ATTACHMENT 2

BACKGROUND COMPARISON AND SCREENING FOR CHEMICALS OF POTENTIAL CONCERN FOR THE SOIL-TO-GROUNDWATER LEACHING PATHWAY

This attachment presents a summary of the comparison of Phase A and Phase B soil concentrations with the background soil dataset selected in accordance with discussions and correspondence with the Nevada Division of Environmental Protection (NDEP). In a letter dated August 17, 2010, NDEP determined that the Remediation Zone A (RZ-A) dataset is appropriate for background comparisons at the Tronox Site (NDEP, 2010c).

Two phases of soil investigations have been performed at the Tronox facility in Henderson, Nevada (Site):

- Phase A soil investigations were conducted in November 2006 (AECOM, 2007);
- Phase B soil investigations were conducted from June 2008 to November 2009

As discussed during conference calls on April 14 and 16, and presented in their April 30, 2010 memorandum (NDEP, 2010a), NDEP previously had determined that Phase B soil metal concentrations in RZ-A would be used as the background dataset for further evaluation of only Phase B soil concentration data in the remaining RZs (RZ-B through RZ-E) at the Tronox Henderson site (the Site), shown on Figure 1 of this memorandum. Accordingly, the results of the background comparisons for RZ-B through RZ-E, using only Phase B data, were previously presented in a technical memorandum submitted to NDEP on July 22, 2010 (Northgate, 2010b). Following NDEP's letter dated August 17, 2010 (NDEP, 2010c), which determined that the RZ-A dataset is appropriate for background comparisons with both Phase A and Phase B data for the remaining RZs, the background comparison tables have been revised in this Attachment to include both Phase A and Phase B soil concentration data .

This evaluation compares the data collected during the Phase A and Phase B investigations from RZs B through E to the Phase B data collected in RZ-A. The results of this evaluation will be incorporated into the health risk assessment reports for RZ-A through RZ-E, as well as the soil to groundwater leaching evaluation presented in the technical memorandum to which this summary is attached. The results presented for the leaching evaluation for the Quaternary alluvium (Qal) include background comparisons for various depth intervals (as discussed below under "Depth Interval Determination"), for which statistical comparisons were performed.

Evaluation of Site Concentrations Relative to Background Conditions

Consistent with United States Environmental Protection Agency (USEPA) guidance (1989, 1992b, and 1992c), Site data for metals were evaluated relative to background concentrations to identify those metals that are not elevated above naturally occurring levels and can, therefore, be eliminated from further quantitative evaluation in the leaching evaluation and risk assessments. This evaluation was based on a combination of exploratory data analysis (EDA) and appropriate statistical methods (USEPA 2002c), each of which is discussed further below. When the weight-of-evidence of the EDA and results of the statistical analyses indicate that a particular chemical is within background levels, then these chemicals will not be evaluated further in the chemical of potential concern (COPC) selection process.

Background Dataset

NDEP has requested Tronox to use the Site soil concentrations from RZ-A as the background dataset (NDEP April 30, 2010). The RZ-A soil samples were collected as part of the Area IV investigation (i.e., a subset of the Phase B Area IV samples) and analyzed in accordance with the Revised Phase B Investigation Work Plan, Tronox LLC Facility, Henderson, Nevada, December 2008 (AECOM, 2008) and the Revised Phase B Quality Assurance Project Plan Tronox LLC Facility, Henderson, Nevada, July 2009 (AECOM and Northgate 2009).

A review of the RZ-A dataset showed that one Phase A boring (SA02) and five Phase B borings (RSAU4, RSAU5, SA28, SA146, and SA147) are located in a boron source area (the former State Industries, Inc. site) in LOU 62 and contributed to elevated concentrations of boron and other metals, including arsenic, chromium (total), cobalt, iron, molybdenum, nickel, platinum, and sodium. Statistical comparison of concentration data from these six borings to the remaining RZ-A data using Gilbert's Toolbox showed differences between the two datasets for nearly all metals, with the sole exception of barium (Table 1; NDEP, 2009c). Therefore, the data associated with these six borings were excluded from the RZ-A dataset. The final "RZ-A background dataset" is composed of 17 borings with a total of 66 samples at various depths.

