**Department of Energy**
Albuquerque Operations Office
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FEB 05 1998

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Hazardous and Radioactive Materials Bureau
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HSWA LANL 6/17/5/98

Dear Dr. Dinwiddie:

Subject: Request for Supplemental Information (SI) for the Hydrogeologic Workplan

The Department of Energy (DOE) and Los Alamos National Laboratory (LANL) are providing the subject SI in response to your January 26, 1998 letter, which requests submittal of the SI within five days of receipt of your notification of extension denial. Your letter was received at DOE on January 30, 1998.

I would like to thank your staff for working with DOE/LANL ahead of the due date for this document so that an adequate response to your November 17, 1997 request for SI for the Hydrogeologic Workplan might be developed. This work included a number of telephone conversations and a meeting to review with your staff proposed LANL responses to the SI. Although LANL staff had planned to pursue this process over a longer period of time, we understand that an extension for the full time period that DOE/LANL originally requested for an extension on December 18, 1997 was not possible, given NMED constraints.

If you have any questions concerning this letter or the enclosure, please contact Bonnie Koch of my staff at 665-7202 or Charlie Nylander of LANL/ESH-18 at 665-4681.

Sincerely,

for

Joseph C. Vozella
Assistant Area Manager
Office of Environment

LAAME:3BK-022

Enclosure

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See page 2

13146

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**General Comment 1**

*"HRMB recommends that quarterly "progress" meetings occur in addition to the meeting scheduled for March. This will provide a regular forum for communication between LANL and HRMB to discuss issues such as the DQO process outputs, new data, etc.. HRMB also recommends communication between NMED and DOE/LANL regarding updates, changes, decisions, etc. in the form of phone calls, E-Mail, and faxes."*

**General Comment 1 Response**

LANL and DOE agree with HRMB on the need to establish and maintain open communication lines to facilitate decision-making when groundwater characterization data are collected. Quarterly meetings would be an excellent forum for maintaining the flow of communication. The Groundwater Integrating Team (GIT) is the DOE/LANL organization that will compile all groundwater characterization data collected, integrate the data, and make refinements to the conceptual model. As it is refined, the conceptual model will be the basis of decisions regarding the location and types of data collected from subsequent wells. The GIT will meet with HRMB on a quarterly basis to discuss refinements to the conceptual model. Communication outside of quarterly meetings will be in a form appropriate to the informational content and regulatory requirements.

**General Comment 1(A)**

*"LANL should submit to HRMB in January all available documents regarding the proposed Workplan negotiation meeting for March. This will enable HRMB to adequately review documents prior to the negotiation meeting."*

**General Comment 1(A) Response**

DOE/LANL concur with the need for HRMB to have adequate review time prior to the March negotiation meeting. This first year the documents will not be ready until March. However, in future years the Annual Report and associated documents will be submitted to HRMB in January. In years when the documents are submitted in January, DOE/LANL would like to encourage HRMB to provide comments and concerns on the Annual Report and associated documents prior to the March meeting to facilitate discussion and decision-making during the negotiation meeting.

**General Comment 1(B)**

*"HRMB reminds LANL that the HSWA Module currently requires that within thirty (30) days of the completion of each well a report is due to HRMB."*

**General Comment 1(B) Response**

LANL acknowledges the requirement for submittal of a well report within 30 days of completion of a well.

**General Comment 1(C)**

*"Describe how the data gathered from the progression of this Workplan, RFI Reports, etc. will be condensed and presented to the HRMB prior to the proposed March meetings. Document if the excluded data will be readily available on FIMAD or another data base by this time."*

**General Comment 1(C) Response**

DOE/LANL intend to evaluate all of the valid data collected during the preceding fiscal year that could be used to refine the conceptual model. The data will be from any program at LANL that collects environmental data – Environmental Restoration Project, Environmental Surveillance, Waste Management, NEPA, facilities, etc. These data and the resulting refinements to the conceptual model will be summarized in the Annual Report, which will be submitted to NMED prior to the March meetings. All valid data will be available from the Facility for Information Management, Analysis, and Display (FIMAD). The conceptual model is will be refined by incorporating all of the available valid data; therefore, no valid data will be excluded.

**General Comment 2**

*"The Hydrogeologic Workplan should be coordinated and consistent with the Watershed Management Project Plan, the Canyons Investigation Core Document and subsequent canyon and site-specific workplans and reports. The Workplan should also coordinate OB/OD/other permitting activities (e.g., TA-14, -15, -36, -39 OB/OD permit)"*

**General Comment 2 Response**

DOE/LANL concur with the need for consistency between Laboratory programs and have taken positive steps to ensure that consistency and coordination. One step is that the Hydrogeologic Workplan Planning Team and the Watershed Management Planning Team consisted of representatives of several LANL programs areas to ensure coordination of efforts. A second step is the establishment of the GIT which consists of representatives of various LANL programs areas, also to ensure coordination. A third step is the coordination of well drilling, construction, and sampling techniques between the Environmental Restoration Program and the Defense Program-funded program, as documented in a Memorandum of Understanding and a December 17 memo from the Laboratory Director, John Browne which assigns roles and responsibilities for completing the work described in the Hydrogeologic Workplan. DOE/LANL do not believe it is appropriate to revise previously submitted documents <u>solely</u> for the purpose of making them consistent with the Hydrogeologic Workplan.

Other permitting activities will be coordinated within the aggregates as part of the comprehensive approach to characterization described in the workplan.

**General Comment 2(A)**

*"Please state clearly how investigations and characterization efforts from the Core Document for Canyons Investigations, Watershed Management, etc. will be integrated by the Workplan."*

**General Comment 2(A) Response**

As described in the response to General Comment 1( C ), all of the valid data that could be used to refine the conceptual model collected during the preceding fiscal year will be described in the Annual Report. The Annual Report will be submitted to NMED in January (after 1998) each year. The GIT will be the integrating entity, responsible for summarizing the data and making refinements to the conceptual model. The GIT is composed of representatives from several program areas at LANL to ensure that all of the valid data available is incorporated into the conceptual model so that decisions about subsequent characterization activities can be made.

**General Comment 3**

*"If modifications, as outlined in the Corrective Action Flow Process, to the Canyons Investigation Core Document, any subsequent canyon-specific workplans and reports, and the Watershed Management Project Plan affect this document, please provide an addendum to this workplan."*

**General Comment 3 Response**

DOE/LANL concur with the need to maintain consistency and coordination between programs. Modification of the Hydrogeologic Workplan are expected and intended to occur as a result of refinements to the conceptual model as more characterization data are collected. These changes to the Hydrogeologic Workplan will be discussed and agreed to during negotiation meetings with the NMED. The discussions and agreements made during the negotiation meeting will be summarized in an annual addenda that will be distributed as an appendix to the workplan. In this way, complete revision of the Hydrogeologic Workplan each year will not be necessary.

Programs conducted pursuant to regulatory requirements other than RCRA, like the Watershed Management project, are intended to ensure a comprehensive approach to groundwater protection and are not enforceable through the Hydrogeologic Workplan.

**General Comment 4**

*"It would be useful if LANL provided a glossary containing pertinent definitions."*

**General Comment 4 Response**

DOE/LANL agrees to provide a glossary containing pertinent definitions in the final Workplan submitted to HRMB.

**General Comment 5**

*"Please provide a figure or figures (plates in Appendix 6?) illustrating the proposed alluvial, intermediate, and regional well locations relative to the existing alluvial, intermediate, and regional wells (please label existing wells). Also, be sure to revise text and reference the appropriate figure that illustrates the location of the referenced well(s)."*

**General Comment 5 Response**
DOE/LANL agrees to provide a map showing both proposed and existing wells and to change the references in the text in the final Workplan submitted to HRMB.

**General Comment 6**
*"LANL should provide a table and figure indicating the sampling locations (spring, surface, and groundwater) that have had at any time detected radioactive or hazardous constituents equal to or above an acceptable regulatory standard or "background" (include analyte, detected concentrations, dates observed, currently above background/MCL, filtered/unfiltered)."*

**General Comment 6 Response**
DOE/LANL concur with the need to identify all areas where contaminants have been detected equal to or above an acceptable regulatory standard or "background". Tasks described in the Hydrogeologic Workplan are intended to accomplish this. The tasks are listed on Table 3-1. One task that is critical to completing this compilation is the in-progress background study to establish what the expected background distributions. When they are complete, the data will be submitted under separate cover and will be summarized in the Annual Report.

Please note that the data on radioactive contaminants will be submitted voluntarily, but radioactive substances are not under the authority of RCRA.

**General Comment 7**
*"HRMB recommends that the tasks identified in Tables 3-1 and 3-2 and other tasks such as compilation of spring and well data, be prioritized and tentative schedules be developed by HRMB and LANL. This could be accomplished in a meeting pursuant of the approval of this workplan."*

**General Comment 7 Response**
DOE/LANL agrees that the tasks listed in Tables 3-1 and 3-2 are critical to characterizing the groundwater regime beneath the Laboratory. Much of the data are currently available in the annual environmental surveillance reports and the ER Project reports. Progress made on these tasks will be described in the Annual Report. Criteria for prioritizing these tasks can be discussed at the meeting in March.

**General Comment 8**

*"The Workplan indicates that the one time sampling of the intermediate systems (sampled as regional aquifer wells are installed) will occur. One time sampling is not likely to provide enough information to "characterize" the intermediate groundwater systems. HRMB recommends that quarterly meetings occur to discuss installation and prioritization of wells.*

**General Comment 8 Response**

DOE/LANL chose to characterize the hydrogeologic setting of LANL by drilling, logging, installing and sampling wells to the regional aquifer without installing separate intermediate depth wells because this approach provides the greatest amount of characterization data. This approach was discussed with NMED representatives at a meeting on August 7, 1996 and consensus with the approach is documented in a letter sent to NMED on September 11, 1996 (addressed to Dr. Ed Kelley, subject: The proposed Los Alamos National Laboratory (Laboratory) Groundwater Protection Strategy and Related Data Quality Objectives and Decision Flow Process) The following reasons are rationale for this approach:

- The presence of intermediate zone(s) is controlled by geologic structure and the geology across the Lab is extremely variable. Understanding the geologic setting from the surface to the regional aquifer is more important in predicting flow than measurements in individual intermediate zones.

- If a well was installed at the first intermediate zone encountered, there would be a gap in the information between the upper intermediate zone and the top of the regional aquifer. Furthermore, wells installed in the first intermediate zone will not provide any information on the underlying less permeable perching layer. The characteristics of the perching layer must be understood in order to assess the impact to the regional aquifer. The perching layer stratigraphy is as important to evaluating potential pathways as the hydrologic characteristics of the saturated zone itself

- The data collection described in the Hydrogeologic Workplan is intended to characterize the hydrogeologic setting to a sufficient degree to develop an adequate detection monitoring system. Wells that may be needed to monitor the intermediate zone(s) will be considered as part of the monitoring system design.

