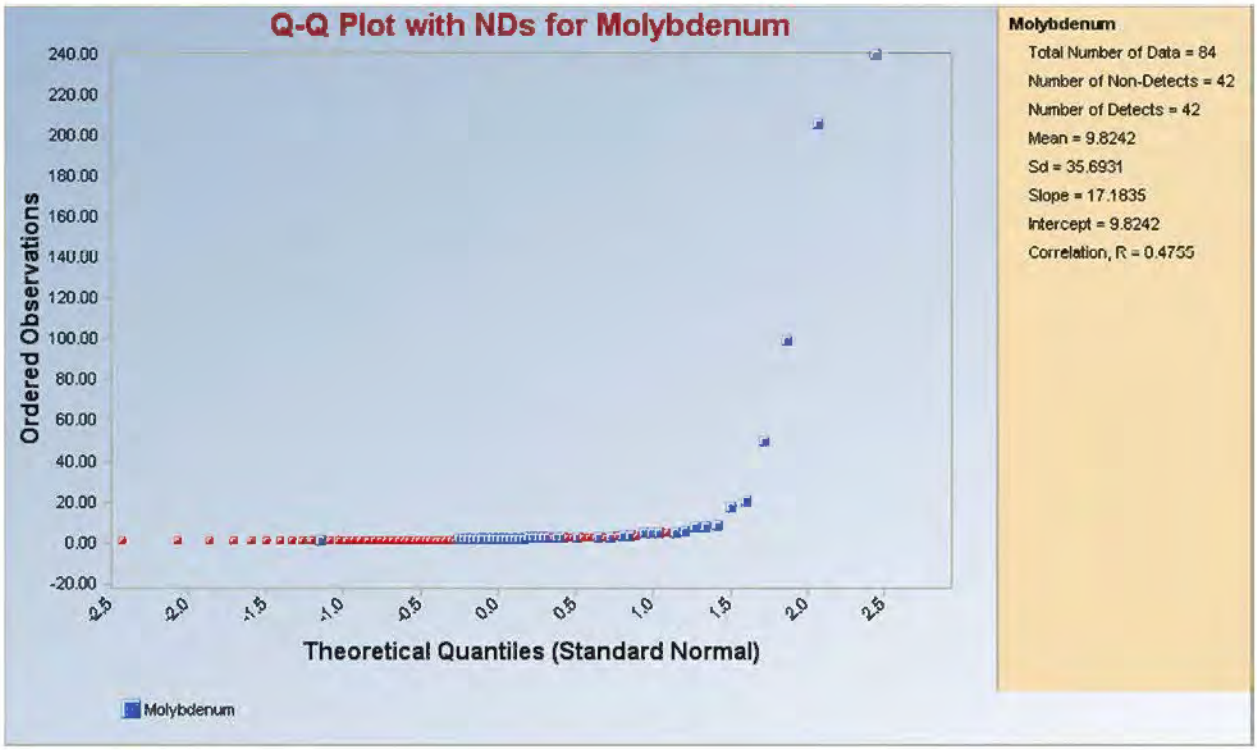
NON-CULTURALLY SIGNIFICANT UPLAND VEGETATION – QQ PLOTS

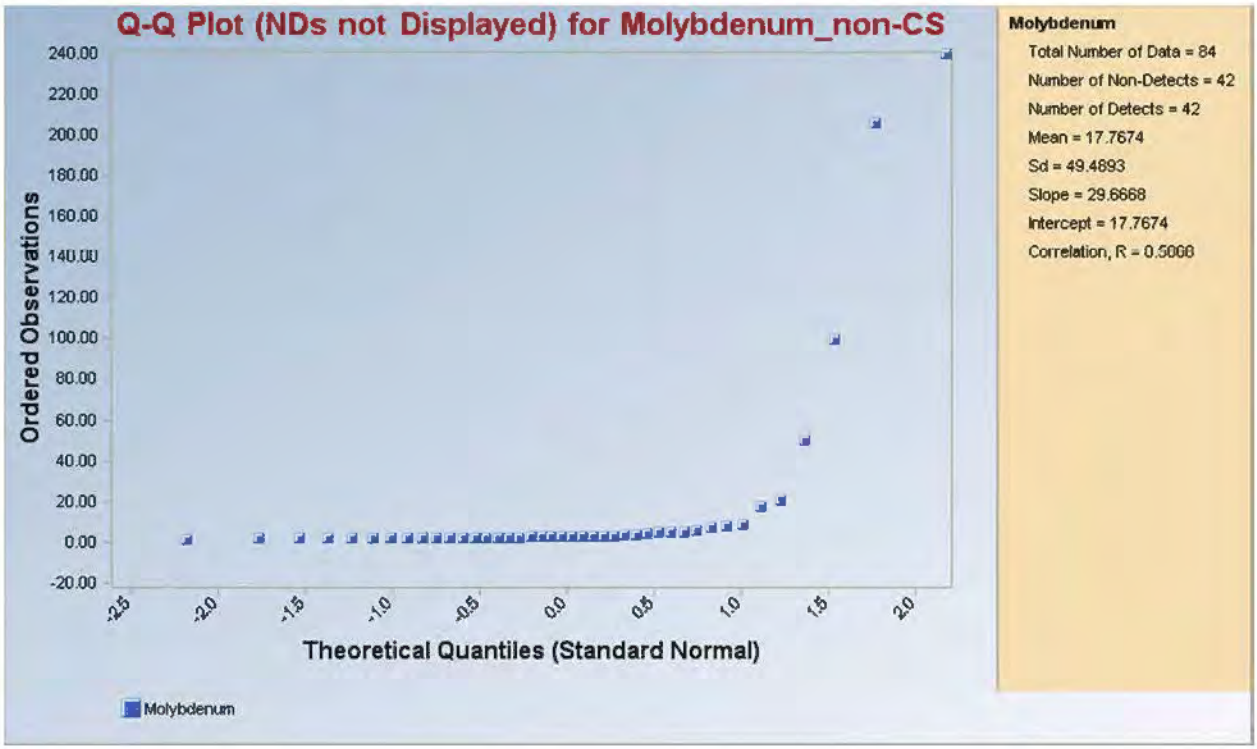

Q-Q Plot with NDs for Boron_non-CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Boron
Total Number of Data = 84
Number of Non-Detects = 3
Number of Detects = 81
Mean = 20.2165
Sd = 12.7856
Slope = 12.3901
Intercept = 20.2165
Correlation, R = 0.9571

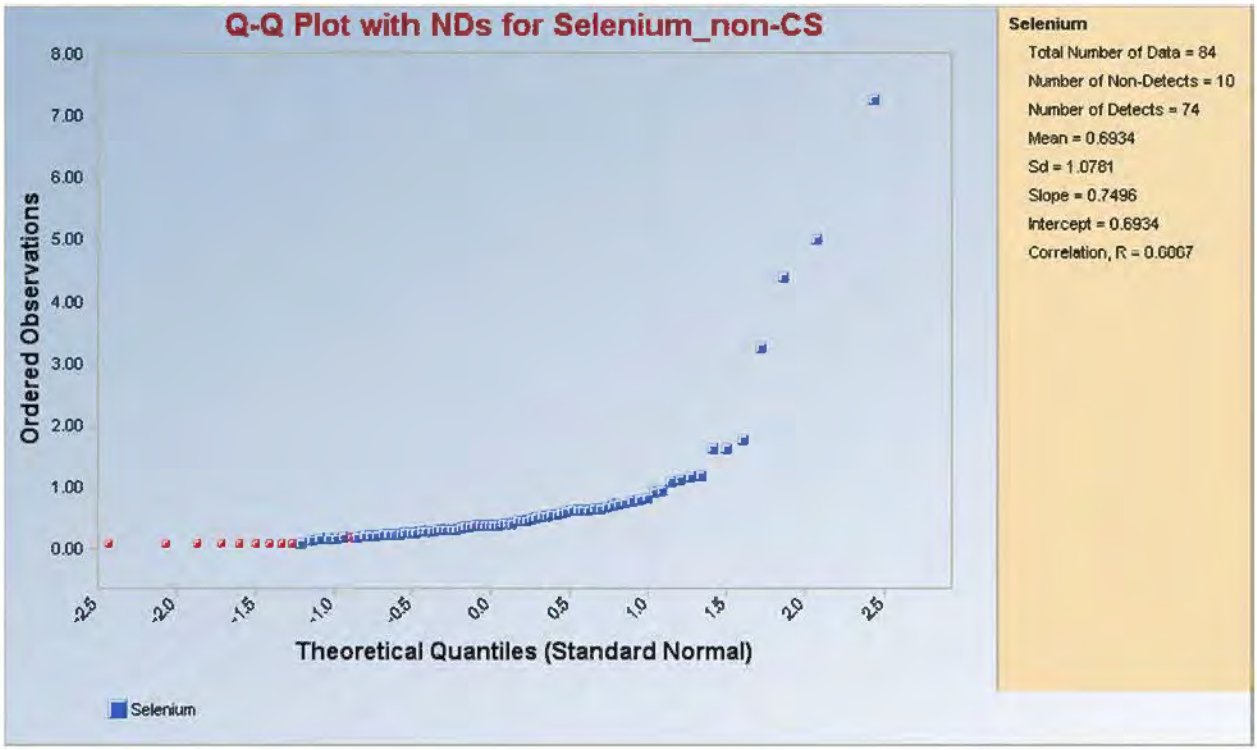

Q-Q Plot with NDs for Cadmium_non-CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Cadmium
Total Number of Data = 84
Number of Non-Detects = 5
Number of Detects = 79
Mean = 0.3020
Sd = 0.3727
Slope = 0.3049
Intercept = 0.3020
Correlation, R = 0.8079

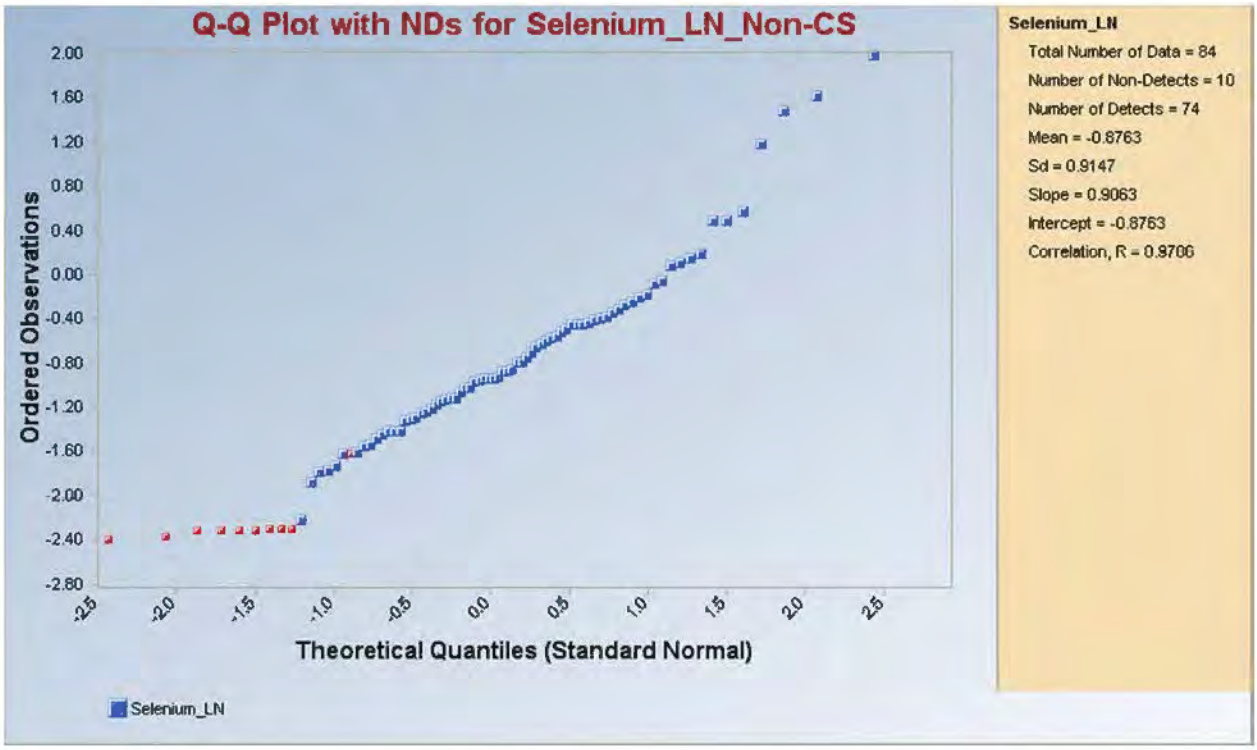

Q-Q Plot with NDs for Mercury_non-CS
Ordered Observations
0.06
0.05
0.04
0.03
0.02
0.01
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Mercury
Mercury
Total Number of Data = 75
Number of Non-Detects = 65
Number of Detects = 10
Mean = 0.0179
Sd = 0.0115
Slope = 0.0098
Intercept = 0.0179
Correlation, R = 0.0393

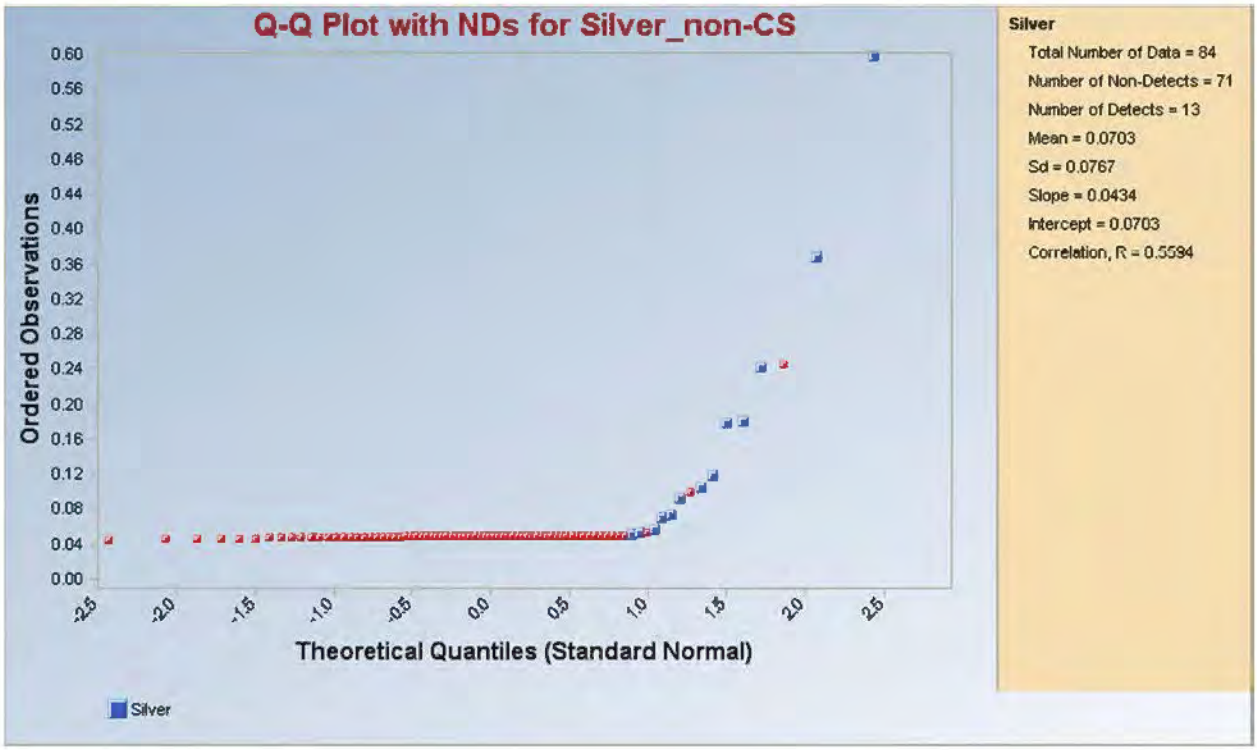

Q-Q Plot (NDs not Displayed) for Mercury_non-CS
Ordered Observations
0.06
0.05
0.04
0.03
0.02
0.01
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Mercury
Mercury
Total Number of Data = 75
Number of Non-Detects = 65
Number of Detects = 10
Mean = 0.0268
Sd = 0.0145
Slope = 0.0145
Intercept = 0.0268
Correlation, R = 0.9405

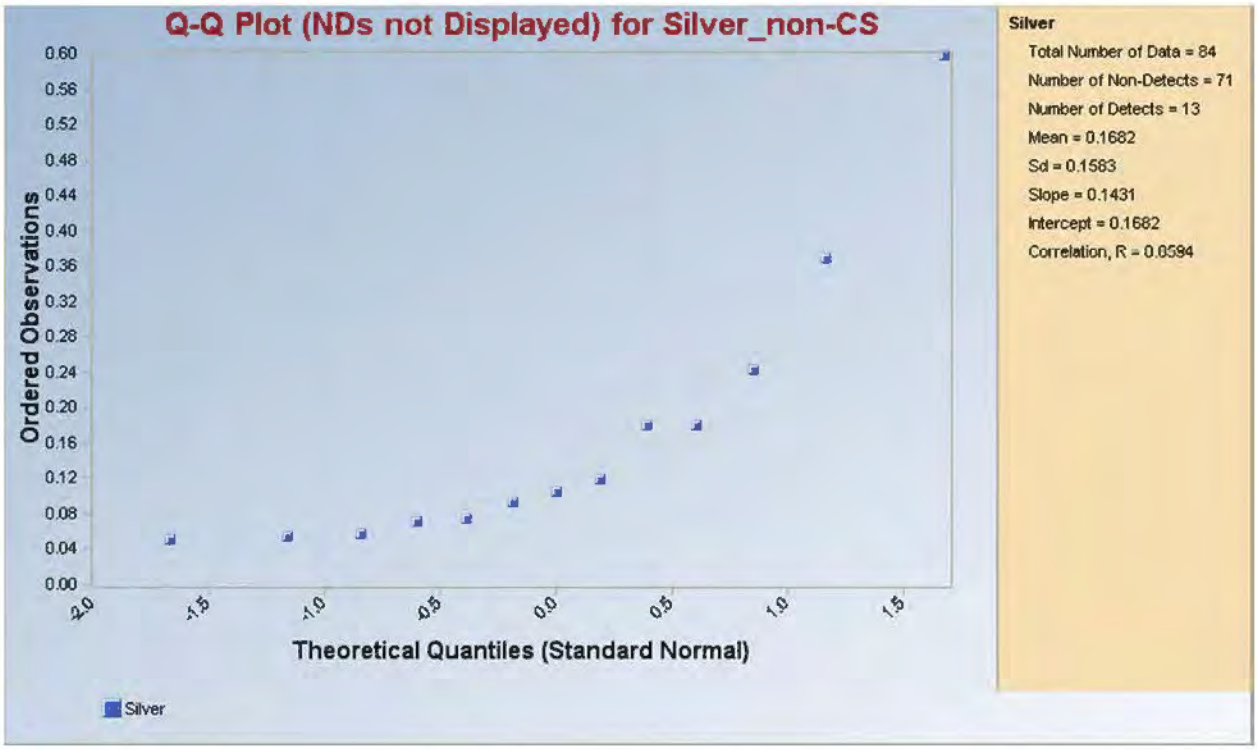

Q-Q Plot with NDs for Molybdenum
Ordered Observations
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 84
Number of Non-Detects = 42
Number of Detects = 42
Mean = 9.8242
Sd = 35.6931
Slope = 17.1835
Intercept = 9.8242
Correlation, R = 0.4755

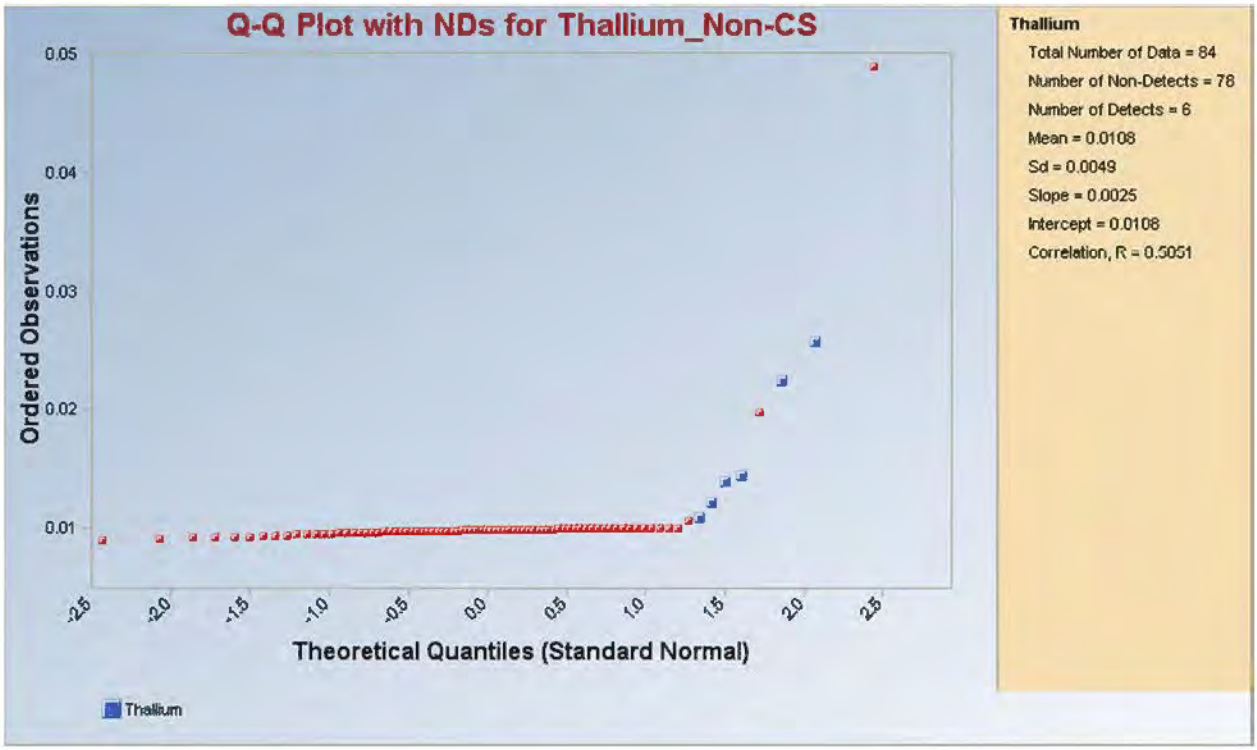

Q-Q Plot (NDs not Displayed) for Molybdenum_non-CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 84
Number of Non-Detects = 42
Number of Detects = 42
Mean = 17.7674
Sd = 49.4893
Slope = 29.6668
Intercept = 17.7674
Correlation, R = 0.5000

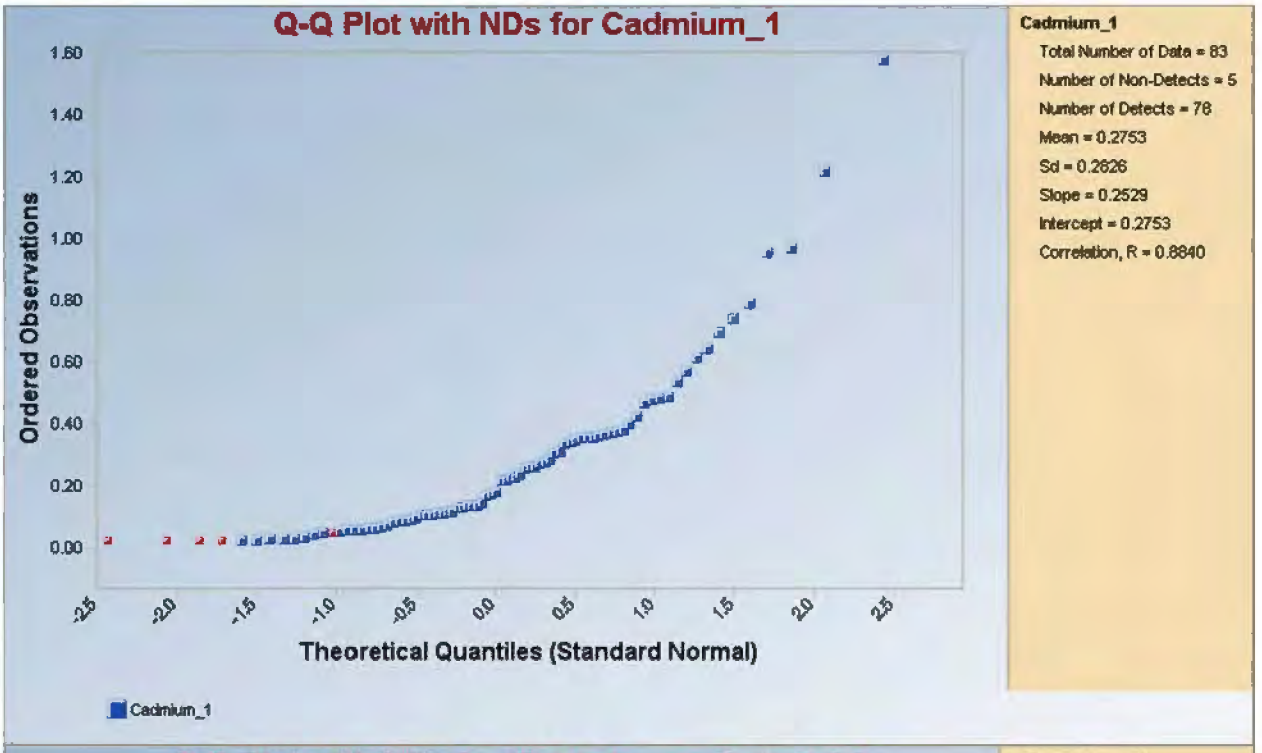

Q-Q Plot with NDs for Selenium_non-CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Selenium
Selenium
Total Number of Data = 84
Number of Non-Detects = 10
Number of Detects = 74
Mean = 0.6934
Sd = 1.0781
Slope = 0.7496
Intercept = 0.6934
Correlation, R = 0.6067

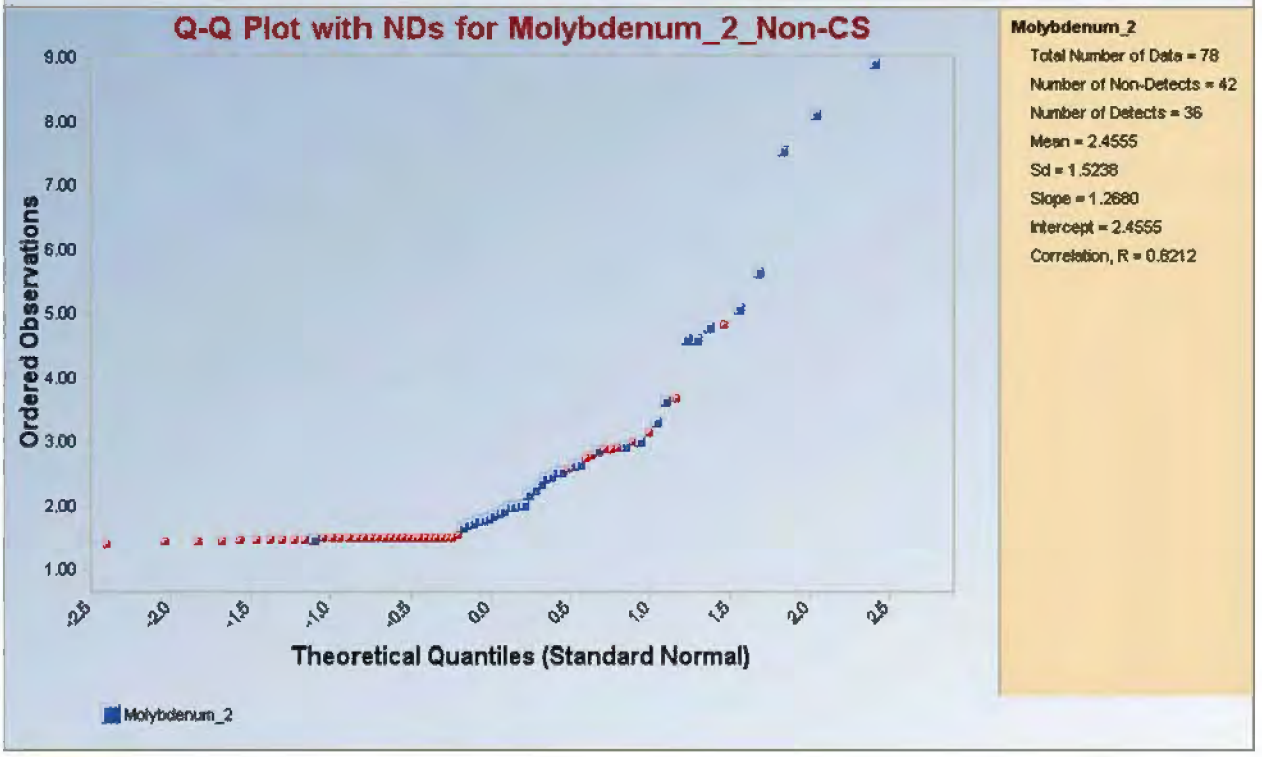

Q-Q Plot with NDs for Selenium_LN_Non-CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Selenium_LN
Selenium_LN
Total Number of Data = 84
Number of Non-Detects = 10
Number of Detects = 74
Mean = -0.8763
Sd = 0.9147
Slope = 0.9063
Intercept = -0.8763
Correlation, R = 0.9706

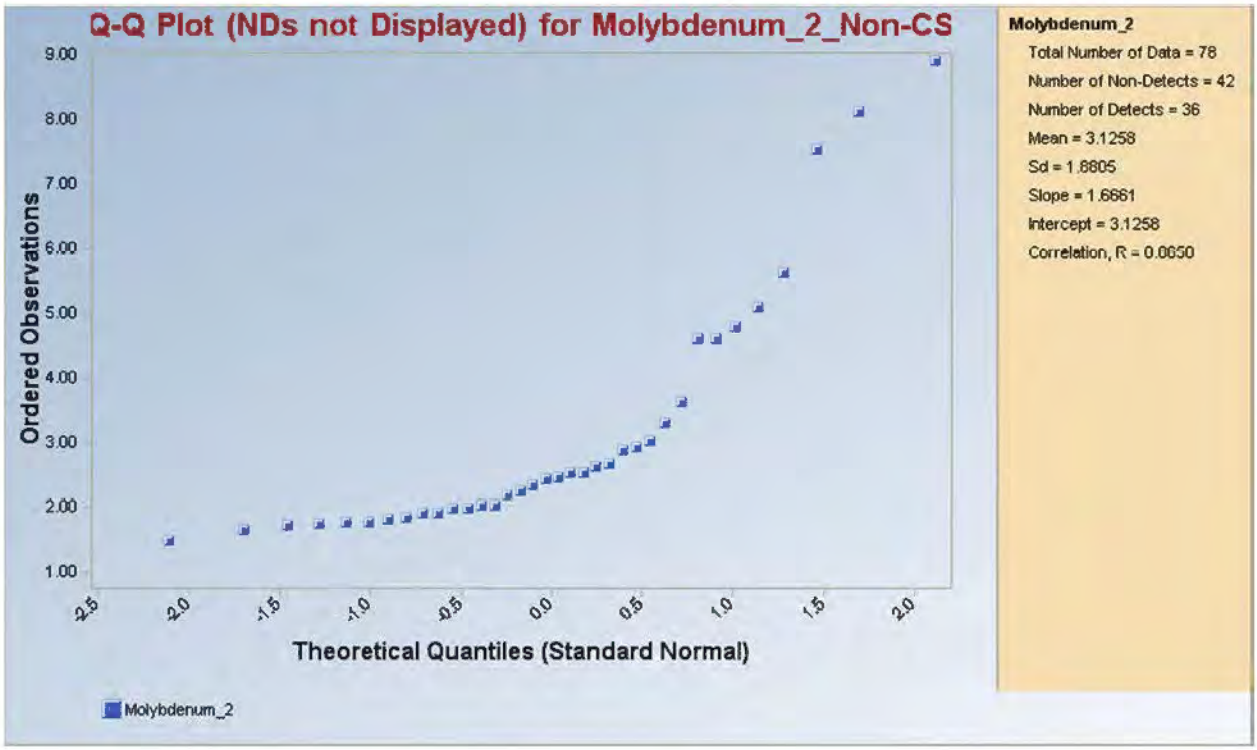

Q-Q Plot with NDs for Silver_non-CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Silver
Silver
Total Number of Data = 84
Number of Non-Detects = 71
Number of Detects = 13
Mean = 0.0703
Sd = 0.0767
Slope = 0.0434
Intercept = 0.0703
Correlation, R = 0.5594


Q-Q Plot (NDs not Displayed) for Silver_non-CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Silver
Silver
Total Number of Data = 84
Number of Non-Detects = 71
Number of Detects = 13
Mean = 0.1682
Sd = 0.1583
Slope = 0.1431
Intercept = 0.1682
Correlation, R = 0.6594

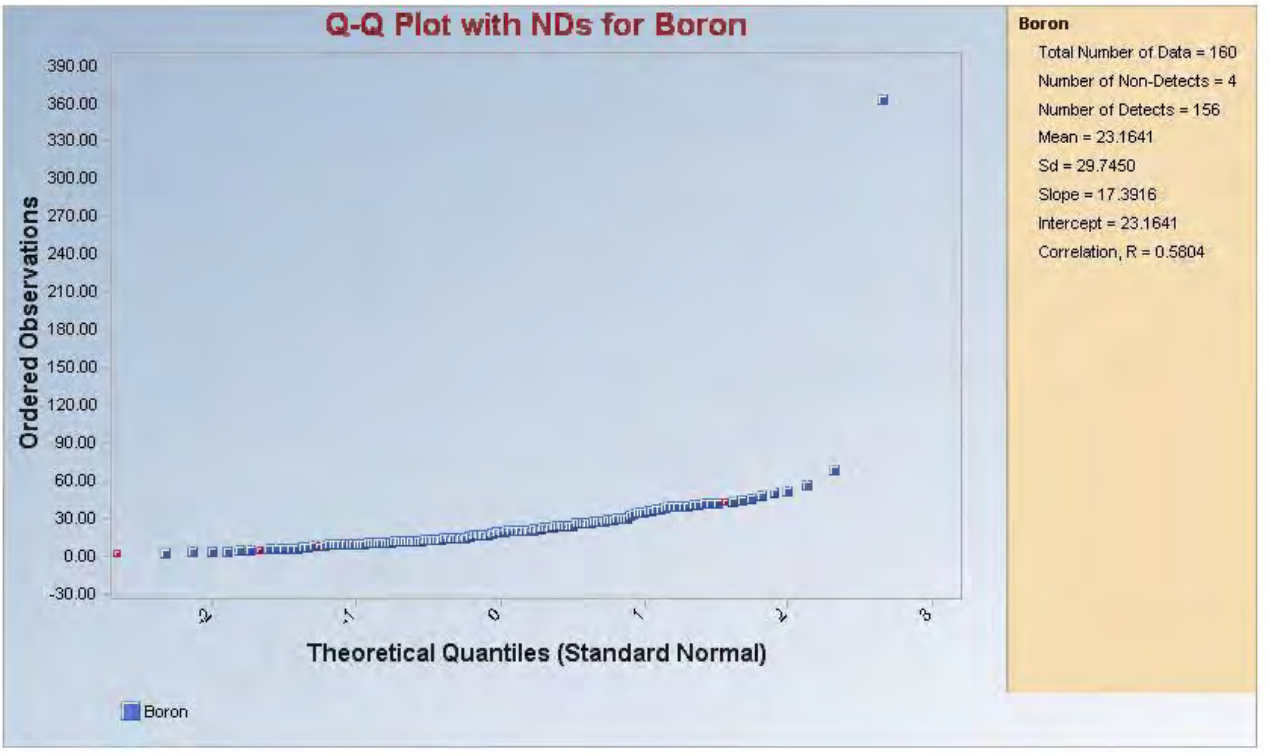

Q-Q Plot with NDs for Thallium_Non-CS
Ordered Observations
0.05
0.04
0.03
0.02
0.01
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Thallium
Thallium
Total Number of Data = 84
Number of Non-Detects = 78
Number of Detects = 6
Mean = 0.0108
Sd = 0.0049
Slope = 0.0025
Intercept = 0.0108
Correlation, R = 0.5051

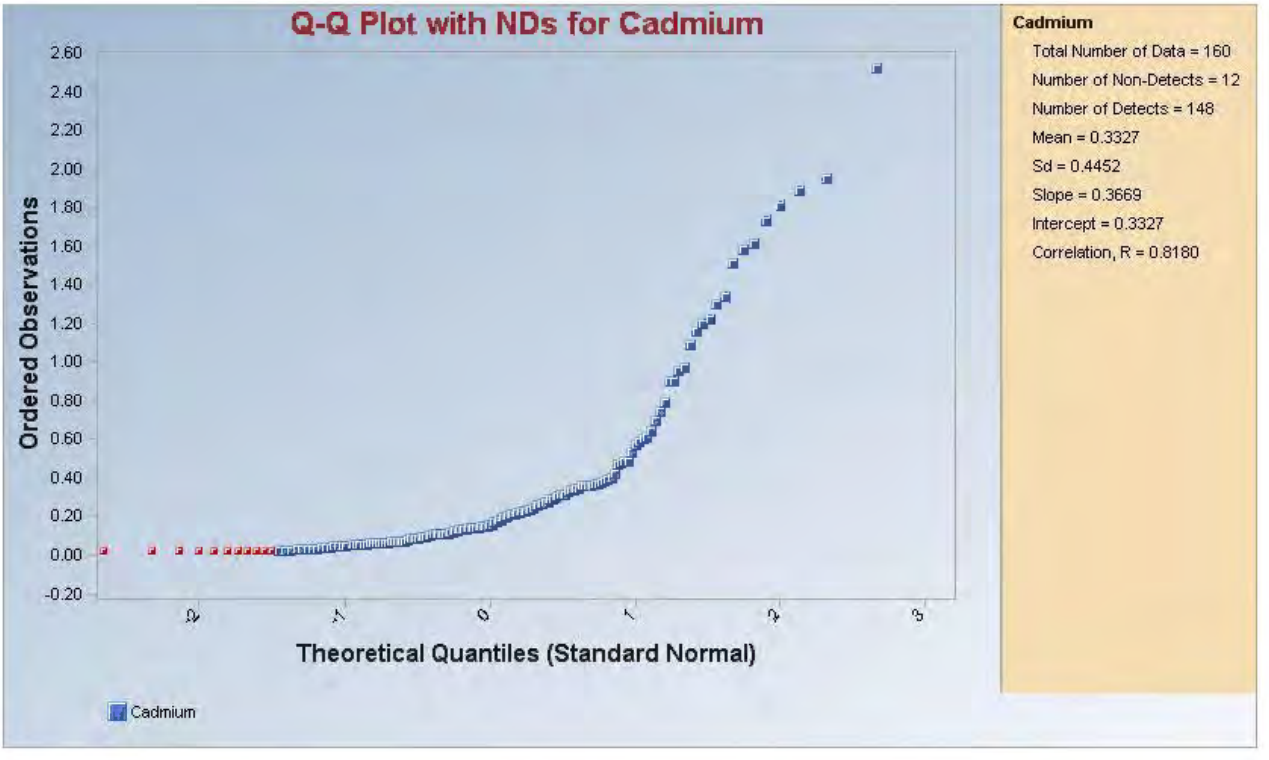

Q-Q Plot with NDs for Cadmium_1
Ordered Observations
Theoretical Quantiles (Standard Normal)
Cadmium_1
Cadmium_1
Total Number of Data = 83
Number of Non-Detects = 5
Number of Detects = 78
Mean = 0.2753
Sd = 0.2626
Slope = 0.2529
Intercept = 0.2753
Correlation, R = 0.8840

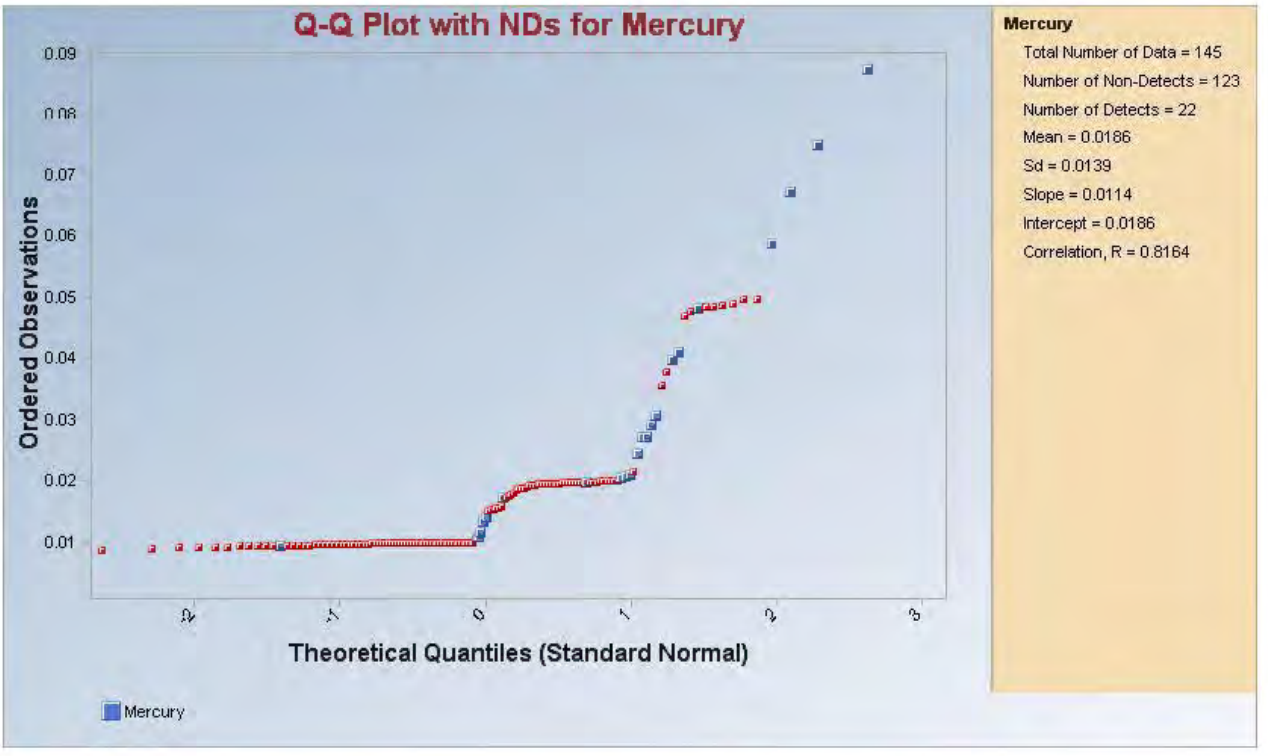

Q-Q Plot with NDs for Molybdenum_2_Non-CS
Ordered Observations
Theoretical Quantiles (Standard Normal)
Molybdenum_2
Molybdenum_2
Total Number of Data = 78
Number of Non-Detects = 42
Number of Detects = 36
Mean = 2.4555
Sd = 1.5238
Slope = 1.2680
Intercept = 2.4555
Correlation, R = 0.8212

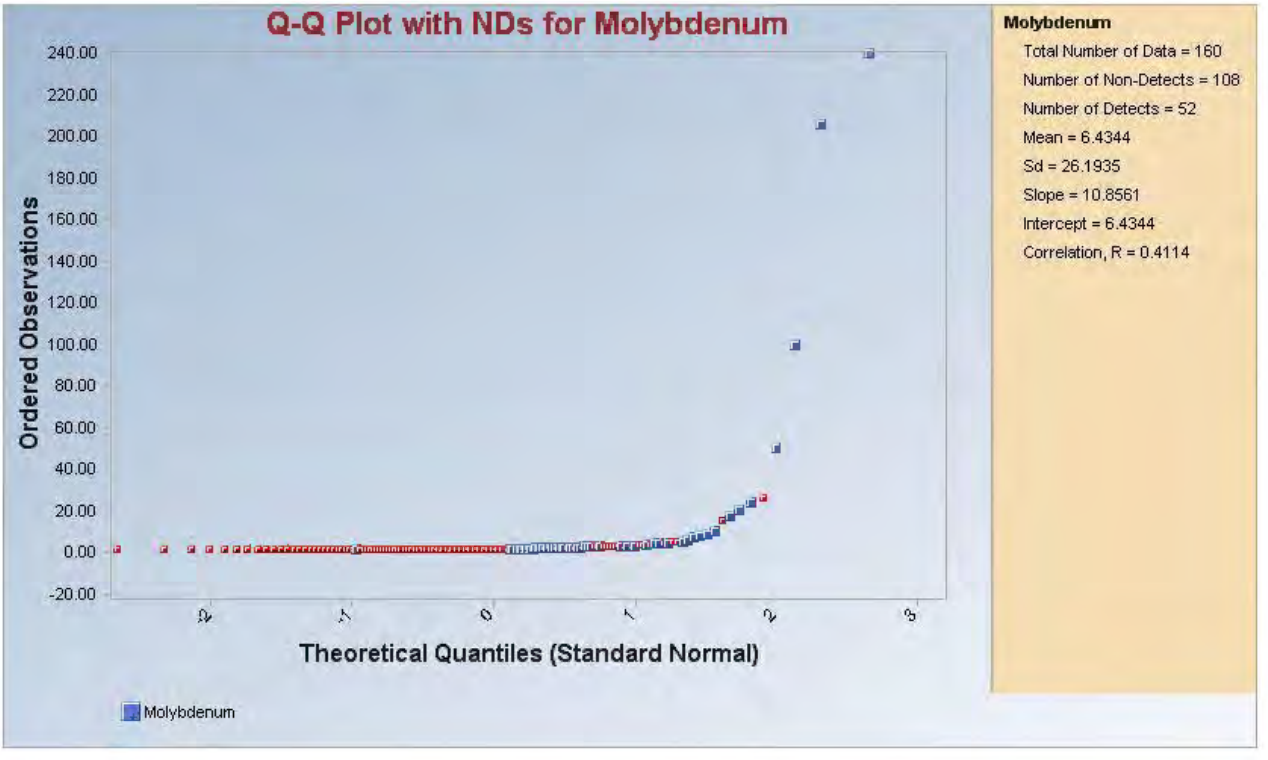

Q-Q Plot (NDs not Displayed) for Molybdenum_2_Non-CS
Ordered Observations
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Molybdenum_2
Molybdenum_2
Total Number of Data = 78
Number of Non-Detects = 42
Number of Detects = 36
Mean = 3.1258
Sd = 1.8805
Slope = 1.6661
Intercept = 3.1258
Correlation, R = 0.0650

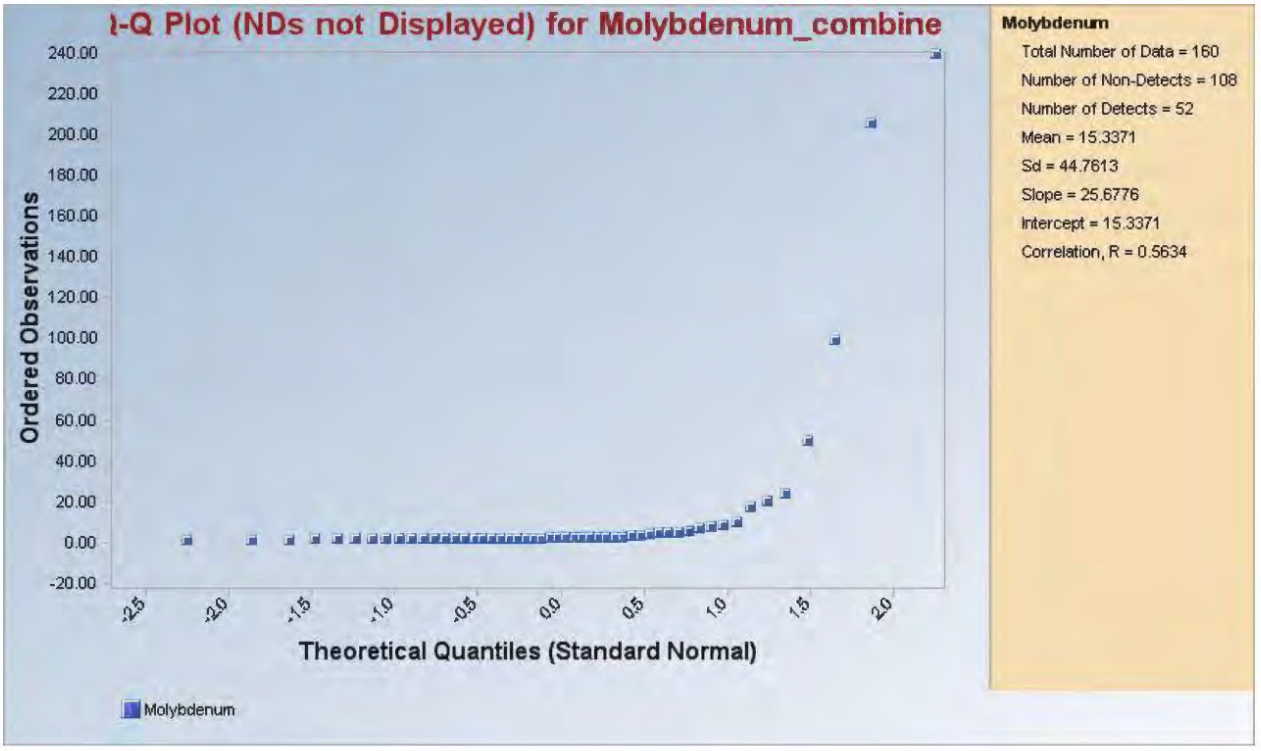
COMBINED UPLAND VEGETATION – QQ PLOTS

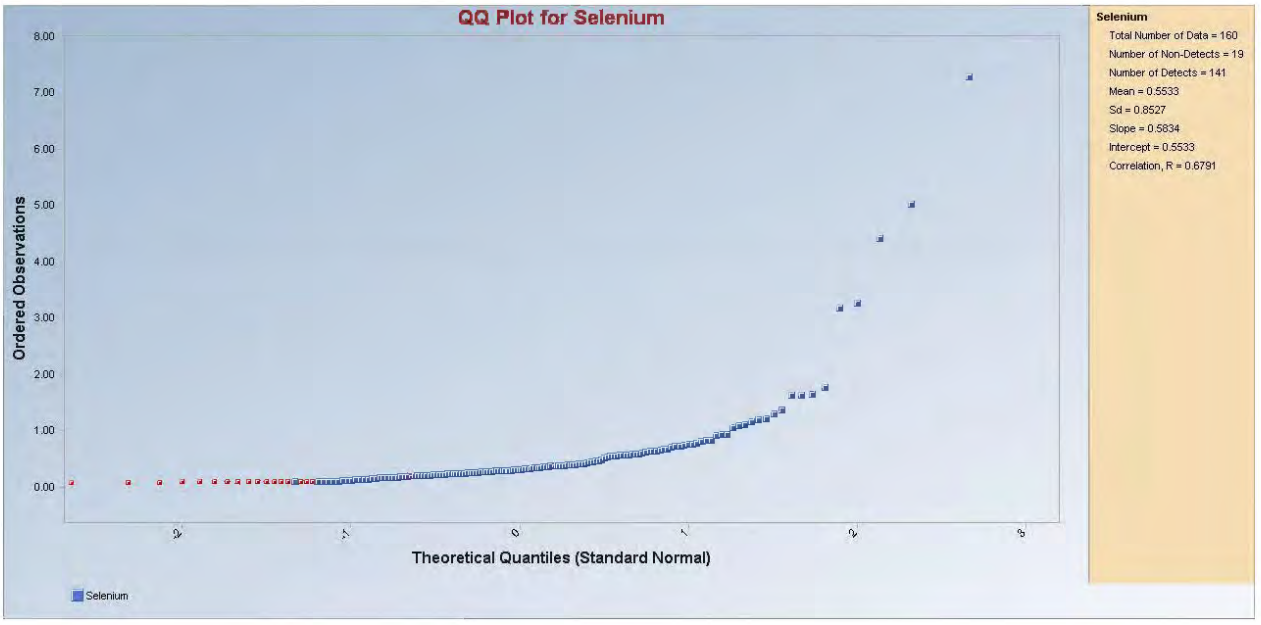

Q-Q Plot with NDs for Boron
Ordered Observations
390.00
360.00
330.00
300.00
270.00
240.00
210.00
180.00
150.00
120.00
90.00
60.00
30.00
0.00
-30.00
-2
-1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Boron
Boron
Total Number of Data = 160
Number of Non-Detects = 4
Number of Detects = 156
Mean = 23.1641
Sd = 29.7450
Slope = 17.3916
Intercept = 23.1641
Correlation, R = 0.5804

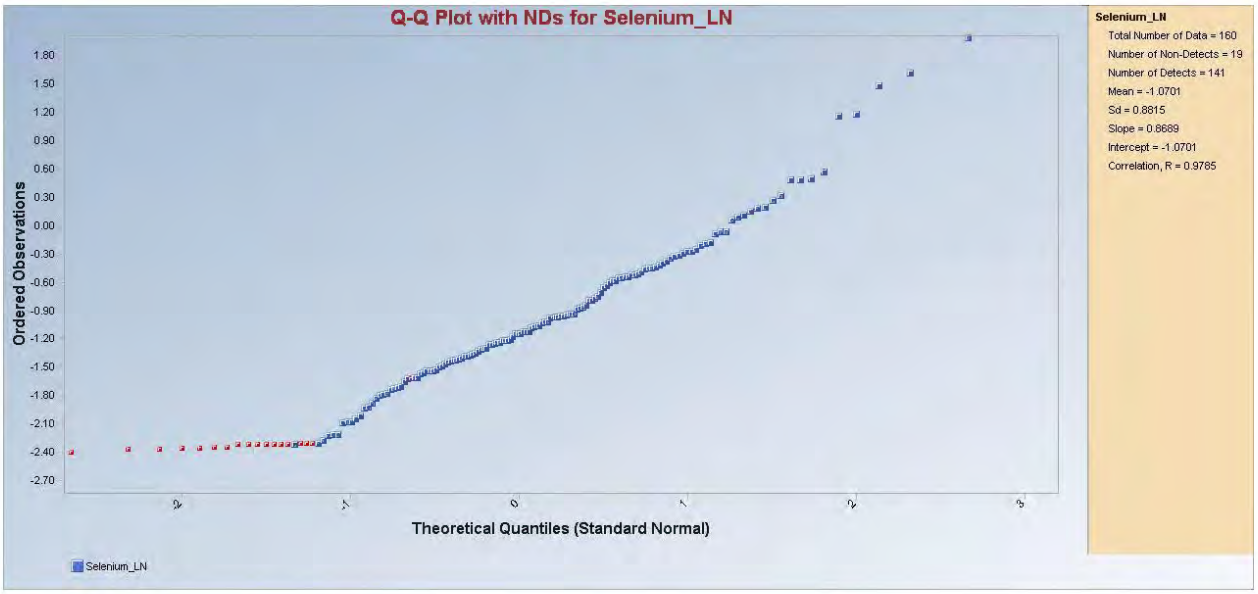

Q-Q Plot with NDs for Cadmium
Ordered Observations
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-2
-1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Cadmium
Cadmium
Total Number of Data = 160
Number of Non-Detects = 12
Number of Detects = 148
Mean = 0.3327
Sd = 0.4452
Slope = 0.3669
Intercept = 0.3327
Correlation, R = 0.8180

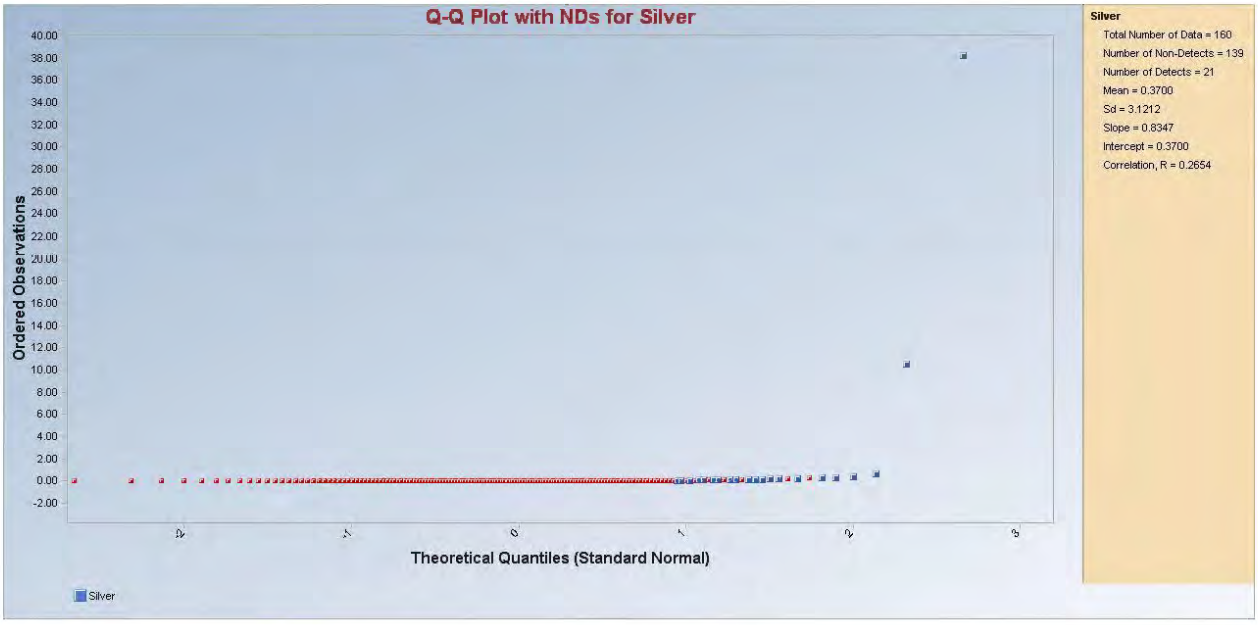

Q-Q Plot with NDs for Mercury
Ordered Observations
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
-2
-1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Mercury
Mercury
Total Number of Data = 145
Number of Non-Detects = 123
Number of Detects = 22
Mean = 0.0186
Sd = 0.0139
Slope = 0.0114
Intercept = 0.0186
Correlation, R = 0.8164

