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EG&G ROCKY FLATS
INTEROFFICE CORRESPONDENCE



000064258

DATE May 15, 1995
TO N A Holsteen, Project Manager, Operable Unit 6, Bldg 080, X6987
FROM M A Siders, Industrial Area OU Closures/D&D Team, Bldg 080, X6933 *MAS*
SUBJECT ADDITIONAL COMMENTS ON THE REVIEW OF POTENTIAL CHEMICALS OF CONCERN (PCOC) SELECTION FOR OPERABLE UNIT 6 (OU6) (COMPARISON OF STATISTICAL ANALYSES PERFORMED BY EG&G STATISTICAL APPLICATIONS GROUP AND WOODWARD CLYDE FEDERAL SERVICES)
DOE Order 4700 1
Action Place in records file for OU6

1.0 STATEMENT OF PROBLEM

This memo responds to your request for additional discussion of the application of professional judgment to the OU6 list of potential chemicals of concern (PCOCs) generated solely on the basis of inferential statistical tests and the hot-measurement test (i.e., the 99/99 Upper Tolerance Limit, UTL_{99/99}). This memo summarizes and compares the results of statistical testing performed by Woodward Clyde Federal Services (WCFS) and EG&G Statistical Applications (SA) and provides geochemical and statistical professional judgment. Also, recent draft reports produced by statisticians at Los Alamos National Laboratories (LANL) suggest that background comparisons at the Rocky Flats Environmental Technology Site (RFETS) are too conservative, and that the overall actual significance level for the tandem testing of the "Gilbert toolbox" is likely to be greater than 5%, estimated at about 10%. In addition, because the OU sampling is biased rather than random, there may be fewer low-end values in the OU data sets. Because the Gehan test is more a test of the *median* than the *mean*, the outcome of biased sampling will tend to make the Gehan test significant more often than the other statistical tests.

2.0 COMPARING DIFFERENCES IN THE STATISTICAL ANALYSES PERFORMED BY WCFS AND SA

In comparing the results of the statistical analysis performed by WCFS and SA, there were some analytes in some media for which the two sets of results did not agree (i.e., different sets of PCOCs were generated). These 19 cases, by medium, are listed below.

- Surface Soils
aluminum (UTL only), nickel, silver (UTL only), uranium-238 (UTL only)
- Subsurface Soils
antimony, cobalt
- Stream Sediments
antimony, lead, mercury, sodium, thallium
- Pond Sediments
mercury, thallium

ADMIN RECORD

1/101

Pond Water
selenium (dissolved), strontium (dissolved)

Groundwater
molybdenum (total), cadmium (dissolved) (UTL only), cobalt (dissolved), plutonium-239,240 (dissolved) (UTL only)

Of these 19 cases, five (26%) were based solely on UTL exceedances. Because the value of the UTL is calculated using the mean and the standard deviation, the method of replacement for non-detects and the inclusion/exclusion of outliers will strongly affect the value of the UTL. Also, as noted in the LANL report, it may be that exceedances of the normal UTL are not uncommon when the null hypothesis holds but the underlying distributions are actually lognormal. Dr. Chuan Mian Zhang (WCFS) made a similar observation. The LANL report suggests that a UTL-exceedance rate of 1 in 20 would not be unexpected for a background population.

The results of the LANL study also suggest that the OU-to-background comparisons performed at RFETS are too conservative, with an actual overall significance level of the tandem test at about 10%, rather than 5%. The LANL statisticians also concur with advice I have given, regarding data sets with a high percentage of non-detects. The LANL study found that for data sets with high rates of non-detects (>80%), the results of the statistical tests (i.e., "Gilbert toolbox") were virtually meaningless, with poor power to accurately determine differences between the data sets. I have recommended solely the application of professional judgment — using graphical depictions of the data, process knowledge, and geochemical reasonableness — to assess the data. The LANL statisticians recommend a test of proportions and the application of professional judgment for such data sets.

Of the 19 cases of disagreement between the SA and WCFS analyses listed above, nine are for data sets with non-detect rates greater than 80%, and an additional two have non-detect rates between 50% and 80%. Certainly for the nine cases, the results of the statistical tests should not be used for making management decisions. In the two other cases, the results of the statistical tests should be viewed as tentative, and professional judgment should be used to make the final call.

The following applies geochemical professional judgment on a case-by-case basis:

Aluminum in Surface Soils

Because aluminum is a principal component in common rock-forming minerals (e.g., feldspars, clays, etc.) and because it occurs with an average abundance of 81,000 mg/kg (Krauskopf, 1979), the levels seen in OU6 surface soils (mean = 10,840 mg/kg) are not unduly elevated. More than anything else, the amount of aluminum in a soil sample is a function of the mineralogy of the sample.

Nickel in Surface Soils

Nickel is a trace metal in the earth's crust (mean concentration = 75 mg/kg) and, like most trace metals, is preferentially enriched in shales and claystones (Krauskopf, 1979). A study of baseline concentrations of metals in surficial soils of the Front Range (Severson and Tourtelot, 1994) found a mean of 9.6 mg/kg and a range of 0.36 to 130 mg/kg for nickel. Based on this information, the OU6 mean of 14 mg/kg is well within background levels.

Silver in Surface Soils

Silver was detected in only 9% of the OU6 samples and 0% of the background samples. Because of the low detection rates, the statistical tests and UTL comparison do not yield meaningful results. A spatial analysis of the silver detects and the application of professional judgment is required. WCFS performed this spatial analysis and retained silver as a COC in OU6 Technical Memorandum No. 4 (OU6 TM 4) (August, 1994).

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Uranium-238 in Surface Soils

Uranium-238 is the most abundant isotope of natural uranium, constituting greater than 99 percent (by weight). The difference in the two sets of statistical results reviewed here is due to one UTL exceedance cited in the SA results, both the SA and WCFS statistical comparisons showed no differences for all other statistical tests. The difference is due to slightly different numbers of samples used for determining the value of the UTL_{99/99} (SA UTL = 1.91 pCi/g, n = 18, WCFS UTL = 2.086 pCi/g, n = 13). The maximum activity for OU6 was 2.082 pCi/L. However, the OU6 maximum is less than the maximum value of 2.6 pCi/g reported in the final report for the Background Soils Characterization Program (BSCP) (May, 1995), and lies well within the range of uranium-238 activities reported for other baseline studies (Myrnick *et al*, 1983). There is no reason to conclude that levels of uranium-238 in OU6 surface soils are not attributable to naturally occurring uranium.

Antimony in Subsurface Soils (Geologic Materials)

Antimony averages only 0.2 mg/kg in the earth's crust, but is preferentially enriched in shales and claystones (mean = 1.5 mg/kg) (Krauskopf, 1979). Antimony was detected in only 15% of background samples and 7% of OU6 samples, with means of 6.6 and 7.1 mg/kg, respectively. The difference between the SA and WCFS statistical analyses are attributable to slightly different treatment of non-detect data, however, the low rate of detection precludes the meaningful application of the Gilbert toolbox, so the statistical results cannot be used to make management decisions, anyway. A review of the data shows that the range of background concentrations is greater than that of OU6, with the background maximum greater than the OU6 maximum. Because of this, it is highly unlikely that antimony in OU6 is elevated above background levels.

Cobalt in Subsurface Soils (Geologic Materials)

The background mean is greater than the OU6 mean for cobalt, but again, the high rate of non-detects in the background data set (78%) makes the outcome of the statistical tests highly sensitive to the method of replacement for non-detects. Because cobalt averages 22 mg/kg in the earth's crust (Krauskopf, 1979), the site maximum of 21.4 mg/kg is not considered to represent contamination.

Antimony in Stream Sediments

Again, the non-detect rate for antimony is high (>80% in both data sets) and renders the outcome of the statistical tests less than meaningful. Professional judgment must be applied in this case, as was done by WCFS for TM 4.

Lead in Stream Sediments

Lead was detected in all background and OU6 samples. The difference between the WCFS and SA analyses results from a slight difference in sample size. Although the means are virtually identical (22.2 and 20.9, respectively), the OU6 median value is greater than the background median value. The Gehan test responds to the difference in median values, to yield a p-value of 0.0488 in the SA results (barely below the significance level of <0.050), but 0.0602 for the WCFS results. None of the other tests were significant. Review of box plots for the background and OU6 data sets shows little real difference between the two data sets (see attached figure). A spatial analysis of the OU6 data would be helpful in making a final determination, but the current analysis suggests that lead concentrations in OU6 stream sediments are not outside the realm of background.

Mercury in Stream Sediments

There is a high rate of non-detects in both the background (96%) and OU6 (73%) data sets, SA calculated means of 0.09 and 0.06, respectively. As with lead, the Gehan test is significant in the SA analysis (p = 0.0111), but not in the WCFS analysis (p = 1.000). However, with such a large percentage of non-detects, the use of the Gilbert toolbox provides fairly ambiguous results. The maximum value in background (0.5 mg/kg) is greater than the maximum value in OU6 (0.2 mg/kg), so there appear to be some high values in both data sets, although the median for the

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OU6 data set is greater than that of background. A spatial analysis of the OU6 data would be helpful in making a final determination, but the current analysis suggests that mercury concentrations in OU6 stream sediments are not outside the realm of background.

Sodium in Stream Sediments

Sodium is the most abundant alkali metal in the crust of the earth (mean = 24,000 mg/kg) (Krauskopf, 1979) and an essential nutrient. Both the background and OU6 data sets have approximately 80% detects, which should provide reliable statistical comparisons. In the SA analysis, the background mean (325 mg/kg) is greater than the OU6 mean (258 mg/kg), but the OU6 median is greater than that of background. The p-value for the SA analysis was significant at 0.0034, whereas the WCFS p-value was non-significant at 0.0806. Despite the low rate of non-detects, apparently the determination and replacement method for non-detects is the cause of the disagreement between the SA and WCFS analyses. However, because the mean and maximum values for background are greater than those for OU6, professional judgment eliminates sodium as a PCOC or COC.

Thallium in Stream Sediments

Thallium has a high rate of non-detects in background (96%) and in OU6 (67%). The Gehan test is the only test that shows a significant difference in the SA analysis, but the high rate of non-detects largely negates the value of the test. No test results were significant in the WCFS analysis. The background maximum exceeds the OU6 maximum. The mean concentration of thallium in claystones and shales is 1.0 mg/kg (Krauskopf, 1979). A spatial analysis of the OU6 data would be helpful in making a final determination, but the current analysis suggests that thallium concentrations in OU6 stream sediments are not outside the realm of background.

Mercury in Pond Sediments

There is a high rate of non-detects in both the background (100%) and OU6 (57%) data sets, SA calculated means of 0.17 and 0.19, respectively. As with lead, the Gehan test is barely significant in the SA analysis ($p = 0.0425$), but not in the WCFS analysis ($p = 0.9994$). However, with such a large percentage of non-detects, the use of the Gilbert toolbox provides fairly ambiguous results. Because mercury is highly enriched in claystones and shales (mean = 0.3 mg/kg) (Krauskopf, 1979), and because none of the OU6 values exceed this concentration, mercury is not considered to be a contaminant in the pond sediments of OU6.

Thallium in Pond Sediments

Thallium has a high rate of non-detects in background (92%) and in OU6 (61%). The Gehan test is the only test that shows a significant difference in the SA analysis, but the high rate of non-detects largely negates the value of the test. No test results were significant in the WCFS analysis. The background maximum exceeds the OU6 maximum. The mean concentration of thallium in claystones and shales is 1.0 mg/kg (Krauskopf, 1979). The current analysis suggests that thallium concentrations in OU6 pond sediments are not outside the realm of background.

Selenium (dissolved) in Pond Water

Selenium has a high rate of non-detects in background (96%) and in OU6 (85%). The Gehan test is the only test that shows a significant difference in the SA analysis, but the high rate of non-detects largely negates the value of the test. No test results were significant in the WCFS analysis. The background maximum exceeds the OU6 maximum. The current analysis suggests that selenium concentrations in OU6 pond water are not outside the realm of background.

Strontium (dissolved) in Pond Water

Strontium is an alkaline-earth metal with a geochemical behavior similar to that of calcium and magnesium. If a given sample has a high concentration of calcium, the strontium concentration may also be expected to be relatively high. Strontium was detected in 67% of background and 100% of OU6 samples. None of the statistical tests was significant in the WCFS analysis, and the Gehan test was only barely significant ($P = 0.0487$) in the SA analysis. However, the

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background mean is considerably higher (0.332 mg/L) than the OU6 mean (0.245 mg/L), and the range of concentrations is similar. Professional judgment suggests that concentration of dissolved strontium in OU6 pond water is similar to that of background, particularly when calcium concentrations are taken into account.

Molybdenum (total) in Groundwater

Molybdenum has comparably high rates of non-detects in both background (72%) and OU6 (76%) samples. In the SA analysis, only the Gehan test was significant ($p = 0.0362$), none of the tests were significant in the WCFS analysis. In both analyses, the background mean (0.070 mg/L, 0.066 mg/L) was higher than the OU6 mean (0.063 mg/L, 0.061 mg/L). The background maximum is greater than the OU6 maximum. With the high rate of non-detects in both data sets, the method of non-detect replacement appears to influence the outcome of the statistical tests, specifically the Gehan test. A spatial analysis of the OU6 data would be helpful in making a final determination, but the current analysis of the mean and maximum values, as well as the marginal significance of only one statistical test, suggests that molybdenum concentrations in OU6 groundwater are not outside the realm of background.

Cadmium (dissolved) in Groundwater

The non-detect rates for dissolved cadmium (as determined by SA) are 88.6% for OU6 and 86.7% for background. None of the inferential statistical tests had a significant p-value in either the SA or WCFS analyses. In the SA analysis, none of the OU6 results exceeded the UTL, in the WCFS analysis, four results exceeded the UTL. However, because of the high rate of non-detects, there is no accurate way to reliably determine the mean and standard deviation for either population, therefore, the UTL value cannot be reliably determined. In short, the results of statistical tests applied to data sets with nearly 90% non-detects produce meaningless results. The maximum concentrations in each data set — 0.011 mg/L for background and 0.014 mg/L for OU6 — are virtually the same, and suggest that dissolved cadmium in OU6 groundwater is not significantly greater than that of background groundwater.

Cobalt (dissolved) in Groundwater

Dissolved cobalt also has a high rate of non-detect results in both the OU6 and background data sets (85.4% and 90.5%, respectively). None of the results exceeded the UTL in either the SA or WCFS analyses, and only the Gehan test was significant ($p = 0.0083$) in the SA analysis. However, as described for cadmium in the preceding paragraph, statistical tests applied to data sets with such high rates of non-detects produce questionable results. The calculated means of the two data sets are virtually identical (0.018 mg/L for OU6, 0.020 mg/L for background) and the background maximum is greater than the OU6 maximum. Professional judgment suggests that concentration of dissolved cobalt in OU6 groundwater is similar to that of background.

Plutonium-239,240 (dissolved) in Groundwater

There is only one record for dissolved plutonium in the background data set, and only four records in the OU6 data set. The statistical tests cannot be reliably performed on such inadequate data sets. Total plutonium-239,240 has been retained as a COC in the OU6 TM 4. Based on the known geochemical behavior of plutonium, which is very strongly sorbed to the solid phase in the groundwater environment at RFETS, there is little reason to include dissolved plutonium as a PCOC or COC. There is additional evidence that the plutonium detected in any of the RFETS wells is a result of contamination of surface soils entrained into the well bore during drilling operations. Recent results from an aseptic drilling operation in the Walnut Creek drainage indicate that, when aseptic drilling methods are used, the plutonium concentrations measured in groundwater are at background levels.

3.0 CONCLUSIONS AND RECOMMENDATIONS

This review of the data and the SA and WCFS test results indicates no real problems with the list of COCs provided in TM 4. In fact, the results are probably too conservative, according to the

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N A Holsteen
May 15, 1995
MAS-008-95
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report from LANL. Even lead in stream sediments, which I suggested in my previous memo should be reviewed further, appears not to be outside the realm of background concentrations (see attached box plot). There is no real need to revise or amend TM 4 for OU6. It appears clear that inferential statistical tests provide essentially meaningless results when applied to data sets with greater than 80% non-detects. Recommendations here mirror my previous recommendation that the results of such tests should not be used to make management decisions. Instead, a careful review of graphical displays of the data, and perhaps a test of proportions (as suggested in the LANL report) should be applied using professional judgment.

4.0 REFERENCES CITED

DOE (1994) *Technical Memorandum No 4, Chemicals of Concern in OU6, Rocky Flats Environmental Technology Site, Draft Final Report*

DOE (1995) *Geochemical Characterization of Background Surface Soils Background Soils Characterization Program, Rocky Flats Environmental Technology Site, Final Report, May, 1995*

Krauskopf, K B (1979) *Introduction to Geochemistry* McGraw-Hill Co 617 pp

Los Alamos National Lab (LANL) (March, 1995) *Data Quality Assessment Pilot Project, rough draft (3-27-95)*

Los Alamos National Lab (LANL) (April, 1995) *Data Quality Assessment Pilot Project Milestone Phase 2 Report Demonstrations of the DQA Process for the Risk-based Decision, rough draft (4-20-95)*

Myrick, T E , Berven, B A , and Haywood, F F (1983) Determination of Concentration of Selected Radionuclides in Surface Soil in the U S *Health Physics*, v 45, n 4, p 631-642

Severson, R C and Tourtelot, H A , 1994 Assessment of Geochemical Variability and a Listing of Geochemical Data for Surface Soils of the Front Range Urban Corridor, Colorado *U S Geological Survey Open-File Report 94-648* 120 pp

MAS mm

Attachment
As Stated

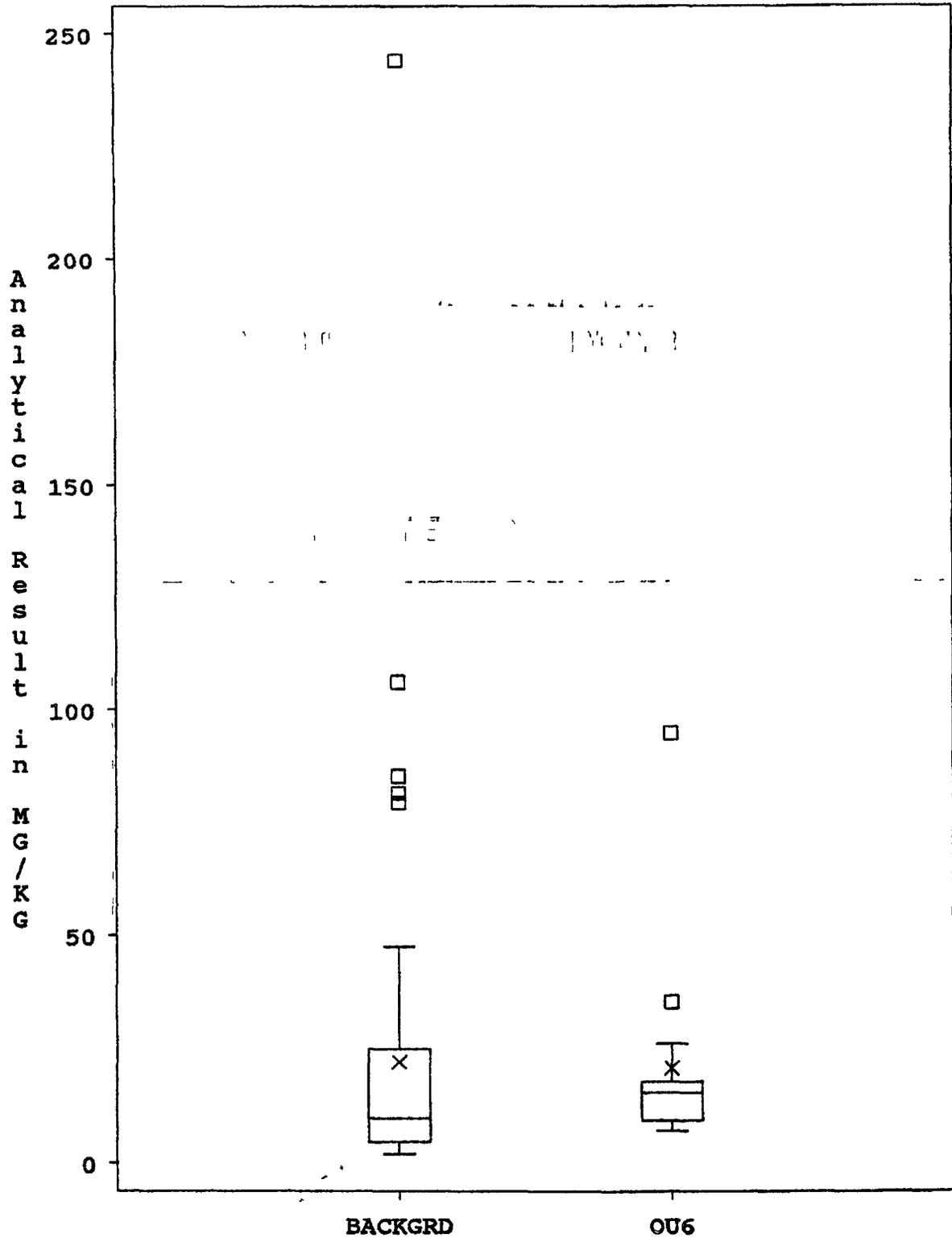
cc

C A Bicher
F W Chromec
B D Peterman
R A Randall
R S Roberts

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TOTAL LEAD FOR OU6 STREAM SEDIMENT AND BACKGROUND



Subgroup Sizes: Min n=15 Max n=57

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INTEROFFICE CORRESPONDENCE

Date May 15, 1995

To M A Siders, Industrial Area Operable Units/D&D, Bldg 080, X6933

From ^{NAH} N A Holsteen, OU5, 6, 7 Closures, Bldg 080, X6987

Subject COMPARISON OF POTENTIAL CHEMICALS OF CONCERN SELECTION BY EG&G
STATISTICAL APPLICATIONS AND WOODWARD-CLYDE FEDERAL SERVICES -
NAH-014-95

DOE Order 4700 1

Action Respond to chemicals not addressed in your review

After reviewing your comparison of the selection of potential chemicals of concern (PCOCs) by Statistical Applications and Woodward-Clyde Federal Services (WCFS), a few chemicals still need further evaluation. The conclusions to your letter dated May 1, 1995, states that "the only significant difference between the two tests is for lead in stream sediments." However, three chemicals appear to fit the criteria for being added as a PCOC. These are strontium (Pond Water - Filtered Metals), molybdenum (Groundwater - Unfiltered Metals), and uranium-238 (Surface Soils - Total Radionuclides).

