

APPENDIX F

**STATISTICAL AND GEOCHEMICAL EVALUATION
OF SITE METALS DATA**

**STATISTICAL
(TIERS 1 AND 2)**

Statistical Comparison of Site and Background Data Old Water Hole, Parcel 205(7) Fort McClellan, Alabama

1.0 Introduction

This report provides the Tier 1 and Tier 2 site-to-background comparison results for the Old Water Hole, Parcel 205(7), Fort McClellan in Calhoun County, Alabama. Tier 1 and Tier 2 evaluations (Shaw E & I, 2003) have been performed on the surface soil, subsurface soil, and groundwater data sets. In the first step of the comparison, the maximum detected concentration (MDC) of each element is compared to two times the arithmetic mean of the background data (SAIC, 1998). Any metal that has an MDC greater than the background screening value is carried forward for Tier 2 evaluation, which includes the Slippage Test, the Wilcoxon Rank Sum Test (WRS), and Hot Measurement Test.

The methodology and results of the Tier 1 and Tier 2 comparisons are summarized in Tables 1 through 3, and described in more detail in the following sections. Site samples used in the site-to-background comparison include 6 surface soil samples (0 to 1 foot below ground surface [bgs]), 6 subsurface soil samples (4 to 12 feet bgs), and 9 groundwater samples that were collected at the site.

Background distributions and screening values have been established for target analyte list metals in surface soil, subsurface soil, and groundwater for Fort McClellan (SAIC, 1998).

2.0 Comparison Methodology

This section describes the statistical techniques that were employed in the Old Water Hole, Parcel 205(7), site-to-background comparisons.

2.1 Statistical Procedures

Contamination can be caused by a variety of processes that yield different spatial distributions of elevated contaminant concentrations. Slight but pervasive contamination can occur from non-point-source releases, and can result in slight increases in contaminant concentrations in a large percentage of samples. Localized, or "hot-spot," contamination can result in elevated concentrations in a small percentage of the total number of site samples. No single two-sample statistical comparison test is sensitive to both of these modes of contamination. For this reason, the use of several simultaneous tests is recommended for a valid and complete comparison of site

Table 1

**Summary of Tier 1 and Tier 2 Site to Background Comparison for Surface Soil
Old Water Hole, Parcel 205(7)
Fort McClellan, Calhoun County, Alabama**

Metals	Frequency of Detection	Tier 1 Evaluation ^a	Tier 2 Evaluation			Carried Forward for Tier 3 Geochemical Evaluation
			Slippage Test ^b	Wilcoxon Rank Sum Test ^b	Hot Measurement Test ^{b,c}	
Aluminum	6 / 6	Passed	NA	NA	NA	
Antimony	0 / 6	NA	NA	NA	NA	
Arsenic	6 / 6	Failed	Passed	Passed	NA	
Barium	6 / 6	Passed	NA	NA	NA	
Beryllium	1 / 6	Passed	NA	NA	NA	
Cadmium	0 / 6	NA	NA	NA	NA	
Calcium	6 / 6	Passed	NA	NA	NA	
Chromium	6 / 6	Failed	Passed	Passed	NA	
Cobalt	2 / 6	Passed	NA	NA	NA	
Copper	6 / 6	Failed	Passed	Failed	NA	Yes
Iron	6 / 6	Failed	Passed	Passed	NA	
Lead	6 / 6	Passed	NA	NA	NA	
Magnesium	6 / 6	Passed	NA	NA	NA	
Manganese	6 / 6	Passed	NA	NA	NA	
Mercury	5 / 6	Passed	NA	NA	NA	
Nickel	1 / 6	Passed	NA	NA	NA	
Potassium	5 / 6	Passed	NA	NA	NA	
Selenium	1 / 6	Failed	Passed	NA ^d	Failed	Yes
Silver	0 / 6	NA	NA	NA	NA	
Sodium	6 / 6	Passed	NA	NA	NA	
Thallium	0 / 6	NA	NA	NA	NA	
Vanadium	6 / 6	Passed	NA	NA	NA	
Zinc	6 / 6	Failed	Passed	Passed	NA	

NA = not applicable

a Tier 1 evaluation per **Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC, Revision 2**, Technical Memorandum, 24 June 2003 by Paul Goetchius.

b Part of Tier 2 evaluation per the above referenced memo.

c Performed only when the Slippage test and/or Wilcoxon Rank Sum (WRS) test cannot be performed.

d WRS test is not performed on data sets containing 50% or more nondetects.

Table 2

**Summary of Tier 1 and Tier 2 Site to Background Comparison for Subsurface Soil
Old Water Hole, Parcel 205(7)
Fort McClellan, Calhoun County, Alabama**

Metals	Frequency of Detection	Tier 1 Evaluation ^a	Tier 2 Evaluation			Carried Forward for Tier 3 Geochemical Evaluation
			Slippage Test ^b	Wilcoxon Rank Sum Test ^b	Hot Measurement Test ^{b,c}	
Aluminum	6 / 6	Passed	NA	NA	NA	
Antimony	0 / 6	NA	NA	NA	NA	
Arsenic	6 / 6	Failed	Passed	Passed	NA	
Barium	6 / 6	Passed	NA	NA	NA	
Beryllium	0 / 6	NA	NA	NA	NA	
Cadmium	0 / 6	NA	NA	NA	NA	
Calcium	6 / 6	Passed	NA	NA	NA	
Chromium	6 / 6	Passed	NA	NA	NA	
Cobalt	2 / 6	Passed	NA	NA	NA	
Copper	6 / 6	Failed	Passed	Passed	NA	
Iron	6 / 6	Passed	NA	NA	NA	
Lead	6 / 6	Passed	NA	NA	NA	
Magnesium	6 / 6	Passed	NA	NA	NA	
Manganese	6 / 6	Passed	NA	NA	NA	
Mercury	2 / 6	Passed	NA	NA	NA	
Nickel	1 / 6	Passed	NA	NA	NA	
Potassium	5 / 6	Failed	Passed	Passed	NA	
Selenium	1 / 6	Failed	NA ^d	NA ^e	Failed	Yes
Silver	0 / 6	NA	NA	NA	NA	
Sodium	6 / 6	Passed	NA	NA	NA	
Thallium	0 / 6	NA	NA	NA	NA	
Vanadium	6 / 6	Passed	NA	NA	NA	
Zinc	6 / 6	Passed	NA	NA	NA	

NA = not applicable

a Tier 1 evaluation per **Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC, Revision 2**, Technical Memorandum, 24 June 2003 by Paul Goetchius.

b Part of Tier 2 evaluation per the above referenced memo.

c Performed only when the Slippage test and/or Wilcoxon Rank Sum (WRS) test cannot be performed.

d Slippage test is not performed on data sets for which the maximum background value is a nondetect.

e WRS test is not performed on data sets containing 50% or more nondetects.

Table 3

Summary of Tier 1 and Tier 2 Site to Background Comparison for Groundwater
 Old Water Hole, Parcel 205(7)
 Fort McClellan, Calhoun County, Alabama

Metals	Frequency of Detection	Tier 1 Evaluation ^a	Tier 2 Evaluation			Carried Forward for Tier 3 Geochemical Evaluation
			Slippage Test ^b	Wilcoxon Rank Sum Test ^b	Hot Measurement Test ^{b,c}	
Aluminum	8 / 9	Passed	NA	NA	NA	
Antimony	0 / 9	NA	NA	NA	NA	
Arsenic	5 / 9	Passed	NA	NA	NA	
Barium	2 / 9	Passed	NA	NA	NA	
Beryllium	0 / 9	NA	NA	NA	NA	
Cadmium	0 / 9	NA	NA	NA	NA	
Calcium	2 / 9	Passed	NA	NA	NA	
Chromium	2 / 9	Failed	NA ^d	NA ^e	Passed	
Cobalt	1 / 9	Passed	NA	NA	NA	
Copper	0 / 9	NA	NA	NA	NA	
Iron	8 / 9	Passed	NA	NA	NA	
Lead	0 / 9	NA	NA	NA	NA	
Magnesium	0 / 9	NA	NA	NA	NA	
Manganese	9 / 9	Passed	NA	NA	NA	
Mercury	0 / 9	NA	NA	NA	NA	
Nickel	1 / 9	Failed	NA ^d	NA ^e	Passed	
Potassium	4 / 9	Failed	Passed	NA ^e	Failed	Yes
Selenium	1 / 9	Failed	NA ^d	NA ^e	Passed	
Silver	0 / 9	NA	NA	NA	NA	
Sodium	3 / 9	Failed	Passed	NA ^e	Passed	
Thallium	0 / 9	NA	NA	NA	NA	
Vanadium	2 / 9	Passed	NA	NA	NA	
Zinc	0 / 9	NA	NA	NA	NA	

NA = not applicable

a Tier 1 evaluation per **Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC, Revision 2**, Technical Memorandum, 24 June 2003 by Paul Goetchius.

b Part of Tier 2 evaluation per the above referenced memo.

c Performed only when the Slippage test and/or Wilcoxon Rank Sum (WRS) test cannot be performed.

d Slippage test is not performed on data sets for which the maximum background value is a nondetect.

e WRS test is not performed on data sets containing 50% or more nondetects.

versus background distributions (U.S. Environmental Protection Agency [EPA], 1989, 1992, and 1994; U.S. Navy, 2002).

Analytes that fail the Tier 1 and Tier 2 comparisons are subject to a geochemical evaluation to determine if the elevated concentrations are due to natural processes or if they represent potential contamination.

2.1.1 Tier 1 - In this step of the background screening process, the maximum detected concentration (MDC) of the site data set is compared to the background screening value of two times the background mean (SAIC, 1998). Elements for which the site MDC does not exceed the background screening value are considered to be present at background concentrations, and are not considered site-related chemicals. Elements for which the site MDC exceeds the background screening value undergo further evaluation (Tier 2).

2.1.2 Tier 2 –

Slippage Test – The nonparametric Slippage test is designed to detect a difference between the upper tails of two distributions, and has been recommended for use in site-to-background comparisons to identify potential localized, or hot-spot, contamination (U.S. Navy, 2002). The test is performed by counting the number (K) of detected concentrations in the site data set that exceed the maximum background measurement, and then comparing this number to a critical value (K_c), which is a function of the number of background samples and the number of site samples. If $K > K_c$, then potential contamination is indicated and the analyte will be subjected to geochemical evaluation. If $K \leq K_c$, then localized contamination is not suspected.

Critical values tables for site and background data sets up to size $n = 50$ are provided in U.S. Navy (2002). Critical values for larger data sets are calculated using the test statistic provided in Rosenbaum (1954). In this report, the Slippage test is performed at the 95 percent confidence level. The test cannot be performed if the maximum background value is a nondetect, because the actual concentration in that sample is unknown.

Wilcoxon Rank Sum Test. The nonparametric WRS test is designed to detect a difference between the medians of two data sets, and has been recommended for use in site-to-background comparisons to identify slight but pervasive contamination (EPA, 2000; U.S. Navy, 2002). In this report, the WRS test is performed when the site and background data sets each contain less than 50 percent nondetects (i.e., measurements reported as not detected below the laboratory reporting limit). The WRS test will not be performed on data sets containing 50 percent or more

nondetects. The medians of such data sets are unknown, and hence the test results would lack sufficient power to yield reliable results.

The WRS test compares two data sets of size n and m ($n > m$), and tests the null hypothesis that the samples were drawn from populations with distributions having the same medians. To perform the test, the two sets of observations are pooled and arranged in order from smallest to largest. Each observation is assigned a rank; that is, the smallest is ranked 1, the next largest is ranked 2, and so on up to the largest observation, which is ranked $(n + m)$. If ties occur between or within samples, each one is assigned the mid-rank. Next, the sum of the ranks of smaller data set m is calculated. Then the test statistic Z is determined,

$$Z = \frac{W - m(m + n + 1)/2}{\sqrt{mn(m + n + 1)/12}}$$

Where:

- W = Sum of the ranks of the smaller data set
- m = Number of data points in smaller group
- n = Number of data points in larger group.

This test statistic Z is used to find the two-sided significance. For instance, if the test statistic yields a probability of a Type I error (p-level) less than 0.2, then there is a statistically significant difference between the medians at the 80 percent confidence level. A Type I error involves rejecting the null hypothesis when it is true. If the p-level is greater than 0.2, then there is no reasonable justification to reject the null hypothesis at the 80 percent confidence level. It can therefore be concluded that the medians of the two data sets are similar, and it can be assumed to be drawn from the same population.