Sampling and testing the intermediate zone within the borehole is expected to provide adequate characterization data to make decisions regarding the need to continue monitoring the intermediate zone. This is supported by data presented at an August 7, 1996 meeting with NMED (documented in a letter sent to Dr. Ed Kelley on September 11, 1996, Subject: The Proposed Los Alamos National Laboratory (Laboratory) Groundwater Protection Strategy and Related data Quality Objectives and Decision Flow Processes). The data consists of analytical results from four wells (PO-4, POI-4, LADP-3, and LAOI-1.1) that were sampled from the borehole before the well was installed and on a quarterly basis from completed wells. The major ion chemistry and tritium analyses were in good agreement for all of the wells. Data from a fifth well, LAO-B, was

presented to show the variation that can be expected in quarterly sampling from completed wells. Based on these data, adequate characterization of the intermediate zones will be accomplished by sampling and comprehensive analyses of groundwater within the borehole and pore water from the core.

The information gathered during the characterization will be used to design a detection monitoring network that almost certainly include monitoring wells in the intermediate zone. However, until the characterization effort described in the workplan is complete, the number and location of intermediate zones wells can not be determined.

**General Comment 9**
*"As the Canyons team (from Field Unit 4) are already mobilized, producing results, and currently drilling R-9, HRMB suggests expanding the role of the Canyons team to encompass the investigations outlined in this workplan."*

**General Comment 9 Response**
DOE/LANL agree with the need to have knowledgeable and experienced teams drilling and installing the wells and collecting data. DOE/LANL retain the responsibility of identifying, selecting, and acquiring resources to complete these activities. To maintain efficiency and consistency and to promote economies of scale, the Laboratory announced on December 17 that the ER Program will be the construction manager for all of the wells described in the Hydrogeologic Workplan.

**General Comment 10**
*"Please check the Table of Contents. Section 3.3.2 is incorrectly identified"*

**General Comment 10 Response**
DOE/LANL agrees to correct the Table of Content in the final Hydrogeologic Workplan.

**Specific Comments: Section 1.2, Comment 1**
*Figure 1-1, ID#48 (page1-5), indicates the first "Annual NMED Negotiation Meeting for Fiscal Year 1998" is scheduled for the second quarter of 1999. Please clarify if the meeting is scheduled for 1999 or the second quarter of FY98 as indicated in the text."*

**Specific Comments: Section 1.2, Comment 1 Response**
DOE/LANL intends to hold the first Annual NMED Negotiation Meeting on March 31, 1998 (second quarter of FY98). Figure 1-1 will be corrected to reflect this date in the final Hydrogeologic Workplan.

**Specific Comments: Section 1.5, Comment 1**

*"Clarify the Canyon Scenario (1-4) that addresses releases to ground and surface water via contaminated soils and sediments in the DQO process is not clear"*

**Specific Comments: Section 1.5, Comment 1 Response**
DOE/LANL agree that the Canyon scenario description should be clarified to reflect all of the contaminant transport pathways that were used in developing the DQO outputs shown in Appendix 4. In the DQO outputs for each canyon, decision 4 is: "Are the alluvial sediments and uppermost subsurface water (USSW) from various present and legacy sources at contaminant concentrations greater than a regulatory limit or risk level?" The questions that were considered to resolve this decision included: "What are the concentrations of these contaminants in sediments and USSW?" When data are used to answer this question and resolve the decision, then releases to groundwater and surface water via contaminated soils and sediments has been addressed.

**Specific Comments: Section 1.5, Comment 2**
*"Please clarify whether there are eight or nine aggregates. There are only eight(8) aggregates described, not nine as mentioned on page 1-17 and in section 4.2."*

**Specific Comments: Section 1.5, Comment 2 Response**
DOE/LANL agree to make the final Workplan internally consistent with respect to the number of aggregates. There are nine aggregates. Eight of the aggregates are specific areas containing one or more canyons and adjacent mesas. The ninth aggregates is the region of the Pajarito Plateau beneath LANL. The decisions that must be resolved for the regional aggregate are large scale, e.g. recharge areas, water supply.

**Specific Comments: Section 1.5, Comment 3**
*"The decisions developed from scenarios (Canyon and Mesa) delineated from the Data Quality Objective (DQO) process overlook some HRMB concerns. Below is a partial list of concerns:"*

**Specific Comments: Section 1.5, Comment 3 Response**
DOE/LANL believe that it is important to address all of HRMB concerns as soon as possible in the planning process. DOE/LANL hope to discuss the full list of HRMB concerns prior to implementing the work described in this Workplan.

**Specific Comments: Section 1.5, Comment 3(A)**
*Although the contaminants in various ground water occurrences may not currently exceed regulatory limit or risk level what provisions are there in the DQO process for future impacts to ground water. LANL should document how this is incorporated into the DQO for the Workplan."*

**Specific Comments: Section 1.5, Comment 3(A) Response**

DOE/LANL concur with the need to address potential future impacts from releases. The DQO process presented in the Workplan explicitly addresses present and potential future impacts by collecting data to determine if pathways exist that would allow migration of contaminants to groundwater. Figure 1-4 is the decision flow diagram for groundwater protection. One the left side of the diagram are a series of decision diamonds that are used to determine whether groundwater currently exceeds standards. On the right side of the diagram are decision diamonds that establish whether pathways exist that may allow contamination to occur in the future. If source terms and pathways exist, then remedial actions may be necessary. The pathways decision shown in Figure 1-4 are incorporated in the DQO process as a decision and associated questions that must be answered to resolve the decision in each aggregate. Existing and newly-collected data are used to characterize sources and pathways to address this issue. As shown in Appendix 4, Aggregate 1, pages 6-7, the decision and questions are:

Decision:

> "what are the pathways for exposure to contaminants from alluvial sediments and uppermost subsurface water?"

Questions:

- "Does significant recharge occur from near surface to underlying groundwater bodies?
- Do we know the hydraulic properties of the alluvium?
- What are the retardation factors of alluvial sediments?
- Do we understand groundwater movement from alluvial water to intermediate perched zones?
- Groundwater movement from intermediate perched zones to Regional Aquifer?
- Are fractures and faults important contaminant transport pathways for liquids in canyons?"

When existing and newly collected data are utilized to answer these questions and resolve the decision, the potential for future impacts to groundwater has been addressed.

**Specific Comments: Section 1.5, Comment 3(B)**

*"As surface water is part of the hydrogeological cycle, LANL should incorporate surface water decisions/concerns into the Canyon and Mesa scenarios."*

**Specific Comments: Section 1.5, Comment 3(B) Response**

DOE/LANL agree that surface water impacts groundwater as it infiltrates and the groundwater impacts surface water when it discharges in springs and other surface water bodies. However, requirements of the Clean Water Act are not enforceable under this document. The final Workplan will contain revised scenario descriptions to clarify the inclusion of surface water in the decision-making process. The impact of surface water has been addressed in the DQO outputs. For the canyons, under decision 1, question 1 the effect of stormwater and NPDES outfalls is listed (for example, Appendix 4, Aggregate 1, p. 1). Also, the recharge of alluvial water from surface water is addressed in Decision 6, question 1 (for example, Appendix 4, Aggregate 1, p. 6). For the mesas, the impact of surface water is addressed under Decision 1, question 4 (for example, Appendix 4,

Aggregate 1, p. 8). The impact of springs discharging to surface water is evaluated under the mesa scenarios (for example Appendix 4, Aggregate 1, p. 12).

**Specific Comments: Section 1.5, Comment 4**
*"Although determination of the cumulative impacts of spatially related technical areas (TAs) is useful, HRMB questions the use of aggregates as outlined in this workplan. HRMB is concerned that impacts to the hydrogeologic system by other Potential Release Sites (PRSs) not included within an aggregate will be overlooked."*

**Specific Comments: Section 1.5, Comment 4 Response**
To ensure that the potential impacts from PRSs not included in an aggregate are not overlooked, the entire length of each canyon and mesa have been evaluated using the DQO process.

**Specific Comments: Section 1.5, Comment 4(A)**
*"Please clarify the applicability/usefulness of aggregates as this approach is unclear to HRMB"*

**Specific Comments: Section 1.5, Comment 4(A) Response**
DOE/LANL agree to clarify the description of the aggregate approach in the final Workplan. The utility of the aggregates is two-fold. First, aggregates facilitate assessing the cumulative impact of multiple sources on the groundwater. This avoids the pitfall of finding no groundwater impacts on a PRS-by-PRS basis, where as the cumulative impact of the PRSs together may warrant remedial action. Second, the aggregate approach prioritizes areas where impacts are most likely to occur, so that resources are not spent on areas likely to have no problems. The aggregates are grouping of PRSs in close proximity to each other. Assessing the cumulative impact of a group of PRSs is a more effective use of resources than to attempt to assess each PRS individually, and has the same outcome – the remediation of groundwater contamination and sources of potential groundwater contamination. Further, focusing finite resources on areas that are likely to have problems is another effective use of resources. The aggregate approach also has a regulatory precedent in the waste management area in 40 CFR 264.95b2, where a line circumscribing a number of related waste units can be used to define a waste management area.

**Specific Comments: Section 1.5, Comment 4(B)**
*"Describe the criteria for how each of the aggregates was defined."*

**Specific Comments: Section 1.5, Comment 4(B) Response**
DOE/LANL agree to clarify how the aggregates were designated in Section 1 of the final Workplan. In general, the aggregate boundaries were drawn to encompass groups of PRSs within canyons and on adjacent mesa tops. The boundaries are proximal to

geographic groupings of PRSs and/or similar operational functions. This is indicated in the individual aggregate descriptions in Section 4 (for example, see Section 4.3.1.1).

**Specific Comments: Section 1.5, Comment 5**

*"Many issues discussed in a letter, Subject: Concerns Regarding the Proposed Los Alamos National Laboratory Groundwater Protection Strategy, The Data Quality Objectives and the Decision Flow Process dated July 24, 1996, were not addressed in the Hydrogeologic Workplan. Please address the issues discussed in the letter (e.g. the inappropriate use of • 50 gallons/day yield used to define ground water and regulator input to the DQO process)."*

**Specific Comments: Section 1.5, Comment 5 Response**

DOE/LANL valued NMED's input throughout the planning process that resulted in the Hydrogeologic Workplan. The referenced letter contains 7 issues, all of which were discussed with HRMB at a meeting on August 7, 1996 and documented in a letter sent to NMED on September 11, 1996(addressed to Dr. Ed Kelley, subject: The Proposed Los Alamos National Laboratory (Laboratory) Groundwater Protection Strategy and Related Data Quality Objectives and Decision Flow Process). The resolution of these issues were incorporated as appropriate in the draft workplan submitted in December, 1997. Those issues and their resolutions are as follows:

1. Issue: Use definitions consistent with regulatory definitions. Resolution: Appendix 3 contains the August 15 version of the "Los Alamos National Laboratory Groundwater Protection Strategy". This version of the Strategy incorporates definitions from the New Mexico Water Quality Control Commission and the Environmental Protection Agency.
2. Issue: Use of 50 gallons/day to define groundwater. Resolution: The yield of a water-bearing zone is not being used to determine **if** the water should be protected, but to decide which standards apply. As described in the strategy, standards for constituents in listed RCRA (40 CFR 264.94) will be applied to water encountered. If an Alternate Concentration Level (ACL) must be proposed, then the yield would be used to determine which WQCC standards are applicable. For water-bearing zones that yield less than 50 gallons per day, the abatement standards (20 NMAC 6.2, Subpart IV) apply. For water-bearing zones that yield greater than 50 gallons per day, the groundwater standards (20 NMAC 4.1) are applied.
3. Issue: Replacing intermediate wells with Regional Aquifer wells. Resolution: This approach to hydrogeological characterization was discussed with NMED during a meeting on August 7, 1996 (documented in a letter sent to Dr. Ed Kelley on September 11, 1996, Subject: The Proposed Los Alamos National Laboratory (Laboratory) Groundwater Protection Strategy and Related data Quality Objectives and Decision Flow Processes). The rationale for this approach is described in greater detail in the response to General Comment 8. There was consensus with this approach by the HRMB staff present at the meeting.
4. Issue: Regulatory input within the DQO process and the decision flow. Resolution: There were four meetings in spring/summer of 1996 to obtain regulatory input on the

**Addenda to Page 10:**

All references to "20 NMAC 4.1" are meant to be interpreted as "20 NMAC 6.2, III."

