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Los Alamos, New Mexico 87545

Date: May 3, 1999
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HSWA LANL 6/21/99

John Young
Hazardous and Radioactive Materials Bureau
New Mexico Environment Department
2044 Galisteo St., Building A
P.O. Box 26110
Santa Fe, New Mexico 87505

SUBJECT: NOTES FROM THE GROUNDWATER ANNUAL MEETING HELD MARCH 29-31, 1999

Dear Mr. Young:

Enclosed please find the notes from the Groundwater Annual Meeting. The notes are being distributed to all meeting attendees and recipients of the "Groundwater Annual Status Report for Fiscal Year 1998" in a three-ring, binder. The binder contains tabs for each fiscal year of the Monitoring Well Installation Project and is intended for your convenience in keeping together annual reports, meeting minutes, and other documentation.

Several of the discussions at the meeting resulted in the identification of action items. The action items are listed as follows with responsible parties in parentheses:

1) Provide comment on LANL's proposed drilling schedule for FY99, specifically regarding the acceleration of the drilling of R-31 for FY99. (NMED)

2) Distribute the Quarterly Meeting agenda before the meeting and formally communicate proposed resolutions after the meeting. (LANL)

3) Include all stakeholders in Quarterly Meetings to get input on all issues, but follow up with a smaller "working" meeting between DOE, NMED, and LANL. (LANL)

4) Interview more NMED representatives for an assessment of user's needs for the Groundwater Database. (LANL)

5.) Develop a process for releasing preliminary data to stakeholders. (LANL)

6.) Develop an action plan to address the unresolved issues identified by stakeholders at the annual meeting. (LANL)

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7.) Update the Drilling Priorities tables every year and include them in the Groundwater Annual Status Report. (LANL)

8.) Distribute the External Evaluation Group (EEG) Semi-Annual Report when finalized, and distribute LANL's EEG Action Plan addressing the EEG's recommendations in the Semi-Annual Report. (LANL)

9.) Finalize the process and decision flow for addressing contamination found in R-wells. (LANL)

Finally, this year's Groundwater Annual Status Report has been reviewed as a Laboratory publication and has received a Los Alamos National Laboratory (LANL) publication number. The publication front pages (cover, title, and author pages), back page, and an abstract replacement page are provided in the binder.

If you have any questions, please call me at (505) 665-4681.

MAY 1999
RECEIVED

Sincerely,

Charles L. Nylander
Water Quality and Hydrology Group

CN/mm

Enclosures: a/s

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A. Armijo, NNMCAB, Nambe Pueblo, NM, w/enc.
R. Enz. DOE/LAAO, w/enc., MS A316
B. Koch, LAAME, DOE/LAAO, w/enc., MS A316
M. Dale, NMED/DOE/OB, w/enc., MS J993
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J. Vozella, DOE/LAAO, w/enc., MS A316
G. Turner, DOE/LAAO, w/enc., MS A316
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D. Broxton, EES-1, w/enc., MS J462
G. Cole, EES-1, w/enc., MS D462
R. Warren, EES-1, w/enc., MS D462
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E. Keating, EES-5, w/enc., MS C306
B. Robinson, EES-5, w/enc., MS-F649
B. Stone, EES-5, w/enc., MS-F649
A. Pratt, EES-13, w/enc., MS M992
R. Gilkeson, EES-13, w/enc., MS H865
A. Dorries, EES-13, w/enc., MS M992
D. Katzman, EES-13, w/enc., MS M992
S. Bolivar, EES-13, w/enc., MS H865
E. Springer, EES-15, w/enc., MS J495

Cy continued:
B. Newman, EES-15, w/enc., MS J495
A. Gallegos, EES-15, w/enc., MS J495
T. Baca, EM-DO, w/enc., MS J591
J. Canepa, EM/ER, w/enc., MS M992
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Groundwater Annual Status Reports and Meeting Minutes for Fiscal Year 1997 through Fiscal Year 2004

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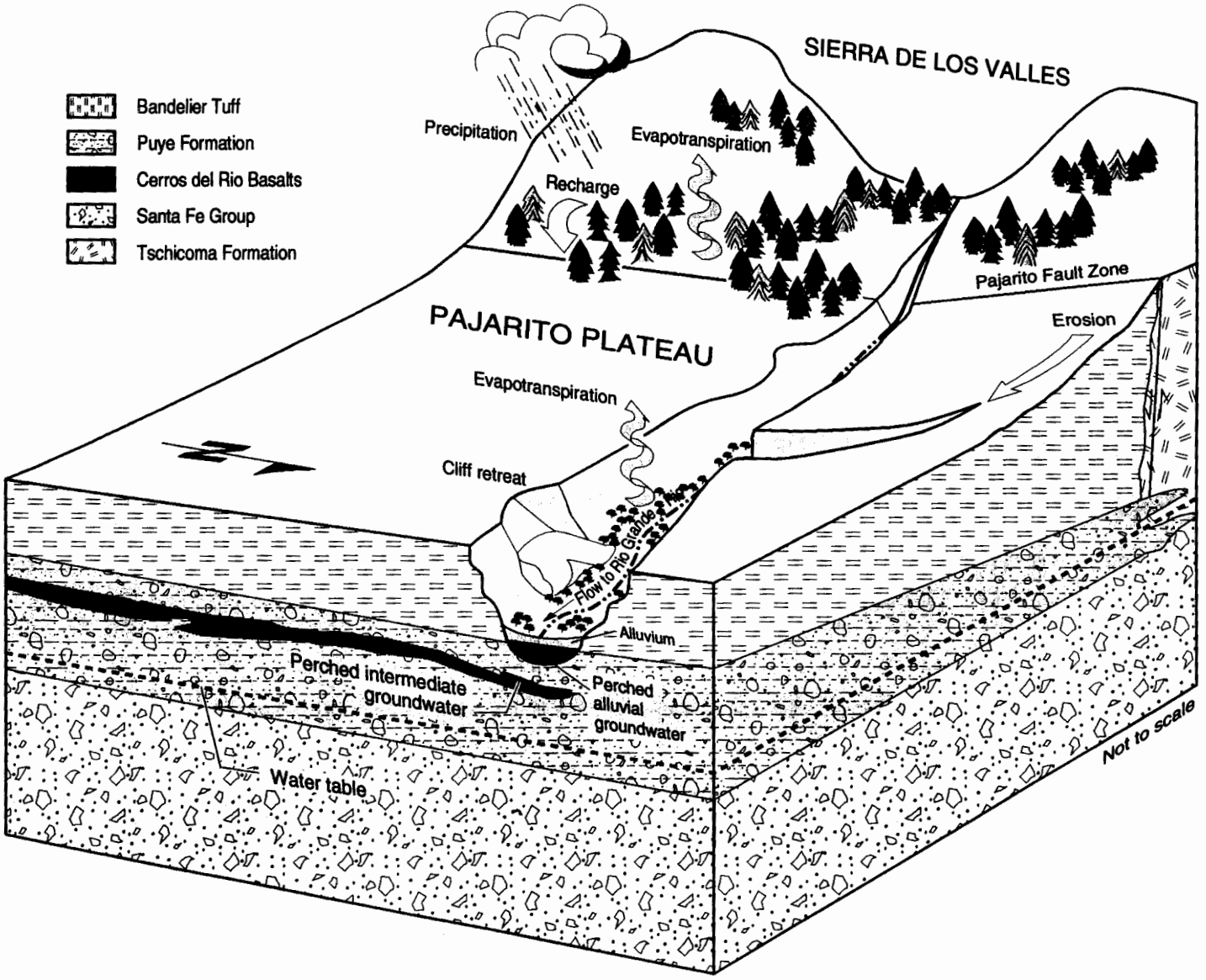

MEETING NOTES

from the
Los Alamos National Laboratory's

2ND ANNUAL GROUNDWATER MEETING

MEETING PURPOSE, ATTENDEES, AND AGENDA

The Los Alamos National Laboratory Groundwater Integration Team (LANL GIT) met with the New Mexico Environment Department (NMED), the Department of Energy (DOE), the External Evaluation Group (EEG) peer reviewers, and stakeholders on March 29-31, 1999 to host the 2nd Annual Groundwater Meeting. The meeting was held in the Convocation Hall at Ghost Ranch, Abiquiu, New Mexico. Charlie Nylander (GIT Chair) facilitated the meeting.