If the p-level is less than 0.2, then the medians of the two distributions are significantly different at the 80 percent confidence level. This can occur if the site data are shifted higher or lower than the background data. If the site data are shifted higher relative to background, then contamination may be indicated, and the analyte in question will be carried on for geochemical evaluation; however, if the site data are shifted lower relative to background, then contamination is not indicated. If the p-level is greater than 0.2, then pervasive site contamination is not suspected.

Box Plots. A quick, robust graphical method recommended by the EPA to visualize and compare two or more groups of data is the box plot comparison (EPA, 1989 and 1992). These plots provide a summary view of the entire data set, including the overall location and degree of symmetry. The box encloses the central 50 percent of the data points so that the top of the box represents the 75th percentile and the bottom of the box represents the 25th percentile. The small box within the larger box represents the median of the data set. The upper whisker extends outward from the box to the maximum point and the lower whisker extends to the minimum point. Nondetect results are set equal to one-half of the reporting limit for plotting purposes.

For each analyte, box plots of site and background data are placed side by side to visually compare the distributions and qualitatively determine whether the data sets are similar or distinct. Accordingly, the box plots are a necessary adjunct to the WRS test. As described previously, the WRS test may indicate that the medians of the site and background data sets are significantly different. Examination of the box plots will confirm whether that difference is caused by site data that are shifted higher or lower relative to background.

Hot Measurement Test. The hot measurement test consists of comparing each site measurement with a concentration value that is representative of the upper limit of the background distribution (EPA, 1994). Ideally, a site sample with a concentration above the background screening value would have a low probability of being a member of the background distribution, and may be an indicator of contamination. It is important to select such a background screening value carefully so that the probability of falsely identifying site samples as contaminated or uncontaminated is minimized.

The 95th upper tolerance limit (95th UTL) is recommended as a screening value for normally or lognormally distributed analytes and the 95th percentile is recommended as a screening value for nonparametrically distributed analytes (EPA, 1989, 1992, and 1994). Site samples with concentrations above these values are not necessarily contaminated, but should be considered suspect. To perform the test, each analyte's site MDC is compared to the background 95th UTL or 95th percentile, in accordance with the type of background distribution. If the site MDC exceeds the background screening value, then that analyte will undergo a geochemical evaluation. If the MDC does not exceed the background threshold value, then hot-spot contamination is not indicated.

2.1.3 Geochemical Evaluation

If an analyte fails the statistical tests described above then a geochemical evaluation is performed to determine if the elevated concentrations are caused by natural processes. The methodology and results of the geochemical evaluation are provided separately.

3.0 Results of the Site-to-Background Comparisons

This section presents the results of the site-to-background comparisons for 23 TAL metals in the Old Water Hole, Parcel 205(7) surface soil, subsurface soil, and groundwater samples. Tables 1 through 3 summarize the Tier 1 and Tier 2 test results for each media as discussed in the following sections, and the box plots discussed are provided in Attachment 1.

3.1 Surface Soil

Twenty-three TAL metals were evaluated in the surface soil data set from Parcel 205. Four metals (antimony, cadmium, silver, and thallium) have no detected concentrations in surface soil, so no further discussion of these metals is included.

Thirteen metals (aluminum, barium, beryllium, calcium, cobalt, lead, magnesium, manganese, mercury, nickel, potassium, sodium, and vanadium) have no detected concentrations above their respective background screening values. Passing the Tier 1 evaluation these metals are considered to be within the range of background. No further testing or discussion of these metals is included.

The remaining 6 metals (arsenic, chromium, copper, iron, selenium, and zinc) are carried forward for Tier 2 evaluation.

Table 1 summarizes the surface soil statistical site to background comparison results. Box plots are provided in Attachment 1.

Arsenic

Tier 1 Evaluation

One site sample exceeds the background screening value of 13.73 mg/kg.

Tier 2 Evaluation

Slippage Test

The critical value, K_c , for arsenic is 2. No site samples exceed the maximum background measurement ($K = 0$). Because $K < K_c$, arsenic passes the Slippage test.

WRS Test

The p-level of 0.99 indicates excellent agreement between the site and background distributions.

Box Plot

The site 25th percentile and maximum are lower than the corresponding background values (Figure 1-1). The site minimum, median, and 75th percentile are slightly elevated compared to those of background.

Conclusion

Arsenic in surface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Chromium

Tier 1 Evaluation

One site sample exceeds the background screening value of 37.04 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for chromium is 2, and no site samples exceed the maximum background measurement. Because $K < K_c$, chromium passes the Slippage test.

WRS Test

The p-level of 0.53 indicates a strong agreement between the site and background distributions.

Box Plot

The site interquartile range and the maximum are lower than the corresponding background values (Figure 1-1). The site minimum is higher than that of background.

Conclusion

Chromium in surface soil is considered to be within the range of background.

Copper

Tier 1 Evaluation

Two site samples exceed the background screening value of 12.71 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for copper is 2, and 1 site sample exceeds the maximum background measurement. Because $K < K_c$, copper passes the Slippage test.

WRS Test

The p-level of 0.117 indicates a weak agreement between the site and background distributions.

Box Plot

The site interquartile range and maximum are higher than the corresponding background values (Figure 1-2). The site minimum is significantly higher than that of background.

Conclusion

Because copper in surface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Iron

Tier 1 Evaluation

One site sample exceeds the background screening value of 34,154 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for iron is 2, and no site samples exceed the maximum background measurement. Because $K < K_c$, iron passes the Slippage test.

WRS Test

The p-level of 0.24 indicates a good agreement between the site and background distributions.

Box Plot

The site interquartile range and maximum are lower than the corresponding background values (Figure 1-2). The site minimum is higher than that of background.

Conclusion

Iron in surface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Selenium

Tier 1 Evaluation

One site sample exceeds the background screening value of 0.48 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for selenium is 2, and 1 site sample exceeds the maximum background measurement. Because $K < K_c$, selenium passes the Slippage test.

WRS Test

The WRS test is not performed because the background and site data sets contain more than 50 percent nondetects.

Box Plot

The site minimum, interquartile range, and maximum are higher than the corresponding background values (Figure 1-3). The shapes and locations of the background and site box plots are influenced by the high percentage of nondetects (99 percent and 83 percent, respectively), and the replacement values of one-half the reporting limit rather than detected concentrations.

Hot Measurement Test

The site MDC of selenium exceeds the background 95th percentile of 0.563 mg/kg.

Conclusion

Because selenium in surface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Zinc

Tier 1 Evaluation

One site sample exceeds the background screening value of 40.64 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for zinc is 2, and no site samples exceed the maximum background measurement. Because $K < K_c$, zinc passes the Slippage test.

WRS Test

The p-level of 0.896 indicates excellent agreement between the site and background distributions.

Box Plot

The site median and maximum are lower than the corresponding background values (Figure 1-3). The site 25th and 75th percentiles are the same as background, and the site minimum is higher than that of background.

Conclusion

Zinc in surface soil passed the Tier 2 evaluation and is considered to be within the range of background.

3.2 Subsurface Soil

Twenty-three TAL metals were evaluated in the Old Water Hole, Parcel 205(7) subsurface soil. Five metals (antimony, beryllium, cadmium, silver, and thallium) had no detected concentrations in subsurface soil. No further discussion of these metals is included.

Fourteen metals (aluminum, barium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, mercury, nickel, sodium, vanadium, and zinc) had no detected results that exceeded the background screening value. Because these metals pass the Tier 1 evaluation, they are considered to be within the range of background. They will not be tested or discussed further.

The remaining four metals are carried forward for Tier 2 evaluation and the test results are discussed below in detail.

Table 2 summarizes the Tier 1 and Tier 2 evaluation of subsurface soil.

Arsenic

Tier 1 Evaluation

One site sample exceeds the background screening value of 18.3 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for arsenic is 2, and one site sample exceeds the maximum background measurement. Because $K < K_c$, arsenic passes the Slippage test.

WRS Test

The p-level of 0.357 indicates a good agreement between the site and background distributions.

Box Plot

The site interquartile range is lower than the corresponding background values (Figure 1-4). The site minimum and maximum are higher than that of background.

Conclusion

Arsenic in subsurface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Copper

Tier 1 Evaluation

One site sample exceeds the background screening value of 19.43 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for copper is 2, and no site samples exceed the maximum background measurement. Because $K < K_c$, copper passes the Slippage test.

WRS Test

The p-level of 0.345 indicates a good agreement between the site and background distributions.

Box Plot

The site median, 75th percentile, and maximum are less than the corresponding background values (Figure 1-4). The site minimum is greater than that of background, and the site and background 25th percentiles are similar.

Conclusion

Copper in subsurface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Potassium

Tier 1 Evaluation

One site sample exceeds the background screening value of 710.74 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for potassium is 2, and no site samples exceed the maximum background measurement. Since $K < K_c$, potassium passes the Slippage test.

WRS Test

The p-level of 0.438 indicates a strong agreement between the site and background distributions.

Box Plot

The site 75th percentile and maximum are lower than the corresponding background values (Figure 1-5). The site median is slightly elevated compared to that of background, and the site minimum and 25th percentile are higher than that of the corresponding background values.

Conclusion

Potassium in subsurface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Selenium

Tier 1 Evaluation

One site sample exceeds the background screening value of 0.47 mg/kg.

Tier 2 Evaluation

Slippage Test

The Slippage test is not performed because the maximum detected background result for selenium is a nondetect.

WRS Test

The WRS test is not evaluated because the background and site data sets contain more than 50 percent nondetects.

Box Plot

The site minimum, interquartile range, and maximum are higher than the corresponding background values (Figure 1-5). The shapes and locations of the background and site box plots are influenced by the high percentage of nondetects (98 percent and 83 percent, respectively) and the replacement values of one-half the reporting limit rather than detected concentrations.

Hot Measurement Test

The site MDC of selenium exceeds the background 95th percentile of 0.574 mg/kg.

Conclusion

Because selenium in subsurface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

3.3 Groundwater

This section presents the results of the statistical site-to-background comparison of 23 TAL metals from unfiltered groundwater samples. Ten metals (antimony, beryllium, cadmium,

copper, lead, magnesium, mercury, silver, thallium, and zinc) had no detected results in the groundwater site samples and are not considered any further.

Eight metals (aluminum, arsenic, barium, calcium, cobalt, iron, manganese, and vanadium) had no detected concentrations exceeding their respective background screening values. These metals are considered to be within the range of background based on the Tier 1 evaluation. They will not be tested or discussed further.

The remaining five metals are carried forward for Tier 2 evaluation. The results of this evaluation are discussed in detail below.

Table 3 summarizes the Tier 1 and Tier 2 results for groundwater.

Chromium

Tier 1 Evaluation

No background screening value is available for chromium. Two site samples have detected results.

Tier 2 Evaluation

Slippage Test

The Slippage test is not performed because the maximum background result for chromium is a nondetect.

WRS Test

The WRS test was not performed because the background and site data sets contain more than 50 percent nondetects.

Box Plot

The site minimum, interquartile range and maximum exceed the corresponding background values (Figure 1-6). The shapes and locations of the background and site box plots are influenced by the high percentage of nondetects (100 percent and 78 percent, respectively) and the replacement values of one-half the reporting limit rather than detected concentrations.

Hot Measurement Test

The site MDC is less than the background 95th percentile of 0.0168 mg/L.

Conclusion

Chromium in groundwater passed the Tier 2 evaluation and is considered to be within the range of background.

Nickel

Tier 1 Evaluation

No background screening value is available for nickel. One site sample has a detected result.

Tier 2 Evaluation

Slippage Test

The Slippage test is not performed because the maximum background result for nickel is a nondetect.

WRS Test

The WRS test was not performed because the background and site data sets contain more than 50 percent nondetects.

Box Plot

The site minimum, 25th percentile, median, and maximum are higher than the corresponding background values (Figure 1-6). The site 75th percentile is lower than that of background. The shapes and locations of the background and site box plots are influenced by the high percentage of nondetects (100 percent and 89 percent, respectively) and the replacement values of one-half the reporting limit rather than detected concentrations.

Hot Measurement Test

The site MDC is less than the background 95th percentile of 0.0343 mg/L.

Conclusion

Nickel in groundwater passes the Tier 2 evaluation and is considered to be within the range of background.

