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Remediation and Restoration Unit
Federal Facilities Program
Hazardous Materials and Waste Management Division
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South, B2
Denver, CO 80246-1530

**Results for the January 2010 Semiannual
Closure / Performance Groundwater Monitoring Program
Headquarters Area TCE Plume
Operable Unit 5
Former Lowry Air Force Base, Colorado**

Dear Mr. Pivonka,

This letter report presents the results of the January 2010 semiannual closure/performance groundwater monitoring program (GMP) event completed for the Operable Unit 5 (OU 5) Headquarters (HQ) Area Trichloroethene (TCE) Plume at the former Lowry Air Force Base (Lowry) in Denver, Colorado. The work was completed by Lowry Assumption, LLC (LAC) as set forth in the Colorado Department of Public Health and Environment (CDPHE)-approved Closure/Performance Groundwater Monitoring Program (GMP) work plan. The Closure/Performance GMP is being implemented to support the eventual regulatory closure of the HQ Area TCE Plume and to be consistent with the requirements of Consent Agreement No. 01-08-07-02 between the Colorado Department of Public Health and Environment (CDPHE), the Lowry Economic Redevelopment Authority (LRA), and LAC..

Background information on the HQ Area TCE Plume is provided in the *Closure/Performance Groundwater Monitoring Program (GMP) Headquarters Area and Fire Training Zone TCE Plumes, Operable Unit 5 Former Lowry Air Force Base* (LAC, revised February 2008). Descriptions of the sampling methodology, analytical methods, quality assurance (QA)/quality control (QC) procedures, investigation-derived waste (IDW) handling procedures, and equipment decontamination procedures are also included in the referenced document.

Closure/Performance Monitoring

The semiannual Closure/Performance GMP sampling event for the HQ Area was conducted on January 21, 2010. Field work for this sampling event was conducted by LT Environmental, Inc. (LTE) on behalf of LAC. As set forth in a letter to CDPHE dated December 18, 2009 (*Modification to Work Plan for the Semiannual Closure/Performance Groundwater Monitoring Program Headquarters Area and Fire Training Zone TCE Plumes*), the Closure/Performance GMP monitoring network for the HQ Area included a total of four bedrock monitoring wells in the



source area and four alluvial monitoring wells within the HQ Area TCE Plume (Figure 1). The monitoring wells included in the GMP network for the January 2010 sampling event at the HQ Area are summarized in Table 1.

There were several variations to the Work Plan as a result of field conditions encountered during the sampling event. Bedrock monitoring well HQPSW01W and shallow alluvial monitoring well MWHQ03 were not sampled because of the presence of a very high concentration of potassium permanganate (KMnO_4) (e.g., deep purple color) in the well bore related to recent treatment (see further discussion below).

Groundwater samples were collected via low-flow methods using a dedicated submersible pump with dedicated tubing. Measurements of temperature, pH, electrical conductivity (EC), dissolved oxygen (DO) concentration, and oxygen reduction potential (ORP) were collected and each monitoring well was sampled after the parameters had stabilized (i.e., readings within +/- 10 percent of the previous reading). Field parameters were measured using a YSI 556® Multi-Probe Field Meter (YSI 556® Meter).

The groundwater samples were submitted to ChemSolutions in Larkspur, Colorado under chain-of-custody protocols and were analyzed for volatile organic compounds (VOCs) using U.S. Environmental Protection Agency (EPA) method 8260B. Field sampling data sheets are provided in Attachment A.

Results

The HQ Area TCE plume is generally divided into two areas, HQ-1 and HQ-2. HQ-1 includes the original contaminant source area for this plume and is characterized by little or no saturated alluvium over a weathered bedrock high in which residual TCE mass resides (Figure 1 – hatched area surrounding wells CPWHQ27D/27XD). HQ-2 includes the downgradient area to the north-northwest of HQ-1 where groundwater moves into and through a deep alluvial paleochannel with saturated alluvium reaching a thickness of over 55 feet.