The following groups and stakeholders were represented (see List of Attendees for specific information):

NMED-Hazardous and Radioactive Materials Bureau
NMED-Groundwater Quality Bureau
NMED-DOE Oversight Bureau
DOE-Environment, Safety, and Health
DOE-Environmental Management
DOE-Defense Programs
Santa Clara Pueblo
San Ildefonso Pueblo
Northern New Mexico Citizen's Advisory Board
Los Alamos County
External Evaluation Group (EEG)
LANL-Groundwater Integration Team (GIT)

The purpose of the Annual Meeting was to provide NMED, DOE, and stakeholders with information on LANL's groundwater protection efforts for the past fiscal year and present planned activities for the upcoming fiscal year. The meeting agenda was as follows:

<u>Monday, March 29, 1999</u>
Introduction
Modeling
Information Management
Regional Site-Wide Conceptual Model
Presentation by GIT members on Aggregates 1-8
NMED Presentations

Tuesday, March 30, 1999
Special Meeting between EEG, NMED, Pueblos, and CAB
All Parties Discussion
Special Presentations

Wednesday, March 31, 1999
EEG/GIT Discussion of Action Plan
EEG Works on FY 98 Semi-Annual Report

SUMMARY OF PRESENTATIONS AND DISCUSSIONS

Introduction

Charlie Nylander (LANL) welcomed all participants to the second Annual Meeting. The Annual Meeting has been expanded to include the External Evaluation Group (EEG), Accord pueblos, and Citizen Advisory Board (CAB). This meeting is intended to provide a forum for keeping stakeholders informed about the progress and direction of the groundwater characterization program and to understand concerns and input from our stakeholders.

Charlie Nylander (LANL) provided an overview of the Annual Meeting agenda and described the Annual Meeting Objectives. The "Communication" section of the Hydrogeologic Workplan was quoted with respect to the purpose and scope of the Quarterly Meetings and the Annual Meeting. The goals of hydrogeologic Workplan were listed and described. To define what is meant by "adequate characterization" Figure 1-3 from the Hydrogeologic Workplan, the decision flow chart, was shown and described. Bob Charles (EEG) asked which group is responsible for the remedial action shown on the decision flow chart. Charlie Nylander (LANL) responded that the responsible group would depend on the source of the problem – legacy waste or operational. There is flexibility in addressing the problems.

Charlie Nylander (LANL) showed a table summarizing the data needed from the regional boreholes, data that has been collected from the 3 completed boreholes, and whether the data will be used in modeling. The data needs, with the exception of hydrologic properties, have been satisfied in R-9, R-12, and R-25. All of the data needed are important to modeling. Joe Vozella (DOE/LAAO) asked if the regional boreholes would be completed in intermediate zones to determine the yield. Charlie Nylander (LANL) responded that the yield would be estimated for the intermediate zones in the regional boreholes.

Charlie Nylander (LANL) pointed out that the Hydrogeologic Workplan describes a regional characterization program. It includes 32 wells and each one provides information, but all necessary to understand the whole system. The schedule is based on an assumption of completing four wells per year. This schedule is constrained by endangered species in some cases. However, R 25 was started in late July and is not yet completed. To meet the schedule needs of four wells per year, there must be 24-hour drilling or more drill rigs.

Charlie Nylander (LANL) said that to make this program successful, partnership with stakeholders is critical. Gil Suazo (LANL) asked if this work quantify how much water is available. Charlie Nylander (LANL) responded that it will give some idea, but would have to drill much deeper wells to completely quantify the potential water supply. The wells will be useful in determining recharge. Steve McLin (LANL) responded that these wells would add to the knowledge, especially those along the western edge.

Charlie Nylander (LANL) described the Groundwater Integration Team (GIT) management activities in FY98. There were Quarterly Meetings, a number of accomplishments, an accounting of the budget for FY98, and planned activities for FY99.

Gil Suazo (LANL) asked what a water balance study is. Dave Broxton (LANL) responded that a water balance study is an accounting of water flowing in and flowing out of a hydrologic system. It will be used to target regional wells where infiltration is occurring. Also needed for modeling. Kim Hill (NMED) asked where in the schedule is R-27. Charlie Nylander responded that R-27 is scheduled for completion beginning of 2000.

Modeling

Bruce Robinson (LANL) described the goals of the modeling effort. The modeling activities are expected to evolve over the course of five years from model development to model use (predictions). By 2003, it is expected that the modeling will provide adequate prediction of plume direction, travel time, and dispersion. Modeling will extend from source to potential receptor and will be done on three different but interconnected scales: MDA-scale, canyon-scale, and regional-scale. The modeling approach is to complete detailed studies at some MDA- and canyon-scale sites that can be extrapolated, if possible, to other MDAs and canyons to cut down on the duplicative effort. The canyon-scale models will be used as source terms for the regional-scale model. The regional aquifer flow model has been completed. The next step is to merge it with MDA and canyons, including contaminant transport predictions.

Bob Powell (EEG) asked if the approach to extrapolate to other MDAs and canyons is driven by budget constraints or because you think you will have enough data. Bruce Robinson (LANL) stated that the approach is based on the judgement that the data will be adequate to do that. Although there are budget constraints, whatever modeling necessary will be done. Bill Holman (DOE/OAK) asked if data for canyon-scale models are available and will future wells be in right sequence to provided necessary data. Bruce Robinson (LANL) responded that there is not enough data now, but the well drilling program will provide necessary data.

Betty Anderson (EEG) asked what is considered to be the risk in the regional aquifer. Bruce Robinson (LANL) responded that risk is based on drinking water in the regional aquifer. Betty Anderson (EEG) asked if there is modeling of the drinking water distribution system. Steve McLin (LANL) responded that it is an extensive distribution system and lots of blending of water, but there is no existing modeling of it.

Bruce Robinson (LANL) described the long-term plan for the modeling effort, including which wells will be most important for specific modeling scales and the evolution of the effort from model development to prediction to remediation over the duration of the project. Charlie Nylander (LANL) pointed out that the wells that are not bolded may not be as important for one particular modeling scale, but are important to another modeling scale. Bruce Robinson (LANL) further explained that there are multiple reasons to drill wells and information about the regional aquifer is just one. Mike Taylor (NMED) asked if the modeling will this be used for remediation. Bruce Robinson (LANL) responded that as we proceed, we will use the model less for prediction and more for plume tracking and remediation. Within a couple of years will have adequate prediction of flow direction, but uncertainty will remain in travel time and dispersion. Joe Vozella (DOE/LAAO) asked if there has been any thought to rearranging the well schedule to contribute to modeling. Bruce Robinson (LANL) responded that shuffling of the well schedule would have to take all of the data uses into account.

