

Shaw® Shaw Environmental, Inc.

VIA EMAIL: okbailey@flash.net

November 20, 2007

Tronox LLC
c/o Mr. Keith Bailey
Environmental Answers, LLC
3229 Persimmon Creek Drive
Edmond, OK 73013

**Re: Proposal (No Compensation) for Demonstration of Perchlorate Treatment within Vadose Zone Soils (ESTCP ER-0435)
Tronox LLC – Henderson, NV**

Dear Keith,

As we have discussed, Shaw is interested in conducting the above referenced demonstration project at the TRONOX LLC (Tronox) facility in Henderson, Nevada. Shaw has prepared this “No Compensation” proposal for your use in preparing and issuing a work order authorizing us to complete the necessary work activities at the Tronox – Henderson site.

Background

The Environmental Security Technology Certification Program (ESTCP) has awarded a grant to support the completion of a field demonstration project related to the treatment of perchlorate within vadose zone soils. Following is a brief description of the proposed demonstration project, with certain modifications to conform with site and regulatory conditions pertinent to Tronox’s operations in Henderson, along with an outline of the initial steps. Further details regarding the ESTCP program can be obtained by visiting their website (<http://www.estcp.org>).

Technical Description of the Proposed Demonstration Project

The primary focus of this project will be to demonstrate and validate the treatment of perchlorate within vadose zone soils through bioremediation and flushing via two electron donor delivery methods:

Approach #1 – Engineered Infiltration Gallery

For approach #1, an engineered infiltration gallery will be designed to effectively deliver and distribute an electron donor to the perchlorate-impacted vadose soils. The electron donor will be a soluble, food grade, organic rich substrate such as sodium lactate, lactic acid, citric acid, ethanol, etc. The conceptual system design involves the installation of a shallow infiltration gallery or a low profile mound-style infiltration system. Factors to be considered during the donor selection process will include:

- Effectiveness at promoting biological reduction of perchlorate
- Cost and availability
- Material handling and safety concerns
- Regulatory acceptance and permitting requirements

Approach #2 – Shallow Soil Mixing with Organic Amendment and Watering

For approach #2, an organic rich electron donor source will be mechanically blended (via tilling or mixing) into the upper few feet of the soil column. A network of sprinklers or drip irrigation lines will be installed to provide periodic watering of the treatment area to promote vertical distribution of water and organic amendments within the vadose zone. A complex electron donor source such as FBR plant sludge, corn steep liquor, or some other food grade, pathogen free carbon source will be selected for use with this demonstration. The electron donor source will be mixed into the upper 2 to 3 feet of the soils, and an automated sprinkling system will be designed to supply water over the test plot area and promote vertical penetration of the electron donor agent along with the infiltrating waters. Similar factors as those outlined above will be considered when selecting the electron donor agent.

Schematic diagrams (plan and cross-sectional views) of the conceptual treatment approaches are presented in **Attachment A**.

The following elements will be common to both demonstrations:

- Detailed characterization of the demonstration areas will be required to develop fluid flow and chemical fate and transport properties within the vadoze zone and underlying saturated zone areas.
- A series of monitoring wells and other sampling methods (soil sampling, suction lysimeters, conductivity probes, etc) will be utilized to monitor the effectiveness of the amendment delivery and contaminant degradation process.
- In order to comply with the current underground injection control (UIC) permit for Tronox, the water source to be utilized for both treatment areas will be stabilized lake water.
- Detailed cost and performance reporting will be prepared for the project participants including ESTCP, Tronox, State and Federal Regulatory Agencies (as required).

Following are the specific tasks to be completed during the course of this demonstration project:

Task 1 Site Selection

The ideal site would have 30 to 50' of unsaturated soils, perchlorate in soils throughout the vertical unsaturated column at levels ranging from moderate (10 mg/kg) to high (>1,000 mg/kg) levels, and soils with moderate to high permeability (sandy silts, silty sands with some clay, sands, etc).

Data from the site investigation sampling conducted in late 2006 indicated that conditions within certain areas of the Tronox – Henderson site meet the criteria outlined above. In order to confirm the final location of the demonstration plots, six additional test borings are proposed to be installed at the locations indicated on **Figure 1** (Areas 1A/B and 2). The proposed borings will be advanced using hollow-stem auger drilling equipment and each boring will be sampled continuously from the ground surface to the terminal boring depth. Borings will be advanced approximately 3 feet into the first saturated soils, which are expected to be encountered at approximately 30 feet below ground surface (bgs). The purpose of these borings are outlined as follows:

- Confirm vadose zone soil lithology will be suitable for infiltration of amendments/water.
- Confirm that the distribution of perchlorate within the vadose zone is adequate for demonstration purposes.
- Obtain or determine the potential for obtaining in-tact core material from the alluvial deposits for laboratory scale geophysical testing
- Initiation of laboratory scale perchlorate treatability and leachability testing (Task 4)

Selected soil samples will be submitted to Shaw's certified analytical laboratory in Lawrenceville, NJ for the following suite of analyses: perchlorate, chlorate, nitrate as N, sulfate, phosphate as P (ortho), chloride, total organic carbon (TOC), and pH. RCRA metals scans may also be completed on selected samples. Groundwater grab samples will also be obtained from one or more borings and analyzed for the same suite of parameters as outlined above, including both total and dissolved metals scans..

