December 9, 2010

Mr. Sai Appaji
Remedial Project Manager
US EPA Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

SUBJECT: COMMENTS ON ENVIRONMENTAL PROTECTION AGENCY'S APRIL 20, 2010, REPORT ENTITLED, "STATISTICAL EVALUATION OF ALLUVIAL GROUNDWATER QUALITY UPGRADIENT OF THE HOMESTAKE SITE NEAR GRANTS, NEW MEXICO."

Dear Mr. Appaji:

On November 10, 2009, the New Mexico Environment Department (NMED) requested that the U.S. Environmental Protection Agency (EPA) and U.S. Nuclear Regulatory Commission (NRC) provide a technical review of a paper entitled, "Statistical Evaluation of Alluvial Groundwater Quality Upgradient of the Homestake Site near Grants, New Mexico: Molybdenum, Selenium, Uranium" by Dr. Richard Abitz (NRC ADAMS Accession No. ML093240126). In response to NMED's request, EPA produced a draft report entitled, "Review Comments: Statistical Evaluation of Alluvial Groundwater Quality Upgradient of the Homestake Site near Grants, New Mexico" dated, April 20, 2010 (Enclosure 1).

On December 7, 2010, NRC, EPA, NMED and U.S. Department of Energy met via teleconference to discuss EPA's April 20, 2010, report. During the meeting, NRC provided the comments included as Enclosure 2 to this letter. NMED provided comments on EPA's April 20, 2010, report in a letter dated May 20, 2010 (Enclosure 3).

If you have any questions, please contact me at 301-415-6607 or by email at John.Buckley@nrc.gov.

Sincerely,

/RA/

John T. Buckley, Senior Project Manager
Decommissioning and Uranium Recovery
Licensing Directorate
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Enclosures: As stated

cc: Homestake Distribution List

Docket No.: 040-08903
License No.: SUA-1471

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Review Comments: Statistical Evaluation of Alluvial Groundwater Quality Upgradient of the Homestake Site near Grants, New Mexico

Anita Singh, Lockheed Martin, April 20, 2010

This letter report summarizes reviewer's comments on the statistical evaluation performed by Environmental Restoration Group (ERG) for the Homestake Mining Company (HMC) near Grants, New Mexico. The ERG statistical evaluation report is referred as the ERG Report in this review report. This review was requested by Mr. Appaji of Environmental Protection Agency (EPA) R6 via Ms. Barnett, Director Tech Support Center. The ERG Report summarizes statistical analysis for the three main contaminants of concern (COCs): uranium, selenium, and molybdenum. The U.S. Nuclear regulatory Commission (NRC) approved groundwater protection standards (Cleanup Levels) for these three COCs are: molybdenum (0.03mg/l), selenium (0.10 mg/l), and uranium (0.04mg/l). This letter report also discusses reviewer's comments on some of the issues raised by Dr. Abitz in a report (GCS Report, April 2009) provided to us by Mr. Appaji.

The reviewer called Mr. Appaji to discuss the main objectives of the present request. Per Mr. Appaji's suggestions, emphasis is given on evaluating the validity and appropriateness of the statistical methods used to perform background evaluations including: normality tests, outlier tests, treatment of nondetects, computing upper tolerance limits (UTLs), comparing data distributions of two or more populations. At this time, the reviewer did not verify or perform any statistical calculations as data were not provided electronically. The reviewer is not familiar with the site geography (e.g., detailed information not provided) and mineralogical operations performed by HMC and other mining companies in the vicinity. Therefore, reviewer did not comment on the issues regarding the appropriateness of the selection of upgradient well locations as raised by Dr. Abitz in the GCS Report.

Review of ERG Statistical Report

General Comments

It is noted that several statistical methods have been used to assess the normality and lognormality of data sets collected from a total of 15 upgradient wells with 9 near upgradient wells and 6 far upgradient wells. It appears that ERG spent majority (>90%) of their computation efforts on performing many goodness - of - fit tests to assess normality and lognormality of upgradient well data sets; which made the report unnecessarily bulky and large. It is noted that most of the data sets consist of many nondetects (NDs) with multiple detection limits. For such data sets consisting of multiple NDs, the use of nonparametric distribution free methods (e.g., Kaplan Meier, 1958; Helsel, 1990; Helsel and Hirsch, 1994; Singh, Maichle, and Lee, 2006) is preferred to compute reliable decision statistics (e.g., UTLs, 95% percentiles, UPLs) needed to estimate background level concentrations.