Prior to 2009, LAC conducted several KMnO_4 injection efforts in the HQ-1 area as part of the OU5 On-base Treatability Study (LAC, 2005). During December 2003 and February 2005, MACTEC, working on behalf of LAC, injected 6,355 gallons of 3.8 percent KMnO_4 solution into the alluvium/bedrock interval at HQ-1 (LAC, 2005). The injections were accomplished using gravity-feed emplacement through temporary two-inch wells completed across the alluvium/bedrock interface or wholly within bedrock. The resulting distribution of the injected solution was not well defined though it is likely that a larger volume was delivered into the alluvium versus bedrock interval based on the relatively higher porosity and permeability in the alluvium. However, there was an apparent response to those injections in bedrock monitoring wells following the injections as TCE concentration decreases were observed in bedrock source area wells CPWHQ27D, CPWHQ27XD, and MWHQ11 (Table 1). The concentrations in well CPWHQ27XD, the deepest bedrock well in HQ-1, eventually rebounded to higher levels representative of the historical range observed in this well. Considering the full range of historical data available for these wells, a general decrease in TCE concentrations in bedrock was observed as a result of the limited treatment performed in 2003/2005 (Table 1).

During June – July 2009, LAC completed focused KMnO_4 injections in the HQ-1 bedrock area and in the HQ-2 alluvium area where higher concentrations of TCE have persisted since the 2003/2005 treatment. Approximately 50,000 gallons of 4 percent KMnO_4 by weight solution was pressure-injected into the weathered bedrock interval through 32 points covering an area



extending from well MWHQ11 northward to surround monitoring wells CPWHQ27D, CPWHQ27XD, and HQPSW01W (Figure 1). An additional 25,000 gallons of the 4 percent KMnO_4 solution was also pressure-injected into the alluvium through 25 points surrounding well MWHQ03 (Figure 1), an area where the alluvium is comprised of thinly inter-bedded fine sands, silts, and clays. A summary report for the Summer/Fall 2009 injection activities was submitted to the CDPHE in January 2010.

Figure 1 illustrates the current interpreted extent of the HQ Area TCE Plume in alluvium greater than the Colorado Basic Groundwater Standard of 5 $\mu\text{g/L}$ and presents the January 2010 TCE analytical results for each well sampled. Figure 1 also includes at a minimum the most recent result sample prior to January 2010 for each well. The interpretation of the HQ Area TCE plume is based on the most recent GMP data for the HQ Area TCE Plume as well as historical groundwater characterization data in OU5, remediation data generated during ongoing monitoring in OU5, and the evaluation of intra-well TCE concentration trends. Though it is not practical to present the cumulative site data on Figure 1, the evolution of the present interpretation has its basis in key documents readily available to the reader. These documents include:

- Operable Unit 5 Remedial Investigation Report – Versar, 2001
- Supplemental Groundwater Characterization Report – LAC, 2005
- On-Site Treatability Study Report – LAC, 2006
- Semiannual Groundwater Monitoring Program Reports – LAC, 2003 - 2009
 - June 2003 – January 2004
 - June 2004
 - December 2004
 - June 2005
 - December 2005
 - June 2006
 - December 2006
 - July 2007
 - January 2008
 - July 2008
 - January 2009

These and other project-specific documents are available for review and study by the public at the CDPHE HWWMD Records Center located at 4300 Cherry Creek Drive South, Denver. For an appointment to review documents at the HWWMD Records Center, contact personnel there by telephone at (303) 692-3331 or by e-mail at comments.hmwmd@state.co. A project library is also maintained by LAC in its office located at 125 Rampart Way, Denver; an appointment to review documents at the project library can be made by calling (303) 972-6633. Lastly, the key documents are also available on the internet at the U.S. Air Force Administrative Record for the Former Lowry Air Force Base at <https://afarpaar.lackland.af.mil/ar/docsearch.aspx>.