Please respond with the corresponding professional judgement that would accept or reject each of these chemicals. If you have any questions, please call me at the above extension.

NAH cb

cc
Records Center (2)



March 23, 1995

Mr Neil Holsteen
EG&G Rocky Flats
Building 80
P O Box 464
Golden, CO 80402-0464

Subject Evaluation of the discrepancies found in tables on the comparison of OU6 data with background

Dear Mr Holsteen

WCFS has examined the discrepancies discussed in EG&G's letter dated March 2, 1995 between the background comparison data tables generated by the EG&G Statistical Applications group and those provided in the Draft Final Chemical of Concern (COC) Technical Memorandum (TM). The following discussion is provided to explain the possible reasons for the discrepancies

- 1) *The percentage of detects for background samples varies considerably between the WCFS and Statistical Applications comparisons. There is no set pattern to these variations, however, they are noted particularly for the metals data for stream sediments and pond sediments. They also vary for other media, but these were not noted on the attached tables.*

As noted in the WCFS memo to EG&G dated on March 16, 1994, WCFS used the field in the Background Geochemical Characterization Report (DOE 1993) titled "DET" to determine whether a background record was a detect or a non-detect. The EG&G Statistical Applications group used the "Lab-Qualifier" field to determine detects and non-detects. This is believed to be the reason for the discrepancies in the detection frequency in the background files between EG&G and WCFS tables.

- 2) *WCFS's numbers of OU6 total and dissolved metals samples for groundwater are greater than those reported by Statistical Applications.*

The groundwater tables provided in the COC TM contained additional sample data which should not have been included in the OU6 data base. The additional data, 1994 sample data, is outside of the OU6 data base window. The error was discovered and the electronic file containing the correct OU6 data base was supplied to the EG&G Statistical Applications group. The discrepancies between the WCFS and EG&G tables are due to the additional 1994 sample data.

- 3) *WCFS's numbers of OU6 radionuclides samples for pond sediments are less than those reported by Statistical Applications.*

The pond sediment data tables contained in the COC TM were generated from an incomplete sample data set. The error was subsequently discovered and corrected. The electronic file

Mr Neil Holsteen
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March 24, 1995
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containing the correct OU6 sample data base was supplied to the EG&G Statistical Applications group for use in their statistical background comparison. The discrepancies between the WCFS and EG&G tables were due to the different data sets

- 4) *WCFS's numbers of OU6 radionuclides samples for surface soils are greater than those reported by Statistical Applications*

At the time the background comparison was conducted, the surface soil data set also included dry sediment sample data and IHSS 167 2 sample data. The background comparison tables in the COC TM included the additional data. Based on discussions and guidance from EG&G it was subsequently decided to remove the dry sediment sample data from the surface soil data base because the data were not analyzed for the same analytes. The IHSS 167 2 sample data were removed from the surface soil data base after the IHSS was transferred to OU7. The electronic file supplied to the EG&G Statistical Applications group included only OU6 surface soil data. Therefore, the discrepancy in the total number of surface soil samples between the WCFS and EG&G tables was a result of the inclusion of the IHSS and dry sediment data in the original

- 5) *WCFS's numbers of background radionuclides samples for surface soils are less than those reported by Statistical Applications*

Discrepancies in the number of background data records used for the radionuclide surface soil background comparison between WCFS and the EG&G Statistical Applications group resulted because of the following. WCFS, based on discussions and guidance with EG&G prior to conducting the background comparison, averaged multiple records to determine a representative concentration for each analyte for a given sampling location. That is, field duplicates and multiple "real" samples for the same location were averaged. Therefore, WCFS used no more than 18 data values for any analyte because there are only 18 sampling sites.

It appears that the EG&G Statistical Applications group treated each "real" data record with equal weight, and did not average the concentration results. Because some sampling locations had more than one "real" sample result, more than 18 values were used for each analyte resulting in a greater number of background samples.

- 6) *WCFS's numbers of background total and dissolved metals samples for pond water are less than those reported by Statistical Applications*

The background sample size for pond water total and dissolved metals and groundwater dissolved metals used by WCFS to generate the COC TM tables is smaller than those used by the EG&G Statistical Applications group because non-detect records with extremely large reporting limits (e.g. 600,000 mg/l) were removed from the background comparison. An initial background comparison containing these outliers was conducted. It was felt that the results were not statistically valid, therefore the outliers were removed from the background data sets for the above media.

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Mr Neil Holsteen
EG&G Rocky Flats
March 24, 1995
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7) *WCFS's numbers of background metals samples for surface soils are less than those reported by Statistical Applications*

Refer to number 5 above.

8) *Other miscellaneous discrepancies are noted on the attached tables*

Other discrepancies between WCFS's and EG&G's background comparison as noted on the tables included differences in the background upper tolerance limit and gehen p-value results. These discrepancies are due to the different treatment (use of "DET" rather than lab qualifier) of the background data sets for the various media.

Please contact me if you have any questions on the above items

Sincerely,



Robert L. Clark
Project Manager

1c File

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INTEROFFICE CORRESPONDENCE

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DATE: February 16, 1995

TO: Neil Holsteen, OU-5-6-7 Closures, Bldg. 080, x6987

FROM: D. K. Sullivan, ^{DKS} Statistical Applications, Bldg. 850, x5586

SUBJECT: GILBERT METHODOLOGY BACKGROUND COMPARISON FOR OU6 METALS AND
RADIONUCLIDES - DKS-007-95

The attached pages contain the summary of the OU-6 metals and radionuclides background comparisons using the battery of statistical tests and the UTL approach which you requested. The media included are surficial soils, subsurface soils, UHSU groundwater, pond sediments, pond surface water, and stream sediments. The summaries are in the form of tables listing the analyte name, number of samples in the site, percent of samples that are detects in the site, number and percent detect for the background, Gehan test p-value, Quantile test p-value, Slippage test p-value, t-test p-value, indicator for whether or not one of the four statistical tests were significant, background 99/99 UTL, and number of UTL exceedances in the site data.

The site data used were from the DBASE files you gave me last week. The background data used were data I already had obtained from Mary Siders.

The tritium data for the site subsurface soil had inconsistent units; some were listed as pCi/L, others as pCi/g. I was unable to reach Dave Baca before this letter was done so I left the tritium results off of the summary and will provide them to you as soon as the problem is cleared up.

If further information is needed feel free to call me.

cc:
E. J. Nuccio w/o attachment
D. R. Weier

OU6 Ground Water Total Radionuclides Summary
(Page 1 of 1)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
AMERICIUM-241	183	100	131	100	0.0151	0.0020	0.0018	0.0461	Y	0.04	16
CESIUM-137	156	100	68	100	0.1002	0.0912	0.3756	0.0865	N	1.03	3
GROSS ALPHA	23	100	7	100	0.0775	1.0000	0.1201	0.0998	N	390.58	0
GROSS BETA	23	100	7	100	0.1056	1.0000	0.1201	N/A	N	221.31	0
PLUTONIUM-238	15	100	7	100	0.0731	1.0000	0.1603	N/A	N	0.03	0
PLUTONIUM-239/240	194	100	138	100	<0.0001	0.0003	<0.0001	0.0109	Y	0.06	12
RADIUM-226	6	100	6	100	0.0547	0.0303	0.0909	0.0509	Y	1.29	1
STRONTIUM-89/90	32	100	3	100	0.0259	0.0857	0.0952	N/A	Y	1.15	1
TRITIUM	84	100	238	100	0.1193	1.0000	0.3271	0.8096	N	12968.15	0
URANIUM-233/234	35	100	4	100	0.3730	1.0000	>0.9999	N/A	N	144.83	0
URANIUM-235	35	100	4	100	0.7981	1.0000	>0.9999	N/A	N	5.23	0
URANIUM-238	22	100	4	100	0.1776	1.0000	0.6759	N/A	N	114.17	0

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OU6 Ground Water Dissolved Radionuclides Summary
(Page 1 of 1)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
AMERICIUM-241	2	100	4	100	0.3217	0.4000	0.4000	0.2490	N	2.11	0
CESIUM-137	38	100	12	100	0.6161	1.0000	0.7636	N/A	N	2.14	0
GROSS ALPHA	213	100	167	100	<0.0001	1.0000	<0.0001	0.0005	Y	94.52	0
GROSS BETA	196	100	177	100	<0.0001	1.0000	<0.0001	<0.0001	Y	37.7	6
PLUTONIUM-239/240	1	100	4	100	0.7602	0.8000	0.8000	N/A	N	-	0
RADIUM-226	36	100	85	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	0.63	18
RADIUM-228	6	100	18	100	0.9713	0.5543	0.8609	N/A	N	5.94	1
STRONTIUM-89/90	180	100	128	100	0.0007	0.4156	0.0004	0.0023	Y	1.16	4
URANIUM-233/234	207	100	172	100	<0.0001	1.0000	<0.0001	0.0016	Y	74.88	0
URANIUM-235	207	100	172	100	<0.0001	1.0000	<0.0001	<0.0001	Y	1.89	4
URANIUM-238	177	100	172	100	<0.0001	1.0000	<0.0001	0.0014	Y	52.61	0

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OU6 Ground Water Total Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
ALUMINUM	149	91.28	98	94.9	<0.0001	0.0005	0.0001	0.0029	Y	24769.8	15
ANTIMONY	141	16.31	84	15.48	0.0006	0.0067	N/A	N/A	Y		0
ARSENIC	138	11.59	98	50	<0.0001	0.0116	N/A	N/A	Y		0
BARIUM	149	81.21	99	97.98	<0.0001	0.0002	<0.0001	0.0001	Y	296.36	28
BERYLLIUM	148	7.43	92	27.17	<0.0001	0.0001	N/A	N/A	Y		0
CADMIUM	148	11.49	98	27.55	0.0044	0.0036	N/A	N/A	Y		0
CALCIUM	149	100	99	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	141865.18	34
CESIUM	142	10.56	89	0	0.5000	1.0000	N/A	N/A	N		0
CHROMIUM	145	41.38	99	73.74	<0.0001	1.0000	<0.0001	N/A	Y	179.87	8
COBALT	148	13.51	99	40.4	0.0002	0.0038	N/A	N/A	Y		0
COPPER	148	54.05	99	50.51	<0.0001	<0.0001	N/A	N/A	Y	40.61	18
IRON	149	93.29	98	94.9	<0.0001	0.0092	0.0001	0.0043	Y	30452.39	13
LEAD	141	63.12	99	71.72	<0.0001	0.0007	<0.0001	N/A	Y	18.73	17
LITHIUM	149	77.18	99	91.92	<0.0001	0.0005	N/A	N/A	Y	166.54	18
MAGNESIUM	149	97.99	99	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	32111.34	44
MANGANESE	149	90.6	99	93.94	0.0001	<0.0001	<0.0001	<0.0001	Y	605.82	26
MERCURY	148	2.03	99	10.1	0.0023	0.0006	N/A	N/A	Y		0
MOLYBDENUM	150	28	99	24.24	0.0362	1.0000	N/A	N/A	Y	190.74	0
NICKEL	146	28.08	99	64.65	<0.0001	0.1623	N/A	N/A	Y	94.92	10
POTASSIUM	150	76.67	99	93.94	<0.0001	<0.0001	N/A	N/A	Y	4978.16	32
SELENIUM	145	23.45	98	61.22	<0.0001	0.4033	N/A	N/A	Y	123.18	18
SILICON	84	100	58	100	0.1502	0.0040	0.0025	0.0043	Y	61338.79	9
SILVER	147	6.8	96	19.79	<0.0001	0.0002	N/A	N/A	Y		0

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**OU6 Ground Water Total Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
SODIUM	149	98.66	99	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	139818.31	26
STRONTIUM	146	89.73	98	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	1056.74	34
THALLIUM	146	8.22	99	5.05	0.1965	1.0000	N/A	N/A	N	.	0
TIN	149	8.05	98	18.37	0.0180	0.1564	N/A	N/A	Y		0
VANADIUM	149	71.14	99	71.72	<0.0001	0.0014	N/A	N/A	Y	66.92	16
ZINC	149	77.18	99	81.82	0.0002	0.0005	N/A	N/A	Y	173.69	17

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OU6 Ground Water Dissolved Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
ALUMINUM	248	68.15	178	41.57	0.2055	1.0000	N/A	N/A	N	1683.34	0
ANTIMONY	248	28.23	176	21.59	0.0001	0.0008	N/A	N/A	Y	47.79	8
ARSENIC	220	5	178	12.36	0.3712	1.0000	N/A	N/A	N		0
BARIUM	256	84.38	178	96.63	<0.0001	<0.0001	N/A	<0.0001	Y	171.18	31
BERYLLIUM	212	2.36	178	5.06	0.3473	1.0000	N/A	N/A	N		0
CADMIUM	240	13.33	176	11.36	0.2182	0.1784	N/A	N/A	N		0
CALCIUM	257	100	178	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	141231.18	51
CESIUM	212	8.96	161	3.73	0.9918	1.0000	N/A	N/A	N		0
CHROMIUM	250	24	176	27.84	0.0087	0.0019	N/A	N/A	Y	13.51	17
COBALT	231	9.52	178	14.61	0.0083	1.0000	N/A	N/A	Y		0
COPPER	250	28.4	177	27.68	0.1448	1.0000	N/A	N/A	N	42.99	4
IRON	256	62.5	175	43.43	0.4403	1.0000	N/A	N/A	N	1552.64	5
LEAD	251	14.74	178	3.37	0.9967	1.0000	N/A	N/A	N		0
LITHIUM	250	70.4	178	90.45	<0.0001	<0.0001	N/A	N/A	Y	179.53	24
MAGNESIUM	254	96.06	178	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	31875.84	75
MANGANESE	256	60.16	178	64.04	0.0060	<0.0001	0.0010	N/A	Y	262.92	35
MERCURY	207	2.42	178	0.56	0.9294	1.0000	N/A	N/A	N		0
MOLYBDENUM	241	28.63	176	20.45	0.0605	1.0000	N/A	N/A	N	182.51	0
NICKEL	236	22.03	178	35.39	<0.0001	0.0060	N/A	N/A	Y	33.96	6
POTASSIUM	253	77.87	178	84.27	<0.0001	1.0000	N/A	N/A	Y	425295.02	0
SELENIUM	220	28.64	178	60.11	<0.0001	1.0000	N/A	N/A	Y	482.8	0
SILVER	236	19.92	177	10.17	0.9901	1.0000	N/A	N/A	N		0

**OU6 Ground Water Dissolved Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
SODIUM	255	98.82	178	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	146814.62	47
STRONTIUM	253	92.89	178	100	<0.0001	1.0000	N/A	<0.0001	Y	1839.85	32
THALLIUM	214	5.14	178	3.93	0.8885	1.0000	N/A	N/A	N		0
TIN	236	28.81	177	19.21	0.4455	1.0000	N/A	N/A	N	1621.77	0
VANADIUM	249	53.82	178	37.08	0.1394	1.0000	N/A	N/A	N	38.67	0
ZINC	256	67.19	178	50.56	0.9714	0.0277	N/A	N/A	Y	60.21	11

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**OU6 Pond Water Total Radionuclides Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
AMERICIUM-241	37	100	49	100	0.1674	1.0000	0.5703	0.7281	N	0.08	0
CESIUM-137	37	100	18	100	0.9796	1.0000	>0.9999	N/A	N	7.16	0
GROSS ALPHA	36	100	35	100	0.9206	1.0000	>0.9999	0.9938	N	340.13	0
GROSS BETA	10	100	35	100	<0.0001	<0.0001	0.0797	N/A	Y	9.74	5
PLUTONIUM-239/240	33	100	51	100	0.9268	1.0000	0.9825	0.9234	N	2.85	0
STRONTIUM-89/90	32	100	51	100	0.1420	0.2267	0.4931	0.1352	N	1.61	0
TRITIUM	31	100	46	100	0.4917	1.0000	0.5178	0.1796	N	4277.76	0
URANIUM-233/234	33	100	51	100	<0.0001	1.0000	0.0352	0.0134	Y	4.99	0
URANIUM-235	32	100	51	100	0.0032	0.0161	0.0266	0.0002	Y	0.31	4
URANIUM-238	28	100	51	100	0.0008	1.0000	0.0995	0.0076	Y	4.89	0

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**OU6 Pond Water Dissolved Radionuclides Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
AMERICIUM-241	8	100	51	100	0.8733	1.0000	0.9904	N/A	N	1.76	0
CESIUM-137	3	100	18	100	0.0104	0.0075	0.4211	0.0206	Y	4.71	0
PLUTONIUM-239/240	8	100	51	100	0.9662	1.0000	0.9539	N/A	N	1.02	0
STRONTIUM-89/90	20	100	49	100	0.9430	0.1697	0.9761	0.8372	N	2.01	1
URANIUM-233/234	13	100	49	100	0.0640	0.1013	0.1760	N/A	N	4.19	0
URANIUM-235	12	100	49	100	0.8972	0.8033	0.9861	N/A	N	0.72	0
URANIUM-238	13	100	48	100	0.0091	0.0155	0.0294	N/A	Y	3.03	7