Potassium

Tier 1 Evaluation

Three site samples exceed the background screening value of 7.195 mg/L.

Tier 2 Evaluation

Slippage Test

K_c for potassium is 2, and no site samples exceed the maximum background measurement. Since $K < K_c$, potassium passes the Slippage test.

WRS Test

The WRS test was not performed because the site data set contains more than 50 percent nondetects.

Box Plot

The site minimum and interquartile range are higher than the corresponding background values (Figure 1-7). The site maximum is less than that of background. The shape and location of the site box plot are influenced by the percentage of nondetects (56 percent) and the replacement values of one-half the reporting limit rather than detected concentrations.

Hot Measurement Test

The site MDC of potassium is greater than the background 95th percentile of 16 mg/L.

Conclusion

Because potassium in groundwater failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Selenium

Tier 1 Evaluation

No background screening value is available for selenium. One site sample has a detected result.

Tier 2 Evaluation

Slippage Test

The Slippage test is not performed because the maximum background result for selenium in groundwater is a nondetect.

WRS Test

The WRS test was not performed because the background and site data sets contain more than 50 percent nondetects.

Box Plot

The site minimum and interquartile range are higher than the corresponding background values (Figure 1-7). The site maximum is lower than that of background. The shapes and locations of the background and site box plots are influenced by the high percentage of nondetects (100 percent and 89 percent, respectively) and the replacement values of one-half the reporting limit rather than detected concentrations.

Hot Measurement Test

The site MDC is less than the background 95th percentile of 0.0971 mg/L.

Conclusion

Selenium in groundwater passes the Tier 2 evaluation and is considered to be within the range of background.

Sodium

Tier 1 Evaluation

Two site samples exceed the background screening value of 14.846 mg/L.

Tier 2 Evaluation

Slippage Test

K_c for sodium is 2, and no site samples exceed the maximum background measurement. Because $K < K_c$, sodium passes the Slippage test.

WRS Test

The WRS test was not performed because the site data set contains more than 50 percent nondetects.

Box Plot

The site 25th percentile, median, and maximum are lower than the corresponding background values (Figure 1-8). The site minimum and 75th percentile are slightly higher compared to that of background. The shape and location of the site box plot are influenced by the percentage of nondetects (67 percent) and the replacement values of one-half the reporting limit rather than detected concentrations.

Hot Measurement Test

The site MDC of sodium is less than the background 95th UTL of 49.028 mg/L.

Conclusion

Sodium in groundwater passes the Tier 2 evaluation and is considered to be within the range of background.

4.0 Summary and Conclusions

The statistical methodology used to compare samples taken from Old Water Hole, Parcel 205(7), and background data sets for 23 elements in surface soil, subsurface soil, and groundwater include a comparison of the site MDC to the background screening value, Tier 1 evaluation. Analytes that failed this comparison were subjected to the Slippage test and WRS test. Box-and-whisker plots were prepared to visually compare the two data sets and properly interpret the WRS test results. For elements with data sets that did not allow for either the Slippage test or WRS test to be performed, the Hot Measurement test was used. Analytes that failed these statistical tests, Tier 2 evaluation, are carried forward for Tier 3 geochemical evaluation to determine if natural processes can explain the elevated concentrations.

Tables 1 through 3 summarize the statistical comparison test results and show the metals carried forward for geochemical evaluation.

