northgate
environmental management, inc.

From: Deni Chambers
Mary Stallard

Date: October 25, 2010

To: Shannon Harbour, Nevada Division of Environmental Protection

RE: Annotated Response to NDEP Comment Letter dated September 24, 2010 regarding Tronox's *Proposal for Demonstration of Perchlorate Treatment within Groundwater Using an Injected Permeable Reactive Barrier, dated August 27, 2010*

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1. *Section 2.0, page 2, 3rd paragraph of section, please show the location and orientation of the City of Henderson (CoH) transect.*

   Response:
   The location of the City of Henderson transect is shown on Figure 1.

2. *Section 2.0, page 2, last bullet on page, TRX should clarify that sulfate may degrade but iron and manganese change valence states.*

   Response:
   Tronox concurs. The text has been modified for clarity.

3. *Section 3.1.1, page 4, 1st line at top of page, TRX stated that a "laboratory experienced in the setup and conduct of treatability tests for environmental remediation will perform the tests." NDEP requests that TRX notify NDEP prior to the selection of the laboratory so NDEP can provide input into this selection.*

   Response:
   As discussed during the October 1, 2010, conference call between NDEP and Tronox, the proposed oil retention testing is to be completed at the Environmental Engineering Laboratory in the Department of Civil, Construction, and Environmental Engineering Department at North Carolina State University. Experimental design, testing, and analysis will be performed under the supervision of Professor Robert C. Borden, P.E. Professor Borden is the inventor of the EOS electron-donor substrate and has extensive experience with the evaluation of emulsified oil retention in aquifer material. As requested during our conference call, additional background information on Dr. Borden was provided to NDEP via email on October 1, 2010.

   As discussed during the October 1, 2010 conference call, the proposed metals mobilization testing will be conducted by PRIMA Environmental, Inc., in El Dorado Hills, California.

4. *Section 3.1.1, page 4, Item 1, NDEP provides the following comments:*
   a. *Please specify to whom "others" refers.*
   b. *As NDEP has previously indicated to TRX, ASTM D422 using both sieve and hydrometer for soil particles finer than #200 sieve must be used for soil particle size analysis. Please revise.*

   Response:
   a. The word "others" has been removed.
   b. Tronox concurs. The work plan has been modified to specify that grain size analysis for the fraction passing through the #4 size sieve will be conducted following ASTM D422, *Standard Test Method for Particle Size Analysis of Soils*.

5. *Section 3.1.1, pages 4 and 5, Item 4, NDEP provides the following comments:*
   a. *Please specify the specific method(s) to be employed for the proposed sampling (i.e. ASTM....)*
   b. *As this area is downgradient of the CoH RIBs, please clarify whether there is any issue with regards to TOC from the previously disposed municipal wastewater.*

   Response:
   a. There are no established standard methods for the measurement of emulsified oil substrate retention on aquifer sediments. The procedure discussed in the work plan has been previously described in SERDP ER-1205 "*Development of Permeable Reactive Barriers (PRB) Using Edible Oils*".
   b. The effects of TOC loads from the historical operation of the Northern CoH rapid injection basins (RIBs) on emulsified oil retention are unknown. TOC groundwater data obtained by querying the NDEP BMI database indicates elevated levels of TOC (11.8 mg/L at monitoring well PC-108) in the area of the Northern RIBs, but not in the area of the Southern RIBs (1.6 mg/L at monitoring well POD8). The TOC values over most of the Site groundwater range from 1-3 mg/L. The presence of organic carbon on aquifer sediments should enhance the retention of emulsified oil substrate.

6. *Section 3.1.2, page 5, NDEP provides the following comments:*
   a. *1st paragraph of section, TRX should notes that the change in mobility of metals may not be restricted to arsenic and iron at this location. NDEP requests review of the following in developing a list of metals:*
      i. *Groundwater monitoring results upgradient of proposed pilot test site,*
      ii. *SPLP testing done by TRX/NGEM*
      iii. *EPA Priority Pollutant Metals (13 metals)*
   b. *1st and 3rd bullets, please add DO and pH in additional to ORP.*
   c. *Last bullet, please refer to above-comment 6.a for guidance.*

   Response:
   a. Tronox reviewed upgradient groundwater monitoring results and available soil data for the area in developing the list of metals proposed for analysis. (Results from SPLP leaching tests completed by TRX/NGEM and other parties were obtained from unsaturated soils under oxidizing conditions, and are not applicable to metals mobilization related to in-situ biological reduction.) Based on this review, arsenic and iron analyses were proposed for the bench-scale testing, and these metals plus

manganese and chromium were proposed for the field pilot test, because these are redox-sensitive metals that may have significantly increased (in the case of arsenic, iron and manganese) or decreased (in the case of chromium) mobility in reduced states. Although no significant changes are expected in other groundwater metals concentrations due to the reducing conditions that occur during in-situ biological reduction of perchlorate, Tronox understands NDEP's concerns and will therefore analyze groundwater samples from the laboratory metals mobilization testing for the 13 EPA Priority Pollutant Metals plus manganese and uranium. The analyte list for the field pilot study (Table 1 of work plan) may be modified based on the laboratory test results. The work plan has been revised to reflect this.

b. DO and pH have been added to the bullets as requested.
c. See response to 6a above.