Furthermore, it is noted that ERG made no effort to use statistically rigorous and/or computer intensive statistical methods (Kaplan Meier, 1958, Helsel and Hirsch, 1994, EPA 1994) to analyze background data sets consisting of outliers and NDs observations with multiple

detection limits. Statistical methods used and cited (e.g., two sample WRS test) in the ERG report date back to earlier 1989 documents. For data sets consisting of NDs, more defensible statistical methods such as the Quantile test and Gehan test (EPA 1994, 2000, 2002, 2006, and ProUCL Technical Guide) supplemented with graphical displays should be used to compare distributions of two populations (e.g., far versus near upgradient wells). The use of appropriate and rigorous methods such as the KM method (e.g., Kaplan-Meier, 1958, Helsel, 2005, Singh et al., 2006, ProUCL) is recommended to compute nonparametric UTLs, UPLs, and percentiles to estimate background concentrations.

It is observed that statistical methods used by ERG are not statistically rigorous. Specifically, not much effort was spent by ERG to address the main project objectives including: 1) establishing statistically defensible background/reference area datasets; 2) proper identification of outliers potentially representing impacted locations (wells); 3) the computation of defensible decision statistics (e.g., UTLs) based upon data sets with NDs; and 4) comparing two or more populations (e.g., near upgradient wells) with multiple NDs.

Specific Comments

Collected Data

Data were collected from 6 far (located between 2-3 miles from HMC) upgradient wells and 9 near (within 1 mile distance) upgradient wells. In the ERG report, it is stated that uranium, selenium, and molybdenum are naturally occurring in upgradient wells due to mineralogical mining operations performed upgradient of the HMC. Due to mining operations upgradient of HMC site, it is necessary to assure that selected upgradient locations are free of contamination due to HMC operations and all other mining operations performed upgradient of HMC.

Establishing Background/Reference Data

Whenever possible, background data sets are collected from pristine unimpacted locations. When using background data sets to establish site-specific background level concentrations, it is necessary to assure that the selected background/ reference locations (e.g., upgradient wells) are not impacted by onsite (HMC) activities and/or contamination originating from other industrial activities (e.g., mining operations upgradient of HMC site) potentially impacting the site background.

Typically, selection of background locations should be performed using statistical sampling plans. Specifically, the selection of background locations should be performed using either a simple random sampling (SRS) plan or a systematic random (e.g., using grid pattern) sampling plan within the chosen reference area (e.g., EPA 2000, 2006). The selected sampling locations (upgradient wells here) should be representative of the background conditions for the site under investigation.

For the HMC site, enough background data (covering 2 decades) are available from near and far upgradient wells. Assuming that the collected data represent background conditions at the

HMC site, the available data should be useable and adequate enough to compute defensible background level concentrations (e.g., 95% UTLs, 95% percentiles) provided appropriate statistically rigorous methods as suggested in this review report are used.

Outliers in Background Data Sets

Elevated outlying observations in a background data set potentially may represent locations impacted by the site activities, especially when background data are collected from locations (e.g., onsite reference area location at large federal facilities) potentially impacted by the site and/or other industrial activities. In such scenarios, all potential outliers should be removed from background data sets (EPA 2000, 2002) before computing decision statistics (e.g., UTLs, UPLs) to estimate background level concentrations.

Tests for Outliers

It is noted that a simple rule-of-thumb test (a priori screening test) was used to screen and remove extreme high outliers. Sequential Grubbs (1969) outlier test (T_n) statistic) was used to test for all other outliers. It should be pointed out that the T_n test statistic suffers from masking effects in the presence of multiple (two or more) outliers and/or when data come from multiple sources such as different upgradient wells. In other words, when multiple outliers or populations are present in a data set, the T_n test fails to identify them.