5.0 References

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ATTACHMENT 1

Figure 1-1

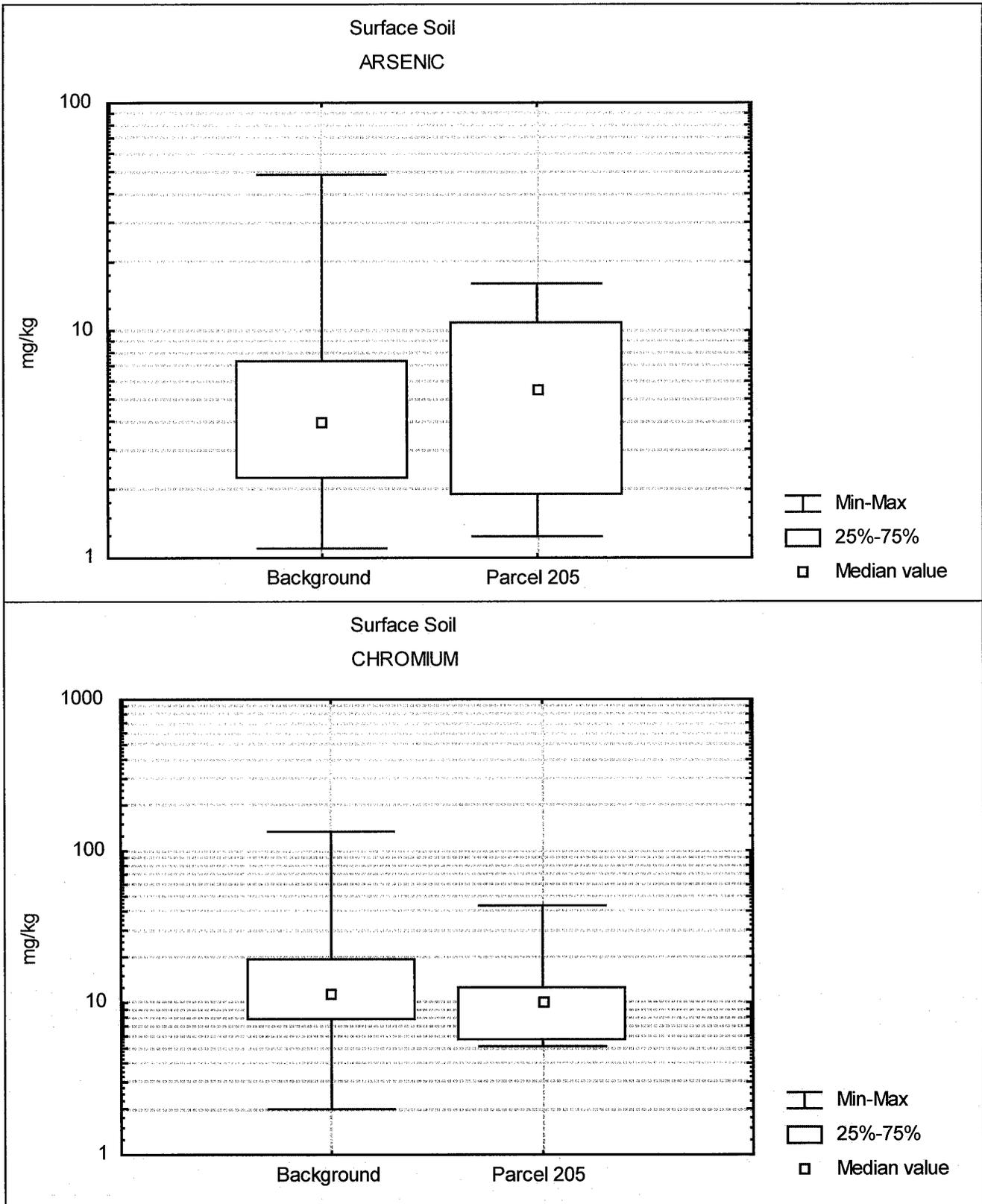


Figure 1-2

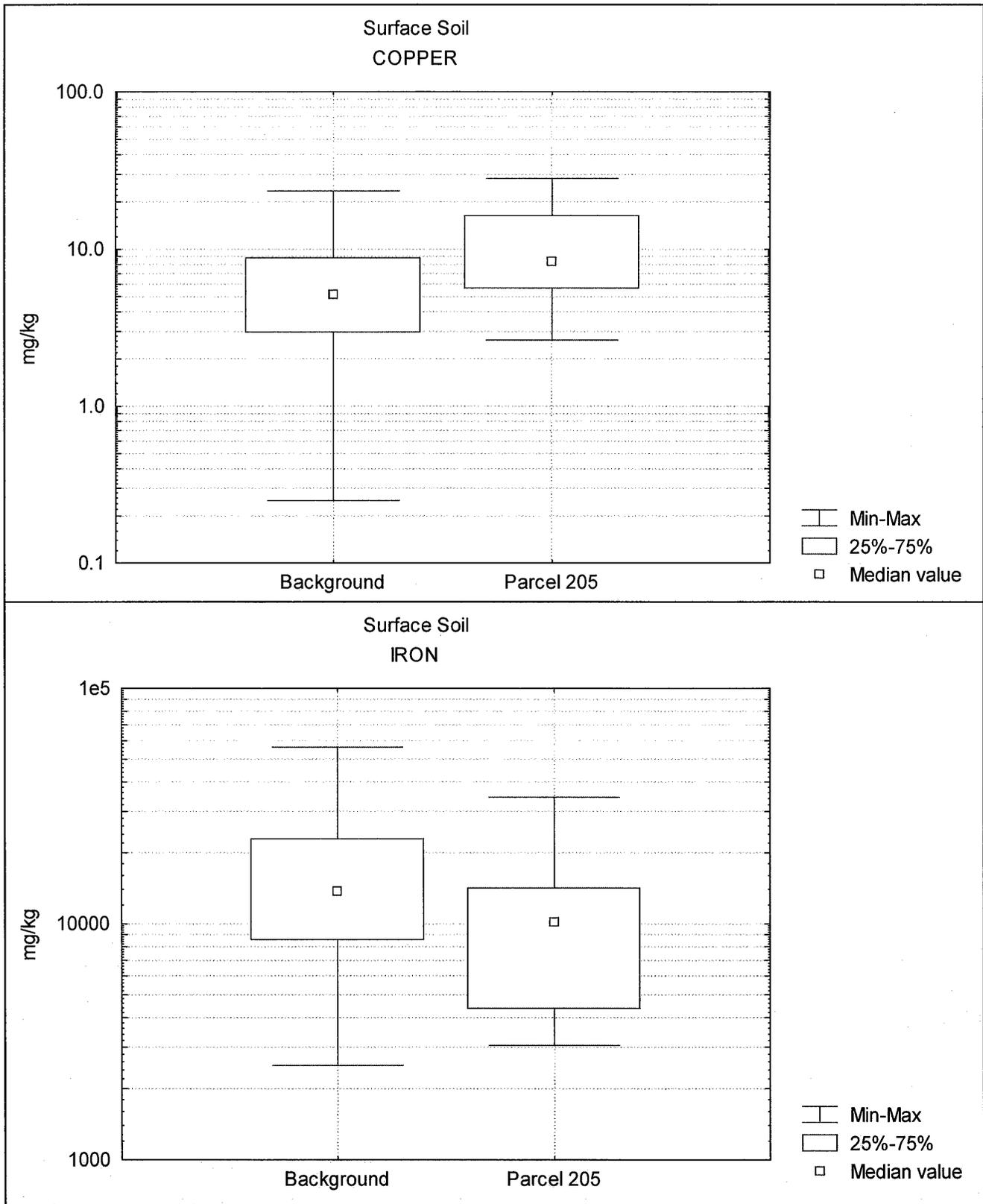


Figure 1-3

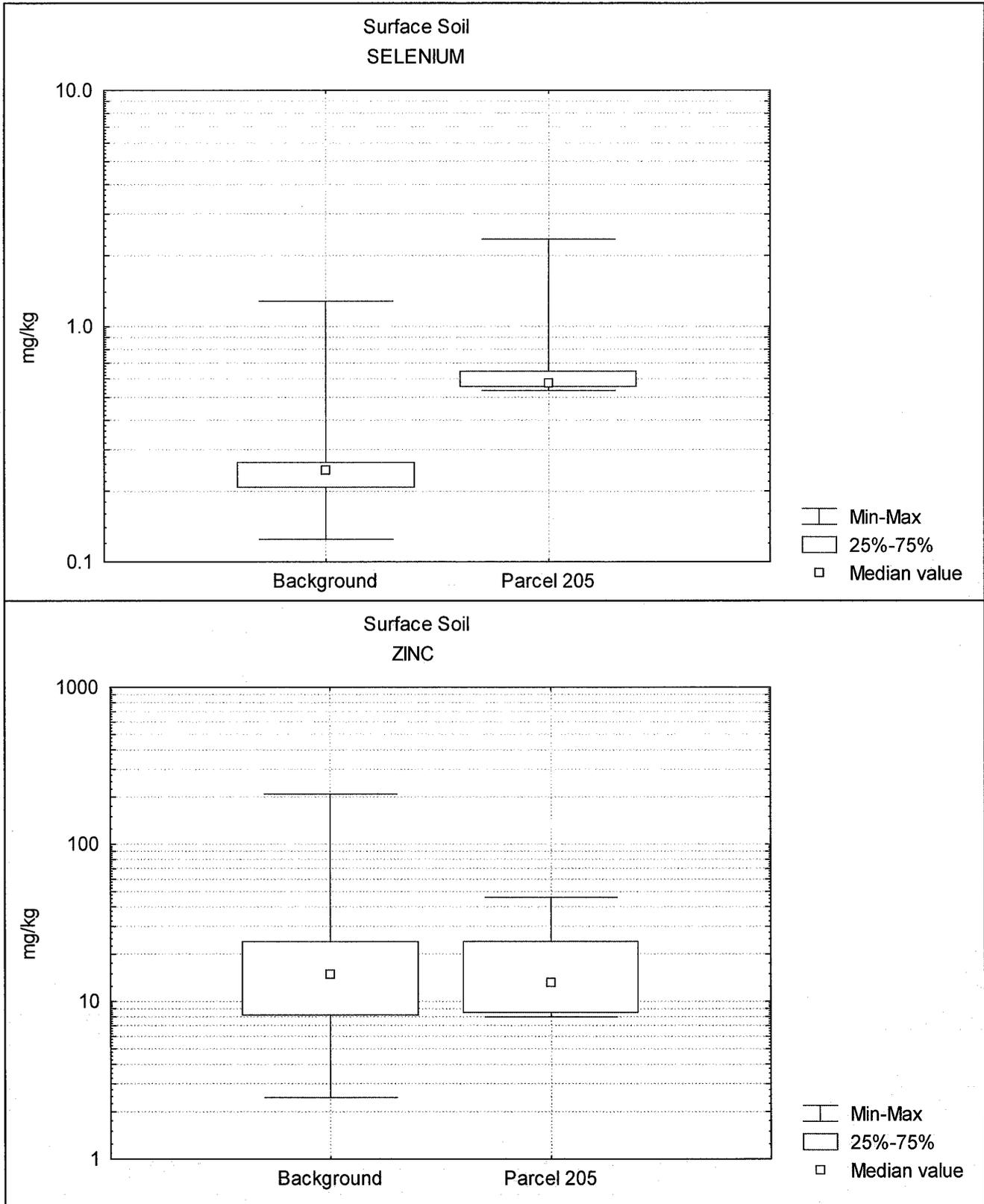


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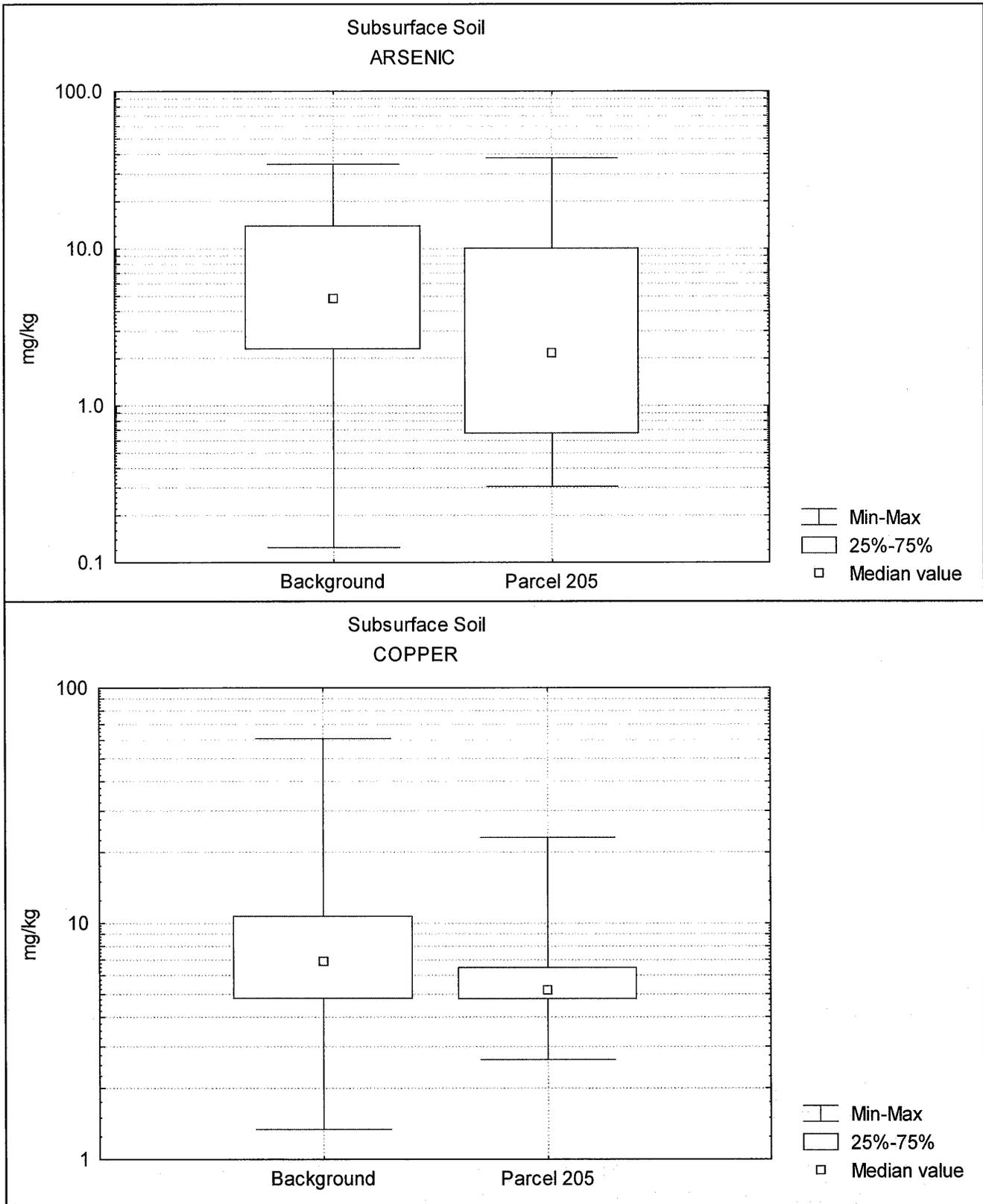