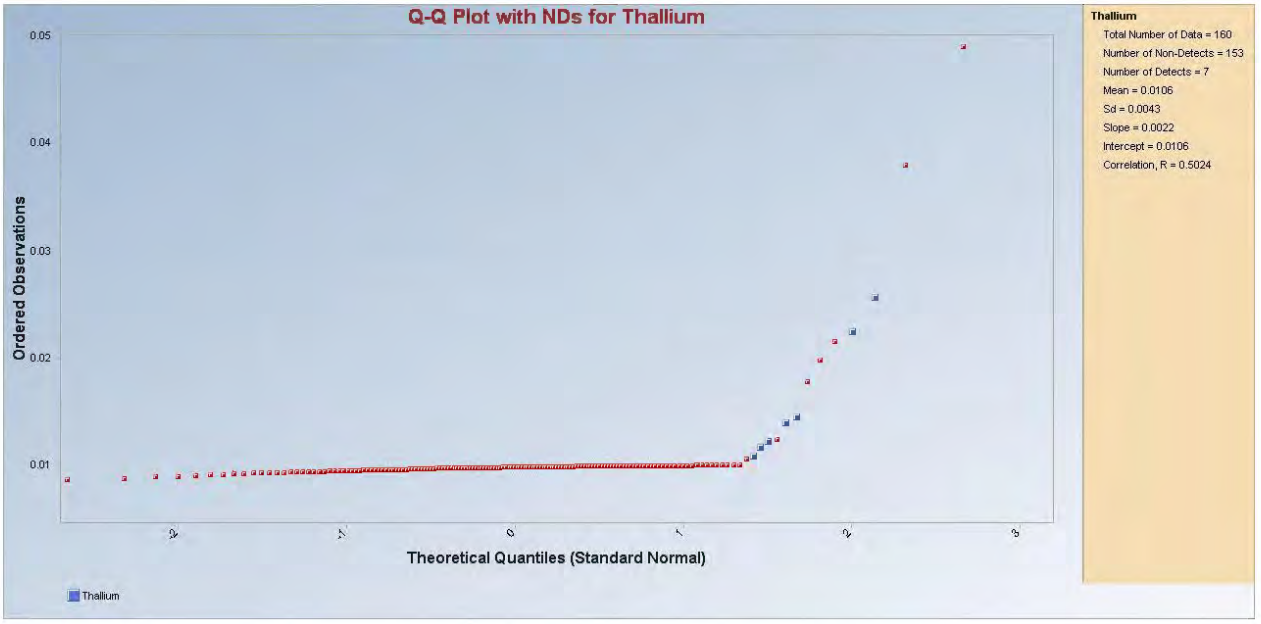

Q-Q Plot with NDs for Molybdenum
Ordered Observations
240.00
220.00
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-2
-1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 160
Number of Non-Detects = 108
Number of Detects = 52
Mean = 6.4344
Sd = 26.1935
Slope = 10.8561
Intercept = 6.4344
Correlation, R = 0.4114

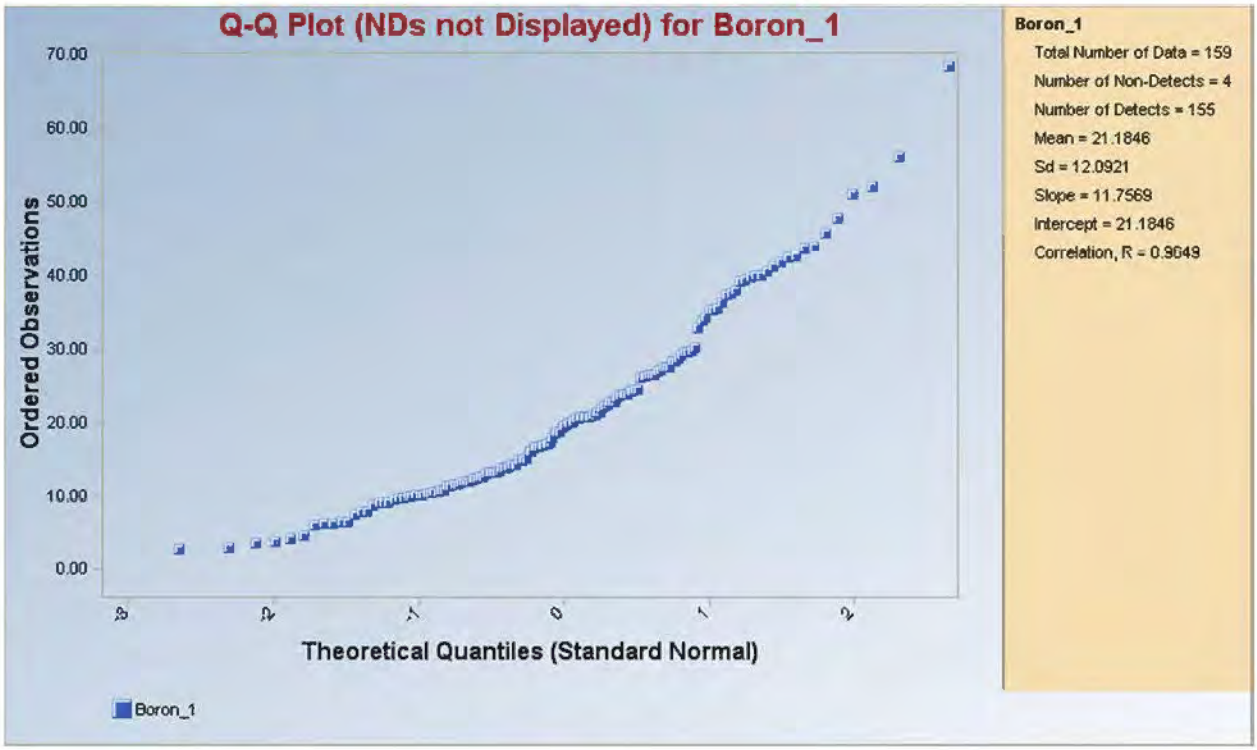

-Q Plot (NDs not Displayed) for Molybdenum_combine
Ordered Observations
Theoretical Quantiles (Standard Normal)
Molybdenum
Molybdenum
Total Number of Data = 160
Number of Non-Detects = 108
Number of Detects = 52
Mean = 15.3371
Sd = 44.7613
Slope = 25.6776
Intercept = 15.3371
Correlation, R = 0.5634

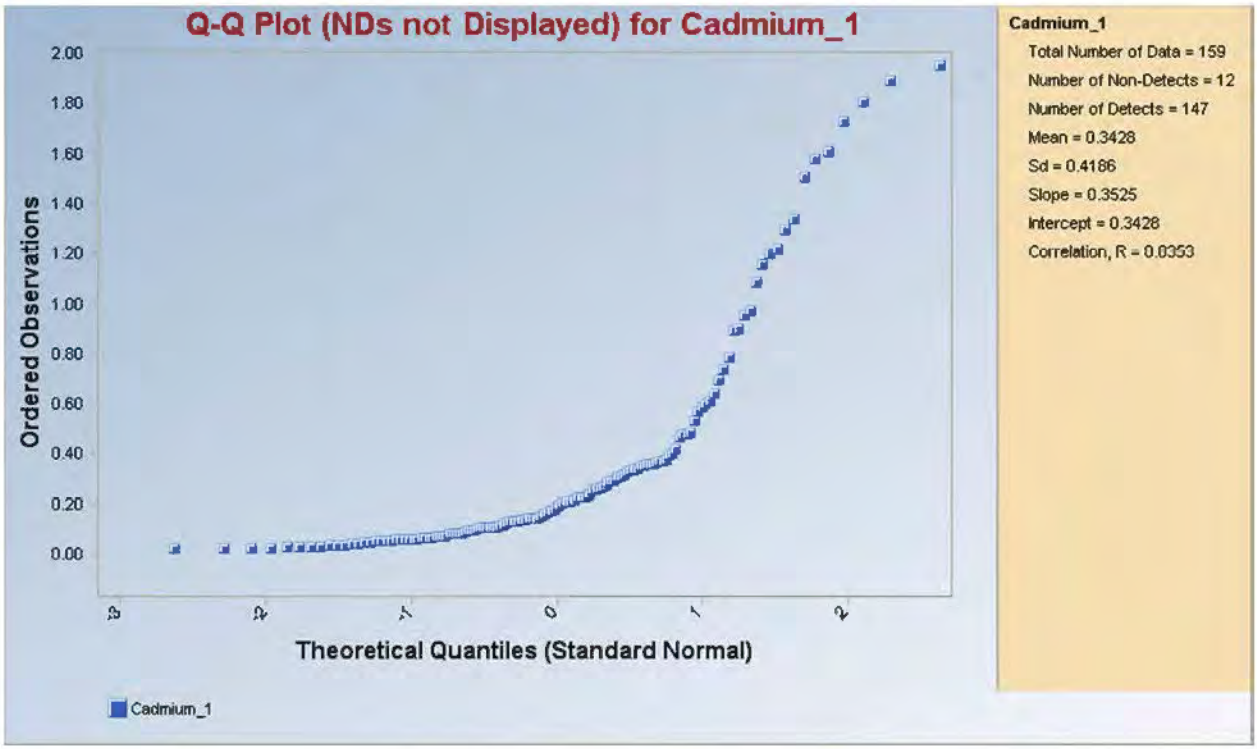

QQ Plot for Selenium
Ordered Observations
Theoretical Quantiles (Standard Normal)
Selenium
Selenium
Total Number of Data = 160
Number of Non-Detects = 19
Number of Detects = 141
Mean = 0.5533
Sd = 0.8527
Slope = 0.5834
Intercept = 0.5533
Correlation, R = 0.6791

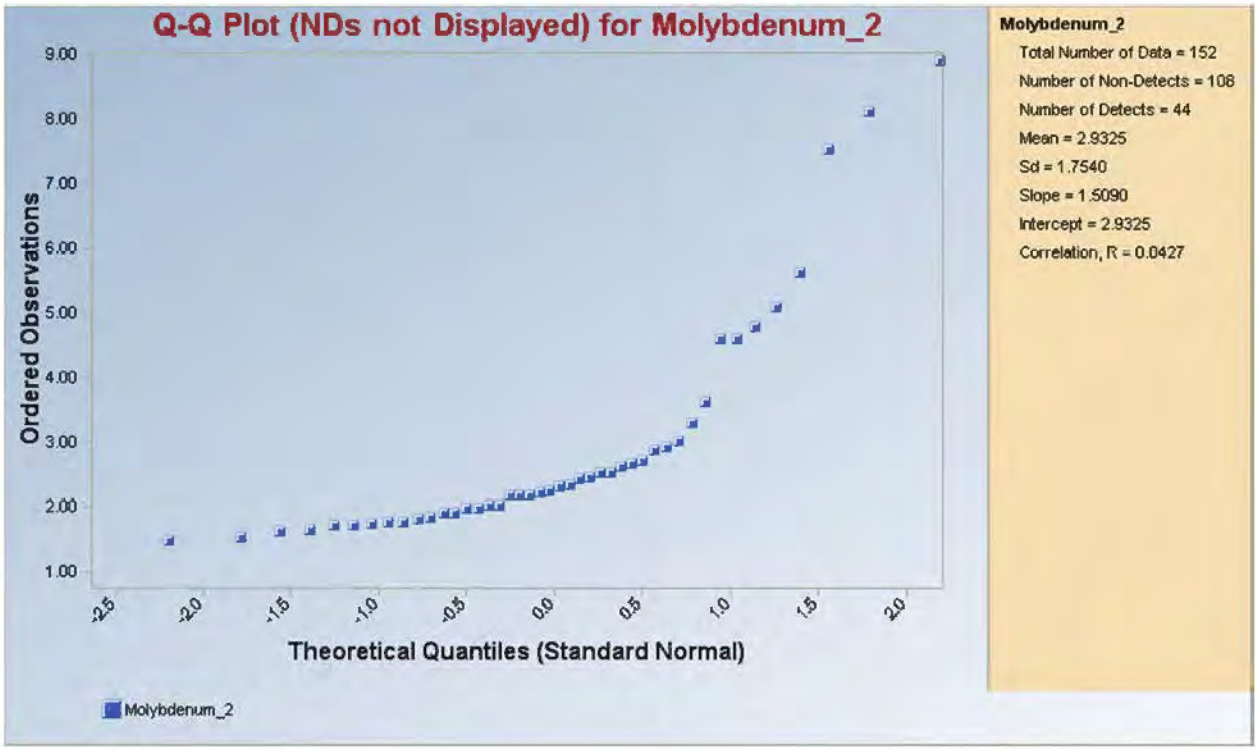

Q-Q Plot with NDs for Selenium_LN
Ordered Observations
Theoretical Quantiles (Standard Normal)
Selenium_LN
Selenium_LN
Total Number of Data = 160
Number of Non-Detects = 19
Number of Detects = 141
Mean = -1.0701
Sd = 0.8815
Slope = 0.8689
Intercept = -1.0701
Correlation, R = 0.9785

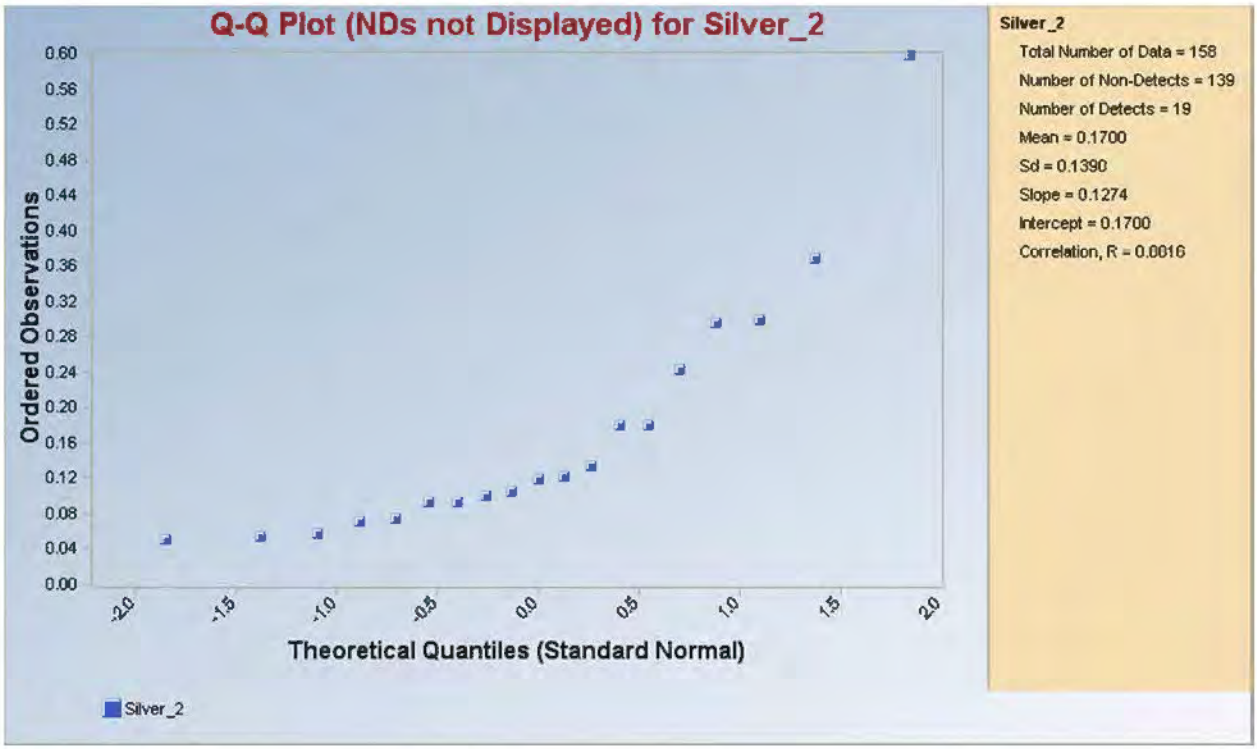

Q-Q Plot with NDs for Silver
Ordered Observations
Theoretical Quantiles (Standard Normal)
Silver
Silver
Total Number of Data = 160
Number of Non-Detects = 139
Number of Detects = 21
Mean = 0.3700
Sd = 3.1212
Slope = 0.8347
Intercept = 0.3700
Correlation, R = 0.2654


Q-Q Plot with NDs for Thallium
Ordered Observations
0.05
0.04
0.03
0.02
0.01
-2
-1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Thallium
Thallium
Total Number of Data = 160
Number of Non-Detects = 153
Number of Detects = 7
Mean = 0.0106
Sd = 0.0043
Slope = 0.0022
Intercept = 0.0106
Correlation, R = 0.5024

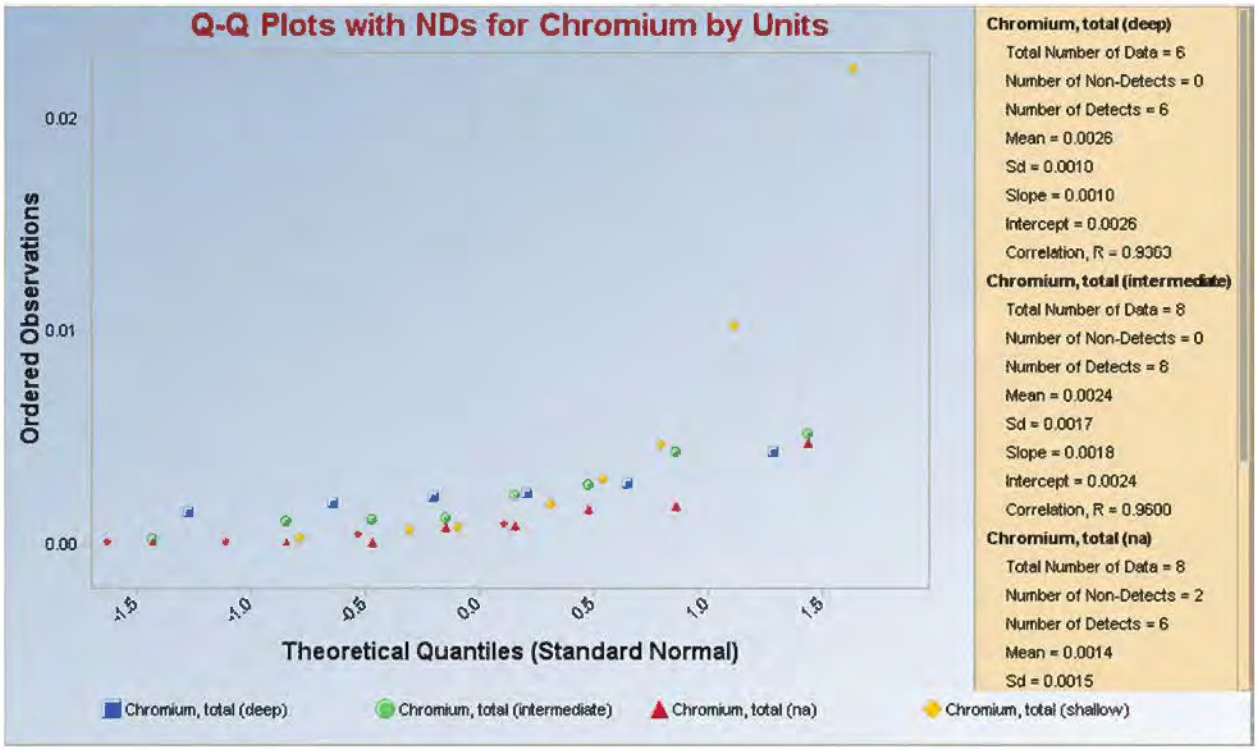

Q-Q Plot (NDs not Displayed) for Boron_1
Ordered Observations
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-3
-2
-1
0
1
2
Theoretical Quantiles (Standard Normal)
Boron_1
Boron_1
Total Number of Data = 159
Number of Non-Detects = 4
Number of Detects = 155
Mean = 21.1846
Sd = 12.0921
Slope = 11.7569
Intercept = 21.1846
Correlation, R = 0.9649

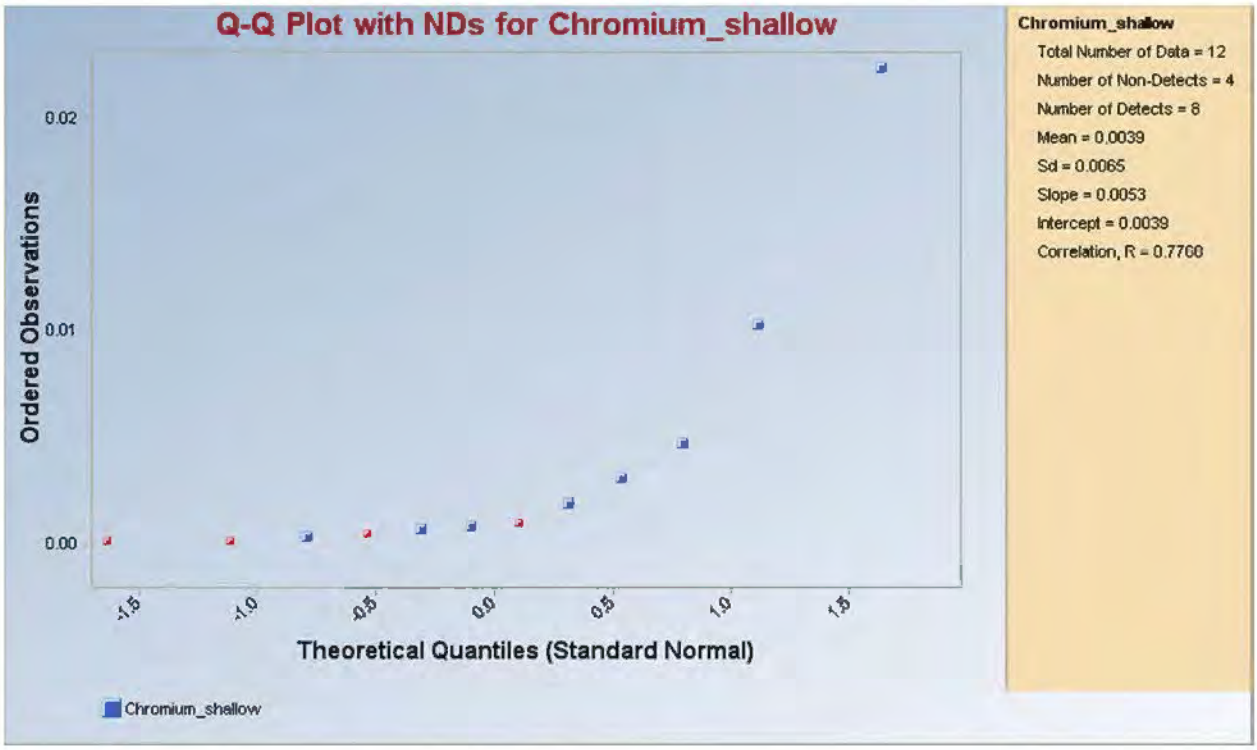

Q-Q Plot (NDs not Displayed) for Cadmium_1
Ordered Observations
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-3
-2
-1
0
1
2
Theoretical Quantiles (Standard Normal)
Cadmium_1
Cadmium_1
Total Number of Data = 159
Number of Non-Detects = 12
Number of Detects = 147
Mean = 0.3428
Sd = 0.4186
Slope = 0.3525
Intercept = 0.3428
Correlation, R = 0.0353

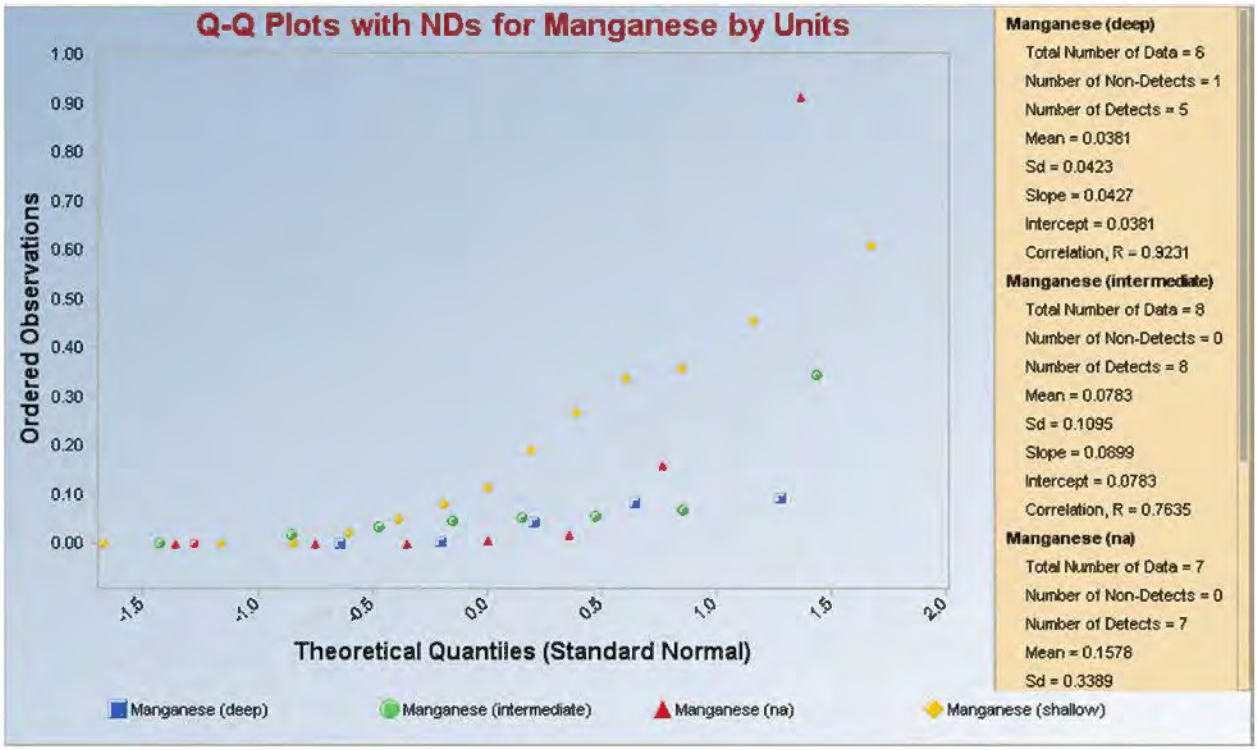

Q-Q Plot (NDs not Displayed) for Molybdenum_2
Ordered Observations
Theoretical Quantiles (Standard Normal)
Molybdenum_2
Molybdenum_2
Total Number of Data = 152
Number of Non-Detects = 108
Number of Detects = 44
Mean = 2.9325
Sd = 1.7540
Slope = 1.5090
Intercept = 2.9325
Correlation, R = 0.0427

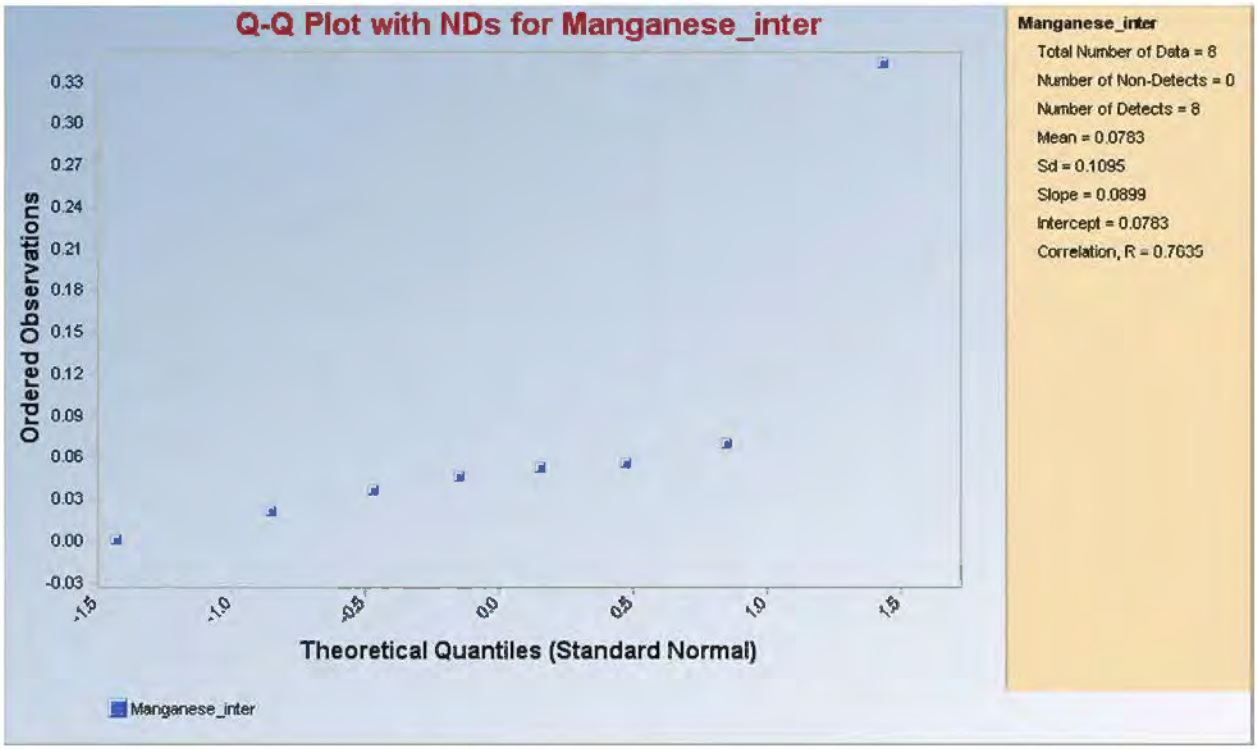

Q-Q Plot (NDs not Displayed) for Silver_2
Ordered Observations
Theoretical Quantiles (Standard Normal)
Silver_2
Silver_2
Total Number of Data = 158
Number of Non-Detects = 139
Number of Detects = 19
Mean = 0.1700
Sd = 0.1390
Slope = 0.1274
Intercept = 0.1700
Correlation, R = 0.0016

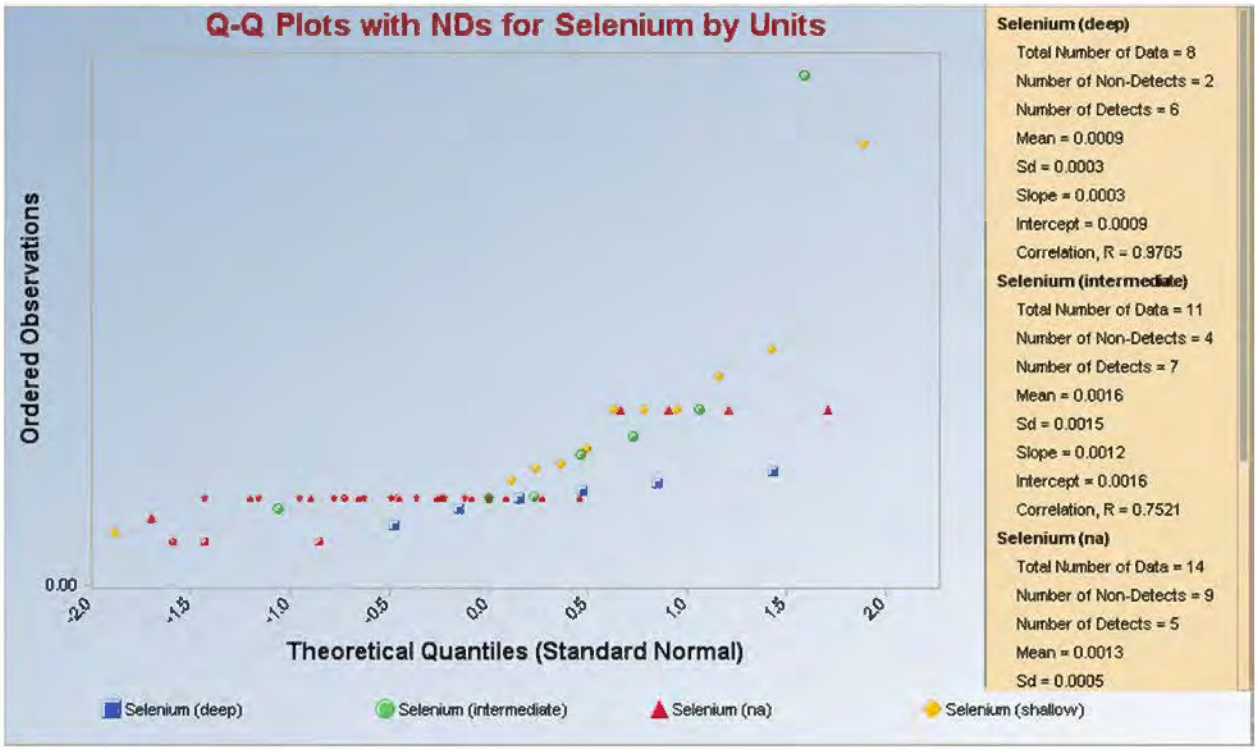
GROUNDWATER – QQ PLOTS

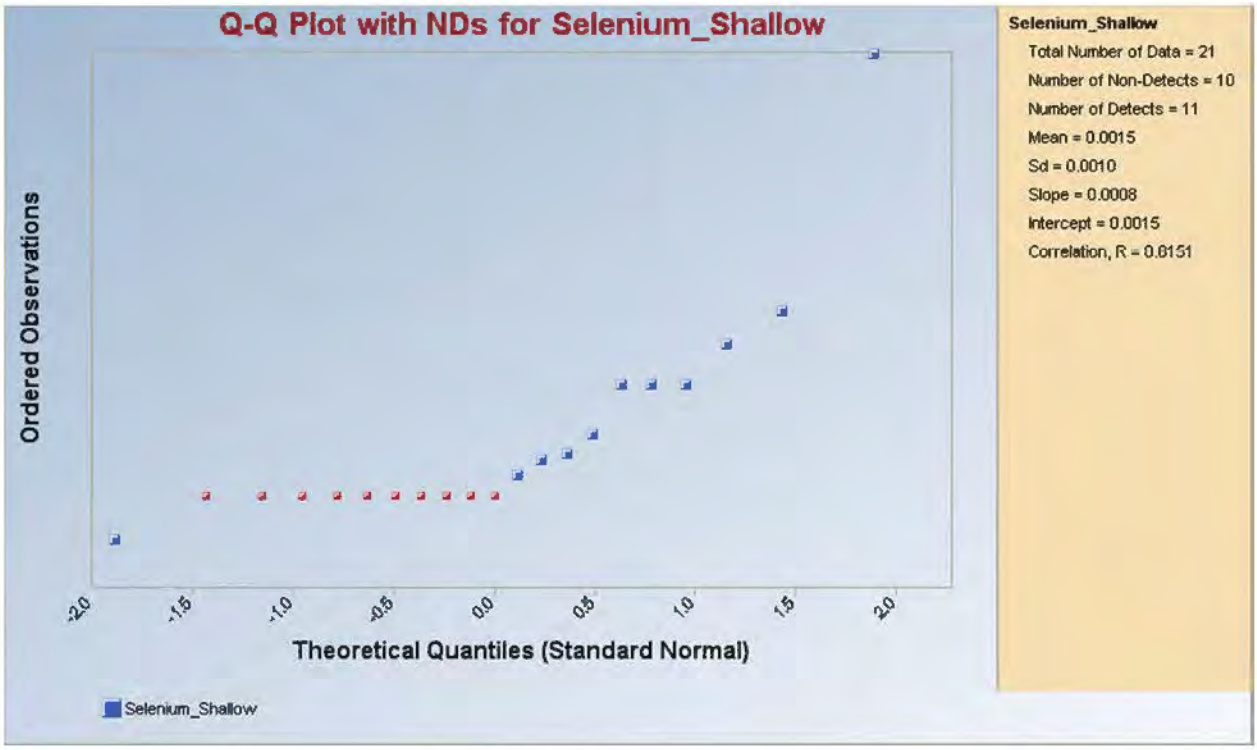

Q-Q Plots with NDs for Chromium by Units
Ordered Observations
0.02
0.01
0.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Chromium, total (deep)
Total Number of Data = 6
Number of Non-Detects = 0
Number of Detects = 6
Mean = 0.0026
Sd = 0.0010
Slope = 0.0010
Intercept = 0.0026
Correlation, R = 0.9363
Chromium, total (intermediate)
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 0.0024
Sd = 0.0017
Slope = 0.0018
Intercept = 0.0024
Correlation, R = 0.9600
Chromium, total (na)
Total Number of Data = 8
Number of Non-Detects = 2
Number of Detects = 6
Mean = 0.0014
Sd = 0.0015
Chromium, total (deep)
Chromium, total (intermediate)
Chromium, total (na)
Chromium, total (shallow)

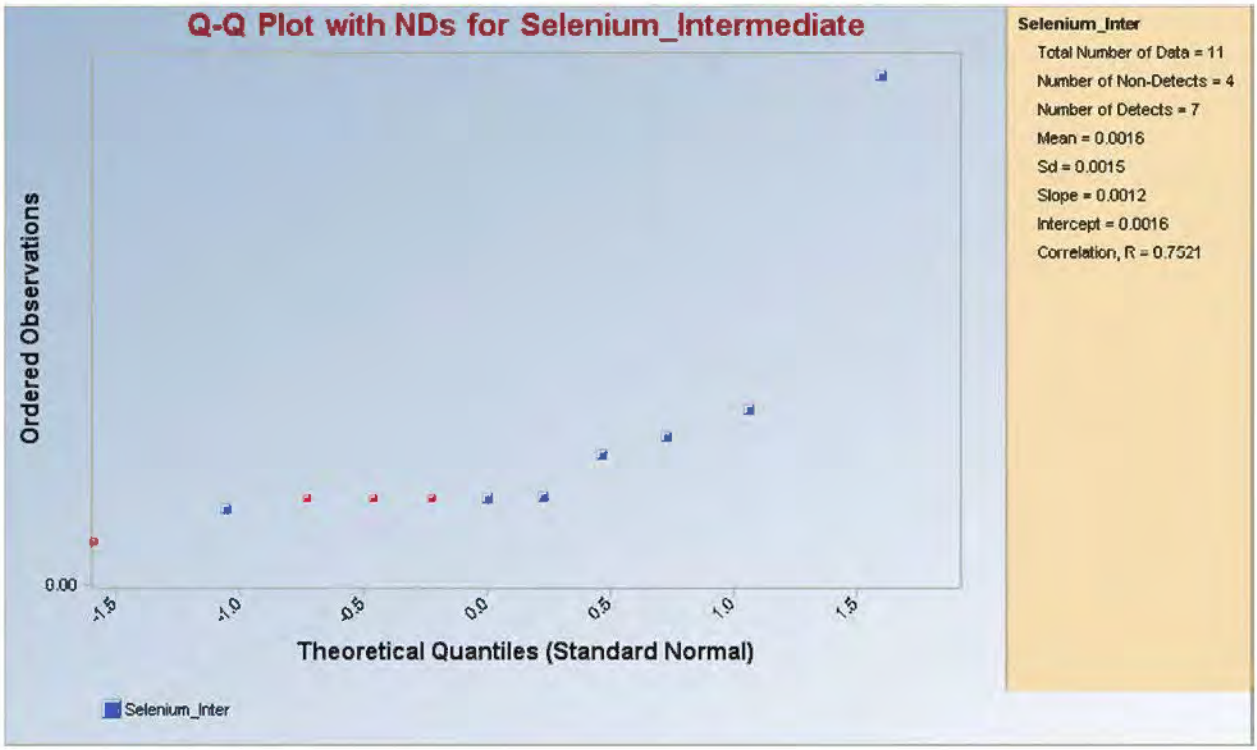

Q-Q Plot with NDs for Chromium_shallow
Ordered Observations
0.02
0.01
0.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Chromium_shallow
Total Number of Data = 12
Number of Non-Detects = 4
Number of Detects = 8
Mean = 0.0039
Sd = 0.0065
Slope = 0.0053
Intercept = 0.0039
Correlation, R = 0.7760
Chromium_shallow

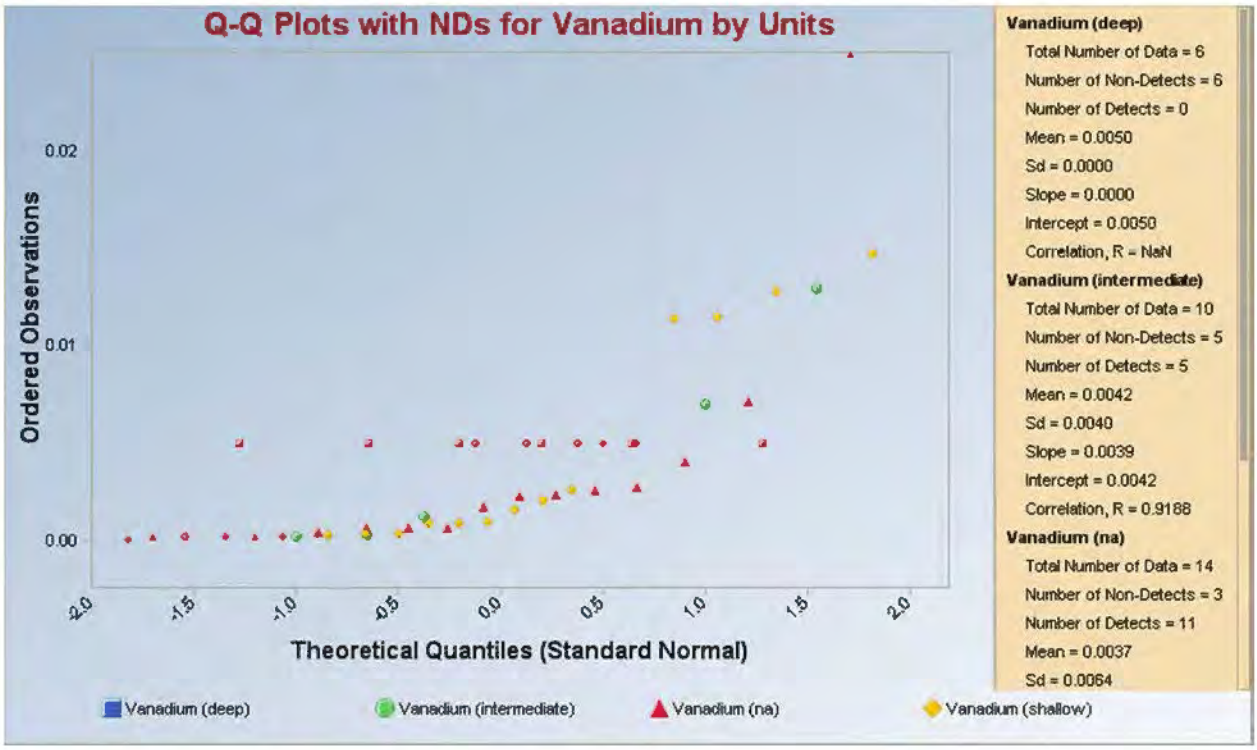

Q-Q Plots with NDs for Manganese by Units
Ordered Observations
Theoretical Quantiles (Standard Normal)
Manganese (deep)
Total Number of Data = 6
Number of Non-Detects = 1
Number of Detects = 5
Mean = 0.0381
Sd = 0.0423
Slope = 0.0427
Intercept = 0.0381
Correlation, R = 0.9231
Manganese (intermediate)
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 0.0783
Sd = 0.1095
Slope = 0.0899
Intercept = 0.0783
Correlation, R = 0.7635
Manganese (na)
Total Number of Data = 7
Number of Non-Detects = 0
Number of Detects = 7
Mean = 0.1578
Sd = 0.3389
Manganese (deep)
Manganese (intermediate)
Manganese (na)
Manganese (shallow)

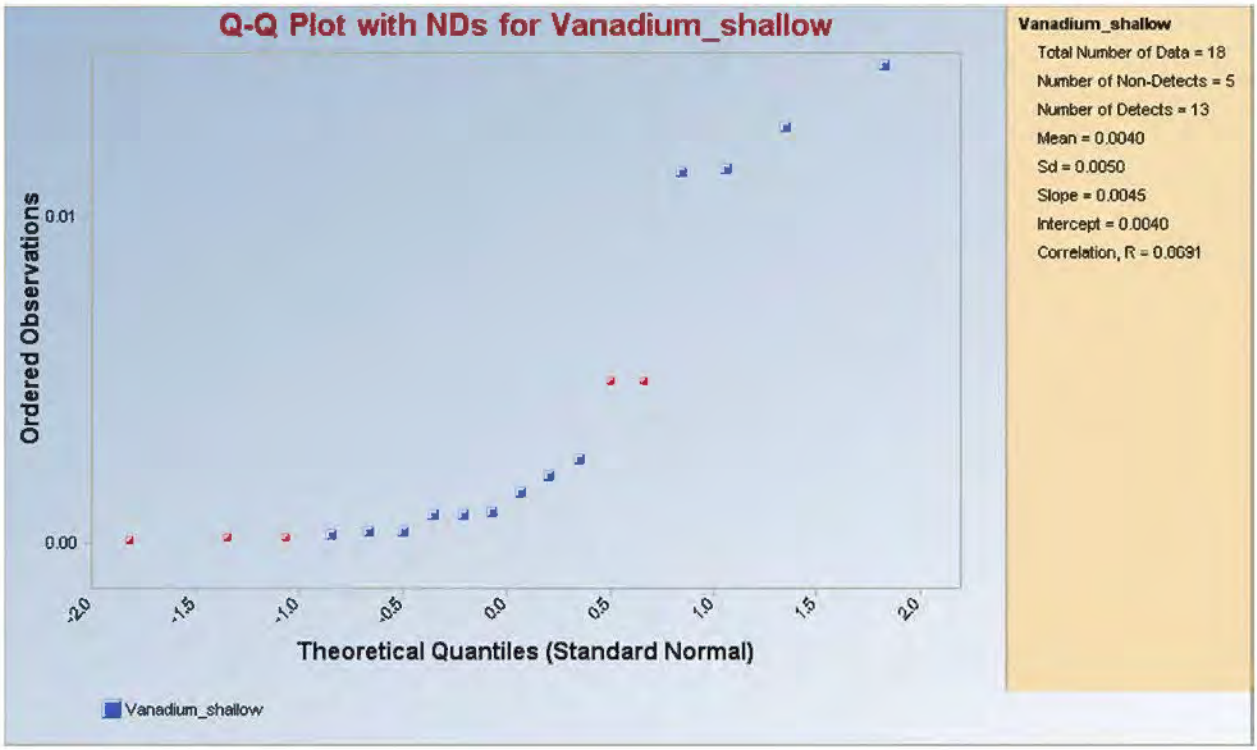

Q-Q Plot with NDs for Manganese_inter
Ordered Observations
Theoretical Quantiles (Standard Normal)
Manganese_inter
Total Number of Data = 8
Number of Non-Detects = 0
Number of Detects = 8
Mean = 0.0783
Sd = 0.1095
Slope = 0.0899
Intercept = 0.0783
Correlation, R = 0.7635
Manganese_inter

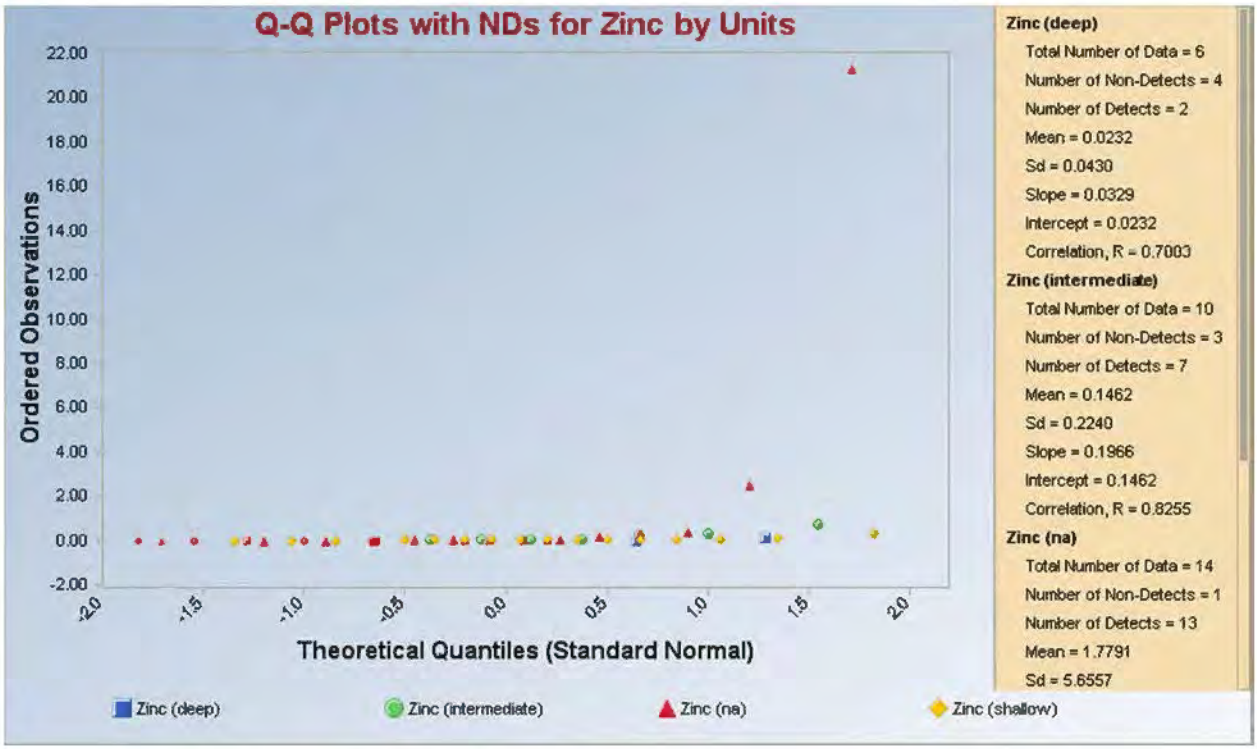

Q-Q Plots with NDs for Selenium by Units
Ordered Observations
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Selenium (deep)
Selenium (intermediate)
Selenium (na)
Selenium (shallow)
Selenium (deep)
Total Number of Data = 8
Number of Non-Detects = 2
Number of Detects = 6
Mean = 0.0009
Sd = 0.0003
Slope = 0.0003
Intercept = 0.0009
Correlation, R = 0.9765
Selenium (intermediate)
Total Number of Data = 11
Number of Non-Detects = 4
Number of Detects = 7
Mean = 0.0016
Sd = 0.0015
Slope = 0.0012
Intercept = 0.0016
Correlation, R = 0.7521
Selenium (na)
Total Number of Data = 14
Number of Non-Detects = 9
Number of Detects = 5
Mean = 0.0013
Sd = 0.0005

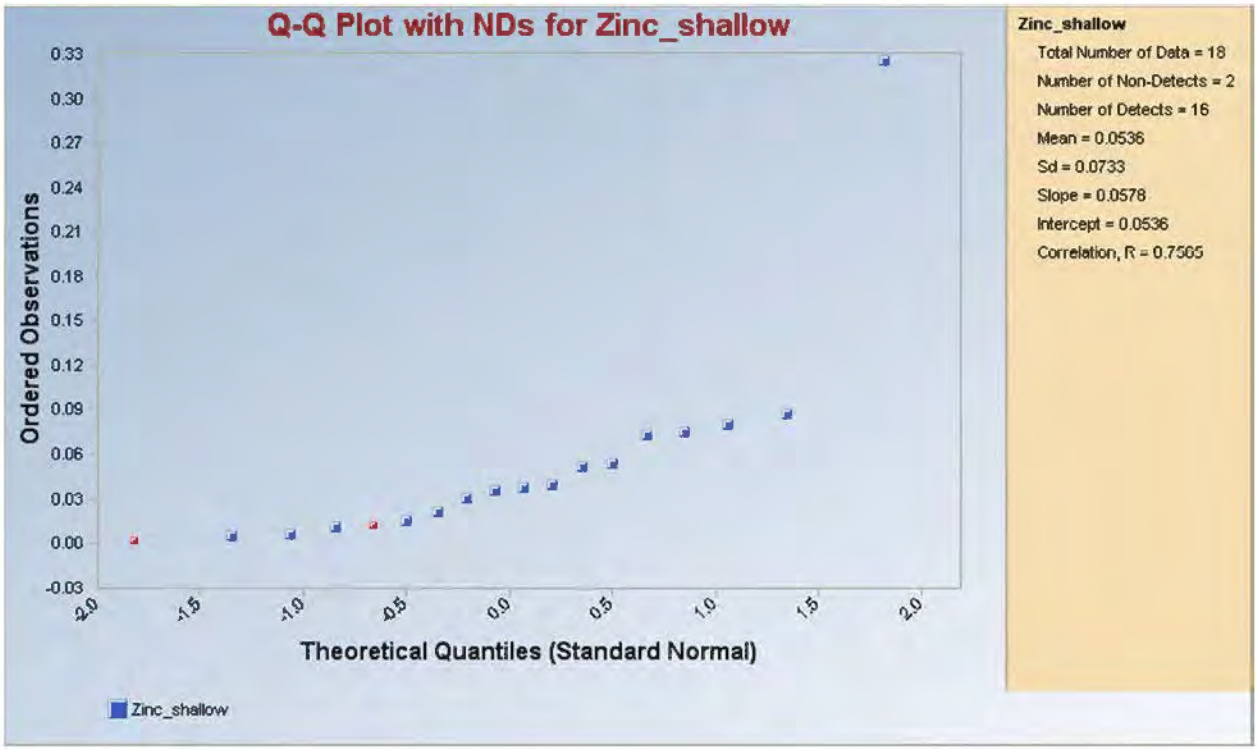

Q-Q Plot with NDs for Selenium_Shallow
Ordered Observations
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Selenium_Shallow
Selenium_Shallow
Total Number of Data = 21
Number of Non-Detects = 10
Number of Detects = 11
Mean = 0.0015
Sd = 0.0010
Slope = 0.0008
Intercept = 0.0015
Correlation, R = 0.6151

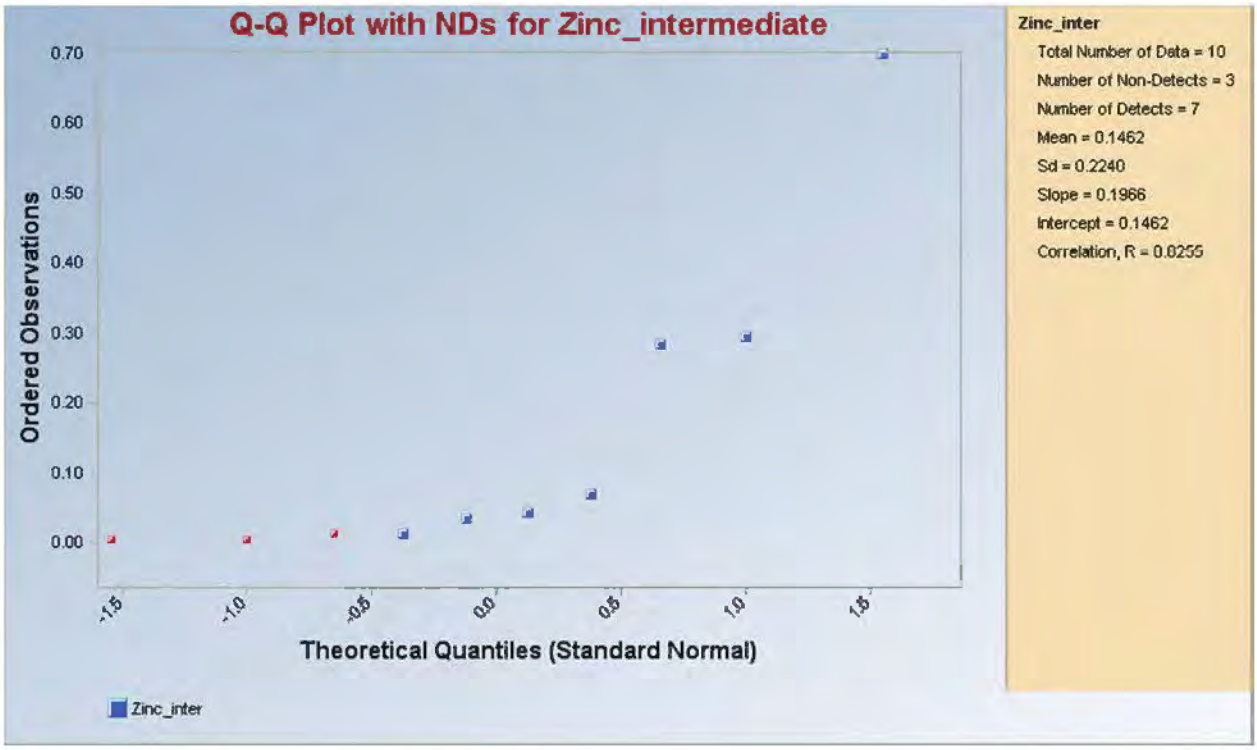

Q-Q Plot with NDs for Selenium_Intermediate
Ordered Observations
0.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Selenium_Inter
Selenium_Inter
Total Number of Data = 11
Number of Non-Detects = 4
Number of Detects = 7
Mean = 0.0016
Sd = 0.0015
Slope = 0.0012
Intercept = 0.0016
Correlation, R = 0.7521

