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GROUND WATER AND ECOSYSTEMS RESTORATION DIVISION
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MEMORANDUM

OFFICE OF
RESEARCH AND DEVELOPMENT

SUBJECT: Review of Appendix Q, East Mission Flats Repository Geochemistry Evaluation, East Mission Flats Repository – Bunker Hill Site (09-R10-001)

FROM: Richard Wilkin, Ph.D., Environmental Geochemist
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TO: Ed Moreen, Coeur d'Alene Field Office
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Per the request for technical assistance, this memo presents a technical review of geochemical issues relating to contaminant behavior in the proposed East Mission Flats (EMF) repository in Kootenai County, Idaho. In particular, this review focuses on the potential for metals contained in waste materials to be leached, mobilized, and to potentially degrade the quality of groundwater underlying the site.

The EMF repository site is located within the Coeur d'Alene River floodplain. The repository footprint is planned to be roughly triangular in shape, covering an area of about 14 acres. The top of the repository will be limited to a maximum elevation of 2165 feet and is designed to rise approximately 32 feet above the existing ground surface. A total of about 445,000 cubic yards of material (yard waste) will be placed in the EMF repository. Wastes will be placed in 6- to 12-inch lifts and compacted to 90% in the interior of the repository and 95% at the perimeter of the repository. It is noteworthy that historical flood events have deposited metals-impacted silt and clay upon the entire site, as the site is covered with a 1 to 4 foot-thick layer of soil that contains elevated concentrations of lead, zinc, arsenic, and cadmium. Below this surface horizon, metals concentrations drop sharply and reflect un-impacted native soils of the area.

Several groundwater monitoring wells have been constructed at the site. These wells have been sampled on a quarterly basis since December 2007. The wells are screened over a depth interval of 10 feet, from 17 to 27 feet below ground surface. Water quality data and water level data have been collected from these wells. To date, results of the monitoring indicate that groundwater underneath the site meets EPA drinking water standards for the suite of metals tested. This is significant given the fact that contaminated soils are present at the land surface.

The potential for groundwater impacts from the placement of metals-impacted soil at the EMF repository has been assessed by evaluating hydrological and geochemical data and by conducting column leach tests to simulate site conditions. The leach tests focused in particular on arsenic, lead, cadmium, copper, and zinc. Based on the results of these tests, the EMF repository is not expected to impact metals concentrations in groundwater beneath the site. The

underlying soils have high sorptive capacity and are predicted to remove any mobile metals from the aqueous phase. Because groundwater impacts are unexpected, liners and leachate collection systems are not part of the design.

With respect to the hydrologic assessment, three different water entry pathways were evaluated. These pathways include infiltration of precipitation and snowmelt, migration of rising groundwater through the base of the repository, and lateral migration along the perimeter of the repository from ponded surface water. Minimization of infiltration will rely on surface grading and construction of a cover consisting of clean soil and a planted native grass seed mix. Over the period of monitoring, groundwater levels within the casing of the monitoring wells were found to rise to within about 0.5 feet of land surface. Estimates of water level changes suggest that the saturated zone will not reach the base of the repository. Lateral ingress of water during seasonal high-water events is expected to cause periodic saturation of a very small portion of waste materials at the base of the repository. Less than 0.05% of the total repository volume is expected to experience a moisture increase from lateral infiltration. Overall, lines of evidence suggest that very little water will reach the waste materials and consequently there is an expectation that limited opportunities will become available for geochemical processes to take place that lead to leaching of metals from soil to the aqueous phase with subsequent migration down to the groundwater table.

Geochemical evaluations involved evaluation of distribution coefficients, sequential extraction procedures, synthetic precipitation leach tests, and column testing. Site specific sorption coefficients were not determined. Average values for soil were taken from the survey document published by EPA (2005). Note the K_d values published in this report differ from those published in a more complete 3-volume review published by EPA (1999a,b; 2004). The significance of this is in the fact that K_d values vary widely and are most appropriately determined on a site-by-site basis. Nevertheless, the main conclusion is reasonable that native materials at the EMF site are expected to have a high sorption capacity for metals. The sequential extraction data collected on two samples are especially important, as they provide some indication of the potential mobility of metals under variable geochemical conditions. A significant fraction of the arsenic, cadmium, copper, lead, and zinc in the soils are bound in the Fe/Mn oxide-bound fraction (0.20 to 0.63). This fraction can potentially be leached under reducing conditions. However, it is expected that oxidizing conditions will prevail throughout the repository. The water that does infiltrate the repository is expected to be oxygenated surface water, without the capacity to drive reductive dissolution.

The question as to whether the redox status of water will shift from oxidizing conditions to more reducing conditions is not specifically evaluated with model or laboratory assessments. The issue is of interest because, under iron-reducing conditions, metals associated with Fe and Mn oxides/hydroxides could potentially be mobilized. Again, as noted above, the sequential extraction tests suggested a significant fraction of metals associated in this bonding environment. It is important to point out that if conditions moved beyond iron-reducing to sulfate-reducing (if sulfate-rich groundwater migrated into the repository), metals would again be strongly partitioned to the solid phase as insoluble metal sulfide clusters and precipitates. Hence there is a narrow window of reduction-oxidation conditions that could develop in conjunction with seepage of water through the repository mass and vadose zone to threaten the quality of the underlying groundwater.

Development of a geochemical model to examine trends as the system moves from oxidizing to reducing would require a significant amount of extra supporting information (e.g., mineralogy, organic carbon concentrations and reactivity, etc.) and would likely yield equivocal results. Likewise establishing lab experimentation to mimic potential changes in reduction-oxidation conditions, would perhaps be more tractable, but would present additional challenges and may ultimately miss conditions that end up developing in the repository. Unfortunately, there is no well-established test that can be performed to evaluate contaminant behavior over variable redox conditions. The primary concern here, however, feeds back to whether or not water is expected to reach the waste soils, from upward, downward, or lateral migration. The analysis presented in the Repository Design documentation suggests that the repository soil mass will not be saturated for prolonged periods of time. These conclusions are based upon a reasonable set of data and model assumptions. Given these conclusions, concerns about the potential for metals mobilization, while not to be discounted, do not warrant additional testing and assessment. It is noted that a groundwater monitoring program is in place to track any changes in groundwater quality through time. A phase of assessment and evaluation of options would be triggered in the event that the monitoring program detected any unanticipated changes in groundwater quality. It is recommended that the monitoring program also track the moisture content in the repository in order to obtain data that can be directly compared with estimates derived during the design phase of the project, and to ensure that stored waste materials stay dry as intended in the repository design.

If you have any questions concerning these comments, please do not hesitate to call me at your convenience (Wilkin: 580-436-8874). I look forward to future interactions with you concerning this and other sites.

References

U.S. EPA (1999a). UNDERSTANDING VARIATION IN PARTITION COEFFICIENT, K_d, VALUES Volume I: The K_d Model, Methods of Measurement, and Application of Chemical Reaction Codes. EPA 402-R-99-004, August 1999.

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U.S. EPA (2004). UNDERSTANDING VARIATION IN PARTITION COEFFICIENT, K_d, VALUES Volume III: Review of Geochemistry and Available K_d Values for Americium, Arsenic, Curium, Iodine, Neptunium, Radium, and Technetium. EPA 402-R-04-002C, July 2004.

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