Effective classical Rosner and trimming tests (Gilbert, 1987), and/or more effective robust outlier identification procedures (e.g., Tukey's Biweight function – Hoaglin, Mosteller, and Tukey,1983; PROP influence function - Singh, 1993, LMS and MCD methods - Rosseeuuw and Leroy, 1987) should be used to identify multiple outliers. Several robust and rigorous outlier identification procedures are available in the peer reviewed software package, Scout 2008 (EPA 2008, 2010). For univariate data sets (e.g., uranium), the use of graphical displays such as quantile-quantile plots (e.g., ProUCL 4.00.04, EPA 2009, 2010) provide added insight about the presence of outliers and/or multiple populations.

It is suggested that more effective outlier tests be used to assure that background data sets based upon far and near upgradient locations are free of outliers (potentially representing impacted values).

Do All Near (or Far) Upgradient Wells Come from a Single Population?

As mentioned in the ERG Report and GCS comments, due to mining operations upgradient of the HMC site, some upgradient wells may be potentially impacted by the site activities or other uranium processing mining operations. Before computing decision statistics to estimate background level concentrations for the three COCs, it is desirable to determine if: 1) all near upgradient wells come from a single statistical population; 2) all far upgradient wells come from a single statistical population; 3) and concentrations of COCs from far and near upgradient wells can be considered as coming from a single statistical population.

Specifically, it needs to be established that all near (far) upgradient wells come from a single background population unimpacted by industrial activities in the region before comparing concentrations of far and near upgradient wells.

Statistical and graphical methods are routinely used to compare concentration distributions of two or more populations (near upgradient wells). Specifically, Oneway Analysis of Variance (ANOVA) supplemented by graphical displays including side-by-side box plots, multiple Q-Q plot are used to compare two or more populations (EPA 1992, 1994, 2000, 2002). It is suggested that proper statistical tests be used to determine if near (far) upgradient wells can be considered as coming from a single background population exhibiting comparable concentrations for the COC(s). At present ERG has assumed that all near (far) wells represent a single population.

The comparison of near (far) upgradient wells should be one of the main objectives of the background evaluation study performed for the HMC site.

WRS test to compare Concentrations of Near and Far Upgradient Wells

A simple two sample WRS test was used to compare near upgradient and far upgradient data assuming that near (far) upgradient wells represent one population. It should be noted that instead of the WRS test, more rigorous statistical tests such as the Quantile test and Gehan test (EPA 1994, EPA 2006, ProUCL) are used when dealing with data sets consisting of NDs with multiple detection limits.

As mentioned earlier, before comparing concentrations of near upgradient and far upgradient well data sets, one need to establish that all near (far) background wells come from a single population. This extra step will identify upgradient wells which might be potentially affected by various other mineralogical operations upgradient of HMC site.

Averaging Values of Duplicate and Split Samples

Averaging the duplicates is a common practice – assuming that all analytical results are properly verified and validated. In the present case, collected data cover at least two decades analyzed by several labs using different analytical methods. In order to make use of all available data (even in the absence of proper QA/QC methods) to compute appropriate decision statistics (UTLs), a single value can be determined using one of the following options. All interested parties should be involved in this process.

- If one of the values in split samples is a detect then the detected value should be used in the data set.

- One can use the minimum value (instead of average) of split samples (duplicate samples) in the computation of UTLs and upper percentiles. The use of the minimum value should result in a conservative estimate of the background parameter.

- If the discrepancy between split/duplicate results is very high, the cause of the discrepancy should be determined before using the minimum value in the data set. Specifically, one needs to make sure that the discrepant results do not represent contamination due to site and other activities.

It is anticipated that the differences in the estimates of background threshold values obtained using the average value or the minimum of duplicates should be insignificant from practical point of view.

Treatment of Nondetects

Several rigorous statistical methods are available in environmental literature (e.g., Kaplan Meier, 1958, Helsel, 1990, Helsel and Hirsch 1994, Singh, Maichle, and Lee, 2006, ProUCL Technical Guide) to compute rigorous estimates of background level concentrations based upon data sets consisting of NDs with multiple detection limits.

It is suggested that UTLs, UPLs, and upper percentiles used to estimate background level concentrations (EPA 1992, 2002) be computed using rigorous statistical methods. EPA software packages ProUCL and Scout 2008 are equipped with rigorous statistical and graphical methods used in background evaluations and background comparisons studies.

