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**RETURN RECEIPT REQUESTED**

December 27, 2006

Mat Johansen
Groundwater Project Manager
Los Alamos Site Office, Department of Energy
528 35th Street, Mail Stop A316
Los Alamos, NM 87544

David McInroy
Remediation Services Deputy Project Director
Los Alamos National Laboratory
P.O. Box 1663, Mail Stop A100
Los Alamos, NM 87545

**RE: NOTICE OF APPROVAL FOR THE INTERIM MEASURES INVESTIGATION REPORT FOR CHROMIUM CONTAMINATION IN GROUNDWATER**
**EPA ID #NM0890010515**
**HWB-LANL-06-027**

Dear Messrs. Johansen and McInroy:

The New Mexico Environment Department (NMED) is in receipt of the United States Department of Energy (DOE) and Los Alamos National Security, LLC (collectively, the Permittees) document entitled *Interim Measures Investigation Report for Chromium Contamination in Groundwater* (hereafter, the Report) dated November 2006 and referenced by LA-UR-06-8372/ER2006-1039. NMED has reviewed the Report and hereby issues this notice of approval. With approval of this first-phase investigation work, NMED expects that the Permittees will expedite the process to submit a subsequent work plan to further investigate the present-day spatial distribution and mass of chromium in the near surface sediment and alluvium, and to develop a numerical model to guide future investigation and potential remediation of the chromium contamination in the regional aquifer. NMED imposes following requirements for the Permittees' development of an investigation work plan to address data gaps that still hinder the selection of a remedy for cleaning up chromium contamination.

1. As outlined in the May 5, 2005 NMED letter, the primary goal of the first phase of investigation is to identify potential sources of chromium. The Permittees have not determined whether or not there is still a significant inventory of chromium in the near-surface sediment and alluvium in the wetland area. Identification of the chromium inventory in the wetland is particularly important because certain chromium species in sediments of the wetland remain a present-day source that could potentially further contaminate the regional aquifer. The Report provided evidence that hexavalent chromium from the wetland is still migrating down canyon via surface water which infiltrates downward to alluvium and then percolates to bedrock, predominantly in the middle reach of Sandia Canyon.

   The spatial distribution and mass of chromium in sediments of the wetland has not been well delineated. In particular, the potential vertical transport of chromium underneath the wetland has not been fully investigated. The fracture flow in the Rendija Canyon fault zone potentially provides a preferential pathway for rapid transport of chromium from the wetland to the regional aquifer, although the flow itself represents only 10% to 13% infiltration of the wetland effluent (seem next comment for detail). In the next-phase investigation, the Permittees must therefore delineate the spatial distribution of chromium and other potential contaminants in the subsurface of the wetland to characterize the potential migration of residual chromium in the wetland either by infiltration beneath the wetland area or through surface water infiltration down canyon. The Permittees also must confirm the preliminary findings that the geochemical conditions in the wetland may currently allow for the transformation of adsorbing phases, including the trivalent form of chromium to the mobile hexavalent form of chromium.

2. The Permittees must develop a numerical flow model in the next phase of investigation to better understand and refine the conceptual model proposed in the Report. The Report estimated that 10% to 13% of effluent flow infiltrates bedrock units across the wetland. The wetland is underlain by relatively impermeable Bandelier Tuff (unit Qbt 2) and thus part, or even a majority, of the water loss may be caused by infiltration along fractures associated with splays of the Rendija Canyon fault zone that cross the lower wetland area. Fracture flow in the fault zone may function as a preferential pathway for rapid transport of chromium from the wetland to the regional aquifer. As a result, chromium migrating through the preferential pathway may play a significant role in transporting contaminants to the regional groundwater although the flow itself represents only 10% to 13% infiltration of the wetland effluent to bedrock. In other words, chromium migration to the regional aquifer through fractures may be another – or even the dominant – pathway that led to the chromium contamination in the regional aquifer. The very high concentrations of chromium detected in the regional groundwater may also imply that focused gravity-driven fracture flow may be the cause of the chromium contamination in the regional aquifer. This scenario must be considered and evaluated as part of the modeling effort.

It is necessary to develop a model at the scale of the watershed because surface water has been identified infiltrating downward from the upper to middle reaches of Sandia Canyon. In addition to flow simulations, it is also important to model chromium transport in the vadose zone in order to set limits on the flow model. Chromium detected in the regional groundwater offers an excellent tracer for testing the validity of the model to simulate the transport of chromium throughout the vadose zone to the regional aquifer. A well-developed model showing the ability to reasonably reproduce the current chromium contamination in the regional aquifer will be useful to guide future investigation of the regional groundwater contamination. The ultimate purpose of the model should be aimed at providing assistance in designing a focused groundwater monitoring network in the vicinity of regional aquifer well R-28 and developing a remedial strategy in the future.

