

ATTACHMENT 2

EVALUATION OF PERCHLORATE MASS DISTRIBUTION TRONOX LLC, HENDERSON, NEVADA

Tronox LLC (Tronox) has calculated leaching-based, site-specific levels (LSSLs) for perchlorate and other inorganic and organic chemicals at the Tronox facility in Henderson, Nevada (the Site) using the NDEP's guidance for Further Evaluation of Leaching from Soil to Groundwater (NDEP, January 16, 2010).¹ Nearly all of the unsaturated-zone soil Site exceeds the LSSL calculated for perchlorate of 0.042 milligrams per kilogram (mg/Kg), and it may not be feasible to treat or remove all of this soil. Therefore, this attachment evaluates the distribution of perchlorate mass so that interim remedial measures can be focused on those areas where the greatest mass reduction can be achieved. The information in this attachment will be used in conjunction with the results of the impending soil flushing pilot study (Attachment 1) to identify areas where larger-scale flushing is recommended, and will also be used in a comprehensive feasibility study of other remedial options for unsaturated zone soil.

Estimated Perchlorate Mass in Unsaturated Soil and Shallow Water-Bearing Zone

Tronox has estimated the total mass of perchlorate present in unsaturated-zone soil and in the shallow groundwater-bearing zone (WBZ) to a depth of 90 feet below ground surface (bgs). As shown in Table 1, an estimated 730,000 Kg (800 tons) of perchlorate are present in the unsaturated-zone soil, and 4.4 million Kg (4,800 tons) of perchlorate are estimated to be currently present in the shallow WBZ. The total mass of perchlorate present in the subsurface at less than 90 feet bgs is estimated to be approximately 5.1 million Kg (5,600 tons).² Therefore, approximately 14 percent of the total mass of perchlorate is present in the unsaturated zone and approximately 86 percent of the mass is in the shallow WBZ, which is being treated by the groundwater treatment system (GWTS).

¹ The "Revised Technical Memorandum: Calculation of Leaching-Based, Site-Specific Levels (LSSLs) for the Soil-to-Groundwater Pathway Using NDEP Guidance," dated September 9, 2010 is undergoing NDEP review.

² The mass of perchlorate in the middle and deeper WBZs has not been estimated and is not included.



Perchlorate Mass Distribution in the Unsaturated Zone

As indicated in the Excavation Plans for the Remediation Zones B through E (Excavation Plans; Northgate, 2010), Tronox proposes to excavate approximately 440,000 cubic yards (cy) of soil containing chemicals above the basic comparison levels (BCLs) for the direct contact exposure pathway to a depth of 10 feet bgs.³ Perchlorate is not targeted for removal by excavation, but will be removed within the excavations where other chemicals are present above BCLs for direct exposure. Tronox has estimated the mass of perchlorate that will be removed by excavation to be approximately 16,000 Kg (18 tons). This would reduce the mass of perchlorate in the unsaturated zone from an estimated 730,000 Kg (800 tons) to 714,000 Kg (780 tons), which is a reduction of approximately 2 percent of the mass in the unsaturated zone and less than 1 percent of the total mass.

Tronox used an interpolation method (inverse distance weighting of the log of concentration) and the maximum perchlorate concentration detected in unsaturated soil from each soil boring to estimate the lateral distribution of perchlorate in the unsaturated zone (Figure 1). As shown on the figure, most of the areas with the highest concentrations of perchlorate in unsaturated-zone soil are upgradient of the Interceptor Wells and barrier wall.

The interpolation method used to generate the contours on Figure 1 was also used to estimate the mass of perchlorate remaining in unsaturated-zone soil below a series of threshold concentrations (10 mg/Kg, 50 mg/Kg, 100 mg/Kg, 400 mg/Kg, and the BCL of 795 mg/Kg). The results of these mass estimates are shown in Table 1. As indicated on Table 1, estimates of the mass above the selected threshold concentrations range from 210,000 Kg (approximately 230 tons) above the 795 mg/Kg threshold to 630,000 Kg (approximately 690 tons) above 10 mg/Kg, or a range of 4 percent to 13 percent of the total mass of perchlorate (pre-remediation).

The area of soil above the threshold concentrations shown on Figure 1 ranges from approximately 0.25 million square feet (ft²) for the area above 795 mg/Kg to approximately 5.6 million ft² above 10 mg/Kg. For example, if all perchlorate is removed from soil containing greater than 100 mg/Kg, up to approximately 370,000 Kg (400 tons) of perchlorate, or approximately 53 percent of the unsaturated-zone mass and 8 percent of the total mass before remediation, could potentially be removed from an area of approximately 1.2 million ft².

Table 2 summarizes the incremental mass of perchlorate removed per unit volume and per unit

³In some areas, perchlorate exceeding the BCL of 795 mg/Kg at depths less than 10 feet bgs will be left in-place because *in situ* methods of remediation are being evaluated to treat perchlorate in soil (see Attachment 1).



ground surface area, which ranges from approximately 50 to 850 g/ft² for the contour intervals evaluated. As expected, the mass of perchlorate that can be removed per unit volume of soil removed or treated, or per unit surface area treated (e.g., in the case of soil flushing), decreases progressively as the perchlorate is reduced to lower concentrations.

Tables

- 1 Estimated Mass of Perchlorate in Soil
- 2 Mass Removal per Unit Volume and Area

Figure

- 1 Perchlorate Remaining in Soil After Excavation

References

- Nevada Division of Environmental Protection (NDEP), 2010a. BMI Plant Sites and Common Areas Projects, Henderson, Nevada, Soil to Groundwater Leaching Guidance. January 16, 2010.
- NDEP. 2010b. Letter to Mr. Matt Paque, Tronox LLC, from Ms. Shannon Harbour, regarding NDEP Response to: Revised Environmental Covenants, Institutional and Engineering Control Plan, Tronox Facility, Henderson, Nevada, dated June, 9, 2010. July 30.
- Northgate Environmental Management, Inc. (Northgate). 2010a. Revised Technical Memorandum: Calculation of Leaching-Based, Site-Specific Levels (LSSLs) for the Soil-to-Groundwater Pathway Using NDEP Guidance. September 9
- Tronox LLC (Tronox). 2010a. Revised Environmental Covenants, Institutional and Engineering Control Plan, Tronox Facility, Henderson Nevada. June 9.