Figure 1-5

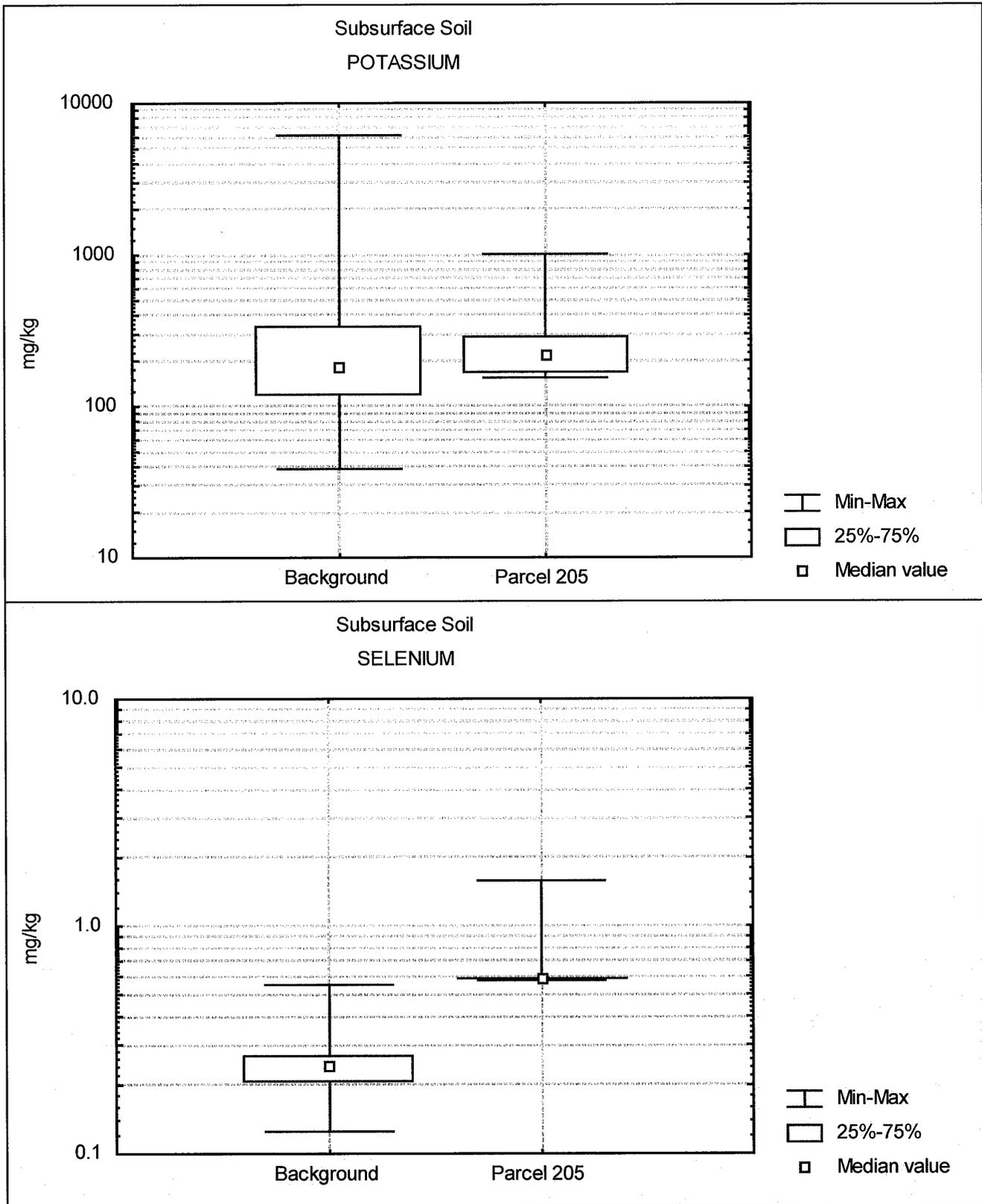


Figure 1-6

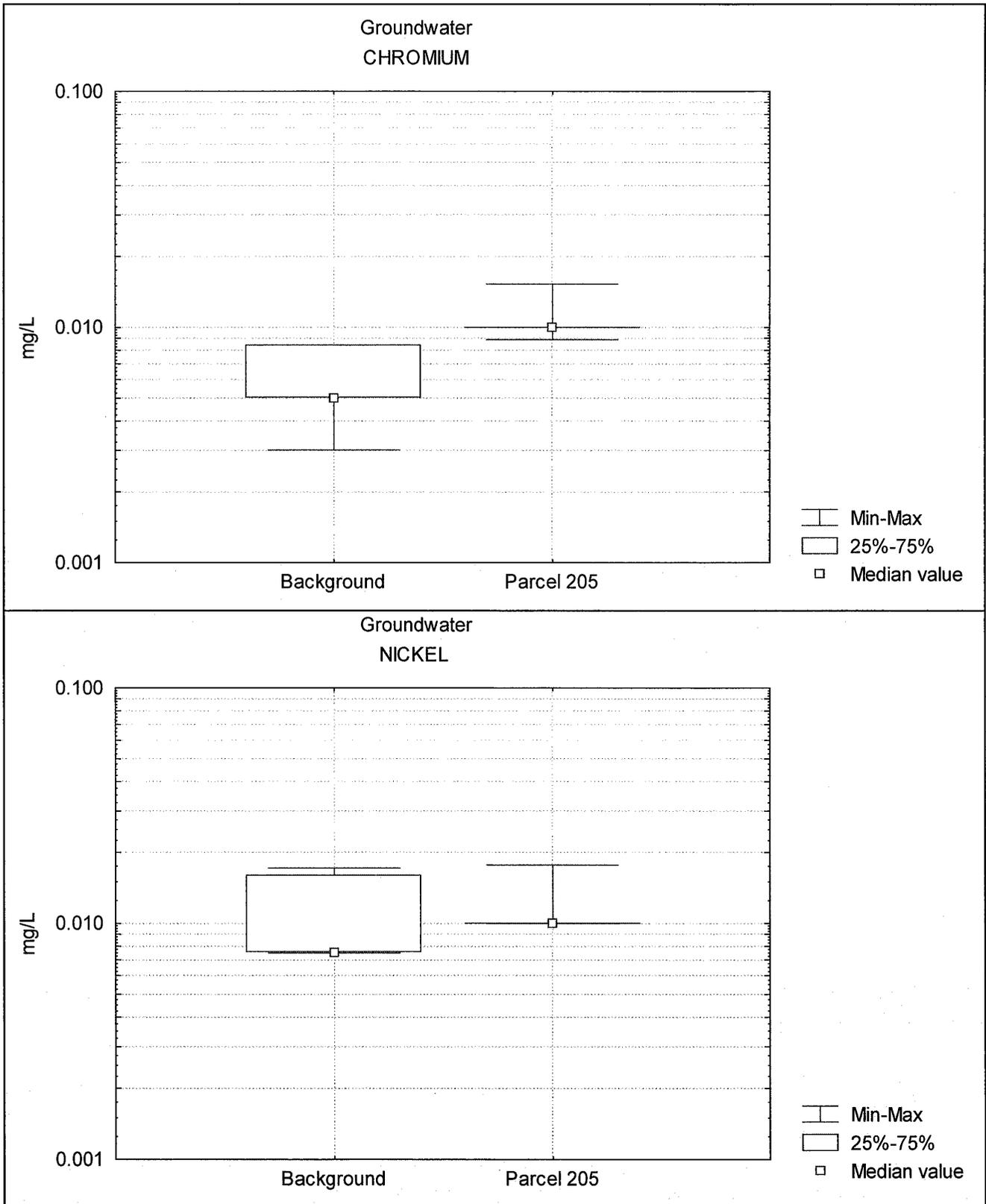


Figure 1-7

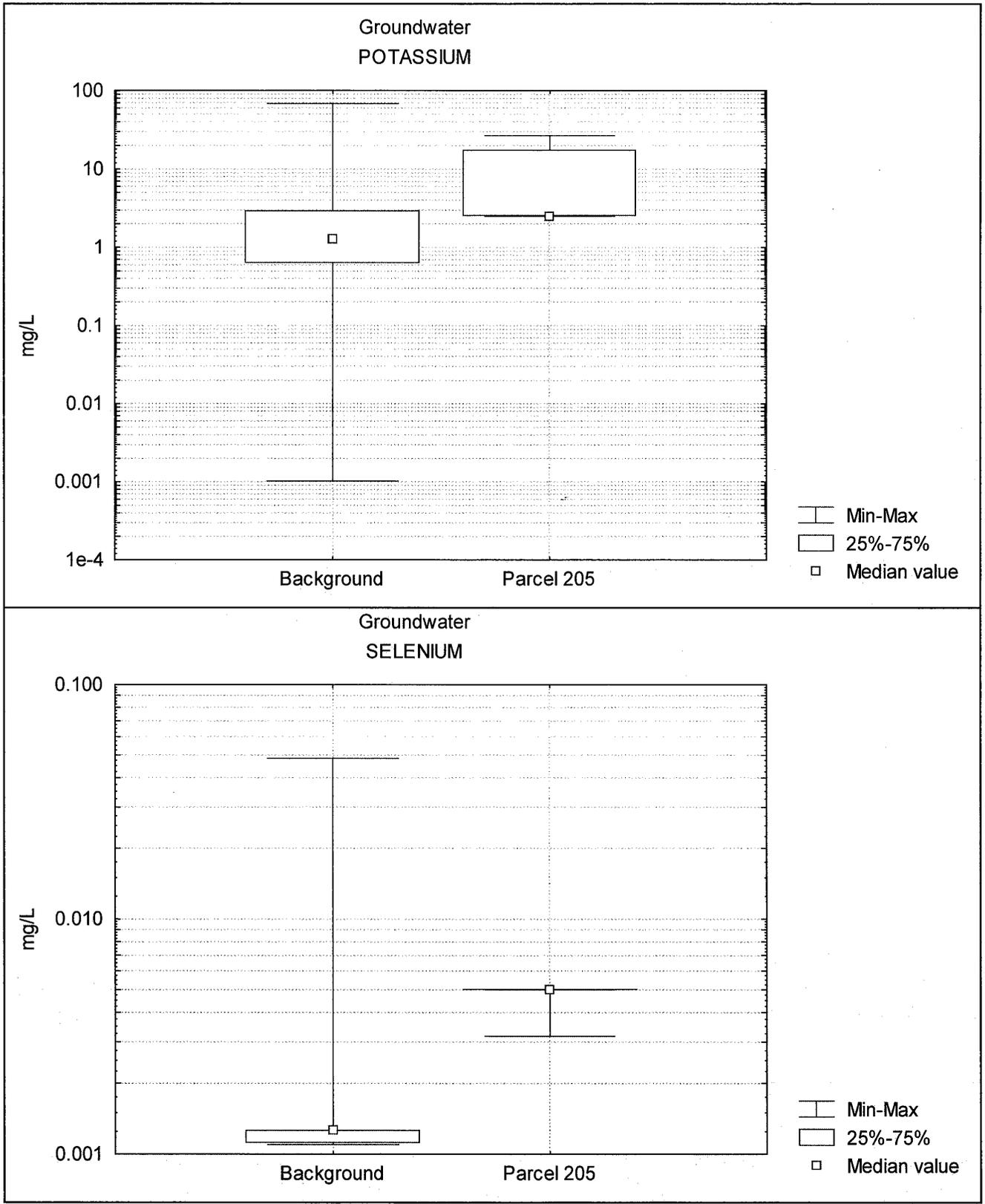
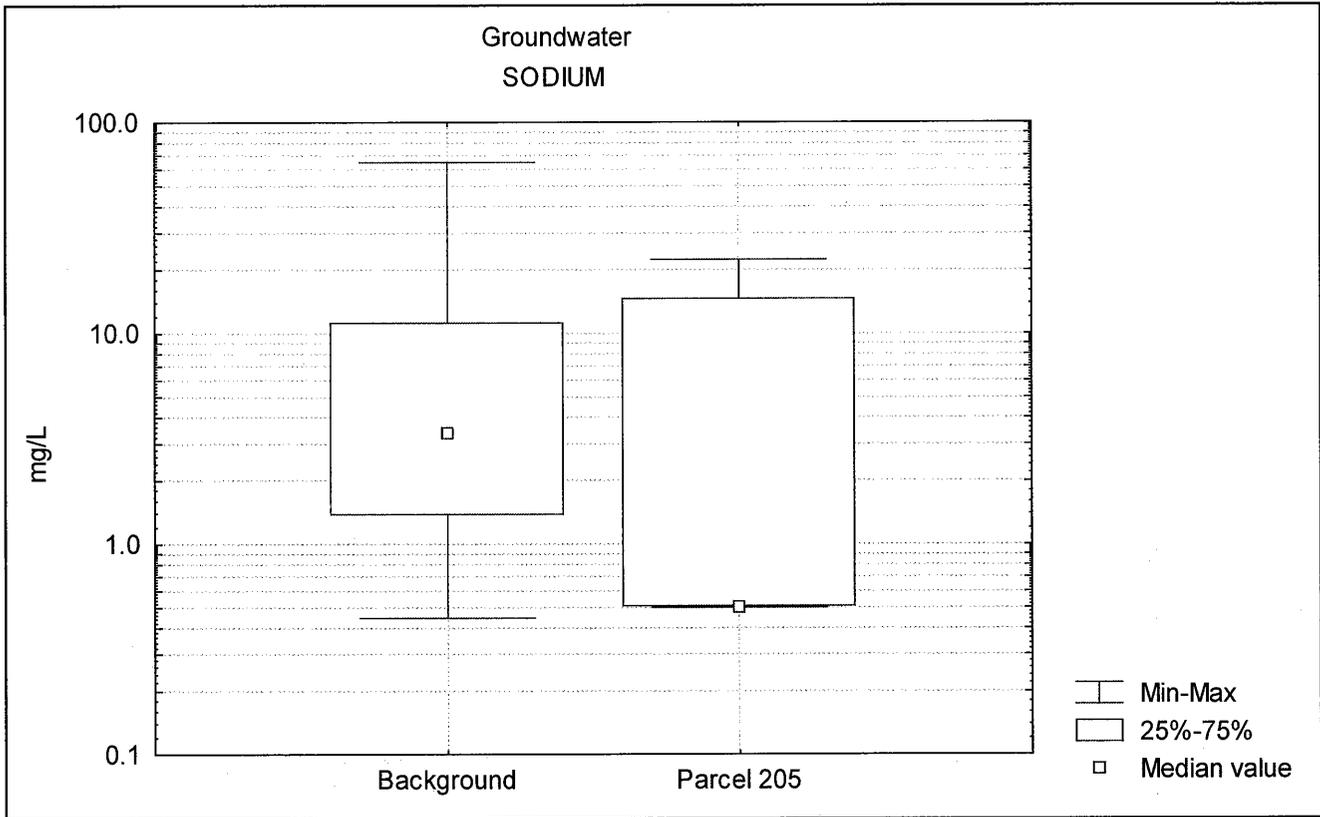


Figure 1-8



**GEOCHEMICAL
(TIER 3)**

Geochemical Evaluation of Metals in Soil and Groundwater Old Water Hole, Parcel 205(7) Fort McClellan, Alabama

1.0 Introduction

This report provides the results of a geochemical evaluation of inorganic constituents in soil and groundwater samples from the Old Water Hole, Parcel 205(7), at Fort McClellan in Calhoun County, Alabama. Two elements in soil and one element in groundwater failed statistical comparison to background. A geochemical evaluation was performed to determine if the elevated concentrations are naturally occurring or if they contain a component of contamination.

Site samples included in the evaluation consist of six surface soil samples (obtained from a depth of 0 to 1 foot below ground surface [bgs]) and six subsurface soil samples (obtained from various depths ranging from 4 to 12 feet bgs) collected in August 2002; and nine unfiltered groundwater samples collected in October and November 2002. All of the site samples were analyzed for the full suite of 23 target analyte list (TAL) metals. Installation-wide background data for TAL metals in soil and groundwater are provided in the background study report (Science Applications International Corporation, 1998) and are used in the following evaluation.

2.0 Geochemical Evaluation Methodology

Naturally occurring trace element concentrations in environmental media commonly exceed regulatory screening criteria or fail statistical comparison to background data sets. Trace element distributions in uncontaminated soil and sediment tend to have very large ranges (two to three orders of magnitude are not uncommon), and are highly right-skewed, resembling lognormal distributions. These trace elements are naturally associated with specific minerals, and the preferential enrichment of a sample with these minerals will result in elevated trace element concentrations. It is thus important to be able to identify these naturally high concentrations and distinguish them from potential contamination.

If an analyte fails statistical comparison to background as described in the “Statistical Comparison of Site and Background Data, Old Water Hole, Parcel 205(7),” then a geochemical evaluation is performed to determine if the elevated concentrations are caused by natural processes. The importance of geochemical evaluations in distinguishing between site and background data sets has been recognized in the industry (U.S. Environmental Protection Agency, 1995; Barclift, *et al.*, 2000; U.S. Navy, 2002; Myers and Thorbjornsen, 2004). When

properly evaluated, geochemistry can provide mechanistic explanations for apparently high, yet naturally occurring, constituents. Anomalous samples that may represent contamination can also be readily distinguished from uncontaminated samples. This section describes the geochemical evaluation techniques that were employed in the site-to-background comparisons for Parcel 205(7). Additional supporting information on these techniques are provided in the installation-wide work plan (IT Corporation, 2002) and Shaw Environmental's technical memorandum dated June 24, 2003.

It should be noted that the geochemical evaluations rely in part on professional judgment and qualitative assessment is a necessary part of the process. Samples that plot off the linear trend on a correlation plot are certainly suspect, but because all uncertainty cannot be eliminated from the evaluation, such plots cannot be construed as definitive proof of contamination. However, anomalous samples should be flagged as suspect and their results used as a basis for further investigation, risk assessment, or remediation, as appropriate. The combination of statistical evaluations (Tiers 1 and 2) and geochemical evaluation (Tier 3) as presented in this appendix is effective in reducing the occurrences of decision errors relative to consideration of statistics or geochemistry alone.