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OU6 Pond Water Total Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
	ALUMINIUM	48	89.58	49							
ANTIMONY	34	17.65	51	5.88	0.9805	1.0000	N/A	N/A	N	-	0
ARSENIC	44	52.27	51	41.18	0.9995	1.0000	N/A	N/A	N	4466.38	0
BARIUM	44	81.82	51	100	>0.9999	1.0000	N/A	0.9749	N	88520.21	0
BERYLLIUM	38	21.05	51	3.92	0.9944	1.0000	N/A	N/A	N	2813.39	0
CADMIUM	33	21.21	51	21.57	0.9996	1.0000	N/A	N/A	N	3098.01	0
CALCIUM	53	100	51	100	>0.9999	1.0000	>0.9999	0.9998	N	491973.67	0
CESIUM	33	15.15	51	11.76	0.9387	1.0000	N/A	N/A	N	-	0
CHROMIUM	40	32.5	51	15.69	>0.9999	1.0000	N/A	N/A	N	4712.1	0
COBALT	35	22.86	51	35.29	0.9991	1.0000	N/A	N/A	N	29758.11	0
COPPER	44	47.73	47	19.15	>0.9999	1.0000	N/A	N/A	N	11038.96	0
IRON	51	96.08	51	100	>0.9999	1.0000	>0.9999	0.9903	N	1790578.73	0
LEAD	45	66.67	50	78	0.9996	1.0000	N/A	N/A	N	2062.31	0
LITHIUM	35	57.14	51	100	0.6658	1.0000	N/A	N/A	N	59525.73	0
MAGNESIUM	50	86	51	100	0.0486	1.0000	N/A	0.8213	Y	1160796.48	0
MANGANESE	51	86.27	51	100	0.3721	1.0000	N/A	0.9937	N	17777.03	0
MERCURY	33	9.09	51	33.33	0.0971	1.0000	N/A	N/A	N	-	0
MOLYBDENUM	33	24.24	51	74.51	0.9007	1.0000	N/A	N/A	N	61986.08	0
NICKEL	35	25.71	51	47.06	0.9996	1.0000	N/A	N/A	N	23805.93	0
POTASSIUM	41	56.1	51	100	0.0001	1.0000	N/A	N/A	Y	2314654.44	0
SELENIUM	36	16.67	49	22.45	0.0653	1.0000	N/A	N/A	N	-	0
SILICON	11	100	51	100	>0.9999	1.0000	>0.9999	N/A	N	23029.71	0
SILVER	32	18.75	47	6.38	0.9958	1.0000	N/A	N/A	N	-	0

**OU6 Pond Water Total Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
SODIUM	53	100	51	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	29547.62	28
STRONTIUM	42	73.81	51	100	0.9687	1.0000	N/A	N/A	N	455364.16	0
THALLIUM	39	2.56	51	0	0.5000	1.0000	N/A	N/A	N	.	0
TIN	35	28.57	51	19.61	0.9986	1.0000	N/A	N/A	N	59514.38	0
VANADIUM	41	48.78	51	49.02	>0.9999	1.0000	N/A	N/A	N	23170.96	0
ZINC	50	80	51	76.47	>0.9999	1.0000	N/A	N/A	N	8257.01	0

OU6 Pond Water Dissolved Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
ALUMINUM	43	18.6	48	66.67	0.4953	1.0000	N/A	N/A	N		0
ANTIMONY	30	23.33	51	17.65	0.8486	1.0000	N/A	N/A	N	19887.25	0
ARSENIC	35	17.14	51	37.25	0.1156	1.0000	N/A	N/A	N		0
BARIUM	47	51.06	51	100	>0.9999	1.0000	N/A	N/A	N	48224.14	0
BERYLLIUM	22	0	51	5.88	0.5000	1.0000	N/A	N/A	N		0
CADMIUM	27	0	51	9.8	0.5000	1.0000	N/A	N/A	N		0
CALCIUM	50	100	51	100	>0.9999	1.0000	>0.9999	0.9997	N	157608.31	0
CESIUM	31	0	51	17.65	0.5000	1.0000	N/A	N/A	N		0
CHROMIUM	28	3.57	51	7.84	0.8742	1.0000	N/A	N/A	N		0
COBALT	31	3.23	51	33.33	0.6496	1.0000	N/A	N/A	N		0
COPPER	41	21.95	44	2.27	0.5897	1.0000	N/A	N/A	N	6622.81	0
IRON	49	63.27	50	96	>0.9999	1.0000	N/A	N/A	N	27962.6	0
LEAD	42	14.29	50	46	0.0196	1.0000	N/A	N/A	Y		0
LITHIUM	43	44.19	51	100	0.1551	1.0000	N/A	N/A	N	25623.3	0
MAGNESIUM	47	70.21	51	100	<0.0001	1.0000	N/A	N/A	Y	1208160.6	0
MANGANESE	44	81.82	51	100	0.5803	1.0000	N/A	0.9210	N	3893.75	0
MERCURY	23	21.74	51	21.57	0.9043	1.0000	N/A	N/A	N	81.28	0
MOLYBDENUM	34	20.59	51	68.63	0.8579	1.0000	N/A	N/A	N	30264.44	0
NICKEL	24	12.5	51	52.94	0.8189	1.0000	N/A	N/A	N		0
POTASSIUM	39	43.59	51	100	<0.0001	1.0000	N/A	N/A	Y	1371806.14	0
SELENIUM	28	3.57	48	14.58	0.0010	1.0000	N/A	N/A	Y		0
SILVER	32	6.25	50	2	0.3979	1.0000	N/A	N/A	N		0

**OU6 Pond Water Dissolved Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
SODIUM	50	100	51	100	<0.0001	<0.0001	<0.0001	<0.0001	Y	29537.87	28
STRONTIUM	45	66.67	51	100	0.0487	1.0000	N/A	N/A	Y	920.93	0
THALLIUM	27	0	51	0		1.0000	N/A	N/A	N		0
TIN	36	13.89	51	15.69	0.9935	1.0000	N/A	N/A	N		0
VANADIUM	38	13.16	51	45.1	0.8696	1.0000	N/A	N/A	N		0
ZINC	46	34.78	51	54.9	0.4652	1.0000	N/A	N/A	N	4897.46	0

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OU6 Pond Sediment Total Radionuclides Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
AMERICIUM-241	14	100	55	100	<0.0001	0.0001	0.0282	N/A	Y	1.46	29
CESIUM-137	13	100	57	100	0.9960	0.8143	0.9827	N/A	N	3.51	0
GROSS ALPHA	15	100	57	100	0.0012	0.0054	0.0191	N/A	Y	78.83	10
GROSS BETA	14	100	57	100	0.0005	0.0552	0.3854	N/A	Y	45.76	4
PLUTONIUM-239/240	16	100	50	100	<0.0001	0.0012	0.0121	N/A	Y	7.68	19
RADIUM-226	9	100	9	100	0.0121	1.0000	0.2882	0.0323	Y	1.97	0
RADIUM-228	9	100	9	100	0.0035	0.0147	0.0412	0.0025	Y	2.88	0
STRONTIUM-89/90	14	100	25	100	0.0188	0.6410	0.7033	N/A	Y	2.63	0
TRITIUM	13	100	50	100	0.7777	0.3014	0.1847	N/A	N	769.75	3
URANIUM-233/234	16	100	56	100	<0.0001	<0.0001	0.0141	N/A	Y	2.39	13
URANIUM-235	17	100	56	100	0.0004	0.0573	0.0790	N/A	Y	0.25	10
URANIUM-238	14	100	56	100	<0.0001	0.0004	0.0300	N/A	Y	2.52	13

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OU6 Pond Sediment Total Metals Summary
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Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedences
	N	% Detect	N	% Detect							
ALUMINUM	20	100	57	100	0.1135	0.4000	0.3476	0.2065	N	29553.14	0
ANTIMONY	18	5.56	28	39.29	0.0024	0.6087	N/A	N/A	Y		0
ARSENIC	20	95	57	100	0.3966	1.0000	0.9962	0.9741	N	67.19	0
BARIUM	20	100	57	100	0.5577	1.0000	0.9300	0.8870	N	794.9	0
BERYLLIUM	16	43.75	57	98.25	0.0001	0.2132	N/A	N/A	Y	2.55	7
CADMIUM	16	18.75	56	39.29	0.0153	0.6025	N/A	N/A	Y		0
CALCIUM	20	100	57	100	0.4400	0.7403	0.9300	0.7545	N	80940.62	0
CESIUM	17	5.88	57	92.98	0.7076	1.0000	N/A	N/A	N		0
CHROMIUM	18	94.44	57	100	0.0083	0.0377	0.0704	0.0107	Y	29.48	7
COBALT	19	68.42	57	100	0.0009	1.0000	N/A	N/A	Y	22.57	0
COPPER	19	73.68	57	100	0.0015	1.0000	0.6377	N/A	Y	175.44	0
IRON	19	100	57	100	0.0235	1.0000	0.9440	0.4195	Y	143862.67	0
LEAD	19	100	57	100	0.7115	1.0000	0.9859	N/A	N	261.07	0
LITHIUM	18	61.11	57	98.25	0.4136	1.0000	N/A	N/A	N	50.8	0
MAGNESIUM	20	90	57	100	<0.0001	0.0785	0.0365	0.0001	Y	6469.99	0
MANGANESE	20	100	57	100	0.0238	1.0000	0.9300	0.7049	Y	1962.46	0
MERCURY	15	0	56	42.86	0.0425	0.7887	N/A	N/A	Y		0
MOLYBDENUM	19	42.11	56	0	0.5000	1.0000	N/A	N/A	N	55.46	0
NICKEL	17	64.71	56	69.64	0.0005	0.7671	N/A	N/A	Y	35.2	1
POTASSIUM	18	61.11	56	89.29	0.0002	0.0496	N/A	N/A	Y	3226.8	2
SELENIUM	19	57.89	57	5.26	0.9998	1.0000	N/A	N/A	N	5.25	0
SILVER	15	20	57	38.6	0.0105	0.0345	N/A	N/A	Y	15.91	16

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**OU6 Pond Sediment Total Metals Summary
(Page 2 of 2)**

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
SODIUM	20	55	57	100	0.0004	1 0000	N/A	N/A	Y	2127.18	0
STRONTIUM	20	80	57	100	0.4288	1 0000	N/A	0.8795	N	355.69	0
THALLIUM	13	7.69	56	39.29	0.0185	1 0000	N/A	N/A	Y	-	0
TIN	19	42.11	56	1.79	0.1501	1 0000	N/A	N/A	N	63.06	0
VANADIUM	19	89.47	57	100	0.0027	0.7500	0.6377	N/A	Y	85.53	0
ZINC	20	90	57	100	<0.0001	<0.0001	0.0042	<0.0001	Y	147.58	18

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**OU6 Surface Soils Total Radionuclides Summary
(Page 1 of 1)**

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedences
	N	% Detect	N	% Detect							
AMERICIUM-241	16	100	91	100	<0.0001	<0.0001	0.0181	N/A	Y	0.06	49
GROSS ALPHA	9	100	116	100	0.9408	0.4239	0.7427	N/A	N	44.56	3
GROSS BETA	9	100	116	100	0.6953	0.4986	0.4287	0.6211	N	55.35	2
PLUTONIUM-239/240	20	100	101	100	<0.0001	<0.0001	0.0061	<0.0001	Y	0.13	56
URANIUM-233/234	18	100	107	100	0.9889	0.1981	0.8638	0.9979	N	1.77	2
URANIUM-235	18	100	105	100	0.5285	0.8537	0.8843	N/A	N	0.2	0
URANIUM-238	18	100	107	100	0.9954	0.5325	0.8843	0.9983	N	1.91	1

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OU6 Surface Soils Total Metals Summary
(Page 1 of 2)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
ALUMINUM	20	100	119	100	0.9985	0.6252	0.8151	0.9974	N	25878.86	0
ANTIMONY	20	0	103	54.37	0.0059	1.0000	N/A	N/A	Y	.	0
ARSENIC	20	100	119	100	0.8815	0.3864	0.8971	0.8772	N	12.96	0
BARIUM	20	100	119	100	0.9956	1.0000	0.9989	0.9917	N	532.66	0
BERYLLIUM	20	55	119	87.39	0.5294	1.0000	N/A	N/A	N	4.98	0
CADMIUM	18	33.33	119	47.06	0.2954	0.8686	N/A	N/A	N	4.9	1
CALCIUM	20	100	119	100	<0.0001	0.0164	0.0536	<0.0001	Y	16658.9	15
CESTUM	20	55	114	91.23	0.2135	1.0000	N/A	N/A	N	598.17	0
CHROMIUM	20	100	119	99.16	0.9999	0.7320	0.9901	0.9999	N	28.11	1
COBALT	20	100	119	100	0.0025	1.0000	0.3911	0.1830	Y	23.83	0
COPPER	20	100	119	100	0.0008	0.0848	0.1599	0.0002	Y	29.57	7
IRON	20	100	119	100	0.9367	0.6252	0.6267	0.8989	N	29051.69	3
LEAD	20	100	119	100	0.9996	0.0711	0.3911	0.9999	N	62.14	3
LITHIUM	20	100	119	96.64	0.9935	0.8561	N/A	0.9966	N	22.11	0
MAGNESIUM	20	100	119	100	0.4215	0.5332	0.9268	0.3815	N	7717.53	3
MANGANESE	20	100	119	100	0.9999	1.0000	0.9268	0.9486	N	2100.16	0
MERCURY	18	0	119	41.18	0.0303	0.8686	N/A	N/A	Y		0
MOLYBDENUM	20	5	119	0.84	0.0224	1.0000	N/A	N/A	Y		0
NICKEL	20	100	118	94.92	0.0896	0.1179	0.3843	0.1321	N	27.13	0
POTASSIUM	20	100	119	92.44	>0.9999	1.0000	>0.9999	>0.9999	N	6190.11	0
SELENIUM	20	75	119	26.89	0.3425	1.0000	N/A	N/A	N	1.39	0
SILVER	20	0	119	9.24	0.2097	0.8561	N/A	N/A	N		0

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**OU6 Surface Soils Total Metals Summary
(Page 2 of 2)**

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
SODIUM	20	55	119	100	0.0624	0.6252	N/A	N/A	N	1051.56	3
STRONTIUM	20	100	119	100	0.1127	0.6252	0.0536	0.0730	N	113.36	3
THALLIUM	20	30	118	41.53	0.7604	1.0000	N/A	N/A	N	2.01	0
TIN	20	60	119	2.52	>0.9999	1.0000	N/A	N/A	N	82.9	0
VANADIUM	20	100	119	100	0.4546	0.2361	0.6267	0.4021	N	59.88	4
ZINC	20	100	119	100	0.1670	0.3864	0.1805	0.0345	Y	99.32	6

OU6 Subsurface Soils Total Radionuclides Summary
(Page 1 of 1)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
AMERICIUM-241	28	100	208	100	<0.0001	0.0001	0.0009	<0.0001	Y	0.02	21
GROSS ALPHA	99	100	209	100	>0.9999	0.4597	>0.9999	>0.9999	N	51.4	2
GROSS BETA	99	100	223	100	>0.9999	1.0000	>0.9999	>0.9999	N	42.01	0
PLUTONIUM-239/240	99	100	206	100	<0.0001	<0.0001	0.0001	<0.0001	Y	0.02	43
URANIUM-233/234	99	100	230	100	0.0344	1.0000	0.0256	0.7451	Y	3.44	0
URANIUM-235	99	100	230	100	<0.0001	1.0000	0.4617	0.0013	Y	0.15	1
URANIUM-238	99	100	230	100	0.3157	0.6991	0.8497	0.1640	N	1.81	2

**OU6 Subsurface Soils Total Metals Summary
(Page 1 of 2)**

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
ALUMINUM	98	98.98	231	100	>0.9999	1.0000	>0.9999	>0.9999	N	45084.25	0
ANTIMONY	66	15.15	210	7.14	0.0202	1.0000	N/A	N/A	Y	-	0
ARSENIC	99	70.71	231	99.13	0.0655	1.0000	N/A	N/A	N	16.23	0
BARIUM	99	88.89	231	100	<0.0001	0.1153	0.0006	0.0004	Y	371.51	17
BERYLLIUM	99	81.82	231	83.98	>0.9999	1.0000	N/A	>0.9999	N	18.26	0
CADMIUM	81	7.41	211	7.58	0.8647	1.0000	N/A	N/A	N	-	0
CALCIUM	99	98.99	231	100	<0.0001	0.0385	<0.0001	<0.0001	Y	53206.53	52
CESIUM	95	1.05	221	67.87	0.6680	1.0000	N/A	N/A	N	-	0
CHROMIUM	99	84.85	231	98.27	>0.9999	0.7000	N/A	0.9976	N	89.09	3
COBALT	99	22.22	231	94.81	0.9061	1.0000	N/A	N/A	N	26.41	0
COPPER	99	94.95	231	100	0.9997	1.0000	0.9931	0.9825	N	49.02	1
IRON	99	100	231	100	>0.9999	1.0000	0.9999	0.9999	N	52351.6	0
LEAD	99	98.99	231	99.57	0.1239	0.4894	0.9548	0.2192	N	31.02	2
LITHIUM	99	61.62	209	87.08	0.0743	1.0000	N/A	N/A	N	34.18	0
MAGNESIUM	99	95.96	231	100	0.6480	1.0000	0.8663	0.8987	N	12093.93	0
MANGANESE	99	100	231	100	0.9998	1.0000	0.9998	0.9813	N	1193.17	0
MERCURY	86	25.58	231	31.17	0.9999	1.0000	N/A	N/A	N	1.18	0
MOLYBDENUM	99	50.51	231	1.73	0.9832	1.0000	N/A	N/A	N	41.09	0
NICKEL	96	85.42	231	65.8	>0.9999	1.0000	N/A	N/A	N	78.67	0
POTASSIUM	98	52.04	230	59.57	>0.9999	1.0000	N/A	N/A	N	7271.37	0
SELENIUM	82	2.44	211	9	0.9568	1.0000	N/A	N/A	N	-	0
SILVER	83	39.76	230	0.43	>0.9999	1.0000	N/A	N/A	N	33.06	0

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**OU6 Subsurface Soils Total Metals Summary
(Page 2 of 2)**

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
	SODIUM	99	17.17	231							
STRONTIUM	99	36.36	231	99.57	<0.0001	0.7000	N/A	N/A	Y	185.42	21
THALLIUM	75	4	223	29.15	0.3339	1.0000	N/A	N/A	N	.	0
TIN	92	27.17	231	3.46	>0.9999	1.0000	N/A	N/A	N	383.39	0
VANADIUM	99	97.98	231	100	>0.9999	1.0000	0.9998	0.9982	N	112.78	1
ZINC	98	92.86	231	100	0.8376	0.7021	0.9259	0.6514	N	182.99	4

OU6 Stream Sediment Total Radionuclides Summary
(Page 1 of 1)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
AMERICIUM-241	37	100	15	100	0.0031	1 0000	0 3923	N/A	Y	1 77	0
CESIUM-137	35	100	15	100	0 5551	1 0000	0 9821	N/A	N	1.54	0
GROSS ALPHA	45	100	15	100	0 6776	1 0000	>0 9999	N/A	N	88.06	0
GROSS BETA	43	100	15	100	>0.9999	1 0000	>0 9999	>0 9999	N	67.34	0
PLUTONIUM-239/240	45	100	15	100	0.0059	1 0000	0 0355	N/A	Y	5 66	0
RADIUM-226	21	100	1	100	0 3466	1 0000	>0 9999	N/A	N	2.22	0
RADIUM-228	20	100	1	100	0 4344	1 0000	>0 9999	N/A	N	4 55	0
STRONTIUM-89/90	43	100	15	100	0.3480	1 0000	0 6603	N/A	N	1.09	0
TRITIUM	42	100	15	100	0 5576	0 2632	0 0460	N/A	Y	1047 69	1
URANIUM-233/234	47	100	15	100	0.9942	1.0000	>0 9999	0 9962	N	5.29	0
URANIUM-235	49	100	15	100	0 9351	1 0000	>0 9999	N/A	N	0 21	0
URANIUM-238	36	100	15	100	0 9530	1 0000	>0 9999	0.8837	N	4 82	0

OU6 Stream Sediment Total Metals Summary
(Page 1 of 2)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit(UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
ALUMINUM	59	100	15	100	0.0705	1.0000	0.6358	N/A	N	20850.44	0
ANTIMONY	52	11.54	15	13.33	0.0140	1.0000	N/A	N/A	Y		0
ARSENIC	59	89.83	15	93.33	0.0005	1.0000	0.0092	<0.0001	Y	9.83	0
BARIUM	57	100	15	100	0.0197	1.0000	0.8810	N/A	Y	250.52	0
BERYLLIUM	57	47.37	15	53.33	0.0668	1.0000	N/A	N/A	N	6.02	0
CADMIUM	51	11.76	15	6.67	0.6967	1.0000	N/A	N/A	N		0
CALCIUM	59	98.31	15	100	<0.0001	0.2027	0.0092	N/A	Y	17845.77	1
CESIUM	56	17.86	15	46.67	0.2854	1.0000	N/A	N/A	N		0
CHROMIUM	59	79.66	15	100	0.4345	1.0000	N/A	N/A	N	30.69	0
COBALT	59	72.88	15	100	0.0002	1.0000	N/A	N/A	Y	17.46	0
COPPER	59	72.88	15	60	0.1341	1.0000	N/A	N/A	N	33.9	0
IRON	59	100	15	100	0.0001	1.0000	0.1471	<0.0001	Y	27928.58	0
LEAD	57	100	15	100	0.0488	1.0000	0.6585	N/A	Y	136.77	0
LITHIUM	57	71.93	15	93.33	0.0520	1.0000	N/A	N/A	N	23.58	0
MAGNESIUM	59	91.53	15	100	0.0018	1.0000	0.0436	N/A	Y	5209.74	0
MANGANESE	59	98.31	15	100	0.0028	1.0000	0.0436	0.0039	Y	884.1	1
MERCURY	49	4.08	15	26.67	0.0111	1.0000	N/A	N/A	Y		0
MOLYBDENUM	58	27.59	15	0	0.5000	1.0000	N/A	N/A	N	34.96	0
NICKEL	57	68.42	15	46.67	0.0617	1.0000	N/A	N/A	N	22.84	0
POTASSIUM	58	74.14	15	93.33	0.0005	1.0000	N/A	N/A	Y	3070.25	0
SELENIUM	58	22.41	15	13.33	0.7650	1.0000	N/A	N/A	N	2.9	0
SILVER	54	3.7	15	6.67	0.4700	1.0000	N/A	N/A	N		0

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INTEROFFICE CORRESPONDENCE

DATE February 13, 1995

TO D Sullivan, Systems Analysis, Bldg 850, X5586

FROM N A ^{NAH} Holsteen, OU5, 6, 7 Closures, Bldg 080, X6987

SUBJECT PERFORM GILBERT METHODOLOGY BACKGROUND COMPARISON FOR ALL MEDIA IN OPERABLE UNIT (OU) 6 - NAH-009-94

DOE Order 4700 1

Action Complete background comparison for all media in OU6

The results from the background comparison on stream sediments indicate that there may be problems with other media in the OU6 database. Please complete the background comparison for all media in OU6. The media are surficial soils, subsurface soils, UHSU groundwater, pond sediments, and pond surface water.