Table 1 presents a summary of the January 2010 analytical results for the HQ Area, as well as the results from the previous groundwater monitoring conducted by LAC and its predecessors. The results presented for each well include the following compounds: trichloroethene, cis-1,2-dichloroethene, and vinyl chloride. Where analytes are non-detect for any given well, i.e., "less than the chemical specific" method detection limit (MDL), the results for such occurrences are shown with the appropriate data qualifier (e.g., "U" or "ND" for non-detect) on Table 1. Non-detected analytes are shown on laboratory analytical reports as "less than the laboratory reporting limit" (RL). The laboratory data sheets for the January 2010 sampling event are provided in Attachment B.



Since active remediation efforts were initiated in 2003, the extent of the HQ Area TCE Plume has contracted with concurrent decreases in dissolved-phase TCE concentrations in the both the bedrock and alluvium. In general, the January 2010 groundwater data presented herein demonstrate further decreases in TCE concentrations throughout the HQ Area TCE Plume when compared to the historical data set. This reduction is considered to be largely a response to remedial efforts implemented by LAC as well as natural attenuation processes.

Bedrock

As summarized above, in June - July 2009 LAC conducted intensive KMnO_4 injections in the weathered bedrock interval in the higher residual concentration areas of HQ-1. The bedrock injections occurred at maximum depths of 47-49 feet below ground surface (bgs) equivalent to the top several feet of the screen interval for well CPWHQ27XD (screened from 45-55 feet bgs) and ranged upward across the screen intervals of wells CPWHQ27D, HQPSW01W, and MWHQ11 (Table 1). There were significant well to well hydraulic responses and KMnO_4 was observed in bedrock wells throughout the HQ-1 area during the injection process including in the deeper screened interval of well CPWHQ27XD. The KMnO_4 observed in the monitoring wells did not persist and was not observed during the January 2010 sampling with the exception of HQPSW01W.

Three bedrock monitoring wells in HQ-1 were sampled in January 2010. As noted above, bedrock monitoring well HQPSW01W could not be sampled because of the presence of KMnO_4 in the well. The January 2010 data indicate an apparent preliminary response to the 2009 injections as evidenced by concentration decreases, particularly in wells CPWHQ27D and CPWHQ27XD (Figure 1) around which the majority of the injections occurred. These decreases are reflected in the time-concentration plots for the three bedrock wells sampled in January 2010 (Figure 2). However, as in other OU5 bedrock locations where similarly intensive injections have occurred, the full affect of the HQ-1 area injections will not likely be evident until a subsequent monitoring event.

Alluvium

As discussed above, the June – July 2009 KMnO_4 injections in HQ-2 were focused in the area surrounding and across the approximate screened interval of well MWHQ03. The stratigraphy of the shallow saturated alluvium across the screen interval of this well is comprised of thinly interbedded fine sands, silts, and clays where there appears to be residual TCE mass sorbed to the finer grained sediment. In HQ-2, three wells completed in the alluvium were sampled in January 2010. As noted earlier, shallow alluvial monitoring well MWHQ03 could not be sampled because of the presence of KMnO_4 in the well. While it is too early to assess the full effects of the 2009 injections; the historical data for MWHQ03 prior to the injections reflect decreasing concentrations since monitoring began in 1996 (Figure 3). The observed concentrations in the more distal, downgradient alluvial wells MWHQ08 and MWOB12 continue to reflect a long-term decrease in TCE concentrations within the alluvium (Figure 3, Table 1) and a contraction of the plume extent when compared to the plume boundary defined in the OU5 Remedial Investigation Report (Versar, 2001) (Figure 1).



Schedule

The next semiannual Closure/Performance GMP sampling event for the HQ Area is scheduled for July 2010. There is no sampling anticipated in the FTZ Area as LAC is evaluating closure options for that area such as a petition to the CDPHE for a risk-based closure under the Consent Agreement. LAC is in the process of preparing a 2010 Remedial Progress Assessment which will incorporate the HQ Area and the FTZ Area.

If you have questions concerning this document or its contents please contact me at (303) 972-6633.

Sincerely,
Lowry Assumption, LLC

Paul H. Weaverling
Senior Project Manager

Attachments

Distribution:

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Attachment A
Field Sampling Data Sheets

Attachment B
Laboratory Data Sheets