DQO process and the decision flow. The draft Hydrogeologic Workplan submitted in December 1996 reflects the input received during those meetings.

5. Issue: Quantification of sources of sufficient magnitude. Resolution: In the DQO outputs in the Hydrogeologic Workplan only the aggregate containing Guaje, Rendija, and Barrancas Canyons was considered to have sources of insufficient magnitude to impact groundwater. This determination is based on current knowledge and historical data. If, as the ER Project progresses, this determination appears to be questionable, the GIT in consultation with NMED will establish new data collection for the aggregate and will document it in the Annual Report.
6. Issue: HSWA permit conditions listed at each step of DQO process and decision flow. Resolution: The DQO process and the decision flow are intended to characterize the hydrogeologic setting of the Laboratory to a sufficient degree such that an adequate detection monitoring system can be developed. As such, the entire process addresses the requirements of the HSWA permit. The process was intended to be a comprehensive response to regulatory requirements, so no one step or decision corresponds to a particular HSWA permit conditions.
7. Issue: Historical pulse release of contaminants. Resolution: The decision flow begins with an evaluation of existing data. One purpose of the evaluation is to determine where pulses might be expected. It shows an evaluation of current groundwater problems and potential future problems through pathway analysis. Long-term monitoring will be used to detect pulses of contamination.

**Specific Comments: Section 1.5, Comment 6**
*"HRMB reminds LANL that in 50 years, contaminants are already found in the intermediate groundwater systems and the regional aquifer. Therefore some of the DQO process decisions may not be appropriate."*

**Specific Comments: Section 1.5, Comment 6 Response**
DOE/LANL acknowledge the presence of anthropogenic substances in the groundwater at some locations beneath the Laboratory. The Groundwater Protection Management Plan and the Hydrogeologic Workplan demonstrate the Laboratory's commitment to protecting groundwater quality and quantity by pollution prevention and remedial activities. The DQO process was used because it is action-oriented. The decisions are statements of what observations will cause DOE/LANL to take an action. The observation that anthropogenic substances are present in groundwater above a specified concentration will lead to an appropriate remedial response.

**Specific Comments: Appendix 4, Comment 1**
*"Page 2, Decision Rule for New Data: If there is saturation in the alluvium, then determine which standards apply". Clarify which standards need to be determined."*

**Specific Comments: Appendix 4, Comment 1 Response**

DOE/LANL have included collecting data on the yield of alluvium in order to determine which standards apply. As described in the strategy, standards for constituents in listed RCRA (40 CFR 264.94) will be applied to water encountered. If an Alternate Concentration Level (ACL) must be proposed, then the yield would be used to determine which WQCC standards are applicable. For water-bearing zones that yield less than 50 gallons per day, the abatement standards (20 NMAC 6.2, Subpart IV) apply. For water-bearing zones that yield greater than 50 gallons per day, the groundwater standards (20 NMAC 4.1) are applied.

**Specific Comments: Appendix 4, Comment 2**

*"Pages 3 and 4, Decision Rule for New Data: utilizing an average yield ( • 50 gallons/day) to determine if WQCC and 20 NMAC 4.1 groundwater standards apply. See comment 5 previous section."*

**Specific Comments: Appendix 4, Comment 2 Response**

DOE/LANL have proposed 50 gallons/day as a numerical value of yield to determine whether saturation can be defined as "groundwater" under 20 NMAC 4.1. If the yield is sufficient to classify the water as "groundwater" under the definition in 20 NMAC 4.1 then the standards applicable to groundwater will be applied. If the yield is not sufficient to be "groundwater", then the water is considered uppermost subsurface water and the abatement standards (20 NMAC 6.2, Subpart IV) will be applied.

**Specific Comments: Appendix 4, Comment 3**

*"Provide rationale for the decisions based on "....various present and legacy sources at contaminant concentrations greater than some regulatory limit or risk level?". HRMB is concerned these decisions may miss some contamination that is possible in the future due to migrating contaminant plumes and sediments."*

**Specific Comments: Appendix 4, Comment 3 Response**

DOE/LANL concurs with the concern regarding future contamination. The DQO process was used to ensure these concerns are addressed. The cited decision is only the first in a series of decisions that will be resolved for each aggregate. The complete set of decisions is illustrated in the Decision Flow Diagram (Figure 1-4). As shown on this figure, the first decisions are focused on present day contamination by evaluating the water quality as it exists now. Other decisions (see for example the right side of Figure 4-1 and Appendix 4, pages 6-7) are focused on potential future contamination by determining whether sources and pathways exist that may allow contaminant migration.

**Specific Comments: Appendix 4, Comment 4**

*"HRMB recommends action be taken prior to contaminant detection in the regional aquifer. The DQO process, for example page 3 of Aggregate 5 (Cañon de Valle), implies*

*if COPCs are detected in the Regional Aquifer only then will remedial options be evaluated. Contamination detected in the intermediate ground water systems, for example, may trigger the evaluation of remedial options."*

**Specific Comments: Appendix 4, Comment 4 Response**
DOE/LANL share the concern that contaminants detected in an upper water-bearing zone may warrant remedial options. As illustrated on Figure 4-1, the detection of contaminants in any water bearing zone leads to both an evaluation of remedial options and the decisions regarding pathways. If there are pathways that would allow contaminants to migrate to other water-bearing zones, then remedial options will be evaluated.

**Specific Comments: Appendix 4, Comment 5**
*"The potential for vapor-phase migration of contaminants should be addressed where tritium, organics, etc. are of concern (e.g., TA-33-Ancho Canyon-Chaquehui Canyon, Los Alamos Canyon, DP Canyon, etc.)"*

**Specific Comments: Appendix 4, Comment 5 Response**
DOE/LANL agree that vapor-phase migration should be addressed and have included data collection for contaminants amenable to vapor phase transport (see for example Aggregate 1, pages 11-12). Vapor transport occurs in any scenario, but is driven mostly by the presence and concentration of contaminant sources.

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 1**
*"As the geology is important to the hydrogeology, LANL should provide a geologic map. In addition, generalized stratigraphic cross-sections of LANL should be included to better illustrate the heterogenic distribution of geologic units observed on the Pajarito Plateau."*

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 1 Response**
DOE/LANL agree with the need to include a geologic map. A geologic map will be included in the final Hydrogeologic Workplan. There are seven generalized stratigraphic cross-sections included in the document which are judged to be sufficient for illustrating the heterogeneity across the Laboratory. These cross sections will also be referenced in this background section in the final Hydrogeologic Workplan.

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 1A**
*"LANL should include on the geologic map(s), the Pajarito Fault Zone, Rendija and Guaje Mountain Faults, fracture swarms, slump blocks and other features."*

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 1A Response**
DOE/LANL concur with the need to show features of significance to the hydrogeologic setting. The geologic map included in the final Hydrogeologic Workplan will include

existing data on geologic features necessary to interpret the hydrogeologic setting and to assess pathways for contaminant migration.

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 2**
*"Clarify, if known, what bounds the eastern boundary of the "Chaquehui Formation" (e.g. fault?)."*

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 2 Response**
The nature of the eastern boundary of the "Chaquehui Formation" is unknown. A statement regarding the uncertain nature of the eastern boundary will be added to the text in the final Hydrogeologic Workplan.

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 3**
*"Although potentially a significant hydrogeologic feature, the "Chaquehui Formation" of Purtymun (1995), has not been recognized, HRMB recommends not using "Chaquehui Formation" instead, refer to the upper coarse-grained facies of the Santa Fe Group or state that the "Chaquehui Formation" is not formally recognized and use quotes around the name (Core Document for Canyons Investigations, 4/97)."*

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 3 Response**
The final Hydrogeologic Workplan will follow the stratigraphic usage in the Core Document for Canyons Investigations, 4/97.

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 4**
*"LANL should provide descriptions of the basic characteristics of the various soil types identified at LANL. This may be accomplished by adding a table with basic descriptions of the Carjo, Frijoles, etc."*

**Specific Comments: 2.1.2.1 Bedrock Stratigraphy, Comment 4 Response**
A table with basic descriptions of the soil types at LANL will be included in the final Hydrogeologic Workplan.

**Specific Comments: 2.1.3.1 Surface Water, Comment 1**
*"LANL should provide locations and extent of the identified perennial reaches and surface water. HRMB suggests this information be incorporated into Figure 2-6."*

**Specific Comments: 2.1.3.1 Surface Water, Comment 1 Response**
The perennial surface water reaches will be added to Figure 2-6 in the final Hydrogeologic Workplan. They are included to ensure a comprehensive approach to groundwater

protection, but requirements of the Clean Water Act are not enforceable through this document.

**Specific Comments: 2.1.3.1 Surface Water, Comment 1A**
*"The Department of Energy-Oversight Bureau (DOE-OB) has indicated to HRMB that there are six canyons that contain perennial reaches within laboratory boundaries, not the four indicated in the text. DOE-OB includes Pajarito, Ancho, Chaquehui, Twomile, Threemile Canyons and Cañon de Valle. Currently, perennial surface-water flow in Water Canyon does not extend onto the western boundary of LANL (see comment 2 this section). The perennial flow in Twomile and Threemile Canyons is supported by Anderson and TA-18 Springs respectively."*

**Specific Comments: 2.1.3.1 Surface Water, Comment 1A Response**
The four perennial surface water reaches within the Laboratory boundary include: Ancho, Water, Pajarito, and Chaquehui Canyons. A spring on DOE property within the western Laboratory boundary occurs in Pajarito Canyon, i.e. perennial flow has been noted in Pajarito Canyon associated with Homestead Spring. Springs near the Rio Grande in Water, Ancho, and Chaquehui Canyons are within the eastern Laboratory boundary. The additional springs that have been located by the NMED Oversight Bureau, will investigated under the tasks described in the Workplan. These springs and any new springs that are identified their flow characteristics will be evaluated, and they will be added to the inventory of springs and the Workplan text regarding perennial reaches of surface water will be amendedd, as appropriate.