Attached is a chart that shows the background data set used for each media.

Please call me at the above extension as soon as you have results. The OU6 charge number is 986492.

NAH cb

Attachment
As Stated

ROCKY FLATS PLANT OU-6
Background Comparison Summary

Media	Background Data	OU6 Data	Analyte Group	No of Analytes in Comparison	No of Analytes Significant in Tests	No of Analytes Greater than UTL ⁹⁹⁹⁹	No of PCOC
Surficial Soil	Rock Creek Surficial Soil	Surficial Soil & Dry Sediment	Metals Rads	28 7	9 2	15 5	16 4
Subsurface Soil	USHU Subsurface Soil	Subsurface Soil	Metals Rads	28 8	3 5	8 6	7 6
Groundwater	UHSU* Groundwater	Historic and New Wells	Total Metals Filtered Metals	29 28	25 13	26 17	25 17
	USHU Groundwater	Historic and New Wells	Total Rads Filtered Rads	11 11	4 7	5 6	5*** 8***
Pond Sediment	Seep/Spring Sediment	Pond Sediment	Metals Rads	27 12	11 10	7 8	12 10
	Seep/Spring* Surface Water	Pond Surface Water	Total Metals Filtered Metals	29 28	3 4	1 4	3 4
Pond Surface Water	Seep/Spring Surface Water	Pond Surface Water	Total Rads Filtered Rads	10 7	4 2	2 2	4 3***
	Stream Sediment	Stream Sediment	Metals Rads	26 12	11 3	2 1	11 3***

* In these background data files non detect records with extremely high reporting limits were not used
 ** Background data files are from "1993 Background Geochemical Characterization Report" except for surficial soil
 *** Some sample sizes too small to draw conclusion

INTEROFFICE CORRESPONDENCE

DATE: February 13, 1995

TO: Neil Holsteen, OU-5-6-7 Closures, Bldg. 080, x6987

FROM: D. K. Sullivan^{DKS}, Statistical Applications, Bldg. 850, x5586

SUBJECT: GILBERT METHODOLOGY BACKGROUND COMPARISON FOR OU6 METALS IN STREAM
SEDIMENT - DKS-006-95

The attached pages contain the summary of the OU-6 stream sediment metals comparison to background using the battery of statistical tests and the UTL approach which you requested.

The data I received had one location code that was different from the codes you listed in your letter. The data had location SED69392 but not SED69592.

If further information is needed feel free to call me.

cc:

E J NUCCIO

D. R. WEIER

OU6 Sediment Metals Summary
(Page 1 of 2)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
ALUMINUM	59	100	15	100	0 0705	1 0000	0 6358	N/A	N	20850 44	0
ANTIMONY	52	11 54	15	13 33	0 0140	1 0000	N/A	N/A	Y		0
ARSENIC	59	89 83	15	93 33	0 0005	1 0000	0 0092	<0 0001	Y	9 83	0
BARIUM	57	100	15	100	0 0197	1 0000	0 8810	N/A	Y	250 52	0
BERYLLIUM	57	47 37	15	53 33	0 0668	1 0000	N/A	N/A	N	6 02	0
CADMIUM	51	11 76	15	6 67	0 6967	1 0000	N/A	N/A	N		0
CALCIUM	59	98 31	15	100	<0 0001	0 2027	0 0092	N/A	Y	17845 77	1
CESIUM	56	17 86	15	46 67	0 2854	1 0000	N/A	N/A	N		0
CHROMIUM	59	79 66	15	100	0 4345	1 0000	N/A	N/A	N	30 69	0
COBALT	59	72 88	15	100	0 0002	1 0000	N/A	N/A	Y	17 46	0
COPPER	59	72 88	15	60	0 1341	1 0000	N/A	N/A	N	33 9	0
IRON	59	100	15	100	0 0001	1 0000	0 1471	<0 0001	Y	27928 58	0
LEAD	57	100	15	100	0 0488	1 0000	0 6585	N/A	Y	136 77	0
LITHIUM	57	71 93	15	93 33	0 0520	1 0000	N/A	N/A	N	23 58	0
MAGNESIUM	59	91 53	15	100	0 0018	1 0000	0 0436	N/A	Y	5209 74	0
MANGANESE	59	98 31	15	100	0 0028	1 0000	0 0436	0 0039	Y	884 1	1
MERCURY	49	4 08	15	26 67	0 0111	1 0000	N/A	N/A	Y		0
MOLYBDENUM	58	27 59	15	0	0 5000	1 0000	N/A	N/A	N	34 96	0
NICKEL	57	68 42	15	46 67	0 0617	1 0000	N/A	N/A	N	22 84	0
POTASSIUM	58	74 14	15	93 33	0 0005	1 0000	N/A	N/A	Y	3070 25	0
SELENIUM	58	22 41	15	13 33	0 7650	1 0000	N/A	N/A	N	2 9	0
SILVER	54	3 7	15	6 67	0 4700	1 0000	N/A	N/A	N		0

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OU6 Sediment Metals Summary
(Page 2 of 2)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
SODIUM	59	79.66	15	86.67	0.0034	1.0000	N/A	N/A	Y	1397.8	0
STRONTIUM	58	82.76	15	100	0.0001	1.0000	N/A	0.0027	Y	219.18	0
THALLIUM	50	4	15	33.33	0.0187	1.0000	N/A	N/A	Y		0
TIN	55	29.09	15	0	0.5000	1.0000	N/A	N/A	N	101.85	0
VANADIUM	57	92.98	15	100	0.0087	1.0000	0.3800	N/A	Y	61.81	0
ZINC	59	94.92	15	100	0.0005	1.0000	0.0144	0.0001	Y	306.91	0

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INTEROFFICE CORRESPONDENCE

DATE February 9, 1995

TO D Sullivan, Systems Analysis, Bldg 850, X5586

FROM ^{NAH} N A Holsteen, OU5, 6, 7 Closures, Bldg 080, X6987

SUBJECT PERFORM GILBERT METHODOLOGY BACKGROUND COMPARISON FOR OPERABLE UNIT 6 METALS IN STREAM SEDIMENTS - NAH-008-94

DOE Order 4700 1

We have noticed several problems with the Operable Unit (OU) 6 background comparison results. As an indicator for problems with the entire OU6 background comparison, I would like to request that you perform the background comparison on metals for OU6 stream sediments. Because we need to resolve this problem as soon as possible, your immediate assistance is desired.

The location codes are as follows

SED68192	SED69492
SED68492	SED69592
SED68592	SED69692
SED68692	SED69792
SED68792	SED69892
SED68892	SED69992
SED68992	SED70092
SED69292	

Please call me at the above extension as soon as you have results. If there are significant differences we may request that you run the background comparison for the complete OU6 database. The OU6 charge number is 986492.

Information is attached on the structure of the files

NAH cb

Attachment
As Stated

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To OU6 Data Users

From David S Baca
WCFS

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Project OU6 RI/FS

Date March 7, 1994

OU6 MATRIX METHOD FILES

The following is the filename structure used for these files. The first two characters designate the sample matrix type. Third and fourth identify the analytical method. The fifth through eighth characters differentiate file numbers and subgenerations. Example BHTM2a.xls, identifies the file as a borehole total metal file from the second generation with a subgeneration of a

The following abbreviations are used for the sample matrices

BH	Borehole
SS	Surficial Soil
SW	Surface Water
SD	Sediments
TR	Trenches
GW	Groundwater

The letters "T" and "F" in the third character identifies a total or filtered sample matrix. The following abbreviations are used for analytical methods

V	Volatiles
SV	Semivolatiles
P	Pesticide/PCBs
M	Metals
R	Radiological
W	Water Quality Parameters (WQPL)

Subgenerations are described in the Treatment of OU6 Data memo

If you have any questions please call David Baca ext 4619

cc Bob Clark, WCFS
Susan Buth, WCC
Pat Westphal, WCFS
Chuan-Mian Zhang, WCFS
Art Gust, WCFS
Ron Eckert, WCFS

(4036-132-420)(ou6files wpf)(3-7-94)

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Mike Schrieber, WCFS
File 4036-420

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(4036-132-420)(ou6files wpf)(3-7-94)

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Flow Diagram of OU6 File Generations

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I Extract file from EDGE

- A Contents of file when complete**
 - 1 Real Samples
 - 2 Field QC Samples (i.e. equipment rinsates, field dups, MS/MSDs)
 - 3 Rejected "R" Qualified Data
 - 4 Not Requested "Z" Qualified Data
 - 5 Sample Re-Extraction Data (if any)
 - 6 Sample Dilution Data (if any)

- B Functions Performed on File**
 - 1 Multiple Record Check
 - 2 Completeness Check (identify what records are missing if any)
 - 3 Save file as 1

II File for Phase I Appendix J

- A Contents of file when complete**
 - 1 Real Samples (minus real samples with associated field dups.)
 - 2 Re-Extracted and Diluted Data (if necessary)

- B Functions Performed on File**
 - 1 Equipment Rinsates and MS/MSDs Deleted
 - 2 Re-Extracted and diluted data if real record exists
 - 3 Delete "R" Qualified Data
 - a Save "R" Qualified Data To Separate File
 - 4 Pull Real/Duplicate Pairs Into Separate File (these pairs will be file 3a)
 - 5 Save file as 2

IIIa Sub-File From II B 4

- A Contents of file when complete**
 - 1 Real/Duplicate Pairs

- B Functions Performed on File**
 - 1 Data Sorted By Sample Location, Number and Analyte
 - a Identify records that are rejected, non-detects and one of the two records is rejected or a non-detect while the other is accepted or a hit. Copies these records to file 3c. Once copied delete these records from this file
 - b Save file as 3a

IIIb Sub-File From IIIa

- A Contents of file when complete**
 - 1 Averaged Result of Real/Duplicate Pairs (minus the records copied to file 3c)

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- B Functions Performed on File**
 - 1 Sort contents of file by location, chemical and qactype
 - a Sort location and chemical in ascending order
 - b Sort qactype by descending order
 - 2 Run Excel macro Avg_dup xlm m
 - a Place an asterisk in last column of the file
 - b Save file as 3b

IIIc Sub-File From IIIb B 1 and IIIb B 2

- A Contents of file when complete**
 - 1 Rejected and Non-Detect Pairs From File IIIb B Above
- B Functions Performed on File**
 - 1 Nothing

IIIc1 Sub-File Of File IIIc

- A Contents of file when complete**
 - 1 Professional Judged Sample Result From File IIIc
- B Functions Performed on File**
 - 1 Rejected Data Treatment
 - a Both Real/Dup Results Rejected, Delete Both From File
 - b One of Two Real/Dup Result Rejected, Use Accepted Result
 - 2 Non-Detect Data Treatment
 - a Both Real/Dup Results Non-Detect, Use Real Result
 - b One of Two Real/Dup Result Non-Detect, Use Detected Result
 - 3 Save file as 3c1

IV Composite file of files II, IIIb and IIIc1

- 1 Open file 2
 - a Open file 3b and append to file 2.
 - b Open file 3c1 and append to file 2
- 2 Sort file by sample location, sample number and chemical
- 3 Save as file 4

INTEROFFICE CORRESPONDENCE

DATE May 9, 1994
TO Greg Manning, Risk Assessment, Bldg. 080, x6976
FROM Douglas K. Sullivan^{DKS}, Statistical Applications, Bldg. 850, x5586
SUBJECT RESULTS OF OU-6 SEDIMENT RADS COMPARISON TO BACKGROUND
DKS-014-94

The attached page contains the summary of the OU-6 pond sediment radionuclides (rads) comparison to background using the battery of statistical tests and the UTL approach.

The sediment data for OU-6 is from ten different ponds on the plantsite: A1-A4, B1-B5, and the pond at Walnut Creek & Indiana Ave. All of the data was grouped for comparison to background. This is inconsistent with what was done for the pond water in the IM/IRA report we provided to you last June. For the IM/IRA, grouping of ponds into pairs within a series was the selected approach. It would seem that the COC determination for pond sediment should follow the same logic as the pond water. Grouping of the data does provide a larger sample size for the statistical tests, but if we have already shown that the ponds are different in rads concentration, as was the case in the IM/IRA report, then it may be inappropriate to group the data.

Another inconsistency noticed is in the handling of data below detection limits. In the past, Statistical Applications has been told to use all rads data as if they were all detects. Woodward-Clyde's results indicate they used less-than values in their analyses of Cesium-137. This use of less-than values in rads data must be resolved before the results can be fully verified.

A minor point for Woodward-Clyde to correct is the use of duplicate values in the analyses. Duplicate values should be handled by averaging the results of the duplicate samples if it can be determined which sample the duplicate is paired with. If the pairing cannot be determined, the duplicate needs to be deleted from the data set. Only one duplicate, for OU-6 Plutonium-239/240, was found in the data used by Woodward-Clyde. I deleted the duplicate from my analyses since I could not determine its corresponding sample.

My results match Woodward-Clyde's for all of the rads except for Cesium-137 and Plutonium-239/240 as explained above.

Please contact me if you have any questions or need additional information.

OU-6 Pond Sediment Radionuclides Summary

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
AMERICIUM-241	14	100	47	100	<0.0001	0.0004	0.0214	N/A	Y	1.46	22
CESIUM-137	13	100	48	100	0.9976	0.7869	0.9996	N/A	N	3.51	0
GROSS ALPHA	15	100	48	100	0.0030	0.0129	0.0184	N/A	Y	78.83	7
GROSS BETA	14	100	49	100	0.0010	0.1164	0.4017	N/A	Y	45.76	2
PLUTONIUM-239/240	16	100	45	100	<0.0001	0.0008	0.0111	N/A	Y	7.68	18
RADIUM-226	9	100	5	100	0.0013	0.0005	0.0050	0.0001	Y	1.97	0
RADIUM-228	9	100	5	100	0.0013	0.0005	0.0275	0.0005	Y	2.88	0
STRONTIUM-89/90	14	100	22	100	0.0175	0.6111	0.6306	N/A	Y	2.63	0
TRITIUM	13	100	45	100	0.9765	0.4599	0.7434	N/A	N	769.75	1
URANIUM-233/234	16	100	48	100	<0.0001	<0.0001	0.0147	N/A	Y	2.39	9
URANIUM-235	17	100	48	100	0.0009	0.1486	0.0839	N/A	Y	0.25	6
URANIUM-238	14	100	48	100	<0.0001	0.0008	0.0232	N/A	Y	2.52	8

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MEMORANDUM

To: Neil Holsteen
From: Mary Lee Hogg *MLH*
Date: April 20, 1994
Subject: Data grouping for wet/dry sediments, OU 6

I have informed Chuan Mian Zhang of Woodward-Clyde Federal Services that data on dry sediments should be grouped with wet sediments as opposed to including dry sediments with surficial soil data. This approach will be used for background comparisons and data aggregation for exposure assessment. Pat Westphal has also been informed of this decision.

cc: John Hopkins
Greg Manning

MEMORANDUM

To Ed Mast

From Mary Lee Hogg *MLH*

Date March 28, 1994

Subject Issues and action items resulting with March 24 meeting with Woodward-Clyde on OU 6 data

These issues and items include the following

- Validated rad results reported as zero (0) - we will first approach RFEDs to see if these were round-off or transcription error (the latter is unlikely, since there are so many 0 values), the next option will be to initiate an inquiry to Karen Schoendaller and/or QUANTALEX
- Multiple results of rad data for same sample location, number and specific rad - Dave states that, often, RFEDs would direct him to delete the entry that had an associated detection limit or count error Therefore, for data with U qualifiers, Dave is left without a verified value for detection limit I do not think we resolved how to approach this
- Non-validated rad results - Woodward-Clyde will get updated data from Neil
- Removal of IHSS 143 from OU 6 - Ed will pursue
- Hits in equipment rinsate, but results rejected in QA - Mary Siders indicated that we should talk to Karen Schoendaller concerning this
- No results reported for baseflow and storm events - WC will get updated data from Neil

cc Neil Holsteen
 John Hopkins
 Greg Manning

INTEROFFICE CORRESPONDENCE

DATE March 23, 1994
TO Greg Manning, Risk Assessment, Bldg. 080, x6976
FROM D. K. Sullivan/D. R. Weier, Stat. Apps, Bldg. 850, x5586/x4194
SUBJECT RESULTS OF OU-6 BOREHOLES METALS COMPARISON TO BACKGROUND
DKS-010-94

The attached pages contain the revised summary of the OU-6 boreholes metals comparison to background using the battery of statistical tests and the UTL approach. Per instructions received, this revision omits data from the LHSU (geology=KAR) from the background data which were included in the original analyses.

Comments regarding the different depths associated with the site data were included in the cover memo of the earlier summary. We want to re-emphasize some of those comments. Several issues are raised with the presence of multiple depths. Are background and site data from possibly different depths comparable? For more than half of the metals compared, the background values are actually statistically significantly greater than the site values. Is this unusual result related to depth differences? Plots generally indicate decreasing concentrations of analytes at greater depths in the site data. Should data from such different depths be averaged in comparisons? It would seem that the depths should be taken into consideration for COC determination, risk assessment, and remediation decisions. As mentioned in the first memo, conversations with Woodward-Clyde personnel indicated that they grouped the results over all depths, so we ran the analyses in the same manner so that the verification of their software could be made.

Another potential data problem observed is the handling of some nondetects by Woodward-Clyde. In comparing the original background data file with the files trimmed by Woodward-Clyde, we noticed that some of the results with "U" qualifiers were listed as detects in the trimmed files. This seems to be limited to "U" qualified results that were higher than the reporting limit.

Chuan-Mian Zhang of Woodward-Clyde expressed concern regarding some of the features of the UTL computations. Her concerns would indeed be quite legitimate if we were treating the UTL comparison method as a rigorous statistical tool. We are not doing so; we are in fact isolating the UTL comparison from the other statistical criteria and simply using it as a "hot measurement check". We are not trying to formalize the criteria by quantifying its Type I error (as the p-value approach does), since it cannot be easily quantified. Similarly the appropriateness of assumptions of an underlying normal distribution for the background data is not that critical for our purposes. We are simply using a computational approach that gives us a "big" value for an analyte relative to

Greg Manning
March 23, 1994
DKS-010-94
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background levels. If site values are found to exceed this "big" value, some sort of investigation is warranted. How good a job the UTL approach does in raising warning flags will certainly depend on the underlying data distribution, treatment of nondetects, and many other factors, but that is not our primary concern. We have four rigorous statistical tests for detecting potential contaminants, and the UTL approach, though statistically flawed, does provide an additional, reasonable "hot measurement" check.