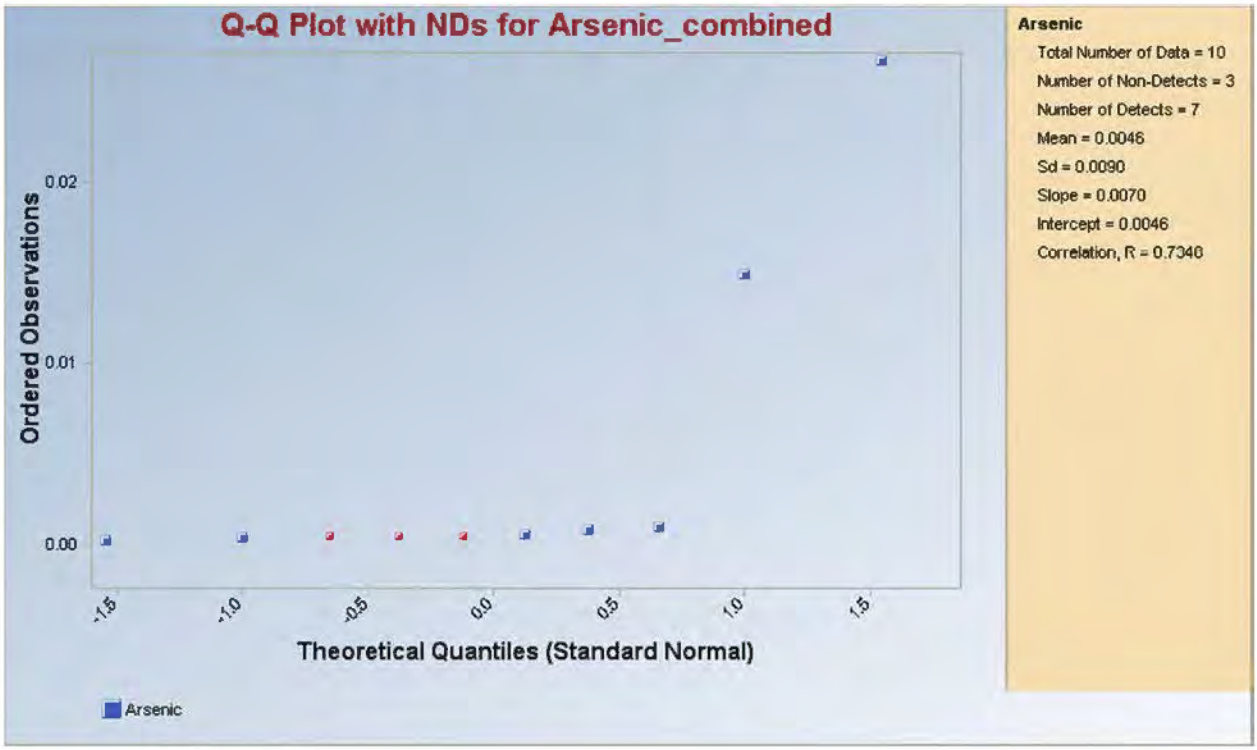

Q-Q Plots with NDs for Vanadium by Units
Ordered Observations
0.02
0.01
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Vanadium (deep)
Vanadium (intermediate)
Vanadium (na)
Vanadium (shallow)
Vanadium (deep)
Total Number of Data = 6
Number of Non-Detects = 6
Number of Detects = 0
Mean = 0.0050
Sd = 0.0000
Slope = 0.0000
Intercept = 0.0050
Correlation, R = NaN
Vanadium (intermediate)
Total Number of Data = 10
Number of Non-Detects = 5
Number of Detects = 5
Mean = 0.0042
Sd = 0.0040
Slope = 0.0039
Intercept = 0.0042
Correlation, R = 0.9188
Vanadium (na)
Total Number of Data = 14
Number of Non-Detects = 3
Number of Detects = 11
Mean = 0.0037
Sd = 0.0064

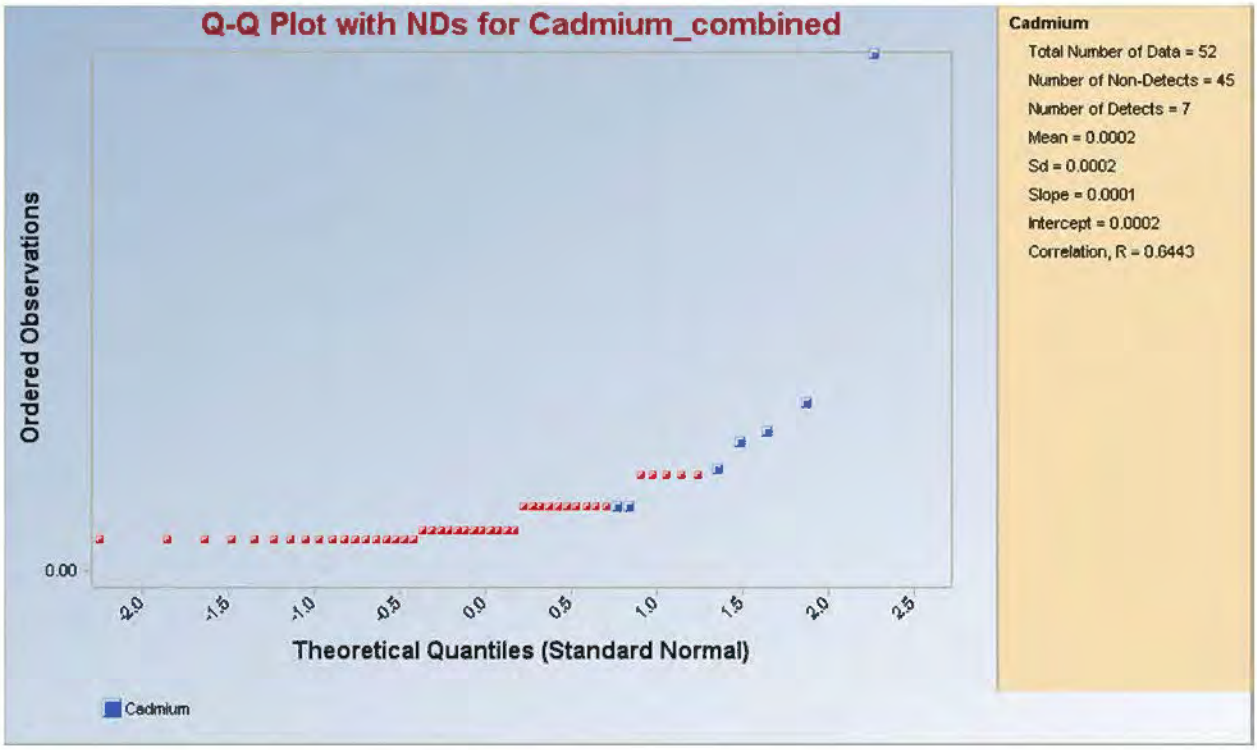

Q-Q Plot with NDs for Vanadium_shallow
Ordered Observations
0.01
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Vanadium_shallow
Vanadium_shallow
Total Number of Data = 18
Number of Non-Detects = 5
Number of Detects = 13
Mean = 0.0040
Sd = 0.0050
Slope = 0.0045
Intercept = 0.0040
Correlation, R = 0.0691

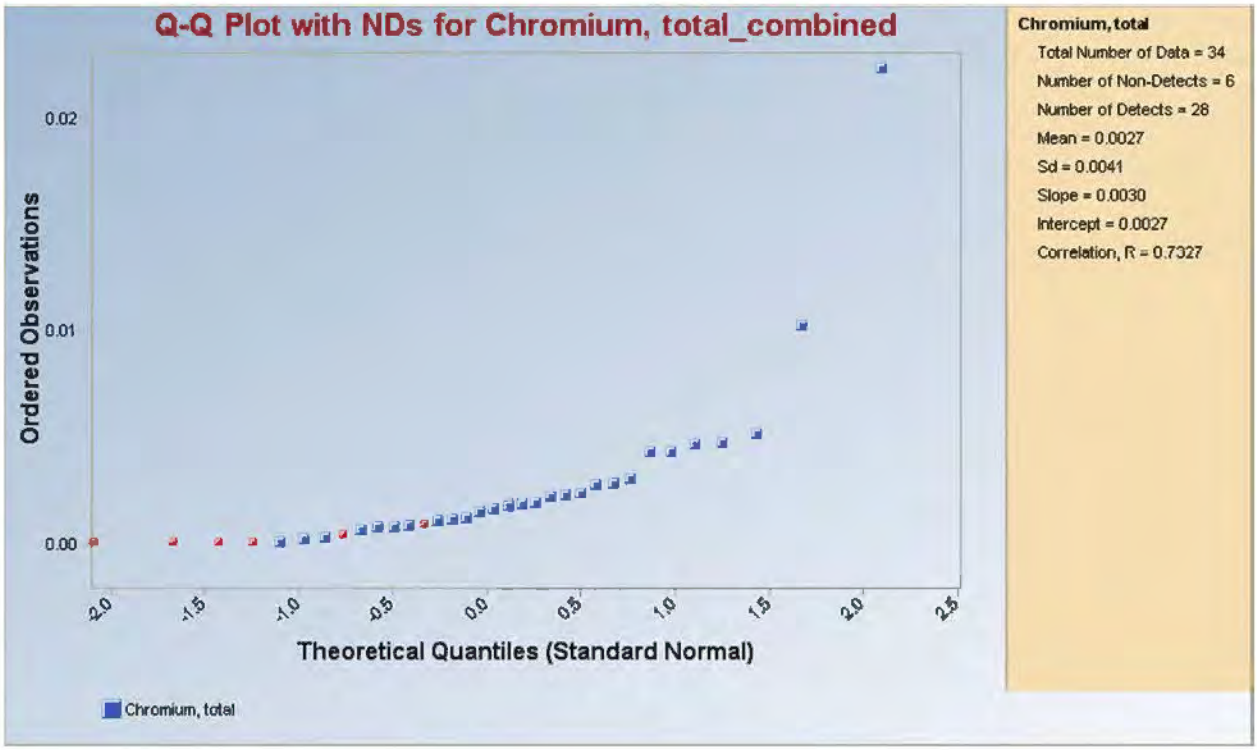

Q-Q Plots with NDs for Zinc by Units
Ordered Observations
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Zinc (deep)
Zinc (intermediate)
Zinc (na)
Zinc (shallow)
Zinc (deep)
Total Number of Data = 6
Number of Non-Detects = 4
Number of Detects = 2
Mean = 0.0232
Sd = 0.0430
Slope = 0.0329
Intercept = 0.0232
Correlation, R = 0.7003
Zinc (intermediate)
Total Number of Data = 10
Number of Non-Detects = 3
Number of Detects = 7
Mean = 0.1462
Sd = 0.2240
Slope = 0.1966
Intercept = 0.1462
Correlation, R = 0.8255
Zinc (na)
Total Number of Data = 14
Number of Non-Detects = 1
Number of Detects = 13
Mean = 1.7791
Sd = 5.6557

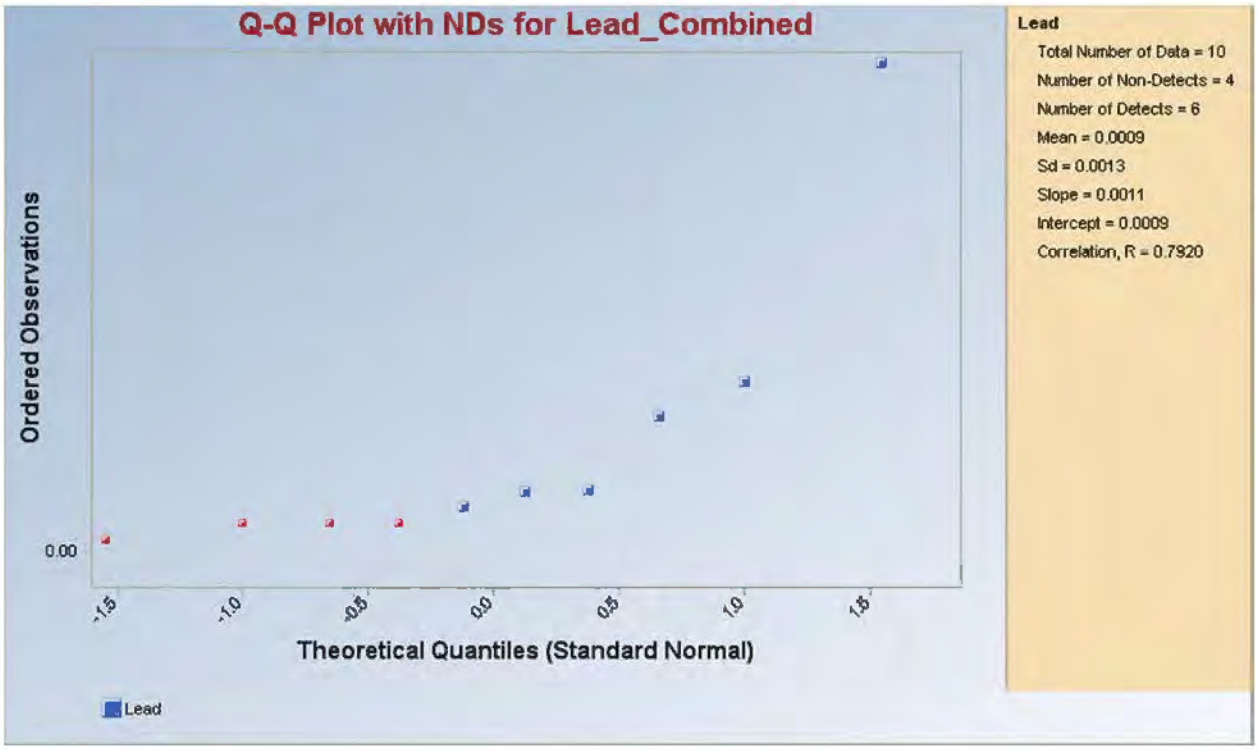

Q-Q Plot with NDs for Zinc_shallow
Ordered Observations
Theoretical Quantiles (Standard Normal)
Zinc_shallow
Zinc_shallow
Total Number of Data = 18
Number of Non-Detects = 2
Number of Detects = 16
Mean = 0.0536
Sd = 0.0733
Slope = 0.0578
Intercept = 0.0536
Correlation, R = 0.7565

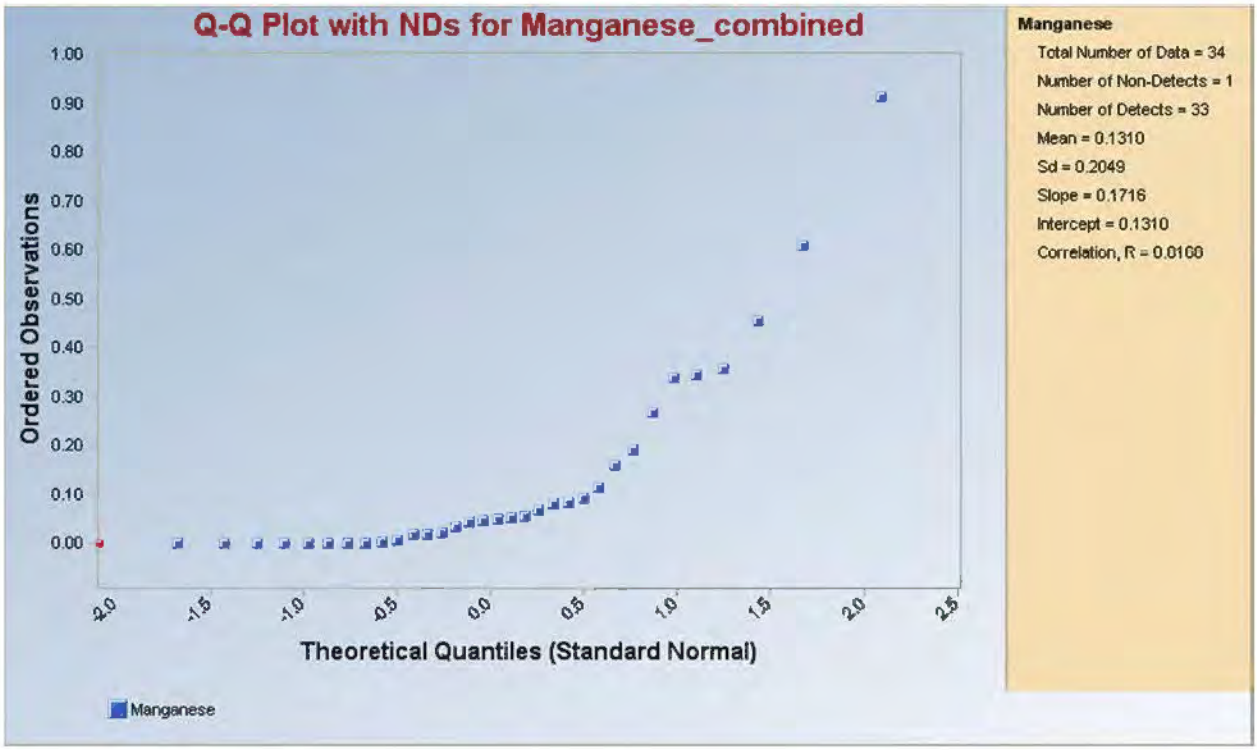

Q-Q Plot with NDs for Zinc_intermediate
Ordered Observations
Theoretical Quantiles (Standard Normal)
Zinc_inter
Zinc_inter
Total Number of Data = 10
Number of Non-Detects = 3
Number of Detects = 7
Mean = 0.1462
Sd = 0.2240
Slope = 0.1966
Intercept = 0.1462
Correlation, R = 0.0255

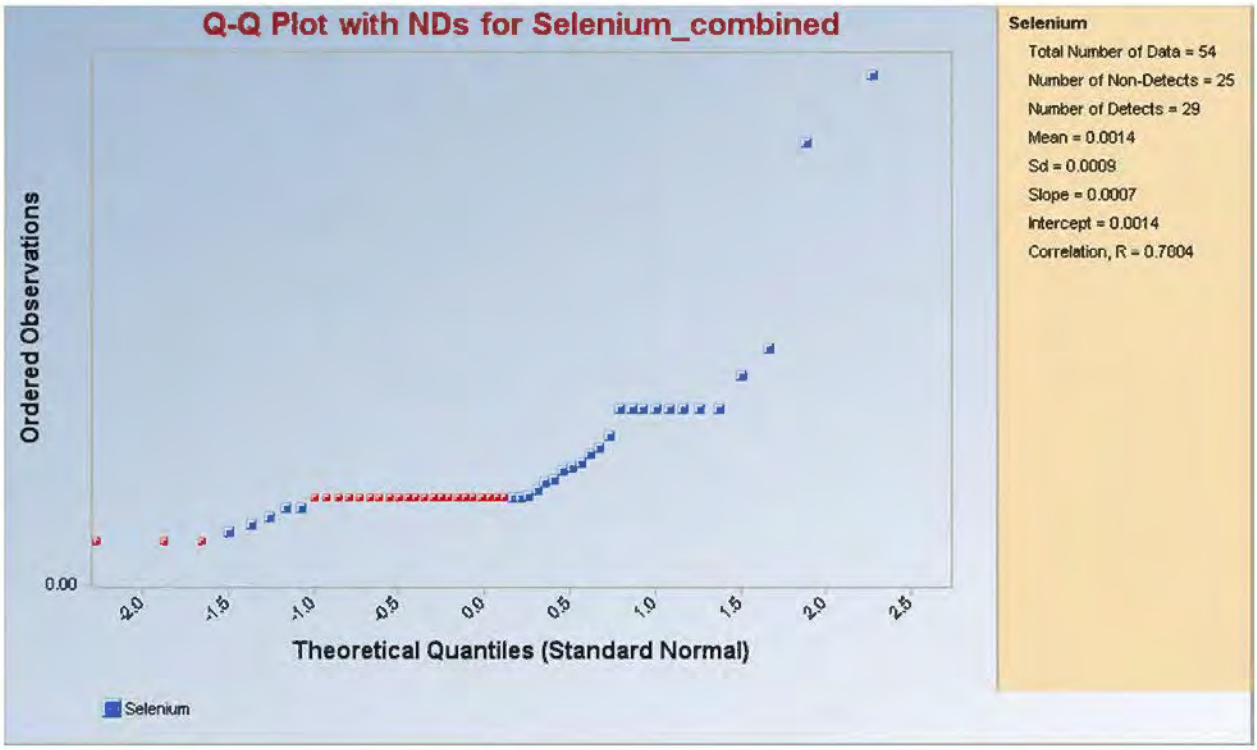

Q-Q Plot with NDs for Arsenic_combined
Ordered Observations
0.02
0.01
0.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Arsenic
Arsenic
Total Number of Data = 10
Number of Non-Detects = 3
Number of Detects = 7
Mean = 0.0046
Sd = 0.0090
Slope = 0.0070
Intercept = 0.0046
Correlation, R = 0.7340

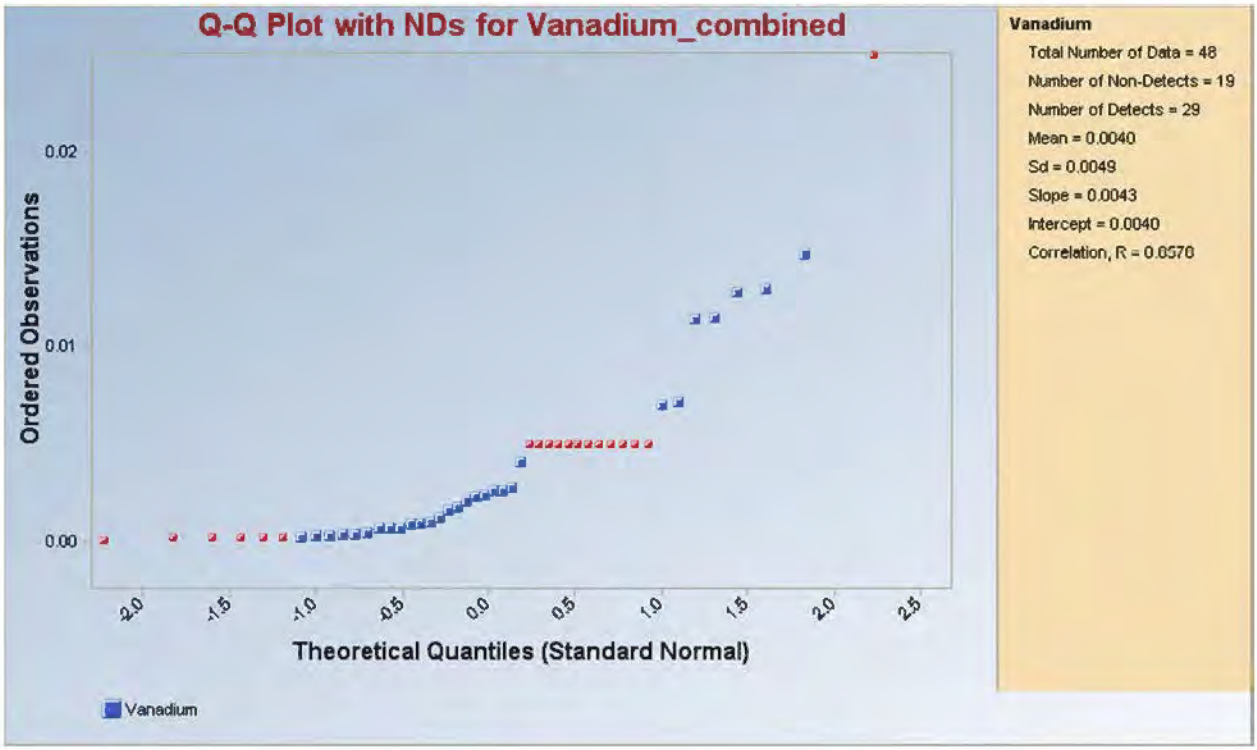

Q-Q Plot with NDs for Cadmium_combined
Ordered Observations
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Cadmium
Cadmium
Total Number of Data = 52
Number of Non-Detects = 45
Number of Detects = 7
Mean = 0.0002
Sd = 0.0002
Slope = 0.0001
Intercept = 0.0002
Correlation, R = 0.6443

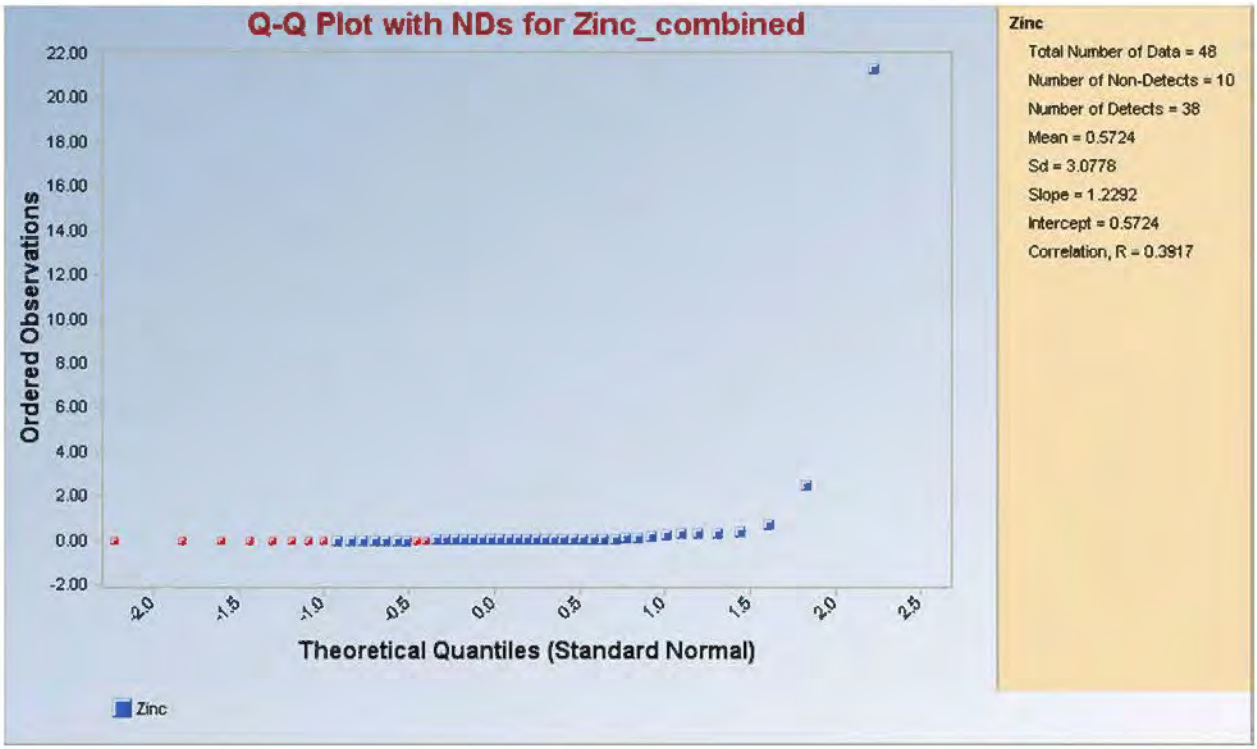

Q-Q Plot with NDs for Chromium, total_combined
Ordered Observations
0.02
0.01
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Chromium, total
Chromium, total
Total Number of Data = 34
Number of Non-Detects = 6
Number of Detects = 28
Mean = 0.0027
Sd = 0.0041
Slope = 0.0030
Intercept = 0.0027
Correlation, R = 0.7327

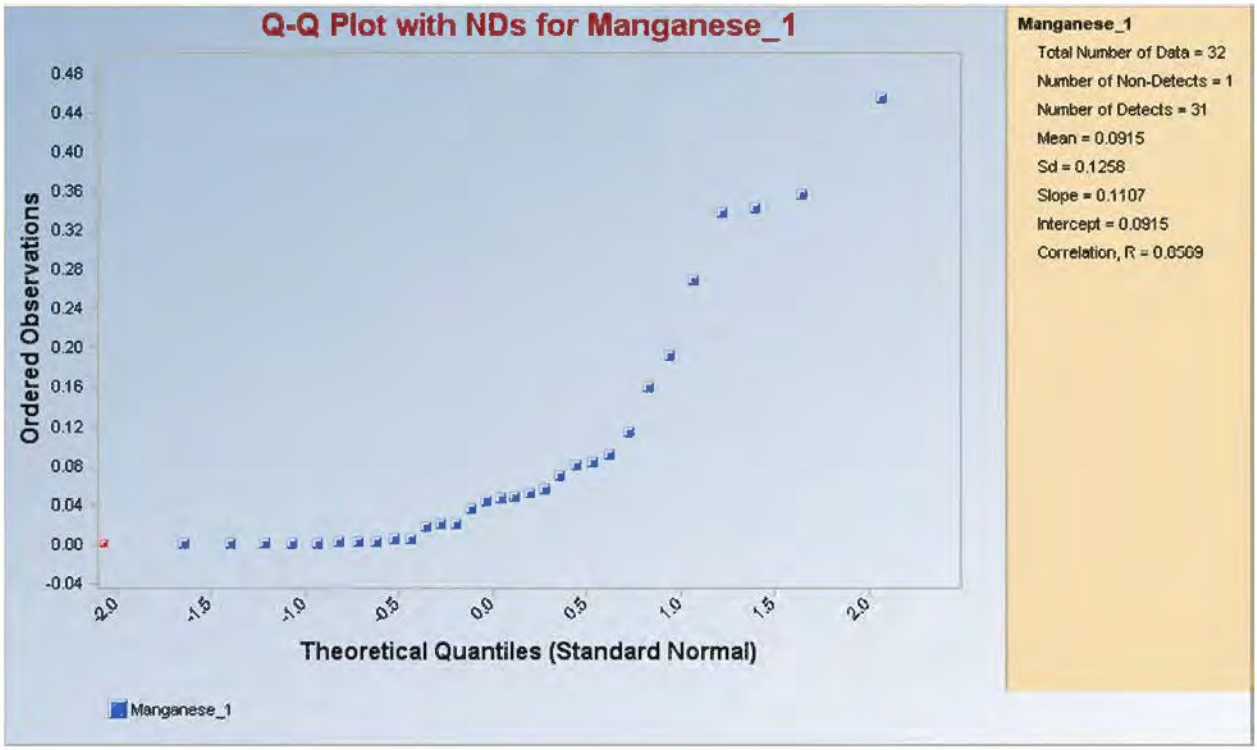

Q-Q Plot with NDs for Lead_Combined
Ordered Observations
0.00
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles (Standard Normal)
Lead
Lead
Total Number of Data = 10
Number of Non-Detects = 4
Number of Detects = 6
Mean = 0.0009
Sd = 0.0013
Slope = 0.0011
Intercept = 0.0009
Correlation, R = 0.7920


Q-Q Plot with NDs for Manganese_combined
Ordered Observations
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Manganese
Manganese
Total Number of Data = 34
Number of Non-Detects = 1
Number of Detects = 33
Mean = 0.1310
Sd = 0.2049
Slope = 0.1716
Intercept = 0.1310
Correlation, R = 0.0160


Q-Q Plot with NDs for Selenium_combined
Ordered Observations
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Selenium
Selenium
Total Number of Data = 54
Number of Non-Detects = 25
Number of Detects = 29
Mean = 0.0014
Sd = 0.0009
Slope = 0.0007
Intercept = 0.0014
Correlation, R = 0.7604


Q-Q Plot with NDs for Vanadium_combined
Ordered Observations
0.02
0.01
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Vanadium
Vanadium
Total Number of Data = 48
Number of Non-Detects = 19
Number of Detects = 29
Mean = 0.0040
Sd = 0.0049
Slope = 0.0043
Intercept = 0.0040
Correlation, R = 0.0570


Q-Q Plot with NDs for Zinc_combined
Ordered Observations
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
Theoretical Quantiles (Standard Normal)
Zinc
Zinc
Total Number of Data = 48
Number of Non-Detects = 10
Number of Detects = 38
Mean = 0.5724
Sd = 3.0778
Slope = 1.2292
Intercept = 0.5724
Correlation, R = 0.3917


Q-Q Plot with NDs for Manganese_1
Ordered Observations
0.48
0.44
0.40
0.36
0.32
0.28
0.24
0.20
0.16
0.12
0.08
0.04
0.00
-0.04
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
Manganese_1
Manganese_1
Total Number of Data = 32
Number of Non-Detects = 1
Number of Detects = 31
Mean = 0.0915
Sd = 0.1258
Slope = 0.1107
Intercept = 0.0915
Correlation, R = 0.0509

APPENDIX E
COMMENTS AND RESPONSES TO COMMENTS (RTC)

APPENDIX E1
NOVEMBER 23, 2011 RTC

P4 Response to A/T Comments on Preliminary Background Maps and Tables For the Ballard, Henry, and Enoch Valley Mines Prepared for P4 Production by MWH, September 12 and October 13, 2011
A/T Comments were transmitted to P4 on November 9, 2011.

APPENDIX E2
FEBRUARY 17, 2012 RTC

P4 Response to A/T Comments on Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical
Memorandum Draft Revision 0 (Background Memorandum - Chapters 1 – 3 only)
-
A/T Comments were transmitted to P4 on January 23, 2012.

APPENDIX E3
MARCH 29, 2012 RTC

Compiled A/T comments on P4 Production, LLC's Response to Agency Comments Document Entitled Comments on Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 0 (Background Memorandum - Chapters 1 – 3 only)
A/T comments were transmitted to P4 on January 23, 2012. Responses prepared for P4 Production, Inc. by *MWH, dated February 17, 2012.*

APPENDIX E4
AUGUST 2, 2012 RTC

Compiled A/T comments on P4 Production, LLC's Response to Agency Comments Document Entitled Site Visit Summary.
A/T comments were transmitted to P4 on July 19, 2012. Responses prepared for P4 Production, Inc. by MWH, dated July 26, 2012.

APPENDIX E5
NOVEMBER 14, 2012 RTC

P4 Responses to A/T comments on Summary Statistics Background Tables, Preliminary COPC and COPEC Tables 1 through 6, and Supplemental Comments on the Background Levels Technical Memorandum.
A/T comments were transmitted to P4 on October 26, 2012.

APPENDIX E6
DECEMBER 11, 2012 RTC

A/T comments on select P4 Responses to A/T comments on Summary Statistics Background Tables, Preliminary COPC and COPEC Tables 1 through 6, and Supplemental Comments on the Background Levels Technical Memorandum.
Responses prepared for P4 Production, Inc. by MWH, dated November 14, 2012.

APPENDIX E7
FEBRUARY 15, 2013 RTC

P4 Responses to A/T comments on Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 1 submitted on December 21, 2012
A/T comments were transmitted to P4 on January 23, 2013

APPENDIX E1

NOVEMBER 23, 2011 RTC

P4 Response to A/T Comments on Preliminary Background Maps and Tables
For the Ballard, Henry, and Enoch Valley Mines Prepared for P4 Production by MWH,
September 12 and October 13, 2011
A/T Comments were transmitted to P4 on November 9, 2011.

P4 Response to A/T Comments on Preliminary Background Maps and Tables
For the
Ballard, Henry, and Enoch Valley Mines
Prepared for P4 Production by MWH, September 12 and October 13, 2011

A/T Comments were transmitted to P4 on November 9, 2011

General Comments

1. At this point, it is not clear to the A/T exactly how the background data will be used and whether the results of this exercise will have any effect on remedy selection. In reviewing the submittal and developing comments, the A/T recognize that we are dealing with geographically large sites, limited data sets for various media, data sets that include samples from a large geographic area, and samples that may overly (or drain) different lithologies. This introduces a number of issues including whether data sets include enough samples to satisfy statistical assumptions, questions on how to pool data, questions on whether it would be appropriate to evaluate subpopulations, and so on. The A/T further recognize that the level of rigor applied to characterization and analysis of background data sets depends on several factors including how the background data is used and whether final cleanup decisions are sensitive to background results. Thus, in responding to the following comments, P4 may deem it appropriate to defer explanatory information to the upcoming comprehensive background summary report. In doing so, P4 should note that they prefer to defer the information and include a brief explanation for the rationale to do so. It would also be appropriate to discuss level of rigor in the background analysis initially in the forthcoming sections 1 – 3, and possibly re-visit this matter as the process moves forward.

   P4 Response:

   P4 submitted the subject drawings and tables to the A/Ts to obtain concurrence on the background sampling data that we intend to use to derive background levels for the P4 Sites. We appreciate your comments regarding the adequacy and appropriateness of the proposed background sampling locations and results. As described in our response to General Comment No.2, below, the manner in which the proposed background sampling data will be statistically evaluated and used to derive background levels will be described in Sections 1 through 3 of the forthcoming P4 Sites Background Levels Development Technical Memorandum (Background Tech Memo). While we have attempted to address all of the A/T comments received on November 9, 2011, we believe that it is in the best interest of the project to defer technical details of the background evaluation to the Background Tech Memo.

   Please note that background levels developed for the P4 Sites will be used during preparation of the human health and ecological risk assessment (HHERA) for COPC/COPEC screening and for the calculation of incremental risk estimates. In addition, background levels may be used during preparation of the feasibility study

(FS) to identify portions of the P4 Sites that are appropriate for consideration of remedial alternatives, and as potential cleanup levels for constituents of concern (COCs) (e.g., arsenic, uranium) that have low risk-based screening levels relative to background concentrations.

2. These comments cover only the drawings and tables that have been provided to date by P4. It is our understanding that P4 will provide all necessary information and rationale on how they intend to use the proposed data including an appropriate statistical approach in the upcoming, comprehensive background summary report.

   P4 Response: *P4 understands that the comments provided by the A/Ts pertain to the drawings and tables submitted to the A/Ts via email on September 12, 2011 and October 13, 2011. The initial sections (Sections 1 through 3) of the Background Tech Memo will be submitted to the A/Ts for review following approval of these responses. The initial sections of the Background Tech Memo include:*

   - *Section 1 - Introduction*
   - *Section 2 - Evaluation and Selection of Background Locations*
   - *Section 3 - Statistical Methods and Procedures for Background Calculations*

   The final section, Section 4.0 of the Background Tech Memo, will present the results of the statistical evaluation and will be submitted to the A/Ts following the approval of Sections 1 through 3.

3. While the three sites (Henry, Ballard, and Enoch Valley) have been administered and investigated collectively to date, background data should be developed for each site individually for each media, as practicable.

   P4 Response:

   As described in the Supplemental Mine Waste Rock Dump and Facility Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009), the primary decision criterion that was used during the selection of A/T-approved background sampling locations was undisturbed areas away from mining activities. Geologic representativeness of a background sampling area to a specific P4 Site was a lesser criterion. It should also be noted that the entire geologic sequence was not represented in the current background data sets for upland soil and vegetation, as samples were not collected from locations overlying, or immediately downslope of, the Phosphoria Formation. As a result, the background datasets for upland soil and vegetation are not necessarily representative of pre-mining geological conditions inside the pit boundaries at individual P4 Sites.

   It should also be noted that the P4 Sites are located in the headwaters of several surface water drainages such that there are limited upstream locations from which un-impacted background surface water, sediment, riparian soil and riparian vegetation samples could be collected. As a result, it was not possible to collect statistically meaningful numbers of background samples for these media for individual P4 Sites.

Similar to surface water, the P4 groundwater locations are generally in or near aquifer recharge areas so that groundwater flow is downgradient from individual monitoring locations and generally away from the Site. As such, true upgradient groundwater sampling locations specific to an individual mine site are not present and those that would be possible are in locations and at depths not readily accessible (e.g., as in the case of Wells Formation). It is therefore necessary to look at background for groundwater more generally with groundwater monitoring locations more dispersed throughout the area of the P4 Sites.

Based on the above, a stratified random sampling design was generally used for background sampling investigations conducted for the P4 Sites. A stratified random sampling design assumes that there are differences in distributions between individual strata, and that statistical tests for differences in distributions between strata are not necessary. Consequently, background datasets for each constituent in each medium will be combined into a single data set for statistical evaluation and derivation of background levels. Due to lack of representativeness between P4 Sites and background areas (upland soil and upland vegetation) or lack of upgradient sample locations (the remaining media), an attempt will not be made to 'assign' background results to a specific P4 mine or to test for statistical differences between background sampling areas. Further details of the background evaluation methodology are described in the forthcoming Background Tech Memo.

4. Data tables should include screening levels for each parameter.

   P4 Response: *The data tables in the Background Tech Memo will be revised to include the screening levels listed in Table 3-1 of the A/T-approved P4 Sites RI/FS Work Plan - Rev 2 Final.*

5. Data tables should highlight a result if it is greater than the screening level.

   P4 Response: *The data tables in the Background Tech Memo will be revised to highlight if the sample reporting limit (RL) or method detection limit (MDL) exceeds the applicable screening criterion in order to evaluate the sensitivity of the analytical methods. In addition, individual sample results in the background data set will be shaded if they exceed risk-based screening criteria.*

   It should be noted that the representativeness and usability of individual data should not be determined through comparisons to screening levels but through statistical evaluations performed during the calculation of Site-wide background levels. Therefore, these data will be evaluated in the forthcoming background evaluation to determine the presence of statistical outliers in the various background data sets. The final A/T-approved medium-specific background levels will be tabulated along with applicable risk-based screening criteria in the HHERA performed for each P4 Site.

Specific comments on the background information provided in the referenced maps and tables are provided below, by media.

Riparian Soil, Vegetation, and Surface Water

1. In reference to Table 2-2, a definition of "site" versus "natural" background should be provided. Presumably, "site" background indicates that a potential upstream, off-site influence to a P4 Mine may be present, whereas "natural" indicates no potential off-site influence is present. Please confirm or provide an alternate definition.

   P4 Response: *Agreed. As defined in the forthcoming Background Tech Memo, "site" background refers to a location that is upstream of all potential P4 mining activities whereas "natural" background indicates that no potential on-site or off-site mining-related influence is present. A "site" background location may be influenced by other non-P4 mining activities. For this re-evaluation of background data, P4 is proposing to use "natural" background locations to the extent practicable. Exceptions are discussed within the pending Background Tech Memo.*

2. Three locations (MST048, MST274, and MST275) were listed as site (Project) background in the *Phase I Site Investigations for Enoch Valley, Henry, and Ballard Mines Draft Interim Phase I SIs Evaluation Summary Version 2*, dated November 2007. One location (MST277) was listed as being potentially affected by mining activities. Please provide a rationale that justifies the change at these locations to Natural Background.

   P4 Response: *Upon further evaluation of the historical background data, P4 revised some of the background designations from "site" to "natural". The rationale for these revisions will be included in the forthcoming Background Tech Memo and is briefly summarized in the bullets below. P4 is unsure as to the reference to "The Phase I Site Investigations for Enoch Valley, Henry, and Ballard Mines Draft Interim Phase I Sis Evaluation Summary Version 2 (PIES)" as the summary was never approved or accepted by the A/T.*

   - *MST048 - This location is proximal to MST049 and MST254 on the Little Blackfoot River. In historical documents, MST048 was assigned as a "site" location whereas MST049 and MST254, both located further upstream, were designated as "natural" background. As there are no inputs from any of the mined areas to the river between these stations, all three stations are representative of natural background. Therefore, P4 revised the designation of MST048 to a "natural" background location.*
   - *MST274 and MST275 - These sampling stations were evaluated and approved as background locations by the A/Ts for the <u>Supplemental Riparian and Surface Water Investigation (MWH, 2010).</u> These locations are separated by a ridge from a non-P4 mine. Based upon the current evaluation, the designation of both locations was changed from "site" to "natural" background.*

- *MST277 - This location was evaluated and approved as a background location by the A/Ts for the Supplemental Sediment and Riparian Soil Sampling and Analysis Plan (MWH, 2010). This background location was positioned outside of an area of possible Henry Mine sediment and surface water loading impacts on Long Valley Creek. It is uncertain why it was stated that there are possible affects from mining. However, it is noted that the P4 haul road is upstream of this location. Data from this surface water location appears to be in the range of the other background data based upon qualitative inspection. However, an outlier analysis will be performed for each medium-specific evaluation.*

3. There may be several concerns from a statistical standpoint (see also general comment above). First, surface water at one location (MST048) has not been sampled since 2004 and another location (MST226) since 2006. Many other locations have not been sampled since 2008. Please justify including these locations in the dataset. Second, please justify pooling the Site Background location (MST226) with Natural Background locations. As the Site Background location can actually be contaminated from upstream mining activities, any concentrations from this location could skew the data from the Natural Background locations. Third, of the 12 proposed locations, three are within close proximity to each other on the Little Blackfoot River. Unless it can shown that these three locations have distinctly different influences, the dataset should be limited to one of these locations, possibly the most downstream location at MST048. Please explain why the Little Blackfoot River is not over-represented in the dataset, with 25 percent of the overall sites located within short reach of the water body.

P4 Response: *First, the medium-specific sampling programs, especially the surface water and groundwater monitoring programs, have varied over time and not all on-Site and background stations have been sampled at regular intervals (e.g, semi-annual). However, unless flagged during validation, the use of 2004 and more recent data is appropriate during the RI/FS and risk assessments as discussed in the Data Quality and Usability Report/Data Approval Request (DQUR/DAR; MWH, 2010). P4 does not understand the A/Ts concern with using older data in the background data set, as long as they meet A/T-approved data usability requirements.*

Second, MST226 is located on an ephemeral drainage to Lone Pine Creek. The uppermost part of this drainage could be affected by another non-P4 mine site, which is why the location was historically and currently defined as a "site" background station. After a qualitative evaluation of the data, the concentrations from MST226 appear to fall within the range of the other concentrations included in the dataset. In addition, data from this background station will be statistically evaluated during the outlier analysis. It should also be noted that there are

several "site" stations that were purposely removed from the background data set (see Specific Comment No. 7 below). These stations have historically shown potential impacts from other non-P4 mines and, thus, were removed from the list of background locations so as not to skew the background data set.

Third, P4 agrees that there are three stations within a short distance from each other on the river. However, as these are historical background stations, P4 proposed to include them in this re-evaluation of background concentrations for surface water. Also, P4 is confused by this comment. In the first part of the comment, the A/Ts express concerns with the use of MST048 because it has not been sampled since 2004. In the third part of the comment, the A/Ts are proposing that MST048 be selected to represent this reach of the Blackfoot River. Nevertheless, P4 will evaluate the data from these three stations during the background statistical analysis to ensure that they don't significantly bias the background data sets either high or low.

4. The 2004 wire diagrams in the RI Work Plan indicate that MST048 is a "Mine-Specific Background" location, whereas MST049 and MST254 are "Program Background" locations. In contrast, background Table 2-2 indicates these riparian locations are all "Natural." Please reconcile/explain why MST048 should or shouldn't be designated as a "Site" background location on Table 2-2.

P4 Response: *As discussed in Specific Comment No. 2 above, MST048 is proximal to MST049 and MST254 on the Little Blackfoot River. MST048 was historically assigned as a "site" location whereas MST049 and MST254, both located further upstream, were designated as "natural" background. As there are no mining-related impacts to the river between these individual sampling locations, all three stations are representative of natural background. Therefore, P4 revised the designation of MST048 to a "natural" background location.*

5. Table 2-2 only shows only one "site" background location at MST226. This location is presumably a "site" background location for Henry Mine, and possibly for Enoch Valley Mine, given its upstream location along Lone Pine Creek. However, it is unclear how a single "site" background location could be representative for all P4 Mines. Please explain.

P4 Response: *MST226 is located on an ephemeral drainage to Lone Pine Creek. The uppermost part of this drainage could be affected by another non-P4 mine site, which is why the location was historically and is currently defined as a "site" background station. After a qualitative evaluation of the data, the concentrations from MST226 appear to fall within the range of the other concentrations included in the dataset. As stated in General Comment No. 3, above, this "site" background station will be combined with "natural" background stations in the background dataset. However, it will be included in an outlier analysis during the background evaluation.*

6. Based on a brief review of the sample locations, there are very few background riparian locations that can be classified as “site-specific” locations; in this case, “site-specific” refers to a sample location that is clearly proximal to and representative of background for an individual mine rather than the “site” versus “natural” background determination described above. For example, it appears that the number of riparian samples that can be construed as being mine-specific are limited to the following locations:

   - Ballard: 1 location at MST093
   - Henry: 1-2 locations at MST226 & MST277
   - EVM: 2 locations at MST274 & MST275

   The other locations at MST048, MST049, MST101, MST235, and MST254 appear more representative of regional background. Provide a description of how these background locations will or won’t be segregated or grouped to calculate site-specific values for media at the individual mines.

   P4 Response: *As stated in General Comment No.3 above, an insufficient number of un-impacted riparian background sampling stations are available to assign them to individual P4 mines and evaluate whether or not there are statistically significant differences between P4 mine-specific datasets. Therefore, the stations listed in Table 2-2 will be combined to develop one set of medium-specific background concentrations for the Sites.*

7. Several potential site and program background locations are shown on the wire diagrams in the RI/FS Work Plan but are not included in the recent background tables. Please explain why they are not included in these referenced tables.

   P4 Response: *There were up to seven (7) background locations shown on the 2004, 2007, and 2008 spatial wire diagrams (SWDs) that were purposely not included in the proposed background stations listed in Table 2-2. P4 did not propose MRV017, at Blackfoot Reservoir, as a background location. P4 also did not propose six (6) stations characterized as "site" or "project" background on the SWDs. Three of these stations (MST128, MST129 and MST130) are located on Angus Creek upstream of Rasmussen Creek and are potentially affected by other mining operations. In addition, three stations (MST028, MST029 and MST229) are located on the Blackfoot River upstream of the confluence with Angus Creek. These stations could also be affected by other mining activities. Historical concentrations from these stations support potential impacts by other non-P4 mining activities. With the exception of MST226, as discussed in Specific Comment No.5, P4 is proposing to use "natural" background for the re-evaluation of medium-specific background concentrations.*

8. The riparian vegetation samples are limited to the 2004 samples that were only analyzed for cadmium, copper, molybdenum, selenium, and zinc. Explain why

the background sample set for riparian vegetation does not need to include the full suite of 22 analytes.

P4 Response: *The COPC/COPEC suite has historically been limited to cadmium, chromium, copper, molybdenum, nickel, selenium, vanadium, and zinc for several media including soils, vegetation and sediment based upon screening performed by IDEQ in the Area-Wide Investigations and Risk Assessment. It was not until recently (2009 and 2010), that the analytical suite was increased to 17 constituents for these media. In addition, it is important to note that the 2009 upland vegetation data and the 2004 riparian and upland vegetation data were evaluated against risk-based screening levels (RBSLs) in the A/T-approved RI/FS Work Plan - Rev2 Final. As shown on Tables 3-5, 3-21, and 3-37 of the RI/FS Work Plan, there are only three analytes (cadmium, molybdenum and selenium) detected in riparian and upland vegetation that exceed RBSLs. The exception to this is one exceedance of the RBSL for boron in a 2009 upland vegetation sample at Enoch Valley. Based on the comparisons of vegetation concentrations to RBSLs presented in the RI/FS Work Plan, and the fact that all three analytes that consistently exceeded vegetation RBSLs were included in the 2004 analytical suite, P4 does not believe that the historically-selective analyte list for the riparian vegetation data represents a significant data gap. Nevertheless, the limited nature of the analytical suite for riparian vegetation will be described in the Uncertainty Analysis section of the HHERA for the P4 Sites.*

9. The MDL/RL values for the riparian vegetation samples are based on glass bead studies, not on tissue samples. Provide a rationale supporting the use of this data given the uncertainties associated with the detection levels.

   P4 Response: *This was evaluated, discussed extensively, and resolved with the A/Ts prior to the analysis of the vegetation samples. In the end, a matrix specific blank material with suitable concentrations of the analytes did not exist. The uncertainty will be noted during the risk assessment.*

10. Please confirm that all surface water data in the table sent attached to the September 12, 2011 e-mail from Cary Folk have been checked for accuracy. For example, one discrepancy was found; for the May 7, 2006 sampling event at MST274, two of the three samples (050706GWMST274-1-F at 0.006 mg/L and 050706GWMST274-2-F at 0.007 mg/L) were for filtered (dissolved) selenium for an average of 0.0065 mg/L. The average calculated for the event for filtered samples was 0.00667 mg/L (050706GWMST274-avg-F). Possibly (based on looking at other analytes) the one unfiltered sample (050706GWMST274-3-U at 0.006 mg/L) was actually a filtered sample, but this would actually lower the average to 0.00633 mg/L. If the latter is the case (i.e., sample 050706GWMST274-3-U is actually a filtered sample), explain how will data from this site be incorporated into the statistics if data are only available for the dissolved fraction.

P4 Response: *P4 reviewed the data tables for accuracy. It does appear that the one unfiltered sample (050706GWMST274-3-U at 0.006 mg/L) was actually a filtered sample and, as this sample was collected in triplicate, all three triplicate samples should have been sampled for the filtered fraction. This will be confirmed and corrected in the database, as necessary. In addition, the reason for the different average calculated for the event is a result of significant figures reported in the table.*

During the background evaluation, background concentrations will be developed for both dissolved and total fractions. Therefore, the data from the sampling event referenced in the comment will be incorporated into the statistical evaluation for the dissolved fraction.

11. In order to adequately assess the applicability of the proposed background locations for the identified media, it would aid greatly to have a map that includes the proposed background locations plus proximal other mine sites. Please provide.

    P4 Response: *Agreed. A drawing will be added to the forthcoming Background Tech Memo that includes the background locations as well as general locations of other mines in the vicinity of the P4 Sites.*

Groundwater

12. In order to adequately assess the applicability of the proposed background locations for groundwater, it would aid greatly to have a map with the proposed locations, the inferred groundwater flow directions (along with the data used to determine flow direction(s)) for each of the groundwater aquifer systems (alluvial, Dinwoody, Rex Chert, and Wells Formations/Members). Please provide.

    P4 Response: *As you know, the groundwater flow conditions at the site are complex because of the multiple flow systems and folded/faulted sedimentary rock sequences. It is very difficult to establish that piezometric measurements from any two wells are from the same hydrostratigraphic unit. Therefore, flow arrows in the best of cases are an approximation, and assessment of flow direction is based on hydrogeologic principals and direct line of evidence along with secondary data. The RI Reports will provide detailed discussions of the flow systems. However, it should be noted that much of this discussion already is provided in the A/T-approved RI/FS Work Plan (Section 3.7.4). Establishment of the background groundwater locations uses a weight of evidence approach, including lack of apparent elevated source-related constituents and hydrogeologic rationale for the lack of impact (e.g., distance from sources, geology and/or flow gradients).*

    We have included preliminary groundwater flow direction arrows on Drawing 4 that was submitted to the A/Ts via email on September 12, 2011(attached). This revised drawing will also be included in the forthcoming Background Tech Memo. The map focuses only on those areas and flow systems that contain background wells. For many of the agricultural and domestic wells, groundwater flow is very

speculative. Identification of these wells as potential background locations is partly based on their distance from any source area. Vertical gradients are not depicted on the map and these are important at both the east Ballard and south Enoch Valley locations. For discussion, of the relevant hydrogeologic conditions in these areas, please see Sections 3.7.4.2 and 3.7.4.4 of the A/T-approved RI/FS Work Plan.

13. Several of the proposed background wells are screened across multiple formations or the formation is undetermined, thus cannot be ascribed to a particular aquifer. Please provide adequate justification for use of these wells as background.

    P4 Response: *As described in the forthcoming Background Tech Memo, the assessment comparing background wells for similarity will consider that wells installed in different geologic units may have different chemical signatures due to the unique geochemistry of each unit. The use of pooled or separate data sets across the different aquifers will be statistically evaluated, as further described in the text of the Background Tech Memo.*

14. Although IDEQ would prefer wells completed in known formations, inclusion of agricultural and domestic wells does give good spatial coverage. We recommend leaving those wells in the coverage; obviously they have to be identified as source unknown. There is concern with MMW007, MMW008, and MMW025 even though it is noted the potentiometric gradient is favorable. It is recommended adding the same language that appears in the "Rationale" below this block which is "to be further evaluated in RI report." We assume field data are still being collected and this will provide a longer record to verify the gradients are favorable and were not a short term anomaly. We also think this same caveat should be added to the "Rationale" for MMW032.

    P4 Response: *The rationale in Table 2-9 for MMW007, MMW008, MMW025, and MMW032 will be revised to include "to be further evaluated in RI report".*

15. Several wells listed in Table 2-10 were not included on the previously submitted data table (*P4 RIFS Background Data (Groundwater) Rev0*) for groundwater including MAW001, MAW003, MDW001, MDW004, MDW006, and MMW031. Please explain. Note that there are several "hidden" rows that are protected and cannot be unhidden by the A/T. Are these wells in the hidden rows?

    P4 Response: *P4 downloaded Table 2-10 attached to the September 12, 2011 email from Cary Foulk. The version of the P4 RIFS Background Data (Groundwater) Rev0 attached to the email includes all wells listed on Table 2-10 and does not include any hidden rows. P4 will re-circulate this table in pdf or EXCEL format upon request.*

16. A brief review of the groundwater data table suggests that some of the proposed background wells (e.g., MMW007, MMW008, and MMW033) may have elevated sulfate levels compared to most of the other proposed background wells. Furthermore, the proximity of these wells to the mines suggests that the potentially elevated sulfate is caused by the mines. This subject was alluded to in the P4 document entitled *Site Background Well Rationale*, dated September 14, 2011. Please be sure to address this in future reports.

    P4 Response: *As discussed in the Background Tech Memo, summary statistics and an outlier analysis will be performed on the background groundwater data set. In addition, for the purpose of this response, the maximum, minimum and mean were calculated for sulfate concentrations as shown in the table below.*

Sulfate Concentrations in Groundwater (mg/L)					
	All GW background locations	MMW007	MMW008	MMW033	GW background locations w/o the 3 wells
n	57	5	4	2	46
Maximum	276	55.1	35.9	37.9	276
Minimum	0.25	8.8	9.2	30.9	0.25
Mean	29.5	28.5	22.9	34.4	30.0

    As evident in the table, sulfate concentrations in groundwater collected from both MMW007 and MMW008 are clearly within the range of sulfate concentrations for the data set and the mean sulfate concentrations from these two wells is actually below the pooled mean. The mean sulfate concentration for MMW033 is slightly higher than the pooled mean, but the concentrations from the two sampling events from this well are well within the range of sulfate background concentrations. As mentioned above, additional statistical evaluations will be performed on the groundwater data set during the development of background levels.