**Specific Comments: 2.1.3.1 Surface Water, Comment 1B**
*"The DOE-OB has also noted to HRMB that perennial flow from Starmer Gulch and Arroyo de Ladelfe should be included in the discussion of perennial reaches in Pajarito Canyon."*

**Specific Comments: 2.1.3.1 Surface Water, Comment 1B Response**
Same as 2.1.3.1 Comment 1A above.

**Specific Comments: 2.1.3.1 Surface Water, Comment 2**
*"Please provide a table listing all known springs. Include range of observed flow rates, contaminants detected, concentrations, dates of sampling, and unit. Illustrate the location of each spring on Figure 2-8."*

**Specific Comments: 2.1.3.1 Surface Water, Comment 2 Response**
DOE/LANL concur with the need to identify the locations and characteristics of all springs at the Laboratory. As agreed with NMED during discussions on the Core Document for Canyons Investigations, spring data will be included with each canyon-specific workplan.

**Specific Comments: 2.1.3.1 Surface Water, Comment 3**
*"Provide the locations of all surface water gauging stations at LANL."*

**Specific Comments: 2.1.3.1 Surface Water, Comment 3 Response**
The location of all surface water gaging stations will be included on Figure ___ in the final Hydrogeologic Workplan.

**Specific Comments: 2.1.3.2 Groundwater, Comment 1**
*"Figure 2-8 incorrectly identifies the north branch of Ancho Canyon as Indio Canyon."*

**Specific Comments: 2.1.3.2 Groundwater, Comment 1 Response**
The mis-identification of Indio Canyon will be corrected in the final Hydrogeologic Workplan.

**Specific Comments: 2.1.3.2 Groundwater, Comment 2**
*"Please include the Technical Areas on Figures 2-7 and 2-8."*

**Specific Comments: 2.1.3.2 Groundwater, Comment 2 Response**
The Technical Areas will be included on Figures 2-7 and 2-8 in the final Hydrogeologic Workplan.

**Specific Comments: 2.1.3.2 Groundwater, Comment 3**
*"Please clarify where the results of an extensive monitoring study of alluvial ground water are presented. The paragraph is unclear whether the "study" is found in Abrahams et al. (1961) and the six references following Abrahams et al. (1961) or the Purtymun reviews."*

**Specific Comments: 2.1.3.2 Groundwater, Comment 3 Response**
The referenced paragraph is incorrectly worded. It should say "The results of extensive monitoring studies of the alluvial groundwater in Mortandad Canyon.....". The final Hydrogeologic Workplan will include this correction.

**Specific Comments: 2.1.3.2 Groundwater, Comment 4**
*"Please indicate if LANL recognizes a separate perched groundwater occurrence within the Tschicoma Formation and Tshirege member of the Bandelier Tuff (located on the western portion of the Pajarito Plateau). Since this ground water system has provided a minimum of 23 to 96 million gallons annually (page 2-18, Hydrogeologic Workplan), it is an important aspect of the hydrogeologic system. Provide rationale of agreement or non-agreement of this fourth groundwater occurrence."*

**Specific Comments: 2.1.3.2 Groundwater, Comment 4 Response**
LANL includes the occurrences of perched groundwater in the Tschicoma Formation and Bandelier Tuff along the western margin of the Pajarito Plateau and on the eastern flanks of the Sierra de Los Valles in the general category of intermediate perched zone groundwater. For simplicity of description, these groundwater bodies are included with all other perched systems that generally lie between alluvial groundwater and the regional aquifer, Although the discharge points (springs) for some intermediate-depth perched zones occur above the local stream channel (e.g.Water Canyon Gallery), the main body of these perched zones follows groundwater pathways within bedrock geologic units rather than alluvium in canyon floors. This is the distinction we made when categorizing alluvial and intermediate zone groundwaters. We see no advantage in further subdividing intermediate perched zone groundwater to distinguish groundwater in the Tschicoma Formation and Bandelier Tuff as a separate category. We recognize that each occurrence of intermediate perched groundwater across the Plateau has its own unique hydrogeologic setting, recharge pathway, bedrock and structural controls, flowpaths, connections to the surface or other groundwater bodies, and geochemistry. Further subdivision of the intermediate perched zone groundwaters would not fundamentally change our recognition of the unique characteristics of each of these perched systems.

**Specific Comments: 2.1.3.2 Groundwater, Comment 5**
*Please provide a figure illustrating where intermediate perched zones have been identified or are speculated to exist. Differentiate between the various hydrostratigraphic zones and between speculated and known occurrences."*

**Specific Comments: 2.1.3.2 Groundwater, Comment 5 Response**
The general locations of intermediate perched zones will be provided as data are collected within each canyon.

**Specific Comments: 2.1.3.2 Groundwater, Comment 6**
*"Considering the 23 to 96 million gallons produced annually by the Water Canyon gallery (page 2-18,Hydrogeologic Workplan) clarify whether the statement "The regional aquifer of the Los Alamos area is the only aquifer capable of large-scale municipal water supply." is appropriate."*

**Specific Comments: 2.1.3.2 Groundwater, Comment 6 Response**
Use of the Water Canyon Gallery for public water supply was discontinued in 1989 due to a heavy and variable sediment load which resulted in undesirable water quality. During 1988 the Water Canyon Gallery produced only about 2% of the municipal and industrial water supply. The gallery was a part of the original Manhattan Project water supply system along with the Los Alamos and Guaje Canyon reservoirs. This system was notoriously inadequate and unreliable, and development of a reliable, high-capacity water supply system was one of the Atomic Energy Commission's highest priorities for Los Alamos following the end of World War II.

In a large-scale municipality, Albuquerque, the average per capita water use (includes residential and industrial users) was 225 gallons/person/day. With conservation efforts, the per capita water use dropped to 185 gallons/person/day in 1997. Based on the latest per capita water use, the Water Canyon gallery could supply water for approximately 340 to 1,420 people. Additionally, the average water use does not take into account peak water use, which could be as high as double the average. If the Water Canyon Gallery were to be used as the sole supply of water, it would support approximately 170 to 710 people. Water canyon gallery could provide a water supply for a very small community, but could not support "large-scale municipal water supply".

**Specific Comments: 2.1.3.2 Groundwater, Comment 7**
*"LANL should clarify within the conceptual model, the confined or unconfined nature of the regional aquifer. The data presented are not clear: the recharge source for the regional aquifer is the Sangre de Cristo Mountains and the regional aquifer responds to barometric and tidal forces?"*

**Specific Comments: 2.1.3.2 Groundwater, Comment 7 Response**
First, a general comment on the conceptual model. The first paragraph of section 2 in the workplan states that "there is considerable uncertainty in the conceptual model as a whole". All elements of the conceptual model are presented in light of this view point. Further, LANL has indicated that the conceptual model will be updated in the annual report, and that much of the purpose of proposed drilling is to gather information needed to clarify these uncertainties.

LANL agrees that the data regarding the confined or unconfined nature of the regional aquifer are indeed not clear. The sources of recharge for the regional aquifer and the confined versus unconfined nature of the aquifer are not completely understood, as NMED has pointed out in several letters to LANL. These questions will be addressed further by the proposed workplan.

As stated in the workplan, the above-ground water levels in some of the former Los Alamos well field (water supply wells with the designation LA- ) indicate that the regional aquifer in that locality is confined. Data from wells in the central portion of the Laboratory suggest that the regional aquifer there may not be confined.

As stated in the workplan, isotope and other data suggest that water found in the Los Alamos well field (water supply wells with the designation LA- ) may originate from the Sangre de Cristo Mountains. Water produced in the Pajarito Mesa field has a different chemical composition and may originate from another source. LANL's studies of the Pajarito Plateau indicate that possible infiltration through the Plateau surface is insufficient to account for the relatively large quantity of water supply pumping.

LANL will modify the workplan to indicate that recharge from the Jemez Mountains and the Pajarito Plateau appears to be insufficient to account for the relatively large quantity of water supply pumping. This is the basis for statements indicating that the hydrologic connection between the plateau surface and the regional aquifer is not strong, and that recharge from the plateau is small.

**Specific Comments: 2.1.3.2 Groundwater, Comment 8**
*"HRMB interprets the discussion of LANL's conceptual model as accepted by LANL and not subject to much debate. LANL should discuss any uncertainties with recharge of the Regional Aquifer beneath the Pajarito Plateau from the Sangre De Cristo Mountains to the east. For example, questions arise from the presence of relatively major faults and the Cerros del Rio volcanic field along the eastern margin of the Espanola Basin.*

**Specific Comments: 2.1.3.2 Groundwater, Comment 8 Response**
LANL agrees that there are many uncertainties regarding the understanding of the hydrogeology of the Pajarito Plateau. LANL's discussion of recharge sources for the regional aquifer begins with the statement "the exact source of recharge to the regional aquifer is unknown".

Regarding HRMB's interpretation that the conceptual model is not subject to debate, the first paragraph of section 2 in the workplan states that "there is considerable uncertainty in the conceptual model as a whole". All elements of the conceptual model are presented in light of this view point. Further, LANL has indicated that the conceptual model will be updated in the annual report, and that much of the purpose of proposed drilling is to gather information needed to clarify uncertainties.

**Specific Comments: 2.1.3.2 Groundwater, Comment 9**
*"The Rodgers (1996b) study collected composite samples (600 to 3,100 ft screened interval) for the radiocarbon analyses. Please discuss any uncertainties that may arise from the collection of composite samples. HRMB believes that caution should be used when considering these age determinations due to uncertainty associated with composite sampling and that the radiometric carbon age determinations do not preclude significant recharge from the Jemez Mountains/Pajarito Plateau."*

**Specific Comments: 2.1.3.2 Groundwater, Comment 9 Response**
The correct citation is Rogers (1996b). The uncertainties present in this sort of age estimate were described in the original article, and given as a caveat for accepting the radiocarbon data on their face. Among the uncertainties are the fact that a water sample may be formed by mixing of several water masses; possible mixing of carbon by dissolution of carbonate minerals; and the fact that the samples are drawn from wells with large screened intervals.

Contrary to HRMB's assumption, LANL does not believe that the radiocarbon age determinations preclude recharge from the Jemez Mountains and Pajarito Plateau. However, these results along with results from a number of independent lines of evidence including age dating, isotopic composition (tritium and stable isotopes), chemical composition, moisture profiles, and measurements of recharge rates, suggest that current recharge through the Pajarito Plateau is only a tiny fraction of the water that is withdrawn from the aquifer for public water supply.

Regarding the phrases "preclude significant recharge from the Jemez Mountains" and "considerable source for recharge to the regional aquifer" (from comment 3 on 2.2), there are two ways to view "significant". In terms of overall volume (as stated above) there are numerous lines of evidence that suggest that recharge through the plateau may be small in relative terms (compared to water supply pumping for example). On the other hand, infiltration of a small volume of contaminated water could have a significant negative impact on the aquifer. LANL agrees that sources of recharge and their relative magnitudes are insufficiently understood, and intends to improve this understanding through activities under the workplan.