2.1 Soil and Sediment

The geochemical evaluation is based on the natural associations of trace elements with specific minerals in the soil or sediment matrix. As an example, arsenic in most uncontaminated oxic soils is almost exclusively associated with iron oxide minerals (Bowell, 1994; Schiff and Weisberg, 1997). (The term "iron oxide" is used here to include oxides, hydroxides, oxyhydroxides, and hydrous oxides of iron.) This association of arsenic with iron oxides is a result of the adsorptive behavior of this particular trace metal in an oxic soil environment. Arsenic is present in oxic soil pore fluid as negatively charged oxyanions (HAsO_4^{-2} , H_2AsO_4^-) (Brookins, 1988). These anions have strong affinities to adsorb on the surfaces of iron oxides, which maintain a strong positive surface charge (Electric Power Research Institute, 1986). If a soil sample has a high percentage of iron oxides, then it is expected to have a proportionally higher concentration of arsenic.

The absolute concentrations of arsenic and iron can vary by several orders of magnitude at a site, but the arsenic/iron ratios in the samples are usually quite constant as long as no contamination is present (Daskalakis and O'Connor, 1995). If a sample has some naturally occurring arsenic plus additional arsenic from an herbicide or some other source, then it will have an anomalously high

ratio relative to the other uncontaminated samples. These ratios thus serve as a powerful technique for identifying contaminated samples.

The evaluation includes the generation of plots in which detected arsenic concentrations in a set of samples are plotted on the y-axis, and the corresponding detected iron concentrations are plotted on the x-axis. The slope of a best-fit line through the samples is equal to the average As/Fe background ratio. If the samples with the highest arsenic concentrations plot on the same linear trend as the other samples, then it is most probable that the elevated concentrations are natural, and are caused by the preferential enrichment of iron oxides in those samples. If the site samples with elevated arsenic concentrations plot above the trend displayed by the uncontaminated samples, then there is evidence that those samples have an excess contribution of arsenic, and contamination may be indicated.

These trends may be linear or may have some curvature to them. The adsorption of a trace element on a mineral surface can usually be described by a linear isotherm over a limited range of concentrations, but a two-parameter curved fit (such as a Freundlich or Langmuir isotherm) can be more appropriate for some trace elements over a broader range of concentrations. The trace-versus-major element correlations are referred to as “linear trends” for convenience in this report, even though there may be some degree of curvature to the natural relationship.

Each trace element is associated with one or more minerals in the soil matrix. Vanadium and selenium, along with arsenic, form anionic species in solution and are associated with iron oxides, which maintain a positive surface charge. Divalent metals such as barium, cadmium, lead, and zinc tend to form cationic species in solution and are attracted to clay mineral surfaces, which maintain a negative surface charge. These trace elements would be evaluated against aluminum, which is a major component of clay minerals. Manganese oxides also have an affinity to adsorb divalent cations such as barium, cobalt, and lead (Kabata-Pendias, 2001). These trace elements would be evaluated against manganese.

2.2 Groundwater and Surface Water

Elevated concentrations of inorganic constituents in groundwater and surface water samples may be due to naturally high dissolved concentrations, the presence of suspended particulates in the samples, reductive dissolution, or contamination resulting from site activities. This section discusses the major geochemical processes considered during the evaluation of groundwater and surface water analytical data.

Effects of Suspended Particulates. The presence of trace elements adsorbed on suspended particulates can greatly increase trace element concentrations as reported by an analytical laboratory. These adsorbed trace elements are not in true solution, and can be removed by settling or filtration. The same concepts involved in the evaluation of soil and sediment data also apply to groundwater and surface water data: samples containing trace elements adsorbed on suspended clay particulates should show a positive correlation with aluminum concentrations, and samples containing trace elements adsorbed on suspended iron oxides should show a positive correlation with iron concentrations. These correlations are evaluated by generating x-y plots of the concentrations of an elevated trace metal versus aluminum or iron (depending on the trace element).

The most common suspended particulates in groundwater samples are clay minerals; hydrous aluminum oxides ($\text{Al}_2\text{O}_3 \cdot n\text{H}_2\text{O}$) and hydroxides [$\text{Al}(\text{OH})_3$]; and iron oxide (Fe_2O_3), iron hydroxide [$\text{Fe}(\text{OH})_3$], and iron oxyhydroxide ($\text{FeO} \cdot \text{OH}$) minerals, collectively referred to as “iron oxides.” All clay minerals contain aluminum and have low solubilities over a neutral pH range of 6 to 8. Measured concentrations of aluminum in excess of ~1 milligram per liter (mg/L) indicate the presence of suspended clay minerals (Hem, 1985; Stumm and Morgan, 1996), with higher aluminum concentrations being a qualitative indicator of the mass of suspended clay minerals. Iron also has a very low solubility under neutral pH and moderate to oxidizing redox conditions, so that measured iron concentrations in excess of ~1 mg/L under these conditions indicate the presence of suspended iron oxides (Hem, 1985).

The presence of suspended clay or iron oxides in groundwater samples has particular importance in the interpretation of trace element concentrations. Most clay particles maintain a negative surface charge under neutral pH conditions, and have a strong tendency to adsorb positively charged (cationic) aqueous species. Iron oxides display the opposite behavior; they maintain a positive surface charge under neutral pH conditions, and have a strong tendency to adsorb negatively charged (anionic) aqueous species.

Barium, lead, and zinc are usually present in groundwater as divalent cations and thus tend to concentrate on clay surfaces (Electric Power Research Institute, 1984; Brookins, 1988). Arsenic, selenium, and vanadium are usually present under oxidizing conditions as oxyanions, and thus tend to concentrate on iron oxide surfaces (Bowell, 1994; Hem, 1985; Pourbaix, 1974; Brookins, 1988).

Chromium can be present in groundwater as a mixture of aqueous species with different charges such as $\text{Cr}(\text{OH})_2^+$, $\text{Cr}(\text{OH})_3^0$, and $\text{Cr}(\text{OH})_4^-$, depending on pH (EPRI, 1984). The positive, neutral, and negative charges on these species result in the distribution of chromium on several different types of sorptive surfaces, including clay and iron oxide minerals.

As an example, the concentrations of zinc (y-axis) would be plotted against aluminum (x-axis). If all of the samples display a common linear trend, then it is most likely that the zinc concentrations are due to the presence of suspended clay minerals in the samples. The slope of a best-fit line through the points is equal to the average Zn/Al ratio. If some samples plot above the linear trend established by the other samples, then those samples have an anomalously high Zn/Al ratio, and most likely contain excess zinc that cannot be explained by these natural processes.

These trends may be linear or may have some curvature to them. The adsorption of a trace element on a mineral surface can usually be described by a linear isotherm over a limited range of concentrations, but a two-parameter curved fit (such as a Freundlich or Langmuir isotherm) can be more appropriate for some trace elements over a broader range of concentrations. The trace-versus-major element correlations are referred to as “linear trends” for convenience in this report, even though there may be some degree of curvature to the natural relationship.

Alternative techniques for assessing the effects of suspended particulates on trace element concentrations are the evaluation of correlations of trace element concentrations versus turbidity, evaluation of correlations of trace element concentrations versus total suspended solids, and comparison of analyses of filtered versus unfiltered splits of samples. Turbidity measurements are qualitative, and do not distinguish between suspended clay minerals, iron oxides, and natural organic material, so this approach lacks the resolution provided by trace element versus aluminum or trace element versus iron correlations.

If the concentrations of trace elements in unfiltered samples are correlated with aluminum or iron, then they are most likely adsorbed to the surfaces of suspended particulates. If these correlations are linear, then the elevated concentrations are most likely natural.

Effects of Reductive Dissolution. Iron and manganese oxides concentrate several trace elements such as arsenic, selenium, and vanadium on mineral surfaces, as discussed above. In soils and sedimentary aquifers, these elements are almost exclusively associated with iron and

manganese oxide minerals and grain coatings, as long as the redox conditions are moderate to oxidizing.

The release of organic contaminants such as fuels or chlorinated solvents can establish local reducing environments caused by anaerobic microbial degradation of the organic compounds. The establishment of local reducing conditions can drive the dissolution of iron and manganese oxides, which become soluble as the redox potential drops below a threshold value. Dissolution of these oxide minerals can mobilize the trace elements that were adsorbed on the oxide surfaces, which is a process termed “reductive dissolution.” Several investigations have documented the mobilization of arsenic, selenium, and other trace elements under locally reducing redox conditions (Sullivan and Aller, 1996; Nickson, *et al.*, 2000; Belzile, *et al.*, 2000).

Evidence for reductive dissolution would be a correlation between elevated trace elements (arsenic, selenium, and vanadium in particular) versus lower redox conditions. Low redox conditions can be identified by local depressions in oxidation-reduction potential (ORP) or dissolved oxygen (DO) measurements, or the presence of reducing gases such as hydrogen, methane, ethane, or ethene. Anaerobic microbes can also reduce sulfate to sulfide and nitrate to ammonia, resulting in local depressions in sulfate and nitrate concentrations, and local detections of sulfide and ammonia. In areas impacted by chlorinated solvents, additional evidence for the establishment of anaerobic reducing conditions is the presence of *cis*-1,2-dichloroethene and/or vinyl chloride, which are reductive dechlorination products resulting from the microbial degradation of trichloroethene or tetrachloroethene under anaerobic conditions.

3.0 Results of the Geochemical Evaluation of Copper and Selenium in Soil

This section presents the results of the geochemical evaluation of copper and selenium in soil samples from Parcel 205(7). Correlation plots are provided in Attachment 1.

Copper

Copper in soil has an affinity for different sorptive surfaces including aluminum hydroxides, clays, iron oxides, and manganese oxides (Kabata-Pendias, 2001); as a result, correlations of copper concentrations versus aluminum, iron, or manganese concentrations are not always strong, even in uncontaminated samples. A plot of copper versus aluminum for the Parcel 205(7) and background samples is provided in Figure 1. Most of the background samples form a generally linear trend with a positive slope, and the site samples lie on this trend. This indicates that copper in the site samples is associated with clays at ratios consistent with those of the background samples, and is natural.

This conclusion is supported by comparison of site versus background Cu/Al ratios. Figure 2 displays the copper concentrations of the site and background samples (y-axis) versus their corresponding Cu/Al ratios (x-axis). If a site sample contained excess copper from a contaminant source, then it would exhibit an anomalously high Cu/Al ratio relative to background and would plot to the right of the background samples in Figure 2. No such samples are observed in the plot. All of the site samples exhibit Cu/Al ratios that are within the background range.

Conclusion

Copper detected in the site soil samples is naturally occurring.

Selenium

Selenium is present in oxic soil pore fluid as oxyanions, and has a strong affinity to adsorb on iron oxides, which tend to maintain a net positive surface charge. A positive correlation between selenium and iron concentrations is thus expected for uncontaminated soil samples. A plot of detectable selenium versus iron concentrations is provided in Figure 3 (site results with “B” validation qualifiers are treated as detections for the purposes of this evaluation). The site samples form a strong linear trend with a positive slope; of the two background samples with detectable selenium, the sample with the higher concentration lies on this linear trend. The site samples with the highest selenium concentrations also exhibit proportionally higher iron content, which indicates that these samples are preferentially enriched in iron oxides and associated trace elements. Selenium in these samples is natural.

Conclusion

Selenium detected in the site soil samples is naturally occurring.

4.0 Results of the Geochemical Evaluation of Potassium in Groundwater

This section presents the results of the geochemical evaluation of potassium in the nine unfiltered groundwater samples from Parcel 205(7). Correlation plots are provided in Attachment 1.

Field-measured pH readings for the groundwater samples range from 5.65 to 10.69 standard units, with a median of 8.11 and mean of 8.18. These values indicate neutral to alkaline pH conditions at the sample locations. Field-measured DO readings range from 1.88 to 10.9 mg/L, with a median of 6.28 mg/L and mean of 6.19 mg/L, and ORP readings range from +73 to +358 millivolts (mV), with a median of +107 mV and mean of +182 mV. These values suggest moderate to oxidizing redox conditions at the sample locations. Turbidity measurements range from 2 to 36 nephelometric turbidity units (NTU), with a median of 9 NTU and mean of 11 NTU. These readings indicate that the site samples did not contain a significant mass of suspended particulates. It should be noted that field readings are not available for the background groundwater samples.