Note that due to ongoing requests from Woodward-Clyde for assistance and guidance, the hours charged by Statistical Applications to this OU6 activity will exceed the initial estimate. We had said two to three days for performing the statistical analysis for generating results for comparison to Woodward-Clyde results. While this was easily sufficient for that task, additional time was used in working with Woodward-Clyde directly and in revising the analyses. Total charges as of March 23 are 50 to 60 hours. Additional charges will be incurred if we run the analyses on radionuclides data as you have mentioned and with continued Woodward-Clyde requests for support.

If you need any further information, please call.

cc:
Ed Mast

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OU-6 Borehole Metals Summary
(Page 1 of 2)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
ALUMINIUM	98	98 98	256	100	>0.9999	1.0000	>0.9999	>0.9999	N	45113.51	0
ANTIMONY	66	15 15	210	7 14	0.0202	1.0000	N/A	N/A	Y	N/A	0
ARSENIC	99	70 71	257	99 22	0.0677	1.0000	N/A	N/A	N	16.24	0
BARIUM	99	88 89	257	100	<0.0001	0.1392	0.0005	0.0001	Y	371.76	19
BERYLLIUM	99	81 82	256	85 55	>0.9999	1.0000	N/A	>0.9999	N	18.27	0
CADMIUM	81	7 41	237	6 75	0.9159	1.0000	N/A	N/A	N	N/A	0
CALCIUM	99	98 99	256	100	<0.0001	0.0507	<0.0001	<0.0001	Y	53247.62	52
CESIUM	95	1 05	246	71 14	0.6543	1.0000	N/A	N/A	N	N/A	0
CHROMIUM	99	84 85	257	98 05	>0.9999	0.7219	N/A	0.9982	N	89.15	3
COBALT	99	22 22	257	94 94	0.9370	1.0000	N/A	N/A	N	26.43	0
COPPER	99	94 95	257	100	0.9986	1.0000	0.9968	0.9764	N	49.05	1
IRON	99	100	257	100	>0.9999	1.0000	>0.9999	0.9999	N	52385.26	0
LEAD	99	98 99	257	99 61	0.0543	0.5206	0.9344	0.1318	N	31.04	2
LITHIUM	99	61 62	235	88 51	0.4580	1.0000	N/A	N/A	N	34.2	0
MAGNESIUM	99	95 96	257	100	0.7971	1.0000	0.9447	0.9248	N	12102.14	0
MANGANESE	99	100	257	100	0.9999	1.0000	0.9999	0.9861	N	1194.04	0
MERCURY	86	25 58	257	28 40	>0.9999	1.0000	N/A	N/A	N	1.18	0
MOLYBDENUM	99	50 51	256	2 34	0.9873	1.0000	N/A	N/A	N	41.11	0
NICKEL	96	85 42	257	63 81	>0.9999	1.0000	N/A	N/A	N	78.73	0

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OU-6 Borehole Metals Summary
(Page 2 of 2)

Analyte	Background		OU6		Gehan p-Value	Slippage p-Value	Quantile p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper 99/99 Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect							
POTASSIUM	98	52.04	256	59.38	>0.9999	1.0000	N/A	N/A	N	7276.48	0
SELENIUM	82	2.44	237	8.44	0.9669	1.0000	N/A	N/A	N	N/A	0
SILVER	83	39.76	256	0.39	>0.9999	1.0000	N/A	N/A	N	33.09	0
SODIUM	99	17.17	256	100	0.9973	1.0000	N/A	N/A	N	N/A	0
STRONTIUM	99	36.36	257	99.61	<0.0001	0.7219	N/A	N/A	Y	185.53	21
THALLIUM	75	4.00	249	34.14	0.3751	1.0000	N/A	N/A	N	N/A	0
TIN	92	27.17	257	3.11	>0.9999	1.0000	N/A	N/A	N	383.7	0
VANADIUM	99	97.98	257	100	>0.9999	1.0000	0.9999	0.9990	N	112.85	1
ZINC	98	92.86	256	100	0.7620	0.7232	0.9230	0.6689	N	183.13	4

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To Ed Mast
Greg Manning
EG&G

From: Chuan-Mian Zhang
WCFS



Date. March 11, 1994

Subject. **Statistical Comparison Procedures for OU6-to-Background**

Statistical comparison procedures for OU6-to-background were prepared following the instruction given by EG&G (1/20/1994), which is primarily based on Dr Gilbert's letter (1993) as attached. Recently according to Dr Weier's instruction, further modification was performed. Applications of the statistical tests include "hot-measurement" test, Gehan test, quantile test, slippage test, and t-test. Procedures for implementing these tests are described as following. dBase programs were developed for applying these procedures.

I General manipulation of data

- 1 Assign 'B' for all the data from background, and assign 'S' for all the data from site
- 2 Read DET = 1 (detect), and DET = 0 (non-detect) from background data, and assign DET = 0 for nondetects for QUAL_LAB as 'U', and DET = 1 for detect for QUAL_LAB as 'B' or blank, for OU6 data
- 3 Combined the background data with OU6 data into one data series,
- 4 Rank the combined series from the smallest to the largest

II Gehan Test

Gehan test follows the procedures described by Gilbert (July 30, 1993)

- 1 Assign initial values $d = 0$, $e = 0$



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 March 11, 1994
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2 DO a DO-LOOP for all the data

For detected data with DET = 1,
 LET ID = 1
 d = d + 1
 e = e
 RANK = d + (total number of non-detect + e)/2
 SCORE = 2*RANK - (total number of measurement + 1)
 LET LOCATION = 0 if data is from background,
 LOCATION = 1 if data is from OU-6

For nondetected data with DET = 0,
 LET ID = 0
 d = d
 e = e + 1
 RANK = (total number of nondetect + 1 + d)/2
 SCORE = 2*RANK - (total number of measurement + 1)
 LET LOCATION = 0 if data is from background,
 LOCATION = 1 if data is from OU-6.

3 Based on the above calculation, calculate the Z value as (Gilbert, 1993)

$$Z = \frac{\sum_{i=1}^N \text{LOCATION}(i) * \text{SCORE}(i)}{\left[\frac{NB * NS}{N * (N-1)} \sum_{i=1}^N (\text{SCORE})^2 \right]^{1/2}} \quad (1)$$

where

NB = number of measurements from background
 NS = number of measurements from site
 N = total number of measurements

4 Compare Z_{calculated} with Z_{95%} from standard normal distribution table. If Z_{calculated} < Z_{95%}, comparison by Gehan test indicates the analyte is not a potential contaminant of concern (PCOC)

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Memo to Ed Mast, Greg Manning
 March 11, 1994
 Page 3

II Slippage Test

- 1 Select the maximum value of measurements from background data, MAXB.
- 2 Count the number of measurements which are greater than MAXB and are from OU6, K
- 3a Following Dr. Gilbert's letter, select critical value from "Tables for a Nonparametric Test of Location" (Rosenbaum, 1954) according to the sample sizes for both background and OU6, given the level of significance of 0.05. When the sample sizes are sufficiently large, the critical value is 5 for level of significance of 0.05, as indicated in the paper
- 4a Compare K with critical value, if $K < \text{critical value}$, comparison by Slippage test indicates the analyte is not a PCOC
- 3b Following Dr. Weier's instruction and the equation that he provided, p_value for the probability that K measurements from OU6 greater than the maximum value from background was calculated as following:

$$p = \sum_{a=K}^{NS} P(a) = 1 - \sum_{a=0}^{K-1} P(a) \quad (2)$$

where

$$P(a) = \frac{\binom{N-a-1}{NS-a}}{\binom{N}{NS}}$$

where

K is the number of site measurements greater than the largest background value

- 4b If p_value is less than or equal to the prescribed significance level, such as 0.05, the analyte is considered as a PCOC

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Memo to Ed Mast, Greg Manning

March 11, 1994

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III Quantile Test

- 1 If the largest 20% of the combined data series do not contain any non-detects, do Quantile test, otherwise not
- 2a Following Dr Gilbert's letter, count the number of measurements, say N_k , from the site that are among the largest r measurements of the combined data set. If N_k is greater than or equal to k , then conclusion is made that the analyte is a PCOC
- 3a The values of r and k are determined from Table A.8 in Gilbert and Simpson (1992), according to the sample sizes of background and OU6. When the sample size is greater than 100, as the maximum size provided by the table, it is assumed that the values of r and k will be as same as the values corresponding to the maximum sizes provided in the table
- 2b Following Dr Weier's instruction, count the number of measurements from the site among the largest 20% of the combined data series
- 3b Following the equation provided by Dr Weier, calculate the p value for the probability that there are K site measurements among the largest 20% of combined data series, as following

$$P = \frac{\max(n, NS)}{\sum_{a=K}^{K-1} P(a)} \quad P(a) = 1 - \sum_{a=0}^{K-1} P(a) \quad (3)$$

where

$$P(a) = \frac{\binom{NS}{a} \binom{NB}{n-a}}{\binom{N}{n}}$$

where

K = the number of measurements from site among the largest 20% of the combined data series

n = the number of 20% rounded up to the next integer

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Memo to Ed Mast, Greg Manning

March 11, 1994

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- 4b If the p value is less than or equal to the prescribed significance level, such as 0.05, the analyte is considered as a PCOC

IV t-Test

- 1 The t-test is conducted under the conditions as

If (a) less than 20% of background and OU6 data sets are nondetects,

AND (b) If EITHER both background and site data contain at least 20 data points,

OR both distribution are normally distributed The normality is checked by probability plotting as recommended by EPA (June 1992)

- 2 Testing for homogeneity of variance following Levene's test (EPA, 1992)
- 3 If the variances from both data sets are the same, apply the standard t-test as following

$$\text{Test statistic. } t = \frac{\bar{x}_s - \bar{x}_B}{\sqrt{\frac{S_p^2}{NB} + \frac{S_p^2}{NS}}} \quad (4)$$

$$S_p^2 = \left(\frac{NB-1}{NB + NS - 2} \right) S_B^2 + \left(\frac{NS-1}{NB + NS - 2} \right) S_S^2$$

where

where

S_B^2 = background sample variance
 S_S^2 = site sample variance
 \bar{x}_B = background sample mean
 \bar{x}_S = site sample mean

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Memo to Ed Mast, Greg Manning

March 11, 1994

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The degree of freedom is equal to $NB + NS - 2$

- 4 If the variances from both data sets are not the same, apply the t-test with unequal variances (Helsel and Hirsch, 1992) as

$$t = \frac{\bar{X}_S - \bar{X}_B}{\sqrt{\frac{S_B^2}{NB} + \frac{S_S^2}{NS}}} \quad (5)$$

The approximate degree of freedom is

$$df = \frac{\left(\frac{S_B^2}{NB} + \frac{S_S^2}{NS}\right)^2}{\frac{(S_B^2/NB)^2}{NB-1} + \frac{(S_S^2/NS)^2}{NS-1}} \quad (6)$$

- 5 Select the t critical values (t_{table}) from standard t critical value table according to the degree of freedom. For degree of freedom greater than 30 and less than 120, linear interpretation was performed to obtain the t critical value, corresponding to the degree of freedom
- 6 Compare the t_{table} and $t_{calculated}$ values, if $t_{calculated} < t_{table}$, the analyte is not considered as a PCOC

V Treatment of Non-detects

According to EG&G's instruction (FAX, March 3, 1994), for t-test, the non-detect are replaced with 1/2 times of the reporting limits. For the non-parametric test, the reporting limit will be used to replace the non-detect values for ranking purpose.

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Memo to Ed Mast, Greg Manning
March 11, 1994
Page 7

References

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- Devore, J and R. Peck, 1986, Statistics, West Publishing Company, 699 pgs
- Helsel, D R and R M Hirsch, 1992 Statistical Methods in Water Resources, 522 pgs
- Rosenbaum, S 1954 Tables for A Nonparametric Test of Location, The Annals of Mathematical Statistics, Volume 25

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M E M O R A N D U M

To Ed Mast
 From Mary Lee Hogg
 Date March 17, 1994
 Subject Background comparison for stream and pond sediments for OU 6 and OU 5

As a result of conversations with the OU 3 Manager and personnel involved in the proposed risk assessment process for OU 3, the question of appropriate background data for comparison to stream and pond sediments has been raised. Persons involved in the background evaluation for OU 3 have discussed this at length with EPA. It appears that this issue is also relevant to OU 6 stream and pond sediments, and the OU 6 manager and EG&G risk assessment team would like to propose the following approach, based on the proposed understanding between EPA and the OU 3 Manager

- Use the background stream sediment data (from Rock Creek) presented in the Background Geochemical Report (DOE 1993) for comparison to OU 6 stream sediments. All OU 6 stream sediments data will be aggregated.
- As discussed at the March 10, 1994 meeting with EPA on background evaluation for OU 3, a quantitative comparison of OU 3 pond sediments to sediments of other surface water bodies along the front range may also yield useful information. This approach could also be applicable to OU 6. A literature search to identify potentially useful and applicable data from surface water bodies has been performed (CH2M Hill 1993). This search identified sediment background data for Chatfield Reservoir, Cherry Creek, Bear Creek, Marston Lake, and Ralston Reservoir. Due to anticipated data limitations, if this approach is used, EG&G will request an exemption from EPA for performing the background comparison according to the Gilbert Methodology.
- After these respective background comparisons are performed for stream and pond sediments, a consistency check will be conducted.

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to indicate whether there are significant differences in stream
and pond sediments

cc John Hopkins
Rick Roberts
Neil Holsteen
Greg Manning ✓

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**Woodward-Clyde
Federal Services****Memorandum 64**

To Ed Mast
EG&G

From: Chuan-Mian Zhang
WCFS



Date March 17, 1994

Subject Estimation of Upper Tolerance Limit

The estimation of the upper tolerance limit (UTL) at 99% confidence level and 99% coverage in the 1993 Background Geochemistry Characterization Report (EG&G) was based on the assumption that data are normally distributed. These UTL values are used in hot measurement comparisons in a statistic background comparison for OU6 according to EG&G's instructions.

Using these UTL values, which are not calculated following the regular procedures, may cause some potential problems in conclusions of statistical background comparison. For example, most of the data are highly skewed (i.e., they have a lower bound at zero and quite large observations differing from the bulk of the data), they do not follow a normal distribution, but rather are close to a log-normal distribution. Estimated UTL based on a normal distribution tends to be smaller than it should be, thereby causing more potential contaminant of concern (PCOC) in the comparison results. The consequence is that it may result in more work in professional judgement and more comments back from regulators.

In order to address my concern, I include the following discussions:

comparison between the UTL calculation procedure proposed by Dr. Gilbert and EG&G's procedure,

potential problem illustration by examples

I UTL Calculation Procedures

Procedure proposed by Dr. Gilbert

(1) Using probability plotting to determine if the background data set is best modeled as a normal or log-normal distribution.

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(2) If it is normally distributed, compute the UTL as

$$UTL = \bar{x} + K*s \quad (1)$$

where \bar{x} is sample mean, s is sample standard deviation, and K is the normal tolerance factor depending on the sample size

(3) If it is log-normally distributed, the UTL should be calculated as

$$UTL = \exp(y + K*s_y) \quad (2)$$

where y is the mean of the logarithms of the data, and s_y is the standard deviation of the logarithms of the data.

(4) If the data set is neither normal nor log-normal distributed, the nonparametric UTL calculation procedure is recommended (Appendix D in Dr Gilbert's letter)

(5) If the background data set contains nondetects, the usual simple computational formulas for the arithmetic mean and standard deviation cannot be used. The robust probability plotting method is recommended.

EG&G's Procedure

UTL calculation is based on applying step (2)

II Examples Analysis

Example 1

Zinc data (no nondetects) at the subsurface were arbitrarily chosen for example analysis. Attached Figures 1 to 7 are relevant figures. Figures 1 and 2 illustrate that Zinc data do not follow a normal distribution for both background and OU6. Figures 3 and 4 show that the data sets are much closer to a log-normal distribution. Differences in results between the two methods are.

UTL₁(normal) 155.9 mg/kg

UTL₂(log-normal) 293.9 mg/kg

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No of OU6 data
greater than UTL₁ 4

No of OU6 data
greater than UTL₂ 1

Example 2

Table "T4GMTM DBF", the result of background comparison for subsurface soil metal, shows that the numbers of analytes which fail to past the tests are as following

Hot Measurement	8
Slippage test	1
Quantile test	2
Gehan test	3

These examples clearly show that the significance of the error resulting from misapplying the normal distribution-based method

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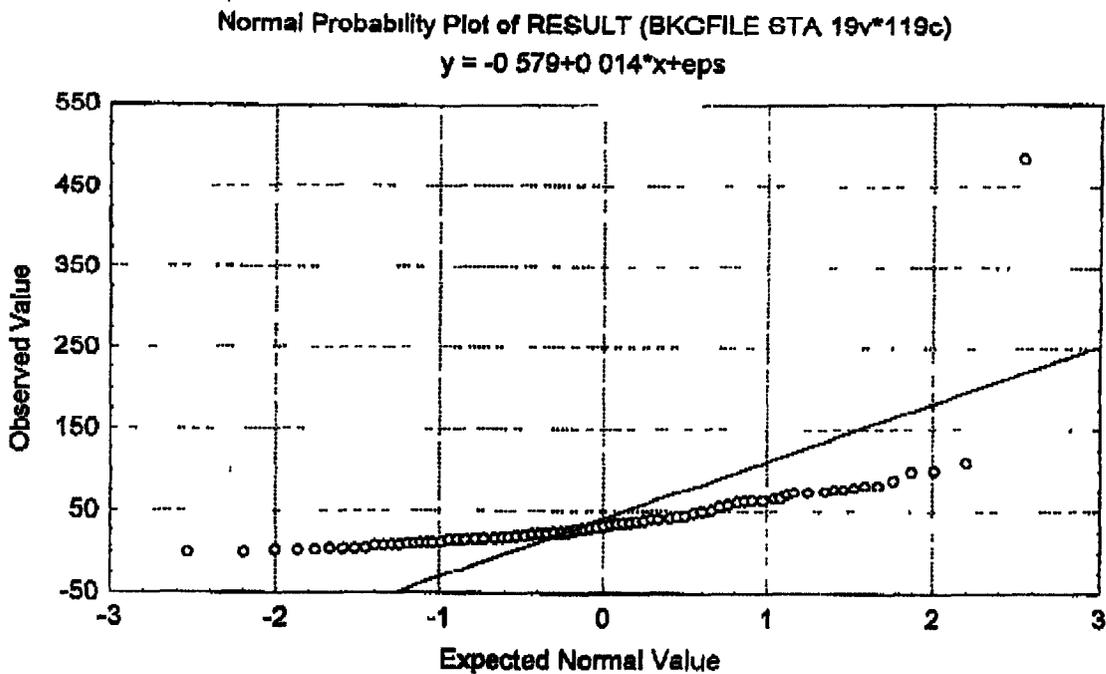


Figure 1 Normal Probability Plot for Background Zinc Data Set at Subsurface

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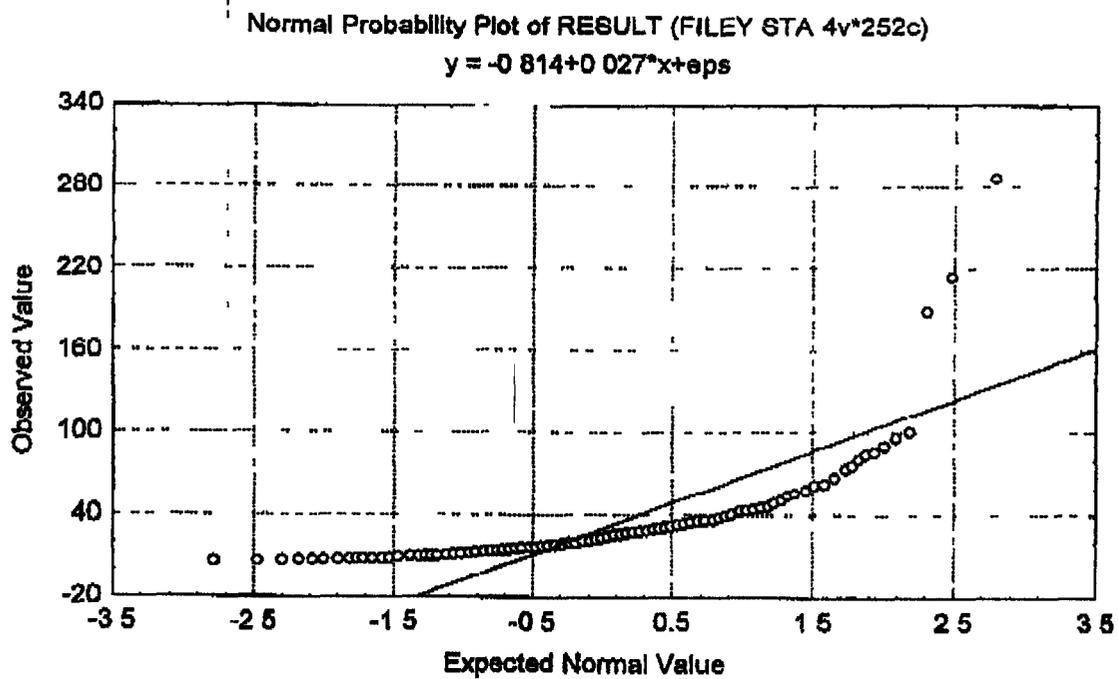