There is ample chemical, isotopic, and hydrologic data to support a hypothesis that the water tapped by the Pajarito Well Field and by the Los Alamos Well Field come from very different water masses. This suggests that the regional aquifer has a somewhat complex structure. The clarification of these issues awaits further modeling studies and data collection, as indicated by the workplan.

**Specific Comments: 2.2 Preliminary Conceptual Model for the Pajarito Plateau, Comment 1**

*"The bullet on Figure 2-11, "~~Vapor phase contaminant movement possible~~" should be omitted. It should be replaced by "Vapor phase contaminant movement likely" or similar terminology as evidenced by tritium and organic vapor plumes beneath TA-54 MDA L and MDA G."*

**Specific Comments: 2.2 Preliminary Conceptual Model for the Pajarito Plateau, Comment 1 Response**

LANL agrees that vapor phase contaminant movement is likely, as investigations have shown. The bullet on Figure 2-11 will be changed to read "Vapor phase contaminant movement likely" in the final Hydrogeologic Workplan. Vapor phase contaminant movement has been established at Material Disposal Area L. However, sources of vapor phase contaminants are only present at a few locations, therefore vapor phase contaminant movement is only possible and a concern at some locations.

**Specific Comments: 2.2 Preliminary Conceptual Model for the Pajarito Plateau, Comment 2**

*"Figure 2-12 ignores the significant contribution of alluvial ground water to the hydrogeologic system and contaminant transport. Please provide rationale for the omission."*

**Specific Comments: 2.2 Preliminary Conceptual Model for the Pajarito Plateau, Comment 2 Response**

LANL feels that Figure 2-12 does not ignore the significant contribution of alluvial groundwater to the hydrologic system and contaminant transports. Please provide a rationale for the viewpoint that there is an omission.

Figure 2-12 describes alluvial groundwater as potentially a significant source of recharge to both the intermediate perched zones and to the regional aquifer. This is further emphasized in section 2.2.2. The remainder of the workplan constantly draws attention to the significance of the alluvial groundwater as a source of both contaminants and of recharge.

**Specific Comments: 2.2 Preliminary Conceptual Model for the Pajarito Plateau, Comment 3**

*Figure 2-12 also indicates that intermediate ground water may be "....laterally extensive near the Jemez Mountains". This suggests that the Jemez Mountains may indeed be a considerable source for recharge to the regional aquifer. The Workplan generally indicates that recharge from the Jemez Mountains and Pajarito Plateau is not significant."*

**Specific Comments: 2.2 Preliminary Conceptual Model for the Pajarito Plateau, Comment 3 Response**

LANL agrees that there is considerable uncertainty regarding recharge along the Jemez Mountains, however no drilling to date has discovered extensive perched groundwater in the western portion of the Laboratory, except possibly SHB-3. The uncertainties regarding possible recharge and the hydrogeologic regime along the Jemez Mountains are the reason that well R-25, near MDA-P, is the highest ranked well on the basis of its timing score. The phrase regarding "significance" of recharge reflects a comparison of relative volumes of such recharge to the amount of public water supply pumping from the regional aquifer. This phrase is not intended to minimize the possible importance of this groundwater as a possible contaminant source and pathway. LANL will clarify this in the text indicated.

**Specific Comments: 2.2.2 Alluvial Groundwater, Comment 1**

*"The text implies that the alluvial groundwater is only interconnected to the perched intermediate groundwater. LANL should clarify if interconnectedness of the alluvial systems to the regional aquifer is precluded (Lower Los Alamos Canyon?)."*

**Specific Comments: 2.2.2 Alluvial Groundwater, Comment 1 Response**

The text does not imply that alluvial groundwater is only connected to the perched intermediate groundwater. Figure 2-12 shows a direct connection between canyon bottom recharge and the regional aquifer. Section 2.2.4 explicitly states that "alluvial groundwater may be a minor source of recharge to the regional aquifer". In this context, "minor" refers to relative volumes of such recharge when compared to public water supply withdrawals. This is not intended to indicate that this is not a potential significant pathway for contamination. LANL will modify the text to clarify this point.

**Specific Comments: 2.2.2 Alluvial Groundwater, Comment 2**
*"LANL should include fractures, joints, surge beds and permeable geologic units (e.g., Guaje Pumice and Puye Formation) as probable pathways for downward movement in the following sentence: "...faults, fractures, joints, surge beds and permeable geologic units (e.g. Guaje Pumice, Cerro Toledo, and Puye Formation) that underlie alluvial saturated zones or intermediate perched zones could provide pathways for downward water movement."'*

**Specific Comments: 2.2.2 Alluvial Groundwater, Comment 2 Response**
The suggested revision will be made in the final Hydrogeologic Workplan.

**Specific Comments: 2.2.4 Regional Aquifer, Comment 3**
*"LANL should omit the statement "~~The hydraulic connection between the regional aquifer and the land surface is not strong~~" as it is misleading. The interconnectedness of the hydrogeologic system is not adequately understood to make this statement at this time.*

**Specific Comments: 2.2.2 Alluvial Groundwater, Comment 3 Response**
As explained above, phrases such as "is not strong" indicate that the relative volume of such recharge is small compared to the overall volume of the aquifer and to the annual volume of public water supply withdrawals. This is not intended to indicate that no connection exists or that it is not a potential contaminant pathway. LANL will clarify this text.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 1**
*HRMB points out that the LANL ranking system may not concur with the requirements of RCRA compliance, for example, Future Water Supply seems inappropriate as a criteria."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 1 Response**
The Hydrogeologic Workplan is intended to ensure a comprehensive, well integrated approach to addressing all applicable regulatory programs. The ranking system was developed to meet, as a minimum, the requirements of RCRA compliance. However, other regulatory programs and best management practices are also embedded within the

ranking system. Additionally, the impact of future pumping of water supply wells must be considered in estimating contaminant migration.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 2**
*"To avoid confusion and remain consistent with other documentation (e.g., the Core Document for Canyons Investigations) the boreholes/wells should have one designation".*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 2 Response**
The boreholes/wells described in the Hydrogeologic Workplan will retain the designations when they are referenced in other documents. The Core Document for Canyons Investigations uses well designations consistent with the Hydrogeologic Workplan.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 3**
*"It is unclear to HRMB why alluvial and regional wells were proposed, but only one intermediate well was proposed. Please clearly explain the rationale for proposing only one intermediate well and indicate where the installation of intermediate wells are to be addressed."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 3 Response**
The rationale supporting the approach to hydrogeologic characterization using alluvial wells and regional wells was not sufficiently described in the text of the Hydrogeologic Workplan. This approach was discussed with NMED representatives at a meeting on August 7, 1996 and consensus with the approach is documented in a letter sent to NMED on September 11, 1996 (addressed to Dr. Ed Kelley, subject: The proposed Los Alamos National Laboratory (Laboratory) Groundwater Protection Strategy and RelatedData Quality Objectives and Decision Flow Process). The rationale is:

- The presence of intermediate zone(s) is controlled by geologic structure and the geology across the Lab is extremely variable. Understanding the geologic setting from the surface to the regional aquifer is more important in predicting flow than measurements in individual intermediate zones.

- If a well was installed at the first intermediate zone encountered, there would be a gap in the information between the upper intermediate zone and the top of the regional aquifer. Furthermore, wells installed in the first intermediate zone will not provide any information on the underlying less permeable perching layer. The characteristics of the perching layer must be understood in order to assess the impact to the regional aquifer. The perching layer stratigraphy is as important to evaluating potential pathways as the hydrologic characteristics of the saturated zone itself

- The data collection described in the Hydrogeologic Workplan is intended to characterize the hydrogeologic setting to a sufficient degree to develop an adequate detection monitoring system. Wells that may be needed to monitor the intermediate zone(s) will be considered as part of the monitoring system design.

The information gathered during the characterization will be used to design a detection monitoring network that almost certainly include monitoring wells in the intermediate zone. However, until the characterization effort described in the workplan is complete, the number and location of intermediate zones wells can not be determined.

One intermediate well was proposed because this well was completed prior to the completion of the Hydrogeologic Workplan. The final Hydrogeologic Workplan will include the rationale for the proposed characterization approach.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 4**
*"Please revise Table 4-1 and 4-2 to reflect current drilling activities (installation of R-9) and include driver for altering the schedule."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 4 Response**
Revised Tables 4-1 and 4-2 will be included in the final Hydrogeologic Workplan. The change in schedule for R-9 was made to meet ER Project needs to accelerate groundwater investigations in Los Alamos Canyon. This canyon is currently the focus of surface and groundwater investigations by the Canyons technical team, and it was felt that data from R-9 could influence the deep groundwater characterization strategy for the rest of the canyon.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5A**
*"HRMB recommends that the proposed location for R-5 is moved closer to TW-1 as it is proposed to replace TW-1 and may provide additional information on a ground water mound present in the TW-1 area."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5A Response**
The location of R-5 further delimits the western extent of the groundwater mound near TW-1. The apparent groundwater mound may have begun to appear in TW-1 after the LA County sewage treatment plant began to discharge effluent to Pueblo Canyon in 1963. The proposed site for R-5 is located between the sewage treatment plant and TW-1. Therefore, the proposed location of R-5 will help determine how far the mound extends up canyon of its already determined occurrence at TW-1. The current location of R-5 will also delimit the western extent of perched groundwater that was encountered in basalts of boreholes TW-1A and POI-4. This perched groundwater is also recharged by effluent from the LA County sewage treatment plant. Adjustments to the siting of R-5 can be made at the quarterly and annual meetings between NMED and DOE/LANL.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5B**
*"R-27 is located in an area where contamination is present. This well is proposed to gather background water chemistry data. If contamination is expected (HE, Ba, etc. in springs) this proposed location may be inappropriate."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5B Response**
R-27 may be in an area where contaminants are present in the regional aquifer. This well serves the dual purpose of determining if contaminants are present from upgradient sources in Aggregate 5 and providing information about the baseline geochemistry of regional groundwater entering Aggregate 3. The term background water chemistry may not be accurate if R-27 contains contaminants from upgradient sources. The term *baseline* will be substituted for *background* in the final Hydrogeologic Workplan.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5C**
*"The proposed location of R-8 in Los Alamos Canyon is above the confluence with DP Canyon. Provide rationale if this location will be useful for detecting contamination originating in DP Canyon."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5C Response**
The location of R-8 is problematic because of the narrow, confined nature of the canyon floor in the vicinity of the Los Alamos Canyon and DP Canyon confluence. As sited now, R-8 is located just west of water supply well Otowi 4, on the narrow strip of canyon floor separating Los Alamos and DP Canyons. As sited, R-8 is about 150 ft northwest of Otowi 4. This location places R-8 downgradient of numerous contaminant sources in aggregate 1, but provides relatively little early warning time if contaminants are present in the regional aquifer and are moving towards Otowi 4. We would like to discuss the location of R-8 at the upcoming annual meeting between NMED and DOE/LANL.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5D**
*"The location of R-10 appears to head in the northern extension of the pre-Bandelier paleodrainage and not the southern extension as indicated in the text."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5D Response**
The text is poorly worded and will be modified to say *"...investigate the southward extension of this perched system from the Los Alamos Canyon area."* in the final Hydrogeologic Workplan.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5E**
*"Due to vapor-phase plumes present beneath MDA L and MDA G, HRMB recommends re-evaluating proposed (FY2001) regional aquifer well R-20."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5E Response**
Data from two deep boreholes (54-0015 and 54-0016) located in Canada del Buey and inclined beneath MDA L suggest there is no immediate threat to the regional aquifer in this area. Acceleration of the schedule R-20 will result in a delayed start at another well

location. Re-prioritization of wells can be made at the quarterly and annual meetings between NMED and DOE/LANL.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5F**
*"Depending on the capture zone of PM-5 and the source of contamination (presumably Mortandad Canyon), the proposed location of R-14 (mesa top and to the west) may be inadequate to provide "protection" for PM-5."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 5F Response**
The location of R-14 will be optimized to detect contamination approaching PM-5 from sources in Mortandad Canyon. The Mortandad Canyon Workplan proposes a location for R-14 that is 800 ft west of the location shown in the Hydrogeologic Workplan. This places R-14 in a more intermediate position between contaminant sources in Mortandad Canyon and water supply well PM-5. The optimum location for R-14 can be discussed at the quarterly and annual discussions between NMED and DOE/LANL. In the meantime, the R-14 location shown in the Mortandad Canyon Workplan will be shown in the final Hydrogeologic Workplan.