Bruce Robinson (LANL) provided a technical update on the three scales of modeling from largest (regional) to smallest (MDA). The status of the regional scale model was described first. Bruce Robinson (LANL) presented a regional water table map to show where the potentiometric surface is supported by well data; the regional modeling objectives; the modeling approach; a list of the significant transport questions; the regional aquifer model FY 98 accomplishments; boundary conditions used in the modeling; the wells in the Espanola Basin used for regional modeling; comparison of predicted to observed water levels in 770 wells to illustrate model calibration; and the planned FY99 regional aquifer modeling work.

Bruce Robinson (LANL) then presented the Los Alamos Canyon modeling approach. The presentation included the canyons modeling current status and canyons model future work. David Schafer (EEG) asked if the saturated and unsaturated zones are included in the modeling. Bruce Robinson (LANL) responded that both are included, although in the canyons the conditions are mostly unsaturated with zones of saturation. Bob Powell (EEG) asked if data on water content, permeability, etc. are coming in from the wells. Bruce Robinson (LANL) responded that some are available – water content, chemical data, air permeability; but we do not have permeability or porosity yet.

Steve Rae (LANL) asked what would be done internally and externally to get consensus on input parameters so that stakeholders can feel comfortable with model results. Bruce Robinson (LANL) responded that initial models have low confidence, with more data and refinements the confidence goes up. Peer review is important. Internally the GIT is important. Predictions in advance of data collection can build confidence in model. Karen Agogino (DOE/AL) asked if there would be a report that specifies the input parameters. Bruce Robinson (LANL) answered the parameters will be in annual reports. Michael Dale (NMED/OB) asked how important are the perched zones for characterization through time. Bruce Robinson (LANL) responded that it is very difficult to model and understand the perched zones, but the are important in understanding flow from surface to regional aquifer. They seem to be pathways to regional aquifer. Michael Dale (NMED/OB) asked when a decision to include perched zones in the modeling would be made. Bruce Robinson (LANL) said the program is already addressing those by the method of drilling and data collection. Bob Powell (EEG) said it seems likely that on a complex site won't be able to model every last square foot. Need to come to agreement on what is enough. Bruce

Robinson (LANL) agreed but said that every site is complex. If it isn't complex there aren't any wells. However the point is well taken that those types of agreements are necessary.

Modeling at the MDA scale is planned for TA-49 (MDA AB), TA-54 (Area L vapor plume), and TA-21 (MDA T adsorption bed). Bruce Robinson (LANL) briefly described other modeling activities: participation in the GIT, provide input to data management and characterization activities, and assist in developing probabilistic risk assessment modeling.

Information Management

Ken Mullen (LANL) said that a project leader, Sue Kinkead, has been hired for information management. The existing state for information management is that data is scattered in hard copy files, floppy disks, independent databases, in the Facility for Information Management, Analysis and Display (FIMAD) and the Environmental Restoration Data Base (ERDB), or in ESH-18 water monitoring data. We need a database to support modeling, make data available, organize data, facilitate manipulation, minimize duplication, and preserve data for further justifications and questions (which data type do we save: raw, selected, interpreted, or modeled?). The ER databases are tabular and include chemical analyses but no data regarding well construction, field measurements, or physical properties. The ER databases feed into the Geographic Information System (GIS) so the data can be viewed spatially. The ESH-18 databases include chemical analyses and water level data.

A user needs assessment was conducted. It recommended an alternative to the existing state. The GIT processes were mapped out and the data flow was diagrammed. The recommendations of the user needs assessment are being implemented. Recent activities include formation of the GIT Information Management Subcommittee, hiring the project team leader, preparation of an initial data management plan, initiation of database redesign, and gathering existing data sets.

The data management plan includes roles and responsibilities, QA/QC, audit responsibilities, data types, data sources, data upload and records filing procedures. Implementation tasks are to install database repository, integrate databases, and define requirements for data analysis and reporting applications. Application development includes developing data access applications, user manuals, and software documentation; installing applications; and instructing users on application use.

The groundwater database must integrate with: ERDB tabular, FIMAD GIS, EES Modeling, ESH-18 tabular and GIS, and have a web interface with graphical and data browser capabilities. The data tables for the groundwater database include: groundwater occurrence, geophysical logs, mineralogic data, porewater anions, petrographic data, geological logs, sample info, boreholes, water level data, chemical analyses, location info, hydraulic properties, well screen, well construction, annular material, and drilling chronology.

Bob Powell (EEG) asked if the data tables will include location data (x, y, z) for multiple completions. Ken Mullen (LANL) said they are not in there now, but clearly they need to be there. John Young (NMED) asked if there will be a data table indicating whether wells have

been developed. Ken Mullen (LANL) responded that there is not one now, would it just be yes or no? Need to think about that. Could have indication of RCRA – compliant well construction. Charlie Nylander (LANL) suggested the data table could have yes/no and the development method.

Ken Mullen (LANL) presented the ER groundwater data – types of data and cost to verify, validate, and load. The estimated cost to perform the tasks and which tasks are unfunded was also presented. Bob Charles (EEG) asked if someone asked for something today what would happen. Ken Mullen (LANL) responded that it depends on what data they wanted. Water level is available on the Web. Request for other types of data would have to be sent some other way to track down the data just like any one of us would have to do. It is not a good system, and that is why we are trying to fix it.

Regional Site-Wide Conceptual Model

Bruce Gallaher (LANL) said the site-wide conceptual model provides a thumbnail sketch of the big picture, a satellite view. It gives you a roadmap for generating site specific investigation plans. The conceptual model will never be completed. It changes with new data collection. In 1996, a conceptual model was developed based on lots of pieces of data. It consisted of canyon systems: wet and dry and the mesa system. The west side was not separated out. It assumed, based on the tritium data in the intermediate and regional water systems that the wet canyons were more dynamic than dry canyons. There were still big questions – Do the intermediate perched zones exist beneath mesas? Are intermediate perched zones laterally extensive near the Jemez Mountains? Where is recharge coming from?

The mesa systems are an entirely different animal. Two-thirds of the Lab is dry. The western one-third of the Lab is different, it is underlain by rocks that are more densely welded and there is more water. There have been detailed studies of the mesa system at TA-54 (Areas G and L); TA-21 (extensive drilling); and TA-67 (at the formerly proposed Mixed Waste Disposal site). These studies have consistently found that there is low moisture content and low flux rates in the dry mesas. The key issue is adding water to mesa sites. Coring at the Meson Facility beneath the surface impoundments has found flux rates of 300 mm/yr. Air exchange as a drying mechanism is very prominent on the east side of the Lab.

The regulatory requirements can be condensed into the site – wide "Big 4" requirements: depth to water(s), direction of flow, rate of flow, and recharge/discharge relationships. In all of our investigations we have to keep our eye on the goal: where is the water and where is it going. A map showing carbon dating does not give a clear indication of the sources of recharge. Further, it was unknown whether there is sufficient water coming from the Jemez Mountains to be the primary source of recharge for the regional aquifer in this location. Based on the age dating information and the unknown water quantity, the 1996 conceptual model stated that sources of recharge are unclear and speculated that water could be coming from the north in the Miocene trough or from the east. The following discussion focuses on a scoping assessment of recharge sources.