Potassium

Potassium was detected in all nine site groundwater samples (site results with “B” validation qualifiers are treated as detected concentrations for the purposes of this evaluation). Potassium and sodium are both major dissolved constituents in groundwater, and are typically derived from the weathering of silicate minerals. The concentrations of these two elements often covary in uncontaminated groundwater samples. The site and background samples form a common, generally linear trend with a positive slope in a plot of potassium versus sodium (Figure 4). The site samples with high potassium concentrations also have high sodium, and lie on the background trend. These observations indicate a natural source for the potassium detected in the site samples.

Conclusion

Potassium detected in the site groundwater samples is naturally occurring.

5.0 Summary

This section summarizes the results of the geochemical evaluations of selected elements in soil and groundwater samples from Parcel 205(7).

Soil. Geochemical evaluation indicates that the detected concentrations of copper and selenium in the site soil samples are naturally occurring.

Groundwater. Geochemical evaluation indicates that the detected concentrations of potassium in the site groundwater samples are naturally occurring.

6.0 References

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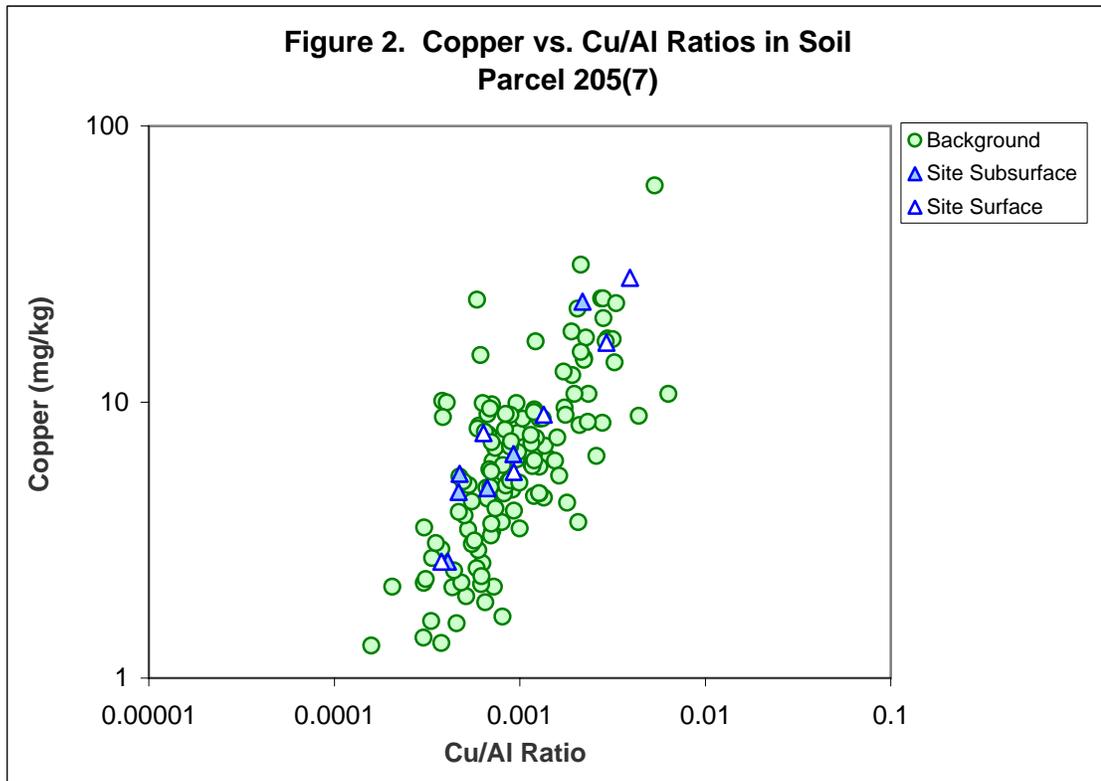
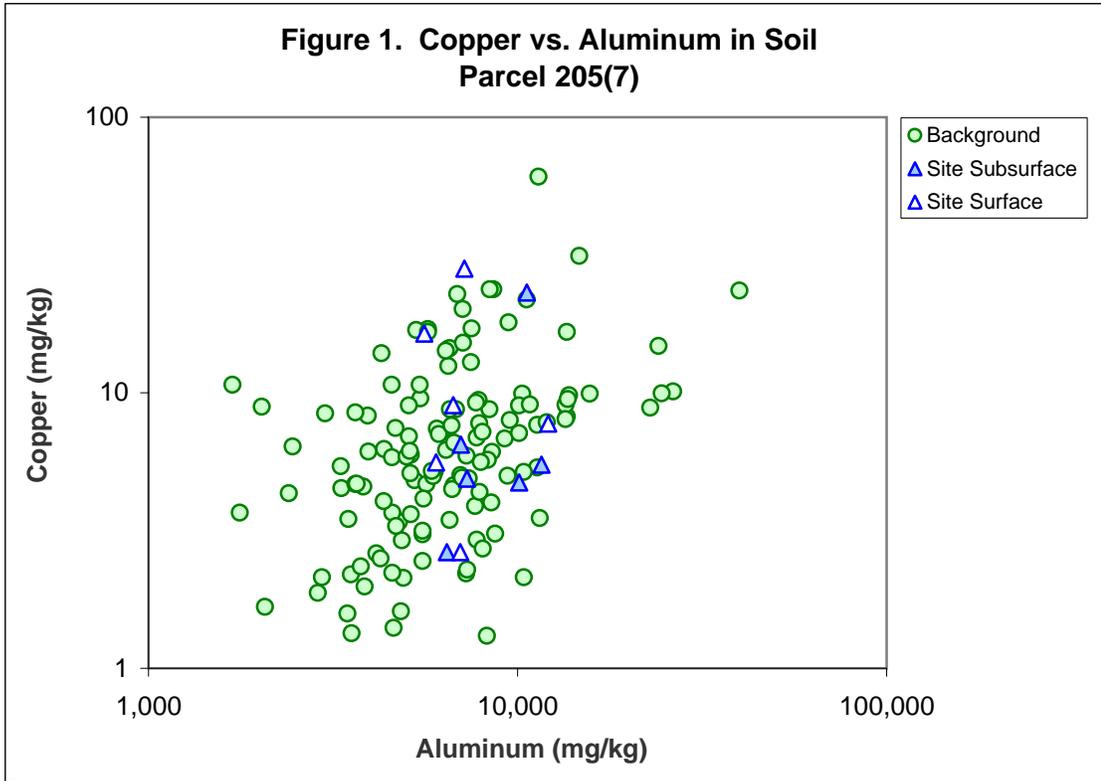
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ATTACHMENT 1



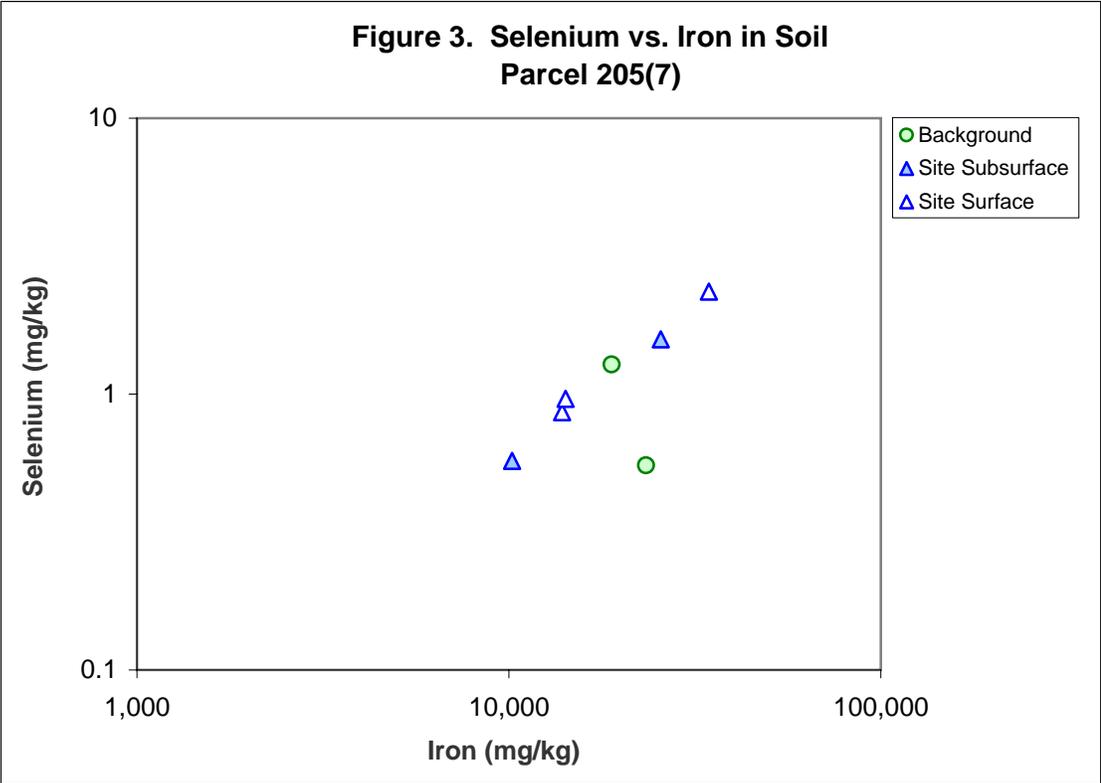
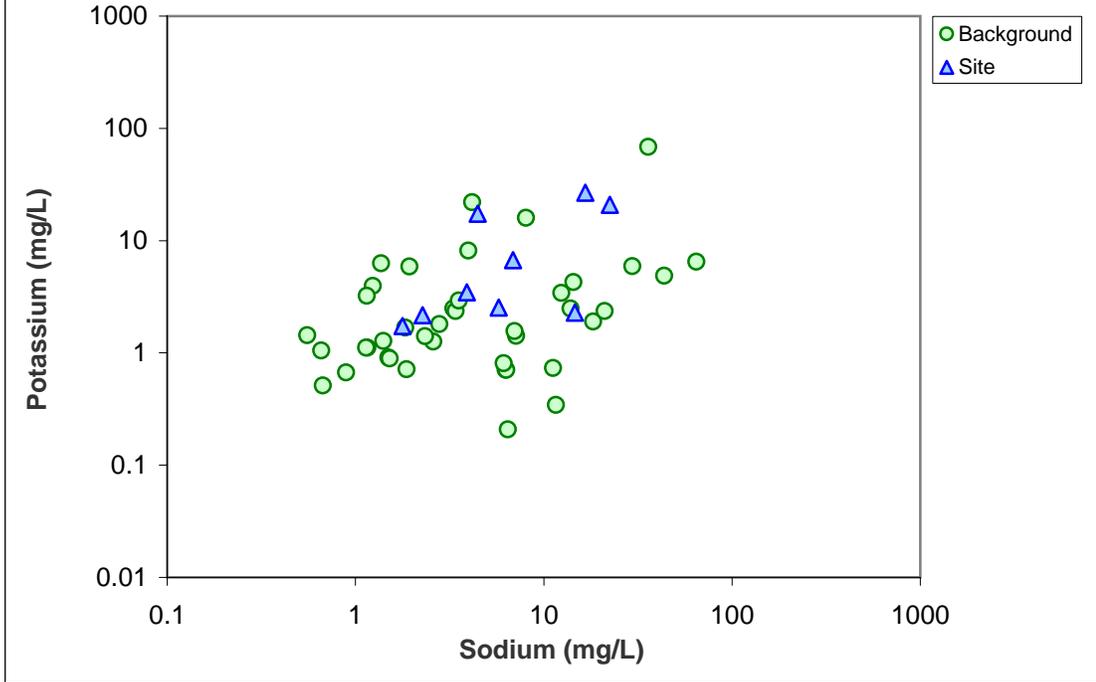


Figure 4. Potassium vs. Sodium in Unfiltered Groundwater, Parcel 205(7)



RESPONSE TO COMMENTS

**Response to Alabama Department of Environmental Management Comments
Draft Supplemental RI Results, Old Water Hole - Pelham Range, Parcel 205(7)
(Dated May 21, 2003)
Fort McClellan, Calhoun County, Alabama**

Comments from Stephen A. Cobb, Chief, Governmental Hazardous Waste Branch, Land Division, dated February 2, 2004.