Depth Interval Determination

For comparison purposes, the RZ-A background dataset was divided into shallow, middle and deep depth intervals. The shallow interval is from 0 to 10 feet below ground surface (bgs) and includes both a 0.5 feet bgs and 10 feet bgs sample. For some chemicals, the shallow interval

was further divided into two intervals from 0 to 2 feet bgs and 2 to 10 feet bgs, based on a chemical-specific statistical comparison between the 0.5 feet bgs and 10 feet bgs samples. If this comparison showed that the 0.5-feet and 10-feet bgs samples were consistent with each other, they were grouped into one shallow depth interval (0-10 feet bgs). Otherwise, these samples were separated into two intervals (0-2 and 2-10 feet bgs) for comparison to the other RZs. The metals which are evaluated for the 0- to 2-foot and >2- to 10-foot depth intervals and are not evaluated for the 0- to 10-feet interval are: arsenic, chromium (total), mercury, magnesium, molybdenum, potassium, sodium, strontium, and uranium. The middle depth interval includes samples from 10 feet bgs to the top of the Upper Muddy Creek Formation (UMCf) and the deep depth interval includes samples from the UMCf.

Site Data

Site data collected during the Phase A and Phase B investigations from RZ-B through RZ-E were compared to the RZ-A background dataset. Field duplicates and Site samples were treated as independent samples on the basis of preliminary evaluation, in consultation with NDEP guidance (NDEP 2008c; Paul Black, personal communication, Nov. 11, 2009), indicating that the variance of the duplicates was similar to the variance of the Site samples. Non-detect results were set equal to one-half of the limit of detection for purposes of this evaluation. The Sample Quantitation Limit (SQL) was used as the detection limit for both the Site and background datasets as per NDEP guidance (NDEP 2008d).

Exploratory Data Analysis

The EDA was performed using summary statistics (Guidance on the Development of Summary Statistics Tables for the BMI Plant Sites and Common Areas Projects, Henderson, Nevada, NDEP, 2008b) and quantile-quantile plots and side-by-side box-and-whisker plots to qualitatively evaluate whether the Site (RZs B through E) and RZ-A background dataset are representative of a single population. The summary statistics for the Site and RZ-A background data are presented in separate tables for RZ-B through RZ-E (Tables 2B through 2D).

Statistical Comparisons

The statistical software package, Guided Interactive Statistical Decision Tools (GiSdT®; Neptune and Company 2007), was used to perform all statistical comparisons. Specifically, statistical background comparisons were performed using the Quantile test, Slippage test, t-

test, and Wilcoxon Rank Sum test with Gehan modification. The t-test is parametric, which assumes that the data are normally distributed. In contrast, the Wilcoxon Rank Sum test, Quantile test, and Slippage test are non-parametric, which do not require an assumption of whether the data are normally or lognormally distributed (USEPA 2002c; NDEP, 2009c). These non-parametric tests are described further below.

- The Wilcoxon Rank Sum test performs a test for a difference between the sums of the ranks for two populations. This is a non-parametric method for assessing differences in the centers of the distributions that relies on the relative rankings of data values. Knowledge of the precise form of the population distributions is not necessary. The Wilcoxon Rank Sum test has less power than the two-sample t-test when the data are normally distributed, but the assumptions are not as restrictive. The GiSdT® version of the Wilcoxon Rank Sum test uses the Mantel approach for ranking the data, which is equivalent to using the Gehan ranking system. The Gehan ranking system is used to rank non-detects with the rest of the data (NDEP, 2009c).
- The Quantile test addresses tail effects which are not addressed in the Wilcoxon Rank Sum test. The Quantile test looks for differences in the right tails (upper-end of the dataset) rather than central tendency like the Wilcoxon Rank Sum test. The Quantile test was performed using a defined quantile = 0.80 (Paul Black, personal communic. Oct. 7, 2009).
- The Slippage test looks for a shift to the right in the extreme right-tail of the background dataset versus the extreme right-tail of the Site dataset. This test determines whether the number of Site samples that exceed the maximum background concentration for each metal is greater than would be expected, statistically, if the Site and background distributions were the same.