The first step was to estimate the extent of shallow alluvial groundwater at LANL. A map of shallow alluvial water developed by NMED was used as a base to estimate where alluvial groundwater is. The alluvial water occurrences were categorized as supported by natural sources and supported by effluent sources. This division was fairly clear for all of the segments with the exception of TA-16, which could be evenly split between natural and effluent sources. An observation at this point is that on a square footage basis, < 1% of the Lab has shallow alluvial water. This does not take into account the dry canyons that may be seasonally or occasionally wet.

The volume of alluvial groundwater was estimated by multiplying the length of the segments identified with shallow alluvial groundwater by the width and depth of the saturation and estimates of porosity. The resulting volumes of alluvial groundwater to the annual stream flow loss (the difference between upstream and downstream gages). There is close similarity between volume of alluvial water and annual stream flow loss, this suggests that there is an annual turnover in alluvial water. This provides an upper band estimate on stream bottom recharge.

Michael Dale (NMED) asked how would you address lower Los Alamos Canyon with permeable units and lateral flow. Bruce Gallaher (LANL) said this is a scoping calculation, and does not consider specific canyon circumstances. Further, it only includes the Lab property, not lower Los Alamos.

Bruce Gallaher (LANL) presented the potential recharge vs pumpage by comparing annual on-site stream flow losses and effluent discharges to the volume of water pumped from the Pajarito well field. Natural stream flow is about 10 percent of pumping. Add in effluents and gets up to 20-30% of the volume pumped on an annual basis.

Another indication of the amount of water available for recharge is the discharge from springs. A comparison of the discharge from springs to the amount of water pumped from the Pajarito well field shows that west side springs represent 30-40% of the water that is pumped. Spring discharge may be a possible upper bound on how much water is passing through the system. This is not a suggestion that all of the spring flow is recharged, but as a reflection of how much water is available within the mountain block. This comparison suggests that there is sufficient water from Jemez Mountains to account for all pumping in Pajarito well field.

With respect to the pathways for contaminant migration, an east-west cross-section in upper Los Alamos Canyon showed the complexities in the downward vertical movement of water. No drilling program that will find all the complexities of subsurface flow, so there is a need to focus on larger water bodies. What is known about movement through the vadose zone was summarized as follows:

Wet systems

- < 40 years based on detection of tritium
- 10 – 100 years based on numerical modeling (Mortandad Canyon)
- Downward but with "stairstep"
- Multiple perched systems

Dry systems

- Maybe > 1000 years

Bruce Gallaher (LANL) pointed out that there has been decades of testing at the groundwater sampling stations (wells and springs) and more recently, low level tritium analysis. New wells have confirmed the above background tritium. The only places where exceedances of MCLs have been confirmed by multiple sampling are at TW-1 with sewage and at R-25 with HE. Both are areas with relatively low amount of water flowing through. At TW-1 there is clearly impact of surface water with nitrates on regional aquifer. Steve McLin (LANL) pointed out that directing the wastewater treatment plant discharge into the canyon was done by the county even though the lab recommended against it. Michael Dale (NMED) asked it the nitrate breakthrough could be from the old Central Plant. Bruce Gallaher (LANL) said that needs to be explored further. The tritium in the water suggests Lab influence.

Michael Dale (NMED) asked if the HE in R-25 was transported to deep water by effluent water – was it a natural or artificial source – are they diluted. Bruce Gallaher (LANL) said along the mountain front, it is a different regime. Water coming in from many depths. The concentration suggests not much dilution. Pat Longmire (LANL) the stable isotopes suggest natural and effluent water, tritium data also supports this because there is meteoric water. The HE concentration shows dispersion, degradation, but no retardation.
Steve Rae (LANL) the amount of water discharged at TA-16 has gone down dramatically. What is effect of eliminating outfalls?

On the other end of the spectrum, Mortandad Canyon has received effluent containing tritium for 30 years and a tritium plume would be expected to exist there. However, the tritium in shallow water in Mortandad Canyon is above background which is evidence of recharge, but there is no plume that exceeds standards. The critical difference between Los Alamos and Mortandad canyons is that Los Alamos is a wet system and Mortandad is a dry system with effluents superimposed on it. Bruce Gallaher (LANL) said lets focus on Los Alamos Canyon - lots of effluent discharge. Surprised that the tritium concentration is not higher, it may be because of the annual turnover. The effluent in wet canyon is diluted. In drier canyons there is little natural water to dilute, e.g. Mortandad there is almost no water left. Bill Holman (DOE/OAK) asked what the tritium levels in springs are. Bruce Gallaher (LANL) responded that the tritium levels are "dead" in the springs, which argues for older regional aquifer water. But position of those two springs is unusual. Pat Longmire (LANL) said that Pajarito Spring is in the Puye, stratigraphically at top of regional aquifer. Background study shows regional aquifer is dead with respect to tritium.

Key refinements to conceptual model are:

- Confirm high water table on west side/mountain front recharge
- Confirmation of regional aquifer connection with surface (HE, tritium, sewage effluents)
- Regional aquifer recharge (most from off-site, mountain front significant, natural streamflow minor)
- Perched systems on west side (beneath mesa, shallow and deep systems?)

Some major uncertainties and next steps:

- TA-16 extent of perched system
- Is there a perched system in central portion of lab feeding Ancho and Pajarito springs?
- Hydraulic gradients: R-25 has steep downward hydraulic gradient

David Schafer (EEG) asked if the water levels in R-9 and R-12 have been incorporated in regional model. David Rogers (LANL) indicated that they have been.

Bruce Gallaher (LANL) said that most of Lab has no water to move contaminants. Fluxes an order of 1 mm/yr. Wet canyon bottoms provide recharge, but are only <1% of Lab. They are seasonally dynamic and provide yearly fresh water. Big unknown is significant subsurface flow on west side, there maybe more water coming in from the west side. Perched systems on east side of lab seem to be coincident with channels, but drilling wells in unknown areas to test this. Jim Horner (NMED)verified that the location of R-25 was selected to help understand the recharge.

Michael Dale (NMED) asked for a discussion of the Watershed Plan and how new gages will help with the water balance. Bruce Gallaher (LANL) explained that the existing gages are mostly upstream and downstream of lab boundary. Under the Watershed Plan, new gages will be installed at every major confluence. Data from these gages will help with inflow, although all surface water does not infiltrate and become recharge. Bill Holman (DOE/OAK) asked if the gaging stations extend across the fault. Charlie Nylander (LANL) responded that three sets of gages are planned as pairs for the upstream and downstream sides of the fault. Bruce Gallaher (LANL) said we looked at 1960 seepage data on four canyons with significant stream flow across fault: Frijoles Creek – flow increased, other 3 had no measurable change. Role of the fault may hold up water in perched zone rather than as a major barrier. Based on stream flow data, no indication that the faults have major influence.

Aggregate 1

Pat Longmire (LANL) presented the objectives of the presentation. He described the drilling and sampling of R-9. It appears that the perched zones in the Cerros Del Rio basalt is isolated from regional aquifer based on stable isotopes. The conceptual model cross section of upper Los Alamos Canyon shows the complexity of flow paths in the vadose zone. The Puye Formation had was significantly altered from glass to clay probably because of water flowing through it. Makes great natural barrier for radionuclides. Bill Holman (DOE/OAK) asked if the alteration is in the saturated or unsaturated zone. Pat Longmire (LANL) responded that the alteration was in the saturated zone, although water has obviously moved through the unsaturated zone.