7. *Section 3.1.2, page 6, Task 1, DI WET test, if this refers to the CA DTSC WET, NDEP has not recommended this test for the BMI Complex. For the leaching to groundwater pathway, NDEP has recommended EPA SPLP using extraction fluids #2 and #3. The latter procedure should be used as it would produce comparable results to the Phase B SPLP testing done for on-Site soils.*

Response:
The proposed testing is intended for the purpose of understanding the stability of metal sulfides that may precipitate under reducing conditions and is not meant to be representative of the leaching to groundwater pathway. If dissolved arsenic concentrations decrease during the bench-scale testing, then soil will be analyzed to assess the stability of the precipitated and/or sorbed species under aerobic conditions, which will likely be re-established once treatment at the Site is complete. The proposed method for testing this is leaching using de-ionized water. SPLP extraction fluid #2 is representative of acid rain leachate, and is not appropriate for this experiment. As SPLP extraction fluid #3 is reagent water (i.e., de-ionized water, the proposed extraction fluid in the work plan), we have changed the specified test from DI WET to SPLP (extraction fluid 2).

8. *Section 3.1.2, page 6 and Table on page 7, please clarify that the control reactors will be run under sterile conditions (i.e. will a sterilant be added to the control test).*

Response:
The control reactors will be run under non-sterile conditions. Their purpose is to establish a baseline for evaluating changes to the microcosm brought about from the addition of the EOS substrate. As discussed during the October 1, 2010, conference call, the text of the work plan has been modified for clarity.

9. *Section 3.1.2, page 7, Task 4, please clarify that the attenuation evaluation will use soil samples from the saturated zone.*

Response:
The text has been modified to clarify that soil samples from the saturated zone will be used.

10. *Section 3.1.2, page 8, Task 5, Analytical Methods Table, NDEP has the following comments:*
    a. *Please correct spelling to "pH" for clarity.*
    b. *Please clarify that Hach analyses are sufficiently accurate and precise enough for the decisions to be made from the test results.*

    Response:
    (a) The spelling of pH has been corrected for clarity.
    (b) Analyses obtained using the Hach DR 2800 portable spectrophotometer with the SulfaVer 4 Method 8051 for sulfate and the Methylene Blue Method 8131 for hydrogen sulfide are sufficiently accurate and precise to determine if the bioreactors are reducing sulfate to sulfide.

11. *Section 3.2.3, page 10 and Figure 4, there appears to be an insufficient number of wells to monitor the groundwater for the pilot test. Please review the proposed monitoring network and propose additional wells for sufficient coverage. Include discussion on the adequateness of the proposed well field. TRX should contact NDEP* ***by September 28, 2010*** *to schedule a conference call to discuss this issue for timely resolution.*

    Response:
    As discussed during the October 1, 2010, conference call, three additional observation wells will be installed down-gradient of the injection well transect: one approximately 75 ft east of O-1, one approximately 60 ft east of O-3, and one approximately 75 ft east of O-5. The work plan text and Figure 4 have been modified to reflect this.

12. *Section 3.2.3, page 11, NDEP has noted that the well screen length for the monitoring wells appears quite large and seems to be based on the assumption that the edible oil injection will be uniform across the wellbore. The NDEP requests cluster well completions with a minimum of two separate vertical screen intervals to provide a more detailed and reliable view of the reactions taking place. Please revise the Deliverable as necessary to address this concern.*

    Response:
    As discussed during the October 1, 2010, conference call, vertical variability in ORP, DO and pH will be monitored at discrete intervals within the screened interval using a flow-through cell and low flow purging. The work plan has been modified to reflect this.

13. *Section 3.2.4, page 12, 1st paragraph, TRX states that "Some wells will be sampled and analyzed for additional compounds, such as bromide, chloride, and/or dissolved methane." TRX should specify which wells will be sampled for which analytes. Additionally, NDEP believes that all wells should be sampled for the same constituents.*

    Response:
    Tronox concurs that all observation wells should be sampled for the same constituents and the PRB Pilot Test Groundwater and Sampling Matrix presented in Table 1 of the work plan illustrates this. The term "some wells" is unclear and has been changed to "the eight observation wells" for clarity.

14. *Section 3.2.4, page 12, 3rd paragraph, please provide supporting calculations or model, which ever was used, for the volume of edible oil substrate to be injected.*

Response:
A print-out of the model parameters has been included in the work plan as Appendix C.

15. *Section 3.3, page 14, please include a list of all the SOPs that will be used including SOP number and title in this section or a referenced appendix.*

Response:
A list of SOPs to be used has been added to Section 3.3 as requested.

16. *Section 4.0, page 15, NDEP requests a Technical Memoranda at the conclusion of Task 3 that presents all field and laboratory data collected, interpretations, slug test results, and re-assessment of the volume of edible oil substrate to be injected prior to starting injection.*

Response:
Tronox included a Laboratory Testing Report in the proposed schedule as part of Task 1 (Section 3.1.2). This report will discuss the results of the oil retention and metals mobilization testing. Any reassessment of the proposed volume of injected edible oil substrate will be made in this report, including a recommendation to cancel the proposed PRB pilot test if the oil retention fails to meet the level required to conduct a successful pilot test. If results are supportive of moving forward with the PRB pilot test, the Laboratory Testing Report will also include a description of how the slug and step-injection test results will be used to determine if the proposed injection rate of 15 gpm should be adjusted. The work plan has been modified to reflect this change.

17. *Section 5, p 16, References, NDEP provides the following comments:*
    a. *The Environmental Security Technology Certification Program (ESTCP) is listed eight times in the references but is not referenced in the text. Please provide the appropriate citations in the work plan text.*
    b. *Strategic Environmental Research and Development Program is listed in the references but not referenced in the text. Please provide the appropriate citations in the work plan text.*
    c. *Interstate Technology & Regulatory Council (ITRC) is listed twice in the references but not referenced in the text. Please provide the appropriate citations in the work plan text.*

Response:
Tronox has revised the work plan text to provide the appropriate citations.