Summary and Recommendations

Enough data have been collected from the upgradient background wells. The available data should be adequate enough to perform background evaluations and compute defensible decision statistics to estimate background level concentrations for the three identified COCs. In order to address concerns of all parties including the local community, it is recommended that the statistical analysis be conducted again using modern rigorous statistical methods to compute defensible decision statistics (e.g., UTLs, UPLs, upper percentiles). Peer reviewed software packages: ProUCL and Scout are equipped with rigorous statistical and graphical methods which can be used to compute defensible decision statistics based upon data sets consisting of outliers and nondetect values.

The reviewer will be happy to provide her assistance in performing statistical analysis for background evaluations for the HMC site.

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U.S. Nuclear Regulatory Commission (NRC) comments on Environmental Protection Agency's (EPA's) 4/20/2010 Analysis of Homestake Mining Company (HMC) Report: Statistical Evaluation of Alluvial Groundwater Quality Upgradient of the Homestake Site near Grants, New Mexico

1. Page 1, paragraph 2, states, "Per Mr. Appaji's suggestions, emphasis is given on evaluating the validity and appropriateness of the statistical methods used to perform background evaluations including ..." NRC believes the purpose of the review is to evaluate whether HMC's consultant, Environmental Restoration Group, Inc. (ERG) followed EPA's guidance at the time for conducting statistical analyses. If ERG followed the available EPA guidance documents, there should be no reason to re-visit the alluvial background issue.

2. Page 1, paragraph 2, states, "The reviewer is not familiar with the site geography (e.g. detailed information not provided) and mineralogical operations performed by HMC and other mining companies in the vicinity. Therefore, reviewer did not comment on the issues regarding the appropriateness of the selection of upgradient well locations as raised by Dr. Abitz in the CGS Report."

   Site specific knowledge is required to evaluate the data used (or excluded) from the ERG statistical analyses. Without site specific knowledge it is only possible to evaluate the statistical methods used, and not possible to evaluate the data used in the statistical analyses.

3. Page 2, paragraph 2, states, "Specifically, not much effort was spent by ERG to address the main project objectives including: (1) establishing statistically defensible background/reference area datasets; …"

   The staff notes that the wells evaluated by ERG were located upgradient and not impacted by HMC mill activities.

4. Page 2, paragraphs 3 & 4, states, "Due to mining operations upgradient of HMC site, it is necessary to assure that selected upgradient locations are free of contamination due to HMC operations and all other mining operations performed upgradient of HMC."

   "Whenever possible, background data sets are collected from pristine unimpacted locations. When using background data sets to establish site-specific background level concentrations, it is necessary to assure that the selected background/reference locations (e.g., upgradient wells) are not impacted by onsite (HMC) activities and/or contamination originating from other industrial activities (e.g. mining operations upgradient of HMC site) potentially impacting the site background."

   The "background" being calculated in this case is the concentration of constituents of concern (COCs) coming onto the HMC site from upgradient. It is not the pristine "background."

5. Page 2, paragraph 5, states, "Specifically, the selection of background locations should be performed using …"

NRC notes that this statement is based on MARSSIM requirements which do not apply to groundwater. MARSSIM states, "Other contaminated media (e.g., subsurface soil, building materials, ground water) and the release of contaminated components and equipment are also not addressed by MARSSIM."

6. Page 3, paragraph 2, states, "In such scenarios, all potential outliers should be removed from background data sets …"

   NRC does not agree that all potential outliers should be removed from background data sets. Only outliers resulting from site activities should be removed from the data set.

7. Page 3, paragraph 3, states, "It should be pointed out that the Tn test …"

   The Tn test was iteratively applied until the largest value in the data set passed. This would eliminate masking effects.

8. Page 4, WRS Test to compare Concentrations of Near and Far Upgradient Wells – This section should be deleted since far upgradient wells were not used in the determination of alluvial background values.

9. Page 4, paragraph 7, states, "In the present case, collected data cover at least two decades …"

   This statement is incorrect. Only 10 years of data were used by ERG to determine the alluvial COC background values. Only one laboratory was used for the last 10 year data set. Therefore, the issues surrounding multiple labs using different analytical methods does not exist for the alluvial background value data set.

   NRC believes that EPA should re-evaluate ERG's statistical evaluation to address the concerns stated above. The re-evaluation should compare the statistical methods used in the ERG report to the methods described in the EPA guidance and other references provided in the report.