Chemical and radionuclide analyses have been done on core samples collected from R-9, R-12 and R-25. Focused on the important aspects of geochemistry not everything everywhere. Typical background concentrations of selected solutes at LANL: nitrate low, oxalate less than detection, uranium low (<1ppb), tritium varies on source of recharge water and position along flow path. At R-9, the groundwater chemistry has chloride and nitrate elevated above background. Oxalate

elevated in 3 zones. Oxalate occurs naturally in root zone, but not in groundwater. Uranium is high in lower perched zone. Tritium concentration suggests the water is less than 50 years old, most likely fallout and discharges. Strontium, cesium, americium, and plutonium are at or below detection. There is an abundance of reactive phases within core samples in borehole R-9. These are important in retardation because they are geochemically reactive. Dominated by smectite in all 5 depth samples (293-, 507-, 616-, 621-, 689-ft). The Kd is necessary to model transport of contaminants. An example of the Kd is a glass particle coated by clay. The Kd is the amount of uranium sorbed onto clay over the amount of uranium in the fluid surrounding the particle. The retardation factor can be calculated from the Kd with the following equation:

$$\text{Retardation factor} = 1 + (\text{bulk density})\,(\text{Kd})/\ \text{porosity}$$

In R-9, the Kd for uranium = 2.31 L/kg. This is consistent with the concentration of uranium in +6 oxidation state. Bob Charles (EEG) asked how was the oxidation state bracketed. Pat Longmire (LANL) responded that the oxidation state was assumed based on evidence of oxidizing conditions in the groundwater, primarily iron in the 3^+ oxidation state. Pat Longmire (LANL) continued that the Kd concept is simplistic, so now he is using models that simulate surface complexation. In this process, the sorbing surface and the uranium form a complex with iron. MINTECH models this process. Bob Powell (EEG) asked if there has been sorption isotherms measured on recovered core. Pat Longmire (LANL) replied that those types of tests have not been done. This material is based on water chemistry and modeling. However, we should have some experimental data also. Surface complexation modeling of R-9 was done using a diffuse layer model. The modeling result reproduced the dissolved uranium measured in the water.

Pat Longmire (LANL) said that the EPA sampling and analysis event detected strontium-90 in the shallow alluvial water. It also found ammonium and total N above state standards. The groundwater chemistry of R-12 water indicates that the perched zone water is less than 50 years old. This is nitrate from sewage source, possibly TA-3; however, if there is southerly flow in the basalt, the nitrate could be from Pueblo Canyon. Bob Charles (EEG) asked if the southerly flow component is related to the Miocene trough. Pat Longmire (LANL) responded that the perched zone is in the basalts which is stratigraphically much higher than the Miocene trough. David Schafer (EEG) asked if the uranium carbonate complex is mobile. Pat Longmire (LANL) responded that it is relatively mobile. Bill Holman (DOE/OAK) asked if the retardation factor is equal to one for these mobile complexes. Pat Longmire (LANL) responded that the Kd is 2 but the retardation factor hasn't been calculated. Bruce Robinson (LANL) responded that the retardation factor is generally a factor of 10 above Kd, so it would be 20. However, it should not be considered as separate species of uranium. The Kd represents the bulk of all the uranium species present, because the equilibrium reactions occur so quickly. Bob Powell (EEG) pointed out that if the uranium does not display linear sorption, then Kd not valid.

Pat Longmire (LANL) described the alluvial wells that were installed in Pueblo Canyon. Four individual wells and a series of wells in a transect across the canyon.

Aggregate 2

David Rogers (LANL) explained that the contaminant sources in Aggregate 2 are Area L, Area G, and TA-18. A cross section showing the conceptual model illustrates the location of these areas in relation to each other and to other features. Areas G and L are on the mesa top and TA-18 is in a canyon. The FY98 investigation at TA-18 included preparation of the Pajarito Canyon Work Plan. This work plan may be revised to include assessing the water budget for Pajarito and Threemile canyons. There was the culmination of eight quarters of sampling in alluvial wells around a septic system detected no volatile organic compounds (VOC) and the tank will be removed.

David Rogers (LANL) said the FY98 activities at TA-54 focused on Area G, the low-level radioactive waste disposal site consisting of numerous pits dug into the mesa. Area L is the chemical waste handling site and it is located further west, up the mesa from Area G. The mesa that both Areas G and L are located on is in the eastern part of Lab. Air moves through mesa and dries it out. Area G performance assessment was completed in March 1997. The results related to groundwater were:

The rate of recharge through the mesa is low – about 1 mm/yr;
Fractures enhance air movement in the mesa but probably do not enhance infiltration of water;
Air movement along fractures causes evaporation within the mesa and decreases the recharge rate. Chloride and stable isotope studies as well as other hydrologic data support this conclusion; and
Due to high sorption and long travel times relative to half-lives, only carbon-14, technecium-99, and iodine-129 are important radionuclides in the groundwater pathway.

David Rogers(LANL) said that uncertainties were identified in the performance assessment and FY98 activities involved data collection to ensure the continued applicability of the performance assessment to current facility activities, reduce the uncertainties in hydrological modeling and dose assessments, and conduct performance monitoring of Area G. The key uncertainties included rates of liquid water infiltration and vapor phase movement. Generally on the mesa, the moisture is pretty static, but disturbances (cutting pits and asphalt pads) affect the moisture content in the mesa . Other activities focus on monitoring and remediation of VOC plumes beneath Areas G and L. The investigations in FY98 were:

Data for water budget determinations including measurements of vegetative cover and water vapor flux to the atmosphere;
Subsurface moisture content measurements including neutron probes in holes in mesa and pits;
Vapor phase monitoring including VOC monitoring in Area G and L, air pressure data collection, and analysis of data from the Pilot Extraction Study at Area L.

David Rogers (LANL) described the planned FY 99 activities in Aggregate 2. At TA-18 the septic tank will be removed. At TA-54 the collection of water budget data, subsurface moisture measurements, and vapor phase movement will all continue. In addition, shallow stable isotope and chloride profiles will be measured to determine patterns of infiltration; data to quantify the moisture build up under asphalt pads; surface gas/vapor flux processes will be investigated

utilizing natural tracers; and modeling and other work for the Pilot Extraction Study Plan. Pat Longmire (LANL) added that the Lab is looking at whether the modeling at MDA G can be applied to other MDAs. John Young (NMED) asked what the extent of VOC and tritium plumes at Area G and L is. Brent Newman (LANL) said that it is down to the basalt at Area L. Alice Barr (LANL) provided a general idea of the tritium plume extent.

Aggregate 3

Brent Newman (LANL) said that in FY98 most of the work was shallow, not much deep. Aggregate 3 provides an example of a disturbed mesa site. Aggregate 3 consists mostly of TA-49, an area used to test the safety of nuclear devices if they were inadvertently dropped while loading or handling. The testing was done in a series of shafts. Most of the efforts were in Area 2, in what is now Material Disposal Area (MDA) AB. The shafts were open holes of various depths. The site issues include an asphalt pad that was placed over Area 2. Core hole 2 (CH-2), in the center of Area 2 was the focus of FY98 work. Area 2 is poorly graded and allows ponding of water on and around the asphalt pad. CH-2 has sporadically had standing water in it. Investigations in CH-2 included measuring a moisture content profile. There is a near surface spike (>30%) from buildup of moisture under the asphalt. On a couple of occasions CH-2 has had water. If water is collecting in the core hole, is the same thing happening in the shafts? There was a moisture content spike at approximately 100-foot depth. Based on this information interim measures were designed and implemented. The asphalt was removed, the areas regraded to control surface water run-on, a new crushed tuff cover was installed, and the area was re-vegetated. The new cover included gopher mesh because gopher intrusions were bringing up contaminated soil.