Comment 1: During the supplemental remedial investigation, the Army found that one surface soil sample (OWH-205-GP05) has chromium (43.5 mg/kg) exceeding all surface soil screening parameters (BKG = 37.0 mg/kg, SSSL = 23.2 mg/kg, ESV = 0.40 mg/kg). Ft. McClellan attributed this finding to variations in the natural range of background levels. ADEM concurs with this assessment regarding the surface soil. However, 150 feet away from this sample, a bedrock well (OWH-205-MW07) was found to contain 1.53×10^{-2} mg/L chromium, which significantly exceeds the groundwater SSSL (4.69×10^{-3} mg/L). Also a residuum well (OWH-205-MW01) located 200 feet northwest also exceeded the groundwater SSSL for chromium with 8.88×10^{-3} mg/L.

The Department understands that the Safe Drinking Water Act Maximum Contaminant Level for chromium is 0.100 mg/L, much higher than the levels found in these wells. The Army addressed chromium as exceeding the SSSL for site wide groundwater. However, the Ft. McClellan Background Metals Survey Report did not address chromium in groundwater.

Because chromium does not have an established background level for groundwater, the Army should revise the report to offer a conclusion and recommendation regarding the relatively high level of chromium found in the groundwater.

Response 1: Comment noted. Site metals data were re-evaluated in accordance with the background screening protocol agreed to by the BCT in March 2003. The three-tiered process consists of statistical testing and geochemical evaluation to select site-related metals. The background screening methodology is described in the technical memorandum "Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC: Revision 2," (Shaw, 2003). The report was revised accordingly based on the results of the evaluation.

Comment 2: In 1995, the Army's RI of the Old Water Hole reportedly found that under either a residential or industrial reuse scenario, certain metals, Semi Volatile Organic Compounds (SVOC), certain polynuclear aromatic hydrocarbons (PAH), three pesticides, one Arochlor PCB, and one

explosive compound were chemicals of concern in the groundwater (reference page 1, para. 5). Subsequent sampling in the supplemental RI apparently provided more information to alleviate most initial concerns regarding groundwater contamination (see also comment 1). However, the Army should consolidate the groundwater results from the supplemental RI with the initial RI results from 1995 to provide a more complete view of available groundwater information, and the Army should include an assessment of how conditions may have changed over time.

The Army did not provide recommendations regarding groundwater in the conclusions and recommendations section of the report (reference page 6). Thus, along with the consolidation of groundwater data and revised groundwater assessment, please revise the report to include conclusions and recommendations regarding the condition of groundwater.

Response 2: Disagree that the data sets should be consolidated. The original data set was not considered appropriate because of high turbidity in the samples. Additionally, the 1995 data are almost 8 years older than the data collected in 2002; risk assessment utilizes only the most recent data set. SVOCs (including PAHs), explosive compounds, and/or CWM breakdown products were not detected at levels above SSSLs in the 2002 data.

The conclusions and recommendations section was revised based on the results of the statistical and geochemical evaluation to clarify the assessment of groundwater.

Comment 3: **Arsenic: Two sampling locations indicated arsenic concentrations in the subsurface soil in excess of 0.426 mg/kg, the established SSSL for Fort McClellan, and in excess of the reported background concentration of 18.3 mg/kg. The EPA Region 4 Office of Technical Services has recommended that the regulation of arsenic in soil be based on its systemic toxicity rather than its carcinogenicity. Based on this recommendation EPA conducted further review and revised its policy to establish a recommended arsenic preliminary remediation goal (PRG) for arsenic in residential soil of 20 mg/kg. Based on EPA Region 4's revised 2002 policy, ADEM believes that the applicable screening criteria for arsenic should be increased to 20 mg/kg.**

Based on ADEM's review of the sampling, it appears that subsurface soil contains locally elevated contamination areas with arsenic concentrations exceeding 20 mg/Kg.

- **In one out of 6 surface soil samples (OWH-205-GP04) arsenic was found to be present at 23.7 mg/kg (>20 mg/kg).**

- **In one out of 6 sub-surface soil samples (OWH-205-GP03) arsenic was found to be present at 37.8 mg/kg (>20 mg/kg; 9-10 feet below surface).**

Please inform ADEM if the Army intends to further identify and investigate areas with elevated levels of arsenic or if the Army intends to propose future land use restrictions for the property.

ADEM understands that arsenic levels may be relatively high at various locations and that the contamination may, in some instances, result from non-DoD activity, perhaps as a result of historical agricultural practices. It is unclear to ADEM if the sporadic presence of arsenic-impacted areas represents native geologic anomalies. If the Army intends to pursue this matter further, the Army should present further information to ADEM to support the Army's conclusion that elevated arsenic levels are a naturally occurring variation in background levels. Alternatively, the Army may wish to consider addressing sporadic elevations in arsenic levels at Pelham Range separately in another manner. Please revise the report and advise ADEM accordingly.

Response 3: Comment noted. No further investigation of the site is planned. However, a statistical and geochemical evaluation of site metals data was performed and was included in the revised report to address ADEM's concerns.

Response to Environmental Protection Agency Comments
Draft Supplemental RI Results, Old Water Hole - Pelham Range, Parcel 205(7)
Fort McClellan, Calhoun County Alabama (dated May 2003)

Comments from Doyle T. Brittain, U.S. Environmental Protection Agency, Senior Remedial Project Manager, dated June 27, 2003.

Specific Comments

Comment 1: Page 2. **The section on Supplemental Field Activities should contain a brief discussion of the rationale behind the selection of the sampling locations.**

Response 1: Agree. A table was added explaining the rationale for selecting the sampling locations.

Comment 2: Appendix C. **The reason for using chain of custody forms is to allow the reconstruction of the custody of the samples from time of collection until time of receipt by the analytical laboratory. This is accomplished by signatures at the appropriate locations on the appropriate forms. The sampling records in this appendix will not allow for the reconstruction of the COC for the following reasons.**

- **On all but six of the sample collection logs (SCLs), the sampling team blocks contained printed names, not signatures as required by the guidance. Anyone can print someone else's name.**
- **On five of the SCLs, the sampling team block contained initials only.**
- **On the remaining SCL, the sampling team members were not identified.**
- **The name of the person who signed the relinquished block on all of the chain of custody (COC) forms does not appear on the sample collection logs.**
- **On two of the COC forms, the relinquished by block contains printed names, not signatures.**
- **On one of the COC forms, the received by block contains a printed name, not a signature.**
- **On another of the COC forms, the received by block is blank.**

Response 2: Disagree. The main thrust of the reviewer's comment regards chain of custody yet the first three bullets above address irregularities with the sample collection

logs (SCL). Chain of custody is documented on the COC form as noted by the reviewer in the comment. While Shaw agrees that the SCLs should have been thoroughly completed as a matter of course, the irregularities therein do not invalidate the chain of custody because that is not their purpose.

With regard to the fourth bullet, Shaw followed the procedures outlined in Section 6.1.7.1 *Field Custody Procedures* presented in the *Draft Installation-Wide Sampling and Analysis Plan*, Revision 3, February 2002 (SAP). This section states, "The sampling team, sample coordinator, and site manager will maintain overall responsibility for the care and custody of the samples until they are transferred or properly dispatched to the on-site screening facility and/or fixed-based laboratory." In addition, SAP Section 6.1.7.2 *Transfer of Custody and Shipment* states, "General custody of the sample will be maintained by the sample collection team members from the time of collection in the field through preparation and shipment to the laboratory. The main custody transfer will occur when the sample shipment is received into the laboratory from the field and is documented." Similar language is also provided in the QAP.

Using these two sections as guidance, all Shaw field personnel who are responsible for the collection of field samples (which includes the sample coordinator and the site manager) were considered part of the "sample team." No custody transfer record was considered necessary among members of the *same* sample collection team. If another contractor, a subcontractor to Shaw, the Army, or other personnel had collected samples and transferred them to Shaw for processing or analysis, then the transfer of custody of those samples would have been formally recorded using a COC form.

Multiple sample technicians were responsible for collecting samples and completing the sample collection logs. The samples and logs were funneled to the Shaw sample coordinator, who then reviewed the documentation, inventoried all of the samples collected, and compiled a single COC record to list all the samples collected (daily) for transfer to the receiving analytical laboratories. Therefore, the sample coordinator's signature on the form represents the transfer of custody from the Shaw sample team in the field to the analytical laboratory personnel (per Section 6.1.7.2 of the SAP). Shaw believes that this is satisfactory custody transfer documentation and, therefore, does not agree this indicates that sample custody was not maintained as stated in the comment. Shaw personnel followed the same chain-of-custody procedures that have been in effect since the beginning of the FTMC project in 1998. It is perplexing that until now these issues have never been called into question.

However, in light of recent comments received by EPA, Shaw has changed its COC procedures to include a separate COC for each sample collection team. Each sample collection team will submit samples, COCs, and SCLs to the sample coordinator. The SCLs and COCs will be reviewed by the sample

coordinator prior to taking possession of the samples and signing the COC. This process will be repeated for each sample collection team in the field. The COCs will then be copied for the field records and maintained onsite. The original forms will be transmitted to the office for filing in the project central files. In future reports, this appendix will include all "supplementary" sample team COCs to document intra-team custody transfers and all SCLs.

Regarding the fifth and sixth bullets: Is EPA implying that someone's "signature" can only be made through cursive writing? If an individual willingly marks a document and affirms that the mark is indeed his own, then the manner in which that mark is made and the form that mark takes are irrelevant. For the reviewer's information, the "Relinquished By" blocks on all of the COCs contained cursive-written signatures.

Agree that the "Received By" block on one of the COCs is blank. It is indicated on the COC that it is a "Corrected Copy." The original signed COC had a minor mistake (wrong sample date) that was corrected. The "Corrected Copy" was simply attached to the original signed version by the laboratory. The report contains both the original signed COC and the "Corrected Copy."

Response to National Guard Bureau Comments
Draft Supplemental RI Results for the Old Water Hole – Pelham Range, Parcel 205(7)
Fort McClellan, Calhoun County, Alabama (dated May 2003)

Comments from Gerald I. Walter, Chief, Environmental Programs Division, dated July 23, 2003.

Comment 1: Previous investigations and their results are discussed in the report with no reference of how the investigations were considered for the conclusion of No Further Action. Please address how previous investigations and the results were considered.

Response 1: Chemical warfare materials (CWM) were not identified as chemicals of potential concern (COPC) in the other investigations. The primary contaminants of concern were identified during the SAIC remedial investigation (RI) conducted in 1994 and 1995. These COPCs consisted of metals and various organic compounds (e.g., SVOCs, pesticides, one explosive compound) in groundwater. The RI report also recommended additional soil sampling. Based on the COPCs identified, Shaw re-sampled the existing SAIC wells, installed and sampled four additional wells, and collected additional soil samples in the area of the Old Water Hole. The analytical parameters selected by Shaw were also based on the previous RI results. Thus, although the previous results established the sample media and analytical parameters, the actual SAIC RI data were not used in reaching conclusions regarding this site. It is worth noting that the SAIC data are almost ten years old. The recent data collected by Shaw did not indicate the presence of unacceptable levels of chemical constituents in site media.

Comment 2: Only three compounds were listed in the report as contaminants of concern (arsenic, chromium, and iron) although more compounds were detected at levels higher than background levels, site-specific screening levels, and ecological screening levels. No explanation was provided on why the other compounds (aluminum, copper, manganese, selenium, vanadium, and zinc) were not considered contaminants of concern. Please include a discussion on why the other compounds were eliminated.

Response 2: Agree. The screening process first compared the metals results to the SSSLs/ESVs and then, for those metals that exceeded SSSLs or ESVs, compared the results to background screening values. Only those metals that exceeded SSSLs/ESVs *and* background (where available) were selected as COPCs or COPECs. Text was added to the “Conclusions and Recommendations” for clarification.

Comment 3: The report does support a No Further Action recommendation with regard to the levels of contamination found in the groundwater. Please include an explanation to support the recommendation.

Response 3: Comment noted. The results of this investigation did not indicate the presence of groundwater contamination at this site. Although two VOCs (acetone and methylene chloride), both of which are common laboratory contaminants, and one CWM breakdown product were detected in groundwater, the results were all below residential human health SSSLs. The metals that exceeded SSSLs were all below background except for one “B”-flagged thallium result and two chromium results for which no background value was available. “B”-flagged data are generally attributed to laboratory contamination. A sentence was added to “Groundwater Analytical Results” explaining that the thallium result was likely a laboratory artifact rather than site-related contamination. A statistical and geochemical evaluation of site metals data was performed and concluded that the metals detected in site media were present at naturally occurring levels. The “Conclusions and Recommendations” section was revised accordingly based on the results of evaluation.