Task 2 Demonstration Plan Preparation

ESTCP requires a detailed plan describing the technical objectives of the study and the proposed methods to be utilized during the demonstration completion. This plan will be developed in conjunction with Task 3.

Task 3 Site Characterization

After confirming that the characteristics of the demonstration area are suitable for the project objectives (Task 1), a series of test borings and wells will be installed and testing will be performed to fully characterize the demonstration area. The characterization phase will include, but may not be limited to, the following:

- Installation of soil borings and monitoring wells
- Collection of soil and groundwater samples
- Laboratory testing on soils including
 - physical properties (grain size)
 - chemical parameters: VOCs, Anions (Perchlorate, Chlorate, Nitrate, Sulfate), TOC, Metals
- Laboratory testing on groundwater including
 - chemical parameters: VOCs, Anions (Perchlorate, Chlorate, Nitrate, Sulfate), TOC, Metals
- Slug, Pump, and Infiltration testing
- Possibly geophysical testing - in conjunction with companion study to be supported by New England Research (NER)

Task 4 Laboratory Studies

Shaw will conduct certain laboratory treatability studies to support the design process. Three specific laboratory studies are currently being contemplated for the following purposes:

1. Electron Donor Selection
2. Evaluation of Perchlorate Leaching rates under differing infiltration scenarios, and
3. Evaluation of preservation methods for perchlorate analysis in soil and groundwater.

Task 5 System Design

The final treatment system and monitoring network components will be designed based on site characteristics established under Task 3 and in accordance with applicable regulatory/permit requirements. A demonstration implementation, startup, and operations and maintenance plan will be developed.

Task 6 System Installation and Startup

Shaw will work with qualified subcontractors to complete the installation of the demonstration system operating and performance monitoring components and will perform startup and baseline sampling activities. Startup testing may include the addition of tracers to aid in the assessment of process effectiveness.

Task 7 System Operations, Maintenance, and Monitoring

Shaw and/or subcontract personnel will operate and maintain the system to insure proper delivery of moisture and amendments is achieved. Shaw personnel will collect samples at regular intervals to assess process performance. Active operations are expected to be conducted over a period of 9 months, with post shutdown monitoring being completed within 3 months of shutdown. A combination of soil sampling, pore water sampling, and groundwater sampling will be used to measure the variability and flux of perchlorate within the vadose zone and to assess the mass of perchlorate degraded within the vadose zone and underlying aquifer zone throughout the demonstration. Fouling control agents may also be added to the amended water to control clogging or plugging within the infiltration gallery.

Task 8 Reporting

ESTCP requires progress reports and detailed performance and cost reporting. These reports will provide information regarding the design, operations, and performance of the treatment approaches as well as compare the costs associated with each. At a minimum it will be necessary to share pertinent details associated with the site location and the demonstration project findings with the ESTCP technical review board. It is not necessary to specifically name the facility; a generic name such as site in Nevada would be suitable. The ESTCP technical review board consists of technical representatives from the ESTCP program office, ESTCP technical support personnel, the various military branches (Army, Navy, and Air Force), EPA, and DOE. This review is limited to the technical progress on the project and does not require access to the Tronox facility by personnel other than Shaw. Information will be shared with the review board at annual in-progress review (IPR) meetings and via written reports. It will not be necessary to provide details regarding the entire facility unless those details have some direct bearing on the demonstration project design and performance.

Task 9 Technology Transfer

ESTCP encourages technology transfer through presentations and publications at conferences and within journals pertinent to the environmental community and particularly the DoD. As mentioned previously, care can be exercised to avoid the disclosure of unnecessary site details such as the specific site name, however, the general demonstration site location would be disclosed.

Anticipated Support Required from Tronox for Project

As noted above, ESTCP has committed grant funding to support the implementation of this demonstration project. However, some in-kind support is anticipated to be required from Tronox to enable this project to be completed at the facility in Henderson, NV. Following is a list of some of the elements that may be required:

- Regular access to the demonstration site location throughout the execution of the project.
- Assistance with clearing subsurface utilities prior to any drilling, excavating, or other subsurface work activities.
- Access to communication lines, power, and water sources within the facility.
- Routine security and system inspections to insure uninterrupted operations can be maintained.

Closing

We look forward to working with Tronox during this technology demonstration project. All services will be performed in accordance with the terms and conditions contained within the Agreement For Construction or Field Services (Class II) between TRONOX LLC and Shaw Environmental, Inc. dated June 8, 2007. Please include the agreed upon indemnity language when issuing the work order authorizing Shaw to proceed with this project.

Tronox LLC – ER0435 Proposal
c/o Keith Bailey
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Please contact me with any questions you may have at 414-291-2357.

Sincerely,
SHAW ENVIRONMENTAL, INC.



Jay Diebold, P.E., P.G.
Program Manager

Attachments

Cc: Paul Hatzinger, PhD., Shaw Environmental, Inc.
Mike DelVecchio, Shaw Environmental, Inc.
Rob Steffan, PhD., Shaw Environmental, Inc.
Andrea Leeson, PhD., ESTCP Program