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 6**
*"If funding is available, HRMB recommends the acquisition of continuous core on R-26 and R-24. The locations are proximal to the Pajarito Fault Zone and may provide information concerning brecciated zones, fault splays, etc. As discussed within the Workplan, only 10% will be cored and overlook some pertinent information."*

**Specific Comments: 4.0 Hydrogeologic Characterization, Comment 6 Response**
We agree that 10% core may not be sufficient to adequately characterize potential groundwater pathways in faults and breccia zones associated with the Pajarito Fault System. The figure of 10% core is an approximate target for Type 2 wells in general and should be adjusted upwards or downwards on a well by well basis to ensure that objectives for each of the wells are achieved. More core should probably be collected in R-24 and R-26, and the additional amount of core needed will be determined when the detailed drilling plans for these holes are developed. Given our current experience with coring operations in R-9, we find that coring goals identified in the planning stage will often be revised during drilling to account for unanticipated or unpredictable geologic and hydrologic conditions.

**Specific Comments: 4.1 Hydrogeologic Characterization, Introduction and Procedures, Comment 1**
*The screened interval in wells advanced to the regional aquifer should be determined on a site-by-site basis. Where LANL can document significant drawdown of the regional aquifer, the screened interval shall not exceed 60 feet. In areas of the Laboratory where little or no drawdown is documented, the screened interval shall be 20 feet according to*

*the Groundwater Technical Enforcement Guidance Document (TEGD, 1986) and the draft Groundwater Monitoring (1992) guidance. Please revise the text as necessary."*

**Specific Comments: 4.1 Hydrogeologic Characterization, Introduction and Procedures, Comment 1 Response**
The screened interval in wells advanced to the regional aquifer will be determined on a site-by-site basis. The text in this section of the Workplan will be revised to indicate this, and to acknowledge the screen length limitations indicated in the NMED comments.

**Specific Comments: 4.1.1.1 Type 1 Wells, Comment 1**
*"The slot size/screen/filter pack should be based on sieve analysis of materials."*

**Specific Comments: 4.1.1.1 Type 1 Wells, Comment 1 Response**
LANL has significant experience installing wells in the alluvium of the canyons. The selected slot size for the screened interval is based on this experience. If the alluvium encountered during the drilling of any Type 1 well is observably different, then a sieve analysis will be performed to determine the appropriate slot size. A statement regarding screen size selection will be added to the text of the final Hydrogeologic Workplan.

**Specific Comments: 4.1.1.2 Type 2 Wells, Comment 1**
*"Clarify what geologic contacts will be cored. Will it include soil horizons/perching units, individual surge/pumice fall deposits, etc. or is it more broad based, for instance Bandelier Tuff, Cerro Toledo interval, etc."*

**Specific Comments: 4.1.1.2 Type 2 Wells, Comment 1 Response**
Core will be collected at stratigraphic contacts and in intermediate zone perched groundwater zones as they are encountered. Core will also be collected at other zones of hydrologic significance such as buried soil horizons and at the top of the regional aquifer.

**Specific Comments: 4.1.1.4 Type 4 Wells, Comment 1**
*HRMB has concerns with using a "multi-port Westbay-type casing" and casing string due to potential problems with isolating individual units of saturation. Provide rationale or list advantages and disadvantages for utilizing this type of casing.*

**Specific Comments: 4.1.1.4 Type 4 Wells, Comment 1 Response**
There are many advantages from using a multi-port casing. These are 1) ability to conduct repeatable sampling and testing of discrete zones within the same well; 2) measurements of vertical gradients; 3) intervals will have dedicated sampling equipment to minimize the potential for cross contamination; 4) provides the most information for least cost. The disadvantages of these wells are: 1) they must be carefully installed to ensure isolation of zones and 2) specialized equipment is required to install and sample the wells.

**Specific Comments: 4.1.1.4 Type 4 Wells, Comment 2**
*"RPMP does not recommend the use of multi-port Westbay-type casing."*

**Specific Comments: 4.1.1.4 Type 4 Wells, Comment 2 Response**
Westbay wells have been installed in at least two locations in New Mexico with NMED approval. One location is the South Valley Superfund Site. Four Westbay wells were installed in 1993-1994. The depths range from 700 to 1100 feet. The number of ports is up to seven. The wells have been sampled on a quarterly basis for a period of 4 years. NMED representatives for this project were Baird Swanson and Susan Morris. The EPA RPM is Bert Gorrod. Several Westbay wells with depths greater 1500 feet have been installed at White Sands Missile Range for NASA. These have also functioned as designed. LANL encourages RPMP to discuss the performance of Westbay wells with personnel in the Groundwater Protection and Remediation Bureau.

**Specific Comments: 4.1.1.5 Type 5 Wells, Comment 1**
*"Schedule 40 PVC may not be appropriate for all intermediate well situations. Please refer to ASTM guidance."*

**Specific Comments: 4.1.1.5 Type 5 Wells, Comment 1 Response**
The specific well design is described in the Drilling Plan developed for each well. The ASTM standards will be applied as appropriate. Reference to the development of detailed well-specific drilling plans will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.1.2 HSWA Module VIII Requirements, Comment 1**
*"Please modify the language stating ~~"Any boring drilled to a depth of 300 feet or deeper~~ shall grout in a surface casing to prevent downward migration of surface contamination along the well bore." With language stating* <u>any saturated condition encountered will require</u> *grout in a surface casing to prevent any downward migration of surface contamination along the well bore".*

**Specific Comments: 4.1.2 HSWA Module VIII Requirements, Comment 1 Response**
Language related to the grouting of surface casings will be amended in the Workplan to address NMED's concerns regarding "saturated conditions encountered" as well as downward migration of surface contamination along the well bore.

**Specific Comments: 4.1.3 Borehole Sampling, Comment 1**
*"Please list the hydraulic properties to be determined (bullet f)."*

**Specific Comments: 4.1.3 Borehole Sampling, Comment 1 Response**
The measured hydraulic properties may vary depending upon the geologic unit and site-specific conditions. A "typical" list of hydraulic properties to be determined on most core samples includes the following: in-situ water content, porosity, particle density, bulk

density, saturated hydraulic conductivity, and water retention characteristics from 0 to 15300 cm suctions.

**Specific Comments: 4.1.4 Groundwater Sampling, Comment 1**
*"LANL should include language that indicates the borehole will be developed and groundwater sampling accomplished according to LANL standard operating procedures, TEGD, and other appropriate RCRA guidance through the use of indicator parameters, etc."*

**Specific Comments: 4.1.4 Groundwater Sampling, Comment 1 Response**
The suggested language will be included in the Hydrogeologic Workplan.

**Specific Comments: 4.1.4 Groundwater Sampling, Comment 2**
*"Please clarify whether ground water samples will be filtered or unfiltered. This section is contradictory as it indicates that filtered and unfiltered samples will be collected in bullet "a" and filtered only in bullet "d"."*

**Specific Comments: 4.1.4 Groundwater Sampling, Comment 2 Response**
Groundwater samples will be both filtered and non filtered prior to inorganic analyses. Organic analyses for volatile and semi volatile anthropogenic organic compounds shall be performed on non-filtered water samples. General inorganic analytes include radionuclides, major cations, major anions, trace metals, and trace non metals. The language will be changed in Section 4.1.4 Groundwater sampling to eliminate ambiguity. The sentence on page 4-27 (third line down from the top of the page) will be changed to "Filtered and non filtered samples will be used for laboratory analyses."

**Specific Comments: 4.2 Site-Wide Hydrogeological Characterization, Comment 1**
*"Aggregate 9 is not defined in Section 1.3"*

**Specific Comments: 4.2 Site-Wide Hydrogeological Characterization, Comment 1 Response**
As described in Section 4.2, Aggregate 9 consists of the regional studies that are not specific to an aggregate. A description of Aggregate 9 will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.2.2.4 Water Supply Issues, Comment 1**
*"Replace "...~~naturally occurring contaminants~~" with* "...naturally occurring constituents" *(last paragraph, 4-33)."*

**Specific Comments: 4.2.2.4 Water Supply Issues, Comment 1 Response**
The suggested wording change will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3 Descriptions of Aggregates, Comment 1**
*"Reference Figure 1-3 in discussions of the individual aggregates. Include locations, in another diagram(?) of former Technical Areas (e.g. TA-1, TA-45, etc.) where appropriate."*

**Specific Comments: 4.3 Description of Aggregates, Comment 1 Response**
References to Figure 1-3 will be included in this section in the final Hydrogeologic Workplan. The locations of former Technical Areas will be shown on the block diagrams for each aggregate in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.1.2 Pueblo Canyon, Comment 1**
*"Intermediate Perched Zone and Regional Aquifer Groundwater Investigations*
*Figure 2-9 does not indicate the "potential recharge mound" referenced in the Workplan. Please provide a revised groundwater contour map indicating this and any other potential recharge mounds that are speculated to exist."*

**Specific Comments: 4.3.1.2 Pueblo Canyon, Comment 1 Response**
Existence of a recharge mound is speculative, based on water level measurements from a single well (TW-1). Insufficient data exist to map such a hypothetical mound in a meaningful fashion. Investigations under the workplan are designed to address this question.

**Specific Comments: 4.3.1.4 Sandia Canyon, Comment 1**
*"Surface Water*
*Clarify if the effluent discharge in Sandia Canyon is considered a "perennial reach".*

**Specific Comments: 4.3.1.4 Sandia Canyon, Comment 1 Response**
The effluent discharge in Sandia Canyon is not considered a "perennial reach", but is rather considered an effluent-supported reach or artificial stream reach.