17. The groundwater data summary Table 2-10 is missing its footnotes.

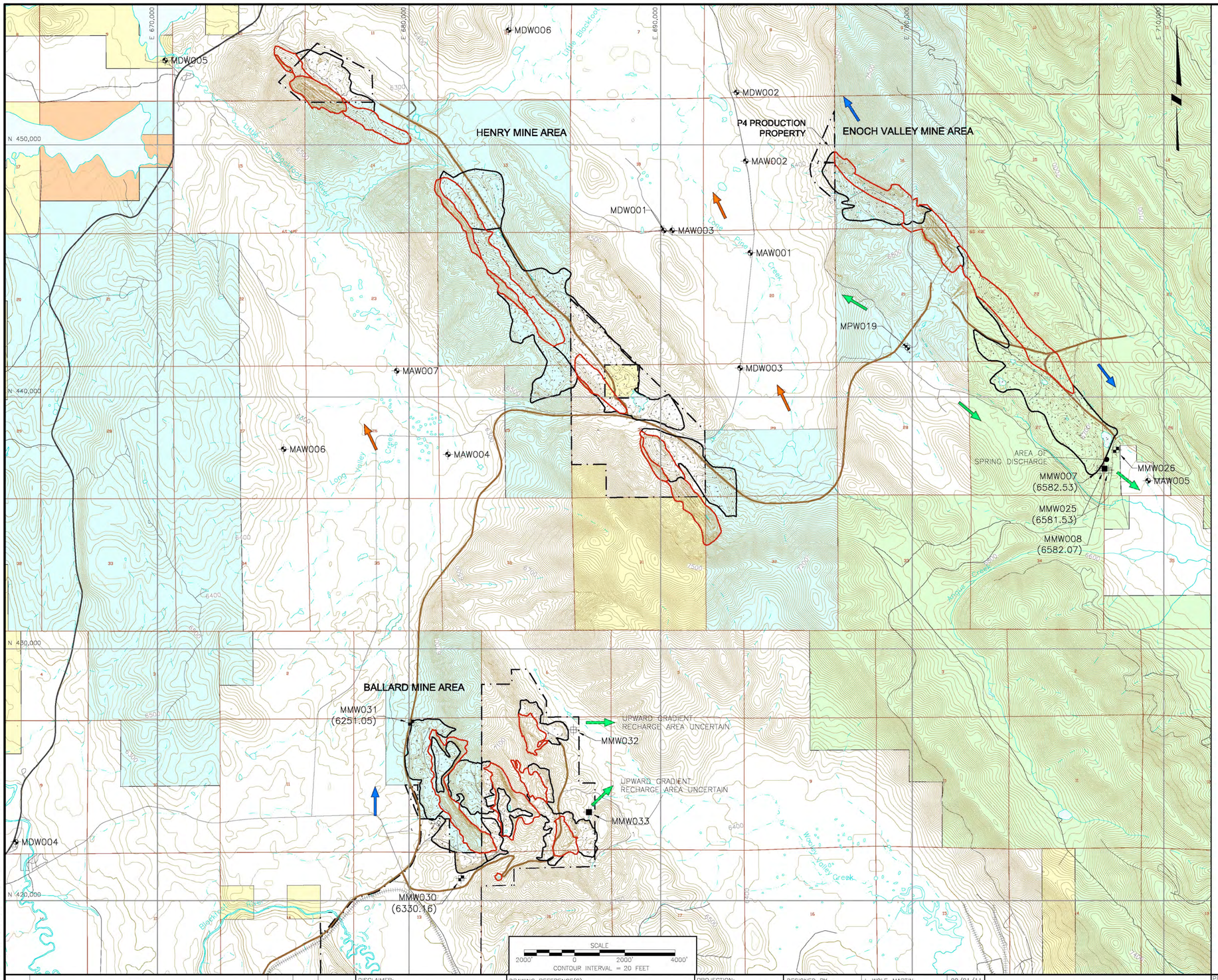
    P4 Response: *Agreed. The footnotes will be included in the revised Table 2-10 presented in the pending Background Tech Memo.*

Upland Soil and Vegetation

18. Proposed locations for upland soil and vegetation are satisfactory as these are the same background locations that were approved by the A/T for the 2009 study.

However, it is noted that soils overlying only two specific lithological units were sampled for background at the three mine sites (soils overlying Dinwoody and Wells Formations), including only soils overlying Wells Formation material for the Ballard Mine and only soils overlying the Dinwoody Formation material for the Henry and Enoch Valley Mines. Recognizing the rationale for collecting background samples overlying only these two formations was approved by the A/T for the 2009 study, the rationale should be repeated here to assist the reader in understanding the representativeness of the limited background data set.

P4 Response: *As stated in the A/T approved RI/FS Work Plan, and as described in the forthcoming Background Tech Memo, background data for the P4 Sites should be representative of the entire geologic sequence that is ultimately disturbed by mining activities. This is important because the undisturbed Phosphoria Formation is known to be elevated in some metals and is classified as a Naturally Occurring Radioactive Material (NORM). As stated in previous conversations and written work products (including our response to General Comment No.3, above), the entire geologic sequence is not represented in the current background data sets for upland soil and vegetation, as samples have not been collected from locations overlying or immediately downslope from the Phosphoria Formation. As a result, the background statistics for upland soil and vegetation likely will not be representative of pre-mining geological conditions at the P4 Sites, in that one would expect elevated levels of arsenic and uranium which are found in high concentrations in the phosphate ore bodies contained in the Phosphoria Formation. P4 agrees that this rationale needs to be captured in Table 2-2 of the Background Tech Memo. The rationale in Table 2-7 will be revised to state "Collected from the Wells (or Dinwoody as applicable) Formation in an area of undisturbed ground based on the A/T-approved Supplemental Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009)."*



LEGEND:

- 7000 — POST–MINE CONTOUR AND ELEVATION, FEET (APPROXIMATE)
- RIVER
- POND OR LAKE
- NATURAL DRAINAGE – PERENNIAL
- NATURAL DRAINAGE – INTERMITTENT
- HIGHWAY
- ROAD
- MONSANTO HAUL ROAD (ACTIVE & INACTIVE)
- RAILROAD
- MINE PIT BOUNDARY (APPROXIMATE WHERE COVERED BY BACKFILL)
- WASTE ROCK DUMP BOUNDARY (APPROXIMATE)
- WASTE ROCK DUMP BOUNDARY OR PIT BACKFILL (APPROXIMATE)
- APPROXIMATE OWNERSHIP BOUNDARY
- SECTION LINES
- A — SECTION NUMBER
- BLM LANDS
- US NATIONAL FORESTS
- STATE LANDS
- NON FEDERAL LANDS
- GENERAL OR ALLUVIAL INFERRED GROUNDWATER FLOW DIRECTION
- DINWOODY/THAYNES FLOW SYSTEM INFERRED GROUNDWATER FLOW DIRECTION
- WELLS FLOW SYSTEM FLOW INFERRED GROUNDWATER DIRECTION
- UPWARD OR FLAT VERTICAL GRADIENT IN DINWOODY OR DINWOODY/ALLUVIAL SYSTEM
- (6582.07) — WATER LEVELS SHOWN ARE FALL 2009

STATION TYPE:

- MAW = AGRICULTURAL WELL
- MDW = DOMESTIC WELL
- MPW = PRODUCTION WELL
- MMW = LOCAL AQUIFER MONITORING WELL (GENERALLY ALLUVIAL SYSTEM)
- MMW = INTERMEDIATE AQUIFER MONITORING WELL (GENERALLY DINWOODY FM.)
- MMW = REGIONAL AQUIFER MONITORING WELL (WELLS FM.)

NOTE:

1. ONLY PROPOSED BACKGROUND WELLS ARE SHOWN, FOR DISCUSSION OF THE BASIS FOR FLOW ARROWS INCLUDING OTHER WELL DATA SEE SECTION 3.7.4 OF THE RI/FS WORK PLAN.

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
B	REVISED FOR CLIENT REVIEW	CHF	CLF	11/22/11
A	DRAFT	CHF	LWM	09/01/11

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THIS DRAWING WAS DEVELOPED THROUGH THE APPLICATION OF PROFESSIONAL ENGINEERING SKILL AND PROPRIETARY METHODOLOGIES, PROCESSES AND KNOW HOW OF MWH AS AUTHOR ALL PURSUANT TO THE TERMS OF A CONTRACTUAL SCOPE OF WORK GOVERNING ITS PREPARATION. THIS DRAWING MAY NOT BE USED OR MODIFIED OTHER THAN IN STRICT ACCORDANCE WITH THE TERMS OF THE GOVERNING CONTRACT AND SCOPE OF WORK OR OTHERWISE ABSENT THE INVOLVEMENT AND CONSENT OF THE AUTHOR. ANY ALTERATION OR ADAPTATION OF THIS DRAWING SHALL BE CONSISTENT WITH THE AUTHOR'S CONTRACTUAL AND PROPRIETARY RIGHTS AND BE AT USER'S SOLE RISK AND WITHOUT ANY LIABILITY OR LEGAL RESPONSIBILITY OF MWH.

DRAWING REFERENCE(S):
1. POST–MINE TOPOGRAPHY GENERATED FROM:
- USGS DIGITAL ELEVATION MODELS (DEM)–24K.
- SURVEY DATA FOR BALLARD MINE PROVIDED BY OLYMPUS AERIAL SURVEYS, INC. DATED: JUNE 2005.
- SURVEY DATA FOR HENRY MINE AREA PROVIDED BY OLYMPUS AERIAL SURVEYS, INC. DATED: NOVEMBER 2006.
- SURVEY DATA FOR ENOCH VALLEY MINE AREA PROVIDED BY P4 PRODUCTION DATED: DECEMBER 2007.
- US CENSUS BUREAU 2007 TIGER LINE DATA

PROJECTION: STATE PLANE COORDINATE SYSTEM
ZONE: IDAHO EAST
HORIZONTAL DATUM: NAD27
VERTICAL DATUM: NGVD29
UNITS: U.S. FEET

DESIGNED BY	L WOLF–MARTIN	09/01/11
DRAWN BY	C FOWLER	09/01/11
CHECKED BY	L WOLF–MARTIN	09/01/11
APPROVED BY	L WOLF–MARTIN	09/01/11
PROJECT MANAGER	V DRAIN	09/01/11
CLIENT APPROVAL	B KOCH	09/01/11
CLIENT REFERENCE NO.		

P4 Production, LLC

PROJECT LOCATION: BALLARD, HENRY AND ENOCH VALLEY MINES
PROJECT: RI/FS
TITLE: GROUNDWATER BACKGROUND LOCATIONS

MWH

DRAWING 4 | REVISION B
FILE NAME 1011872D001

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APPENDIX E2

FEBRUARY 17, 2012 RTC

P4 Response to A/T Comments on Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 0 (Background Memorandum - Chapters 1 – 3 only) - A/T Comments were transmitted to P4 on January 23, 2012.

Comments on *Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 0* (Background Memorandum - Chapters 1 – 3 only) - Transmitted to P4 on January 23, 2012

Responses prepared for P4 Production by MWH, dated February 17, 2012.

Please note that revisions to the Chapter 1-3 text described in these responses to A/T comments will be included in the complete draft version of the Background Memorandum. The complete version of the Background Memorandum will include the revised text for section 1-3, Section 4, and the background levels for each medium.

General Comments

1. The Agencies cannot complete a comprehensive review of the referenced document in the context of the evaluation of background for the RI/FS without the specific information on how P4 proposes to ultimately use the summary statistics. Therefore this review and related comments are to be considered preliminary based on the information provided in the partial draft of the referenced document and are subject to further evaluation and modification pending review of the full draft of the document.

   P4 Response:

   We are attempting to use a stepping stone process for development of the Sites' background levels to ensure that the process is transparent and is agreed to before this information is used for screening along with other relevant EPA screening criteria in the RI Reports that will be prepared for the Sites. In addition, these background levels will be used as we discuss in our earlier response package "…..during preparation of the human health and ecological risk assessment (HHERA) for COPC/COPEC screening and for the calculation of incremental risk estimates. In addition, background levels may be used during preparation of the feasibility study (FS) to identify portions of the Sites that are appropriate for consideration of remedial alternatives, and as potential cleanup levels for COCs/COPECs that have low risk-based screening levels relative to background concentrations"

   This stepwise approach was agreed to during a bi-weekly call prior to our preparation and submittal of materials representing the initial step in this process. This initial step included submittal of drawings and tables via email on September 12, 2011 and October 13, 2011. Individual background sampling locations for each medium are depicted on these drawings.

   The text representing sections 1-3 of Background Levels Development Technical Memorandum (the Background Memorandum) was the second submittal in this process and is the subject of your current comments. The third submittal in this process will include the calculated background levels of metals and radionuclides for each of the selected media once we have agreed to the statistical methods and outcomes of this processes discussed in sections 1-3. The third submittal will also

include the completed Memorandum, which will be submitted for final A/T review. ***As*** *discussed above, the background levels developed in this Background Memorandum will be used in:*

- *The RI Report for preliminary screening, along with appropriate Agency risk-based standards, of sampling results from various media. Preliminary screening of sampling results will be based on an upper bound estimate of the background population, such as an upper tolerance limit (UTL) or maximum concentration, for each medium. Please also refer to our responses to Specific Comments No. (SC) #46 and #48.*
- *The HHERA for COPC and COPEC screening. Screening for COPCs and COPECs will be based on an upper bound estimate of the background population, such as a UTL, for each medium. Please also refer to our responses to Specific Comment (SC) #46 and SC#48.*
- *The HHERA for the calculation of background risk estimates. The calculation of background risk estimates for use in the derivation of incremental risk will be based on 95% upper confidence limit (UCL) on the mean concentrations, or maximum detected concentrations, for consistency with the exposure point concentrations used in the calculation of Sites' risk estimates.*
- *The FS to identify portions of the Sites that are appropriate for consideration of remedial action, and as potential cleanup levels for COCs/COPECs that have low risk-based screening levels relative to background concentrations. Background evaluations in the FS will be based on an upper bound estimate of the background population, such as a UTL or maximum concentration, for each medium.*

2. The referenced document focuses on background threshold values (BTVs) representing the upper range of the background data set. BTVs are important and necessary for advancing the RI/FS process, but other summary statistics are also important to support various decisions. For example, the document mentions calculating background human health risks which would typically imply that P4 would calculate upper confidence limits (UCLs) of the mean (as one would for site concentrations), but it is unclear if P4 will pursue this or not (no mention in this text). The discussion in this memorandum is primarily about comparing individual site concentrations to the calculated BTVs to draw conclusions on whether those site concentrations exceed background. Please clarify how UCLs of the mean will be used, if at all. In the final report, include summary tables that include the various summary statistics that will be used in the RI/FS, including 95 UCL of the mean.

   P4 Response: *Tables presenting summary statistics for each analyte in each medium will be included in Section 4.0 of the Background Memorandum. Summary statistics will include maximum detected concentration, minimum detected concentration, standard deviation, mean concentration, and 95% UCL*

on the mean concentration. As described in our response to General Comment (GC) #1, above, 95% UCL on the mean concentrations will be used in the HHERA during the calculation of background risk estimates for the derivation of incremental risk estimates.

3. As noted in the previous comment, there is no mention in the text of using two sample tests to compare background and site concentrations. P4 appears to be choosing the method that provides the highest available BTVs which has the potential to be calculated with spurious concentrations present in the data given the nature of the small data sets for some media. Two-sample comparisons, however, often offer increased evidence of background exceedances. Please provide a rationale for the exclusive use of BTVs in lieu of two-sample comparisons that might provide increased evidence of background exceedances.

   P4 Response: *In P4's experience, two sample tests such as the Wilcoxon Rank Sum test are non-robust when sample sizes are small and/or there are numerous non-detect results. This is the case for the sediment, riparian soil, riparian vegetation, and surface water data sets, where there are relatively few samples (e.g., sediment, riparian soil and riparian vegetation) or some analytes with numerous non-detect results (e.g., surface water). Please refer to Tables 2-3 through 2-6 of the Background Memorandum.*

4. As written, the text appears to be biased toward keeping all statistical outliers in the datasets. The document should be revised to provide more detail on the process that will be used to exclude or include statistical outliers.

   P4 Response: *No, the outlier evaluation is not biased to retain statistical outliers. Rather, it is intended to examine and understand the basis for statistical outliers. According to USEPA (2006), an outlier should not be removed from a dataset based solely on a statistical test. Instead, the decision to discard an outlier should be based on a scientific or quality assurance basis. As described in Section 3.3, the decision to remove an outlier from a given dataset will be based on a "weight-of-evidence" evaluation that includes results of the statistical outlier test as well as qualitative issues such as sampling anomalies or quality assurance/quality control (QA/QC) concerns.*

5. Throughout the document the term "re-evaluation" is used to describe the current work. The term is confusing. As the Agencies did not approve previous background evaluations submitted for the three P4 CERCLA sites, those previous evaluations are not relevant to the current work. Please replace "re-evaluation" with "evaluation" when discussing the current work.

P4 Response: *P4 believes that it important for a reader of the Background Memorandum to understand the investigation history of the three Sites as the investigation transitioned from the Area-Wide studies to EE/CA studies and from the EE/CA studies to the CERCLA RI/FS under the 2009 CO/AOC. Notably, that a significant portion of the background data was collected during the EE/CA studies in addition to data collected under the RI/FS. P4 understands the A/Ts concerns with the previous background evaluations and will change "re-evaluation" to the "current evaluation" throughout the document. However, P4 maintains that the historical context of this current background evaluation is important and has left necessary background information in the revised Background Memorandum.*

6. Please provide maps depicting the background concentrations (presented in whatever statistic is proposed [i.e., average]) of each media for each mine separately (Enoch Valley; soil, upland vegetation, sediment, riparian vegetation, surface water, groundwater = 6 maps).

   P4 Response: *If the reviewer can clarify the purpose of the requested maps relative to the statistical evaluation of background, it would help P4 to understand the merits of this request. For example, is the purpose of the maps to spatially evaluate whether specific stream sampling stations may exhibit higher analyte concentrations than other stream sampling locations, which could suggest an influence from an adjacent or upgradient mine site? In order to depict all background sampling results, a total of 18 maps (i.e., six media per background sampling area, times three background sampling areas) would be required. In addition, it is not practicable to post background sampling results for all analytes in all media on such maps. Therefore, if the purpose of this request is to evaluate whether data from a specific background sampling location should be included in the background dataset for a given medium, P4 believes that this objective can be met through an alternative, less labor intensive process, as discussed below.*

   For example, P4 could generate concentration-probability graphs for specific media and analytes where individual sample results are color coded by P4 background sampling location. The reader of these graphs will be able to view the distribution of all sampling results, identify which results correspond to a given P4 mines' background sampling location, and discern whether or not any of the sample results appear to be anomalous. Examples of this approach are presented for arsenic, manganese and selenium in upland soils (refer to Attachment 1). Again we do not believe that because an individual concentration graphed is high that it should automatically be thrown out but flagged until further statistical tests can be run. If the weight of evidence (i.e., its location, its concentration(s), the results of statistical tests, etc.) shows that an analyte in a medium is indeed anomalous, then it would be removed from the data set.

7. The FS/BLM does not agree that data for all three mine sites should be combined into a single data set for statistical evaluation and derivation of background levels.

While it may have been convenient to administer the three sites collectively for the investigation phase, according to the 2009 ASAOC Statement of Work, individual RI reports and baseline risk assessments will be prepared and submitted separately for each of the three mines thereby indicating each site is to be evaluated separately.

P4 Response: *There are several reasons to "pool" or combine the background data from the Sites. First and foremost, the geology of each of the Sites is derived from the same sequence of sedimentary rock formations (from oldest to youngest) which is the Pennsylvanian Wells Formation, the Permian Phosphoria Formation, and the early Triassic Dinwoody Formation. These three primary geologic formations are present at each of the mines as depicted on Drawing 1 and Drawing 2 (see Attachment 2). As described in the* <u>*Supplemental Mine Waste Rock Dump and Facility Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009),*</u> *the primary decision criterion that was used during the selection of A/T-approved background sampling locations was undisturbed areas away from mining activities, but still within the mined area footprint. Based on this criterion, upland soils and vegetation samples were collected from undisturbed areas overlying the Dinwoody Formation at the Henry and Enoch Valley mines' background (reference) areas, and from over the Wells Formation at the Ballard Mine reference area. Because the collection of background samples was limited to undisturbed areas overlying a discreet formation, none of the mine-specific reference areas reflect the heterogeneous geology that exists at each of the Sites. Consequently, the only way to attempt to capture the heterogeneous geology at the P4 Sites is to combine the background data collected from discreet formations. However, even when background data collected from the three Site reference areas are combined, these datasets only represent the Wells and Dinwoody Formations; the Phosphoria Formation is conspicuously absent.*

Second, natural variation is anticipated within a given geologic formation, such that there may be multiple populations within the geologic formation. As stated above, upland soil and vegetation background data were collected from media over the Dinwoody Formation at the Henry and Enoch Valley mines as shown on Drawings 1 and 2. When these drawings are combined with the distribution plots depicting, for example, the distribution of selenium (Se) concentrations detected in the background soils samples, what immediately becomes apparent is that the lower Se concentrations are found in soil samples collected from the Wells Formation at the Ballard Mine. The Enoch Valley and Henry mines have higher concentrations of Se, but they are collected from soils overlying the Dinwoody Formation. It is likely that the concentrations which are represented in the graphs of Se, arsenic (As), and manganese (Mn) represent the natural variation in the concentration of these metals in these two geologic formations. In each case, concentrations of these metals are lower in the Wells Formation when compared to the Dinwoody Formation.

Third, the Phosphoria Formation, which historically contains elevated concentrations of selenium and other metals (Herring, J.R. and Grauch, R.I.,

2004), is absent from the background sampling locations that were sampled during the background sampling investigations. As stated above, in the case of upland soil and vegetation media, samples were only collected from the Dinwoody and Wells Formations. As a result, the background datasets for upland soil and vegetation are not necessarily representative of pre-mining geological conditions inside the pit boundaries at individual mines. Therefore, if these data from the Wells and Dinwoody Formations are not pooled or combined then the representativeness of background levels for individual mines or the Sites as a whole will be sacrificed and the power of the statistics will be lost because the low sample number might make some of the statistical calculations meaningless or in the worst case invalid.

It should be noted that the background data were collected during the EE/CA and RI with the intent that they would be combined for development of background levels. As noted in previous comment responses and discussions with the A/T, the Sites are located in the headwaters of several surface water drainages such that there are limited upstream locations from which un-impacted background surface water, sediment, riparian soil and riparian vegetation samples could be collected. As a result, it was not possible to collect statistically meaningful numbers of background samples for these media at individual mine sites.

Individual RI Reports and risk assessments for each of the three Sites can and will be prepared where the data collected from the analyses of various media at a particular mine is compared, not only to the combined P4 background levels that are developed in this document, but to standard risk-based benchmarks developed by the EPA and others (as discussed under GC #1). Again, the risk assessment process will inform future decisions as to areas at each of the Sites that may warrant further examination in the FS for remedial action. The background levels developed herein are just one component in the evaluation process of human and ecological risks posed by each of the Sites.

8. P4 states that that the representativeness and usability of individual data should not be determined through comparisons to screening levels but through statistical evaluations performed during the calculation of Site-wide background levels. Please clarify why statistical evaluations are not used to categorize "site" versus "natural" background instead of using comparisons to screening levels.

   P4 Response: *The first step of the current background evaluation process was to determine the locations for background so that statistics can be performed using the data that were collected from those selected sample locations. In most cases these locations were previously agreed to as "background" sample locations in work plans that were submitted and approved by the A/Ts. Later, several of these background sample locations were given the designation "site" background to differentiate them from "natural" background locations. As discussed in Section 2.0 of the draft Background Memorandum "site" background refers to a location that is upstream of all potential P4 mining activities, but could possibly have*

influences from other nearby sources of contamination, whereas "natural" background indicates that no potential onsite or off-site mining-related influence is present. Upon further evaluation of the historical background data, P4 realigned five historical background designations and changed them from "site" to "natural" as described in Section 2.2.1 of the Background Memorandum. Currently, none of the background sampling locations proposed for use in the background evaluation are designated as "site" background. Please note that all background data will be included in the statistical outlier analysis, as described in Section 3.3 of the Background Memorandum. In the event that a sample result collected from one of the formerly designated "site" background locations is identified as an outlier, it will be considered for removal from the background data set. In addition, sampling results collected from formerly designated "site" locations will be flagged in graphs of the data to see where they occur within the data distribution. This information will be used in a 'weight of evidence' evaluation (as discussed above in GC#6) to determine the appropriateness of excluding the location from the background data sets. .

Specific Comments

1. **Section 1.0, page 1-1, 1st paragraph, 2nd sentence**. Please revise "…the United States Department of Agriculture (USDA), United States Forest Service (USFS), the United States Department of the Interior, United States Bureau of Land Management (BLM)…" to "the United States Department of Agriculture (USDA), Forest Service Region 4, the United States Department of the Interior (DOI), Bureau of Land Management (BLM)…" for consistency with the 2009 ASAOC.

   P4 Response: *To be consistent with page 2 of the 2009 CO/AOC, Section 1.0, page 1-1, 1st paragraph, 2nd sentence has been revised as follows:*

   "The 2009 CO/AOC *is a voluntary agreement between P4 and the United States Environmental Protection Agency (EPA), the Idaho Department of Environmental Quality (IDEQ), the United States Department of Agriculture, Forest Service (Forest Service), the United States Department of the Interior (DOI), Bureau of Land Management (BLM), the Shoshone-Bannock tribes (Tribes), collectively referred to as the Agencies and Tribes or A/Ts."*

2. **Section 1.0, page 1-1. The** Fish and Wildlife Service (FWS) should be included with the agency list for the 2009 CO/AOC.

   P4 Response: *Page 2 of the 2009 CO/AOC does not include the Fish and Wildlife Service (FWS) in the agency list. However, P4 has referenced the FWS in Section 1.0, page 1-1, 1st paragraph, 2nd sentence of the revised Background Memorandum as requested.*

3. **Section 1.1, page 1-1, 1st paragraph, 3rd sentence.** Please explain which 2003 CO/AOC this is referring to.

   P4 Response: *Effective October 24, 2003, the United States Environmental Protection Agency ("EPA"), the Idaho Department of Environmental Quality ("IDEQ"), the United States Department of Agriculture, Forest Service ("Forest Service"), and P4 Production, L.L.C ("P4"), the latter as Respondent, voluntarily entered into an Administrative Order on Consent/Consent Order ("2003 CO/AOC"). The 2003 CO/AOC provided for the performance by P4 of a Site Investigation ("SI") and an Engineering Evaluation/Cost Analysis ("EE/CA") for the Enoch Valley Mine, the Ballard Mine, and the Henry Mine. In 2009, these same Agencies and P4 entered into the CO/AOC for Remedial Investigation/Feasibility Study for the Enoch Valley Mine, the Ballard Mine, and the Henry Mine (2009 CO/AOC) that superseded the 2003 CO/AOC. Section 1.1, page 1-1, 1st paragraph has been revised to clarify the differences between the 2003 and 2009 CO/AOC.*

4. **Section 1.1, pages 1-1 and 1-2, last sentence page 1-1, first sentence page 1-2 and full first paragraph page 1-2.** This section is confusing and the need to conduct the proposed work is unclear. The text states that previous studies included statistically derived background numbers that have not been agreed to by the A/Ts, but does not explain why. The text states that background concentrations will be an important consideration in future work, but does not explain why (see Sections 2.1 and 2.2, Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites, US EPA, 2007). The text states that this memo fulfills this data gap, but no data gap is identified. It is unclear what will be done differently for this "re-evaluation" than what was previously done and not approved by the Agencies. Please revise for clarity.

   P4 Response: *As there are multiple parts of this comment. P4 will address each individual part of the comment as follows:*

   1) In order to address the portion of the comment stating that previous studies included statistically derived background numbers that have not been agreed to by the A/Ts, but does not explain why, P4 will revise the last sentence of Section 1.1 on page 1-1 to explain:

   "As stated in the RI/FS Work Plan, previous Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Engineering Evaluation and Cost Analysis (EE/CA) studies collected background data that will be used as part of the current evaluation of background.

   2) In order to address the portion of the comment stating that background concentrations will be an important consideration in future work, but does not

explain why, P4 will revise the text to include a bullet list of potential uses of the background concentrations as discussed in our response to GC #1.

3) In order to address the portion of the comment stating that this memo fulfills this data gap, but no data gap is identified, P4 directs the commenter to the beginning lines of Section 1.1 (see below).

"In May 2011, P4 submitted the Remedial Investigation/Feasibility Study Work Plan for the P4 Site – Revision 2 Final (RI/FS Work Plan), which was approved by EPA on June 20, 2011. As part of the RI/FS scoping process, historical data were evaluated in the RI/FS Work Plan to identify data gaps and the additional data collection activities that must be completed under the RI before the risk assessment (RA) and FS processes can begin. This evaluation primarily used data collected under the 2003 CO/AOC. As part of the data gap analysis, it was determined that sufficient data for the various media have been collected to characterize background."

The original text goes on to discuss how although the background data exists, the A/T have not approved the previous statistical evaluations of the background data. Therefore, the data gap is included in this Section, and no revision to the Background Memorandum is required.

The difference between this evaluation and previous background evaluations is that this the current process is working towards the A/Ts approving the methods and statistical tests/evaluations to be conducted, prior to generating the background concentrations for each medium of concern. The A/Ts previously have not approved the statistical tests used to evaluate the historical data.

5. **Section 1.2, page 1-2, and Table 1-1.** The utility of the information presented here in the context of the proposed work for the RI/FS is unclear given that there are more recent site-specific data available for the background evaluation at each of the three mine sites. The background data collected for the Area Wide Investigation was not subject to the same level of data quality rigor as that collected under the 2009 P4 CERCLA ASAOC, so has limited utility in the current work other than as anecdotal information. Additionally, the FUBOB calculated background values are not relevant to the current work nor have they been approved by the Agencies. Please delete everything after "…the Comprehensive Site Investigation Sampling and Analysis Plan (SI SAP; MWH, 2004)" including the reference to the draft PIES document (there is a reason it is still draft from 2007, i.e., not approved by the Agencies). Please revise Table 1-1 by deleting the FUBOB values and qualifying the Area Wide background data as limited in the number of COPCs analyzed and the unknown quality of the data. Present only data for those locations proximal to or within the project study area boundaries for the three P4 CERCLA sites. Present the data using the same statistical approach as that proposed for the entire background evaluation.

P4 Response: *P4 believes that it important for a reader of the Background Memorandum to understand the investigation history of the three Sites as the investigation transitioned from the Area-Wide studies to EE/CA studies and from the EE/CA studies to the CERCLA RI/FS. Notably, that a significant portion of the background data was collected during the EE/CA studies in addition to data collected under the RI/FS. P4 maintains that the historical context of this current background evaluation is important and has left necessary background information in this Background Memorandum. However, P4 agrees to qualify the Area-Wide data in Table 1-1, add additional statistics (e.g., maximum, minimum and average, in addition to removing the FUBOB values from the table. P4 does not believe that further statistical analysis is warranted for the Area-Wide data set (i.e., using only Area-Wide locations proximal to or within the project study areas); therefore, the Area-Wide statistics as used in the Area-Wide Risk Assessment; IDEQ, 2002 will be presented in Table 1-1. Based on this response, Section 2.1 has been revised as follows (new text underlined):*

"Background samples of various media have been collected dating back to the Site-Wide Investigations, which started in 1996 and ran through approximately 2004, when the investigations began focusing on specific mines with specific owners. An area-wide human health and ecological risk assessment (HHERA) was performed by the IDEQ in 2002 using sampling data collected throughout the region. Background samples at P4's historic Sites were also collected between 2002 and 2009 under the 2003 AOC/CO as part of an expedited CERCLA EE/CA approach that was consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). In 2009, the A/Ts determined that the RI/FS process (also under CERCLA) was more appropriate for assessment of risk to human health and the environment and the subsequent identification of cleanup solutions, if necessary. This Background Levels Tech Memo is part of the RI/FS process.

Background levels have previously been evaluated and reported in the Area-Wide Human Health and Ecological Risk Assessment Selenium Project Southeast Idaho Phosphate Mining Resource Area (Area-Wide Risk Assessment; IDEQ, 2002). <u>The Area-Wide range, average, and 95% UCL background values are summarized in Table 1-1 although it must be noted that the data quality requirements may be less than the current data quality requirements under the RI/FS and the Area-Wide data were analyzed for a limited data set.</u>

<u>Background data was also collected and evaluated under the 2003 AOC/CO area as referenced in the Comprehensive Site Investigation Sampling and Analysis Plan (SI SAP; MWH, 2004), as well as the draft Interim Phase I SIs Evaluation Summary (draft PIES document; MWH, 2007). These background evaluations were not approved by the A/T.</u>

<u>The EE/CA background evaluations</u> were based on the analyte list agreed upon in the 2003 AOC, with slight adjustments made for the approved 2004 analyte list (MWH, 2004). This list of analytes also was based upon screening performed by IDEQ in the Area-Wide Investigations and Risk Assessment. The COPCs for which preliminary background concentrations were calculated are listed below.

- *cadmium*
- *chromium*
- *copper*
- *molybdenum*
- *nickel*
- *selenium*
- *vanadium*
- *zinc"*

6. **Section 2.1, page 2-1.** For clarity and consistency, please revise this section using the definitions of background provided by EPA in various EPA guidance documents discussing background under CERCLA. Additionally the term "upstream" has limited utility in the context of soil and vegetation background locations. Please revise accordingly.

   P4 Response: *Agreed. Section 2.1 will be revised as follows (new text underlined):*

   "In general, background for the RI/FS for the Sites has been defined as "locations unaffected by P4 mining operations that are representative of pre-mining geological conditions." More specifically, "site" background refers to a location that is upstream, <u>upgradient, or upwind of</u> all potential P4 mining activities whereas "natural" background indicates that no potential on-site or off-site mining-related influence is present. A "site" background location may be influenced by other non-P4 mining activities. <u>In the context of EPA guidance for evaluating background concentrations at CERCLA sites, "natural" background is the same as "naturally-occurring" background and "site" background is the equivalent of "anthropogenic" background (EPA, 2002).</u> For this re-evaluation of background data, P4 is proposing to use "natural" <u>(i.e., naturally-occurring)</u> background locations to the extent practicable. For several media (sediment, surface soil, riparian soils, and riparian vegetation), background stations were initially selected during the area-wide and EE/CA studies, although there have been additions <u>to the number of sampling events</u> as a result of ongoing RI/FS activities. Background sampling locations for all media are depicted on Drawing 1-1."

7. **Section 2.1.1, page 2-1, last sentence.** It is unclear why stations that may have been influenced by other mining activities in the district are not included in the current background evaluation given the statement in the preceding paragraph that a "site" background location may be influenced by other non-P4 mining activities. Please revise for consistency and clarity.

   P4 Response: *Section 2.1, first paragraph has been revised to include that P4 is proposing to use "natural" background locations to the extent practicable as the inclusion of "site" background locations in the background dataset may bias the background concentrations. In addition, Section 2.1.1, page 2-1, last sentence, has been revised to state the following:*

   "These stations are not included in this evaluation of background for surface water, sediment, and riparian media as further discussed in Section 2.2.1."

8. **Section 2.1.2, page 2-1, last sentence:** Please clarify what "comparable in extent to other waste rock dumps being characterized" means (i.e., extent in what context, what "other" waste rock dumps, etc.).

   P4 Response: *The criteria stated in this sentence were included verbatim from the Supplemental Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009). However, in the context of this Background Memorandum the sentence has been revised to state the following:*

   "3) comparable in areal extent to the waste rock dumps that were characterized at the mine sites during the 2009 Supplemental Soil and Vegetation Characterization program."

9. **Section 2.1.2, page 2-2, 1st paragraph.** The text states that the background statistics for upland soil and vegetation are likely not all inclusive of pre-mining geological conditions at the P4 CERCLA sites, but there is no discussion on what this means to the proposed work. Please explain. Additionally, the text states that the undisturbed Phosphoria Formation is classified as a Naturally Occurring Radioactive Material (NORM), but there is no reference provided to identify classified by who or what agency. Please revise accordingly.

   P4 Response: *The following sentence will be revised:*

   "This is important because the undisturbed Phosphoria Formation is known to be elevated in some metals and is classified as a Naturally Occurring Radioactive material (NORM)."

   The new sentence will read:

   "This is important because the undisturbed Phosphoria Formation is known to be elevated in some metals (Herring, J.R. and Grauch, R.I., 2004) and excluding

data from this unit may bias the representative background concentrations for some elements low. This may affect the calculation of incremental risk for some elements such as arsenic and uranium."

The reference to NORM is not particularly important and is removed.

10. **Section 2.2.1, page 2-3.** The text states that sampling for riparian vegetation occurred once in 2004. The 2004 sampling event analyzed for a very limited set of COPCs (five analytes according to Table 2-6). Please explain how the background evaluation (and subsequent risk assessment) will be conducted for the remaining COPCs.

    P4 Response: *The COPC/COPEC suite has historically been limited to cadmium, chromium, copper, molybdenum, nickel, selenium, vanadium, and zinc for several media including soils, vegetation and sediment based upon screening performed by IDEQ in the Area-Wide Investigations and Risk Assessment. It was not until recently (i.e., 2009 and 2010), that the analytical suite was increased to 17 constituents for these media. In addition, it is important to note that the 2009 upland vegetation data and the 2004 riparian and upland vegetation data were evaluated against risk-based screening levels (RBSLs) in the A/T-approved RI/FS Work Plan - Rev2 Final (RI/FS Work Plan). As shown on Tables 3-5, 3-21, and 3-37 of the RI/FS Work Plan, there are only three analytes (cadmium, molybdenum and selenium) detected in riparian and upland vegetation that exceeded RBSLs. The exception to this is one exceedance of the RBSL for boron in a 2009 upland vegetation sample at Enoch Valley.*

    Based on the comparisons of vegetation concentrations to RBSLs presented in the RI/FS Work Plan, and the fact that all three analytes that consistently exceeded vegetation RBSLs were included in the 2004 analytical suite, P4 does not believe that the historically-selective analyte list for the riparian vegetation data represents a significant data gap. Nevertheless, the limited nature of the analytical suite for riparian vegetation will be described in the human health and ecological risk assessments (HHERA) for the Sites.

    In the HHERAs to be performed for the Sites, biota consumption pathways will be evaluated by inputting measured riparian vegetation concentrations into the dose equations for those chemicals with available riparian vegetation sampling results. For those chemicals without riparian vegetation sampling results, riparian vegetation concentrations will be modeled from riparian soil concentrations using published soil-to-plant bioaccumulation factors, as available.

11. **Section 2.2.1, page 2-3, last two sentences.** Please delete. The current document should focus on what is proposed rather than discussing data collected in the past that will not be used.

P4 Response: *As stated in response to GC #5, P4 believes that it important for a reader of the Background Memorandum to understand the investigation history of the three Sites as the investigation transitioned from the Area-Wide studies to EE/CA studies and from the EE/CA studies to the CERCLA RI/FS. Notably, that a portion of the background data was collected during the EE/CA studies in addition to data collected under the RI/FS. P4 maintains that the historical context of this current background evaluation is important and has left necessary background information in this Background Memorandum. However, P4 agrees to remove the last two sentences of Section 2.2.1, page 2-3 as requested.*

12. **Section 2.2.1, page 2-4, 2nd paragraph.** According to the text, P4 has changed these five locations from "site" background to "natural" background for sediment. Please explain the category of background P4 is proposing for these five locations for riparian vegetation, surface water and riparian soils.

    P4 Response: *P4 meant to state that that these five locations would be changed from "site" to "natural" background for all media discussed in this Section. P4 will revise this paragraph to state the following:*

    "As shown in Table 2-2, none of the proposed background sediment, surface water, riparian soil, and riparian vegetation sample locations are characterized as "site" background locations. Upon further evaluation of the historical background data, P4 realigned five of the historical background locations from "site" to "natural" as defined on the spatial wire diagrams (SWDs) included in previous documents (e.g., the draft PIES document and the RI/FS Work Plan). The five locations that were changed from "site" to "natural" background designations are MST226, MST048, MST274, MST275, and MST277."

13. **Section 2.2.1, page 2-4, 3rd paragraph.** It appears that the drainage from the Wooley Valley Mine waste rock pile as well as the haul road adjacent to MST226 would potentially impact this location. It is unclear how the determination has been made to reclassify this location from site to natural background. Please clarify.

    P4 Response: *As discussed in the Background Memorandum, MST226 is located on an ephemeral drainage to Lone Pine Creek. This location was historically characterized as a "site" location based on its proximity to an adjacent mine, which is not owned by P4. This classification was based on a regional waste rock boundary definition that did not have the resolution needed to accurately indicate if the drainage in question contained mine waste rock. During this re-evaluation and remapping of the waste rock in this area, it was determined that the uppermost part of the drainage does not contain a portion of the waste rock dump in question, and that in fact the waste rock associated with the adjacent mine is located in a drainage over a divide from MST226. However, data from this*

background station will be statistically evaluated during the outlier analysis, as discussed in the Background Memorandum.

14. **Section 2.2.1, page 2-5.** Throughout the document when there is reference to 'inputs' that may impact background, are the 'inputs' that were evaluated both surface water and groundwater inputs? This should be clarified.

    P4 Response: *Inputs refers to flows from mining disturbed areas. For surface water this is an obvious evaluation – are there mine waste or other mining-related disturbance in the drainage? As for impacted groundwater flows that may contribute to stream baseflow, this evaluation is less obvious. However, such contributions are most likely to be locally sourced from the alluvial groundwater system at the selected location. Given the nature of these systems, the evaluation of possible mining influence is the same as with surface water, because the alluvial groundwater flow generally mirrors the surface water flow. Based on the conceptual groundwater models for the Sites, neither the Dinwoody Formations nor the Wells Formation are likely to be contributing impacted baseflow to the selected background locations.*

    A sentence will be added to the end of Section 2.1.1 stating that, "When evaluating the locations for surface water, sediment and riparian soil locations for background, both potential surface water and groundwater flows (inputs) from adjacent mine areas were considered."

15. **Section 2.2.1, page 2-5 first paragraph.** It is unclear from Figure 1-1where the North Rasmussen Mine lies in relation to MST254, MST049 and MST048. When comparing the figure provided to a large scale map, there may be influence from the North Rasmussen Mine to MST048. Please provide a graphic depicting the North Rasmussen Mine in relation to these background locations.

    P4 Response: *The locations of the referenced stations are well out of the area of influence of the North Rasmussen Mine. However, it is noted that the boundaries shown of Figure 1-1 for the mine are out of date. The boundaries will be updated and the inset relocated as needed to more accurately show the relationship.*

16. **Section 2.2.1, page 2-5, 2nd complete paragraph:** The point of this paragraph is unclear. The text states that MST277 was evaluated as a background location in a previous work product and that the data from MST277 is in the range of other background data.

    P4 Response: *This paragraph is providing P4's rationale for changing the background designation of MST277 from a "site" to "natural" background location. The first sentence of the 2nd complete paragraph has been revised to*

state "The fifth station to be changed from a "site" to a "natural" background location, MST277, was evaluated and approved as a background location by the A/Ts for the Supplemental Sediment and Riparian Soil Sampling and Analysis Plan (MWH, 2010b)."

17. **Section 2.2.1, page 2-6, 1st incomplete paragraph, last sentence.** The text states that P4 is proposing to use "natural' background data for the evaluation of medium-specific background concentrations. This statement begs the question of the utility of the "site" background data. Please clarify.

    P4 Response: *P4 agrees with the utility of the "site" background data that has been historically collected. The "site" background data may help P4 and the A/Ts assess the influence (i.e., contamination impacts) to particular media located on the P4 Sites from non-P4 sites. However, as discussed throughout these responses, P4 believes that inclusion of "site" background stations would bias or skew the background data and this evaluation of background is proposing to use "natural" background locations.*

18. **Section 2.2.1, page 2-6, last paragraph.** The text states that the final representativeness and usability of data or sampling locations is determined through statistical evaluations performed during the calculation of Site-wide background levels. Please clarify that "Site-wide" refers to each of the three individual P4 mine sites, not the three sites collectively.

    P4 Response: *Please note that the term 'Site-wide' was intentional and refers to the calculation of background levels using the combined (pooled) data collected at all three of the Sites, rather than for individual mines. The rationale and basis for this approach are provided in our response to GC #7, above.*

19. **Section 2.2.1.1, page 2-7, Antimony.** Please explain the justification for comparing antimony in sediments to antimony in soils given the different ecological and geomorphologic environments between sediments and soils. This comment applies to subsequent discussions of the various COPCs in sediments.

    P4 Response: *As described in Section 2.2.1.1, regional background levels are not currently available for antimony in sediment. Therefore, antimony concentrations in the two sediment sampling locations where antimony was detected were compared to published background concentrations of antimony in U.S. soils, under the assumption that shallow stream sediment concentrations of metals are influenced by surface water runoff from adjacent soils. However, we agree with the reviewer that sediments and soils represent different geomorphologic*

environments, and concentrations in soil are not directly comparable to sediment. Text within Section 2.2.1 will be revised as follows:

> *"Although regional background levels for antimony in sediment are not currently available, Kabata-Pendias (2001) cites a range of antimony concentrations in U.S. soils as 0.11 to 14.0 mg/kg. The sediment screening level for antimony and the range of detected concentrations of antimony in background sediment samples are within the range of reported background concentrations for antimony in soil. It should be noted that sediments and soils represent different geomorphologic environments, and background levels for antimony in soil are not directly comparable to background concentrations in sediment."*

20. **Section 2.2.1.1, page 2-7, Cadmium.** The text states that, according to the Area-Wide Risk Assessment, the background concentration for cadmium in sediment was 5.15 mg/kg. However, on page 143 of the Final Area Wide Human Health and Ecological Risk Assessment (AWHHERA), the text states:

    "The maximum detected concentration of cadmium in impacted sediments was 14.0 mg/kg with an average impacted area concentration of 5.47 mg/kg. These values were compared to the average background area concentration of 1.06 mg/kg. The maximum detected value in the impacted area exceeded the average background area concentration by a factor of 13."

    Please revise for accuracy.

    P4 Response: *As noted in Table 1-1, the Area-Wide Risk Assessment background concentrations included in this table were based on the 95% UCL as reported in Table AT1-4 of the Summary of Descriptive Statistics for Background Areas in the Phosphate Resource Area. However, Table 1-1 incorrectly cited the reference. Table AT1-4 is an attachment from the Area Wide Risk Management Plan, Selenium Area Wide Investigation Southeast Idaho Phosphate Mining Resource Area (IDEQ, 2004) not the Area-Wide Risk Assessment (IDEQ, 2002) as currently referenced in Table 1-1. The correct reference is provided in the revised Background Memorandum.*

    In addition, as the Area-Wide Human Health and Ecological Risk Assessment Tier 2 screening compared data against two times the average background concentrations (page 21 of the Final Area-Wide Human Health and Ecological Risk Assessment [IDEQ, 2002]), the background concentrations in Table 1-1 of the Background Memorandum have been revised to include the mean and range of the data in addition to the 95% UCL, and the discussions in Section 2.2.1.1 have been revised to reflect comparison to the Area-Wide mean background concentrations (e.g., 1.06 mg/kg for cadmium).

21. **Section 2.2.1.1, page 2-7, Cadmium.** Throughout the document, there is reference to many of the analytes having a "conservative screening benchmark" and P4 seems to be using that argument to support the dismissal of use of that benchmark rather than the conclusion that the concentration sampled is not representative of background conditions. Please provide more discussion on why the screening benchmark is being dismissed, as there is a reason why the benchmark was set at the concentration is was. Why should that concentration not apply to the P4 sites?

    P4 Response: *P4 is not trying to make a case that specific screening criteria do not apply to the Sites. Rather, we are pointing out that for some chemicals in some media, available published benchmarks are low relative to background concentrations. An example is arsenic for which human health-based screening levels are commonly at or below the range of background concentrations observed in most regions of the U.S. The fact that measured concentrations of arsenic in soil at a given location exceed a screening benchmark, such as the EPA Regional Screening Level (RSL) for arsenic in residential soil, does not necessarily mean that the concentrations are not representative of background.*

22. **Section 2.2.1.1, page 2-7, Cadmium, line 8.** It isn't "clear" to this reader considering that the range of Cd concentrations in sediment at the sites is from 0.22 to 3.84 mg/kg and the range of Cd in western soils is <0.01 to 2 mg/kg, an almost 2-fold difference at the upper end of the range. Please clarify and/or revise accordingly.

    P4 Response: *The sentence states "Clearly, the sediment screening level for cadmium is within the range of reported background concentrations for cadmium in soils and is less than the Area-Wide background concentration." The discussion by no means implies that the range of cadmium concentrations in Site sediments is within the range of western soils' cadmium concentrations. The discussion is focused on the conservative nature of the screening level in order to explain the number of samples that are greater than this screening level. However, for clarity, the sentence has been revised as follows:*

    " Clearly, the sediment screening level of 0.583 mg/kg for cadmium is within the range of reported background concentrations for cadmium in soils (0.22 to 3.85 mg/kg) and the sediment screening level is less than the Area-Wide mean background concentration (1.06 mg/kg)."

23. **Section 2.2.1.1, page 2-7, 1st paragraph, last sentence.** Provide a reference for ". . . zinc concentrations are known to be higher in the naturally occurring Phosphoria Formation than in other geologic materials."

P4 Response: *The world shale average concentration of zinc is 100 to 200 ppm (Turekian and Wedepohl, 1961). Herring and Grauch (2004) analyzed 374 samples of the Meade Peak phosphatic shale member and determined an average zinc concentration of 1,653 ppm. Desborough and Poole (1983) analyzed samples from an underground crosscut at Pritchard Creek near the Snake River in southeastern Idaho and found an average zinc concentration of 1,670 ppm for 31 samples. This is the basis for the statement. These references will be added to the text and reference list:*

Desborough, G.A. and Poole, F.G., 1983, Metal Concentrations in Some Marine Black Shales of the United States. In: W.C. Shanks (ed.), Cameron Volume on Unconventional Mineral Deposits. Society of Economic Geologists, pp. 99-110

Herring, J.R. and Grauch, R.I., 2004, Lithogeochemistry of the Meade Peak Phosphatic Shale Member of the Phosphoria Formation, Southeast Idaho. In: J.R. Hein (ed.), Lifecycle of the Phosphoria Formation. Handbook of Exploration and Environmental Geochemistry, U.S. Geological Survey, Menlo Park, CA. Vol. 8: pp. 321-366

Turekian, K.K. and Wedepohl, K.H., 1961, Distribution of the elements in some major units of the earth's crust. Geol. Soc. Am. Bull., 72: pp. 175-191

24. **Section 2.2.1.1, page 2-7.** If comparison to the Area-wide is going to be made, the Area-Wide definition of 'background' should be provided. This reviewer assumes the Area-wide definition of background is the same as 'natural' background as defined earlier in this P4 document, but that needs to be clarified.

    P4 Response: *Page 29 of the Final Area Wide Human Health and Ecological Risk Assessment, Selenium Project Southeast Idaho Phosphate Mining Resource Area (IDEQ, 2002) defined background riparian soils, and presumably sediments and surface waters, as areas upstream of mining facilities or as unimpacted reaches. Areas downstream of mining facilities were referred to as impacted reaches. This definition is provided in Section 1.2 of the revised Background Memorandum.*

25. **Section 2.2.1.1, page 2-8, 1st incomplete paragraph, last sentence.** Provide a reference for ". . . cadmium concentrations are known to be higher in the naturally occurring Phosphoria Formation than in other geologic materials."

    P4 Response: *The average world shale concentration of cadmium is 0.3 to 2 ppm (Turekian and Wedepohl, 1961). Herring and Grauch (2004) analyzed 374 samples (96 percent were above the lower detection limit for cadmium) of the Meade Peak phosphatic shale member. They estimated the average cadmium concentration as 70 ppm. Desborough and Poole (1983), found an average Meade Peak cadmium concentration of 75 ppm when they analyzed 31 samples.*

This is the basis for the statement. These references will be added to the text, and the references added to the reference list per the response to SC #23.

26. **Section 2.2.1.1, page 2-8.** The text infers that naturally occurring elevated analytes (i.e., cadmium, zinc, and selenium) in the Phosphoria could impact background concentrations. Clarification should be provided on whether background locations for the P4 sites were taken from locations that were of known phosphoria formation geology. If so, were these from actual phosphoria outcrops? If samples were collected from phosphoria outcrops, discussion should be provided on whether there is concern that calling known phosphoria outcrops 'background' locations will skew the data?

    P4 Response: *The statements at the end of the cadmium zinc, and selenium discussions will be revised to say (depending on the analyte being discussed),*

    > *"In addition, (cadmium, zinc and selenium) concentrations are known to be higher in the naturally occurring Phosphoria Formation than in other geologic materials, so therefore, it is possible that the stream sediment would have naturally elevated concentrations of (cadmium, zinc and selenium)where streams channels cross undisturbed Phosphoria Formation areas. However, none of the proposed background sediment locations are directly originating in or across known Phosphoria Formation outcrop areas."*

    In addition references will be added to the document per SC #23 and #25.

27. **Section 2.2.1.1, page 2-8, Nickel.** The text states that, according to the Area-Wide Risk Assessment, the background concentration for nickel in sediment was 26.42 mg/kg. However, on page 145 of the AWHHERA, the text states:

    "The maximum detected concentration of nickel in impacted sediments was 164 mg/kg with an average of 64 mg/kg. These values were compared to the average background area concentration of 14 mg/kg. The maximum detected value and the average in the impacted area exceeded the average background area concentration by a factor of 12."

    Please revise for accuracy.

    P4 Response: *As discussed in response to SC #20, the background concentrations in Table 1-1 of the Background Memorandum have been revised to include the range, mean and 95% UCL and the discussions in Section 2.2.1.1 have been updated to reflect comparison to the mean Area-Wide background concentrations.*

28. **Section 2.2.1.1, page 2-8, Zinc.** The text states that, according to the Area-Wide Risk Assessment, the background concentration for zinc in sediment was 112.67 mg/kg. However, on page 145 of the AWHHERA, the text states:

    "The maximum detected concentration of zinc in impacted sediments was 866 mg/kg with an average impacted area concentration of 251.73 mg/kg. These values were compared to the average background area concentration of 75.50 mg/kg. The maximum detected value in the impacted area exceeded the average background area concentration by a factor of 11."

    Please revise for accuracy.

    P4 Response: *As discussed in response to SC #20, the background concentrations in Table 1-1 of the Background Memorandum have been revised to include the range, mean, and 95% UCL and the discussions in Section 2.2.1.1 have been updated to reflect comparison to the mean Area-Wide background concentrations.*

29. **Section 2.2.1.2, page 2-11, Selenium.** In general, it is fair to say that natural background concentrations of selenium in surface water above 0.002-0.003 mg/L are extremely rare in the phosphate district. They are so rare in fact that it is reasonable to suspect that MST274 and MST275 have been impacted from mining activities in the region and do not reflect natural background. This premise has caused the A/T to question the inclusion of these two locations in the background database. Evidence supporting the removal of MST274 and MST275 from the background database is presented below.

    MST274
    MST274 is apt to be impacted by the haul road that runs past this site and the minor drainage that runs to the west (West Fork of Rasmussen Creek). The haul road appears to be a significant feature near to MST274, possibly causing the selenium to be elevated at this sample location.

    There is also evidence that MST274 may be impacted by a release from Enoch Valley Mine. For example, both cross sections ***D-D'*** and ***J-J'*** of the RI/FS work plan show that infiltration from MWD092 is expected to migrate within the alluvium toward the south. If MST274 is projected northeast onto these cross sections, there appears to be a distinct possibility that MST274 is downgradient of the mine. Recognizing the possibility that MST274 is actually Thaynes Formation spring water expressed through a veneer of alluvium (as suggested by Drawing 2-5 of the RI/FS work plan), the fact that MST274 is downdip of, south of (downgradient), and lower in elevation than the Enoch Valley Mine is sufficient evidence to suspect that MST274 may not be an appropriate background location. Note that the A/T recognizes that intervening push probe results just to the north of MST274 are low in selenium, typically <0.001 mg/L. Again, recognizing the possibility that MST274 is actually Thaynes Formation spring water expressed

through a veneer of alluvium (as suggested by Drawing 2-5 of the RI/FS work plan), the direct push samples may not representative of the water sampled at MST274.

Based on the above uncertainties, it is the A/T's position that MST274 be deleted from the background database unless P4 can provide other compelling evidence showing MST274 cannot be impacted by the haul road, Enoch Valley Mine, or any other mine in the region.

MST275

MST275 is located between the Enoch Valley and Henry Mines and its provenance is Thaynes Formation, assuming the lithology provided in Drawing 2-5 of the RI/FS work plan is correct. MST275 is also located very close to the Henry Thrust Fault. In Section ***B-B'*** of Drawing 2-7 of the RI/FS work plan, easterly dipping bedding beneath the Henry Mine is depicted as overlying Dinwoody Formation that is shown to be discharging towards the Henry Thrust Fault. Westerly dipping Dinwoody/Thaynes bedding beneath the Enoch Valley Mine could also be discharging towards the Henry Thrust Fault. Furthermore, there is a possibility that the South Rasmussen Mine is contributing to the Dinwoody/Thayes in this region and potentially discharging towards the Henry Thrust Fault. The West Limb Pit and overburden pile of the South Rasmussen Mine are located on the western limb of the Snowdrift Anticline and probably have direct contact with the Dinwoody Formation to the west. Additionally, the Enoch Valley Fault is positioned immediately west of the South Rasmussen West Limb Pit and overburden pile. The Enoch Valley Fault is a high-angle, down-to-the-southwest fault that runs along the southwestern margin of the Rasmussion Mine to the north to Enoch Valley Mine. Assuming that northerly flow in the Dinwoody/Thaynes is possible, the selenium in MST275 (and MST274) could potentially reflect impact from the South Rasmussen mine due to these potential preferential pathways. Based on the uncertainty created by potential interconnection of Mines in the region to MST275 via the Henry Thrust and Enoch Valley Faults, it is the A/T's position that MST275 be deleted from the background database unless P4 can provide other compelling evidence showing MST274 cannot be impacted by mine in the region.