Brent Newman (LANL) described the future work at TA-49, MDA AB. Some of the work includes drilling horizontal holes beneath the shafts to measure water content. David Schafer (EEG) noted that it is difficult to grout horizontal holes.

Bill Holman (DOE/OAK) asked if the moisture content at 100ft is stratigraphically controlled. Brent Newman (LANL) replied that it is near a contact and it is common around the Lab to find increased moisture content at the contact of units with different hydrologic properties. CH-2 has been plugged, so we can not go back and verify the exact nature of the contact. John Young (NMED) asked about measurements of tritium profiles. Brent Newman (LANL) said he was not familiar with that work and could not address it. Michael Dale (NMED) asked what material CH-2 was backfilled with.
Brent Newman (LANL) responded that is was backfilled with sand and concrete plugs.
Kim Hill (NMED) asked the depth of CH-2 at Area 2. Steve Rae (LANL) responded that information is in the surveillance report.

Aggregate 4

Bruce Gallaher (LANL) explained that Aggregate 4 is in the southeast corner of the Lab. It includes two technical areas: TA-33 for tritium production and TA-39, a canyon site for high

explosives work. One concern in TA-39 is landfills with high explosives residues. In FY98, alluvial wells were checked for saturation in the North Branch of Ancho Canyon. All of the wells were dry. The stream flow in the canyon is very limited. Consequently there is not much shallow groundwater. Previous (1995) sampling at Ancho Spring detected HE. Follow up testing in last 3 years (1996, 1997, and 1998) have detected no HE. ER sampling of stream sediments detected no HE. Two deep boreholes are planned for this aggregate. R-31 will be drilled this year. The depth to the regional aquifer is expected to be about 600ft.

Aggregate 5

Brent Newman (LANL) explained that TA-16 is the subject of a special topic presentation on Tuesday afternoon, this presentation will be brief. Aggregate 5 consists of TA-16, which is bounded by the Pajarito Fault Zone, Water Canyon, and Canon de Valle. There are numerous sources of water for recharge including springs, surface water, and other water sources. SWSC Spring and Burning Ground Spring are contaminated with HE, and both are perennial. Martin Spring is perennial, and it has the highest HE content of the springs. The 90's line pond was another source of water. It contained HE and barium. The 260 outfall was another large volume source of water. Water was used while machining the HE to keep it cool. The water from machining collected in sump to settle the particulates and then discharged onto the mesa. The historic flow rates for major TA-16 water sources was very substantial effluent discharges and these had a large impact on hydrologic system. Investigations of soil and shallow subsurface around the 260 outfall found screening and lab results above detection limits and background values for bore hole 16-2702; particularly RDX at about 70ft below land surface. A trend plot for RDX in outfall drainage sediments shows a trend of decreasing HE concentration downstream. Laterally the concentrations drop off dramatically away from center of stream (sharp decreases in samples collected more than 12ft from the center line of the drainage).

Brent Newman (LANL) described a tracer study conducted at the springs. A bromide tracer was injected into the suspected source area (260 outfall) and the springs were sampled until the tracer appeared. A plot of bromide concentration versus time for SWSC spring shows there is a definite connection between the 260 outfall and SWSC spring. Burning Ground Spring is borderline and Martin Spring does not appear to be related to 260 outfall. There was a question about whether the break through in the spring was related to rainfall. Brent Newman (LANL) responded that it did not appear to be related to rainfall because the matrix was quite dry. The connection between the outfall and the springs may be related to transient moisture along fractures.

Brent Newman (LANL) continued discussing Cañon de Valle investigations, which involved shallow alluvial water and sediments. In the alluvial water, RDX and HMX were present. There was up to 600 mg/l in some water samples. However, there is variability over time, possibly as a result of different flow paths kicking in. Barium was present in sediments in concentration high enough to precipitate minerals. The barium is probably from Baratol, which has not been used for awhile. The residence time of barium is longer than HE. Geochemical modeling confirms barium precipitating. A curious observation is that water samples were undersaturated with respect to witherite, but witherite was precipitating in the soil. This maybe due to seasonal drop in water level. When water level goes back up, it dissolves the witherite. Scanning Electron

Microscope finds dissolution pits. This could explain why barium concentration varies at same place.

Brent Newman (LANL) briefly described the R-25 distribution of HE compounds detected in the upper saturated zone and in the regional aquifer. He also listed the Aggregate 5 previous activities and documents and the ongoing and upcoming activities.

Aggregate 6

Bill Stone (LANL) explained that Aggregate 6 is the Open Burning/Open Detonation (OB/OD) area. There were no FY98 activities planned, but this aggregate is using Aggregate 5 information from alluvial wells and sediment sampling. The conceptual model for this area is generally supported, but it is more complex. Transport appears to be controlled by fractures.

Aggregate 7

Bill Stone (LANL) said that Aggregate 7 is Mortandad Canyon, which is second only to Los Alamos Canyon for priority within the ER Project. Mortandad Canyon receives outfall from the TA-50 radioactive liquid wastewater treatment plant. In FY98 there was unsaturated zone modeling which suggests that contamination may get down deeper and quicker. Phase 1 of R-15 was completed. It was drilled with hollow stem auger, and will be completed with the Barber drill rig. Samples were collected for to measure moisture content, hydraulic properties, and chemistry. The conceptual model was essentially confirmed except there was no water in the Cerro Toledo. The borehole location may be too far from the side of the canyon where recharge is optimal.

Pat Longmire (LANL) said that based on the drilling and sampling of R-15, vapor phase transport of radionuclides (excluding tritium) is not occurring at R-15. The tritium content with depth shows spikes at the Tshirege unit 1G/Cerro Toledo Interval contact, Cerro Toledo Interval/Otowi Member contact, and at 350ft. The earlier study by Alan Stoker also found high tritium, but the holes were closer to stream channel. EPA did sampling and analysis of shallow alluvial groundwater. The results showed nitrate and strontium distributions. These results confirm the long-term surveillance and AIP sampling. Nitrate isotopes can be used to determine sources (sewage is enriched in ^{15}N). Nitric acid plots near zero (not enriched in either ^{14}N or ^{15}N isotope). The nitrogen chemistry and nitrogen isotopes for selected surface waters and groundwater shows that there is more enrichment of ^{14}N as you go down the canyon. This was the isotopically lightest $^{14}N/^{15}N$ ration that the analytical laboratory (Coastal Science Laboratories) had ever measured. Research into early Laboratory research turned up a previous Lab program to separate ^{14}N and ^{15}N. The ^{15}N was used and the ^{14}N was sent to TA-50, and hence was discharged to Mortandad canyon. This gives indication of residence time.