3. The next phase of investigation must generate useful data to help select a remedy. The recent findings by Ellis et al. (*Science*, 15 March 2002, Volume 295, p.2060) provide a practical and scientifically sound method to evaluate the capability of natural attenuation of hexavalent chromium by monitoring the chromium isotope ratio of $^{53}Cr$ to $^{52}Cr$ in water. The patterns of the chromium isotope ratio in water samples collected from the wetland, surface water, alluvium, intermediate zone and the regional aquifer may shed light on the migration pathways from the wetland to the regional aquifer. More importantly, chromium isotope data obtained from R-28 and appropriately selected regional wells surrounding R-28 may provide a chemical fingerprint or evidence of flow paths of the chromium plume in the regional aquifer. In addition, the chromium isotope data may help discern the rates of natural attenuation of hexavalent chromium in the regional aquifer. The site-specific rate data are extremely important to evaluate suitable remedies for cleaning up chromium contamination in the regional groundwater. In short, the Permittees must evaluate the feasibility to monitor the chromium isotope ratio in water samples for further characterization of chromium fate and transport in the regional aquifer.

4. The Permittees estimate that approximately 35% of infiltration of the wetland effluent currently occurs in the reach between gauging stations E123 and E123.5. However, the present-day infiltration in this zone may not represent the historical conditions in the 1960s. There is evidence that the present-day channel has cut to bedrock in the zone approximately one mile upstream of SCC-1/SCI-1. Such incision can remove large volumes of alluvium. Where this kind of incision of the alluvium occurred, surface water contaminated with chromium could have infiltrated decades ago, as chromium in the alluvium would have been subject to vertical transport with infiltrating water. Such transport could have resulted in further downward migration of contaminants to the regional aquifer.

In addition, the relevant data suggest that chromium migration and infiltration in Sandia Canyon is a direct analog to Mortandad Canyon. The infiltration from alluvium to the basalt in Mortandad Canyon primarily occurs in the reach approximately from TW-8 to MT-2. A projection of this zone northward to Sandia Canyon also suggests that infiltration in Sandia Canyon possibly occurs in the reach approximately one mile upstream of SCC-1/SCI-1. Therefore, an additional one or two boreholes must be drilled in this reach of Sandia Canyon to the Cerros del Rio basalts to evaluate the inventory of chromium in the vadose zone, if NMED determines that this area is accessible.

5. Based on the results of the next phase of investigation, NMED may require the Permittees to conduct further study to characterize the chromium plume in the regional aquifer in the future. NMED notes that installation of the regional aquifer wells R-35a and R-35b proposed by the Permittees has been delayed. The next phase of investigation activities for characterizing the chromium plume and its behavior in the regional aquifer will be determined largely based on the data obtained from R-35a and R-35b. NMED expects that the Permittees will expedite the process to install the two regional groundwater monitoring wells and conduct the necessary monitoring and testing that have been approved in NMED's July 24, 2006 letter. NMED requires the results of the drilling activities and chemical data to be submitted no later than September 14, 2007.

6. To confirm the safety of drinking water supplied by municipal well PM-3, the Permittees must perform zonal sampling in PM-3 as soon as possible to evaluate chromium concentrations and distributions in the regional aquifer. The Permittees must report the results to NMED no later than April 30, 2007.

NMED generally agrees with the Permittees' recommendation to include the next phase of investigation as part of the work plan for Sandia Canyon and Cañada del Buey referenced by LA-UR-99-3610. The Permittees must incorporate the above comments as an addendum to the work plan for Sandia Canyon and Cañada del Buey and submit the addendum to NMED for approval within 30 days of receipt of this letter. The Sandia Canyon investigation report must include the results of the next-phase chromium contamination investigation and must be submitted to NMED no later than September 14, 2007. Considering that it may need four-quarter sampling of water samples to yield statistical significance of the chromium isotope data, the chromium isotope results may be submitted separately, but in no event later than July 31, 2008. If the Permittees fail to comply with the requirements specified in this letter, the approval for the Report will be automatically rescinded. Changes to the Order schedule based on these requirements will be documented after the Sandia Canyon work plan addendum has been reviewed by NMED.

Should you have any questions or comments, please contact John Young at (505) 476-6038 or Hai Shen at (505) 476-6039.

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

JPB:hs

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file: Reading and LANL General (Groundwater, IMIR for Cr)