Finally, it is our understanding that the Thaynes Formation can have strata of black shale which could conceivably contribute higher levels of COPCs to surface water, sediment, etc., including the water at MST274 and MST275. Please discuss if you feel this potential source is relevant to the discussion of background at MST274 and MST275.

P4 Response: *The rationale that either MST274 or MST275 are impacted by groundwater from either Enoch Valley or South Rasmussen mines or the haul road is unsubstantiated. There is no evidence that suggests flows of mine-impacted water occur along faults at the magnitude suggested in the comment.*

Even if it did, the distance and travel time are such that the discharge of impacted water is unlikely to occur currently. MST275 also is located high in the drainage and regional discharge from one of the mention fault systems would more probably occur in the valleys. In addition, as noted in the comment, it appears the shallow alluvial water near MST274 is not impacted by the Enoch Valley Mine based on the direct push results.

We are not aware of any data on seleniferous shales in the Thaynes Formation similar to the Phosphoria Formation, which are not represented in this background data set (i.e., none of the background stream stations have a province that includes undisturbed Phosphoria Formation, which as discussed in prior responses may already be biasing the natural background data low).

We propose that MST274 be flagged initially and if it fails the outlier analysis (e.g., statistical evaluation and weight-of-evidence process)), then remove it from the background data set. Also, we do not think the rationale for excluding the MST275 data from the background data set is supported at this time. For example, the MST275 location is at 6,764 feet AMSL, which is above or very near the same elevation of the potential sources mentioned in the comment. The nearest portion of the Enoch Valley Mine, over a half mile distance, is largely at a lower in elevation than MST275 (see Drawing 3-58 of the RI/FS Work Plan). The hydraulic gradients to support that the surface water could be impacted by the Enoch Valley or South Rasmussen Mines are lacking.

Finally, P4 believes that it would be most appropriate to include these sampling locations in the initial background sediment datasets and allow the statistical analysis to determine whether a given result for a given analyte represents a statistical outlier or an extreme value that may be due to mine site impacts. Furthermore, in the event that a result for one metal at a background sampling station, such as MST274, turns out to be an outlier or extreme value representative of mine site impacts doesn't mean that all metals at that sampling location are influenced by the Sites. By not excluding these background sampling locations prior to the statistical analysis, P4 proposes to preserve as much of the background sediment data as possible.

30. **Section 2.2.1.4, page 2-13, 1st paragraph.** Please explain why, given the differences in ecological, geographical and geomorphologic environments between riparian soils and upland soils that a comparison is made between the two, especially to draw some sort of correlation for COPCs that were not analyzed in riparian soils.

    P4 Response: *A correlation was not made for COPCs in riparian soils as both the riparian and upland soil background locations were analyzed for the same suite of constituents in 2009 and 2010. P4 believes the commenter meant to refer to the correlation made between riparian vegetation and upland vegetation.*

As discussed in SC #10, both the 2009 upland vegetation data and the 2004 riparian and upland vegetation data were evaluated against risk-based screening levels (RBSLs) in the A/T-approved RI/FS Work Plan. As shown on Tables 3-5, 3-21, and 3-37 of the RI/FS Work Plan, the riparian concentrations in vegetation from unimpacted stream stations and upland vegetation background concentrations are similar. Also, there are only three analytes (cadmium, molybdenum and selenium) detected in riparian and upland vegetation that exceeded RBSLs. The exception to this is one exceedance of the RBSL for boron in a 2009 upland vegetation sample at the Enoch Valley Mine.

Based on the similarity of the upland and riparian concentrations, the comparisons of vegetation concentrations to RBSLs presented in the RI/FS Work Plan, and the fact that all three analytes that consistently exceeded vegetation RBSLs were included in the 2004 analytical suite, P4 does not believe that the historically-selective analyte list for the riparian vegetation data represents a significant data gap. As stated in our response to SC#10, above, those chemicals without riparian vegetation sampling results will be evaluated in the HHERA using published soil-to-plant bioaccumulation factors, as available. Nevertheless, the limited nature of the analytical suite for riparian vegetation will be described in the Uncertainty Analysis section of the HHERA for the Sites.

31. **Section 2.2.1.4, page 2-13, 1st paragraph, line 1.** Recommend including a proposed course of action in the event COPCs/COPECs that do not have background data are found in site soils at levels associated with significant ris

    P4 Response: *As stated in our responses to SC#10 and SC#30, those chemicals without riparian vegetation sampling results will be evaluated in the HHERA using published soil-to-plant bioaccumulation factors, as available. In the event that a COPC/COPEC turns out to be a risk driver based on modeled riparian vegetation concentrations, P4 will consider the potential to collect additional riparian vegetation samples for the analysis of applicable COCs/COECs. This type of validation study is common and can be included at any point in the RI/FS process.*

32. **Section 2.2.1.4, page 2-13, 1st paragraph, line 6**. Start at new paragraph with the sentence beginning "However, the 2009 . . ."

    P4 Response: *Agreed. The Background Memorandum has been revised to incorporate this revision.*

33. **Section 2.2.1.4, page 2-13, 1st paragraph, line 9.** Change the phrase to read ". . . three analytes (cadmium, molybdenum, and selenium) consistently detected . . ."

    P4 Response: *Agreed. The Background Memorandum has been revised to incorporate this revision.*

34. **Section 2.2.1.4, page 2-13, 1st paragraph, line 11**. Delete the last sentence.

    P4 Response: *Agreed. The Background Memorandum has been revised to incorporate this revision.*

35. **Section 2.2.2.2, page 2-16, 1st paragraph, line 2.** Change "riparian" to upland.

    P4 Response: *Agreed. The Background Memorandum has been revised to incorporate this revision.*

36. **Section 2.2.2.2, page 2-16, 2nd paragraph**. Some mention should be made of the one sample from Enoch Valley with high boron.

    P4 Response: *Agreed. The text has been revised to include the following: "The exception is one 2009 upland vegetation sample at Enoch Valley Mine that reported a boron concentration greater than the vegetation screening level for boron.*

37. **Section 2.2.2.2, page 2-17, 1st paragraph, line 1.** This should probably read Ballard and Enoch Valley mines rather than "Henry Mine."

    P4 Response: *Agreed. The Background Memorandum has been revised to incorporate this revision.*

38. **Section 2.2.2, page 2-17, 1st full paragraph:** Given the higher concentrations in COPCs in upland vegetation and soils at the Henry Mine background locations, it may reflect that the chosen background location in general, while undisturbed, may not be unaffected (wind or erosion transport of waste rock). Please revise to include this possibility.

    P4 Response: *The text will be revised to say Enoch Valley Mine as opposed to the Henry Mine. The location is in the dominantly upwind direction from the mine (west of the mine), and the data, while slightly higher than the other Sites, are not*

spatially distributed such that there appears to be a hot spot that might suggest contamination from a specific facility. In addition, as discussed in GC #7, the distribution plot shows what appears to be a natural range of concentrations in the Dinwoody Formation. However, the possibility cannot be excluded for any of the upland soil and vegetation background locations because of the requirement to sample in the Site areas (i.e., be mine-specific). Because of this possibility, the following sentence will be added to the end of Section 2.2.2 – "However, evaluation of any outliers will have to consider that the background areas are located within the mine areas, and wind deposition impacts cannot be positively excluded."

39. **Section 3.1, page 3-1, 2nd paragraph**. Although items 1, 2, and 5 could be pursued via a variety of statistical approaches, one can envision pursuing them only with comparisons to calculated BTVs. However, the referenced document does not discuss why the only discussed approach is the use of BTVs. UCLs of the mean are typically used to gauge risk as opposed to estimates of the upper range of the population. For items 3 and 4 one would presumably use calculated UCLs of the mean, not BTVs. The only potential discussion of such UCLs appears to be in Table 1-1 where a footnote says "Background value was determined from the 95% UCL" which were calculated in the Area Wide Risk Assessment. Site risk calculations typically use 95% UCLs of the mean. If this approach is used with site concentrations, then the same should be pursued with background. The memorandum does not explicitly state that BTVs will be used in risk calculations, but the absence of discussion of other calculations (i.e. UCLs of the mean) raises questions on the intent. In essence, this report needs a discussion of the type of limits used for goals 3 and 4.

    Additionally, a 6th use of background concentrations is comparison to screening values. Please add or discuss how this is captured in any of the five identified uses.

    Section 3.2, page 3-3, 3rd paragraph, line 6. In regard to "Inappropriate exclusion of data points from a background dataset can also lead to Type I errors (i.e., false positives)." This seems counterintuitive. Elimination of "extreme" data points would seem to result in less false positives and possibly more false negatives.

    P4 Response: *Please refer to our response to GC#1. Background levels developed in the Background Memorandum will be used in:*

    1) *The RI Report for preliminary data screening, along with comparisons to screening criteria. Preliminary screening of sampling results will be based on an upper bound estimate of the background population, such as a UTL or maximum concentration, for each medium.*

2) *The HHERA for COPC and COPEC screening. Screening for COPCs and COPECs will be based on an upper bound estimate of the background population, such as a UTL, for each medium.*

3) *The HHERA for the calculation of background risk estimates. The calculation of background risk estimates will be based on 95% UCL on the mean concentrations, or maximum detected concentrations, for consistency with the exposure point concentrations used in the calculation of the Sites' risk estimates.*

4) *The HHERA for the calculation of incremental risk estimates. The calculation of incremental risk estimates will be based on 95% UCL on the mean concentrations, or maximum detected concentrations, for consistency with the exposure point concentrations used in the calculation of the Sites' risk estimates.*

5) *The FS to differentiate impacted areas from un-impacted areas, and as potential cleanup levels. Background evaluations in the FS will be based on an upper bound estimate of the background population, such as a UTL or maximum concentration, for each medium.*

Please note that background concentrations will be compared to screening criteria in the RI Report as part of Item #1, above, to put the screening criteria in context.

Type I errors (i.e., false positives) may occur during COPC/COPEC screening when the maximum concentration of an analyte appears to be higher than background because the background statistic (e.g., an UTL) was biased low. Low bias in the background statistic may occur when extreme values are mistakenly eliminated from the background dataset, and the range of background concentrations is compressed.

40. **Section 3.2, page 3-3, 2nd paragraph. This** is not the approach recommended in other background guidances:

- United States Environmental Protection Agency (USEPA). *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites,* Office of Emergency and Remedial Response, 2002.
- United States Environmental Protection Agency (USEPA), *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities—Unified Guidance,* Office of Resource Conservation and Recovery, March, 2009.
- United States Environmental Protection Agency (USEPA), *ProUCL Version 4.1 Technical Guide (Draft),* Office of Research and Development, May, 2010.

While complete reliance on mathematical outlier tests is not typically recommended either, the inability to exclude unusually elevated background results because there is not assignable cause available is an unusual approach with regard to background data sets.

P4 Response: *Please note that the intent of the process outlined in text for evaluating outliers will not create an inability to exclude outliers unless a cause of the outlier can be identified. Rather, the process cautions against blindly eliminating outliers on the basis of the statistical outlier test alone. Exclusion of outliers during the statistical evaluation will be part of a weight-of-evidence process that starts with the outlier test, and then proceeds to a review of the sample location and data quality issues such as sampling anomalies or quality assurance/quality control (QA/QC) concerns. If the specific cause for an outlier cannot be identified, the outlier may still be excluded from the final background dataset based on the judgment of the statistician. Such decisions will be made in consultation with the A/Ts. Text in Sections 3.2 and 3.3 will be revised to clarify the above points.*

41. **Section 3.2, page 3-4, 1st paragraph.** Stratified random sampling designs are useful in sampling heterogeneous populations. The initial decision, however, has to be made on whether such a heterogeneous population needs to continue to be treated as a single population, or partitioned into separate populations as is sometimes done in background studies. We do not see a discussion of the wisdom of retaining a single population for this study.

Stratified random sampling designs do ensure more uniform coverage of the entire population being targeted than simple random sampling. Coupled with the more complicated statistical procedures (if employed) for calculating the mean and variance, they can also offer more precise estimates of the mean or a proportion. This design does not, however, prevent any given strata or group of stratus with inherently higher concentrations from biasing the BTV high.

While it may be difficult with this particular background population to control the types of samples and any inherent heterogeneity, the BTV will nevertheless be most affected by the strata with the most elevated concentrations (and in the case of nonparametric approaches, completely dominated by them). Site concentrations associated with strata with lower concentration ranges will continue to effectively be compared to the overall BTV heavily influenced by background strata with the highest concentrations. A stratified random sampling design does not prevent the BTV from being biased by the background strata with the highest concentrations. The report text does not present information on whether heterogeneity between various strata is or is not of concern, but one should not believe that the use of a stratified random sampling design alleviates any excessive heterogeneity if it does exist.

P4 Response: *As described in our response to GC#7, background samples were collected from areas representative of the Dinwoody Formation and the Wells Formation. However, the Sites are located on a heterogeneous combination of various geologic units including the Dinwoody Formation, Wells Formation, and*

Phosphoria (which is known to contain high levels of certain elements including phosphorous, cadmium, zinc, selenium and uranium). As shown in the attached concentration-probability plots, it is apparent that background concentrations of arsenic, manganese and selenium are lowest in soils collected from the Wells Formation and highest in the Dinwoody Formation. The A/Ts did not permit P4 to sample in the Phosphoria Formation during the background investigation for upland soils and vegetation. Background concentrations of selenium, uranium, and perhaps even arsenic are higher in the Phosphoria Formation than in the Dinwoody Formation. Thus, the current background datasets are biased low for these elements (which are likely to be the primary risk drivers in the HHERA).

Because each of the three Sites' background reference areas represents only one geologic formation, these data must be combined to capture the heterogeneous nature of the Sites. Even when the data from the three background reference areas are combined, the concentrations for upland soils and vegetation are likely to be biased low for certain elements, relative to the Sites because of missing background data from the Phosphoria Formation.

42. **Section 3.2, page 3-5.** These two limit types are presented as commonly used upper bound estimates of the background population. The USL appears in Scout software but does not have the earned reputation of upper prediction limits and upper tolerance limits. Its application as a BTV has appeared to be used infrequently in background studies. Furthermore, on projects we've been associated where ProUCL and Scout authors have encouraged the use of USLs as BTVs, they have pointed out that the background data was consistent with few outliers. The P4 background data set may be inconsistent with many outliers which would make USLs less appropriate for providing sufficiently conservative background values (protection against false negatives).

    P4 Response: *Please note that P4 can cite recent example projects where upper simultaneous limits (USLs) were selected by the EPA as the preferred background statistic over upper prediction limits (UPLs) or upper tolerance limits (UTLs). For one project, EPA's consultant calculated all three of these statistics and, following a weight-of-evidence evaluation, selected the USL as the preferred background statistic. Because we don't know whether the background datasets for the Sites will be consistent with few outliers, or inconsistent with many outliers, P4 proposes to calculate all three of these statistics and then consult with the A/Ts on the selection of the appropriate background statistic.*

43. **Section 3.3, page 3-6, 2nd full paragraph.** The 2006 reference was discussing outliers in general, not background outliers. EPA typically distrusts automatic exclusion of elevated site outliers, but prefers to pursue review of background outliers even when no assignable cause is available for the spurious result.

P4 Response: *Please refer to our response to SC#40. Background results identified as statistical outliers will be pursued in a weight-of-evidence evaluation. If the specific cause for an outlier cannot be identified, the outlier may still be excluded from the final background dataset based on the judgment of the statistician. Such decisions will be made in consultation with the A/Ts. Text in Sections 3.2 and 3.3 will be revised to clarify the above.*

44. **Section 3.3.1.2, page 3-7, 1st paragraph.** As mentioned previously, stratified random sampling designs are useful in sampling heterogeneous populations, but they do not eliminate concerns in combining disparate populations. For instance, if one of three subpopulations has concentrations substantially elevated above other populations (and those elevated concentrations are retained in the data set as opposed to being excluded in the outlier evaluation), those concentrations will result in elevated BTVs exceeding concentrations from site populations whose corresponding background populations were potentially lower than site. The use of a stratified random sampling design does not solve this dilemma. Background studies are routinely confronted with decisions of how important partitioning background data is. The need to consider the potential need to partition the data is not eliminated by incorporating a stratified random sampling design. Such a design can, however, be useful when the decision to not partition is made.

    P4 Response: *Please refer to our responses to GC#7 and SC#41. Due to the homogeneous nature of the three Sites' background reference areas, and the fact that the Sites are located on a heterogeneous combination of various geologic units, the data must be combined to capture the heterogeneous nature of the Sites.*

45. **Section 3.3.2, page 3-8.** There is no discussion of how those selections were made. One understands without reviewing these data from this background study that

    UPL (for the next observations) < UTL < USL

    One also understands that the more elevated BTVs are usually more impacted by spurious elevated concentrations (outliers). UPLs for some other number of future observations (> 1) will vary in relationship to the UTL and USL. If, for instance, the selected BTVs were always the USLs (or maximum detected concentrations when they were as high as or higher than the USL), then discussion of the other type of BTVs would merely be a disguise for a selection process based a desired balance of false negative and false positive rates. It is not clear from the text I have been provided what the criteria was for these selections or even what the selections were.

    P4 Response: *Please refer to our response to SC#42. P4 intentionally has not pre-selected the UPL, USL or UTL as the preferred statistic to represent the*

upper bound estimate of background for the Sites because issues related to variance and numbers of outliers cannot be determined until the statistical evaluations are performed. Rather than pre-select one statistic, P4 proposes to calculate all three of the above statistics for each analyte in each medium, and then consult with the A/Ts on the selection of the appropriate background statistic.

46. **Section 3.3.2, page 3-8.** It is not clear whether one or multiple types of statistical measures will be used to estimate the upper bound of the background data. The 95/95 UTL is commonly used for this purpose, and a rationale is not presented for using one or more of the other statistics. Presumably there is such a discussion in some of the cited guidance documents, but the document should at the least specify the decision rules for selecting the 95% UPL, 95/95 UTL, 95% USL or maximum value. Please include additional information for clarification.

    The report indicates that 95% UPL, 95/95 UTL, 95% USL calculations will be conducted and that an upper bound estimate will be selected from these or the maximum detected concentrations. However, discussion on how arbitration of these values will occur is absent. Details on this selection process need further explanation.

    The discussion of comparing background data and site data is all based on the calculation of an upper end background threshold value (BTV). Hypothesis testing between two data groups is not described. Please explain why this approach is not considered or, if it will be, under what circumstances and at what point in the process will these statistical approaches be used.

    P4 Response: *Please refer to our responses to SC#42 and GC#3, above.*

    P4 intentionally has not pre-selected the UPL, USL or UTL as the preferred statistic to represent the upper bound estimate of background for the Sites because issues related to variance and numbers of outliers cannot be determined until the statistical evaluation is performed. Rather than pre-select one statistic, P4 proposes to calculate all three of the above statistic for each analyte in each medium, and then consult with the A/Ts on the selection of the appropriate background statistic.

    In P4's experience, two sample tests such as the Wilcoxon Rank Sum test are non-robust when sample sizes are small and/or there are numerous non-detect results. This is the case for the sediment, riparian soil, riparian vegetation, and surface water data sets, where there are relatively few samples (e.g., sediment, riparian soil and riparian vegetation) or some analytes are associated with numerous non-detect results (e.g., surface water). Please refer to Tables 2-3 through 2-6 in the Background Memorandum.

47. **Section 3.4, page 3-9, 3rd paragraph.** This statement was made with regards to groundwater data based on IDEQ guidance. No discussion was made of how such corrections were employed. If a claim is made that a guidance was followed, further details to support that claim should be provided.

    P4 Response: *As a result of this process of providing the A/Ts with the initial sections (sections 1-3 of the Background Memorandum), the statistical evaluation will not be completed until we have agreed to the statistical methods and outcomes of this processes discussed in Sections 1-3. The final submittal in this process will include the calculated background levels of metals and radionuclides for each of the selected media and will include details of the descriptive statistics, outlier analysis, and any other evaluations conducted on the background data sets. The further details that the commenter is looking for will be included as part of Section 4 of the Background Memorandum or the paragraph referred to in the comment will be revised as part of the final Background Memorandum.*

48. **Section 3.4, page 3-10.** Again, the lack of discussion on how 95% UPL, 95/95 UTL, 95% USL selections will made is problematic. The selection process should be explained.

    P4 Response: *Please refer to our responses to SC#42, above. Rather than pre-select one statistic, P4 proposes to calculate all three of the above statistic for each analyte in each medium, and then consult with the A/Ts on the selection of the appropriate background statistic.*

49. **page 3-9, Section 3.4, 2nd paragraph, 2nd sentence.** The text states that the selenium and sulfate concentrations are the most direct indicators of impacts from the Sites. Please clarify this may be the case if sources and transport pathways remain unsaturated. Under saturated or partially saturated conditions, selenium may not be a leading indicator of mine-related impacts to groundwater.

    P4 Response: *We do not agree with this revision. In regards to groundwater, the text states that selenium and sulfate concentration are the <u>most</u> direct indicators of impacts from the Sites. This statement is correct in that so far there have not been any other indicators identified at the Sites. At the Sites, we do agree that there may be situations where selenium may not be elevated, but sulfate is, or selenium but not sulfate (the Ballard Shop area excluded). Nonetheless, this is an evaluation and discussion most appropriate for the RI Reports and does not have significant bearing on this Background Memorandum. Because of the debatable uncertainty associated with this topic we propose keep the statement unrevised, but it should be noted that the statement is not definitive and suggests that other indicators are possible.*

50. **Tables 2-3 through 2-6**. Tables provide screening levels for comparison and reference the RI/FS Work Plan as the source of the benchmarks. In a stand-alone document, such as this, it would be helpful to provide specific references to the benchmarks so the reader can understand their basis.

    P4 Response: *The tables have been revised to provide specific references to the benchmarks similar to the footnotes on Table 3-1 of the RI/FS Work Plan.*

51. **Table 2-3**. The table does not indicate whether benchmarks and data are in terms of wet-weight or dry-weight. Most benchmarks would be reported in dry-weight; however it is unclear whether some, none, or all of the background data are in dry-weight. Please clarify.

    P4 Response: *All of the data are reported on a dry-weight basis. This is included as a footnote on Tables 2-3, 2-5, 2-6, 2-8, and 2-9.*

52. **Table 2-9**. There is significant variability in vegetation concentrations between background locations. It is imperative that an outlier analysis be performed. For example, molybdenum and selenium concentrations in vegetation tissue at MBE001-007 are approximately an order of magnitude above those seen at other locations, while other metals concentrations are similar to those found at other locations. These would appear to either be outliers or there will need to be a reasonable explanation as to why these levels should be considered as background.

    P4 Response: *Agreed. As stated in Section 2.2.2.2, "Comparisons of detected vegetation results to vegetation screening levels show that several analytes have one or more detections that are higher than their respective screening levels (refer to Table 2-9).*

    - ***Molybdenum*** *concentrations in upland vegetation are higher than the vegetation screening level for molybdenum of 5.0 mg/kg in eight of the 30 sample locations. The concentrations in these eight samples range from 5.08 to 240 mg/kg. These molybdenum concentrations were reported from vegetation samples collected in a variety of different vegetation types at both the Ballard and Enoch Valley Mines. Regional background levels for upland vegetation are not available. As described in Section 2.2.1 above, these data will be further evaluated during the statistical analysis for the presence of potential statistical outliers.*
    - ***Selenium*** *concentrations in upland vegetation are higher than the screening level of 5 mg/kg in a variety of vegetation types from one sample location at the Enoch Valley Mine, MBE001-07. Other samples with selenium*

concentrations above the screening level occurred in vegetation samples with molybdenum concentrations higher than its screening level. The selenium concentrations in these vegetation samples above the screening level ranged from 5.02 to 10.4 mg/kg. Regional background levels for upland vegetation are also not available. As described in Section 2.2.1, above, these data will be further evaluated during the statistical analysis for the potential presence of statistical outliers."

53. **Table 2-11, page 4 of 9, MMW-008:** Total chromium results for 9/21/2008 were .0224 mg/L which is above the screening level. Please add shading to the cell.

    P4 Response: *The total chromium result from MMW008 on 9/21/08 is indeed 0.0224 mg/l. However, the screening level for total chromium is 0.1 mg/l. Therefore, this sample result does not exceed the screening level and no revision to the table is necessary.*

54. **Table 2-1, Secondary Media, Fish 2004, BM 2004**. Table 6-2 in the DQUR notes that 2004 fish and aquatic invertebrate data need to be further evaluated against RI/FS DQOs. In the RI/FS workplan, Table 4-10 lists the DQOs for aquatic biota, but I do not see an evaluation. Please indicate where this evaluation has been done or delete these Xs indicating the data are of known quality to be used for risk assessment and the feasibility study.

    P4 Response: *Step 7 of the DQO in Table 4-10 of the RI/FS Work Plan indicated that the data have been evaluated for quality and risk assessment needs (e.g., suitability of detection limits). The data have, therefore, been indicated as suitable in Table 4-11 of the Work Plan for nature and extent, risk assessment, and feasibility study. Therefore, Table 2-1 of the Background Memorandum is correct.*

Editorial Comments

Section 2.2.1, page 2-3, paragraph 3, line 11. MST048 is listed twice. Please correct.

Section 2.2.1.1, page 2-7, bullet 1 (Antimony). Insert a bullet similar to the other COPCs.

Section 2.2.1.1, page 2-7, bullet 1 (Antimony), line 7. Delete the second period in the middle of the line.

Section 2.2.3, page 2-18, paragraph 1, line 4. Change "is" to "are."

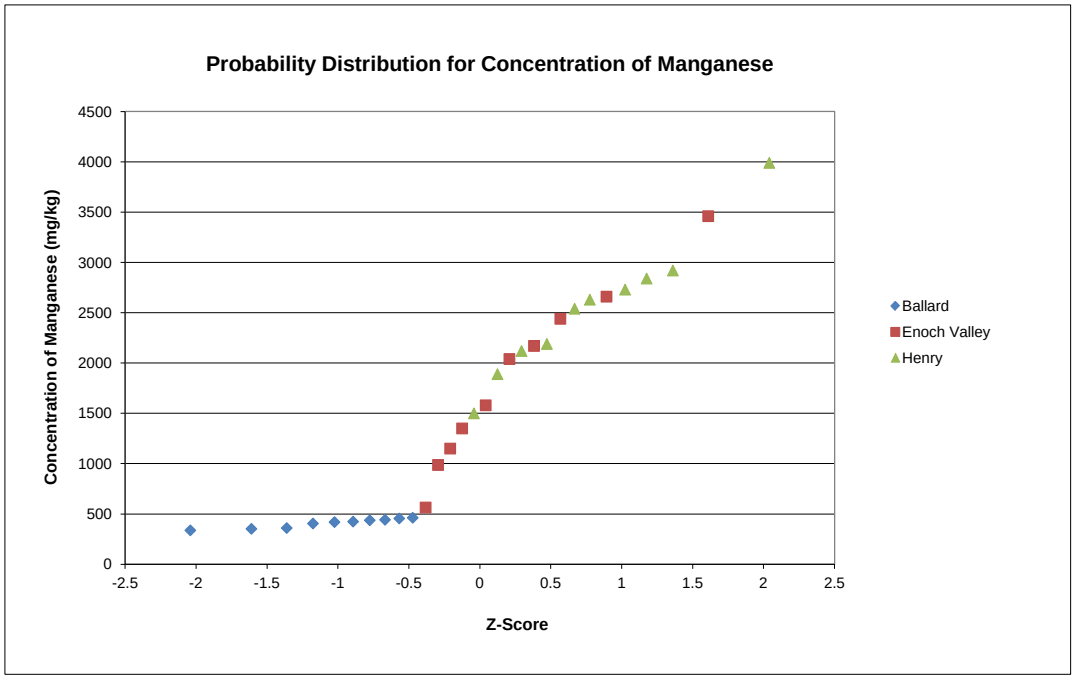
Section 2.2.3, page 2-18, paragraph 3, line 1. Change "locations" to location.

Section 2.2.3, page 2-20, bullet 1 (Manganese), line 9 (last). Add a period after "P4 Sites."

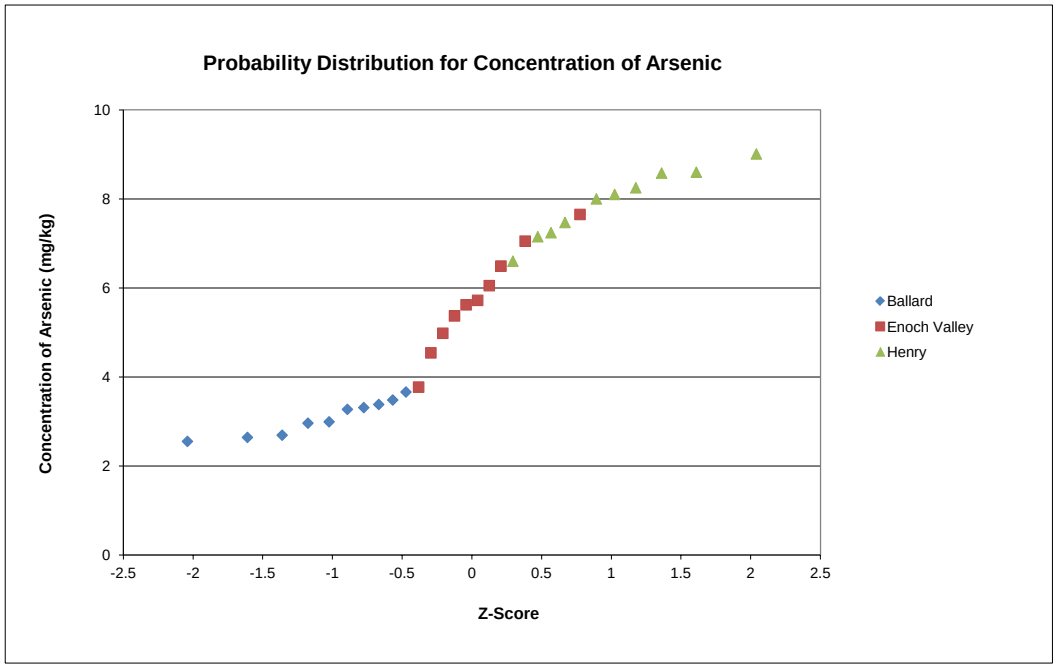
Section 3.0, page 2-22, paragraph 1, line 2. Delete the last comma to read, ". . . riparian soil and vegetation, . . ."

> **P4 Response:** *Agreed. The Background Memorandum has been revised to incorporate these revisions.*

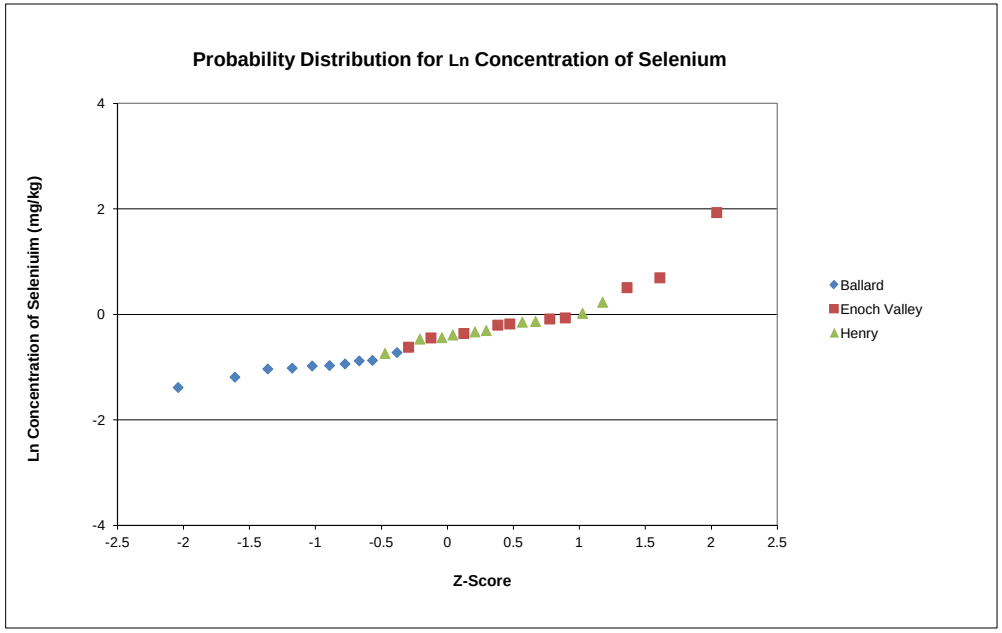
Site	Sample ID	[Manganese]	z-score	Geologic Fm
Ballard	0906-MBB001-07-SS-avg	337	-2.040281322	Wells Fm
Ballard	0906-MBB001-08-SS	352	-1.609816067	Wells Fm
Ballard	0906-MBB001-10-SS	360	-1.360873343	Wells Fm
Ballard	0906-MBB001-03-SS	405	-1.175813473	Wells Fm
Ballard	0906-MBB001-05-SS	419	-1.024106184	Wells Fm
Ballard	0906-MBB001-04-SS	424	-0.892918486	Wells Fm
Ballard	0906-MBB001-01-SS	437	-0.775546958	Wells Fm
Ballard	0906-MBB001-06-SS	442	-0.668002132	Wells Fm
Ballard	0906-MBB001-02-SS	455	-0.567686391	Wells Fm
Ballard	0906-MBB001-09-SS	462	-0.472789121	Wells Fm
Enoch Valley	0906-MBE001-AH2-SS	564	-0.381975768	DinwoodyFm
Enoch Valley	0906-MBE001-07-SS-avg	987	-0.294213139	DinwoodyFm
Enoch Valley	0906-MBE001-08-SS	1150	-0.208663746	DinwoodyFm
Enoch Valley	0906-MBE001-06-SS	1350	-0.124617408	DinwoodyFm
Henry	0906-MBH002-08-SS	1500	-0.041443733	DinwoodyFm
Enoch Valley	0906-MBE001-10-SS	1580	0.041443733	DinwoodyFm
Henry	0906-MBH002-05-SS	1890	0.124617408	DinwoodyFm
Enoch Valley	0906-MBE001-05-SS	2040	0.208663746	DinwoodyFm
Henry	0906-MBH002-01-SS	2120	0.294213139	DinwoodyFm
Enoch Valley	0906-MBE001-09-SS	2170	0.381975768	DinwoodyFm
Henry	0906-MBH002-04-SS	2190	0.472789121	DinwoodyFm
Enoch Valley	0906-MBE001-04-SS	2440	0.567686391	DinwoodyFm
Henry	0906-MBH002-03-SS	2540	0.668002132	DinwoodyFm
Henry	0906-MBH002-07-SS-avg	2630	0.775546958	DinwoodyFm
Enoch Valley	0906-MBE001-03-SS	2660	0.892918486	DinwoodyFm
Henry	0906-MBH002-06-SS	2730	1.024106184	DinwoodyFm
Henry	0906-MBH002-02-SS	2840	1.175813473	DinwoodyFm
Henry	0906-MBH002-10-SS	2920	1.360873343	DinwoodyFm
Enoch Valley	0906-MBE001-01-SS	3460	1.609816067	DinwoodyFm
Henry	0906-MBH002-09-SS	3990	2.040281322	DinwoodyFm

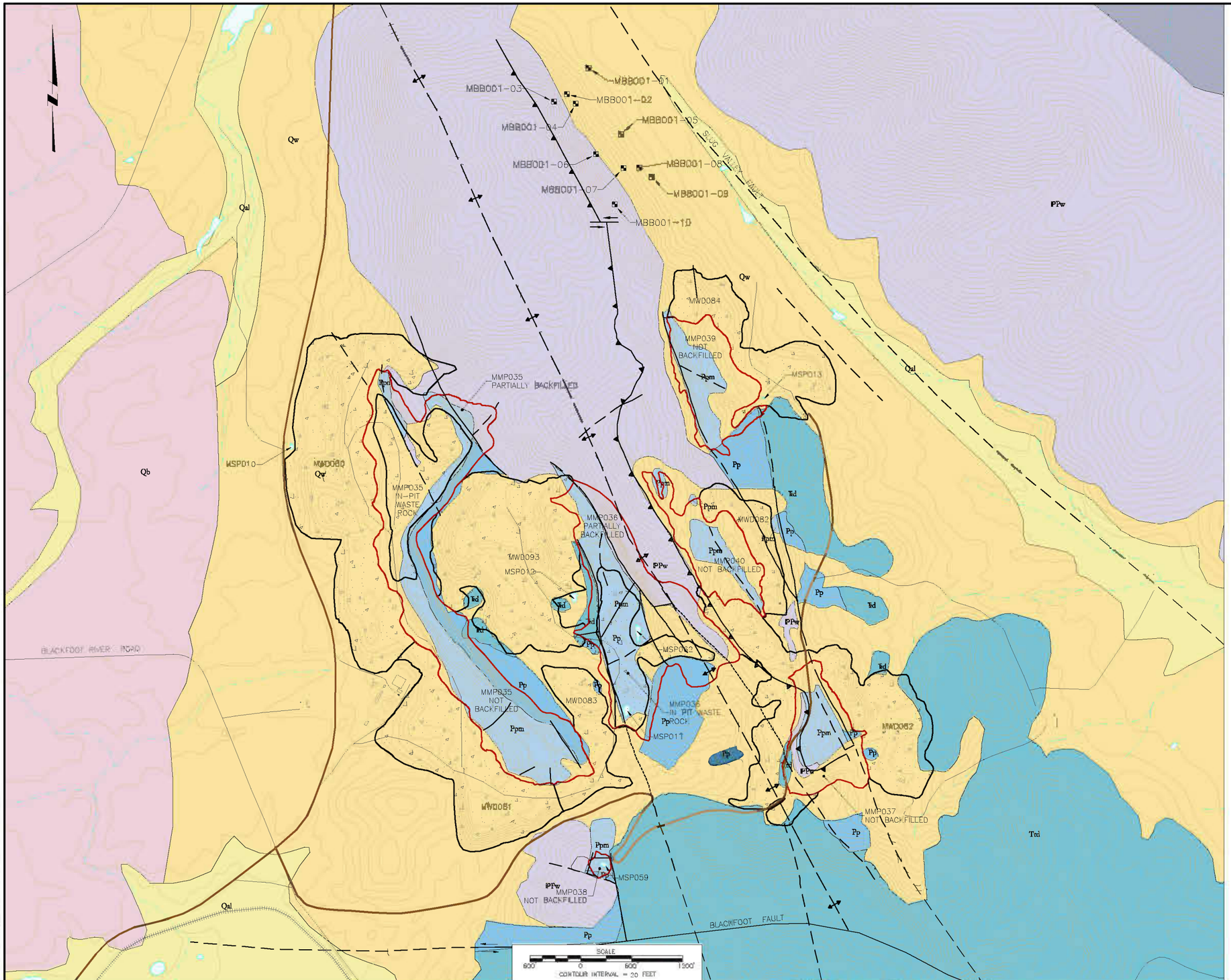


Site	Sample ID	[Arsenic]	z-score	Geologic Fm
Ballard	0906-MBB001-05-SS	2.55	-2.040281322	Wells Fm
Ballard	0906-MBB001-09-SS	2.64	-1.609816067	Wells Fm
Ballard	0906-MBB001-08-SS	2.69	-1.360873343	Wells Fm
Ballard	0906-MBB001-01-SS	2.96	-1.175813473	Wells Fm
Ballard	0906-MBB001-04-SS	2.99	-1.024106184	Wells Fm
Ballard	0906-MBB001-02-SS	3.27	-0.892918486	Wells Fm
Ballard	0906-MBB001-07-SS-avg	3.31	-0.775546958	Wells Fm
Ballard	0906-MBB001-03-SS	3.38	-0.668002132	Wells Fm
Ballard	0906-MBB001-06-SS	3.48	-0.567686391	Wells Fm
Ballard	0906-MBB001-10-SS	3.66	-0.472789121	Wells Fm
Enoch Valley	0906-MBE001-06-SS	3.77	-0.381975768	DinwoodyFm
Enoch Valley	0906-MBE001-10-SS	4.54	-0.294213139	DinwoodyFm
Enoch Valley	0906-MBE001-01-SS	4.98	-0.208663746	DinwoodyFm
Enoch Valley	0906-MBE001-04-SS	5.37	-0.124617408	DinwoodyFm
Enoch Valley	0906-MBE001-05-SS	5.62	-0.041443733	DinwoodyFm
Enoch Valley	0906-MBE001-09-SS	5.72	0.041443733	DinwoodyFm
Enoch Valley	0906-MBE001-03-SS	6.05	0.124617408	DinwoodyFm
Enoch Valley	0906-MBE001-08-SS	6.49	0.208663746	DinwoodyFm
Henry	0906-MBH002-09-SS	6.6	0.294213139	DinwoodyFm
Enoch Valley	0906-MBE001-AH2-SS	7.05	0.381975768	DinwoodyFm
Henry	0906-MBH002-06-SS	7.15	0.472789121	DinwoodyFm
Henry	0906-MBH002-10-SS	7.24	0.567686391	DinwoodyFm
Henry	0906-MBH002-03-SS	7.47	0.668002132	DinwoodyFm
Enoch Valley	0906-MBE001-07-SS-avg	7.65	0.775546958	DinwoodyFm
Henry	0906-MBH002-05-SS	8	0.892918486	DinwoodyFm
Henry	0906-MBH002-01-SS	8.1	1.024106184	DinwoodyFm
Henry	0906-MBH002-02-SS	8.25	1.175813473	DinwoodyFm
Henry	0906-MBH002-08-SS	8.58	1.360873343	DinwoodyFm
Henry	0906-MBH002-07-SS-avg	8.6	1.609816067	DinwoodyFm
Henry	0906-MBH002-04-SS	9.01	2.040281322	DinwoodyFm



Site	Sample ID	[Selenium]	ln[Selenium]i	z-score	Geologic Fm
Ballard	0906-MBB001-05-SS	0.25	-1.386294361	-2.040281322	Wells Fm
Ballard	0906-MBB001-01-SS	0.304	-1.190727578	-1.609816067	Wells Fm
Ballard	0906-MBB001-07-SS-avg	0.355	-1.03563749	-1.360873343	Wells Fm
Ballard	0906-MBB001-02-SS	0.361	-1.018877321	-1.175813473	Wells Fm
Ballard	0906-MBB001-09-SS	0.376	-0.978166136	-1.024106184	Wells Fm
Ballard	0906-MBB001-03-SS	0.379	-0.970219074	-0.892918486	Wells Fm
Ballard	0906-MBB001-08-SS	0.391	-0.939047719	-0.775546958	Wells Fm
Ballard	0906-MBB001-04-SS	0.414	-0.881889305	-0.668002132	Wells Fm
Ballard	0906-MBB001-06-SS	0.418	-0.872273846	-0.567686391	Wells Fm
Henry	0906-MBH002-08-SS	0.477	-0.740238788	-0.472789121	DinwoodyFm
Ballard	0906-MBB001-10-SS	0.485	-0.723606388	-0.381975768	Wells Fm
Enoch Valley	0906-MBE001-10-SS	0.537	-0.621757184	-0.294213139	DinwoodyFm
Henry	0906-MBH002-06-SS	0.626	-0.468404908	-0.208663746	DinwoodyFm
Enoch Valley	0906-MBE001-01-SS	0.64	-0.446287103	-0.124617408	DinwoodyFm
Henry	0906-MBH002-01-SS	0.643	-0.441610555	-0.041443733	DinwoodyFm
Henry	0906-MBH002-10-SS	0.677	-0.390084006	0.041443733	DinwoodyFm
Enoch Valley	0906-MBE001-04-SS	0.696	-0.362405619	0.124617408	DinwoodyFm
Henry	0906-MBH002-07-SS-avg	0.717	-0.332679438	0.208663746	DinwoodyFm
Henry	0906-MBH002-05-SS	0.736	-0.30652516	0.294213139	DinwoodyFm
Enoch Valley	0906-MBE001-05-SS	0.816	-0.203340924	0.381975768	DinwoodyFm
Enoch Valley	0906-MBE001-09-SS	0.834	-0.181521877	0.472789121	DinwoodyFm
Henry	0906-MBH002-09-SS	0.863	-0.147340588	0.567686391	DinwoodyFm
Henry	0906-MBH002-04-SS	0.874	-0.134674903	0.668002132	DinwoodyFm
Enoch Valley	0906-MBE001-03-SS	0.917	-0.086647807	0.775546958	DinwoodyFm
Enoch Valley	0906-MBE001-06-SS	0.935	-0.06720875	0.892918486	DinwoodyFm
Henry	0906-MBH002-03-SS	1.02	0.019802627	1.024106184	DinwoodyFm
Henry	0906-MBH002-02-SS	1.26	0.231111721	1.175813473	DinwoodyFm
Enoch Valley	0906-MBE001-08-SS	1.66	0.506817602	1.360873343	DinwoodyFm
Enoch Valley	0906-MBE001-AH2-SS	2	0.693147181	1.609816067	DinwoodyFm
Enoch Valley	0906-MBE001-07-SS-avg	6.89	1.930071085	2.040281322	DinwoodyFm





LEGEND:

- POST-MINE CONTOUR AND ELEVATION, FEET (APPROXIMATE)
- RIVER
- POND OR LAKE
- NATURAL DRAINAGE – PERENNIAL
- NATURAL DRAINAGE – INTERMITTENT
- HIGHWAY
- ROAD
- MONSANTO HAUL ROAD (ACTIVE & INACTIVE)
- RAILROAD
- MINE PIT LOCATION (APPROXIMATE WHERE COVERED BY BACKFILL)
- WASTE ROCK DUMP LOCATION (APPROXIMATE)
- WASTE ROCK DUMP LOCATION OR PIT BACKFILL (APPROXIMATE)
- FAULT
- THRUST FAULT (DASHED WHERE INFERRED)
- APPROXIMATE OR INFERRED FAULT
- AXIS SYNCLINE (DASHED WHERE INFERRED)
- AXIS ANTICLINE (DASHED WHERE INFERRED)

STATION TYPE:

MBB = BACKGROUND SOIL AND VEGETATION SAMPLE LOCATION

GEOLOGIC KEY:

- Qb BASALT
- Qbw BASALTIC ASH – TUFF
- Qal ALLUVIUM
- Qt TRAVERTINE
- Qc COLLUVIUM AND OLDER ALLUVIUM
- Ꝑ DEADMAN LIMESTONE
- Th HIGHAM GRIT
- Tr THAYNES FORMATION
- Trp TIMOTHY SANDSTONE – THAYNES MEMBER
- Trd DINWOODY FORMATION – WOODSIDE SHALE
- Pp / Ppm PHOSPHORIA FORMATION / MEADE PEAK MEMBER
- PPw WELLS FORMATION
- Mb BRAZER LIMESTONE
- Mm MADISON LIMESTONE

KEY:

MMP – MINE PIT
MWD = WASTE ROCK DUMP
MSP = POND

NOTE:

GEOLOGIC DATA SOURCES: HOVLAND, 1981; MANSFIELD, 1927.

REV	DESCRIPTION	TECH	ENG	DATE
B	ISSUED DRAFT FOR AGENCY REVIEW	CHF	LMM	02/17/13

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1. POST-MINE TOPOGRAPHY GENERATED FROM:
- USGS DIGITAL ELEVATION MODELS (DEM)-2M
- SURVEY DATA FOR BALLARD MINE PROVIDED BY OLYMPUS AERIAL SURVEYS, INC. DATED: JUNE 2005
- SURVEY DATA FOR HENRY MINE AREA PROVIDED BY OLYMPUS AERIAL SURVEYS, INC. DATED: NOVEMBER 2004
- SURVEY DATA FOR ENOCH VALLEY MINE AREA PROVIDED BY P4 PRODUCTION, DATED: DECEMBER 2007
- US CENSUS BUREAU 2007 TIGER LINE DATA

PROJECTION: STATE PLANE COORDINATE SYSTEM
ZONE: IDAHO EAST
HORIZONTAL DATUM: NAD27
VERTICAL DATUM: NGVD29
UNITS: U.S. FEET

DESIGNED BY	J. MARTIN	02/17/13
DRAWN BY	C. FOWLER	02/17/13
CHECKED BY	J. MARTIN	02/17/13
APPROVED BY	C. POULK	02/17/13
PROJECT MANAGER	V. DRAKE	02/17/13
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

P4 Production, LLC

PROJECT LOCATION: BALLARD, HENRY AND ENOCH VALLEY MINES
PROJECT: RI/FS

MWH

TITLE: BALLARD MINE AREA
BACKGROUND UPLAND SOIL AND VEGETATION LOCATIONS AND SURFACE GEOLOGY

DRAWING: 1
REVISION: A
FILE NAME: 1005813D181-Ballard

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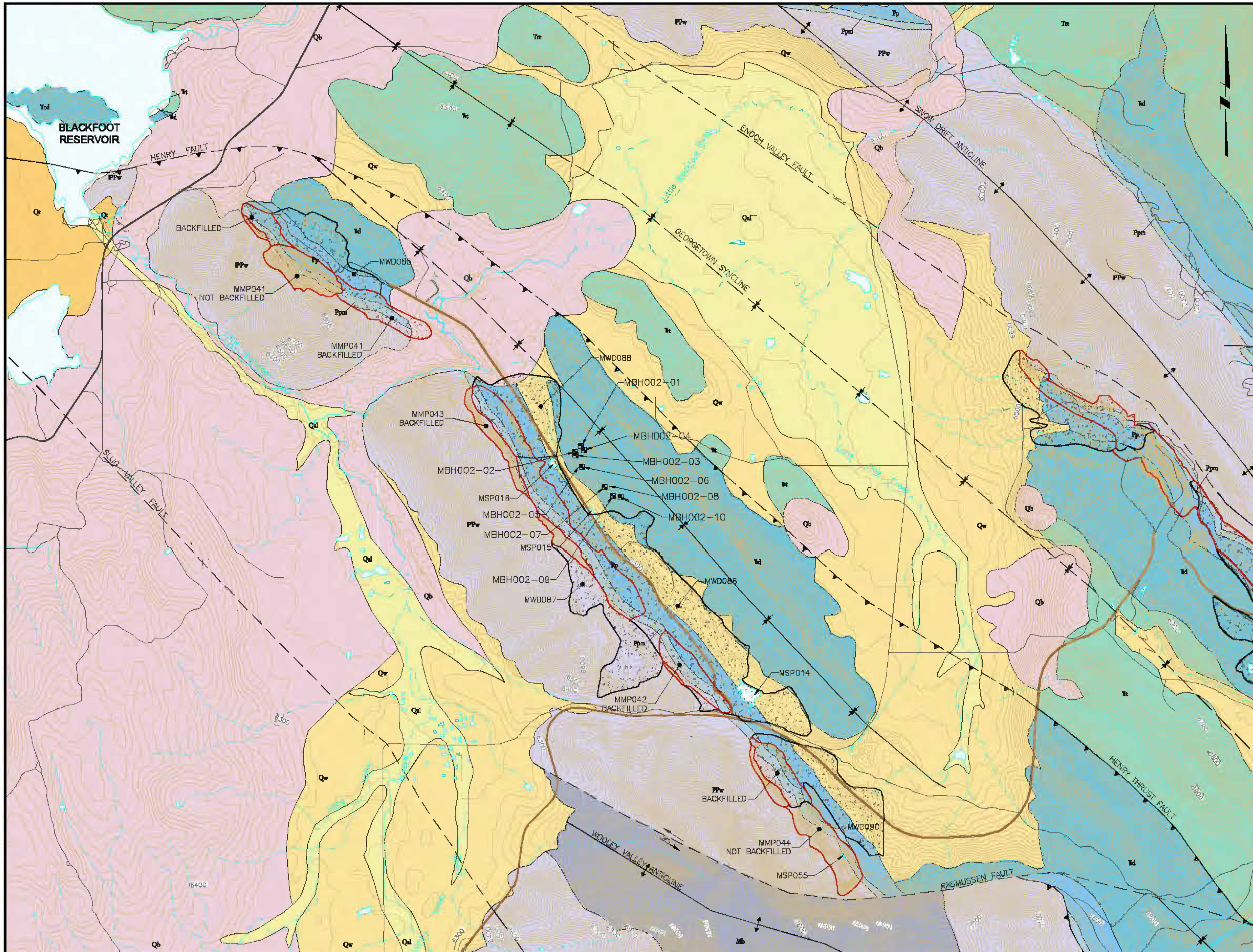

SCALE
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CONTOUR INTERVAL = 20 FEET

LEGEND:

- POST-MINE CONTOUR AND ELEVATION, FEET (APPROXIMATE)
- RIVER
- POND OR LAKE
- NATURAL DRAINAGE – PERENNIAL
- NATURAL DRAINAGE – INTERMITTENT
- HIGHWAY
- ROAD
- MONSANTO HAUL ROAD (ACTIVE & INACTIVE)
- RAILROAD
- MINE PIT LOCATION (APPROXIMATE WHERE COVERED BY BACKFILL)
- WASTE ROCK DUMP LOCATION (APPROXIMATE)
- WASTE ROCK DUMP LOCATION OR PIT BACKFILL (APPROXIMATE)
- FAULT
- THRUST FAULT (DASHED WHERE INFERRED)
- APPROXIMATE OR INFERRED FAULT
- AXIS SYNCLINE (DASHED WHERE INFERRED)
- AXIS ANTICLINE (DASHED WHERE INFERRED)

STATION TYPE:

MBH = BACKGROUND SOIL AND VEGETATION SAMPLE LOCATION

GEOLOGIC KEY:

Qb	BASALT
Qba	BASALTIC ASH – TUFF
Qal	ALLUVIUM
Qt	TRAVERTINE
Qw	COLLUVIUM AND OLDER ALLUVIUM
Tl	DEADMAN LIMESTONE
Th	HIGHAM GRIT
Trt	THAYNES FORMATION
Trty	TIMOTHY SANDSTONE – THAYNES MEMBER
Trd	DINWOODY FORMATION – WOODSIDE SHALE
Pp / Ppm	PHOSPHORIA FORMATION MEADE PEAK MEMBER
PPw	WELLS FORMATION
Mb	BRAZER LIMESTONE
Mm	MADISON LIMESTONE

KEY:

MMP = MINE PIT
MWD = WASTE ROCK DUMP
MSP = POND

NOTE:

1. GEOLOGIC DATA SOURCES: OBERLINDACHER, ET AL., 1982; HOVLAND, 1981; MANSFIELD, 1927; OBERLINDACHER, 1990. MAP HAS IN PART BEEN UPDATED BASED ON OBERLINDACHER, ET AL., UNPUBLISHED. SHA

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
0	ISSUED DRAFT FOR AGENCY REVIEW	CHF	LWN	02/17/12

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- USGS DIGITAL ELEVATION MODELS (DEM)-24K.
- SURVEY DATA FOR BALLARD MINE PROVIDED BY OLYMPUS AERIAL SURVEYS, INC. DATED: JUNE 2005.
- SURVEY DATA FOR HENRY MINE AREA PROVIDED BY OLYMPUS AERIAL SURVEYS, INC. DATED: NOVEMBER 2008.
- SURVEY DATA FOR ENOCH VALLEY MINE AREA PROVIDED BY P4 PRODUCTION DATED: DECEMBER 2007.
- US CENSUS BUREAU 2007 TIGER LINE DATA

DESIGNED BY	L MARTIN	02/17/12
DRAWN BY	C FOWLER	02/17/12
CHECKED BY	L MARTIN	02/17/12
APPROVED BY	C FOULK	02/17/12
PROJECT MANAGER	V DRAIN	02/17/12
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

P4 Production, LLC

PROJECT LOCATION
BALLARD, HENRY AND ENOCH VALLEY MINES

PROJECT
RI/FS

TITLE
HENRY MINE AREA BACKGROUND UPLAND SOIL AND VEGETATION LOCATIONS AND SURFACE GEOLOGY

MWH

DRAWING 2
REVISION A
FILE NAME 1005813D186-henry

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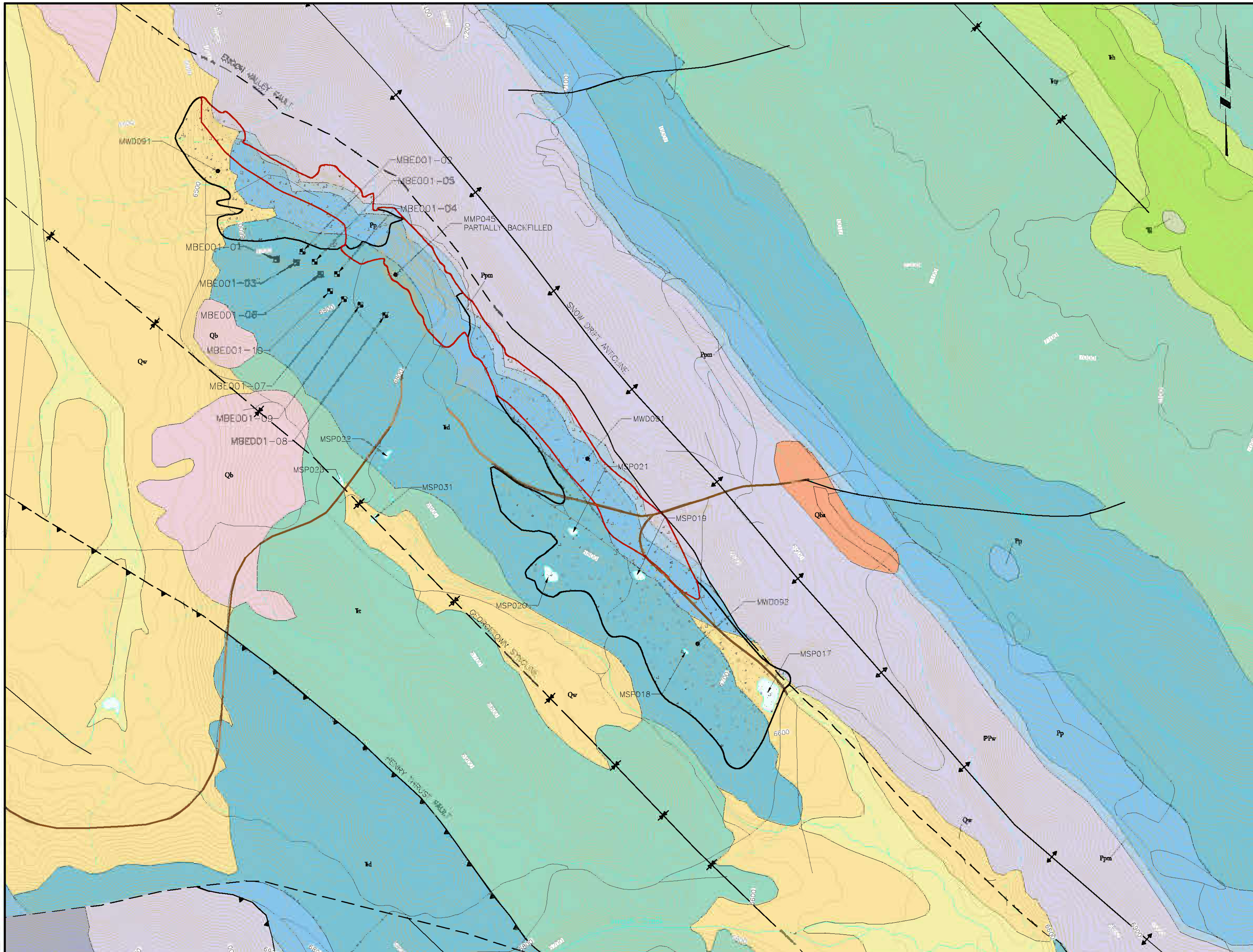

SCALE

1000' 0 1000' 2000'

CONTOUR INTERVAL = 20 FEET

LEGEND:

- POST-MINE CONTOUR AND ELEVATION, FEET (APPROXIMATE)
- RIVER
- POND OR LAKE
- NATURAL DRAINAGE – PERENNIAL
- NATURAL DRAINAGE – INTERMITTENT
- HIGHWAY
- ROAD
- MONSANTO HAUL ROAD (ACTIVE & INACTIVE)
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- MINE PIT LOCATION (APPROXIMATE WHERE COVERED BY BACKFILL)
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STATION TYPE:

MBH = BACKGROUND SOIL AND VEGETATION SAMPLE LOCATION

GEOLOGIC KEY:

Symbol	Unit
Qb	BASALT
Qba	BASALTIC ASH – TUFF
Qal	ALLUVIUM
Qt	TRAVERTINE
Qw	COLLUVIUM AND OLDER ALLUVIUM
Trdl	DEADMAN LIMESTONE
Trh	HIGHAM GRIT
Trt	THAYNES FORMATION
Trtv	TIMOTHY SANDSTONE – THAYNES MEMBER
Trd	DINWOODY FORMATION – WOODSIDE SHALE
Pp / Ppm	PHOSPHORIA FORMATION MEADE PEAK MEMBER
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Mb	BRAZER LIMESTONE
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MMP = MINE PIT
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NOTE:

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ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
b	ISSUED DRAFT FOR AGENCY REVIEW	CHF	LMM	02/17/12

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DESIGNED BY	J. MARTIN	02/17/12
DRAWN BY	C. FOWLER	02/17/12
CHECKED BY	J. MARTIN	02/17/12
APPROVED BY	C. POULK	02/17/12
PROJECT MANAGER	V. DRAIN	02/17/12
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

P4 Production, LLC

PROJECT LOCATION
BALLARD, HENRY AND ENOCH VALLEY MINES

PROJECT
RI/FS

TITLE
ENOCH VALLEY MINE AREA
BACKGROUND UPLAND SOIL AND VEGETATION LOCATIONS AND SURFACE GEOLOGY

MWH

DRAWING 3 REVISION A

FILE NAME 1005813D186-Enoch

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APPENDIX E3

MARCH 29, 2012 RTC

Compiled A/T comments on P4 Production, LLC's Response to Agency Comments Document Entitled Comments on Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 0 (Background Memorandum - Chapters 1 – 3 only)
A/T comments were transmitted to P4 on January 23, 2012. Responses prepared for P4 Production, Inc. by MWH, dated February 17, 2012.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
IDAHO OPERATIONS OFFICE
1435 N. Orchard St.
Boise, Idaho 83706

March 29, 2012

Rachel Roskelley
Sr. Environmental Engineer
Monsanto Company
Soda Springs Operations
1853 Highway 34
Soda Springs, Idaho 83276

Re: Compiled A/T comments on P4 Production, LLC's Response to Agency Comments Document Entitled *Comments on Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 0 (Background Memorandum - Chapters 1 – 3 only) - Transmitted to P4 on January 23, 2012*. Responses prepared for P4 Production, Inc. by MWH, dated February 17, 2012.