**Specific Comments: 4.3.1.4 Sandia Canyon, Comment 2**
*"Alluvial Groundwater Investigations*
*Since the piezometer transect (A-26, A-27, and A-28) is located near the eastern limit of alluvium saturation , clarify if the transect will be moved to a point where saturation occurs if no saturation is encountered."*

**Specific Comments: 4.3.1.4 Sandia Canyon, Comment 2 Response**
The purpose of the transect is to determine the presence, extent, and quality of alluvial water in Sandia Canyon (see Appendix 4, Aggregate 1, pp. 1-2). The transect will be located to encounter alluvial water.

**Specific Comments: 4.3.1.4 Sandia Canyon, Comment 3**
*"Intermediate Perched Zones and Regional Aquifer Groundwater Investigations Please clarify what chemical data will be used to determine if the perched zones are interconnected (R-12 relative to POI-4 and TW1A). If the data are inconclusive, provide alternatives to be used in the determination of interconnectedness."*

**Specific Comments: 4.3.1.4 Sandia Canyon, Comment 3 Response**
The following physical data will be measured or collected to determine if two saturated zones are hydrologically and chemically connected: temperature and hydraulic gradient information. The following chemical data will also be measured or collected from the saturated zones: radionuclides (tritium, Sr-90, Cs-137, Am-241, plutonium isotopes, uranium isotopes, gamma spectrometry, and gross alpha, beta, and gamma), pH, specific conductance, alkalinity, stable isotopes (hydrogen, oxygen, and in special cases nitrogen), major ions (cations and anions), trace metals, and trace elements. Mobile species such as tritium, chloride ($Cl^-$), nitrate ($NO_3^-$), and boron ($B(OH)_3^0$) have been very useful in determining if two or more saturated zones are interconnected within Los Alamos and Pueblo Canyons, especially at future R-12 relative to POI-4 and TW-1A. Tracer tests will be considered under special conditions to determine if a hydraulic connection occurs between two or more saturated zones. Potentiometric maps shall be constructed to determine flow directions and hydraulic gradients.

Use of chemical data for determining groundwater flow paths and contaminant chemistry require that background concentrations are well established for the different saturated zones found in the alluvium, Tschicoma Formation, Bandelier Tuff, basalts, Puye Formation, and Santa Fe Group beneath Los Alamos and Pueblo Canyons. Geochemical modeling consisting of mixing reactions based on chloride (or some other tracer) and reaction path modeling are useful in determining if two or more saturated zones are connected. Time-chemical species plots will be used to establish short- and long-term trends between two or more saturated zones. Hydrologic flow and solute transport modeling shall be used to quantify the degree of connection between different saturated zones.

**Specific Comments: 4.3.2.3 Cañada del Buey, Comment 1**
*"Alluvial Groundwater*
*The first sentence of this section states there is not; however, CDBO-6 and CDBO-7 have encountered water perched in the alluvium and may result from discharges from PM-4. Because of the discrepancy please clarify if alluvial groundwater is present in Cañada del Buey."*

**Specific Comments: 4.3.2.3 Cañada del Buey, Comment 1 Response**
Alluvial groundwater is present in the canyon along an approximately one-half mile long reach near wells CDBO-6 and CDBO-7; this reach is immediately below the PM-4

discharge point. Saturation has not been observed in other wells in the canyon. The final Hydrogeologic Workplan will be revised to clarify this issue.

**Specific Comments: 4.3.2.3 Cañada del Buey, Comment 1A**
*"Provide the date of start-up for PM-4. In addition, clarify if discharges from PM-4 still occur, list the range of documented water levels at CDBO-6 and 7, and what time of year the wells are sampled."*

**Specific Comments: 4.3.2.3 Cañada del Buey, Comment 1A Response**
Well PM-4 began to produce water in 1982. Discharges from PM-4 still occur (under NPDES permit) but infrequently. The most recent discharge occurred on November 10, 1997. The discharge was for 20 minutes at approximately 1350 gallons per minute. Water levels in CDBO-6 since 1992 have ranged from 0 (dry) to 12 feet of saturation. Water levels in CDBO-7 since 1992 have ranged from 0 (dry) to 7 feet of saturation. CDBO-6 and –7 are sampled quarterly for nitrogen species and in the 3rd or 4th quarter for metals and radioactivity.

**Specific Comments: 4.3.2.3 Cañada del Buey, Comment 2**
*"Intermediate Perched Zone and Regional Aquifer*
*Please clarify "No intermediate perched zones occur in this area". Intermediate perched ground water was encountered at 334 feet in PM-2 and tentatively identified in SHB-4 between 125-145 feet."*

**Specific Comments: 4.3.2.3 Cañada del Buey, Comment 2 Response**
There is no current evidence of intermediate perched zones beneath Cañada del Buey. The cited wells are located in Pajarito Canyon.

**Specific Comments: 4.3.2.4 Pajarito Canyon, Comment 1**
*"Please check the Purtymun and Kennedy, (1971) reference to determine if it is appropriately cited concerning "....springs issue from hillslopes in the Tshirege Member of the Bandelier Tuff...".."*

**Specific Comments: 4.3.2.4 Pajarito Canyon, Comment 1 Response**
This is not an appropriate reference for this information, and will be deleted in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.2.4 Pajarito Canyon, Comment 2**
*"Intermediate Perched Zone and Regional Aquifer Groundwater Investigations*
*The proposed location of R-20 is 0.25 miles east of PM-2. Clarify if this well is proposed to be early detection from up-gradient sources or if it is providing early detection for potential capture of the tritium and organic plumes at TA-54."*

**Specific Comments: 4.3.2.4 Pajarito Canyon, Comment 2 Response**
R-20 is located between PM-2 and tritium and organic plumes at TA-54. It is designed to provide early detection of contamination moving towards PM-2.

**Specific Comments: 4.3.3.1 Area Description and History, Comment 1**
*"Intermediate Perched Zones and Regional Aquifer*
*LANL should provide the locations of Areas 1, 2, 2A, 2B, 3 and 4"*

**Specific Comments: 4.3.3.1 Area Description and History, Comment 1 Response**
The locations of these areas will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.3.1 Area Description and History, Comment 2**
*"Please provide any explanations as to the source of water in CH-2.*

**Specific Comments: 4.3.3.1 Area Description and History, Comment 2 Response**
The Laboratory's 1992 RFI Workplan for TA-49 (Sections 7.3.6.3 – 7.3.6.5) considered various hypotheses of possible sources of water in CH-2. That review did not identify a conclusive source of the water. RFI characterization activities are ongoing to allow a determination of the source(s) of the water.

**Specific Comments: 4.3.3.1 Area Description and History, Comment 2A**
*"Document what unit the groundwater is found (e.g. Guaje Pumice Bed). If known, document the groundwater "occupance" relative to pre-Bandelier geologic surfaces"*

**Specific Comments: 4.3.3.1 Area Description and History, Comment 2A Response**
The comment implies that saturated conditions have been found at TA-49 within the Bandelier Tuff. None of the many boreholes drilled at TA-49 have encountered groundwater in the tuff during drilling. A natural perched zone that either was not detected during site characterization or is episodic in nature could hypothetically explain the infrequent shows of water in CH-2. This hypothesis seems unlikely, however, given the relatively extensive site characterization performed to date and the fact that this recharge pathway apparently developed more than a decade after the hole was completed. The 20-ft slotted interval of CH-2 straddles the Unit 1v/Unit 1g contact.

**Specific Comments: 4.3.3.1 Area Description and History, Comment 3**
*"Describe, if known, what unit the water loss occurred during the drilling of DT-5A and CH-2."*

**Specific Comments: 4.3.3.1 Area Description and History, Comment 3 Response**

In the drilling of deep test well DT-5A, air circulation was lost at about 285 feet near the Unit 1v/Unit 2 contact. In the unsuccessful attempt regain circulation, an estimated 2.5 to 10 million gallons of drilling fluid was expended in this hole. According to Weir and Purtymun (1962) circulation was very poor in the upper 520 feet of the hole, within the Tshirege Member of the Bandelier Tuff. Twelve-inch casing was installed and cemented at this depth. Below 520 feet, drilling mud circulation was maintained to the total depth of 1821 feet. There was no water loss during the drilling of CH-2; the hole was drilled with air. After the drilling was completed, water was added to CH-2 to facilitate borehole geophysical logging. In the logging of CH-2, a significant amount of fluid was lost below a depth of about 300 feet, indicating the presence of a relatively permeable formation in stratigraphic Unit 1v and/or Unit 1g.

**Specific Comments: 4.3.3.1 Area Description and History, Comment 4**
*"Intermediate Perched zones and Regional Aquifer Groundwater Investigations Clarify if the location of proposed regional well R-30 is in a position to monitor the east to southeast component of potential groundwater flow in this area of LANL. Given the volumes and nature of the materials used at TA-49 and those found in groundwater samples, justify the number of wells proposed and the location of each well associated with this aggregate."*

**Specific Comments: 4.3.3.1 Area Description and History, Comment 4 Response**
R-30 is located east (downgradient in the regional aquifer) of the major source term at TA-49. This well will deepen existing borehole 49-2-700-1 which is already drilled to a depth of 700 ft, providing a significant cost savings to the drilling program. The need for additional wells in this area can be determined after characterization data becomes available from the planned wells.

**Specific Comments: 4.3.4.2 Ancho Canyon, Comment 1**
*"Alluvial Groundwater*
*Please clarify the 4 ft to 9 ft of saturation encountered in ASC-15, -16, and -18."*

**Specific Comments: 4.3.4.2 Ancho Canyon, Comment 1 Response**
The thickness of saturated alluvium encountered ranged from a minimum of 4 feet in one boring to a maximum of 9 feet in another boring. The thickness of saturated alluvium in the third boring was between 4 and 9 feet.

**Specific Comments: 4.3.4.2 Ancho Canyon, Comment 2**
*"Figure 4-16 indicates MDA Y is located below the confluence of Ancho and the north fork of Ancho canyons. HRMB believes that it is incorrectly located on Figure 4-18 as MDA Y is located at TA-39 above the confluence. Please correct the figure if appropriate."*

**Specific Comments: 4.3.4.2 Ancho Canyon, Comment 2 Response**

The location of MDA Y is in error in Figure 4-18 and will be corrected in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.4.2 Ancho Canyon, Comment 3**
*"Please justify the statement that "...the alluvium is quite permeable in contrast to the underlying Bandelier Tuff and underlying basalts." Due to the highly fractured and jointed nature of both the Bandelier Tuff and underlying basalts this statement is not entirely accurate."*

**Specific Comments: 4.3.4.2 Ancho Canyon, Comment 3 Response**
If the alluvium were not "quite permeable" in contrast to the underlying rock, water would not be perched in the alluvium overlying the tuff. The exact nature of the perching interface requires more investigation in several areas. In some places the perching horizon appears to be weathered tuff.