Finally, an alpha = 0.05 is typically used to evaluate a statistically significant result (USEPA, 2002c). However, as more tests are performed, it is more likely that a statistically significant result will be obtained purely by chance. Given the use of multiple statistical tests, an alpha = 0.025 was selected as a reasonable significance level for determining if Site data are different than background (NDEP, 2009c). Generally, any chemical that resulted in a p-value less than 0.025 in one of four tests will be retained for further consideration in the COPC selection process. Additionally, because these tests are set up with one-sided hypotheses, not only are differences between the two samples able to be detected, a directional determination can be made as well (e.g., Site is greater than background).

Results for the four statistical tests (p-values) are included in Tables 2A-2D, as well as a determination as to whether the site data are greater than background. It is important to note

that there are several chemicals for which there is a low frequency of detection (less than 25%) in the site or RZ-A background dataset. Finally, chemicals for which only one p-value was less than 0.025 are noted in the tables.

It is important to note in the following summary that those metals which are evaluated in the 0- to 2-feet and 2- to 10-feet depth intervals are not included in the evaluation for the combined 0- to 10-feet depth interval. (For example, sodium exceeds RZ-A background from 0-2 feet and 2-10 feet in RZs B through E, but is not evaluated in the 0- to 10-feet depth interval). Likewise, metals that are evaluated in the combined 0- to 10-feet depth interval are not evaluated in the 0- to 2-feet and 2- to 10-feet depth intervals.

Results for RZ-B

The results for RZ-B are presented in Attachment 2 Table 2A. The metals which exceed RZ-A background are listed below:

- 0 to 2 feet bgs: arsenic, chromium (total), sodium, and uranium
- 2 to 10 feet bgs: arsenic, potassium, and sodium
- 0 to 10 feet bgs: antimony, boron, chromium (VI), lead, and manganese
- 10 feet bgs to Upper Muddy Creek formation (UMCf): boron, chromium (VI), magnesium, selenium, and sodium

The chemicals that are consistent with background at all depth intervals in RZ-B are: aluminum, barium, beryllium, cadmium, cobalt, copper, iron, mercury, molybdenum, nickel, platinum, silver, strontium, thallium, tin, titanium, tungsten, vanadium, and zinc.

Results for RZ-C

The results for RZ-C are presented in Attachment 2 Table 2B. The metals which exceed background are listed below:

- 0 to 2 feet bgs: arsenic, chromium (total), magnesium, molybdenum, sodium, and uranium
- 2 to 10 feet bgs: arsenic, and sodium
- 0 to 10 feet bgs: barium, boron, chromium (VI), cobalt, lead, manganese, platinum, thallium, and tungsten
- 10 feet bgs to UMCf: barium, chromium (VI), cobalt, manganese, selenium, sodium, thallium, and tungsten

The chemicals that are consistent with background at all depth intervals in RZ-C are: aluminum, antimony, beryllium, cadmium, copper, iron, mercury, nickel, platinum, potassium, silver, strontium, tin, titanium, vanadium, and zinc.

Results for RZ-D

The results for RZ-D are presented in Attachment 2 Table 2C. The metals which exceed background are listed below:

- 0 to 2 feet bgs: arsenic, chromium (total), magnesium, molybdenum, sodium, and uranium
- 2 to 10 feet bgs: arsenic, magnesium, sodium, strontium, and uranium
- 0 to 10 feet bgs: barium, beryllium, boron, manganese, and tungsten
- 10 feet bgs to UMCf: barium, chromium (VI), and sodium,

The chemicals that are consistent with background at all depth intervals in RZ-D are: aluminum, antimony, cadmium, cobalt, copper, iron, lead, mercury, nickel, platinum, potassium, selenium, silver, thallium, tin, titanium, vanadium, and zinc.