Dear Ms Roskelley,

The Agencies and Tribes (A/T) have reviewed the above referenced deliverable submitted by P4. This work product was developed pursuant to the 2009 RI/FS Settlement Agreement. Our comments on are enclosed.

We will be available to discuss this matter during our next bi-weekly conference call, or if necessary during a subject-specific meeting. Please contact me if you have questions or concerns. I can be reached at 208-378-5763 or electronically at tomten.dave@epa.gov.

Sincerely,

//s//

Dave Tomten
Remedial Project Manager

Enclosure

cc: Cary Faulk, MWH (electronic version only)

Printed on Recycled Paper

Vance Drain, MWH (electronic version only)
Mike Rowe, IDEQ
Mary Kaufman, FS
Jim Alexander, USDA
Forest Service - Enoch Valley Site Record
Jeff Cundick, BLM
Sandi Fisher, US FWS
Kelly Wright, Shoshone Bannock Tribes
Susan Hanson (for the tribes)
Talia Martin, Shoshone Bannock Tribes (electronic version only)
Colleen O"Hara, BLM (electronic version only)
Eldine Stevens, BIA (electronic version only)
Tim Mosko, CH2MHill (electronic version only)
Sherri Clark, FS (electronic version only)
Charles Allbritton, EPA Records Center (electronic version only)

Compiled A/T comments on P4 Production, LLC's Response to Agency Comments Document Entitled *Comments on Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 0 (Background Memorandum - Chapters 1 – 3 only) - Transmitted to P4 on January 23, 2012.* Responses prepared for P4 Production, Inc. by MWH, dated February 17, 2012. These compiled comments transmitted to P4 on March 29, 2012

General Comments

1. The Agencies cannot complete a comprehensive review of the referenced document in the context of the evaluation of background for the RI/FS without the specific information on how P4 proposes to ultimately use the summary statistics. Therefore this review and related comments are to be considered preliminary based on the information provided in the partial draft of the referenced document and are subject to further evaluation and modification pending review of the full draft of the document.

   P4 Response: We are attempting to use a stepping stone process for development of the Sites" background levels to ensure that the process is transparent and is agreed to before this information is used for screening along with other relevant EPA screening criteria in the RI Reports that will be prepared for the Sites. In addition, these background levels will be used as we discuss in our earlier response package "…..during preparation of the human health and ecological risk assessment (HHERA) for COPC/COPEC screening and for the calculation of incremental risk estimates. In addition, background levels may be used during preparation of the feasibility study (FS) to identify portions of the Sites that are appropriate for consideration of remedial alternatives, and as potential cleanup levels for COCs/COPECs that have low risk-based screening levels relative to background concentrations"

   This stepwise approach was agreed to during a bi-weekly call prior to our preparation and submittal of materials representing the initial step in this process. This initial step included submittal of drawings and tables via email on September 12, 2011 and October 13, 2011. Individual background sampling locations for each medium are depicted on these drawings.

   The text representing sections 1-3 of Background Levels Development Technical Memorandum (the Background Memorandum) was the second submittal in this process and is the subject of your current comments. The third submittal in this process will include the calculated background levels of metals and radionuclides for each of the selected media once we have agreed to the statistical methods and outcomes of this processes discussed in sections 1-3. The third submittal will also include the completed Memorandum, which will be submitted for final A/T review. As discussed above, the background levels developed in this Background Memorandum will be used in:

   - The RI Report for preliminary screening, along with appropriate Agency risk-based standards, of sampling results from various media. Preliminary screening of

sampling results will be based on an upper bound estimate of the background population, such as an upper tolerance limit (UTL) or maximum concentration, for each medium. Please also refer to our responses to Specific Comments No. (SC) #46 and #48.

- The HHERA for COPC and COPEC screening. Screening for COPCs and COPECs will be based on an upper bound estimate of the background population, such as a UTL, for each medium. Please also refer to our responses to Specific Comment (SC) #46 and SC#48.
- The HHERA for the calculation of background risk estimates. The calculation of background risk estimates for use in the derivation of incremental risk will be based on 95% upper confidence limit (UCL) on the mean concentrations, or maximum detected concentrations, for consistency with the exposure point concentrations used in the calculation of Sites' risk estimates.
- The FS to identify portions of the Sites that are appropriate for consideration of remedial action, and as potential cleanup levels for COCs/COPECs that have low risk-based screening levels relative to background concentrations. Background evaluations in the FS will be based on an upper bound estimate of the background population, such as a UTL or maximum concentration, for each medium.

A/T Response: *In the response to the second bullet of P4's responses to General Comment #1, P4 indicates that an upper bound estimate of background will be used for COPC/COPEC screening, which is inconsistent with previous agreements made during negotiations for the RI/FS Work Plan. Specifically, with Comment AC#6 to the RI/FS WP, which indicated that EPA guidance cautions use of a background screening for COPC/COPEC selection and that background data should be used for interpreting risk during risk characterization. The A/Ts also described that a focused list of COPCs/COPECs required for the evaluation in the risk assessment had previously been agreed upon. In follow-up discussions with P4 regarding background screening, a resolution was made to allow for background screening during the risk assessment following an initial risk screening step (e.g., during a preliminary risk conclusion/COPEC refinement following Step 2 of EPA's eight-step ERA guidance). P4's responses (on December 30th, 2010) "agreed" with this approach and stated that "analytes will not be eliminated during COPC selection based on background concentrations." Considering this, the uses of background screening described in the Background Memorandum needs to reflect the previous agreements made during the RI/FS planning.*

2. The referenced document focuses on background threshold values (BTVs) representing the upper range of the background data set. BTVs are important and necessary for advancing the RI/FS process, but other summary statistics are also important to support various decisions. For example, the document mentions calculating background human health risks which would typically imply that P4 would calculate upper confidence limits (UCLs) of the mean (as one would for site concentrations), but it is unclear if P4 will pursue this or not (no mention in this text). The discussion in this memorandum is primarily about comparing individual site concentrations to the calculated BTVs to draw conclusions on whether those site

concentrations exceed background. Please clarify how UCLs of the mean will be used, if at all. In the final report, include summary tables that include the various summary statistics that will be used in the RI/FS, including 95 UCL of the mean.

P4 Response: Tables presenting summary statistics for each analyte in each medium will be included in Section 4.0 of the Background Memorandum. Summary statistics will include maximum detected concentration, minimum detected concentration, standard deviation, mean concentration, and 95% UCL on the mean concentration. As described in our response to General Comment (GC) #1, above, 95% UCL on the mean concentrations will be used in the HHERA during the calculation of background risk estimates for the derivation of incremental risk estimates.

A/T Response: *In combination with P4's response to A/T Comment SC#39 below, P4 appears to describe the roles of background statistical limits in more polished and definitive terms than in the 2011 background report. As noted throughout this document, the additional details on the reporting and use of the statistical limits as provided in P4's responses should be included in the next draft of the report.*

3. As noted in the previous comment, there is no mention in the text of using two sample tests to compare background and site concentrations. P4 appears to be choosing the method that provides the highest available BTVs which has the potential to be calculated with spurious concentrations present in the data given the nature of the small data sets for some media. Two-sample comparisons, however, often offer increased evidence of background exceedances. Please provide a rationale for the exclusive use of BTVs in lieu of two-sample comparisons that might provide increased evidence of background exceedances.

P4 Response: In P4"s experience, two sample tests such as the Wilcoxon Rank Sum test are non-robust when sample sizes are small and/or there are numerous non-detect results. This is the case for the sediment, riparian soil, riparian vegetation, and surface water data sets, where there are relatively few samples (e.g., sediment, riparian soil and riparian vegetation) or some analytes with numerous non-detect results (e.g., surface water). Please refer to Tables 2-3 through 2-6 of the Background Memorandum.

This comment discusses the potential use of statistical tests besides individual comparison to a background threshold value (such as two-sample comparison tests). P4 indicates that in their experience small data sets with low frequencies of detections make these tests unreliable (actually the response said "non-robust", but it is not understood what specifically is meant by "non-robust" here, so we've paraphrased with "unreliable"). When the data are prepared for comparisons and the stepping stone process has reached the point where statistical sections have been written, it may be good to keep in mind recommendations from U.S. EPA such as in the ProUCL technical guide which suggests that a minimum of 8-10 samples (preferably more) should be available in the background data to calculate background threshold values and the same minimum (preferably more) should be available in both the site and background data sets for two-sample comparisons. For example, the upland soil and vegetation data meet the 8-10 sample number criteria

for both background and site data, thus two-sample comparisons should be applicable.

Perhaps it will be more obvious later whether the necessary data are available for both or either of the individual or two-sample comparison methods and whether either alone could benefit from companion approaches to understand the relationship between site and background. Thus, in summary, we believe a two-sample comparison approach may be needed for some COPCs for some media (i.e., larger data sets such as soil and vegetation), to be determined as the need arises.

4. As written, the text appears to be biased toward keeping all statistical outliers in the datasets. The document should be revised to provide more detail on the process that will be used to exclude or include statistical outliers.

   P4 Response: No, the outlier evaluation is not biased to retain statistical outliers. Rather, it is intended to examine and understand the basis for statistical outliers. According to USEPA (2006), an outlier should not be removed from a dataset based solely on a statistical test. Instead, the decision to discard an outlier should be based on a scientific or quality assurance basis. As described in Section 3.3, the decision to remove an outlier from a given dataset will be based on a "weight-of-evidence" evaluation that includes results of the statistical outlier test as well as qualitative issues such as sampling anomalies or quality assurance/quality control (QA/QC) concerns.

   A/T Response*: Generally agree. We continue to point to EPA recommendations that background outliers undergo a different scrutiny than site outliers. The 2006 guidance did not offer specific recommendations for background data as opposed to site, so it appears better to rely on other EPA recommendations that do focus on background when making decisions specific to background outliers. We welcome a "weight of evidence" discussion on the outliers to help determine whether to retain or exclude such elevated values in the background data set. We further welcome related statements elsewhere in the response to comments below that point out that outliers will not be retained only because no cause could be identified.*

5. Throughout the document the term "re-evaluation" is used to describe the current work. The term is confusing. As the Agencies did not approve previous background evaluations submitted for the three P4 CERCLA sites, those previous evaluations are not relevant to the current work. Please replace "re-evaluation" with "evaluation" when discussing the current work.

   P4 Response: P4 believes that it important for a reader of the Background Memorandum to understand the investigation history of the three Sites as the investigation transitioned from the Area-Wide studies to EE/CA studies and from the EE/CA studies to the CERCLA RI/FS under the 2009 CO/AOC. Notably, that a significant portion of the background data was collected during the EE/CA studies in addition to data collected under the RI/FS. P4 understands the A/Ts concerns with the previous background evaluations and will change "reevaluation" to the "current evaluation" throughout the document. However, P4 maintains that the historical context of this current background evaluation is important and has left necessary background information in the revised Background Memorandum.

A/T Response: *P4/Monsanto's response is insufficient and does not address the Agencies' comment. Please revise the text according to the original comment. Note that the A/T agrees that the subject data can be brought forward, as approved under the RI/FS Work Plan. However, the text in the RI/FS Work Plan adequately acknowledges the prior work conducted by P4. There is no need to repeat the same information here, especially the discussion regarding prior derivations of background values by P4/Monsanto that were not approved by the Agencies and will not be used for the RI/FS.*

6. Please provide maps depicting the background concentrations (presented in whatever statistic is proposed [i.e., average]) of each media for each mine separately (Enoch Valley; soil, upland vegetation, sediment, riparian vegetation, surface water, groundwater = 6 maps).

   P4 Response: If the reviewer can clarify the purpose of the requested maps relative to the statistical evaluation of background, it would help P4 to understand the merits of this request. For example, is the purpose of the maps to spatially evaluate whether specific stream sampling stations may exhibit higher analyte concentrations than other stream sampling locations, which could suggest an influence from an adjacent or upgradient mine site? In order to depict all background sampling results, a total of 18 maps (i.e., six media per background sampling area, times three background sampling areas) would be required. In addition, it is not practicable to post background sampling results for all analytes in all media on such maps. Therefore, if the purpose of this request is to evaluate whether data from a specific background sampling location should be included in the background dataset for a given medium, P4 believes that this objective can be met through an alternative, less labor intensive process, as discussed below.

   For example, P4 could generate concentration-probability graphs for specific media and analytes where individual sample results are color coded by P4 background sampling location. The reader of these graphs will be able to view the distribution of all sampling results, identify which results correspond to a given P4 mines" background sampling location, and discern whether or not any of the sample results appear to be anomalous. Examples of this approach are presented for arsenic, manganese and selenium in upland soils (refer to Attachment 1). Again we do not believe that because an individual concentration graphed is high that it should automatically be thrown out but flagged until further statistical tests can be run. If the weight of evidence (i.e., its location, its concentration(s), the results of statistical tests, etc.) shows that an analyte in a medium is indeed anomalous, then it would be removed from the data set.

   A/T Response: *The request for mine-specific maps depicting the background samples locations and concentrations for each media was to assist in evaluating whether there was sufficient site-specific background data for each media for each site and to determine the spatial relevance of said data points. The concentration-probability curves for the ln concentrations of the analytes submitted by P4/Monsanto in lieu of the requested maps do not provide the same information as requested.*

Please note that the A/T appreciates P4's attempt to come up with an alternative to the maps. However, the A/T requests that P4, at a minimum, proceed with preparing three maps that show background selenium concentrations for the various media. We recommend that the maps show the number of samples and the maximum, minimum, and average concentration for each proposed background location. We believe that these three maps could be prepared as follows:

- *1 map showing surface water, sediment, and riparian data*
- *1 map showing groundwater data*
- *1 map showing upland soil and vegetation*

Furthermore, we recommend that P4 prepare similar maps for any other potentially significant analytes that will be important to understanding the contribution of background to total risk, based on P4's professional judgment. Note that the A/T reserves the right to require additional maps in the future, if deemed warranted.

7. The FS/BLM does not agree that data for all three mine sites should be combined into a single data set for statistical evaluation and derivation of background levels. While it may have been convenient to administer the three sites collectively for the investigation phase, according to the 2009 ASAOC Statement of Work, individual RI reports and baseline risk assessments will be prepared and submitted separately for each of the three mines thereby indicating each site is to be evaluated separately.

   P4 Response: There are several reasons to "pool" or combine the background data from the Sites. First and foremost, the geology of each of the Sites is derived from the same sequence of sedimentary rock formations (from oldest to youngest) which is the Pennsylvanian Wells Formation, the Permian Phosphoria Formation, and the early Triassic Dinwoody Formation. These three primary geologic formations are present at each of the mines as depicted on Drawing 1 and Drawing 2 (see Attachment 2). As described in the Supplemental Mine Waste Rock Dump and Facility Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009), the primary decision criterion that was used during the selection of A/T-approved background sampling locations was undisturbed areas away from mining activities, but still within the mined area footprint. Based on this criterion, upland soils and vegetation samples were collected from undisturbed areas overlying the Dinwoody Formation at the Henry and Enoch Valley mines" background (reference) areas, and from over the Wells Formation at the Ballard Mine reference area. Because the collection of background samples was limited to undisturbed areas overlying a discreet formation, none of the mine-specific reference areas reflect the heterogeneous geology that exists at each of the Sites. Consequently, the only way to attempt to capture the heterogeneous geology at the P4 Sites is to combine the background data collected from discreet formations. However, even when background data collected from the three Site reference areas are combined, these datasets only represent the Wells and Dinwoody Formations; the Phosphoria Formation is conspicuously absent.

   Second, natural variation is anticipated within a given geologic formation, such that there may be multiple populations within the geologic formation. As stated above, upland soil and vegetation background data were collected from media over the

Dinwoody Formation at the Henry and Enoch Valley mines as shown on Drawings 1 and 2. When these drawings are combined with the distribution plots depicting, for example, the distribution of selenium (Se) concentrations detected in the background soils samples, what immediately becomes apparent is that the lower Se concentrations are found in soil samples collected from the Wells Formation at the Ballard Mine. The Enoch Valley and Henry mines have higher concentrations of Se, but they are collected from soils overlying the Dinwoody Formation. It is likely that the concentrations which are represented in the graphs of Se, arsenic (As), and manganese (Mn) represent the natural variation in the concentration of these metals in these two geologic formations. In each case, concentrations of these metals are lower in the Wells Formation when compared to the Dinwoody Formation.

Third, the Phosphoria Formation, which historically contains elevated concentrations of selenium and other metals (Herring, J.R. and Grauch, R.I., 2004), is absent from the background sampling locations that were sampled during the background sampling investigations. As stated above, in the case of upland soil and vegetation media, samples were only collected from the Dinwoody and Wells Formations. As a result, the background datasets for upland soil and vegetation are not necessarily representative of pre-mining geological conditions inside the pit boundaries at individual mines. Therefore, if these data from the Wells and Dinwoody Formations are not pooled or combined then the representativeness of background levels for individual mines or the Sites as a whole will be sacrificed and the power of the statistics will be lost because the low sample number might make some of the statistical calculations meaningless or in the worst case invalid.

It should be noted that the background data were collected during the EE/CA and RI with the intent that they would be combined for development of background levels. As noted in previous comment responses and discussions with the A/T, the Sites are located in the headwaters of several surface water drainages such that there are limited upstream locations from which un-impacted background surface water, sediment, riparian soil and riparian vegetation samples could be collected. As a result, it was not possible to collect statistically meaningful numbers of background samples for these media at individual mine sites.

Individual RI Reports and risk assessments for each of the three Sites can and will be prepared where the data collected from the analyses of various media at a particular mine is compared, not only to the combined P4 background levels that are developed in this document, but to standard risk-based benchmarks developed by the EPA and others (as discussed under GC #1). Again, the risk assessment process will inform future decisions as to areas at each of the Sites that may warrant further examination in the FS for remedial action. The background levels developed herein are just one component in the evaluation process of human and ecological risks posed by each of the Sites.

A/T Response: *P4 appears to be proposing to pool all data for each media. The A/T recognizes that the issue of pooling versus not pooling background data is complicated given the smaller datasets for some media. In further reviewing this issue, we have discussed the importance of considering the most site-specific and*

spatially relevant data, as well as the need for data that is unbiased and representative of the range of lithologic and environmental conditions that are present in the project areas. To resolve this issue, we believe it is appropriate and necessary to develop summary statistics for both pooled and site-specific data sets, and to consider all statistical results, pooled and non-pooled, in making future risk based decisions, as appropriate. It is important to note that the A/T recognizes that the significance of the statistics produced for some of the non-pooled datasets may be unreliable given the small number of samples for some datasets. The A/T expects that P4 will include a discussion of background results in the uncertainty analysis section of future risk assessments.

Thus, for the purposes of this tech memo, the A/T does not disagree with pooling data by media, however, in some cases the A/T sees an advantage to also preparing statistical summaries for select non-pooled datasets in order to better understand the differences in summary statistics (for specific datasets) when looking in closer proximity to a site and looking at a larger area. Presented below are the A/T's recommendations for pooling data on a media by media basis.

Groundwater*. P4 appears to be proposing to pool groundwater data across the different aquifers (formations). The A/T agrees that preparation of summary statistics for the pooled aquifer dataset is acceptable. However, the A/T requires that P4 also prepare summary statistics for each aquifer in an attempt to capture the heterogeneity between aquifer materials. The usual outlier analysis and weight-of-evidence assessment would be included in the statistical analysis of the individual aquifer datasets. Also, this process will likely require that some of the proposed background locations be excluded from the individual aquifer datasets; that is, data from wells screened across multiple aquifers (formations) may need to be excluded from the aquifer-specific datasets. That said, P4 is expected to exercise professional judgment in deciding which of these latter wells should or should not be excluded based on available information for each individual well.*

There is also the issue that several of the proposed background wells appear to be close to areas of mine disturbance and/or are potentially located within a flowpath from the mine. P4 noted this possibility in Table 2-10. Potential background wells identified by P4 that fit into this category include MMW007, MMW008, MMW025, MMW026, MMW030, MMW031, and MMW032. The list should be expanded to include well MMW033 which appears on cross section S-S' of the RI/FS Work Plan to be potentially within a flowpath from the mine. The A/T expects that these potential background wells will be flagged pending outcome of the outlier analysis and weight-of-evidence evaluations.

Surface water, sediment, riparian soil, and riparian vegetation*. P4 is proposing to pool background surface water, sediment, riparian soil, and riparian vegetation data by media. The A/T agrees that preparation of summary statistics for the pooled datasets is acceptable for these media. The A/T also requires that P4 prepare background data summaries on a mine by mine basis for these media. This will require that P4 assign representative sampling stations to individual mines. This will likely require that P4 exclude some stations from these non-pooled datasets if they are not spatially relevant, based on P4's professional judgement and agreement by*

the A/T. The usual outlier analysis and weight-of-evidence assessment would be included in the statistical analysis of the non-pooled media datasets.

There is also the issue that at least two of the proposed stations (MST274 and MST275) are questionable background locations as discussed under Specific Commnet #29. The A/T expects that both of these potential background stations be flagged pending outcome of the outlier analysis and weight-of-evidence evaluations.

***Upland soil and vegetation**. P4 is proposing to pool background upland soil and vegetation data by media. The A/T agrees that preparation of summary statistics for the pooled datasets is acceptable for these media. The A/T also requires that P4 prepare background data summaries on a mine by mine basis for these media. The usual outlier analysis and weight-of-evidence assessment would be included in the statistical analysis of the non-pooled media datasets.*

Included in the process will be a site visit to further assess the suitability of select background locations, with emphasis placed on visiting a select number of the flagged locations, such as MST274 and MST275. The site visit will have to occur after snowmelt to allow both access and unobstructed review of the select locations. It is assumed that P4's submittal of the next draft of the background development technical memorandum will occur before this site visit. Therefore, P4 should proceed with preparation of the document with the understanding that agency review, including the site visit, may result in deletion of the some background locations from the datasets proposed by P4.

8. P4 states that that the representativeness and usability of individual data should not be determined through comparisons to screening levels but through statistical evaluations performed during the calculation of Site-wide background levels. Please clarify why statistical evaluations are not used to categorize "site" versus "natural" background instead of using comparisons to screening levels.

   P4 Response: The first step of the current background evaluation process was to determine the locations for background so that statistics can be performed using the data that were collected from those selected sample locations. In most cases these locations were previously agreed to as "background" sample locations in work plans that were submitted and approved by the A/Ts. Later, several of these background sample locations were given the designation "site" background to differentiate them from "natural" background locations. As discussed in Section 2.0 of the draft Background Memorandum "site" background refers to a location that is upstream of all potential P4 mining activities, but could possibly have influences from other nearby sources of contamination, whereas "natural" background indicates that no potential onsite or off-site mining-related influence is present. Upon further evaluation of the historical background data, P4 realigned five historical background designations and changed them from "site" to "natural" as described in Section 2.2.1 of the Background Memorandum. Currently, none of the background sampling locations proposed for use in the background evaluation are designated as "site" background. Please note that all background data will be included in the statistical outlier analysis, as described in Section 3.3 of the Background Memorandum. In the event that a sample result collected from one of the formerly designated "site"

background locations is identified as an outlier, it will be considered for removal from the background data set. In addition, sampling results collected from formerly designated "site" locations will be flagged in graphs of the data to see where they occur within the data distribution. This information will be used in a „weight of evidence" evaluation (as discussed above in GC#6) to determine the appropriateness of excluding the location from the background data sets.

A/T Response: *The explanation provided here should be included in the revised Tech Memo. It will be important to conduct a weight of evidence evaluation for background sites that are flagged, either because they are statistical outliers or because there are questions about whether they are representative of background (for example, groundwater locations that may be in a flow path from a nearby source area).*

Additionally, in the context of A/T General Comment #6, P4/Monsanto raised the concern that through evaluation of the spatial distribution of the various COPC concentrations in background samples, it might be determined that some of the locations were not appropriate as "background" locations based on COPC concentrations. And that such a conclusion would not be valid since background locations were selected on their geographical locations and should remain as background samples regardless of the actual concentrations of COPCs. However, P4/Monsanto did exactly this when they selected "natural" and "site" background locations based on geographical locations and then re-assigned the designation of "natural" or "site' based on actual COPC concentrations. If this process is valid for designation of "natural" vs. "site" it should also be valid for determining if sample locations are appropriate for any type of background designation.

Specific Comments

4. **Section 1.1, pages 1-1 and 1-2, last sentence page 1-1, first sentence page 1-2 and full first paragraph page 1-2.** This section is confusing and the need to conduct the proposed work is unclear. The text states that previous studies included statistically derived background numbers that have not been agreed to by the A/Ts, but does not explain why. The text states that background concentrations will be an important consideration in future work, but does not explain why (see Sections 2.1 and 2.2, Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites, US EPA, 2007). The text states that this memo fulfills this data gap, but no data gap is identified. It is unclear what will be done differently for this "re-evaluation" than what was previously done and not approved by the Agencies. Please revise for clarity.

   P4 Response: As there are multiple parts of this comment. P4 will address each individual part of the comment as follows:

   1) In order to address the portion of the comment stating that previous studies included statistically derived background numbers that have not been agreed to by the A/Ts, but does not explain why, P4 will revise the last sentence of Section 1.1 on page 1-1 to explain:

   "As stated in the RI/FS Work Plan, previous Comprehensive Environmental

Response, Compensation, and Liability Act (CERCLA) Engineering Evaluation and Cost Analysis (EE/CA) studies collected background data that will be used as part of the current evaluation of background.

A/T Response (#1): *A more appropriate response given the A/T's comment and response for General Comment #5, would be to delete the discussion of previous derivations of background concentrations that were not approved by the Agencies and substitute "As stated in the RI/FS Work Plan, previous Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Engineering Evaluation and Cost Analysis (EE/CA) studies collected background data that will be used as part of the current evaluation of background." Please revise accordingly, both to this comment and General Comment #5.*

2) In order to address the portion of the comment stating that background concentrations will be an important consideration in future work, but does not explain why, P4 will revise the text to include a bullet list of potential uses of the background concentrations as discussed in our response to GC #1.

3) In order to address the portion of the comment stating that this memo fulfills this data gap, but no data gap is identified, P4 directs the commenter to the beginning lines of Section 1.1 (see below).

"In May 2011, P4 submitted the Remedial Investigation/Feasibility Study Work Plan for the P4 Site – Revision 2 Final (RI/FS Work Plan), which was approved by EPA on June 20, 2011. As part of the RI/FS scoping process, historical data were evaluated in the RI/FS Work Plan to identify data gaps and the additional data collection activities that must be completed under the RI before the risk assessment (RA) and FS processes can begin. This evaluation primarily used data collected under the 2003 CO/AOC. As part of the data gap analysis, it was determined that sufficient data for the various media have been collected to characterize background."

The original text goes on to discuss how although the background data exists, the A/T have not approved the previous statistical evaluations of the background data. Therefore, the data gap is included in this Section, and no revision to the Background Memorandum is required.

The difference between this evaluation and previous background evaluations is that this the current process is working towards the A/Ts approving the methods and statistical tests/evaluations to be conducted, prior to generating the background concentrations for each medium of concern. The A/Ts previously have not approved the statistical tests used to evaluate the historical data.

A/T Response (#3): *Simply clarify here that a statistical evaluation of background has been identified as a data gap and that while the Agencies have not approved prior P4/Monsanto derivations of calculated background values presented for the SI/EECA, this Technical Memorandum is intended to provide such an evaluation for the RI/FS.*

5. **Section 1.2, page 1-2, and Table 1-1.** The utility of the information presented here in the context of the proposed work for the RI/FS is unclear given that there are more recent site-specific data available for the background evaluation at each of the

three mine sites. The background data collected for the Area Wide Investigation was not subject to the same level of data quality rigor as that collected under the 2009 P4 CERCLA ASAOC, so has limited utility in the current work other than as anecdotal information. Additionally, the FUBOB calculated background values are not relevant to the current work nor have they been approved by the Agencies. Please delete everything after "…the Comprehensive Site Investigation Sampling and Analysis Plan (SI SAP; MWH, 2004)" including the reference to the draft PIES document (there is a reason it is still draft from 2007, i.e., not approved by the Agencies). Please revise Table 1-1 by deleting the FUBOB values and qualifying the Area Wide background data as limited in the number of COPCs analyzed and the unknown quality of the data. Present only data for those locations proximal to or within the project study area boundaries for the three P4 CERCLA sites. Present the data using the same statistical approach as that proposed for the entire background evaluation.

P4 Response: P4 believes that it important for a reader of the Background Memorandum to understand the investigation history of the three Sites as the investigation transitioned from the Area-Wide studies to EE/CA studies and from the EE/CA studies to the CERCLA RI/FS. Notably, that a significant portion of the background data was collected during the EE/CA studies in addition to data collected under the RI/FS. P4 maintains that the historical context of this current background evaluation is important and has left necessary background information in this Background Memorandum. However, P4 agrees to qualify the Area-Wide data in Table 1-1, add additional statistics (e.g., maximum, minimum and average, in addition to removing the FUBOB values from the table. P4 does not believe that further statistical analysis is warranted for the Area-Wide data set (i.e., using only Area-Wide locations proximal to or within the project study areas); therefore, the Area-Wide statistics as used in the Area-Wide Risk Assessment; IDEQ, 2002 will be presented in Table 1-1. Based on this response, Section 2.1 has been revised as follows (new text underlined):

"Background samples of various media have been collected dating back to the Site-Wide Investigations, which started in 1996 and ran through approximately 2004, when the investigations began focusing on specific mines with specific owners. An area-wide human health and ecological risk assessment (HHERA) was performed by the IDEQ in 2002 using sampling data collected throughout the region. Background samples at P4's historic Sites were also collected between 2002 and 2009 under the 2003 AOC/CO as part of an expedited CERCLA EE/CA approach that was consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). In 2009, the A/Ts determined that the RI/FS process (also under CERCLA) was more appropriate for assessment of risk to human health and the environment and the subsequent identification of cleanup solutions, if necessary. This Background Levels Tech Memo is part of the RI/FS process.

Background levels have previously been evaluated and reported in the Area-Wide Human Health and Ecological Risk Assessment Selenium Project Southeast Idaho Phosphate Mining Resource Area (Area-Wide Risk Assessment; IDEQ, 2002). <u>The Area-Wide range, average, and 95% UCL background values are summarized in</u>

Table 1-1 although it must be noted that the data quality requirements may be less than the current data quality requirements under the RI/FS and the Area-Wide data were analyzed for a limited data set.

Background data was also collected and evaluated under the 2003 AOC/CO area as referenced in the Comprehensive Site Investigation Sampling and Analysis Plan (SI SAP; MWH, 2004), as well as the draft Interim Phase I SIs Evaluation Summary (draft PIES document; MWH, 2007). These background evaluations were not approved by the A/T.

The EE/CA background evaluations were based on the analyte list agreed upon in the 2003 AOC, with slight adjustments made for the approved 2004 analyte list (MWH, 2004). This list of analytes also was based upon screening performed by IDEQ in the Area-Wide Investigations and Risk Assessment. The COPCs for which preliminary background concentrations were calculated are listed below.

- cadmium
- chromium
- copper
- molybdenum
- nickel
- selenium
- vanadium
- zinc"

A/T Response: *P4/Monsanto's response is insufficient. Please refer to the A/T comment and response in General Comment #5 and Specific Comment #4. Please revise as requested in the original comment.*

10. **Section 2.2.1, page 2-3.** The text states that sampling for riparian vegetation occurred once in 2004. The 2004 sampling event analyzed for a very limited set of COPCs (five analytes according to Table 2-6). Please explain how the background evaluation (and subsequent risk assessment) will be conducted for the remaining COPCs.

    P4 Response: The COPC/COPEC suite has historically been limited to cadmium, chromium, copper, molybdenum, nickel, selenium, vanadium, and zinc for several media including soils, vegetation and sediment based upon screening performed by IDEQ in the Area-Wide Investigations and Risk Assessment. It was not until recently (i.e., 2009 and 2010), that the analytical suite was increased to 17 constituents for these media. In addition, it is important to note that the 2009 upland vegetation data and the 2004 riparian and upland vegetation data were evaluated against risk-based screening levels (RBSLs) in the A/T-approved RI/FS Work Plan -Rev2 Final (RI/FS Work Plan). As shown on Tables 3-5, 3-21, and 3-37 of the RI/FS Work Plan, there are only three analytes (cadmium, molybdenum and selenium) detected in riparian and upland vegetation that exceeded RBSLs. The exception to this is one exceedance

of the RBSL for boron in a 2009 upland vegetation sample at Enoch Valley.

Based on the comparisons of vegetation concentrations to RBSLs presented in the RI/FS Work Plan, and the fact that all three analytes that consistently exceeded vegetation RBSLs were included in the 2004 analytical suite, P4 does not believe that the historically-selective analyte list for the riparian vegetation data represents a significant data gap. Nevertheless, the limited nature of the analytical suite for riparian vegetation will be described in the human health and ecological risk assessments (HHERA) for the Sites.

In the HHERAs to be performed for the Sites, biota consumption pathways will be evaluated by inputting measured riparian vegetation concentrations into the dose equations for those chemicals with available riparian vegetation sampling results. For those chemicals without riparian vegetation sampling results, riparian vegetation concentrations will be modeled from riparian soil concentrations using published soil-to-plant bioaccumulation factors, as available.

A/T Response: *Please revise the text in the Technical Memorandum according to the explanation provided here in the response to comments.*

11. **Section 2.2.1, page 2-3, last two sentences.** Please delete. The current document should focus on what is proposed rather than discussing data collected in the past that will not be used.

    P4 Response: As stated in response to GC #5, P4 believes that it important for a reader of the Background Memorandum to understand the investigation history of the three Sites as the investigation transitioned from the Area-Wide studies to EE/CA studies and from the EE/CA studies to the CERCLA RI/FS. Notably, that a portion of the background data was collected during the EE/CA studies in addition to data collected under the RI/FS. P4 maintains that the historical context of this current background evaluation is important and has left necessary background information in this Background Memorandum. However, P4 agrees to remove the last two sentences of Section 2.2.1, page 2-3 as requested.

    A/T Response: *P4/Monsanto's response is insufficient. Please refer to the A/T comment and response for General Comment #5 and Specific Comments #4 and #5. Please revise the text according to the original Agency comment.*

13. **Section 2.2.1, page 2-4, 3rd paragraph.** It appears that the drainage from the Wooley Valley Mine waste rock pile as well as the haul road adjacent to MST226 would potentially impact this location. It is unclear how the determination has been made to reclassify this location from site to natural background. Please clarify.

    P4 Response: As discussed in the Background Memorandum, MST226 is located on an ephemeral drainage to Lone Pine Creek. This location was historically characterized as a "site" location based on its proximity to an adjacent mine, which is not owned by P4. This classification was based on a regional waste rock boundary definition that did not have the resolution needed to accurately indicate if the drainage in question contained mine waste rock. During this re-evaluation and remapping of the waste rock in this area, it was determined that the uppermost part of the drainage does not contain a portion of the waste rock dump in question, and that in fact the

waste rock associated with the adjacent mine is located in a drainage over a divide from MST226. However, data from this background station will be statistically evaluated during the outlier analysis, as discussed in the Background Memorandum.

A/T Response: *Please revise the text in the Technical Memorandum according to the explanation provided here in the response to comments. Please respond to the portion of the original comment about the adjoining haul road. If the haul road is a potential source, please explain if data from this station should or should not be flagged for further weight of evidence evaluation.*

17. **Section 2.2.1, page 2-6, 1st incomplete paragraph, last sentence.** The text states that P4 is proposing to use "natural" background data for the evaluation of medium-specific background concentrations. This statement begs the question of the utility of the "site" background data. Please clarify.

    P4 Response: P4 agrees with the utility of the "site" background data that has been historically collected. The "site" background data may help P4 and the A/Ts assess the influence (i.e., contamination impacts) to particular media located on the P4 Sites from non-P4 sites. However, as discussed throughout these responses, P4 believes that inclusion of "site" background stations would bias or skew the background data and this evaluation of background is proposing to use "natural" background locations.

    A/T Response: *Please revise the text in the Technical Memorandum according to the explanation provided here in the response to comments. Please also refer to the A/T's comment and response to General Comment #8.*

18. **Section 2.2.1, page 2-6, last paragraph.** The text states that the final representativeness and usability of data or sampling locations is determined through statistical evaluations performed during the calculation of Site-wide background levels. Please clarify that "Site-wide" refers to each of the three individual P4 mine sites, not the three sites collectively.

    P4 Response: Please note that the term „Site-wide" was intentional and refers to the calculation of background levels using the combined (pooled) data collected at all three of the Sites, rather than for individual mines. The rationale and basis for this approach are provided in our response to GC #7, above.

    A/T Response: *Please see the A/T's comments and responses to General Comment #7 regarding the pooling of data.*

21. **Section 2.2.1.1, page 2-7, Cadmium.** Throughout the document, there is reference to many of the analytes having a "conservative screening benchmark" and P4 seems to be using that argument to support the dismissal of use of that benchmark rather than the conclusion that the concentration sampled is not representative of background conditions. Please provide more discussion on why the screening benchmark is being dismissed, as there is a reason why the benchmark was set at the concentration is was. Why should that concentration not apply to the P4 sites?

    P4 Response: P4 is not trying to make a case that specific screening criteria do not apply to the Sites. Rather, we are pointing out that for some chemicals in some media, available published benchmarks are low relative to background concentrations. An example is arsenic for which human health-based screening levels are commonly at or

below the range of background concentrations observed in most regions of the U.S. The fact that measured concentrations of arsenic in soil at a given location exceed a screening benchmark, such as the EPA Regional Screening Level (RSL) for arsenic in residential soil, does not necessarily mean that the concentrations are not representative of background.

A/T Response: *Please revise the text in the Technical Memorandum according to the explanation provided here in the response to comments.*

29. **Section 2.2.1.2, page 2-11, Selenium.** In general, it is fair to say that natural background concentrations of selenium in surface water above 0.002-0.003 mg/L are extremely rare in the phosphate district. They are so rare in fact that it is reasonable to suspect that MST274 and MST275 have been impacted from mining activities in the region and do not reflect natural background. This premise has caused the A/T to question the inclusion of these two locations in the background database. Evidence supporting the removal of MST274 and MST275 from the background database is presented below.

MST274

MST274 is apt to be impacted by the haul road that runs past this site and the minor drainage that runs to the west (West Fork of Rasmussen Creek). The haul road appears to be a significant feature near to MST274, possibly causing the selenium to be elevated at this sample location.

There is also evidence that MST274 may be impacted by a release from Enoch Valley Mine. For example, both cross sections *D-D'* and *J-J'* of the RI/FS work plan show that infiltration from MWD092 is expected to migrate within the alluvium toward the south. If MST274 is projected northeast onto these cross sections, there appears to be a distinct possibility that MST274 is downgradient of the mine. Recognizing the possibility that MST274 is actually Thaynes Formation spring water expressed through a veneer of alluvium (as suggested by Drawing 2-5 of the RI/FS work plan), the fact that MST274 is downdip of, south of (downgradient), and lower in elevation than the Enoch Valley Mine is sufficient evidence to suspect that MST274 may not be an appropriate background location. Note that the A/T recognizes that intervening push probe results just to the north of MST274 are low in selenium, typically <0.001 mg/L. Again, recognizing the possibility that MST274 is actually Thaynes Formation spring water expressed through a veneer of alluvium (as suggested by Drawing 2-5 of the RI/FS work plan), the direct push samples may not representative of the water sampled at MST274.

Based on the above uncertainties, it is the A/T"s position that MST274 be deleted from the background database unless P4 can provide other compelling evidence showing MST274 cannot be impacted by the haul road, Enoch Valley Mine, or any other mine in the region.

MST275

MST275 is located between the Enoch Valley and Henry Mines and its provenance is Thaynes Formation, assuming the lithology provided in Drawing 25 of the RI/FS work plan is correct. MST275 is also located very close to the Henry Thrust Fault. In

Section *B-B'* of Drawing 2-7 of the RI/FS work plan, easterly dipping bedding beneath the Henry Mine is depicted as overlying Dinwoody Formation that is shown to be discharging towards the Henry Thrust Fault. Westerly dipping Dinwoody/Thaynes bedding beneath the Enoch Valley Mine could also be discharging towards the Henry Thrust Fault. Furthermore, there is a possibility that the South Rasmussen Mine is contributing to the Dinwoody/Thaynes in this region and potentially discharging towards the Henry Thrust Fault. The West Limb Pit and overburden pile of the South Rasmussen Mine are located on the western limb of the Snowdrift Anticline and probably have direct contact with the Dinwoody Formation to the west. Additionally, the Enoch Valley Fault is positioned immediately west of the South Rasmussen West Limb Pit and overburden pile. The Enoch Valley Fault is a high-angle, down-to-the-southwest fault that runs along the southwestern margin of the Rasmussen Mine to the north to Enoch Valley Mine. Assuming that northerly flow in the Dinwoody/Thaynes is possible, the selenium in MST275 (and MST274) could potentially reflect impact from the South Rasmussen mine due to these potential preferential pathways. Based on the uncertainty created by potential interconnection of Mines in the region to MST275 via the Henry Thrust and Enoch Valley Faults, it is the A/T"s position that MST275 be deleted from the background database unless P4 can provide other compelling evidence showing MST274 cannot be impacted by mine in the region.

Finally, it is our understanding that the Thaynes Formation can have strata of black shale which could conceivably contribute higher levels of COPCs to surface water, sediment, etc., including the water at MST274 and MST275. Please discuss if you feel this potential source is relevant to the discussion of background at MST274 and MST275.

P4 Response: The rationale that either MST274 or MST275 are impacted by groundwater from either Enoch Valley or South Rasmussen mines or the haul road is unsubstantiated. There is no evidence that suggests flows of mine-impacted water occur along faults at the magnitude suggested in the comment.

Even if it did, the distance and travel time are such that the discharge of impacted water is unlikely to occur currently. MST275 also is located high in the drainage and regional discharge from one of the mention fault systems would more probably occur in the valleys. In addition, as noted in the comment, it appears the shallow alluvial water near MST274 is not impacted by the Enoch Valley Mine based on the direct push results.

We are not aware of any data on seleniferous shales in the Thaynes Formation similar to the Phosphoria Formation, which are not represented in this background data set (i.e., none of the background stream stations have a province that includes undisturbed Phosphoria Formation, which as discussed in prior responses may already be biasing the natural background data low).

We propose that MST274 be flagged initially and if it fails the outlier analysis (e.g., statistical evaluation and weight-of-evidence process)), then remove it from the background data set. Also, we do not think the rationale for excluding the MST275 data from the background data set is supported at this time. For example, the MST275

location is at 6,764 feet AMSL, which is above or very near the same elevation of the potential sources mentioned in the comment. The nearest portion of the Enoch Valley Mine, over a half mile distance, is largely at a lower in elevation than MST275 (see Drawing 3-58 of the RI/FS Work Plan). The hydraulic gradients to support that the surface water could be impacted by the Enoch Valley or South Rasmussen Mines are lacking.

Finally, P4 believes that it would be most appropriate to include these sampling locations in the initial background sediment datasets and allow the statistical analysis to determine whether a given result for a given analyte represents a statistical outlier or an extreme value that may be due to mine site impacts. Furthermore, in the event that a result for one metal at a background sampling station, such as MST274, turns out to be an outlier or extreme value representative of mine site impacts doesn"t mean that all metals at that sampling location are influenced by the Sites. By not excluding these background sampling locations prior to the statistical analysis, P4 proposes to preserve as much of the background sediment data as possible.

A/T Response: *Agree that data from these two locations can be included in the initial background datasets pending findings of the outlier and weight of evidence analysis. Stations MST274 and MST275 should be flagged as previously noted in the A/T's response to General Comment #7. From the A/Ts perspective, the weight of evidence evaluation will need to consider the validity of the original A/T observations regarding these two potential background locations and the findings of the upcoming site visit to these locations.*

P4's weight-of-evidence assessment for these two stations should also consider two recent questions raised by the A/T. The total selenium concentration data from MST274 suggests there may be an increasing trend in concentrations. Please explain if this could occur at a natural background data station? Selenium data from MST275 (total Se concentrations from 4 sampling events), generally show low concentrations in the spring (May) and high concentrations in the fall (late September-early October). Please address how this pattern might occur at a background station. Also, please advise if cattle graze in the area and could be having an effect (e.g., selenium spiked salt blocks, defecating in the stream)?

39. **Section 3.1, page 3-1, 2nd paragraph**. Although items 1, 2, and 5 could be pursued via a variety of statistical approaches, one can envision pursuing them only with comparisons to calculated BTVs. However, the referenced document does not discuss why the only discussed approach is the use of BTVs. UCLs of the mean are typically used to gauge risk as opposed to estimates of the upper range of the population. For items 3 and 4 one would presumably use calculated UCLs of the mean, not BTVs. The only potential discussion of such UCLs appears to be in Table 1-1 where a footnote says "Background value was determined from the 95% UCL" which were calculated in the Area Wide Risk Assessment. Site risk calculations typically use 95% UCLs of the mean. If this approach is used with site concentrations, then the same should be pursued with background. The memorandum does not explicitly state that BTVs will be used in risk calculations, but the absence of discussion of other calculations (i.e. UCLs of the mean) raises questions on the intent. In essence, this

report needs a discussion of the type of limits used for goals 3 and 4.

Additionally, a 6th use of background concentrations is comparison to screening values. Please add or discuss how this is captured in any of the five identified uses.

Section 3.2, page 3-3, 3rd paragraph, line 6. In regard to "Inappropriate exclusion of data points from a background dataset can also lead to Type I errors (i.e., false positives)." This seems counterintuitive. Elimination of "extreme" data points would seem to result in less false positives and possibly more false negatives.

P4 Response: Please refer to our response to GC#1. Background levels developed in the Background Memorandum will be used in:

1) The RI Report for preliminary data screening, along with comparisons to screening criteria. Preliminary screening of sampling results will be based on an upper bound estimate of the background population, such as a UTL or maximum concentration, for each medium.

2) The HHERA for COPC and COPEC screening. Screening for COPCs and COPECs will be based on an upper bound estimate of the background population, such as a UTL, for each medium.

3) The HHERA for the calculation of background risk estimates. The calculation of background risk estimates will be based on 95% UCL on the mean concentrations, or maximum detected concentrations, for consistency with the exposure point concentrations used in the calculation of the Sites' risk estimates.

4) The HHERA for the calculation of incremental risk estimates. The calculation of incremental risk estimates will be based on 95% UCL on the mean concentrations, or maximum detected concentrations, for consistency with the exposure point concentrations used in the calculation of the Sites' risk estimates.

5) The FS to differentiate impacted areas from un-impacted areas, and as potential cleanup levels. Background evaluations in the FS will be based on an upper bound estimate of the background population, such as a UTL or maximum concentration, for each medium.

Please note that background concentrations will be compared to screening criteria in the RI Report as part of Item #1, above, to put the screening criteria in context.

Type I errors (i.e., false positives) may occur during COPC/COPEC screening when the maximum concentration of an analyte appears to be higher than background because the background statistic (e.g., an UTL) was biased low. Low bias in the background statistic may occur when extreme values are mistakenly eliminated from the background dataset, and the range of background concentrations is compressed.

A/T Response: *As noted in the A/T's response to GC #1 and #2, P4's response to our comments describes the roles of background statistical limits in more polished and definitive terms than in the 2011 background report. This is welcome and this type of detail should be included in the report. The discussion also mentions that low bias in the background statistic (e.g. UTL) may occur when extreme values are mistakenly eliminated from the background dataset, and the range of background concentrations*

is compressed. This is true, as is the possibility that a high bias may occur when extreme values are mistakenly retained in the background data set. The latter potential for bias should be added within the discussion.

40. **Section 3.2, page 3-3, 2nd paragraph.** This is not the approach recommended in other background guidances:

    - United States Environmental Protection Agency (USEPA). *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*, Office of Emergency and Remedial Response, 2002.
    - United States Environmental Protection Agency (USEPA), *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities—Unified Guidance,* Office of Resource Conservation and Recovery, March, 2009.
    - United States Environmental Protection Agency (USEPA), *ProUCL Version 4.1 Technical Guide (Draft),* Office of Research and Development, May, 2010.

    While complete reliance on mathematical outlier tests is not typically recommended either, the inability to exclude unusually elevated background results because there is not assignable cause available is an unusual approach with regard to background data sets.

    P4 Response: Please note that the intent of the process outlined in text for evaluating outliers will not create an inability to exclude outliers unless a cause of the outlier can be identified. Rather, the process cautions against blindly eliminating outliers on the basis of the statistical outlier test alone. Exclusion of outliers during the statistical evaluation will be part of a weight-of-evidence process that starts with the outlier test, and then proceeds to a review of the sample location and data quality issues such as sampling anomalies or quality assurance/quality control (QA/QC) concerns. If the specific cause for an outlier cannot be identified, the outlier may still be excluded from the final background dataset based on the judgment of the statistician. Such decisions will be made in consultation with the A/Ts. Text in Sections 3.2 and 3.3 will be revised to clarify the above points.

    A/T Response: *Please see A/T response to General Comment #4. We agree with the response to our comment that potential exclusion of mathematical outliers involves review of a variety of factors supported by knowledge from different technical aspects of the background data set. Please also see A/T response to General Comment #4.*

41. **Section 3.2, page 3-4, 1st paragraph.** Stratified random sampling designs are useful in sampling heterogeneous populations. The initial decision, however, has to be made on whether such a heterogeneous population needs to continue to be treated as a single population, or partitioned into separate populations as is sometimes done in background studies. We do not see a discussion of the wisdom of retaining a single population for this study.

    Stratified random sampling designs do ensure more uniform coverage of the entire population being targeted than simple random sampling. Coupled with the more complicated statistical procedures (if employed) for calculating the mean and variance, they can also offer more precise estimates of the mean or a proportion. This

design does not, however, prevent any given strata or group of stratus with inherently higher concentrations from biasing the BTV high.

While it may be difficult with this particular background population to control the types of samples and any inherent heterogeneity, the BTV will nevertheless be most affected by the strata with the most elevated concentrations (and in the case of nonparametric approaches, completely dominated by them). Site concentrations associated with strata with lower concentration ranges will continue to effectively be compared to the overall BTV heavily influenced by background strata with the highest concentrations. A stratified random sampling design does not prevent the BTV from being biased by the background strata with the highest concentrations. The report text does not present information on whether heterogeneity between various strata is or is not of concern, but one should not believe that the use of a stratified random sampling design alleviates any excessive heterogeneity if it does exist.

P4 Response: As described in our response to GC#7, background samples were collected from areas representative of the Dinwoody Formation and the Wells Formation. However, the Sites are located on a heterogeneous combination of various geologic units including the Dinwoody Formation, Wells Formation, and Phosphoria (which is known to contain high levels of certain elements including phosphorous, cadmium, zinc, selenium and uranium). As shown in the attached concentration-probability plots, it is apparent that background concentrations of arsenic, manganese and selenium are lowest in soils collected from the Wells Formation and highest in the Dinwoody Formation. The A/Ts did not permit P4 to sample in the Phosphoria Formation during the background investigation for upland soils and vegetation. Background concentrations of selenium, uranium, and perhaps even arsenic are higher in the Phosphoria Formation than in the Dinwoody Formation. Thus, the current background datasets are biased low for these elements (which are likely to be the primary risk drivers in the HHERA).

Because each of the three Sites' background reference areas represents only one geologic formation, these data must be combined to capture the heterogeneous nature of the Sites. Even when the data from the three background reference areas are combined, the concentrations for upland soils and vegetation are likely to be biased low for certain elements, relative to the Sites because of missing background data from the Phosphoria Formation.

A/T Response: *Please see the A/T response to General Comment #7 regarding pooling of data. It is also noteworthy to point out that if different grouping of background appear to constitute separate populations, then those with higher concentrations will dominate the background UTLs calculated for screening site concentrations. The example probability plots provided in Probability Plots for Soil_As_Mn_Se_02.17.12.xlsx were informative. They demonstrated how data from the Enoch Valley and Henry sites are consistently sources for much higher concentrations than the Ballard site (particularly since the plots are prepared with a log scale). This information will be useful to the A/T as it makes its decisions of whether it is best (considering all issues) for the background data to simply be combined.*

42. **Section 3.2, page 3-5.** These two limit types are presented as commonly used upper bound estimates of the background population. The USL appears in Scout software but does not have the earned reputation of upper prediction limits and upper tolerance limits. Its application as a BTV has appeared to be used infrequently in background studies. Furthermore, on projects we‟ve been associated where ProUCL and Scout authors have encouraged the use of USLs as BTVs, they have pointed out that the background data was consistent with few outliers. The P4 background data set may be inconsistent with many outliers which would make USLs less appropriate for providing sufficiently conservative background values (protection against false negatives).

    P4 Response: Please note that P4 can cite recent example projects where upper simultaneous limits (USLs) were selected by the EPA as the preferred background statistic over upper prediction limits (UPLs) or upper tolerance limits (UTLs). For one project, EPA‟s consultant calculated all three of these statistics and, following a weight-of-evidence evaluation, selected the USL as the preferred background statistic. Because we don‟t know whether the background datasets for the Sites will be consistent with few outliers, or inconsistent with many outliers, P4 proposes to calculate all three of these statistics and then consult with the A/Ts on the selection of the appropriate background statistic.