Figure 2. Normal Probability plot for 046 Zinc Data set at Subsurface

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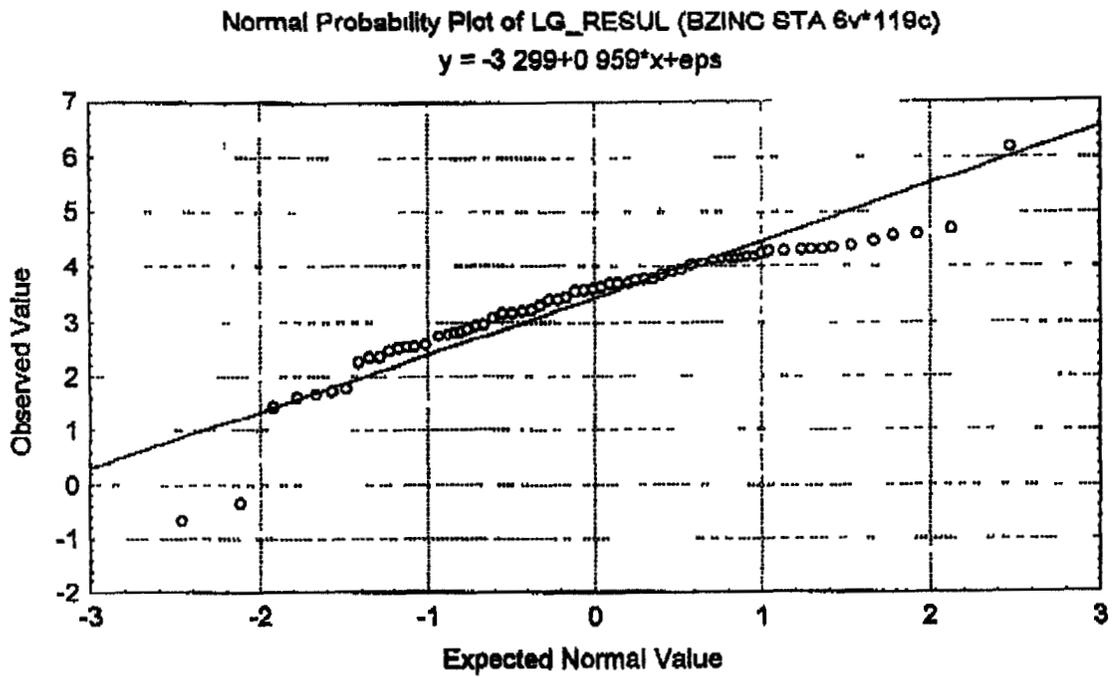


Figure 3. Lognormal Probability Plot for Background Zinc Data Set at Subsurface

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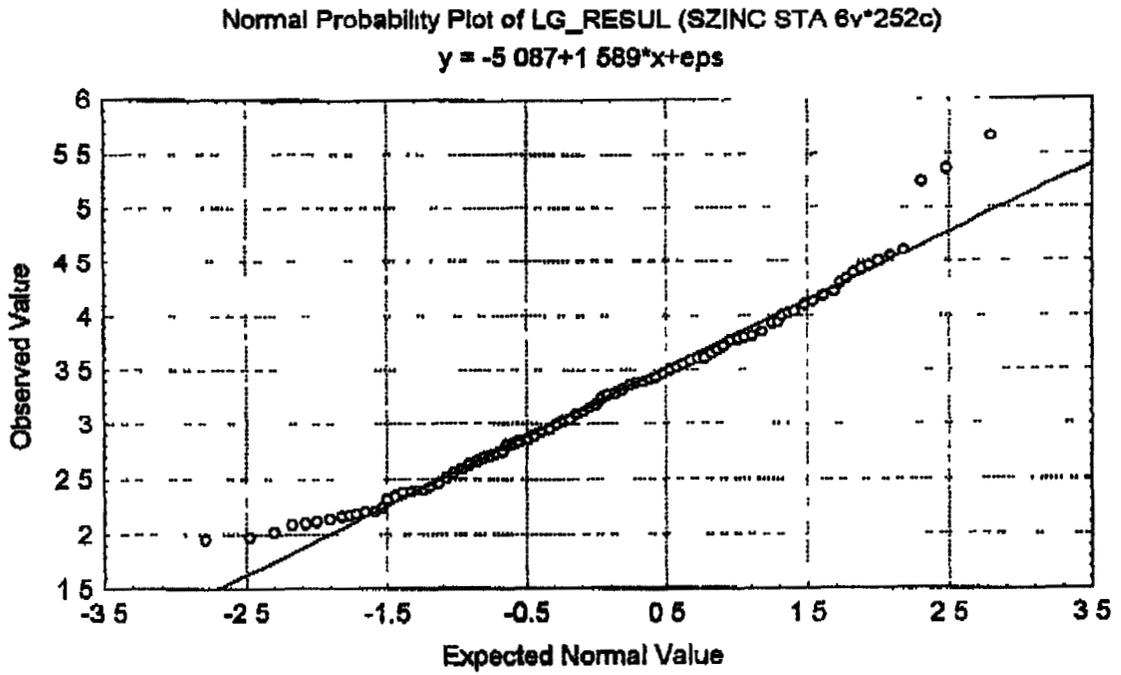


Figure 4. Lognormal Probability Plot for 046 Zinc Data set. at subsurface

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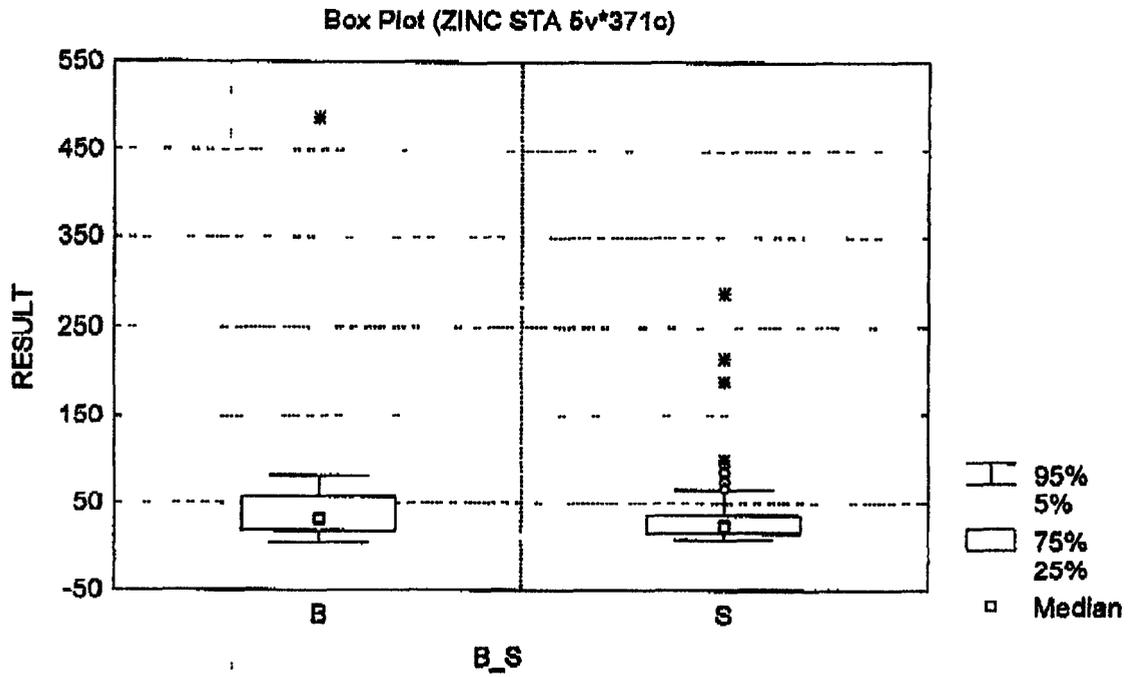


Figure 5. Box plot for Zinc at Background (B) and at 046 (S) at Subsurface

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BZINC.XLS Chart 1

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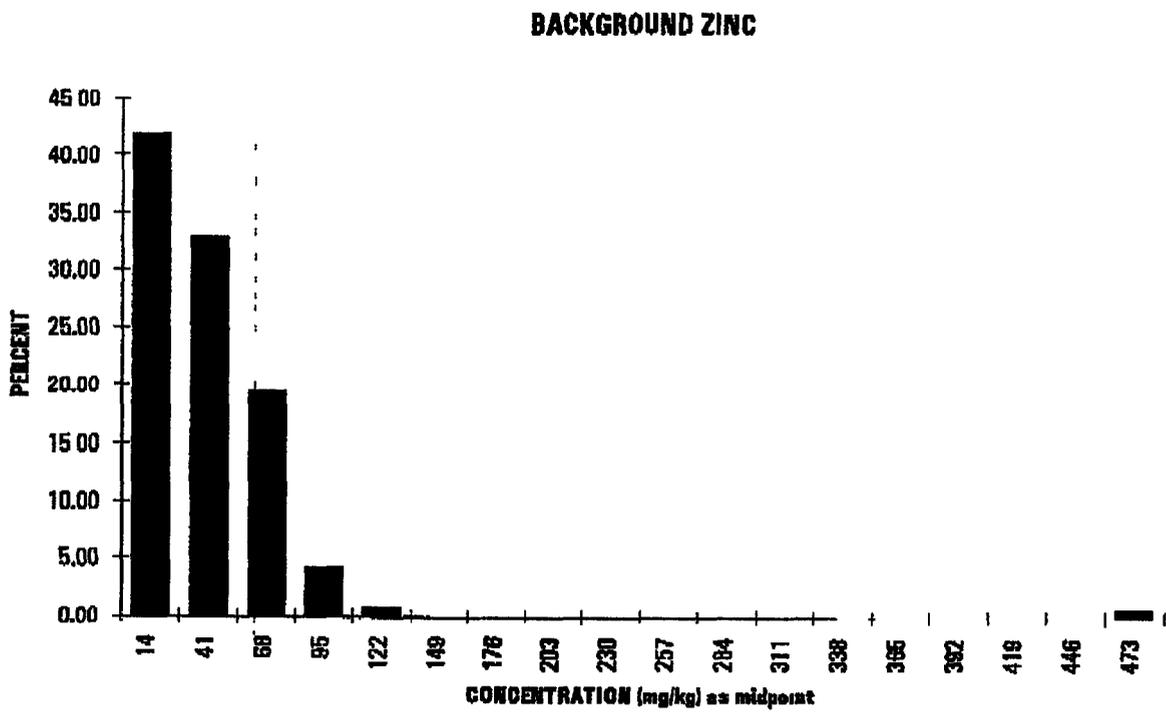


Figure 6. Histogram of Background Zinc at Subsurface

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SZINC.DBF Chart 1

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OU6 ZINC

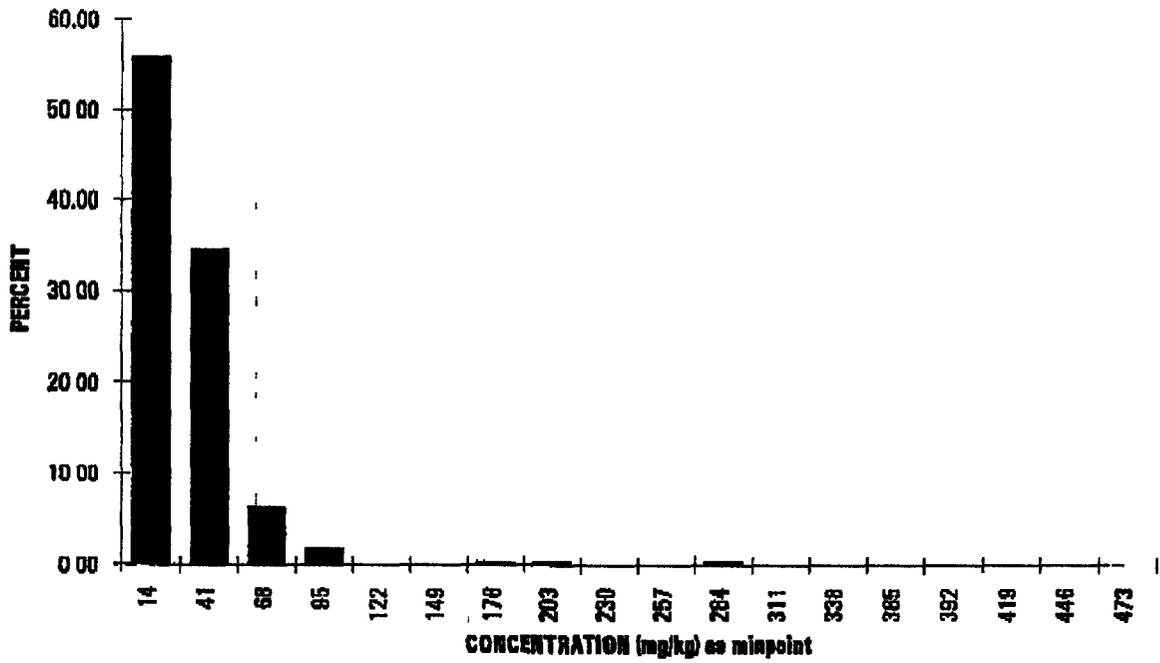


Figure 7. Histogram of OU6 Zinc at subsurface

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Subsurface Soil Metal

T48MTM.DBF

3/18/94

(4 tests)

ANALYTE	N B	N S	ND B	ND S	UTL99	INGUTL	MAX B	NGMAX P	SLP	NDT20	N	T20	N	SITE	P	QUAN	Z	CAL	Z	95	P	Gohem
ALUMINIUM	98	256	0	0	39105.7	0	182000.00	0	1.060	0	71	0	71	30	1.000	7.408	1.645	1.645	1.645	1.645	1.645	1.090
ANTIMONY	66	210	54	195	47.0	0	47.00	0	1.060	38	56	38	56	989	999,000	9.963	1.645	1.645	1.645	1.645	1.645	0.168
ARSENIC	89	257	19	2	14.7	0	41.80	0	1.060	0	72	0	72	49	0.847	9.425	1.645	1.645	1.645	1.645	1.645	0.936
BARIUM	99	257	8	0	321.2	21	777.00	6	0.139	0	72	0	72	63	0.001	4.560	1.645	1.645	1.645	1.645	1.645	0.090
BERYLLIUM	89	258	9	37	15.8	0	23.50	0	1.000	0	71	0	71	0	1.000	-14.100	1.645	1.645	1.645	1.645	1.645	1.090
CADMIUM	81	237	42	221	2.2	0	2.40	0	1.000	21	64	21	64	989	999,000	9.938	1.645	1.645	1.645	1.645	1.645	1.090
CALCIUM	80	256	10	0	44733.4	61	157000.00	9	0.061	0	71	0	71	78	0.000	6.608	1.645	1.645	1.645	1.645	1.645	0.090
CESIUM	95	246	21	71	867.7	0	2830.08	0	1.000	16	68	16	68	989	999,000	-14.252	1.645	1.645	1.645	1.645	1.645	1.090
CHROMIUM	88	257	0	5	76.3	4	178.08	1	0.722	0	72	0	72	27	1.000	-8.911	1.645	1.645	1.645	1.645	1.645	1.090
COBALT	99	257	65	13	32.6	0	83.90	0	1.000	22	72	22	72	989	999,000	-3.673	1.645	1.645	1.645	1.645	1.645	1.090
COPPER	88	257	3	0	42.4	1	123.00	0	1.000	0	72	0	72	43	0.987	3.130	1.645	1.645	1.645	1.645	1.645	0.989
IRON	99	257	0	0	45421.4	0	122800.00	0	1.060	0	72	0	72	37	1.000	-8.914	1.645	1.645	1.645	1.645	1.645	1.090
LEAD	88	257	0	1	27.3	3	39.80	2	0.521	0	72	0	72	47	0.945	1.588	1.645	1.645	1.645	1.645	1.645	0.056
LITHIUM	99	235	61	27	38.5	0	83.20	0	1.000	18	67	18	67	989	999,000	-5.107	1.645	1.645	1.645	1.645	1.645	1.090
MAGNESIUM	99	257	29	0	10426.1	0	32500.00	0	1.060	0	72	0	72	47	0.945	-0.850	1.645	1.645	1.645	1.645	1.645	0.742
MANGANESE	99	257	0	0	1014.4	0	3330.00	0	1.060	0	72	0	72	39	1.000	3.887	1.645	1.645	1.645	1.645	1.645	1.090
MERCURY	88	257	53	184	2.2	0	5.90	0	1.060	0	72	0	72	39	1.000	-8.341	1.645	1.645	1.645	1.645	1.645	1.090
MOLYBDENUM	99	256	81	250	67.6	0	67.60	0	1.000	68	71	68	71	989	999,000	2.282	1.645	1.645	1.645	1.645	1.645	0.989
NICKEL	96	257	4	93	68.1	0	193.00	0	1.000	0	71	0	71	28	1.000	7.951	1.645	1.645	1.645	1.645	1.645	1.090
POTASSIUM	98	256	59	104	7002.9	0	18700.00	0	1.000	46	71	46	71	989	999,000	-4.324	1.645	1.645	1.645	1.645	1.645	1.090
SELENIUM	82	237	80	217	6.7	0	13.70	0	1.000	41	64	41	64	989	999,000	-3.336	1.645	1.645	1.645	1.645	1.645	1.090
SILVER	83	258	47	255	34.4	0	40.90	0	1.000	0	68	0	68	989	999,000	18.582	1.645	1.645	1.645	1.645	1.645	1.090
SODIUM	98	256	81	0	3680.0	0	3680.00	0	1.000	69	71	69	71	989	999,000	-2.971	1.645	1.645	1.645	1.645	1.645	0.989
STRONTIUM	88	257	66	1	235.4	12	484.00	1	0.722	8	72	8	72	989	999,000	3.003	1.645	1.645	1.645	1.645	1.645	0.091
THALLIUM	75	248	71	164	20.0	0	20.00	0	1.000	84	65	84	65	989	999,000	-4.775	1.645	1.645	1.645	1.645	1.645	0.791
TIN	92	257	71	249	323.4	0	441.00	0	1.000	50	70	50	70	989	999,000	-8.653	1.645	1.645	1.645	1.645	1.645	1.090
VANADIUM	99	257	2	0	97.9	1	283.00	0	1.000	0	72	0	72	39	1.000	-4.987	1.645	1.645	1.645	1.645	1.645	1.090
ZINC	98	256	0	0	155.9	4	486.00	1	0.723	0	71	0	71	47	0.923	-9.573	1.645	1.645	1.645	1.645	1.645	0.835

1. SLP = γ , value for the probability that NORMAX also measurements exceed MAX_B
 2. CAL = number of non-detect among the largest 20% of the combined data set
 3. T20 = number of largest 20% measurements of the combined data set
 4. SITE = number of site measurements among N_T20 largest measurements; value
 5. QUAN = p value for the probability that QUANT is not exceeded
 6. Gohem = p value for the probability that Gohem is not exceeded
 7. Z_95 = value Z value for 95% confidence level
 8. Z_CALC = calculated Z value from Gohem test
 9. Z_95 = value Z value for 95% confidence level
 10. P-Gohem = p-value for Gohem test
 11. For data non-parametric test, non-detects were replaced with reporting limits for
 making purpose.