Results for RZ-E

The results for RZ-E are presented in Attachment 2 Table 2D. The metals which exceed background are listed below:

- 0 to 2 feet bgs: arsenic, chromium (total), magnesium, molybdenum, sodium, and uranium
- 2 to 10 feet bgs: arsenic, chromium (total), and sodium
- 0 to 10 feet bgs: aluminum, barium, beryllium, boron, chromium (VI), cobalt, copper, lead, manganese, nickel, platinum, selenium, silver, thallium, tin, tungsten, and zinc
- 10 feet bgs to UMCf: sodium

The chemicals that are consistent with background at all depth intervals in RZ-E are: antimony, cadmium, iron, mercury, potassium, strontium, titanium, and vanadium.

Selection of Inorganic Chemicals of Potential Concern for the Leaching Evaluation

Attachment 2, Tables 3A through 3D present the screening evaluation used to select the inorganic COPCs for the leaching evaluation: COPCs were selected for each Remedial Zone (RZ-B through RZ-E) using the steps summarized below:

1. Comparison with background dataset: chemicals that are consistent with background in each RZ for a given depth interval are excluded from further evaluation of leaching potential.
2. Screening using leaching-based, basic comparison levels (LBCLs) for a dilution attenuation factor (DAF) equal to one (no dilution). Chemicals that did not exceed LBCLs for DAF=1 were excluded from further evaluation.
3. Screening using LBCLs for DAF=20. Chemicals that did not exceed LBCLs for DAF=20 were excluded from further evaluation of leaching potential.
4. Chemicals that exceeded background and LBCLs for DAF=1 and DAF=20 were retained as COPCs for the leaching evaluation.[1]

In addition to the metals evaluated in Tables 3A through 3D, perchlorate was retained as a COPC because it exceeds the calculated generic LBCL of 0.072 milligrams per kilogram (mg/Kg) at all depth intervals in all RZ areas.[2]

Attachment 2, Table 3 presents the Site-wide screening evaluation to select the organic COPCs for the leaching evaluation using the steps summarized below:

1. Screening using LBCLs for a DAF equal to one (no dilution). Chemicals that did not exceed LBCLs for DAF=1 were excluded from further evaluation.
2. Screening using LBCLs for DAF=20. Chemicals that did not exceed LBCLs for DAF=20 were excluded from further evaluation of leaching potential.
3. Chemicals that exceeded LBCLs for DAF=1 and DAF=20 were retained as COPCs for the leaching evaluation.

[1] The maximum background concentration of iron in all depth intervals in the RZ-A background dataset exceeds the LBCL for DAF=20. Therefore, iron was excluded as a COPC in all RZs because it did not exceed background in RZ-A. The maximum background concentration of magnesium in the depth interval from >10 feet to the UMCf contact in the RZ-A background dataset exceeds the LBCL for DAF=20.

[2] For the purpose of defining and measuring source lengths, generic leaching-based comparison levels (LBCLs) were calculated for certain inorganic and organic chemicals for which LBCLs have not been published by NDEP. The generic LBCLs were calculated using default soil and chemical parameters as described in Attachment 3.

Tables

1 LOU 62 Comparison to RZ-A Background
2A RZ-B Comparison to RZ-A Background
2B RZ-C Comparison to RZ-A Background
2C RZ-D Comparison to RZ-A Background
2D RZ-E Comparison to RZ-A Background
3A Screening of Inorganic Chemicals for Leaching Concerns in RZ-B
3B Screening of Inorganic Chemicals for Leaching Concerns in RZ-C
3C Screening of Inorganic Chemicals for Leaching Concerns in RZ-D
3D Screening of Inorganic Chemicals for Leaching Concerns in RZ-E
4 Screening of Organic Chemicals for Leaching Concerns

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