    A/T Response: *The practice of calculating all three of these statistics (UPLs, UTLs, and USLs) and then consult with the A/Ts on the selection of the appropriate background statistic is reasonable. Note that in regards to Specific Comments #42, #43, and #48, a key part of future discussion will be how aggressive the movement to retain unusually elevated results is made. It is the A/T's understanding that to retain very questionable outliers and then routinely applying USLs would be a recipe for potential false negative rates of concern.*

43. **Section 3.3, page 3-6, 2nd full paragraph.** The 2006 reference was discussing outliers in general, not background outliers. EPA typically distrusts automatic exclusion of elevated site outliers, but prefers to pursue review of background outliers even when no assignable cause is available for the spurious result.

    P4 Response: Please refer to our response to SC#40. Background results identified as statistical outliers will be pursued in a weight-of-evidence evaluation. If the specific cause for an outlier cannot be identified, the outlier may still be excluded from the final background dataset based on the judgment of the statistician. Such decisions will be made in consultation with the A/Ts. Text in Sections 3.2 and 3.3 will be revised to clarify the above.

    A/T Response: *Please refer to A/T responses to General Comment #4 and Specific Comment #40. One specific statement by P4, however, promotes additional thought, that outliers may be excluded from the background data set without assignable cause "based on the judgment of the statistician". The statistician's input is valuable, and so would be the input of other practitioners such as those most familiar with the sample locations history, geology, etc. as well as those who will be involved in any risk decisions with the data. Decisions on outlier exclusion may best be made using the technical input of a variety of professionals.*

44. **Section 3.3.1.2, page 3-7, 1st paragraph.** As mentioned previously, stratified random sampling designs are useful in sampling heterogeneous populations, but they do not eliminate concerns in combining disparate populations. For instance, if one of three subpopulations has concentrations substantially elevated above other populations (and those elevated concentrations are retained in the data set as opposed to being excluded in the outlier evaluation), those concentrations will result in elevated BTVs exceeding concentrations from site populations whose corresponding background populations were potentially lower than site. The use of a stratified random sampling design does not solve this dilemma. Background studies are routinely confronted with decisions of how important partitioning background data is. The need to consider the potential need to partition the data is not eliminated by incorporating a stratified random sampling design. Such a design can, however, be useful when the decision to not partition is made.

    P4 Response: Please refer to our responses to GC#7 and SC#41. Due to the homogeneous nature of the three Sites' background reference areas, and the fact that the Sites are located on a heterogeneous combination of various geologic units, the data must be combined to capture the heterogeneous nature of the Sites.

    A/T Response: *Please see the A/T response to General Comment #7 regarding the pooling of data. We believe the process of providing both pooled and non-pooled statistical summaries as described in General Comment #7 should resolve A/T concerns on this issue.*

45. **Section 3.3.2, page 3-8.** There is no discussion of how those selections were made. One understands without reviewing these data from this background study that

    UPL (for the next observations) < UTL < USL

    One also understands that the more elevated BTVs are usually more impacted by spurious elevated concentrations (outliers). UPLs for some other number of future observations (> 1) will vary in relationship to the UTL and USL. If, for instance, the selected BTVs were always the USLs (or maximum detected concentrations when they were as high as or higher than the USL), then discussion of the other type of BTVs would merely be a disguise for a selection process based a desired balance of false negative and false positive rates. It is not clear from the text I have been provided what the criteria was for these selections or even what the selections were.

    P4 Response: Please refer to our response to SC#42. P4 intentionally has not pre-selected the UPL, USL or UTL as the preferred statistic to represent the upper bound estimate of background for the Sites because issues related to variance and numbers of outliers cannot be determined until the statistical evaluations are performed. Rather than pre-select one statistic, P4 proposes to calculate all three of the above statistics for each analyte in each medium, and then consult with the A/Ts on the selection of the appropriate background statistic.

    A/T Response: *As stated in Specific Comment #42, the practice of calculating all three of these statistics (UPLs, UTLs, and USLs) and then involving the A/Ts on the selection of the appropriate background statistic is considered to be a reasonable approach.*

46. **Section 3.3.2, page 3-8.** It is not clear whether one or multiple types of statistical measures will be used to estimate the upper bound of the background data. The 95/95 UTL is commonly used for this purpose, and a rationale is not presented for using one or more of the other statistics. Presumably there is such a discussion in some of the cited guidance documents, but the document should at the least specify the decision rules for selecting the 95% UPL, 95/95 UTL, 95% USL or maximum value. Please include additional information for clarification.

    The report indicates that 95% UPL, 95/95 UTL, 95% USL calculations will be conducted and that an upper bound estimate will be selected from these or the maximum detected concentrations. However, discussion on how arbitration of these values will occur is absent. Details on this selection process need further explanation.

    The discussion of comparing background data and site data is all based on the calculation of an upper end background threshold value (BTV). Hypothesis testing between two data groups is not described. Please explain why this approach is not considered or, if it will be, under what circumstances and at what point in the process will these statistical approaches be used.

    P4 Response: Please refer to our responses to SC#42 and GC#3, above.

    P4 intentionally has not pre-selected the UPL, USL or UTL as the preferred statistic to represent the upper bound estimate of background for the Sites because issues related to variance and numbers of outliers cannot be determined until the statistical evaluation is performed. Rather than pre-select one statistic, P4 proposes to calculate all three of the above statistic for each analyte in each medium, and then consult with the A/Ts on the selection of the appropriate background statistic.

    In P4"s experience, two sample tests such as the Wilcoxon Rank Sum test are non-robust when sample sizes are small and/or there are numerous non-detect results. This is the case for the sediment, riparian soil, riparian vegetation, and surface water data sets, where there are relatively few samples (e.g., sediment, riparian soil and riparian vegetation) or some analytes are associated with numerous non-detect results (e.g., surface water). Please refer to Tables 2-3 through 2-6 in the Background Memorandum.

    A/T Response: *As noted in the A/T response to General Comment #3, the upland soil and vegetation data meet the 8-10 sample number criteria for both background and site data, thus two-sample comparisons may be applicable, and may be a useful tool for resolving key questions of interest during the risk assessment process. Also note, it may be more obvious later whether the necessary data are available for both or either of the individual or two-sample comparison methods and whether either alone could benefit from companion approaches to understand the relationship between site and background. Thus, in summary, we believe a two-sample comparison approach may be needed for some COPCs in some media (i.e., larger datasets), to be determined as the need arises.*

48. **Section 3.4, page 3-10.** Again, the lack of discussion on how 95% UPL, 95/95 UTL, 95% USL selections will made is problematic. The selection process should

be explained.

P4 Response: Please refer to our responses to SC#42, above. Rather than preselect one statistic, P4 proposes to calculate all three of the above statistic for each analyte in each medium, and then consult with the A/Ts on the selection of the appropriate background statistic.

A/T Response: *As stated in SC#42, the practice of calculating all three of these statistics (UPLs, UTLs, and USLs) and then involving the A/Ts on the selection of the appropriate background statistic is reasonable.*

49. **Section 3.4, page 3-9, 2nd paragraph, 2nd sentence.** The text states that the selenium and sulfate concentrations are the most direct indicators of impacts from the Sites. Please clarify this may be the case if sources and transport pathways remain unsaturated. Under saturated or partially saturated conditions, selenium may not be a leading indicator of mine-related impacts to groundwater.

    P4 Response: We do not agree with this revision. In regards to groundwater, the text states that selenium and sulfate concentration are the most direct indicators of impacts from the Sites. This statement is correct in that so far there have not been any other indicators identified at the Sites. At the Sites, we do agree that there may be situations where selenium may not be elevated, but sulfate is, or selenium but not sulfate (the Ballard Shop area excluded). Nonetheless, this is an evaluation and discussion most appropriate for the RI Reports and does not have significant bearing on this Background Memorandum. Because of the debatable uncertainty associated with this topic we propose keep the statement unrevised, but it should be noted that the statement is not definitive and suggests that other indicators are possible.

    A/T Response*: The A/T agrees that in many, if not most cases, selenium and sulfate are the leading indicators of mine-related impacts to groundwater at phosphate mines in southeast Idaho. The intent of the original comment, however, was to point out that under saturated or near saturated conditions, such as a waste pile or backfilled pit that directly interacts with a shallow alluvial aquifer, other analytes may be leading indicators of mine-related impacts to groundwater. This situation has been observed at other phosphate mines in southeast Idaho. We can provide contacts for other projects or citations for reports at other sites, if it becomes necessary to further investigate and understand the use of additional leading indicators. Please revise the text to acknowledge this possibility according to the original Agency comment.*

APPENDIX E4

AUGUST 2, 2012 RTC

Compiled A/T comments on P4 Production, LLC's Response to Agency Comments Document Entitled Site Visit Summary.

A/T comments were transmitted to P4 on July 19, 2012. Responses prepared for P4 Production, Inc. by MWH, dated July 26, 2012.

Background Sample Station Site Visit, June 27, 2012

A/T Summary/Recommendations (dated July 19, 2012),
P4/MWH Responses (dated July 26, 2012),
and A/T Response (August 2, 2012)

On June 27, 2012 P4/Monsanto, MWH, and members of the A/T completed a site visit to the three P4 Mines at Ballard, Henry, and Enoch Valley. The primary purpose of the site visit was to review several background sample locations identified by the A/T as needing further review.

Attendees included: Dave Tomten, USEPA; Mike Rowe, IDEQ; Talia Martin, Shoshone-Bannock Tribes; Bob Blessing, BIA; Sandi Fisher, USFWS; Gary Billman, IDL; Becky Greenwood, IDL; Tim Mosko, CH2MHILL; Randy Vranes, P4; Rachael Roskelley, P4; Emily Yeager, MWH; and Vance Drain, MWH.

Background sample locations visited on June 27, 2012 included, by media:

- Soil and vegetation: background plots at Ballard, Henry, and Enoch Valley Mines
- Surface water: MST048, MST049, MST226, MST254, MST274, and MST275
- Groundwater: MMW007, MMW008, MMW025, MMW026, MMW030, MMW031, MMW032, and MMW033

Following is a summary of observations and findings from the site visit that relate to whether specific sites are representative of background conditions. The discussion below is focused on just those sites where there were outstanding questions regarding representativeness. Also included are recommendations related to inclusion of these sample sites in the background data set.

Surface water background locations MST049 and MST254. These two Little Blackfoot River (LBR) stations may be redundant of one-another. MST254 is located at the mouth of a small reservoir on the LBR. MST049 is also located on the LBR, approximately 3,000 feet downstream of MST254. There does not appear to be any significant drainages that enter the LBR between the two sample locations. Both locations are arguably within the same reach and subdrainage of the LBR. As shown below, there is probably no difference in selenium concentrations between the two stations.

- MST049: n=6. Five samples are nondetect for Se. One sample is 0.00052 mg/L ("J" flagged)
- MST254: n=6. Five samples are nondetect for Se. One sample is 0.00063 mg/L ("J" flagged)

Recommendation: The A/T don't believe that data from both of these sites should be included in the background sample set as they represent the same reach of stream. This is based on our review of the 7.5 min topo map, which shows that there is only one ephemeral drainage between the two stations.

P4 Response: P4/MWH does not strongly disagree with removal of data from one of these stations from the data set. However, they are separated by 3000 feet as you note and likely there is a significant inflow of groundwater between those two sampling locations which influences the concentrations of each analyte. As a result, we believe these are unique sampling locations in the headwaters of the major drainage in the region and removal of one of these locations from the background data set is not necessary.

A/T Response: *The A/T agrees to include both MST049 and MST254 in the background data set.*

Surface water background location MST226. This sample station is located in a headwater tributary to Lone Pine Creek. This sampling station is potentially downstream/downgradient of the north dump and north pit lake at Wooley Valley Mine. The north dump was reportedly placed onto eastwardly dipping Dinwoody Formation at the top of a tributary to Angus Creek adjacent to the divide to Lone Pine Creek. If so, then infiltrate from the Wooley Valley north dump may flow east towards Angus Creek rather than towards MST226 and Lone Pine Creek. The

north pit lake is within the Lone Pine Creek drainage and leakage from the north pit lake potentially discharges to the tributary occupied by MST226. At the time of the visit, P4 agreed that they would review historic topographic information to determine the probable direction of flow of seepage from the Wooley Valley north dump. Additionally, in spring 2012, the USFS collected water samples from several stations within the same Lone Pine Creek tributary upstream of MST226. Two of these stations probably flow towards MST226 within the same channel and may provide insight into the potential representativeness of MST226 as a background location. The USFS data for Wooley Valley may be available later this year. Data for MST226 are summarized as follows:

- MST226: n=1. The sample was nondetect for Se.

Recommendation: The representativeness of MST226 as a natural background location is uncertain and suspect. Even though the one sample result was non-detect for Selenium, we recommend deletion due to the close proximity of mining features. The A/T however may reconsider if P4 chooses to provide more persuasive evidence that the sample station represents natural background. Further evidence may include more thorough evaluation of geology and hydrology of the drainage area immediately upstream from MST226, and additional forthcoming analytical data.

P4 Response: Wooley Valley Mine is located south of the Rasmussen Fault whereas MST226 is located north of the fault. The Rasmussen Fault truncates the Phosphoria Formation so mining was not extended northward beyond the fault. Whether this strike slip fault is a barrier or a conduit either way it likely deflects groundwater flow keeping it from contributing to MST226 baseflow. Also it should be noted that the pre-mine topography directed precipitation falling on the ground surface south of the fault to the southwest, so any water migrating below the waste rock dump is directed down the old drainage surface away from MST226. Refer to Figure 1 which includes the Rasmussen Fault trace and pre-mine topography overlying the geologic map, and depicts the limit of Wooley Valley mine dump in the area. These physical factors, when coupled with the historical MST226 water quality data collected at this location, support its inclusion in the background data set.

A/T Response: *The A/T believes that MST226 is influenced by mine features at the Wooley Valley site. Provisional data collected and to be released by the FS supports the CSM outlined above. I will forward this provisional information separately and we will be available to discuss during our next call*

Surface water background location MST274. This sample station is located in a tributary to Angus Creek. The Agrium haul road passes along side and through this drainage directly upstream of the sample station. This sample station is potentially impacted by the haul road. The general consensus at the time of the site visit appeared to be that the station should not be included in the background dataset. Data for MST274 are summarized as follows:

- MST274: n=8. One sample was nondetect for Se. The rest of the samples ranged from 0.002 mg/L ("J" flagged) to 0.007 mg/L.

Recommendation: This station should be deleted as a background sample location because it is potentially impacted by the haul road up-channel of station.

P4 Response: We concur with this recommendation.

A/T Response: *Agreed.*

Surface water background location MST275. This sample station is located in a headwater tributary to Lone Pine Creek. Several concerns regarding this sample station were identified during the site visit. The sample station consists of a pond in a meadow that appeared to be a man-made feature, likely excavated for the purpose of livestock watering. No streams or channels enter the pond. At the time of the site visit, the level of the pond was about 1-2 feet below ground surface. The pond reportedly overflows upon occasion, probably in the spring during high water table conditions. The pond was not flowing at the time of the site visit. The topography suggests that overflowing water infiltrates back into the ground within a short distance from the pond. No bed and bank features were observed immediately below the outlet. Additionally, no riparian vegetation was noted adjacent to the pond or along the area where overland flow occurs. Past samples from this station include both samples from

the pond and the outlet channel when it has flowed. Given that the feature is really a pond that is probably a surface expression of groundwater, it should not be classified as a stream, thus the MST ("stream location") designation may not be appropriate. Data for MST274 are summarized as follows:

- MST275: n=4. Two samples were nondetect for Se. The rest of the samples ranged from 0.0047 mg/L to 0.008 mg/L.

Recommendation: This station should be deleted as a stream (MST) sample location. A more appropriate classification <u>may</u> be as an alluvial groundwater background sample location.

P4 Response: We feel that evapoconcentration that may occur over the summer is the main concern with the MST275 samples. Water flow in the spring likely is representative of overland flow, where water quality in the fall season may be groundwater, but it also may show the effects of evaporation on the retained surface water. For example, chloride data from the spring 2004 and 2006 sampling events were 5.6 and 1.2 mg/L, respectively. The fall 2004 concentration was 27 mg/L. A similar trend is seen for other conservative major ions (e.g., calcium, magnesium, potassium and sodium). Unfortunately, total dissolved solids analyses were not commonly run. The only detected concentrations of selenium were from fall sampling events.

We feel that it is important to retain some data from this location to help maintain the statistical robustness of the background calculations. We are proposing to exclude the fall surface water data as representative of background stream (MST) conditions, given the uncertainty of its representativeness of surface water flow in the drainage (two events). However, we believe that it is important to retain surface water data from the spring monitoring events where flow through the pond and into the small stream leading from the pond was likely. We also feel that it is appropriate to retain the sediment, soil and riparian vegetation data from this location as representative of background conditions. In addition, we believe that surface water data collected from this location in the fall is representative of background conditions in stock ponds, where evaporation occurs during the summer resulting in higher analyte concentrations in the fall, and should be retained for comparison to concentrations of metals measured in ponds located on the P4 Mine Sites.

A/T Response: *The A/T agrees that this sample location is probably not impacted by mining. However, the A/T does not agree with P4's rationale to retain MST275 as a background steam/riparian location. At best, the site is a background pond/stock pond location or an upland soils/vegetation location. As previously noted, the sample station consists of a pond in a meadow that could be a man-made feature. The pond periodically overflows, but infiltrates back into the ground within a short distance from the pond. No streambed, streambank features, or riparian vegetation is apparent. This indicates the soils, sediment, and vegetation are more likely representative of upland conditions rather than stream/riparian conditions. Additionally, as P4 notes, the pond is subject to substantial evapoconcentration during the summer which suggests that all media from this location be excluded as representative of a stream/riparian environment. The A/T believes that inclusion of the surface water, sediment, and riparian soil and vegetation from this sample location is not appropriate. We believe that this is good data and will have some utility in the RI/FS, but that it should not be grouped with stream data. Use of data from this site for background should be limited at most to media in a pond or upland environment.*

<u>Enoch Valley Mine background soil and vegetation plot</u>. This plot consists of a strip of native soil and vegetation located downslope from mine pit MMP045 and upslope of a former haul road. The mine pit was partially backfilled and reclaimed. The former haul road was also reclaimed. This strip of land is located on Dinwoody Formation, directly downslope of the Phosphoria Formation. A premise raised by P4/Monsanto was that this plot represents natural conditions on the Dinwoody Formation downslope of the Phosphoria Formation. That is, naturally occurring downslope mass movement (e.g., soil creep) or dust migration originating from the Phosphoria Formation would be reflected in data collected at this plot. However, the proximity of the plot to the mining area and haul road raise questions about whether dust generated from mining activities may have been deposited onto the plot. These facts and circumstances raise uncertainty about whether the plot is influenced by mining activity and thus whether it is truly representative of natural background conditions for soil and vegetation. Data for the Enoch Valley Mine soil and vegetation background plot are summarized as follows:

- The selenium mean for background soils was higher at the Enoch Valley Mine than at Ballard and Henry Mines (1.59 compared to 0.37 and 0.79, respectively).

- In composited grasses and forbs, the selenium mean was slightly lower at the Enoch Valley Mine than the Ballard and Henry Mines (0.49 compared to 0.67 and 0.54, respectively).

Recommendation: We recommend that samples from this plot be retained in the background data set, and that the data be further reviewed and an outlier analysis be performed. If outliers are identified, they should be excluded due to the questions and concerns raised above.

P4 Response: We concur with this recommendation. However, it should be noted, as we have discussed previously, colluvial soil creep (i.e., transport of soil fragments by gravity, rainwash, and sheetwash) over the millennia prior to mining likely is responsible for most of the downhill transport of the eroding Phosphoria Formation. Dust transport and actual physical soil movement during mining of the area probably are minor contributors. Dust transport off the mine area, if it were present, would represent only a very thin layer of the soil profile sampled. In addition, the prevailing wind direction more typically is toward the east, which would blow the mine dust in the opposite direction. However, the geologic erosional processes discussed above in all likelihood is the most significant factor in the blending the upslope chemical profiles of the Phosphoria Formation into the downslope area soils which overlie the Dinwoody Formation.

A/T Response: *Agreed. Samples from this plot may be retained in the background data set pending results from an outlier analysis and further review as noted above.*

APPENDIX E5

NOVEMBER 14, 2012 RTC

P4 Responses to A/T comments on Summary Statistics Background Tables, Preliminary COPC and COPEC Tables 1 through 6, and Supplemental Comments on the Background Levels Technical Memorandum.

A/T comments were transmitted to P4 on October 26, 2012

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
IDAHO OPERATIONS OFFICE
1435 N. Orchard St.
Boise, Idaho 83706

October 26, 2012

Rachel Roskelley
Sr. Environmental Engineer
Monsanto Company
Soda Springs Operations
1853 Highway 34
Soda Springs, Idaho 83276

Re: A/T comments on P4 Production, LLC *Summary Statistics Background Tables 4-1 through 4-7 and Preliminary COPC and COPEC Tables 1 through 6* of the *Ballard, Henry, and Enoch Valley Mines Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 0,* prepared for P4 Production by MWH.

Dear Ms Roskelley,

The Agencies and Tribes (A/T) have reviewed the above referenced deliverable. Our comments and direction are enclosed. Please note that in commenting on the tables, questions and comments were generated that will need to be addressed in the technical memorandum. We believe it is appropriate to proceed with assembling the full background levels technical memorandum considering the comments we are now providing, as well as comments provided previously

We will be available to further discuss this matter during our next bi-weekly conference call, or if necessary during a subject-specific meeting. Please contact me if you have questions or concerns. I can be reached at 208-378-5763 or electronically at tomten.dave@epa.gov.

Sincerely,

//s//

Dave Tomten
Remedial Project Manager

Enclosure

Printed on Recycled Paper

cc: Cary Faulk, MWH (electronic version only)
Vance Drain, MWH (electronic version only)
Mike Rowe, IDEQ
Mary Kaufman, FS
Forest Service - Enoch Valley Site Record
Sandi Fisher, US FWS
Mark Jankowski, US FWS
Kelly Wright, Shoshone Bannock Tribes
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Eldine Stevens, BIA (electronic version only)
Bob Blaesing, BIA (electronic version only)
Tim Mosko, CH2MHill (electronic version only)
Charles Allbritton, EPA Records Center (electronic version only)

A/T comments *Summary Statistics Background Tables, Preliminary COPC and COPEC Tables 1 through 6, and Supplemental Comments on the Background Levels Technical Memorandum.*

General Comments

G1: Use of Upper Simultaneous Limits (USLs) as Background Threshold Values (BTVs): USLs have not appeared in guidance yet, but discussion by the authors of the Scout software which calculated the USLs in this report indicate that USLs are appropriate when the data are largely free of outliers, at least partly because the USL is naturally more elevated than the UTL. The lack of discussion of the USLs in guidance is probably largely due to their relative new status in background studies. With more widespread use, limitations and weaknesses of this technique will be better understood and endorsement of this statistic for the A/T may be easier. Thus, the use of USLs on this project will receive line by line review by the A/T along with a stricter stance on outliers. Due to the uncertainties in the use of the USL, it is imperative that P4 is careful to not retain inappropriate outliers. Therefore, to retain the USL as the BTV, P4 must make every effort to provide full documentation of the methods and assumptions used to identify and retain or exclude potential outliers in preparation for review by the A/T.

> **P4 Response:** Agreed. Please note that outliers were removed based on visual observation of the data distribution in Q-Q plots, and the results of appropriate statistical outlier tests. The methods and assumptions that were used to remove outliers for each COPC in each medium will be described in text of Section 4.0, and the Q-Q plots will be included in an appendix to the Technical Memorandum.

G2: It is unclear if the screening tables will be included in Section 4 of the background Technical Memorandum. The screening tables complement the tables containing the summary statistics. Please explain where you plan on organizing and discussing Tables 1 through 6.

> **P4 Response:** The COPC and COPEC screening tables will be included in the Technical Memorandum as Tables 4-1 through 4-6, and described in Section 4.0.

G3: Please explain how, in some instances, the USL of the censored data becomes higher than the uncensored maximum detected concentration? For example, in upland soil (Table 4-1), the manganese 95% USL is 4,595 mg/kg, yet the uncensored maximum detected concentration is 3,990 mg/kg.

> **P4 Response:** The upper simultaneous limit (USL) represents the statistical limit such that all observations from the established background dataset will be less than or equal to the estimated limit. The estimated USL also takes into account the variability associated with future observations. Due to the variability in the

background dataset and the variability in future observations, the estimated USL can be higher than the uncensored maximum detected concentrations.

G4: The Technical Memorandum should be revised to include a discussion of the uncertainties associated with pooling background data over a large area. Also include a discussion of the uncertainties associated with pooling groundwater data across aquifers.

P4 Response: Agreed. Potential uncertainties in pooling background data over large areas and across aquifers will be described in updated text.

G5: Please include a section in the text that describes the strengths and limitations of each statistical limit (i.e., 95% UPL, 95/95 UTL, and 95% USL). For example, discuss which provides a better measure when variability is high.

P4 Response: Agreed. The Technical Memorandum will be updated to include a discussion of the strengths and limitations of the three statistical parameters that were calculated.

G6: In comments provided previously, the A/T commented on development of statistics for pooled and non-pooled data (for example, by proximity to a specific mine or aquifer). The draft tables provided present statistics for pooled data, and for some un-pooled data (e.g., by aquifer). We believe the type of information that has been provided is appropriate for advancing the RI/FS process. We continue to believe, however, that it may be necessary in the future to better understand background conditions for some media or parameters of interest in closer proximity to individual sites. Thus we may require P4 to supplement the background levels technical memorandum in the future if a demonstrated need arises to better understand background levels (in particular media or for specific parameters of interest in close proximity to a mine) to support project decisions. Working through the risk assessment and remedial investigation for the Ballard Mine should illuminate specific additional questions of interest regarding background.

P4 Response: Comment noted.

G7: It appears that for those COPCs with all non-detects values (e.g., antimony for culturally significant upland vegetation) the statistics such as mean concentration and standard deviation were based on the actual detection limit? If so, this “practice” needs to be justified.

P4 Response: The ProUCL Technical Guide (USEPA, 2010) strongly recommends against using one-half the detection limit to compute summary statistics. To be consistent with this guidance, the full detection limits were used to calculate summary statistics for non-detected results.

Specific Comments

S1: **Tables 1 through 6.** The footnote discussing bioaccumulative compounds should not be limited to mercury and needs to be expanded to include all COPCs considered bioaccumlative. The following USEPA document provides some guidance for which metals should be considered bioaccumulative:

> *Bioaccumulative Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs*, EPA-823-R-00-001, February 2000.

Table 4-2 provides the list of chemicals that EPA Region 3 considers to be important bioaccumulative compounds.

> **P4 Response:** As noted in P4's response to A/T comment AC#26 on the Draft RI/FS Work Plan, metals that are considered by the USEPA to be persistent, bioaccumulative and toxic (PBT) will be carried into the quantitative risk assessment regardless of whether measured concentrations are lower than screening levels and background concentrations. Of the PBT metals, only mercury was detected at the P4 Mine Sites. Therefore, only mercury will be carried into the quantitative risk assessment when concentrations of this metal are below screening levels and background concentrations.

S2: **Table 5** (and related future sediment screening). Sediment screening levels provided in Table 5 are consistent with those presented in Appendix C of the RI Work Plan, however the source of most, *Sediment Evaluation Framework for the Pacific Northwest* (May 2009) which uses now outdated Sediment Management Standards from the Washington Department of Ecology, has been superseded by subsequent work. Most notably, the following work has been used to update Washington Department of Ecology's sediment cleanup levels:

> *Development of Benthic SQVs for Freshwater Sediments in Washington, Oregon, and Idaho. Prepared by* Teresa Michelsen, Ph.D of Avocet Consulting for the Washington Department of Ecology.

Considering this, sediment screening benchmarks need to match those recommended by USEPA at: http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fwsed/screenbench.htm

It may be appropriate to include other literature or benchmarks as lines of evidence in subsequent phases of the risk assessment, however use the USEPA screening benchmarks for future sediment screening.

> **P4 Response:** Agreed. Table 5 will be revised to include USEPA Region 3 BTAG freshwater sediment screening benchmarks as the primary source of sediment screening benchmarks. The USEPA Region 3 sediment screening benchmarks will be supplemented with other sources listed in the footnotes to Table 5, as necessary.

S3: **Tables 4-1, 4-3, 4-4, and 4-6. :** It appears that Maximum and Minimum values need to be inserted for columns "Detection Limit for Non-detects" for both Uncensored and Censored data (columns 9 and 10, 18 and 19). Furthermore, on Table 4-6, the minimum detection limit for selenium appears to be larger than the maximum detection limit for both censored and uncensored data. Please revise.

> **P4 Response:** The maximum and minimum detection limits for non-detect results are only applicable when a medium has one or more chemicals with non-detect results. This is because the maximum detection limit is proposed as the background threshold value (BTV) for a chemical with no detections rather than a calculated statistic. Media for which one or more chemicals were associated with all non-detect results were upland vegetation (Table 4-2), surface water (Table 4-5), sediment (Table 4-6) and groundwater (Table 4-7). Thus, columns presenting maximum and minimum detection limits were included in these tables. The quality of the background data, including the adequacy of detection limits for all COPCs in all media, is described in Section 2. Please also note that the maximum detection limit is greater than the minimum detection limit for selenium in Table 4-6. However, the column headings for these columns were inadvertently cut off and did not include the words 'Maximum' and 'Minimum'. This will be corrected in an update to Table 4-6.

S4: **Summary Statistics for Background Metals, Tables 4-1 – 4-7, distributional assumption**. In the BTV summary tables, there are often conflicts between the distributional assumptions for the 95% UCL of the mean and the UPL/UTL. For instance the first table page of Table 4-1 includes Kaplan-Meier/Gamma assumptions for boron, Normal/Lognormal assumptions for Mercury, and Gamma/Lognormal for Selenium. The technical memorandum (in which the tables will be included) should include a discussion of how these assumptions were made for these statistical limits. Please explain how the distributional assumptions were determined.

> **P4 Response:** In cases where the distribution of a dataset is not definitive, the ProUCL output file will identify that the distribution appears to fit more than one distribution (e.g., lognormal *and* gamma distributions). However, the ProUCL output file will often recommend the use of an upper confidence limit (UCL) on the mean concentration that is based on *one* of the distributions. The distribution of the recommended UCL on the mean concentration may or may not be the same as the distribution of the appropriate upper prediction limit (UPL) or upper tolerance limit (UTL) that is calculated by ProUCL. This is a function of the multiple outputs provided by ProUCL, and is not attributable to errors in the background summary statistics tables.

S5: **Summary Statistics for Background Metals, Tables 4-1 – 4-7, outliers**. If outliers were removed (for example, one selenium sample was removed from the censored data in upland soil but apparently the rest of the constituents were utilized for their data sets),

please explain why all constituents were not considered an outlier and the sample removed entirely from the data set. In Section 3.3, Selected Statistical Methods for the P4 Background Level Evaluation, you used a "weight of evidence" evaluation to determine outliers. It is unclear how a sample is considered an outlier for one constituent and not another.

The P4 Draft Technical Memorandum references USEPA (2006) which specifies that an outlier should never be removed from a dataset based solely on a statistical test, and that the decision to discard an outlier should be based on a scientific or quality assurance basis. As an example, it appears that the upland soil selenium sample with the highest concentration was removed as an outlier. Please explain the rationale you used to determine an outlier and provide this information for all outliers removed for all media.

> **P4 Response:** Samples based on individual sample locations were removed from the background datasets after the A/Ts expressed concerns about the locations, and a field visit was conducted on June 27, 2012 to confirm that the sample locations may have been impacted by the P4 Sites. The remaining background sample locations were assumed to represent background conditions, and samples collected from these locations were included in the statistical evaluation and outlier analysis.
>
> The fact that an outlier is identified for one constituent doesn't necessarily mean that the sample location was impacted by the P4 Sites. There could be a variety of reasons why an individual analytical result is anomalous for one constituent. For example inadvertent collection of a rock chip in a sample that is naturally high in one mineral or analytical error related to the method for analyzing one constituent. However, an anomalous result for one constituent doesn't mean that the entire sample is anomalous. The remaining constituents in that sample could be representative of their respective background populations.
>
> Please also note that the "weight of evidence" evaluation for identifying outliers included data validation and quality assurance/quality control (QA/QC) procedures, screening of method detection limits (MDLs) to risk-based screening levels (Section 2.0), visual observation of background distributions using (Q-Q plots), and statistical outlier tests. If sample results for an individual constituent were deemed to be representative of the background population based on these procedures, it was retained in the background data set for that constituent. To do otherwise, would unnecessarily reduce the robustness of the background data sets.
>
> Text in Section 3.0 will be revised to include the above explanation.

S7: **Summary Statistics for Background Metals in Upland Vegetation, Table 4-2.** It is discussed in the draft Background Technical Memorandum (section 2.2.2) that upland vegetation consists predominantly of sagebrush and/or aspen for all three sites. In the combined data for the different plant types, it is not clear as to which plants were sampled, as both sagebrush and aspen are both culturally significant. The specific plant

types are in the RI/FS data (P4 RIFS Background Data (Upland-Veg).xls); however where the information came from is unclear. The absent information is how a plant is categorized as culturally significant or not. Please add a footnote that references where this information can be found or what type of plant type the combined data refers to.

> **P4 Response:** Agreed. A footnote will be added to Table 4-2 to specify which plant species are included in the culturally significant and combined background data sets.

S8: **Summary Statistics for Background Metals in Upland Vegetation, Table 4-2 and Summary Statistics for Background Metals in Riparian Vegetation, Table 4-4.** The inconsistency between these tables is apparent not only because the fewer metals that are detected, but also the riparian vegetation did not have combined plant types that were defined. It is understandable that these are two different mediums and the riparian vegetation had only high concentrations of three metals compared to their screening levels. The concern is that the plant types are significant to the riparian and the upland vegetation data sets. Please clarify if the riparian plant types are unknown and will this be discussed in the in the Background Technical Memorandum.

> **P4 Response:** As noted in the RI/FS Work Plan, riparian vegetation in the background areas is similar in composition to riparian vegetation communities on the P4 Mine Sites, with willow, cattail, rush and sedge species often present. The background technical memorandum will be revised to refer the reader to the RI/FS Work Plan, where additional information regarding the types of riparian vegetation communities present at the P4 Mine Sites can be found. Riparian vegetation was only sampled in 2004, which predated the A/T's request to collect and catalogue culturally-significant plants. As a result, the specific plant species corresponding to riparian vegetation samples are unknown.

S9: **Summary Statistics for Background Metals in Riparian Soil, Table 4-3 and Summary Statistics for Background Metals in Riparian Vegetation, Table 4-4.** When comparing the co-located riparian vegetation and riparian soil samples, it appears that fewer samples were in the data set for vegetation than for soil; the riparian soil utilized 17 samples for both uncensored and censored data, yet the riparian vegetation samples only used 9 samples. Please explain why there are different sample sizes for the two co-located sample sets.

> **P4 Response:** As summarized in Section 2.2.1 of the background technical memorandum, sediment samples from background stations were collected in 2004 and 2010, while riparian vegetation samples from background stations were only collected during the 2004 sampling event. As a result, fewer background sample results are available for riparian vegetation than are available for riparian soil.

S10: **Summary Statistics for Background Metals in Upland Soil, Table 4-7.** This table appears to have several errors as noted below. Please explain or revise the table accordingly.

1) The summary columns for censored data often do not add up. Using arsenic as an example, some of the bolded numbers in the table below must be in error:

	Uncensored		Censored	
	No. of Samples	No. of Detections	No. of Samples	No. of Detections
Shallow	4	2	**4**	**2**
Intermediate	3	2	**3**	**2**
Deep	3	3	**3**	**3**
Combined	10	7	**8**	**5**

This same situation occurs in several locations, e.g., cadmium, lead, zinc, etc.

2) - The maximum value for the combined aquifers does not always equal the maximum value for the combined dataset. For example, the uncensored combined manganese maximum concentration is shown as 0.915 mg/L, whereas, the maximum concentration shown for the individual aquifers is 0.61 mg/L (shallow). Other examples include cadmium and zinc. Note that similar situations occur for uncensored minimum (chromium) and censored maximum (vanadium).

P4 Response: 1) Please note that the numbers presented in Table 4-7 for arsenic are accurate. The statistical analyses were conducted separately for individual aquifers and the combined dataset. Statistical outliers were only identified in the combined dataset but not for the individual aquifers. 2) The maximum value for the combined aquifer might be different from the maximum value presented for individual aquifers because some groundwater wells were not classified into individual aquifers but were included in the combined dataset.

S11: **Section 3.2, p 3-3, 2nd paragraph of tech memo.** As mentioned in previous reports, the following discussion in Section 3-2 is not the approach recommended in USEPA background guidance documents. Monsanto states:

> "According to USEPA (2006), an outlier should never be removed from a dataset based solely on a statistical test. Instead, the decision to discard an outlier should be based on a scientific or quality assurance basis. Removing an outlier from a dataset should be done with extreme caution, particularly for environmental datasets, which often contain legitimate extreme values. If scientific reasoning does not explain the outlier, it should not be removed from the dataset."

We support a "weight of evidence" discussion on the outliers to help determine whether to retain or exclude such elevated values in the background data set. We do not support the statement that outliers can only be removed from the data set when scientific reasoning does not explain the outlier. This text is inappropriate for this report. The second mention of the USEPA (2006) guidance in Section 3-3 (page 3-8) is appropriate. This passage acknowledges a weight-of-evidence approach, listing two potential issues

from the many that could be considered. Following are several pertinent references on this issue. Please revise accordingly.

> United States Environmental Protection Agency (USEPA). *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*, Office of Emergency and Remedial Response, 2002.
>
> United States Environmental Protection Agency (USEPA), *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities—Unified Guidance,* Office of Resource Conservation and Recovery, March, 2009.

United States Environmental Protection Agency (USEPA), *ProUCL Version 4.1 Technical Guide (Draft),* Office of Research and Development, May, 2010.

> **P4 Response:** Please note that Q-Q plots were initially used to identify visual outliers as a first step in the outlier evaluation process. Visual outliers were then tested with appropriate statistical outlier tests to determine whether the visual outliers are statistical outliers. All statistical outliers identified were removed from the 'uncensored' dataset to obtain the 'censored' dataset. The excerpt stating, "If scientific reasoning does not explain the outlier, it should not be removed from the dataset" is included to support this process and to ensure that the reader understands that it is inappropriate to blindly run statistical outlier tests and remove all values solely based on the statistical outlier test when the values appear to be from the same distribution via visual inspection.

S12: **Section 3.2, p 3-4 of tech memo.** Regarding stratified random sampling, P4 states:

> "These comparative statistical tests are only necessary when the sampling design does not account for the differences between strata. A sampling design that accounts for differences between strata and produces one dataset that is inclusive of the whole populations is referred to as 'stratified random' sampling (USEPA, 2002b; USEPA, 2002c). In stratified random sampling, the whole population is divided into different strata, and simple random sampling is used within each stratum after the sample size is determined (USEPA, 2002b; USEPA, 2002c). Datasets collected using stratified random sampling are representative of the entire sampled population, and account for differences between strata (USEPA, 2002b; USEPA, 2002c), unlike datasets collected using simple random sampling."

A stratified random sampling design does not prevent a calculated background threshold value from being biased high by the background strata(s) with the highest concentrations. Therefore, P4 should not allude to a conclusion that the use of this design alleviates meaningful differences between strata. To make that claim would be to say that there is never a need to partition background into various strata and stratified random sampling is always appropriate. The A/T recognizes that background data are limited for some media, thus requiring that potentially diverse sub-populations be pooled together in some cases.

Please revise the text to not infer that a stratified random sampling design alleviates such concerns.

> **P4 Response:** Agreed. Text in Section 3.2 of the background technical memorandum will be revised to exclude the following statement, "These comparative statistical tests are only necessary when the sampling design does not account for the differences between strata."

S13: **Section 3.4, p 3-9 of tech memo.** The occurrence of seasonal or secular trends was also considered and corrected as appropriate. However, no explanation is provided on how seasonal or secular trends were executed. Please provide this information.

> **P4 Response:** The occurrence of season and secular trends was evaluated prior to the statistical evaluation of background groundwater concentrations. This evaluation was performed through qualitative (visual) analysis of concentration trend graphs for primary groundwater constituents. Due to the number of sampling events for many of the background wells at the P4 Sites (between two and four annual sampling events and occasionally a semi-annual event), either no conclusion on trends could be made (e.g., only two sample points) or no trend was visually apparent (three to five sampling events). This applies to some of the on-site wells but primarily the agricultural and domestic wells that make up a large portion of the background data set but were not regularly sampled because of access difficulties. Section 3.4 of the technical memorandum will be revised to state: "The occurrence of seasonal and secular trends was also considered through qualitative evaluation of concentration trend graphs, and no corrections of the data were necessary prior to the statistical analysis of the background groundwater concentrations.

APPENDIX E6

DECEMBER 11, 2012 RTC

A/T comments on select P4 Responses to A/T comments on Summary Statistics Background Tables, Preliminary COPC and COPEC Tables 1 through 6, and Supplemental Comments on the Background Levels Technical Memorandum. Responses prepared for P4 Production, Inc. by MWH, dated November 14, 2012.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
IDAHO OPERATIONS OFFICE
1435 N. Orchard St.
Boise, Idaho 83706

December 11, 2012

Rachel Roskelley
Sr. Environmental Engineer
Monsanto Company
Soda Springs Operations
1853 Highway 34
Soda Springs, Idaho 83276

Re: A/T Response to P4's October 26, 2012 Response to Comments on *Summary Statistics Background Tables 4-1 through 4-7 and Preliminary COPC and COPEC Tables 1 through 6*.

Dear Ms Roskelley,

The Agencies and Tribes (A/T) have reviewed the above referenced interim deliverable. Our comments, including a summary of our understanding of discussions at our previous bi-weekly meeting, are enclosed. We believe these additional comments may be addressed in the forthcoming background levels technical memorandum.

We will be available to further discuss this and related matters during our next bi-weekly conference call, or if necessary during a subject-specific meeting. Please contact me if you have questions or concerns. I can be reached at 208-378-5763 or electronically at tomten.dave@epa.gov.

Sincerely,

//s//

Dave Tomten
Remedial Project Manager

Enclosure

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Vance Drain, MWH (electronic version only)
Mike Rowe, IDEQ
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Susan Hanson (for the tribes)
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Colleen O'Hara, BLM (electronic version only)
Eldine Stevens, BIA (electronic version only)
Bob Blaesing, BIA (electronic version only)
Tim Mosko, CH2MHill (electronic version only)
Charles Allbritton, EPA Records Center (electronic version only)

A/T Response to P4's October 26, 2012 Response to Comments on *Summary Statistics Background Tables 4-1 through 4-7 and Preliminary COPC and COPEC Tables 1 through 6*

Specific Comment S1:
A/T Comment. **Tables 1 through 6.** The footnote discussing bioaccumulative compounds should not be limited to mercury and needs to be expanded to include all COPCs considered bioaccumlative. The following USEPA document provides some guidance for which metals should be considered bioaccumulative:

> *Bioaccumulative Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs*, EPA-823-R-00-001, February 2000.

Table 4-2 provides the list of chemicals that EPA Region 3 considers to be important bioaccumulative compounds.

P4 Response: As noted in P4"s response to A/T comment AC#26 on the Draft RI/FS Work Plan, metals that are considered by the USEPA to be persistent, bioaccumulative and toxic (PBT) will be carried into the quantitative risk assessment regardless of whether measured concentrations are lower than screening levels and background concentrations. Of the PBT metals, only mercury was detected at the P4 Mine Sites. Therefore, only mercury will be carried into the quantitative risk assessment when concentrations of this metal are below screening levels and background concentrations.

A/T Response: During the December 3, 2012 A/T-P4 Production conference call, the A/T disagreed with the response to Specific Comment #1 (S1) as mercury is not the only potentially bioaccumulative COPC detected at the P4 mines. Therefore, it was agreed that footnote d on Tables 1 and 2 (and any other relevant references) would be removed. Instead, it was agreed, that following the risk screening process, prior to eliminating a COPC from further evaluation a consideration will be made of whether the COPC is potentially bioaccumulative. COPCs identified as potentially bioaccumulative by EPA at www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fwsed/screenbench.htm will be considered as a starting point for this determination; however, the risk screening results along with site-specific biotic and abiotic data may also be used to support decisions on refining the list of COPCs carried forward into subsequent tiers of the risk assessments.

Specific Comment S4:
A/T Comment. **Summary Statistics for Background Metals, Tables 4-1 – 4-7, distributional assumption**. In the BTV summary tables, there are often conflicts between the distributional assumptions for the 95% UCL of the mean and the UPL/UTL. For instance the first page of Table 4-1 includes Kaplan-Meier/Gamma assumptions for boron, Normal/Lognormal assumptions for Mercury, and Gamma/Lognormal for Selenium. The technical memorandum (in which the tables will be included) should include a discussion of how these assumptions were made for these statistical limits. Please explain how the distributional assumptions were determined.

P4 Response: In cases where the distribution of a dataset is not definitive, the ProUCL output file will identify that the distribution appears to fit more than one distribution (e.g., lognormal *and* gamma distributions). However, the ProUCL output file will often recommend the use of an upper confidence limit (UCL) on the mean concentration that is based on *one* of the distributions. The distribution of the recommended UCL on the mean concentration may or may not be the same as the distribution of the appropriate upper prediction limit (UPL) or upper tolerance limit (UTL) that is calculated by ProUCL. This is a function of the multiple outputs provided by ProUCL, and is not attributable to errors in the background summary statistics tables.

A/T Response: We acknowledge that ProUCL for BTV calculations output sometimes states that data for some constituents appear to follow more than one distribution, but that same ProUCL output also offers an overall conclusion under "Data Distribution Test" provided the best distributional recommendation for those data. For instance, for chromium the individual tests for both gamma and lognormal distributions suggest the data follows those separate distributions, but the overall conclusion is that the data follows the gamma distribution and that should be the distributional choice.

As noted in the previous response to this comment, the ProUCL output file for UCLs of the mean offers a recommended UCL basis. Although the ProUCL output file for BTVs does not offer a recommended BTV, the recommendations in that file should be followed, including the distributional choice. As for the Kaplan-Meier approaches, they appear to follow the recommendations in the ProUCL Technical Guide since the frequency of detection (FOD) is so high, but if the FOD were lower the Kaplan Meier approach would be preferable over parametric choices.

<u>Specific Comment S11</u>:
A/T Comment. Section 3.2, p 3-3, 2nd paragraph of tech memo. As mentioned in previous reports, the following discussion in Section 3-2 is not the approach recommended in USEPA background guidance documents. Monsanto states:

> "According to USEPA (2006), an outlier should never be removed from a dataset based solely on a statistical test. Instead, the decision to discard an outlier should be based on a scientific or quality assurance basis. Removing an outlier from a dataset should be done with extreme caution, particularly for environmental datasets, which often contain legitimate extreme values. If scientific reasoning does not explain the outlier, it should not be removed from the dataset."

We support a "weight of evidence" discussion on the outliers to help determine whether to retain or exclude such elevated values in the background data set. We do not support the statement that outliers can only be removed from the data set when scientific reasoning does not explain the outlier. This text is inappropriate for this report. The second mention of the USEPA (2006) guidance in Section 3-3 (page 3-8) is appropriate. This passage acknowledges a weight-of-evidence approach, listing two potential issues from the many that could be considered. Following are several pertinent references on this issue. Please revise accordingly.

United States Environmental Protection Agency (USEPA). *Guidance for*

Comparing Background and Chemical Concentrations in Soil for CERCLA Sites, Office of Emergency and Remedial Response, 2002.

United States Environmental Protection Agency (USEPA), *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities—Unified Guidance,* Office of Resource Conservation and Recovery, March, 2009.

United States Environmental Protection Agency (USEPA), *ProUCL Version 4.1 Technical Guide (Draft),* Office of Research and Development, May, 2010.

P4 Response: Please note that Q-Q plots were initially used to identify visual outliers as a first step in the outlier evaluation process. Visual outliers were then tested with appropriate statistical outlier tests to determine whether the visual outliers are statistical outliers. All statistical outliers identified were removed from the „uncensored‟ dataset to obtain the „censored‟ dataset. The excerpt stating, "If scientific reasoning does not explain the outlier, it should not be removed from the dataset" is included to support this process and to ensure that the reader understands that it is inappropriate to blindly run statistical outlier tests and remove all values solely based on the statistical outlier test when the values appear to be from the same distribution via visual inspection

A/T Response: The A/T looks forward to reviewing output for the entire outlier evaluation process, including the Q-Q plots which formed the first (visual) evaluation step. The phrase "If scientific reasoning does not explain the outlier, it should not be removed from the dataset" might be suitable depending on what is understood by the term "scientific reasoning". Having preceded this phrase with the text "According to USEPA (2006), an outlier should never be removed from a dataset based solely on a statistical test. Instead, the decision to discard an outlier should be based on a scientific or quality assurance basis. Removing an outlier from a dataset should be done with extreme caution, particularly for environmental datasets, which often contain legitimate extreme values" gives the appearance that that the report is bestowing the same perspective intended for investigative data to background data. USEPA guidance has been clear that elevated background values be treated with a more conservative approach. USEPA supports a weight of evidence approach that can potentially include graphical and mathematical approaches as well as potential input from site or subject matter experts. USEPA will review the outlier evaluation for this background study when that evaluation is presented in full.

Thus, the current evaluation is neither deemed appropriate nor deficient. The inclusion of text that attempts to apply USEPA policy toward investigative data toward background, however, should not be included in the report.

<u>Specific Comment S12</u>:
A/T Comment. Section 3.2, p 3-4 of tech memo. Regarding stratified random sampling, P4 states:

> "These comparative statistical tests are only necessary when the sampling design does not account for the differences between strata. A sampling design that accounts for differences between strata and produces one dataset that is inclusive of the whole population is referred to as „stratified random" sampling (USEPA, 2002b; USEPA, 2002c). In stratified random sampling, the whole population is divided into different strata, and simple random sampling is used within each stratum after the sample size is determined (USEPA, 2002b; USEPA, 2002c). Datasets collected using stratified random sampling are representative of the entire sampled population, and account for differences between strata (USEPA, 2002b; USEPA, 2002c), unlike datasets collected using simple random sampling."

A stratified random sampling design does not prevent a calculated background threshold value from being biased high by the background strata(s) with the highest concentrations. Therefore, P4 should not allude to a conclusion that the use of this design alleviates meaningful differences between strata. To make that claim would be to say that there is never a need to partition background into various strata and stratified random sampling is always appropriate. The A/T recognizes that background data are limited for some media, thus requiring that potentially diverse sub-populations be pooled together in these cases. Please revise the text to not infer that a stratified random sampling design alleviates such concerns.

P4 Response: Agreed. Text in Section 3.2 of the background technical memorandum will be revised to exclude the following statement, "These comparative statistical tests are only necessary when the sampling design does not account for the differences between strata."

A/T Response We agree with deleting the sentence "These comparative statistical tests are only necessary when the sampling design does not account for the differences between strata" because this sentence could be interpreted to mean that not pursuing differences between strata is always appropriate when using a stratified random sampling design. That is, projects cannot avoid considering the potential partitioning of background by strata simply by using a stratified random sampling design.

The basis for using a single background population (as opposed to partitioning by strata) was not made on a statistical basis, but rather has been made based on the acknowledgment that background data for some media are too limited to support a more diverse background evaluation. The report should acknowledge that the A/T is allowing the use of a single background population for some media largely due to a lack of options (due to the scarcity of available background locations). The text should be revised to say that resources were simply too scarce to pursue a multi-strata approach for some media. Nothing has been shown statistically that would indicate that potential differences in strata are not meaningful.

APPENDIX E7

FEBRUARY 15, 2013 RTC

P4 Responses to A/T comments on Ballard, Henry, and Enoch Valley Mines (the Sites) Remedial Investigation and Feasibility Background Levels Development Technical Memorandum Draft Revision 1 submitted on December 21, 2012

A/T comments were transmitted to P4 on January 23, 2013

P4's Responses to Compiled A/T comments, dated January 23, 2013 on the *Background Levels Development Technical Memorandum for the Ballard, Henry, and Enoch Valley Mines Remedial Investigation and Feasibility Study - Draft Revision 1* Prepared for P4 Production by MWH, dated December 2012.

General Comments

1. The upper simultaneous limits (USLs) coming from the Scout Software (2008) are being used in this monitoring effort in an introductory fashion. A discussion of recommendations or cautionary advice such as exists for other potential background threshold value (BTV) statistics (e.g. upper prediction limits, upper tolerance limits) does not yet exist in USEPA technical papers or guidance. If the recommendations of a regulatory agency come forth with markedly different approaches than are used in this monitoring effort, the calculated BTVs may be reevaluated for consistency with stated regulatory opinion, and to evaluate whether revised approaches may affect important project conclusions or decisions. This is not a question of shifting regulatory opinion or standards over time, but rather the lack of discussion currently available in regulatory literature on USLs.

   P4 Response: *Comment noted.*

2. Upon inspection of the results presented in Appendix C, it is apparent that several datasets followed more than one distribution examined. For example, the data in file "Sed values.wst" are Normal, Gamma, and Lognormal. This same output file appears to indicate that the Normal distribution was selected, but it is not clear. Thus, it would be helpful to state which statistical distribution was selected for the construction of each QQ (quantile-quantile) plot shown in Appendix D. The selected distribution could be given on the same page as the plot.

   P4 Response: The *Q-Q plots were only used as a preliminary, exploratory data analysis tool to visually identify potential outliers in the metals data sets. The graphing tool within ProUCL prepares Q-Q plots assuming a normal distribution, and all Q-Q plots included in Appendix D are normal Q-Q plots. Please note that the outlier test in ProUCL is also parametric and assumes normality. The Q-Q plots were prepared, and statistical outliers were removed, prior to determining the distribution of the 'censored' data sets. This is because the presence of outliers will often 'mask' the true data distribution and make the distribution test not meaningful. Text in Section ~~4.0~~3.3 of the Background Memorandum will be revised to clarify how the Q-Q plots were generally used in the statistical evaluation of background, and text in Section 4.3 and Sections 4.6 through 4.8 will be revised to describe ~~what~~the medium-specific Q-Q plots that are presented in Appendix D.*

3. The FS/BLM have provided multiple comments on multiple previous documents stating that although the three P4 CERCLA mine sites were administered

collectively, the objective of the RI for each of the Sites (as defined in the 2009 ASAOC) is to determine the nature and extent of contamination and to assess risk to human health and the environment. P4 is to provide an RI Report for each Site individually and an FS for each Site individually. Some media, such as groundwater, may warrant a wider spatial distribution of background locations. Other media, such as surface water, due to the individual drainages unique to each mine, may warrant a more limited spatial site-specific background dataset.

P4 Response: *The A/T provided a similar comment (General Comment No. 7) in their January 23, 2012 comments on Section 1-3 of the Background Memorandum as shown below.*

A/T General Comment No. 7 January 23, 2012

The FS/BLM does not agree that data for all three mine sites should be combined into a single data set for statistical evaluation and derivation of background levels. While it may have been convenient to administer the three sites collectively for the investigation phase, according to the 2009 ASAOC Statement of Work, individual RI reports and baseline risk assessments will be prepared and submitted separately for each of the three mines thereby indicating each site is to be evaluated separately.

P4 Response General Comment No. 7 February 17, 2012
There are several reasons to "pool" or combine the background data from the Sites. First and foremost, the geology of each of the Sites is derived from the same sequence of sedimentary rock formations (from oldest to youngest) which is the Pennsylvanian Wells Formation, the Permian Phosphoria Formation, and the early Triassic Dinwoody Formation. These three primary geologic formations are present at each of the mines. As described in the Supplemental Mine Waste Rock Dump and Facility Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009), the primary decision criterion that was used during the selection of A/T-approved background sampling locations was undisturbed areas away from mining activities, but still within the mined area footprint.

Based on these criterion, upland soils and vegetation samples were collected from undisturbed areas overlying the Dinwoody Formation at the Henry and Enoch Valley mines' background (reference) areas, and from over the Wells Formation at the Ballard Mine reference area. Because the collection of background samples was limited to undisturbed areas overlying a discreet formation, none of the mine-specific reference areas reflect the heterogeneous geology that exists at each of the Sites. Consequently, the only way to attempt to capture the heterogeneous geology at the P4 Sites is to combine the background data collected from discreet formations. However, even when background data collected from the three Site reference areas are combined,

these datasets only represent the Wells and Dinwoody Formations; the Phosphoria Formation is conspicuously absent.

Second, natural variation is anticipated within a given geologic formation, such that there may be multiple populations within the geologic formation. As stated above, upland soil and vegetation background data were collected from media over the Dinwoody Formation at the Henry and Enoch Valley mines. When geologic maps are combined with the distribution plots depicting, for example, the distribution of selenium (Se) concentrations detected in the background soils samples, what immediately becomes apparent is that the lower Se concentrations are found in soil samples collected from the Wells Formation at the Ballard Mine. The Enoch Valley and Henry mines have higher concentrations of Se, but they are collected from soils overlying the Dinwoody Formation. It is likely that the concentrations which are represented in the graphs of Se, arsenic (As), and manganese (Mn) represent the natural variation in the concentration of these metals in these two geologic formations. In each case, concentrations of these metals are lower in the Wells Formation when compared to the Dinwoody Formation.

Third, the Phosphoria Formation, which historically contains elevated concentrations of selenium and other metals (Herring, J.R. and Grauch, R.I., 2004), is absent from the background sampling locations that were sampled during the background sampling investigations. As stated above, in the case of upland soil and vegetation media, samples were only collected from the Dinwoody and Wells Formations. As a result, the background datasets for upland soil and vegetation are not necessarily representative of pre-mining geological conditions inside the pit boundaries at individual mines. Therefore, if these data from the Wells and Dinwoody Formations are not pooled or combined then the representativeness of background levels for individual mines or the Sites as a whole will be sacrificed and the power of the statistics will be lost because the low sample number might make some of the statistical calculations meaningless or in the worst case invalid.