Aggregate 8

Steve McLin (LANL) said that Aggregate 8 is in the northern portion of the Lab. It includes Guaje, Rendija, and Barrancas canyons. Four water supply wells were drilled and installed to replace old wells. One of the old wells, G-3, will become ESH-18 observation well. A cross section through GR-1, GR-4, GR-3, and GR-2 shows the Chaquehui Formation thickens and there are more frequent basalts. The spinner log from GR-2 shows that 95% of water is being produced out of upper zone of Chaquehui Formation. Sieve analysis results show how much of the material is fine grained. A diagram of the well construction was presented. A pumping test was conducted using the old production wells as observation wells. Because the observation wells are constructed similarly and are screened over the same interval as the pumping well, these test results can be used to calculate storage coefficient. A step drawdown test was also done which is good for well design and to see where water occurs. Most water from is from the uppermost part of Santa Fe Group. The transmissivity is up to 13,200 gpd/ft. Michael Dale (NMED) asked if the other G wells were used as observation wells. Steve McLin (LANL) responded that both G-3 and G-4 were used - they are fully penetrating and constructed similarly to the pumping well. Michael Dale (NMED) asked if there was consideration of using the LA wells as observation wells. Steve McLin (LANL) responded that the LA wells are too far away and they are located in a zone of upwelling, so they would not be very good for observation well.

NMED activities

Michael Dale (NMED) described the activities of the DOE Oversight Bureau (DOE/OB). These activities include review of documents, data collection, split sampling with ESH-18, groundwater, surface water, sediment split sampling at R wells, split sampling with background group, split sampling at TA-16 springs, sediments; and independent surface water sampling at Santa Clara Pueblo and in Los Alamos Canyon. There was not much independent stormwater sampling because there was no rain. The DOE/OB also recommended sampling areas to EPA. The technical reviews that were completed were:

MDA AB asphalt pad
Mortandad Canyon RFI
DP Canyon SAP
SWEIS
CMS 260 outfall

One publication by DOE/OB was about the Cañon de Valle stream. The 1998 data was released. Planned activities for 1999 include:

Review the draft Watershed Management Plan
Review the Pajarito Canyon Work Plan
Split samples with all groups, but focus on R-wells
Independent surface water sampling
Spring sampling in White Rock Canyon to confirm Frasier Goff's work

Charlie Nylander (LANL) asked how the DOE/OB documents and data releases are accessible. Michael Dale (NMED) responded that there is a web site through DOE. The annual report is on web site. Trying to get all data on Web site. Charlie Nylander (LANL) asked for a description of the role of the Oversight Bureau. Michael Dale (NMED) responded that it is non-regulatory. Review documents for content and accuracy. Provide input to anyone who wants it. Steve Yanicak (NMED) added that DOE/OB plays more of a consultant role. Karen Agogino (DOE/AL) asked how the split sample results compared to LANL results. Michael Dale (NMED) responded that they are trying to compare the 1994 and 1995 LANL and OB data. Doing statistical tests, student T-tests with ESH-18 data, match up well. Looking at cutting back on that type of sampling and focus on R-wells or other areas. Meeting at end of next month with DOE, Pueblos, and NMED to discuss data comparison. This year will compile 1996-1997 data with statistical analysis. Steve Yanicak (NMED) added that DOE/OB uses different labs to analyze split samples. The HE analyses are matching quite well.

John Young (NMED) talked about the Hazardous and Radioactive Material Bureau (HRMB) activities. HRMB mostly reviews documents. In FY98, HRMB did collect samples of springs in White Rock Canyon. This year there is $10,000 to spend in conjunction with DOE/OB for sampling in White Rock Canyon. The staffing level has just been increased by 2 1/2 people. However, that won't help on Hydrogeologic Workplan, because those people will be working on the permit. HRMB's position with respect to a number of issues is:

- Prioritization of Hydrogeologic Workplan activities: we will do whatever it takes to get another rig in. The drilling is falling behind in schedule, the drilling schedule could even be in the new permit.
- R-25 results: we are not sure on what wells are going to come next, would like resolution on that.
- Intermediate wells at R-9: the intermediate zones are important and R-9 is on the Lab boundary. Data from intermediate zones would help the modeling and could identify significant problems.
- Reusing test wells: This seems like a worthwhile endeavor, and the Lab needs to pursue that.
- Analyses not done: It is important to have the hydrologic properties; testing should be expedited.
- Prioritization scheme: Needs to be reassessed as ER project is doing.
- Plume Chasing: Identify mechanism to approach further investigations without stopping progress on the Hydrogeologic Workplan. Only have a single data point in R-well and don't know where the plume is or how big. Not responsible on our part to let it sit. Need approach to remediate or protect down gradient wells.

Brent Newman (LANL) said that a discussion on actions to define the HE plume at TA-16 will occur tomorrow. Pat Longmire (LANL) asked about time frames for reviewing documents. John Young (NMED) responded that reviews are on hold because risk assessor has been reassigned. Documents that rely on her review are on hold. Recognize these are high priority.

Kim Hill (NMED) described what the Bureau has been doing. Big priority issues and topics:

- 102 NFAs accomplished, will be looking at 400+ this year
- Developing guidance documents: PCBs, ecorisk
- Canyons: R wells, 260 outfall, *in situ* vitrification
- Prioritization with ER: shift from looking at old documents to documents that need to be looked at right now
- ER reorganization to watersheds, related to annual unit audit
- Permit re-issuance
- Looking at old documents to see if some can be put together

Dave Broxton (LANL) asked about the schedule for permit re-issuance. Kim Hill (NMED) responded that it is expected early next summer. John Young (NMED) added that the permit re-issuance will be broken up. NMED learned through the WIPP hearings that there is public distrust of LANL, so we expect a long time to get through that. Kim Hill (NMED) said the permit needs improvements, for example the HSWA module. Alice Barr (LANL) asked if the ecorisk guidance just for HRMB or will all of NMED be using it. Kim Hill (NMED) said that HRMB is writing the guidance, but will get review from all bureaus. It will be a RCRA-oriented document. Steve Yanicak (NMED) asked how many HRMB staff there are for LANL. Kim Hill (NMED) responded there is Kieling and 8 people. New folks just started - don't know how it will be divided up.

All Parties Discussion – Results of EEG Meeting with Stakeholders

The EEG met with all non-DOE, non-LANL stakeholders present at the meeting. These included representatives from NMED/HRMB, NMED/DOE-OB, Santa Clara Pueblo, San Idelfonso Pueblo, Citizens Advisory Board, and Los Alamos County. The positive and unresolved issues from the board were:

Positive Issues	Unresolved Issues
Data exchange improving	Parking of wells
Hydrogeologic Workplan is a plus	Cost of drilling/Information
Nylander – good job trying to coordinate	Quarterly meetings are too large – should be working session
Team work with LANL	Prioritization of drilling – Land transfer and canyon RFI reports
External stakeholder involvement	Plume chasing not defined
Web site	Funding between ER and DP not transferable
Data Base improvement – read and understand	Sampling of supply wells
Change in upper management (Canepa)	Stakeholders not consulted on database structure
Scientists	Use or misuse of large screened wells
Communications upper management should know (LANL, NMED)	Intermediate wells
Progress has been made	Scope of investigation of 260 outfall
Unresolved issues partly non-LANL (use	Drilling rebid/reevaluation

of Barber rig) Spirit of cooperation Prioritization Scheme Iterative nature Geochemistry EEG formulation	Modeling shouldn't be substituted for monitoring Structure and DQOs for modeling Technical calls made by the wrong person at the drill site Information from downhole logging especially for multiport systems Temporary PVC casing in R-9 and R-12 Decision to use Barber rig Communication Cochiti not here Recharge from Jemez needs clarification Dry mesas regarding no transport of waste R-25: remediation/treatment Share more information about contamination of aquifer Guaje information: uncertainty about whether data has been collected Quality of historical data: collection methods, analysis, reporting, validation GIT too large – affects decision making Data Collection – distribution delays, compartmentalization, not available to regulators Individual meetings with CAB, State