In any case, the tuff beneath the alluvium is unsaturated. It is well established among hydrologists that in the case of unsaturated water flow, fractures and joints are a barrier to aqueous flow. Fractures and joints can only contain and transport water if the entire rock is saturated. If the rock is unsaturated water will be drawn into the surrounding rock matrix.

**Specific Comments: 4.3.4.2 Ancho Canyon, Comment 4**
*"Intermediate Perched Zone and Regional Aquifer*
*The RFI Report for Operable Unit 1132 (March 1997) indicates that the regional aquifer is estimated to be between 300 to 600 feet below the canyon bottom (page 2-3). The Workplan indicates an estimate of 600 feet. Please clarify the discrepancy (be sure to include references)."*

**Specific Comments: 4.3.4.2 Ancho Canyon, Comment 4 Response**
These depths are given as generalities. The exact depth of the regional aquifer in this area is unknown as there are no wells nearby. The elevation of the floor of Ancho Canyon in this area is about 6000 ft; the Rio Grande (which is believed to be contiguous with the regional aquifer surface) is approximately 600 ft lower, at an elevation of about 5400 ft. References for these observations include topographic maps.

**Specific Comments: 4.3.4.3 Chaquehui Canyon, Comment 1**
*"Intermediate Perched Zones and Regional Aquifer*
*Ancho Spring is indicated to be 300 feet above the Rio Grande in Section 4.3.4.2, Intermediate Perched Zones and Regional Aquifer. In this section it is indicated to be 130-200 feet above the Rio Grande. Please clarify the discrepancy and provide references."*

**Specific Comments: 4.3.4.3 Chaquehui Canyon, Comment 1 Response**
The correct elevation difference is 300 feet. Available GPS survey data (LANL FIMAD database) indicates that Ancho Spring issues at an altitude of approximately 5700 feet; the altitude of Ancho Canyon at the Rio Grande is approximately 5400 feet. The text will be corrected in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.4.3 Chaquehui Canyon, Comment 2**
*"Intermediate Perched Zones and Regional Aquifer Ground Water Investigations Considering the presence of a tritium source/other contamination at TA-33, provide rationale for not proposing characterization/monitoring wells in this area of LANL."*

**Specific Comments: 4.3.4.3 Chaquehui Canyon, Comment 2 Response**
The mesa-top setting of the tritium source suggests that the need for characterization well(s) will be based on results of on-going RFI investigations. The largest canyon near TA-33, Chaquehui Canyon, is generally dry, and it is inaccessible because of deep incision. However, the need for characterization/monitoring wells in this area can be discussed at the quarterly and annual meetings between NMED and DOE/LANL.

**Specific Comments: 4.3.5 Aggregate 5, Comment 1**
*"Table 4-7 lists proposed alluvial and regional wells for aggregate 5 not aggregate 4 as indicated in the text."*

**Specific Comments: 4.3.5 Aggregate 5, Comment 1 Response**
The reference to aggregate 4 was an error. The correct reference to aggregate 5 will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.5.2 Cañon de Valle, Comment 1**
*"Surface Water*
*The text refers to Cañon del Valle, replace with Cañon de Valle."*

**Specific Comments: 4.3.5.2 Cañon de Valle, Comment 1 Response**
The name of Cañon de Valle will be corrected in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.5.2 Cañon de Valle, Comment 2**
*"Alluvial Groundwater*
*Figure 4-20 mis-labels/identifies the Tschicoma Formation in the key."*

**Specific Comments: 4.3.5.2 Cañon de Valle, Comment 2 Response**
The labeling of the Tschicoma Formation in the key of Figure 4-20 was an error. The correct identification will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.5.2 Cañon de Valle, Comment 3**
*"The text refers to Cañon del Valle, replace with Cañon de Valle."*

**Specific Comments: 4.3.5.2 Cañon de Valle, Comment 3 Response**
The name of Cañon de Valle will be corrected in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.6 Aggregate 6, Comment 1**
*"Table 4-8 lists proposed alluvial and regional wells for aggregate 6 not aggregate 4 as indicated in the text."*

**Specific Comments: 4.3.6 Aggregate 6, Comment 1 Response**
The reference to aggregate 4 was an error. The correct reference to aggregate 6 will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.6.1 Area Description and History, Comment 1**
*"TA-39 is included in Aggregate 4, Figure 4-22 indicates it is part of Aggregate 6. TA-36 appears to be mis-identified on Figure 4-22."*

**Specific Comments: 4.3.6.1 Area Description and History, Comment 1 Response**
The identification of TA-39 on Figure 4-22 was an error. Figure 4-22 will show TA-36 in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.6.2 Potrillo Canyon, Comment 1**
*"Surface Water*
*The reference for Becker (1991) is not listed in the references in Section Six (6)."*

**Specific Comments: 4.3.6.2 Potrillo Canyon, Comment 1 Response**
The omission of the Becker (1991) in the reference list was an error. The complete citation to Naomi Becker's doctoral dissertation will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.6.2 Potrillo Canyon, Comment 2**
*"Provide the location of the discharge sink on Figure 4-22."*

**Specific Comments: 4.3.6.2 Potrillo Canyon, Comment 2 Response**
The location of the discharge sink will be included on Figure 4-22 in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.6.2 Potrillo Canyon, Comment 3**

*"The number and location of wells should reflect the significance of the discharge sink to groundwater recharge and the overall groundwater protection strategy at the lab. Since the discharge sink is collecting uranium contaminated surface water and sediments, groundwater monitoring of any alluvial, intermediate groundwater systems and the regional aquifer should be included in the design of the well type, placement and number in order to adequately delineate the effect of the discharge sink on potential contaminant (e.g., U) transport offsite."*

**Specific Comments: 4.3.6.2 Potrillo Canyon, Comment 3 Response**

Potrillo Canyon has been the focus of some of the most detailed near-surface characterization activities at the Laboratory. A partial list of subsurface instrumentation already installed within or adjacent to the discharge sink includes 3 neutron moisture access tube clusters and 2 multi-level observation wells. These stations monitor the vertical moisture movement and the occurrence of saturation within the discharge sink (the observation wells have remained dry since their installation in 1991). Monitoring results from these holes and data from additional surface water and sediment monitoring activities will be evaluated to guide the design, placement, and number of additional wells needed to characterize this site.

**Specific Comments: 4.3.6.2 Potrillo Canyon, Comment 3A**

*"Document, if known, what controls the discharge sink (e.g., structurally controlled?)."*

**Specific Comments: 4.3.6.2 Potrillo Canyon, Comment 3A Response**

The probable feature that creates the discharge sink is an underlying fault, below the alluvium at the upstream end of the discharge sink, according to Becker (1991). The discharge sink will be investigated during site characterization activities.

**Specific Comments: 4.3.7 Aggregate 7, Comment 1**

*"Table 4-9 lists proposed alluvial and regional wells for aggregate 7 not aggregate 4 as indicated in the text."*

**Specific Comments: 4.3.7 Aggregate 7, Comment 1 Response**

The reference to aggregate 4 was an error. The correct reference to aggregate 7 will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.7.2 Mortandad Canyon, Comment 1**

*"Alluvial Groundwater*
*If available, provide the estimated volumes of water lost to seepage into the tuff from the Purtymun (1977) and Koenig (1993) water balance studies:"*

**Specific Comments: 4.3.7.2 Mortandad Canyon, Comment 1 Response**

Purtymun et al (1977) report that from 1963 through 1974, the estimated losses to the tuff ranged from 64,000 to 150,000 $m^3$ of water per year. These should be viewed as estimates with possible large sources of error.

For the two year period July 1963 to June 1965, Koenig (1993) estimated a total inflow to the tuff of 177,000 $m^3$. These figures cannot be directly compared to Purtymun's (1977) values as he gives figures on an annual basis. Assuming that Purtymun's values can be divided in half for 1963 and 1965 to represent the latter and first halves of these years, a rough approximation of 244,500 $m^3$ comes from his values for this time period.

**Specific Comments: 4.3.7.2 Mortandad Canyon, Comment 1A**
*"Please clarify the last paragraph of this section as it is unclear. 20% of water entering the canyon is stored in the alluvium. 80% of the water entering the canyon is lost. 15% of the 80% water lost is due to evapo-transpiration. The remaining 65% of the 80% is lost to seepage into the tuff?"*

**Specific Comments: 4.3.7.2 Mortandad Canyon, Comment 1A Response**
The previous paragraph incorrectly cited Purtymun's (1977) findings. Purtymun states that the average annual losses are "about the same volume that entered the canyon each year". Regarding the mechanism of loss, he says that "The losses attributed to evapotranspiration were estimated at about 15%..." (of the total loss) "with infiltration accounting for the remainder". The amount in storage does not directly bear on either the amount entering or the amount lost.

**Specific Comments: 4.3.7.2 Mortandad Canyon, Comment 1B**
*"The reference for Koenig (1993) is missing in Section 6."*

**Specific Comments: 4.3.7.2 Mortandad Canyon, Comment 1B Response**
The omission of Koenig (1993) from the reference list in Section 6 was an error. The correct reference will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.8 Aggregate 8, Comment 1**
*"Table 4-10 lists proposed alluvial and regional wells for aggregate 8 not aggregate 4 as indicated in the text."*

**Specific Comments: 4.3.8 Aggregate 8, Comment 1 Response**
The reference to aggregate 4 was an error. The correct reference to aggregate 8 will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.8.1 Area Description and History, Comment 1**
*"Cabra Canyon is not identified on the figures. Please indicate on a figure and reference."*

**Specific Comments: 4.3.8.1 Area Description and History, Comment 1 Response**

A block diagram showing the boundaries of Aggregate 8, including Cabra Canyon, will be included in the final Hydrogeologic Workplan.

**Specific Comments: 4.3.8.1 Guaje Canyon, Comment 1**
*"Surface Water*
*The Guaje Canyon and Area Description and History sections share the same 4.3.8.1 section number."*

**Specific Comments: 4.3.8.1 Guaje Canyon, Comment 1 Response**
The mis-numbering in this section was an error. The section numbering will be corrected in the final Hydrogeologic Workplan.

**Specific Comments: Appendix 5, Criteria for Scheduling Well Installation, Comment 1**
*"See Comment 1, Section 4.0."*

**Specific Comments: Appendix 5, Criteria for Scheduling Well Installation, Comment 1 Response**
The Hydrogeologic Workplan is intended to ensure a comprehensive, well integrated approach to addressing all applicable regulatory programs. The ranking system was developed to meet, as a minimum, the requirements of RCRA compliance. However, other regulatory programs and best management practices are also embedded within the ranking system.

**Specific Comments: Appendix 6, Maps, Comment 1**
*"See Comment 1, Section 2.1.2.1."*

**Specific Comments: Appendix 6, Maps, Comment 1 Response**
DOE/LANL agree with the need to include a geologic map. A geologic map will be included in the final Hydrogeologic Workplan. There are seven generalized stratigraphic cross-sections included in the document which are judged to be sufficient for illustrating the heterogeneity across the Laboratory. These cross sections will also be referenced in this background section in the final Hydrogeologic Workplan.