It should be noted that the background data were collected during the EE/CA and RI with the intent that they would be combined for development of background levels. As noted in previous comment responses and discussions with the A/T, the Sites are located in the headwaters of several surface water drainages such that there are limited upstream locations from which un-impacted background surface water, sediment, riparian soil and riparian vegetation samples could be collected. As a result, it was not possible to collect statistically meaningful numbers of background samples for these media at individual mine sites.

Individual RI Reports and risk assessments for each of the three Sites can and will be prepared where the data collected from the analyses of various media at a particular mine is compared, not only to the combined P4 background levels that are developed in this document, but to standard risk-based

benchmarks developed by the EPA and others. Again, the risk assessment process will inform future decisions as to areas at each of the Sites that may warrant further examination in the FS for remedial action. The background levels developed herein are just one component in the evaluation process of human and ecological risks posed by each of the Sites.

In the A/Ts' March 29, 2012 comments on P4's February 27, 2012 responses, the A/T did does not disagree with pooling data by media. However, the A/T proposed preparing statistical summaries for select non-pooled datasets in order to better understand the differences in summary statistics (for specific datasets) when looking in closer proximity to a site and looking at a larger area. The A/T also stated in their responses that the A/T recognized that the significance of the statistics produced for some of the non-pooled datasets may be unreliable given the small number of samples for some datasets. In addition to requesting site-specific background datasets for all the media, the A/T specific asked for summary statistics for each aquifer.

In response to the A/Ts comment, P4 prepared pooled and hydrostratigraphic unit (HSU) datasets for groundwater as discussed in Section 3.4, 4.8 and Table 4-14 of the Background Memorandum. However, for surface water, riparian soil, vegetation, and sediment, there are too few samples to statistically evaluate the background datasets on a mine-specific basis and P4 maintains that there is a geologic basis for pooling the data among the three Site. As a result, no further revisions to Background Memorandum are proposed.

4. There is substantial discussion of how the method detection limits (MDLs) relate to each of the element-specific risk-based screening level. However, it was the understanding of this reviewer that the reporting limits (RLs) are the more appropriate data quality measurement for comparison to the element-specific risk-based screening level since analytical values between the MDL and the RL are estimated values with a higher associated error than values above the RL. Therefore the comparison of media COPC concentrations to screening levels presented here should be revised to include a discussion and evaluation of reporting limits to each element-specific risk-based screening values.

P4 Response: *We agree that method reporting limits (MRLs) are typically compared to medium-specific risk-based screening levels during site characterization planning, such as during laboratory selection or the preparation of a sampling and analysis plan (SAP), to ensure that the analytical results will be sufficiently low. Please note that the comparison of method detection limits (MDLs) to medium-specific risk-based screening levels described in Section 2.2.1 were for a different purpose. For the statistical evaluation of background, non-detect background sampling results are entered into ProUCL as the MDL. When MDLs for non-detect results are higher than medium-specific risk-based screening levels, this indicates that the MDLs may be biased high due to matrix interference effects or the use of an insensitive analytical method. During*

development of Sites sampling programs, comparison of the MDLs and RLs were often provided in the field sampling plan or quality assurance plan and Tables 2-4 and 2-9 of the Background Memorandum flag samples where the MDLs exceeded the risk-based screening levels. In such cases, these data were further evaluated during preparation of the Background Memorandum summary statistics.

5. It is unclear from the discussion presented in Section 2.2.3, Section 4.8, and Drawing 2-5 whether P4 is proposing to pool all the groundwater data across hydrostratigraphic units or to use the combined dataset across hydrostratigraphic units. The FS/BLM have commented the pooled dataset approach for groundwater previously and do not believe this is appropriate especially given the hydrogeologic conceptual model that the Wells Fm is not in communication with the hydrostratigraphic units above due to separation by the supposed aquitard of the Phosphoria Formation. Recommend revising accordingly.

   P4 Response: *As stated in P4's response to General Comment No. 3 above, P4 addressed previous A/Ts comments on the groundwater background dataset by developing summary statistics for pooled data as well as for individual aquifers or hydrostratigraphic units (HSUs). This is clearly stated in Section 3.4 as reiterated below.*

   "The use of a pooled dataset across the different aquifers as well as data separated out by the different geologic units (shallow, intermediate, and deep) was evaluated, as further described Section 4.0."

   Section 4.8 of the Background Memorandum describes the summary statistics for the various aquifers/HSUs and these data are presented in Table 4-14.

6. One commenter asked that if a concentration has a U qualifier, should it not also have a less than (<) sign in front of the presented reporting limit? Please follow state of the science practice in this regard.

   P4 Response: *To clarify the U values in Tables 2-2 thru 2-11: If results are not detected followed by the U qualifier (e.g., <2.0 mg/l U), then they are reported to the MDL. Results where a detection is noted followed by the U qualifier (e.g., 0.2 mg/l U) are considered not detected based on concentration detected in an associated blank. In order to clarify these two uses of the "U" validation flag, P4 will revise Tables 2-2 thru 2-11 in the final version of the Background Memorandum, as appropriate.*

Specific Comments

1. **Legal Notice, 1st page following document cover**. Please delete the page titled "Notice" to avoid any potential conflicts with the terms of liability provided in the AOC/CO. This page and the liability statements should also be deleted from all

other future P4 deliverables. This is a general legal matter that pertains to all deliverables. If you would like to discuss further, we should have our respective legal advisors meet separately to discuss this matter.

P4 Response: *Agreed. We will remove this notice from the final version of the Background Memorandum.*

2. **Section 1.0, Page 1-1, Sentence 2.** The relevant Department of Interior's Bureaus include the U.S. Fish and Wildlife Service and the Bureau of Land Management. Please revise this sentence to state this fact more clearly than it is currently written in the document.

P4 Response: *The A/Ts have made previous comments regarding the language in this paragraph of Section 1.0. In response to Specific Comment No. 1 and Specific Comment No. 2 of the A/Ts January 23, 2012 comments on Sections 1 to 3 of the Background Memorandum, P4 stated the following:*

<u>P4 Response Specific Comment No. 1 February 17, 2012</u>

To be consistent with page 2 of the 2009 CO/AOC, Section 1.0, page 1-1, 1st paragraph, 2nd sentence has been revised as follows: "The 2009 CO/AOC is a voluntary agreement between P4 and the United States Environmental Protection Agency (EPA), the Idaho Department of Environmental Quality (IDEQ), the United States Department of Agriculture, Forest Service (Forest Service), the United States Department of the Interior (DOI), Bureau of Land Management (BLM), the Shoshone-Bannock tribes (Tribes), collectively referred to as the Agencies and Tribes or A/Ts."

<u>P4 Response Specific Comment No. 2 February 17, 2012</u>

Page 2 of the 2009 CO/AOC does not include the Fish and Wildlife Service (FWS) in the agency list. However, P4 has referenced the FWS in Section 1.0, page 1-1, 1st paragraph, 2nd sentence of the revised Background Memorandum as requested.

The A/Ts did not have further comments on these P4 responses in their March 29, 2012 comments. As the above text is consistent with the 2009 CO/AOC and now includes reference to FWS, no further revisions to the Background Memorandum are nescessary.

3. **Section 1.1, pages 1-2 and 1-3, bullets**. In the bullets, P4 repeatedly refers to UTLs as an upper bound rather than USLs. However, P4 ultimately selected the USL. The bullets should also refer to USLs. Please revise.

P4 Response: *The referenced text was only providing the UTL as an example upper bound estimate of background population. However, the text will be revised to include the USL as suggested.*

4. **Section 1.1, page 1-2, 1st bullet.** The text here has led to some confusion or misunderstanding of the purpose and use of background in the RI, risk assessment and the FS. The text states that the background levels developed in this tech memo will be used for "The RI Report for preliminary screening, along with appropriate Agency risk-based standards, of sampling results from various media." Please clarify if the text should read "Agency approved risk-based standards" as many of the risk-based standards are not Agency-regulated but rather derived from scientific studies. The text goes on to state "Preliminary screening of sampling results will be based on an upper bound estimate of the background population, such as an upper tolerance limit (UTL) or maximum concentration, for each medium. It appears that the discussion of background in the context of the RI Report is unwarranted and premature. According to EPA Guidance, "A background evaluation usually is considered when certain contaminants that pose risks and may drive an action are believed to be attributable to background" (EPA Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites, 2002). Therefore, one would need to know if certain contaminants pose a risk prior to initiating a background evaluation. Additionally, EPA Guidance defines "screening" as "a comparison of site media concentrations with site-specific risk-based values" not a comparison with site-specific background values (EPA Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites, 2002, Appendix B). This same guidance goes on to state "When concentrations of naturally occurring elements at a site exceed risk-based screening levels, that information should be discussed qualitatively in the risk characterization." Based on this information, it is unclear why screening of sampling results based on quantitative statistical values of site-specific background is included at all at this point in the RI/FS process. Please clarify and provide further explanation on how this is consistent with guidance, and whether and how is may diverge from guidance.

   P4 Response: *As agreed during the teleconference between the A/T's and P4 held on 5 February 2013, comparisons of Site concentrations of COPCs to background concentrations of COPCs will not be conducted as part of a COPC/COPEC refinement/screening step. All COPCs with maximum detected concentrations in excess of relevant COPC/COPEC screening criteria will be carried forward into the quantitative risk assessment. This agreement is in contrast to text in Sections 3.1.1 and 4.1.2 of the A/T-approved Final RI/FS Work Plan (MWH, 2011) that describes a COPC/COPEC refinement step utilizing background concentrations. Text in Section 1.1 of the Background Memorandum will be revised accordingly.*

5. **Section 1.1, page 1-2, 2nd bullet.** It is unclear why "refinement" of COPCs and COPECs would be based on comparison of background UTLs for each medium and it appears the proposed approach is inconsistent with EPA Guidance (see information provided in the preceding comment). The proposal to eliminate COPCs and COPECs from further evaluation based on background levels also appears inconsistent with EPA Guidance based on the information provided in the

preceding Agency comment. Please clarify and provide further explanation on how this approach is consistent with guidance, and whether and how is may diverge from guidance.

P4 Response: *Please refer our response to Specific Comment No. 4, above. Text in Section 1.1 will be revised accordingly.*

6. **Section 1.2, page 1-3, 2nd paragraph, 2nd sentence.** Please include a brief discussion on how the definitions of background from the Area Wide Investigation as discussed here are consistent (or not) with the EPA definition of background.

P4 Response: *The A/T provided a similar comment (Specific Comment No. 6) in their January 23, 2012 comments on Section 1-3 of the Background Memorandum. Consistent with P4's response on February 17, 2012, P4 will add a similar discussion to Section 1.2. This paragraph will be revised as follows (new text underlined):*

"Background levels have previously been evaluated and reported in the Area-Wide Human Health and Ecological Risk Assessment Selenium Project Southeast Idaho Phosphate Mining Resource Area (Area-Wide Risk Assessment; IDEQ, 2002). The Final Area Wide Human Health and Ecological Risk Assessment, Selenium Project Southeast Idaho Phosphate Mining Resource Area (IDEQ, 2002) defined background riparian soils, and presumably sediments and surface waters, as areas upstream of mining facilities or as unimpacted reaches. Areas downstream of mining facilities were referred to as impacted reaches. <u>In the context of EPA guidance for evaluating background concentrations at CERCLA sites, the Area-Wide background samples are the same as "naturally-occurring" background (EPA, 2002)</u>. The Area-Wide range, average, and 95% UCL background levels are summarized in Table 1-1 although it must be noted that the data quality requirements may be less than the current data quality requirements under the RI/FS and the Area-Wide data were analyzed for a limited dataset."

7. **Section 1.2, page 1-4, 1st incomplete paragraph, 2nd complete sentence.** Recommend revising to "The Area-Wide range, average, and 95% UCL background levels are summarized in Table 1-1. It must be noted that the data quality requirements for this data were less than the current data quality requirements under the RI/FS and the Area-Wide list of COPCs was more limited than the current COPC list for the RI/FS."

P4 Response: *Agreed. This revision will be incorporated in the Background Memorandum as shown in the response to Specific Comment No. 6 above.*

8. **Section 2.2.1, page 2-5, 2nd paragraph.** It is not clear why "site" background stations should be noted? It was discussed above that only natural background

sites were included in the analysis. Delete the rest of the paragraph beginning with the sentence "In addition, six (6).

P4 Response: *P4 agrees that only natural background locations were included in the current background analysis. However, the above referenced paragraph was included in the Background Memorandum as clarification based on a previous A/T comment as noted below.*

> *<u>A/T Comment Specific Comment No. 17 January 23, 2012</u>*
> *Section 2.2.1, page 2-6, 1st incomplete paragraph, last sentence. The text states that P4 is proposing to use "natural' background data for the evaluation of medium-specific background concentrations. This statement begs the question of the utility of the "site" background data. Please clarify.*
>
> *<u>P4 Response Specific Comment No. 17 February 17, 2012</u>*
>
> *P4 agrees with the utility of the "site" background data that has been historically collected. The "site" background data may help P4 and the A/Ts assess the influence (i.e., contamination impacts) to particular media located on the P4 Sites from non-P4 sites. However, as discussed throughout these responses, P4 believes that inclusion of "site" background stations would bias or skew the background data and this evaluation of background is proposing to use "natural" background locations.*
>
> *<u>A/T Response Specific Comment No. 17 March 29, 2012</u>*
>
> *Please revise the text in the Technical Memorandum according to the explanation provided here in the response to comments. Please also refer to the A/T's comment and response to General Comment #8.*

The explanation provided in P4's response above was included in the Background Memorandum submitted December 21, 2012. As such, P4 believes that it important for a reader of the Background Memorandum to understand the investigation history of the three Sites as the investigation transitioned from the Area-Wide studies to EE/CA studies and from the EE/CA studies to the CERCLA RI/FS. Notably, the collection of "site" and "natural" background stations. No revisions to the Background Memorandum are necessary.

9. **Section 2.2.1, page 2-6, last paragraph, line 15.** Delete "the "site" and." It was said previously that "site" background locations were not being used.

   P4 Response: *Agreed. This revision will be incorporated in the Background Memorandum.*

10. **Section 2.2.1.1, page 2-7, 1st bullet, Antimony.** Please explain antimony at MST093 on 4 Oct 2010 as the MDL appears to be above its respective screening level (Table 2-3).

P4 Response: *The antimony data for MST093 sampled on October 4, 2011 are flagged with U and are non-detect due to associated blank data as discussed in response to General Comment No. 6 above. In order to clarify these two uses of the "U" validation flag, P4 will revise Tables 2-2 thru 2-11 in the Background Memorandum, as appropriate.*

11. **Section 2.2.1.1, page 2-7, 2nd bullet, Cadmium.** The intent of this technical memorandum is to present the available background data and statistical analysis of same for qualitative use in the baseline risk characterization, which is where the discussion of appropriate risk-based screening levels belongs. Please delete all discussion presented here related to P4's opinion on the appropriateness of the risk-based screening level for cadmium.

P4 Response: *This comment is similar to a previous A/T comment. The original A/T comment and P4's response are provided below.*

A/T Comment Specific Comment No. 21 January 23, 2012

Section 2.2.1.1, page 2-7, Cadmium. Throughout the document, there is reference to many of the analytes having a "conservative screening benchmark" and P4 seems to be using that argument to support the dismissal of use of that benchmark rather than the conclusion that the concentration sampled is not representative of background conditions. Please provide more discussion on why the screening benchmark is being dismissed, as there is a reason why the benchmark was set at the concentration is was. Why should that concentration not apply to the P4 sites?

P4 Response Specific Comment No. 21 February 17, 2012
P4 is not trying to make a case that specific screening criteria do not apply to the Sites. Rather, we are pointing out that for some chemicals in some media, available published benchmarks are low relative to background concentrations. An example is arsenic for which human health-based screening levels are commonly at or below the range of background concentrations observed in most regions of the U.S. The fact that measured concentrations of arsenic in soil at a given location exceed a screening benchmark, such as the EPA Regional Screening Level (RSL) for arsenic in residential soil, does not necessarily mean that the concentrations are not representative of background.

A/T Comment to P4 Response Specific Comment No. 21 March 29, 2012

A/T Response: Please revise the text in the Technical Memorandum according to the explanation provided here in the response to comments.

P4 included the explanation above in Section 2.2.1, page 2-6, 4th paragraph. No further revision of the Background Memorandum is warranted.

12. **Section 2.2.1.1, page 2-8, 1st incomplete paragraph (partial bullet 1).** If the streams do not cross Phosphoria outcrops, why mention that they could be higher in naturally occurring constituents? Delete here and in subsequent sections where this language is repeated.

    P4 Response: *P4 maintains that cadmium and other metal concentrations are known to be higher in the Phosphoria Formation than in other geologic materials (Desborough and Poole ,1983; Herring and Grauch, 2004; Turekian and Wedepohl, 1961), so therefore, it is possible that the stream sediment would have naturally elevated concentrations of cadmium where streams channels cross undisturbed Phosphoria Formation areas. P4 cannot definitively state whether or not there are background sample locations downstream of Phosphoria Formation outcrops. Therefore, P4 agrees to remove the text in this section and other sections where the language is repeated.*

13. **Section 2.2.1.1, page 2-8, 1st incomplete paragraph (partial bullet 1).** Recommend deleting everything after the 1st partial sentence (discussion on potentially elevated cadmium in naturally occurring Phosphoria) since it appears to be irrelevant (none of the proposed background sediment locations are associated with outcrops of the Phosphoria). Additionally, one could safely assume that some portion of the Phosphoria Formation soils were included in the cited assessments of metals concentrations in soils of the Western U.S., so any potentially elevated COPC concentrations associated with Phosphoria outcrops would already be accounted for in the comparison to soils of the Western U.S.

    P4 Response: *As stated in Specific Comment No. 12 above, P4 agrees to delete the text for everything after the 1st partial sentence (discussion on potentially elevated cadmium in naturally occurring Phosphoria). However, P4 disagrees that these potentially elevated COPCs concentration are accurately accounted for in these surveys. If any samples were collected from the Phosphoria Formation they likely represent a very small portion of the exposed bedrock in the Western US. In addition, where the Phosphoria Formation exists, it could have been removed through mining at the time of the survey.*

14. **Section 2.2.1.1, page 2-8, 2nd bullet, Zinc.** See immediate preceding comment regarding deletion of irrelevant discussion on potentially elevated sediment COPCs due to Phosphoria outcrops.

    P4 Response: *See our response to Specific Comment No. 12.*

15. **Section 2.2.1.1, page 2-9, 1st bullet, Selenium.** See immediate preceding comment regarding deletion of irrelevant discussion on potentially elevated sediment COPCs due to Phosphoria outcrops. Furthermore, this list is for COPCs

where detected concentrations were above screening levels. If Se is not above the screening level, delete or discuss in another section.

P4 Response: *See our response to Specific Comment No. 12. In addition, the convention in the RI/FS Work Plan (MWH, 2011) and the Background Memorandum has been to include selenium in discussions comparing medium concentrations to screening levels even if selenium concentrations were below these screening levels. An explanation will be included in Section 2.2.1.1of the Background Memorandum and other similar sections to clarify the inclusion of selenium in these discussions.*

16. **Section 2.2.1.2, page 2-10, 1st partial paragraph, line 6.** It appears that "sediment" should be "surface water." Please change accordingly.

P4 Response: *Agreed. This revision will be made in the Background Memorandum.*

17. **Section 2.2.1.2, page 2-10, 1st partial paragraph, 4th sentence.** In addition to the differences between filtered and unfiltered samples, please also discuss turbidity and total suspended solids concentrations.

P4 Response: *Turbidity samples were not collected as part of the standard field parameter list for surface water sampling. A limited number of total suspended solids (TSS) analyses were performed from the background samples. If any conclusions can be drawn from this limited dataset for TSS, they will be incorporated in to the discussion.*

18. **Section 2.2.1.2, page 2-10, 1st partial paragraph, 5th sentence.** On the one hand you argue that aluminum is high in groundwater because of excessive clay particles in the sample. Then you argue that aluminum is naturally elevated. Either delete this sentence or explain how if aluminum was naturally high, then dissolved aluminum concentrations are below detection limits. Similar language also occurs in subsequent sections and needs to be addressed similarly.

P4 Response: *Both of these statements are consistent with respect to aluminum. Aluminum is often naturally elevated in water throughout the sites as discussed in the RI/FS Work Plan (MWH, 2011). The aluminum is found in several of the geologic formations (e.g., claystones of the Dinwoody Formation) at the Sites and this translates to elevated aluminum in the particles and sediments entrained in the waters. When samples are filtered, this removes clay particles and therefore the aluminum. At the pH of waters at the Sites, aluminum is not particularly soluble, which may explain why the aluminum concentrations are not detected in the dissolved phase. As a result, no revision to the Background Memorandum is necessary in this section or similar sections.*

19. **Section 2.2.1.2, page 2-11, 3rd bullet, Selenium.** This list was for COPCs where detected concentrations were above screening levels. If Se is not above the screening level, delete or discuss in another section.

    P4 Response: *As discussed for Specific Comment No. 15 above, the convention in the RI/FS Work Plan (MWH, 2011) and the Background Memorandum has been to include selenium in discussions comparing medium concentrations to screening levels even if selenium was below these screening levels. An explanation will be included in Section 2.2.1.2 of the Background Memorandum and other similar sections to clarify the inclusion of selenium in these discussions.*

20. **Section 2.2.1.3, page 2-12, 1st paragraph, 1st bullet, sentence 6.** A reference for arsenic concentrations being higher in the Phosphoria Formation than other geologic materials should be provided.

    P4 Response: *Agreed. The following reference will be added to Section 2.2.1.3, page 2-12, 1st paragraph, 1st bullet, sentence 6:*

    (Desborough and Poole ,1983; Herring and Grauch, 2004; Turekian and Wedepohl, 1961)

21. **Section 2.2.2, page 2-13, 1st paragraph, 3rd sentence**. The A/T disagrees with this representation of events that led to the Phosphoria not being sampled for background upland soil and vegetation. It is our recollection that P4's initial proposal was to sample upland soil and vegetation only on Phosphoria Formation outcrops. This was rejected by the A/T because the bulk of waste rock was placed on the Wells and Dinwoody Formations, and the footprint of the mines covered other lithologies. We recognize that there may have been a misunderstanding of the A/T's position, such that P4 interpreted our initial response as a request to avoid the Phosphoria Formation entirely. However, the A/T did not reject any specific proposal to collect representative background samples from all formations that have waste rock dumps, i.e., Dinwoody, Wells, alluvium, and Phosphoria,etc.). Thus, the sentence should deleted or be revised to more accurately reflect how it came to be that only the Dinwoody and Wells Formations are represented in the upland soil and vegetation background samples.

    P4 Response: *P4 has responded to A/T comments with a similar representation of events as provided in the P4 response below. Specifically, P4 stated in their response to Specific Comment No. 41 dated February 17, 2012:*

    > *"The A/Ts did not permit P4 to sample in the Phosphoria Formation during the background investigation for upland soils and vegetation. Background concentrations of selenium, uranium, and perhaps even arsenic are higher in the Phosphoria Formation than in the Dinwoody Formation. Thus, the current*

> *background datasets are biased low for these elements (which are likely to be the primary risk drivers in the HHERA)."*

In the A/T's March 29, 2012 comment to P4's February 17, 2012 response, the A/Ts did not disagree with P4s interpretation of events.

In addition, as stated by the A/Ts in their comments on the Supplemental Mine Waste Rock Dump and Facility Soil and Vegetation Characterization Sampling and Analysis Plan (draft SAP submitted on June 26, 2008), the A/T's stated the following:

> *"Comment 22. Page 6, Section 3.2.1, Paragraph 3 and Table 3-1a. As discussed previously in meetings, outcrops of the Phosphoria Formation are not suitable background locations for waste rock dumps. Prior to the disposal of waste rock on the surface, the pre-mining soil profile would be comprised of loess, other transported weathered geologic materials, and the weathered immediate underlying strata. Engineered and reclaimed waste rock dumps are not the natural geologic surface expression at those locations and the dumps have been graded and reclaimed which makes them attractive sites for unauthorized recreational use, much more so than natural rock outcrops. More appropriate background locations must be selected, i.e., on-site, undisturbed areas representative of pre-mining conditions. If such locations are non-existent within the area of the mine, only then should P4/Monsanto consider collecting representative background information from off-site areas."*

Note that the upland soil and vegetation background data are being used in the risk assessment to evaluate constituent concentrations in soil and vegetation not only from the surface of waste rock dumps, but from mine pits, haul roads, and other Site areas as well.

As stated in the final 2009 SAP, P4 agreed to collect background samples from undisturbed areas, away from potential sources, representative of background conditions for Ballard, Henry, and Enoch Valley Mines. As there is no undisturbed Phosphoria Formation with the mines' footprints, the Phosphoria Formation was unable to be sampled during these investigations.

Regardless of the historical representation, P4 maintains that because each of the three Sites' background reference areas for upland soil and vegetation represents only select geologic formations (which exclude the Phosphoria), these data must be combined to capture the heterogeneous nature of the Sites. Even when the data from the three background reference areas are combined, the concentrations for upland soils and vegetation are likely to be biased low for certain elements, relative to the Sites because of missing background data from the Phosphoria Formation. As a result, no change to the text is warranted.

22. **Section 2.2.1.4, page 2-13, 4th paragraph, last sentence.** Please explain how will riparian vegetation concentrations be modeled from riparian soil concentrations if no riparian vegetation sampling results are available and no soil-to-plant bioaccumulation factors are published and available?

    P4 Response: *Soil-to-plant bioaccumulation factors are available for all chemicals selected as riparian soil COPCs or COPECs in Table 4-3.*

23. **Section 2.2.2.2, page 2-16, last paragraph.** Make this a bullet to read "Boron concentration from one sample at one site at Enoch Valley was greater than the vegetation screening level. As described in Section 2.2.1 above, this result will be further evaluated during the statistical analysis for the potential presence of statistical outliers."

    P4 Response: *Agreed. This revision will be incorporated into the Background Memorandum.*

24. **Section 2.2.3, page 2-17, 3rd paragraph.** The text states that preliminary groundwater flow direction arrows are shown on Drawing 2-5, but this does not appear to be the case. Please revise accordingly. Additionally, the Agencies requested groundwater flow directions (along with the data used to determine flow direction(s)) for each of the groundwater aquifer systems (alluvial, Dinwoody, Rex Chert, Wells Fm). Drawing 2-5 does not clearly identify the hydrostratigraphic unit associated with each monitoring well. Please revise.

    P4 Response: *Agreed. Drawing 2-5 of Background Memorandum will be revised.*

25. **Section 2.2.3, page 2-18, 2nd full paragraph.** The text states "As discussed in Section 2.2.1 above, the final representativeness and usability of individual data should not be determined through comparisons to screening levels, but through statistical evaluations performed during the calculation of Site-wide background levels." As noted in previous specific comments above, this approach is in direct conflict with EPA guidance on the role of background in CERCLA which defines "screening" as "a comparison of site media concentrations with site-specific risk-based values" not a comparison with site-specific (or site-wide) background values (EPA Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites, 2002, Appendix B). Please explain.

    P4 Response: *Please refer our response to Specific Comment No. 4, above. Text in Section 1.1 will be revised ~~accordingly~~to omit statements that describe comparisons of P4 Mine Site COPC/COPEC concentrations to background concentrations during COPC/COPEC refinement. Please also note that the quoted text in Section 2.2.3 refers to comparisons of background data MDLs to risk-based screening levels to evaluate the representativeness and usability of the*

background data. Such comparisons are a common practice in data usability evaluations, and they have little relevance to EPA's guidance on the role of background in CERCLA.

26. **Section 2.3, page 2-20.** Please provide additional details on the potential use of secondary media, including the intended protocol if exposure estimates modeled from primary media are not in agreement with secondary media data. For example, if elk data indicate different exposure and risk than what is estimated based on primary media, which would be favored for decision-making? In other words, are there intended decision rules for integrating multiple lines of evidence? It will be necessary to have a full discussion of the uncertainties and potential for over- and under-risk estimation, with use of primary and secondary media, in the uncertainty section of the risk assessment.

    P4 Response: *We agree that it will be necessary to have a full discussion of the uncertainties and potential for over- and under-estimation of risk associated with the use of primary and secondary media in the uncertainty section of the risk assessment. However, this discussion is beyond the current scope of the Background Memorandum, and we ask that such discussions be 'tabled' until the risk assessments are under way.*

27. **Section 2.3, page 2-20.** Small Mammals data are not indicated to be of use in risk assessment according to Table 2-1. Please resolve this incongruity.

    P4 Response: *As stated in the RI/FS Work Plan (MWH, 2011) and Table 2-1 of the Background Memorandum, fish, benthic macroinvertebrates, and small mammals are not to be used in the quantitative risk assessment. However, as stated in both the Work Plan and Background Memorandum these data can qualitatively support the risk assessment. No revisions to this section are necessary.*

28. **Section 2.3, page 2-20.** Table 2-1 does not indicate that the pre-2004 data for fish, aquatic vertebrates, small mammals, and terrestrial vertebrates can be used for the feasibility study. Please reconcile.

    P4 Response: *Section 2.3, page 2-20, 3rd paragraph, the 2nd sentence has been revised to state "These data are useful for RI/FS scoping and site characterization, and supporting the FS evaluation of alternatives, but are not for use in the quantitative risk assessment."*

29. **Section 3.1, page 3-1, 2nd paragraph.** Recommend to delete. This was already mentioned in Section 1.2.

    P4 Response: *Agreed. Section 3.1, page 3-1, 2nd paragraph of the Background Memorandum will be deleted.*

30. **Section 3.1, page 3-1, last paragraph, last complete sentence on page**. The sentence states "Data for surface water were collected between 2004 and 2010, and data for groundwater were collected between 2004 and 2010 . . ." Please explain if groundwater and surface water from 2011-2012 have been collected from any of the background locations and why they are not included in the background document.

    P4 Response: *Groundwater and surface water samples were not collected in 2011, but were collected in 2012 under the A/T-approved 2012 Surface and Groundwater Monitoring Program -Final Rev 2 dated May 7, 2012. Data collected in June and September 2012 are not included in the Background Memorandum submitted December 21, 2012 as the background summary statistics were developed starting in summer 2012 and were submitted to the A/T on September 17, 2012. However, as previously discussed with the A/T, the 2012 data will be compared to the 2004-2010 datasets and a discussion will be added to the Background Memorandum as to whether the 2012 data are found to be within the range of historical values.*

31. **Section 3.1, page 3-3, 1st partial paragraph.** Begin a new paragraph with the sentence "Similar to surface water . . ."

    P4 Response: *Agreed. Section 3.1, page 3-3, 1st partial paragraph of the Background Memorandum will be revised to incorporate this revision.*

32. **Section 3.3, page 3-7, 2nd paragraph, 2nd sentence**. Delete ", and groundwater samples" as groundwater is being discussed in Section 3.4. Modify the rest of the sentence accordingly.

    P4 Response: *Agreed and similar language as discussed in this paragraph will be added to Section 3.4 in reference to groundwater.*

33. **Section 3.3, page 3-7, 2nd paragraph, last sentence**. It is probably an overstatement to say ". . . it was not possible to collect statistically meaningful numbers of background samples for these media from individual P4 mine sites." Replace the words "not possible" with "not practicable." Also revise text to reflect that background upland soil and vegetation were collected on an individual mine basis.

    P4 Response: *P4 has revised the Background Memorandum to state that "it may not be possible or practicable..."*

34. **Section 3.3, page 3-8, 1st partial paragraph**. Insert a paragraph break separating out the following two sentences as a new paragraph: "Samples corresponding to individual sample locations were removed from the background datasets after the A/Ts expressed concerns about the locations, and a field visit was conducted on June 27, 2012 to confirm that the sample locations may have been impacted by

the Sites. The remaining background sample locations were assumed to represent background conditions, and samples collected from these locations were included in the statistical evaluation and outlier analysis."

P4 Response: *Agreed. Section 3.3, page 3-8, 1st partial paragraph of the Background Memorandum will be revised to incorporate this revision.*

35. **Section 3.3, page 3-8, last paragraph**. Change to read "In the event an outlier was identified in a sample, the data for other constituents from the same sample were not automatically removed as outliers. The fact that an outlier . . ."

P4 Response: *As a more complete explanation of the outlier analysis is described in the first complete paragraph on Page 3-8, the aforementioned text will be revised to state "An outlier analysis was conducted for the combined medium-specific dataset prior to the estimation of statistical limits as described in the paragraph above".*

36. **Section 3.4, page 3-12, 1st full paragraph, 2nd sentence.** The text states "The selenium and sulfate concentrations are the most direct indicators of impacts from the Sites." Please clarify these are leading indicators under oxidizing conditions. Where reducing conditions prevail in the various aquifer systems, cadmium, manganese, and nickel can be considered leading indicators. Without the evaluation of the redox conditions associated with each individual well, initial screening based on only selenium and sulfate may not be appropriate. Please explain if redox conditions were included in the evaluation of selection of groundwater background wells.

P4 Response: *Redox conditions were excluded from the discussion for the following reasons:*
Evaluation of the complete data set for the P4 Sites has shown that sulfate and selenium are the best indicators for impacts from the Sites. It is accepted that the primary source of sulfate and selenium is from the oxidation of metal sulfides in the reduced organic rocks of the Phosphoria Formation. The oxidation may have occurred in situ prior to mining or as the result of mining, but this establishes the fundamental relationship between sulfate, selenium and transition metals such as cadmium, nickel and zinc. However, the solubility of the transition metals are more pH dependent and are less soluble at the near neutral pH conditions observed in the groundwater at the Sites; whereas, the solubility of sulfate is not pH dependent and selenium tends to be more soluble at neutral to alkaline pH.

It is possible that impacted groundwater may be attenuated and sulfate and selenium precipitated in the aquifer under reducing conditions. If conditions are reducing enough to immobilize sulfate through reduction to sulfide (including biologically mediated reduction), metals sulfide precipitation would result and concentrations of metals like cadmium and nickel would also be very low.

Manganese and iron may still be mobile under these conditions, although significant iron sulfide could precipitate. There is not a unique association of elevated manganese and iron shown with the P4 Sites. These elements appear to be ubiquitous in the groundwater in the region.

The most commonly observed condition associated with mine-impacted groundwater at the P4 Sites is that of elevated selenium and sulfate, associated with or without elevated concentrations of other transition metals. Iron and manganese will be more mobile in reduced groundwater conditions, but at the P4 Sites, there has not been any evidence that this is an indication of impacts from the mining at the Sites. Should Eh (redox) be considered in screening the background wells, it is uncertain what hypotheses would be tested. It is unlikely that a monitoring well with a low Eh, and elevated iron and manganese is exclusively suggestive of impacts from P4 Sites, as these constituents appear to be common in wells regionally.

Detailed statistical and water typing evaluation of the groundwater quality data will be conducted for each mine-specific RI. The wells identified as background will not be excluded. Therefore, the above conclusions will be further tested. However, based on the data evaluations conducted to date, redox has not been considered as a critical parameter is assessing impacted verses unimpacted groundwater for the reasons presented above.

37. **Section 4**. The document explains how to statistically determine an outlier, using either a Dixon test or Rosner test along with a Q-Q plot for visual inspection. In Section 4.0, it seems that a Dixon test is used when fewer outliers are observed for a metal. Rosner is used when there are more than a few outliers. Is this the only difference in the tests or is one test better than the other to statistically determine outliers? There could be a quick explanation as to why you use one over the other. Unless it is somewhere in another document, then it can be referenced.

P4 Response: *Rosner's test was used when the sample size was equal or greater to 25, and Dixon's test was used when the sample size was less than 25. This information will be added to Section ~~4.0~~3.3 of the Background Memorandum.*

38. **Section 4**. The date of reference within the document for Kabata-Pendias should be changed from 2011 to 2001 to accurately match the correct date shown in the References Section 5.0.

P4 Response: *The Kabata-Pendias (2011) values cited in Section 4 were actually obtained from Kabata-Pendias (2011) and not Kabata-Pendias (2001). Kabata-Pendias (2011) will be added to the Reference Section.*

39. **Section 4**. There appear to be additional QQ plots for some media. If these QQ plots are relevant then they need to be discussed. Please provide brief language somewhere describing what the reader is viewing.

P4 Response: *The Q-Q plots were included for the reader to better identify potential visual outliers. Text in Section 4.3~~0~~ and Sections 4.6 through 4.8 will be revised ~~as needed~~ to describe the medium-specific Q-Q plots included in Appendix D.*

40. **Section 4**. Interpretations of Q-Q plots can be instinctive and subjective. This is further complicated by the possibility that the background populations for some of the media are skewed or heavily tailed rather than normal. As a result, one person's designation of a visual outlier may differ from another person's interpretation. Please add a brief description of the process that was used to identify outliers for testing including any assumptions that were applied the analysis.

P4 Response: *A brief description of the process for identifying outliers for testing will be included in Section ~~4.0~~3.3 of the Background Memorandum.*

41. **Section 4.6, page 4-4**. There are several "extra" QQ plots in Appendix D (e.g., Q-Q Plot with NDs for Mercury_Out, Q-Q Plot with NDs for Selenium_OutR, Q-Q Plot with NDs for Uranium, Total_test). Either discuss these QQ plots if relevant or delete them.

P4 Response: *The Q-Q plots were included for the reader to better identify potential visual outliers. Text in Section 4.0 will be revised as needed to describe the Q-Q plots included in Appendix D.*

42. **Section 4.6 page 4-4, 3rd paragraph**. Please explain if all the other COPCs listed here are based on the total fraction? Why single out "total" uranium and chromium? The same question holds true for upland vegetation.

P4 Response: : *Chromium and uranium were listed as total chromium and total uranium to distinguish total chromium and total uranium from chromium (III) and chromium (VI) and other uranium isotopes, respectively. The remaining constituents discussed in this comment were based on the total fraction.*

43. **Sections 4.7.1 and 4.7.2, pages 4-5 and 4-6**. There are several "extra" QQ plots in Appendix D (e.g., Q-Q Plot with NDs for Selenium, LN_CS, Q-Q Plot with NDs for Boron_1_CS, Q-Q Plot with NDs for Molybdenum_2_CS). Either discuss these QQ plots if relevant or delete them.

P4 Response: *The Q-Q plots were included for the reader to better identify potential visual outliers. Text in Section 4.0 will be revised as needed to describe the Q-Q plots included in Appendix D.*

44. **Sections 4.7.2, page 4-6**. Similar to a previous comment on Section 4 regarding the subjectivity of interpreting QQ plots, please explain how visual inspection of the QQ Plot with NDs for Molybdenum resulted in eight potential outliers.

P4 Response: *Only six outliers, not eight, were removed from the molybdenum non-culturally significant plants dataset prior to estimating statistical limits. The plots and description below explains how six outliers were removed from the molybdenum non-culturally significant plants dataset. Figure 1 shows the Q-Q plot for the molybdenum non-culturally significant plants dataset, inclusive of non-detect results (indicated in red). Note the upper six values that appear to be potential outliers.*

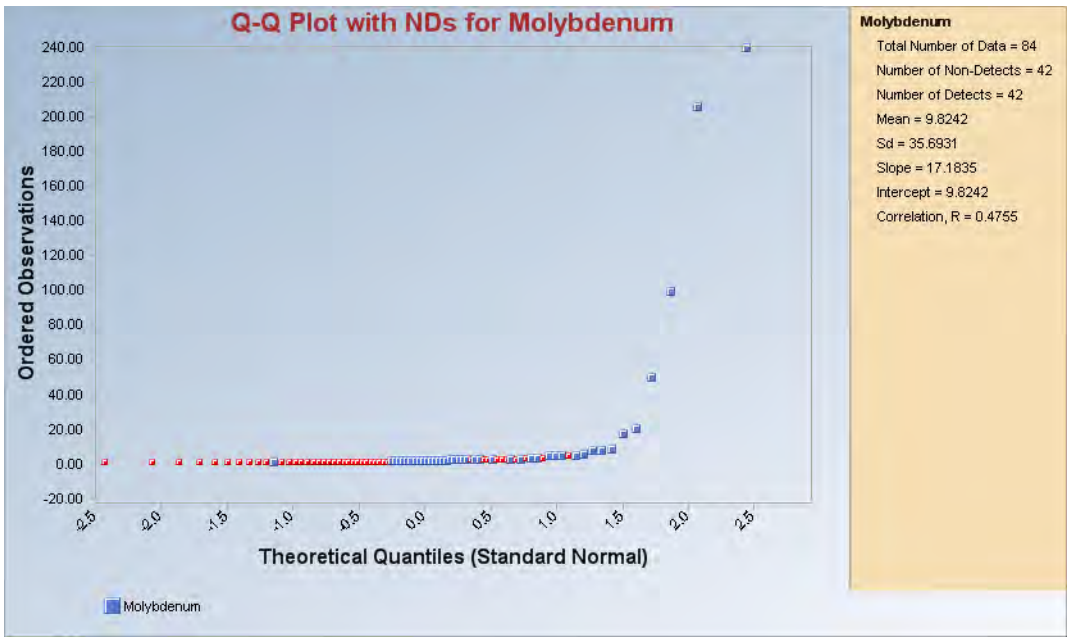

Figure 1

The non-detect results were temporarily removed to better visualize the distribution of detected results for the molybdenum non-culturally significant plants dataset (Figure 2). The upper six values still appear to be potential outliers.

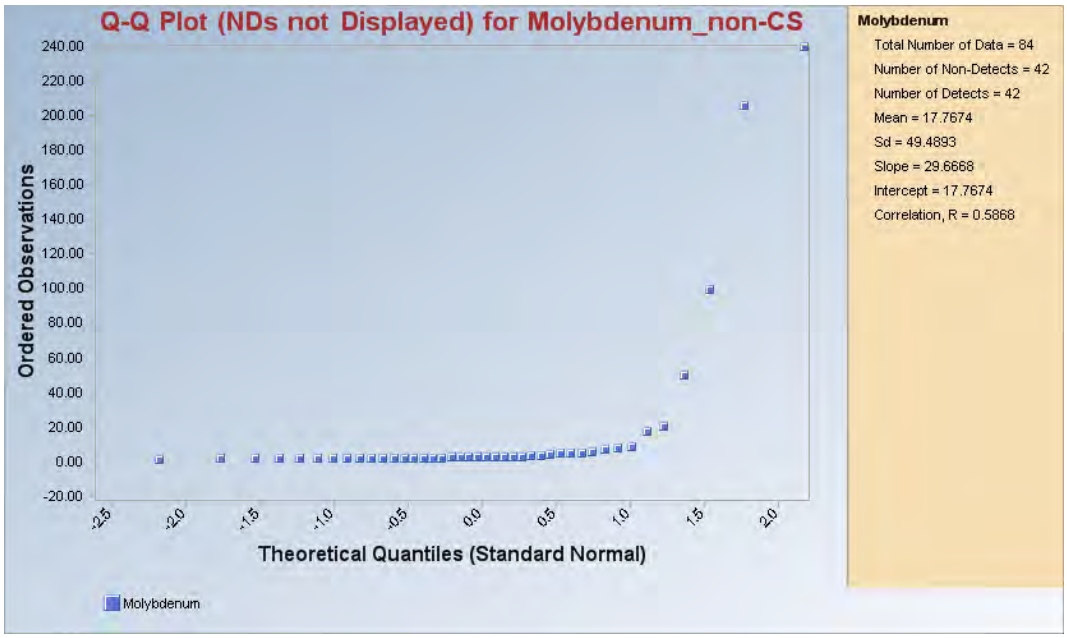

Figure 2

The upper six values were removed from the molybdenum culturally significant plant dataset, the non-detect values were added back into the dataset, and the dataset was re-plotted (Figure 3). The apparent 'plateaus' in Figure 3 result from multiple non-detected results with the same or very similar detection limits.

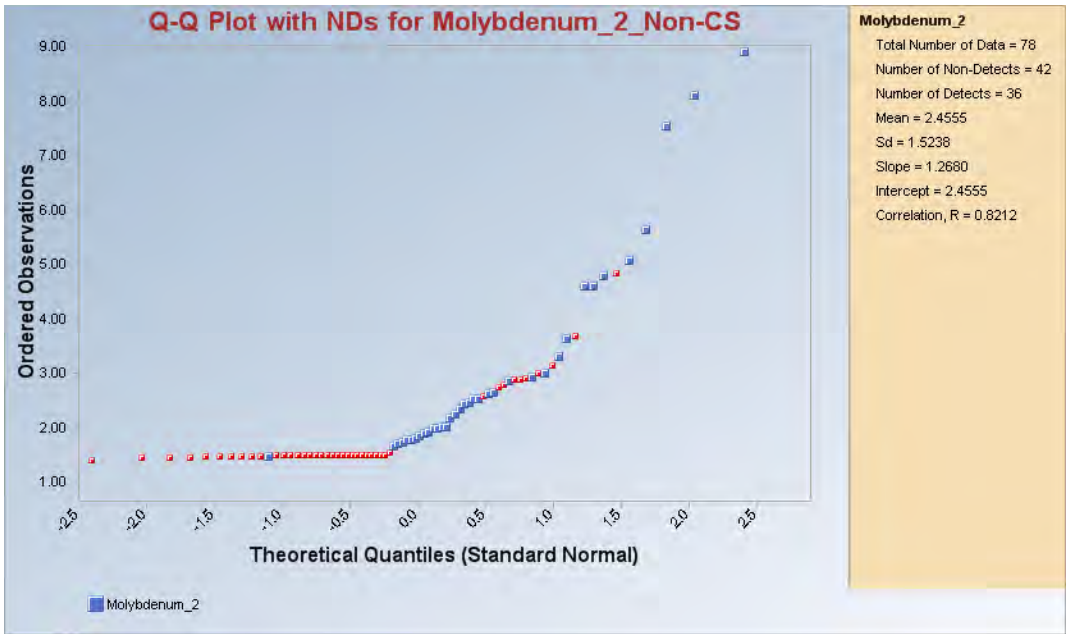

Figure 3

The non-detect values were then removed from the molybdenum culturally significant plant dataset, with the upper six values removed, and the dataset was re-plotted (Figure 4).

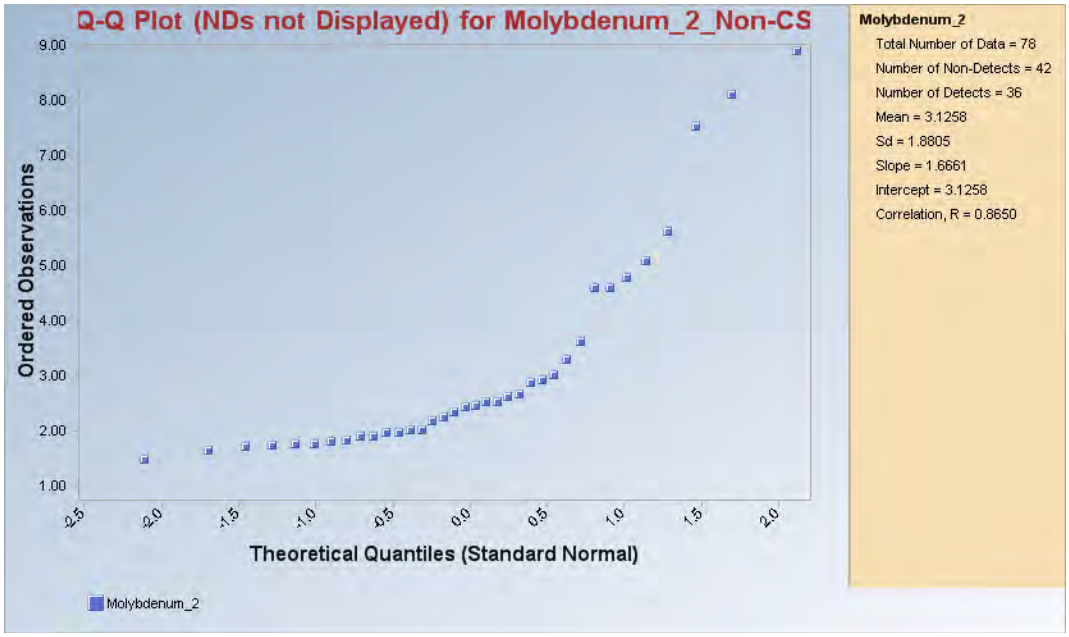

Figure 4

Note the correlation coefficient of 0.865 and how the dataset appears to be normally distributed. No additional visual outliers were identified. Results of Rosner's statistical test determined that the upper six values were, in fact, statistical outliers. These six outliers were removed from the molybdenum non-culturally significant upland vegetation dataset.

45. **Table 2-6.** Does a T qualifier matter for Percent Moisture? Please revise accordingly.

    P4 Response: *Agreed, the table will be revised to remove the T qualifier from the percent moisture results.*

46. **Table 2-11.** Complete this column for all wells to match categories noted in Table 2-10.

    P4 Response: *Agreed. Table 2-11 of Background Memorandum will be revised to incorporate this revision.*

47. **Tables 4-1 through 4-7.** Superscripts referring to the Notes section seem to be misplaced within the table. That is, the footnote superscript appears to the far right of each column rather than next to the value. Please revise accordingly.

    P4 Response: *Tables 4-1 to 4-7 will be revised to include a column heading for notes and the table will be formatted to remove the space between the value and the note.*

48. **Tables 4-1 through 4-7.** Please provide a note or explanation for highlighting of the BTV column on these tables.

    P4 Response: *Highlights were included for the 'Will BTVs be Established? (Yes/No)' columns in Table 4-1 through 4-7 to allow the readers to quickly identify which BTVs were established based on the results of the COPC and/or COPEC screening.*

49. **Tables 4-1 through 4-7.** Review footnotes for consistency as sometimes acronyms in the Notes are defined and sometimes they are not (e.g., BTAG, HHERA), sometimes they actually appear and sometimes they do not (e.g., LEL, MOE in Table 4-1).

    P4 Response: *Agreed, the tables will be checked for defined acronyms.*

50. **Table 4-1**. The Table shows that BTVs will not be established for aluminum and iron, although the maximum detected concentration is greater than the screening value. Please explain or revise, accordingly.

    P4 Response: *Sediment BTVs were not established for aluminum and iron because background sediment data are not available for aluminum and iron.*

51. **Table 4-2**. The Table identifies several footnotes as a—e, but only one footnote "a" is shown at the bottom of the Table. Please revise.

    P4 Response: *Table 4-2 is formatted to print on two pages as included in the pdf of the Background Memorandum submitted on December 21, 2012. Footnotes b to e and additional table notes are included on this second page. The table will be revised to include Page 1 of 2 and Page 2 of 2.*

52. **Tables 4-4 and 4-6**. For consistency with the other screening Tables, Tables 4-4 and 4-6 should be revised to show the Maximum Detected Concentration in the first column rather than the Screening Value.

    P4 Response: *Agreed. Tables 4-4 and 4-6 will be revised as suggested.*

53. **Table 4-8**. The Ecological COPEC Screening Criteria in the last column of Table 4-8 are different than the Sediment Screen Level criteria shown in second column of Table 4-1. Please explain or revise. Also, please check all tables for similar errors.

    P4 Response: *Agreed. Tables 4-8 and 4-14 will be checked and revised as necessary.*

54. **Table 4-9**. The arsenic Screening Criteria in the last column of Table 4-9 is shown to be the COPEC value of 0.15 mg/L. However, Table 4-2 shows that the lower screening value is the COPC value of 0.01 mg/L. Please revise. Also, please check all tables for similar errors.

    P4 Response: *Tables 4-8 through 4-14 will be revised as necessary.*

55. **Table 4-14.** Footnote this column (Number of Detections) to tell the reader that apparently only the "total" concentrations were counted as number of detections.

    P4 Response: *Footnote a in column (Constituent) states that total concentrations are presented for all constituents. This footnote will be added to the column (Number of Detections)*

56. **Table 4-15**. This Table would be more meaningful if the Table identified which of the proposed background levels exceeded their respective human and ecological screening values. One possibility would be to add footnotes designating that the value exceeds the human or ecological screening value or both.

    P4 Response: *Please note that risk-based screening levels were added to Table 4-8 thru Table 4-14 at the request of the A/T's. However, the proposed background levels are based on local geological conditions and have little relevance to risk-based screening levels that are based on published toxicity criteria and hypothetical exposure assumptions. For example, it is well known that risk-based soil screening levels for arsenic are within typical background ranges for this metalloid. As stated in the Background Memorandum, the final representativeness and usability of individual data or sampling locations should not be determined through comparisons to screening levels, but through statistical evaluations performed during the calculation of Site-wide background levels and review of the physical sample location.*

57. **Table 4-15**. There are substantial differences of background levels for some constituents (e.g., antimony, manganese, molybdenum) between upland soil, riparian soil, and sediment. Although different media, one might expect similar concentrations between the three. Please discuss.

    P4 Response: *The A/T's identified reference areas that should be sampled as part of the P4 Mine Sites background investigation. Differences in background concentrations between upland soil and downgradient riparian soil/sediment may be due to contaminant fate/transport mechanisms. However, any attempts to discuss reasons for the differences in background concentrations observed between media would be purely speculative.*

58. **Figure 2-5**. In the 3rd paragraph of Section 2.2.3, P4 notes that groundwater flow direction arrows were placed on the Figure. However, the arrows do not appear on the Figure. Please revise.

    P4 Response: *Agreed. Drawing 2-5 of Background Memorandum will be revised to incorporate this revision.*

59. **Drawing 2-5:** Please revise to include some form of identifier for hydrostratigraphic unit of completion for each monitoring well. Also, it appears the groundwater flow direction arrows described in the text are missing from the drawing.

    P4 Response: *Agreed. Drawing 2-5 of Background Memorandum will be revised to incorporate this revision.*

60. **Appendix D**. Riparian vegetation Q-Q plots. Table 2-6 shows there were four metals (cadmium, copper, molybdenum, and zinc) with more than 5 detections. However, Q-Q plots were only provided for two of the metals, cadmium and molybdenum. Please explain.

    P4 Response: *Only three constituents (i.e, cadmium, molybdenum, and selenium) were identified as COPECs according to Table 4-4 of the Background Memorandum. Only one detection was present for selenium, and as a result, only cadmium and molybdenum riparian vegetation Q-Q plots were presented in Appendix D of the Background Memorandum.*

General Editorial Comments

- Be consistent on whether the word data is singular or plural. It is suggested that data be considered plural.

- Sometimes mg/l is used and sometimes mg/L is used. Please be consistent. It is recommended to use mg/L.

  P4 Response: *Agreed. The Background Memorandum will be revised to incorporate these revisions suggested below.*

Specific Editorial Comments

Section 1.1, page 1-2, 2nd bullet, line 7. Change "mediums" to "media."

Section 1.1, page 1-3, 1st full paragraph after the bullet, 2nd sentence: It appears "such as evaluation…" should be changed to "such an evaluation…".

Section 2.2.1, page 2-4, 4th paragraph, last line. Change "affects" to "effects."

Section 2.2.1, page 2-5, 2nd paragraph, line 1. Change "ten (10)" to "several."

Section 2.2.1, page 2-5, 2nd paragraph, line 4. Change to "For example, the proposed . . ."

Section 2.2.1.1, page 2-8, 1st incomplete sentence. Delete second period.

Section 2.2.1.1, page 2-9, 2nd bullet, line 2. Inset a space between "(1.6" and "mg/kg)."

Section 2.2.1.2, page 2-11, 1st partial bullet, line 2. Inset a space between "0.02" and "mg/l."

Section 2.2.1.3, page 2-12, 1st bullet, line 3. Change "ranges" to "ranged."

Section 2.2.2, page 2-14, 2nd paragraph, line 2. Change to read ". . . medium also highlight detected concentrations and shade exceedances of screening levels for each analyte." Similar language also occurs in subsequent sections and needs to be addressed similarly.

Section 2.2.2.2, page 2-16, 1st bullet, line 3. Change "range" to "ranged."

Section 2.2.3, page 2-17, 3rd paragraph, line 5. Change "is" to "are."

Section 2.2.3, page 2-17, 3rd paragraph, line 9. Change "principals" to "principles."

Section 2.2.3, page 2-18, partial paragraph, line 3. "Flow gradients" is not term used for groundwater. Change "flow gradients" to either "flow direction" or "hydraulic gradients."

Section 2.2.3.1, page 2-19, 1st and 2nd complete bullets, lines 3 and 4, respectively. Change "range" to "ranged."

Section 2.3, page 2-20, 1st paragraph, 1st sentence. Change to "Secondary media include biotic receptors and data from these receptors will be considered supporting . . ."

Section 2.3, page 2-20, 4th paragraph, line 1. Insert "elk tissue, bird egg, and cattle study" between "pre-2004" and "data."

Section 3.3, page 3-8, 3rd paragraph. Append this sentence to the end of the previous paragraph.

Section 3.3.1.2, page 3-9, 1st paragraph, line 9. Change "Site'" to "Site's."

Section 3.3.1.2, page 3-10, 1st partial paragraph, line 4. Change "(below)" to "(above)."

Section 3.4, page 3-13, last paragraph, last line. Delete "a."

Section 4.4, page 4-4, 2nd paragraph. Append this sentence to the end of the previous paragraph.

Section 4.6, page 4-5, 2nd paragraph. Append this sentence to the end of the previous paragraph.

Section 4.7.2, page 4-6, 4th paragraph. Append this sentence to the end of the previous paragraph.

Section 4.7.3, page 4-7, 1st full paragraph, line 5. Insert a period between "limits" and "No."

Section 4.8.2, page 4-9, 1st paragraph. Append this sentence to the end of the previous paragraph.

Section 4.8.4, page 4-9, 2nd paragraph, line 1. Insert "manganese," between "chromium," and "selenium."

Section 4.8.4, page 4-9, last paragraph. Delete first two sentences. Append third sentence starting with "No potential visual . . ." to the previous paragraph.

Section 4.8.4, page 4-10, 2nd paragraph. Append this sentence to the end of the previous paragraph.