N_B = number of measurements at background
 N_S = number of measurements at site
 ND_B = number of non-detect at background
 ND_S = number of non-detect at site
 UTL99 = Background UTL
 NGUTL = No. of site measurements greater than UTL
 MAX_B = confidence background measurement
 NORMAX = number of measurements exceeding the maximum background
 measurement, MAX_B

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INTEROFFICE CORRESPONDENCE

DATE March 14, 1994
TO Greg Manning, Risk Assessment, Bldg 080, x6976
FROM D. K. Sullivan^{DKS}, Stat. Apps, Bldg 850, x5586
SUBJECT RESULTS OF OU-6 BOREHOLES METALS COMPARISON TO BACKGROUND
DKS-009-94

The attached pages contain the summary of the OU-6 boreholes metals comparison to background using the battery of statistical tests and the UTL approach.

The data used was the data provided by Woodward-Clyde so the results should provide a basis for comparison.

Since the data is from boreholes and contains depth information, the question of independence of samples is an issue. If several samples are taken from the same borehole but at different depths, statistical dependence is introduced. Also, the mixing of data from different depths into one statistical comparison may not be the best approach in site to background comparisons. Conversations with Woodward-Clyde personnel indicated that they used all the results as independent samples, so I ran the analyses in the same manner so that the verification of their software could be made.

If you need any further information, please call me at x5586.

cc:
D. R. Weier

OU-6 Borehole Metals Summary
(Page 1 of 2)

Analyte	Background		OU-6		Slipage Test p-Value	Quantile Test p-Value	t-Test p-Value	Any Tests Significant? (Y/N)	Background Upper Tolerance Limit (UTL)	Number of UTL Exceedances
	N	% Detect	N	% Detect						
ALUMINUM	119	99 16	256	100	1	1	1	N	41280 63	0
ANTIMONY	81	16 05	210	7 14	1	NA	NA	Y	NA	0
ARSENIC	120	68 33	257	99 22	1	NA	NA	Y	15 25	0
BARIUM	120	89 17	257	100	0 0985	0 0001	0 0001	Y	350 03	20
BERYLLIUM	120	80	256	85 55	1	NA	1	N	17 18	0
CADMIUM	100	6	237	6 75	1	NA	NA	N	NA	0
CALCIUM	120	99 17	256	100	0 0300	0 0001	0 0001	Y	47957 15	57
CESIUM	111	0 9	246	71 14	1	NA	NA	N	NA	0
CHROMIUM	120	82 5	257	98 05	0 6817	NA	0 9949	N	80 66	4
COBALT	120	24 17	257	94 94	1	NA	NA	N	26 01	0
COPPER	119	95 8	257	100	1	1	0 9970	N	46 56	1
IRON	119	100	257	100	1	1	1	N	49550 25	0
LEAD	120	98 33	257	99 61	0 4641	NA	0 6658	N	33 10	2
LITHIUM	120	64 17	235	88 51	1	NA	NA	N	31 55	0
MAGNESIUM	120	95	257	100	1	0 8628	0 9136	N	11082 88	0
MANGANESE	120	99 17	257	100	1	0 9998	0 9895	N	1104 78	0
MERCURY	107	21 5	257	28 4	1	NA	NA	N	1 06	0
MOLYBDENUM	120	50	256	2 34	1	NA	NA	N	39 30	0
NICKEL	115	85 22	257	63 81	1	NA	NA	N	74 34	0

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To Ed Mast
Greg Manning
EG&G

From Chuan-Mian Zhang
WCFS



Date March 11, 1994

Subject Statistical Comparison Procedures for OU6-to-Background

Statistical comparison procedures for OU6-to-background were prepared following the instruction given by EG&G (1/20/1994), which is primarily based on Dr Gilbert's letter (1993) as attached. Recently according to Dr Weier's instruction, further modification was performed. Applications of the statistical tests include "hot-measurement" test, Gehan test, quantile test, slippage test, and t-test. Procedures for implementing these test are described as following. dBase programs were developed for applying these procedures.

I General manipulation of data

- 1 Assign 'B' for all the data from background, and assign 'S' for all the data from site
- 2 Read DET = 1 (detect), and DET = 0 (non-detect) from background data, and assign DET = 0 for nondetects for QUAL_LAB as 'U', and DET = 1 for detect for QUAL_LAB as 'B' or blank, for OU6 data
- 3 Combined the background data with OU6 data into one data series,
- 4 Rank the combined series from the smallest to the largest.

II. Gehan Test

Gehan test follows the procedures described by Gilbert (July 30, 1993)

- 1 Assign initial values $d = 0, e = 0$

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2 DO a DO-LOOP for all the data

For detected data with DET = 1,
 LET ID = 1
 d = d + 1
 e = e
 RANK = d + (total number of non-detect + e)/2
 SCORE = 2*RANK - (total number of measurement + 1)
 LET LOCATION = 0 if data is from background,
 LOCATION = 1 if data is from OU-6

For nondetected data with DET = 0,
 LET ID = 0
 d = d
 e = e + 1
 RANK = (total number of nondetect + 1 + d)/2
 SCORE = 2*RANK - (total number of measurement + 1)
 LET LOCATION = 0 if data is from background,
 LOCATION = 1 if data is from OU-6

3 Based on the above calculation, calculate the Z value as (Gilbert, 1993)

$$Z = \frac{\sum_{i=1}^N \text{LOCATION}(i) * \text{SCORE}(i)}{\left[\frac{NB * NS}{N * (N-1)} \sum_{i=1}^N (\text{SCORE})^2 \right]^{1/2}} \quad (1)$$

where

NB = number of measurements from background
 NS = number of measurements from site
 N = total number of measurements

4 Compare $Z_{\text{calculated}}$ with $Z_{95\%}$ from standard normal distribution table. If $Z_{\text{calculated}} < Z_{95\%}$, comparison by Gehan test indicates the analyte is not a potential contaminant of concern (PCOC)

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II Slippage Test

- 1 Select the maximum value of measurements from background data, MAXB
- 2 Count the number of measurements which are greater than MAXB and are from OU6, K.
- 3a Following Dr Gilbert's letter, select critical value from " Tables for a Nonparametric Test of Location" (Rosenbaum, 1954) according to the sample sizes for both background and OU6, given the level of significance of 0.05. When the sample sizes are sufficiently large, the critical value is 5 for level of significance of 0.05, as indicated in the paper
- 4a Compare K with critical value, if $K < \text{critical value}$, comparison by Slippage test indicates the analyte is not a PCOC
- 3b Following Dr weier's instruction and the equation that he provided, p_value for the probability that K measurements from OU6 greater than the maximum value from background was calculated as following:

$$p = \sum_{a=K}^{NS} P(a) = 1 - \sum_{a=0}^{K-1} P(a) \quad (2)$$

where

$$P(a) = \frac{\binom{N-a-1}{NS-a}}{\binom{N}{NS}}$$

where

K is the number of site measurements greater than the largest background value

- 4b If p_value is less than or equal to the prescribed significance level, such as 0.05, the analyte is considered as a PCOC

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III Quantile Test

- 1 If the largest 20% of the combined data series do not contain any non-detects, do Quantile test, otherwise not
- 2a Following Dr Gilbert's letter, count the number of measurements, say N_k , from the site that are among the largest r measurements of the combined data set. If N_k is greater than or equal to k , then conclusion is made that the analyte is a PCOC
- 3a The values of r and k are determined from Table A.8 in Gilbert and Simpson (1992), according to the sample sizes of background and OU6. When the sample size is greater than 100, as the maximum size provided by the table, it is assumed that the values of r and k will be as same as the values corresponding to the maximum sizes provided in the table
- 2b Following Dr. Weier's instruction, count the number of measurements from the site among the largest 20% of the combined data series
- 3b Following the equation provided by Dr Weier, calculate the p value for the probability that there are K site measurements among the largest 20% of combined data series, as following

$$P = \max_{a=K} (n, NS) \quad P(a) = 1 - \sum_{a=0}^{K-1} P(a) \quad (3)$$

where

$$P(a) = \frac{\binom{NS}{a} \binom{NB}{n-a}}{\binom{N}{n}}$$

where:

- K = the number of measurements from site among the largest 20% of the combined data series
 n = the number of 20% rounded up to the next integer

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- 4b If the p value is less than or equal to the prescribed significance level, such as 0.05, the analyte is considered as a PCOC.

IV t-Test

- 1 The t-test is conducted under the conditions as

If (a) less than 20% of background and OU6 data sets are nondetects,

AND (b) If EITHER both background and site data contain at least 20 data points,

OR both distribution are normally distributed. The normality is checked by probability plotting as recommended by EPA (June 1992)

2. Testing for homogeneity of variance following Levene's test (EPA, 1992)
- 3 If the variances from both data sets are the same, apply the standard t-test as following:

$$\text{Test statistic: } t = \frac{\bar{x}_s - \bar{x}_B}{\sqrt{\frac{S_p^2}{NB} + \frac{S_p^2}{NS}}} \quad (4)$$

$$S_p^2 = \left(\frac{NB-1}{NB + NS - 2} \right) S_B^2 + \left(\frac{NS-1}{NB + NS - 2} \right) S_S^2$$

where

where

S_B^2 = background sample variance

S_S^2 = site sample variance

\bar{x}_B = background sample mean

\bar{x}_s = site sample mean

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The degree of freedom is equal to $NB + NS - 2$

- 4 If the variances from both data sets are not the same, apply the t-test with unequal variances (Helsel and Hirsch, 1992) as

$$t = \frac{\bar{X}_S - \bar{X}_B}{\sqrt{\frac{S_B^2}{NB} + \frac{S_S^2}{NS}}} \quad (5)$$

The approximate degree of freedom is

$$df = \frac{\left(\frac{S_B^2}{NB} + \frac{S_S^2}{NS}\right)^2}{\frac{(S_B^2/NB)^2}{NB-1} + \frac{(S_S^2/NS)^2}{NS-1}} \quad (6)$$

- 5 Select the t critical values (t_{table}) from standard t critical value table according to the degree of freedom. For degree of freedom greater than 30 and less than 120, linear interpretation was performed to obtain the t critical value, corresponding to the degree of freedom.
6. Compare the t_{table} and $t_{calculated}$ values, if $t_{calculated} < t_{table}$, the analyte is not considered as a PCOC.

V Treatment of Non-detects

According to EG&G's instruction (FAX, March 3, 1994), for t-test, the non-detect are replaced with 1/2 times of the reporting limits. For the non-parametric test, the reporting limit will be used to replace the non-detect values for ranking purpose.

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References

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EG&G, January 1994, Statistical Comparison of Site-Background Data in Support of RFI/RI Investigations.

Devore, J and R. Peck, 1986, Statistics, West Publishing Company, 699 pgs.

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Rosenbaum, S. 1954 Tables for A Nonparametric Test of Location, The Annals of Mathematical Statistics, Volume 25.

Woodward-Clyde Federal Services

Memorandum

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To Ed Mast
EG&G

From David Baca
WCFS

Date March 10, 1994

Subject Aggregation of Operable Unit No 6 (OU6) Data

Woodward-Clyde (W-C) and EG&G personnel have had numerous discussions regarding data aggregation. To evaluate the chemical concentrations collected during the OU6 Phase I field investigation, W-C will compare these chemical concentrations to the concentrations cited in the 1993 Background Geochemical Characterization Report (BGC). The purpose of this memo is to identify the OU6 data subsets that will be used for comparisons with Rocky Flats Plant (RFP) background.

The following media types were collected during the Phase I OU6 field investigation:

- Surface Soil
- Subsurface Soil (Borehole)
- Groundwater
- Surface Waters
 - Pond
 - Baseflow (Stream)
 - Storm Event (Stream)
- Sediments
 - Pond
 - Baseflow (Stream)
 - Dry
- B-1 Dam Drum Sample
- Trenches (Litaor)

The 1993 BGC evaluated four of the five media. W-C proposes the following OU6 subsets be compared to the background data subsets identified:

OU6 Media

Compared to 1993 BGC Media

Surficial Soil & Dry Sediments (Phase I)

Rock Creek surface soil
data (from OU1, OU2)

Subsurface Soil (Phase I)

Upper Flow System

Groundwater (Phase I and some historic)

Upper Flow System

Surface Water

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OU6 Media

Compared to 1993 BGC Media

Surface Water

Pond & Baseflow (Phase I)
Storm Event (Phase I)

Stream Water
No Comparison

Sediments

Pond & Stream (Phase I)

Seep / Spring Sediment

B-1 Dam Drum Sample

No Comparison

Trenches (Litaor)

No Comparison

We are ready to run background comparisons for the above media, and would appreciate your concurrence with or revisions to the proposal above as soon as possible. We have a question regarding the aggregation of the sediment data. In a previous meeting, Rick Roberts (EG&G) suggested that the stream sediment and pond sediments be combined. We feel it would be appropriate to revisit this decision with the risk assessment personnel at W-C and EG&G prior to finalizing the aggregation for sediments. In addition, as requested by EPA and CDH, we have reviewed the selection of the background data set for sediment comparisons, as proposed by Rick Roberts. The discussion of this selection is attached for your review.

BACKGROUND DATA SET TO BE USED FOR SEDIMENT COMPARISONS

Background

The Final Background Geochemical Characterization Report (BGCR)(DOE 1993) for the Rocky Flats Plant (RFP) is being used for the RFI/RI Report preparation (by several operable units) to provide background data sets for comparing the operable unit-specific data with background concentrations. The BGCR contains several different data sets for each medium discussed in the report (groundwater, subsurface geologic materials, surface water, and sediment). It is necessary to select the appropriate BGCR data set within each medium that will be used for the background comparison.

Operable Unit No 6 (OU-6) is in the process of selecting the BGCR data sets that will be used for each medium. The Upper Flow System has been selected for both subsurface geologic materials and for groundwater. Stream water has been selected for surface water. The selection for the BGCR data set for sediments is more problematic since most of the OU-6 sediment data are from ponds.

The purpose of this document is to present a rationale for the selection of the data sets to be used for comparison of OU-6 sediment data to background sediment data.

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Sediments in the Final Background Geochemical Characterization Report

The geochemistry of stream-bed sediments was evaluated in the BGCR by sampling and chemically analyzing sediments from nine background locations at RFP (Figure 1). The stations were paired with nine background surface-water stations. Four stations are located in the Rock Creek drainage, one station is in the McKay Ditch, and four stations are located in Woman Creek. Three of the nine stations (one in Rock Creek and two in Woman Creek) are located at seeps. All of the seep sample locations (SED018, SED019, and SED021) are in small ponds that have formed or have been constructed adjacent to seeps.

Background sediment samples were collected at one point in the stream if the channel width was less than 5 feet. If channel width was greater than 5 feet but less than 10 feet, two samples were collected within the channel from locations one-third and two-thirds of the way across the channel. If the width of channel was greater than 10 feet but less than 20 feet, three samples were obtained from locations 25, 50, and 75 percent of the way across the channel. Stream sediments were sampled twice in 1989, and quarterly during 1990, 1991, and 1992. Sediment samples were analyzed for total metals, total radionuclides, CLP VOCs, SVOCs, pesticides, herbicides, and water quality parameters. The three seep-sediment locations were treated as a single statistical population (called seep/spring sediments) for computing tolerance limits. The results of the stream sediment sampling and testing are two data sets (with separate statistics) for sediments: stream sediments and seep/spring sediments.

OU-6 Sediments

The sediment data for OU-6 consist of data from five samples from each of the 10 detention ponds along Walnut Creek (for a total of 50 samples). In addition, 15 sediment samples were collected from the stream bed along north and south Walnut Creek. Sediment samples were taken from each sampling location only once. Samples were analyzed for total metals, total radionuclides, CLP VOCs, SVOCs, TOC, pesticides, and water quality parameters.

Discussion

In general, pond sediments in the Walnut Creek ponds are saturated with pond water. The pond water may originate from precipitation and runoff, from groundwater, or from water producing processes such as the Rocky Flats sewage treatment facility that discharges treated water to Pond B-3. The residence time of water in the sediments is long. Sediments in Walnut Creek stream beds are generally dry except during spring runoff and precipitation events. The residence time of water in stream bed sediments is relatively short, and there are periods when the sediments dry out between wetting.

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Saturated sediments in Walnut Creek ponds are not as likely to be transported as are sediments in stream beds. The sediments in the stream beds are subject to moving water and hydraulic transport. The water is likely to cause leaching and removal of some chemical constituents. On the other hand, sediments in the ponds are not likely to be moved and may actually be subject to concentration of chemicals in the water. In the BGCR, statistical summaries of both the stream sediments and the seep/spring sediments show higher concentrations of cations in the seep/spring sediments. These higher concentrations suggest longer residence times of water in the sediments, similar to what would be expected in ponds.

Proposal

OU-6 proposes to use the seep/spring sediments from the BGCR for background comparison purposes, since these sediments are more likely to be similar to pond sediments. Seep/spring sediment samples were taken from areas where the sediments are saturated for long periods of time and have not likely been subject to transport. Since the background spring/seep sediment samples were taken from pond areas with saturated sediments, these samples are more similar to pond sediments than are stream sediment samples, and are therefore more representative of background for the pond sediments.

If you have any questions please call Robert L. Clark at 740-3961

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File 4036-422

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NOTE: The only background data that should be used (for OUs 3 through 16) in the OU v. Background comparisons, are those ASCII files dated 9-30-93 or later. Previous information regarding instrument detection limits, and earlier file generations of the background data should be discarded.

PRACTICAL SUGGESTIONS FOR USERS OF RFEDS DATA (2-17-94)

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4-2-96

The standard RFEDS output format changed on February 21, 1994. The old output format is given here as Appendix A, the new output format is given here as Appendix B

In general, there are actually three related issues that may arise for users of RFEDS data

- (1) How to deal with multiple detection limits
- (2) How to treat non-detects
- (3) How to perform data cleanup

1.0 MULTIPLE DETECTION LIMITS

The standard reporting format for RFEDS data (through 1993) gives one field for the reported detection limit. Unfortunately, this one field may contain either of three variables: the instrument detection limit (IDL), the method detection limit (MDL), or the contract-required detection/quantitation limit (CRDL/CRQL). The significance of these three different types of detection limits is that, for inorganic analytes (i.e., metals and water-quality parameters), the CRDL may be one to two orders of magnitude greater than the corresponding IDL for a particular analyte.

The "Ganseccki rule" was proposed (in EPA comments on the 1990 *Background Geochemical Characterization Report*) as an attempt to eliminate the high-value non-detects from the data set. The "Ganseccki rule" calls for exclusion of all non-detects greater than two times the minimum reporting limit, however, this "rule" has come under criticism as arbitrary and possibly not technically defensible.

1.1 Summary and Recommendations

- * Decisions based on a graphical review of the data distribution are thought to be more technically defensible than the general application of an arbitrary rule (i.e. the "Ganseccki rule"), even if the "rule" comes from EPA comments. The use of professional judgement and technically arguable reasoning, is recommended. It is incumbent upon the data users to document all steps in their analysis of RFEDS data.

EG&G will review the graphics jointly with the subcontractor, and provide guidance at this point in the data analysis.

- * The values of CRDLs for metals, as given in EPA SOW for Inorganics Analysis, should be compared with the data set to ascertain what percentage of the data is reported as the value of the CRDL (see Table 1) EG&G will review the data jointly with the subcontractor, and give directions on how to proceed

Table 1 INORGANIC TARGET ANALYTE LIST (TAL)

Analyte	CRDL (ug/L)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

2.0 TREATMENT OF NON-DETECTS

For those data sets containing censored data, the method of replacement affects the value obtained for the mean and upper confidence limit (UCL). The mean and skewness generally increase in deviation from the true values, as the proportion of non-detects increases. The deviation from true mean value is also greater as the amount of skewness increases. Maximum Likelihood Estimation (MLE) generally does a better job of estimating skewness than does simple substitution.

Sanford *et al* (1993) tested the "accuracy" of different replacement methods for non-detects, evaluating the accuracy of different methods by the root mean square error, and by a scoring system. Sanford *et al* (1993) concluded that the performance of the different replacement methods were, as follows

SCORING OF DIFFERENT REPLACEMENT METHODS

	<u>MLE</u>	<u>Simple Sub</u>	<u>Drop Non-detects</u>
40% Non-detects	93%	89%	64%
80% Non-detects	61%	54%	29%

Therefore, for as much as 80-percent non-detects, simple substitution and MLE have been shown to have similar "strength" (see Sanford *et al*, 1993). In cases with greater than 80-percent non-detects, the results obtained from simple substitution and MLE may be quite different, and can lead to different — possibly opposite — conclusions.

Certainly the *worst* possible treatment of non-detects is to drop them from the data set (Helsel, 1990, Sanford *et al*, 1993). Non-detects should **NEVER** be excluded from any statistical comparison of OU versus background data.

Given the cumulative uncertainties throughout the processes of sampling and chemical analysis, the possible error introduced by using simple substitution rather than using MLE replacement of non-detects, is probably acceptable. The standard practice for treatment of non-detects, as given in EPA statistical guidance for RCRA sites (1989, 1992), calls for simple substitution using $\frac{1}{2}$ the detection limit, for non-detect rates of as much as 15 percent. However, for RFEDS data, it may be better to use $\frac{1}{2}$ the result if the CRDL or the MDL is given in the reporting-limit field instead of the IDL.

At this point in the data analysis, EG&G will assist the subcontractor in making the appropriate decision as to which value (result or reporting/detection limit) to use.

2.2 Summary and Recommendations

- * Data for which all unit designations are blank, should be deleted from the working data set if it is not possible to obtain verification of units.
- * As a replacement value for any non-detect prior to standard statistical analyses, the data user may choose to do the following:
 - > Use $\frac{1}{2}$ the detection limit, for replacement of non-detects.
 - > Maximum-likelihood methods (see Helsel, 1990), in which non-detects are fitted to a distribution and assigned a range of values, may also be used as a method of replacing non-detects. (NOTE: This method does require the analyst to choose a

distribution — either lognormal or normal — to assign values to non-detects The analyst should also be aware of back-transformation bias in the case of log-transformed data)

Based on the study of Sanford *et al* (1993) and EPA CERCLA guidance, the recommendation of EG&G is to use 1/2 the detection limit as a replacement value for analytes with as much as 80-percent non-detects For analytes with a non-detect rate of greater than 80 percent, the use of inferential statistical analysis is not recommended EG&G will provide additional guidance for treatment of these high-rate non-detects

- * All data for radionuclides should be used as detects, except for rejected data (validation code = R) For liquid samples, radionuclide data are generally given in units of PCI/L, for solids, radionuclide data are in PCI/G, except for TRITIUM data, which are always in units of PCI/L
- * For organics, use the result qualifier or validated result qualifier should be used to determine the percentage of non-detects Non-detects for organic analytes are generally qualified "U", but other designations may also appear in the result-qualifier field (for additional information about result qualifiers (see attached Appendix C)

"Hits" of some common lab contaminants such as acetone, methylene chloride, and certain phthlates may indicate contamination if detected in the associated lab blank, such sample results are designated by a "B" in the lab-qualifier field. EPA guidance for risk assessment (1989 EPA/540/1-89/002) indicates that if the concentration of a common lab contaminant in a sample is more than 10 times the concentration of the same analyte in the blank, then the sample result is taken to be a real "hit", not just lab contamination For other analytes that are not typically found as lab contaminants, EPA guidance (EPA, 1989) states that if the concentration in the sample exceed 5 times the concentration in the blank, then the sample result is taken to be a real "hit", not just lab contamination

- * For metals and water-quality parameters, it is ineffective to rely on the result qualifier alone The following criteria have been employed to differentiate detects from non-detects, and are suggested as guidelines for the data
 - > If a validated qualifier is available, it is used rather than the lab qualifier
 - > If the qualifier contains a "U", the result is taken as a non-detect (i.e., censored data point)
 - > If the lab qualifier and validation qualifier fields are blank, the result is used as a detected value
 - > If the lab qualifier had a "B" code (indicating that the result was above the IDL but below the CRDL), the result is taken to be a detected value
 - > Other characters also are found in the qualifier field, and, barring any other evidence to the contrary, these are generally accepted as detects

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- * All data should be reviewed graphically (non-detects and detects together) prior to the application of any statistical tests. This will help to illustrate any potential problems, such as high-value non-detects (e.g., non-detect values reported as the value of the CRDL). EG&G will give guidance to the subcontractor after jointly reviewing the graphical presentations of the data.

3.0 ISSUES REGARDING DATA CLEANUP

The so-called "data cleanup" of RFEDS output is mostly a task to make the data consistent. This consists of a time-consuming series of steps (which should be documented by the data user) including the standardization of units, standardization of geologic codes, standardization of locations if the location designation has changed over time, standardization of analyte names (usage has changed over the years), deletion of blank "form-generated" records for which no results are given, exclusion of QC data (rinsates, etc.) from the working data set, removal of any rejected (val = 'R') data, replacement of non-validated records with corresponding validated records (if available), correction of incorrect units (e.g., pH should have 'PH' as the unit, *not* 'MG/L' as the unit), averaging of qc DUP/REAL pairs, appropriate use of DIL data, outlier analysis, etc.

Upon receipt of RFEDS data, the user should verify the field positions of all variables in the RFEDS ASCII output file. After verification, the ASCII file may be transformed into data files for a specific software (e.g., SAS, Lotus, Excel, SPSS, etc.) to be used in the data manipulation. It is recommended that the user create successive generations of the data files rather than just continually updating the original data file, thus simplifying data analysis if back-tracking is required for any reason.

Successive generations of data files may proceed as follows (this is just a suggestion)

- (1) Original data files created from RFEDS ASCII files. These files contain the entire RFEDS data pull, including QC samples, rejected data, etc.
- (2) Second generation of data files, drop QC samples (except qc DUPs of DUP/REAL pairs), rejected data, blank form-generated records, tentatively identified compounds (TICs), etc. Create new variables, using validated data (where available) to supersede non-validated results, units, qualifiers, and detection limits. Standardize units within each analyte suite. Note that in the old RFEDS output format (Appendix A) there were variable fields entitled "Qualifier" (lab qualifier), "Validation" (the validation code), and "VQual" (the validation qualifier). The validation qualifier ("VQual") should supersede the lab qualifier ("Qualifier"). The validation code ("Validation") is a code, not a qualifier.

In the new RFEDS output format (i.e., data extracted after February 21, 1994), the validation qualifier ("VQual") field is not present, rather, the validated qualifier will automatically replace the lab qualifier ("Qualifier"). The validation code field ("Validation") will still indicate whether the datum is acceptable (Validation = A), or rejected (Validation = R), or other.

Standardize location names if designations have changed over time (check cross-reference listings of well location names, etc) Standardize geologic codes Standardize analyte names (e g "PLUTONIUM-239,240" = "PLUTONIUM-239/240", etc) (NOTE standardization of analyte names and units should now be automatic in the new RFEDS data output)

- (3) From (1), create a separate file with QC data for analysis of data quality Check the PARCC parameters (precision, accuracy, representativeness, completeness, and comparability)
- (4) From (2), create a third generation of data files with averaged DUP/REAL pairs (change REAL value to the mean value of the averaged DUP/REAL pair, then delete the DUP record) In the case of DUPs with no corresponding REAL record, change "DUP" to "REAL" (NOTE Prior to averaging of DUP/REAL pairs, sort the data by LOCATION, SAMPLE NUMBER, SAMPLE DATE, and ANALYTE This should bring together all existing DUP/REAL pairs)

Treatment of DIL data requires the data analyst to find the analyte(s) that necessitated the dilution, these should have a qualifier of "E" (for exceedance) The DIL result(s) for the E-qualified analyte(s) should be used in the data analysis, other analytes may have results reported for the DIL sample analysis, but these results should be deleted if these analytes in the original undiluted sample were NOT qualified as "E"

Outlier analysis, and exclusion of identified outliers from data analysis, may not be allowable by the regulatory agencies That is, it is easy to argue that an extremely high value in background is probably an outlier that can be excluded from data analysis, but it is difficult to argue that an extremely high value in an OU is an outlier rather than contamination

The RFEDS has shown continuous improvement in the quality of data contained in the system Newer data (1992-93) are generally "cleaner" than historic (pre-1992) data However, all data users need to be made aware of potential pitfalls before applying statistical tests to the data The steps listed in the previous paragraph give a general overview for the process of data cleanup

3.1 Summary and Recommendations

- * All data users should carefully document the steps used in the process of data cleanup If questions arise, review of this documentation should be able to provide the necessary information
- * RFEDS and the Sample Management Group are committed to Continuous Improvement, recent data (1992 to present) have fewer problems than historic data (pre-1992) Issues of duplicate records, incorrect units, etc , are currently being addressed

The new RFEDS program for uploading data now runs automatic checks to ensure standardization of units and analyte names, checks to ensure that appropriate QC samples are included, and checks for completeness of analyte suites

4.0 REFERENCES

Helsel, D R (1990) Less than obvious statistical treatment of data below the detection limit. *Environmental Science & Technology*, v 24, n 12, p 1766- 1774

Sanford, R F , Pierson, C T , and Crovelli, R A (1993) An objective replacement method for censored geochemical data *Mathematical Geology*, v 25, n 1, p 59-80

U S Environmental Protection Agency (February, 1989) *Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities, Interim Final Guidance* EPA/530-SW-89-026

U S Environmental Protection Agency (July, 1992) *Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance*

BASIC ANALYTICAL DATA EXTRACTION FORMAT DESCRIPTION

The output file from a standard data extraction is ASCII format, column delimited with spaces used to fill out column width. An additional space has been added between columns for legibility.

The requested data extraction has the following column format:

FIELD	STARTING POSITION	FIELD LENGTH
Location	1	15
Sample Number	17	20
Project Name	38	15
Sample Type	54	2
Sample QC Code	57	4
Sample QC Partner	62	20
Sample Date	83	9
Laboratory	93	5
Lab Batch Id	99	15
Analysis Date	115	9
Test Group Code	125	10
Result Type	136	3
Chemical	140	40
Parameter Code	181	11
Run Number	193	3
Count Number	197	3
Lab QA Code	201	4
Lab Sample Number	206	10
Result Qualifier	217	1
Result	219	10
Unit Measure	230	10
Error	241	10
Qualifier	252	5
Detect Limit	258	10
Validation	269	2
Reason1	272	3
Reason2	276	3
Reason3	280	3
Reason4	284	3
VResult	288	10
VUnit	299	10
VQual	310	5
VDetect	316	10
Validation Date	327	9
Sequence Id (RFEDS ID)	337	10

RFEDS BASIC ANALYTICAL
 DATA EXTRACTION FORMAT DESCRIPTION
 2/14/94

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The output file from a standard data extraction is ASCII format, column delimited with spaces used to fill out column width. An additional space has been added between columns for legibility.

The requested data extraction has the following column format:
 ADDITIONAL SPACE = 1

FIELD	STARTING POSITION	FIELD LENGTH
Location	1	15
Sample Number	17	20
Project Name	38	15
Sample Type	54	2
Sample QC Code	57	4
Sample QC Partner	62	20
Sample Date	83	9
Laboratory	93	5
Lab Batch Id	99	15
Analysis Date	115	9
Test Group Code	125	10
Result Type	136	3
Chemical	140	40
Parameter Code	181	11
Run Number	193	3
Count Number	197	3
Lab QA Code	201	4
Lab Sample Number	206	10
Result Qualifier (archaic)	217	1
Result	219	10
Unit Measure	230	10
Error	241	10
Qualifier	252	5
Detect Limit	258	10
Validation	269	2
Reason1	272	3
Reason2	276	3
Reason3	280	3
Reason4	284	3
Validation Date	288	9
Sequence Id (RFEDS ID)	298	10
(Secondary Result Type)	309	3
Matrix	313	8
Lab Disposition	322	15

longer →
 has TICs or
 SUR

Explanation

TIC → SUR ← must now include

Must specify no TICs or SURrogates in extraction
 (TICs are now 'TRG' in 'result-type' field and TIC in 'secondary result type')

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APPENDIX C

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LABORATORY DATA QUALIFIERS

<u>Qualifier</u>	<u>Definition</u>	<u>Include in data analysis</u>	<u>Detected? ("Hit"?)</u>
+	inorganics correlation coefficient for matrix spike analysis (MSA) is < 0.995 (estimated value)	yes	yes
- or *	inorganics duplicate analysis not within control limits (estimated value)	yes	yes
A	organics indicates a tentatively identified compound (TIC) as a suspected aldol condensation product	yes, but remove to TIC table	no
B	organics warns that analyte was also detected in blank	yes	yes
	inorganics reported values is less than CRDL but greater than the IDL	yes	yes
	rads constituent also detected in associated blank, where concentration in blank was > CRDL or > MDA (estimated value)	yes	yes
C	organics pesticide result confirmed by GC/MS	yes	yes
	rads presence of high TDS in sample increased the MDA (minimum detectable activity)	yes	yes
D	organics identified in an analysis at a secondary dilution	yes	yes
E	organics compound exceeded calibration range of instrument, use dilution analysis result for this analyte, not this E-qualified result	no	no
	inorganics value estimated due to interference	yes	yes
F	rads for alpha spectrometry — FWHM exceeded acceptable limits (estimated value)	yes	yes
G	TOC dilution result exceeded range of instrument (estimated value)	yes	yes
H	rads sample analysis performed outside of method (specified maximum hold)	yes	yes
I	organics interference with target peak (estimated value)	yes	yes
JB	organics result below detection limit and analyte detected in lab blank	yes	no

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J	organics MS data indicate presence of compound but below detection limit (estimated value)	yes	yes
?delete?	inorganics value greater than IDL but control sample analysis not within control limits (estimated value)	yes	yes
L	undefined	no	no
N	organics compound presumed present (TIC)	yes, but remove to TIC table	no
	inorganics spiked sample recovery not within control limits (estimated value)	yes	yes
N*	inorganics spiked sample recovery and duplicate analysis not within control limits (estimated value)	yes	yes
R	validation code for rejected data accidentally entered in lab qualifier field (unusable data)	no	no
S	inorganics the reported value determined by the method of standard additions	yes	yes
U	organics and inorganics analyte analyzed below detection limit	yes	no
UC	organics pesticide result confirmed but below detection limit	yes	no
UJ	organics analyte analyzed but below detection limit	yes	no
UN	organics compound presumed present but below detection limit	yes	no
	inorganics spiked sample recovery not within control limits and sample result below detection limit	yes	no
UW	inorganics post-digestion spike for GFAA analysis is out of control limits and sample result is below detection limit	yes	no
UX		yes	no
V	validation code for valid data accidentally entered into lab-qualifier field	yes	yes
W	inorganics post-digestion spike for GFAA analysis is out of control limits while sample absorbance < 50% of spike absorbance	yes	yes
X	organics (pre-1992) lab software flag (combines more than one qualifier, not defined) ** COMMENT Do not include in analysis unless accompanied by a validated result **	**	**

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X	inorganics (pre-1992) detection limit greater than normal, spike matrix interference	yes	(00	yes
	other (OU7 RFI/RI samples) result by calculation defined in GRRASP	yes		yes
Y	rads chemical yield exceeded acceptable limits (estimated value)	yes		yes

Note on the use of X qualifiers X is defined in the GRRASP as a result determined by calculation, not by direct laboratory analysis Therefore, for samples analyzed during the period that the GRRASP has been in effect (since January 1992), the results qualified by an X will be treated as estimated values (similar to J) For historic data, when the GRRASP was not used by laboratories, an X qualifier has two definitions For organics, the X is a flag entered manually by the laboratory, but is not defined in RFEDS Therefore, organic results qualified by X are not considered usable data, unless a validated result is given For inorganics, an X qualifier indicates that the detection limit for the analyte is higher than normal due to matrix interference Inorganics qualified with an X will be treated like a J result The X qualifier is sometimes also used with other qualifiers (i e , UX, XJ), in these cases, the meaning of X depends on the analyte and the date of the analysis

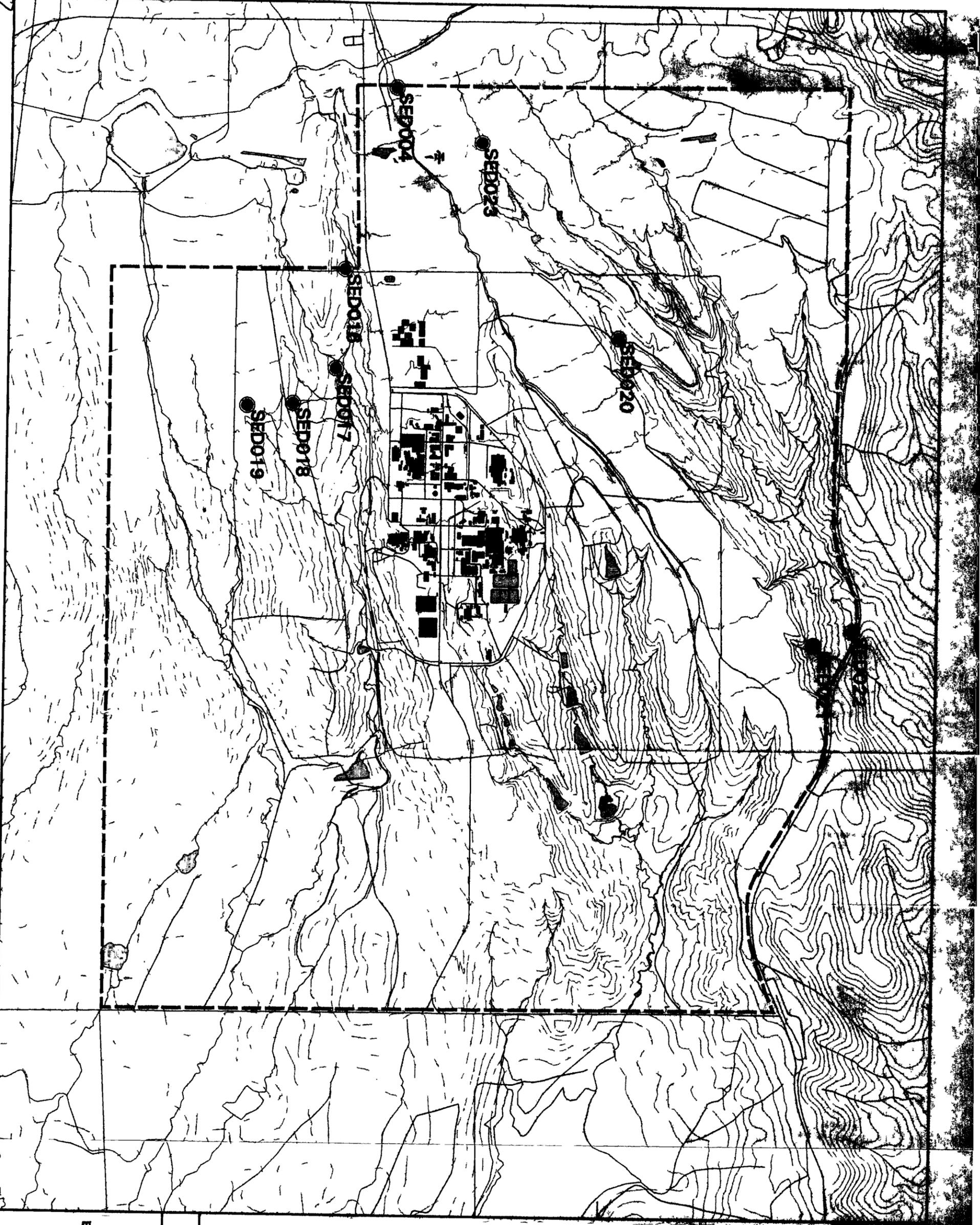
APPENDIX D

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VALIDATION CODES

<u>Code</u>	<u>Definition</u>	<u>Include in Data Analysis?</u>
J	estimated result	yes
A	acceptable result	yes
JA	acceptable result for estimated value	yes
R	rejected result	no
V	valid result	no yes
Y	not yet validated, validation in progress	yes
Z	validation not required	yes

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EXPLANATION 88

-  20' Topographic Contours
-  Paved roads
-  RFP Perimeter Fence
-  Ponds, Lakes and Streams
-  Buildings or Other Structures
-  Background Stream Sediment Sample Location
-  Background Seepspring Sediment Sample Location



Scale 1 24000

U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado
 OPERABLE UNIT NO. 6
 PHASE I RFA/RM REPORT

BACKGROUND SEDIMENT SAMPLE LOCATIONS

FIGURE 1
 FEBRUARY 1994