Bob Charles (EEG) facilitated the discussion of the unresolved issues. The issue on communication is based on the feeling that the Quarterly Meetings are too large for working meetings. Charlie Nylander responded that the Quarterly Meetings were added because HRMB felt one meeting per year was not enough. The intent was to communicate progress. There is communication on a daily basis, but the Quarterly Meetings are for communicating progress. At the last Quarterly Meeting there was concern expressed by NMED about being pinned down, perhaps this concern could be addressed by measures other than reducing number of attendees. For example:

Prior to the meeting, distribute an agenda with issues to be discussed and resolved
Formally communicate proposed resolutions after meetings

John Young (NMED) said that when having technical discussions, it is more productive with free flow of discussion between decision makers. The most productive meeting was the June Quarterly Meeting. We are not opposed to having informational meetings, but need to have smaller working sessions also. Charlie Nylander (LANL) suggested that the informational Quarterly Meeting could be preview for a working meeting the following week or so. In that way we can get input from the Pueblos and the CAB to consider in making decisions. John Young (NMED) said that would work.

Bob Charles (EEG) said the next unresolved issue is in regard to the Hydrogeologic Workplan prioritization– the criteria in Workplan need to be adjusted to reflect current thinking and to coordinate with Canyons. There is deferral of ER work until wells are in. Charlie Nylander (LANL) responded that the original criteria are still valid. The scores haven't changed, but other things have. There are budget constraints – the program is one well behind because ER funding lower than expected. Threatened and endangered species – spotted owl- constrains timing of some wells. Mike Taylor (NMED) pointed out that the criteria do not include meeting regulatory requirements. Charlie Nylander (LANL) responded that it is a characterization work plan, so the entire work plan is the response to regulatory requirements. John Young (NMED) pointed out that the Hydrogeologic Workplan fulfills regulatory requirements under RCRA and HSWA. Charlie Nylander (LANL) said that the denial of the groundwater waivers was based on inadequate characterization, and that is the point of this program. Paul Schumann (LANL) suggested that we could explicitly point out how each well (on completion) meets the criteria. This information could be in the well completion reports or the Annual Status Report. Charlie Nylander (LANL) said that the Annual Report includes summaries of the Quarterly Meeting minutes that documents discussions and agreements of reprioritization. An example is R-15, which was moved up because the State was feeling pressure form public concern on Mortandad Canyon. We should try to keep reprioritization somewhat formal and not haphazard. The table in the Annual Report reflects the criteria and other factors in developing the well drilling schedule.

John Young (NMED) suggested changing the criteria so the RFI reports can be completed or to fit on watershed basis. Charlie Nylander (LANL) said there is flexibility to reprioritizing based on ER work, but it must be balanced against the objectives of the Hydrogeologic Workplan. Dave Broxton (LANL) said that the ER roadmapping suggests decoupling the groundwater. So an RFI report would have sediment, surface water and alluvial groundwater. That way RFI could be completed without the deep groundwater. The Hydrogeologic Workplan criteria purposely did not include ER work. Is it supposed to be plateau-wide with priority based on importance in understanding the hydrogeologic system.

Bob Charles (EEG) said the next unresolved issue is that stakeholders were not consulted in the database. Ken Mullen (LANL) said that for the User Needs Assessment, John Parker at NMED was asked for a list of people to interview. Those people were interviewed. But the structure of the database has not been finalized and this can be corrected. Charlie Nylander (LANL) said we can have a meeting to discuss that.

Bob Charles (EEG) said there was a concern that representatives from the Cochiti Pueblo are not here. Charlie Nylander said they were invited but could not come.

Bob Charles (EEG) explained that the next issue is there should be more sharing of information about contamination of aquifer. There should be more visibility of program within the lab; crossing program lines. Ken Mullen (LANL) responded that the data is not centralized, so it is just as difficult for stakeholders as for us to find the data. Charlie Nylander said there is an issue about when to communicate preliminary data. We can provide validated data to NMED and Pueblos at same time. Releasing preliminary data runs the risk that the data would change as a result of validation. The real problem comes in near the bottom of the borehole when have to use

preliminary data to make decisions about well completion. We feel comfortable sharing this type of preliminary data with NMED and other stakeholders. Pat Longmire (LANL) said the validation takes one day after complete data packages are in. An example of where this was a problem was on R-9 when two labs had different tritium results. One lab finally said they had contaminated the sample. Charlie Nylander (LANL) said the goal to get data out to everyone who wants to see it as soon as we can. Gil Suazo (LANL) asked when do you share data. Charlie Nylander (LANL) said we share validated data as soon as it is available, until the bottom of the hole, then we have to use the preliminary data. We would like to share preliminary data, but are concerned about premature release of data to the newspaper or other media. Gil Suazo (LANL) pointed out that on the Area G work the Pueblos looked at raw data and had MOU about not releasing the data. That could work. Charlie Nylander (LANL) said we are confident that we can share preliminary data because working better with tribal environmental departments. Bob Powell (EEG) pointed out that people should not want to see unvalidated data. In my experience I have seen tons of bad data from labs. Betty Anderson (EEG) suggested data release could be a process rather than a schedule, that would reduce disappointment when data is received late. A process could be:

Collect data
Process issues Agreement leading to release within LANL
Sharing procedures intra LANL
Release data externally

Charlie Nylander (LANL) said the concern is the time between preliminary and validated data, it could lead to unnecessary angst. Steve Yanicak (NMED) pointed out the DOE/OB experience with labs has led to coordinating with LANL on results. Ken Mullen (LANL) said that at the speed of groundwater movement, 30 days isn't going to make a difference. Just because it is validated data, doesn't mean it is right. Should sample again to confirm. Bob Charles (EEG) said there were a number of unresolved data issues. Perhaps these could be worked out by a smaller group. Steve Yanicak (NMED) said the Oversight Bureau is happy with the level of data now. Charlie Nylander (LANL) said the Oversight Bureau provides communication within Lab on data.

Bob Charles (EEG) said another unresolved issue is compartmentalism. It seems to be unnecessary when one part of the Lab has money that it can't be used to drill another well. Charlie Nylander (LANL) responded that the characterization program has funding for 4 wells each year. If the characterization program goes on, how does further investigation occur? At TA-16, ER is developing plan for further investigation. Also, GIT moved up another R-well. For FY2000, will drill R-19 and R-27 in first half of year. Still may be concern about these wells not close enough to R-25. Open to suggestions. Have asked DOE for additional funding for the year. ER program has expedited CMS.

Dave Broxton (LANL) pointed out that the two wells for next year (R-27, R-19) will not allow progress in Los Alamos Canyon. Charlie Nylander said we can't transfer funding between DP and ER. Some years ago, at DOE Headquarters, DP (the site landlord) gave EM half their budget. Now EM has to go to Congress to get funding. DP expects EM to take care of themselves. Bill Holman (DOE/OAK) said that EM is responsible for investigation, cleanup and

waste management. DP has responsibility for characterization and some sentry wells, but doesn't want to pay for finding out where contamination is.

Gene Turner (DOE/LAAO) said DP money has to be reprogrammed in Congress to go to EM. Bill Holman (DOE/OAK) added that DP has an interest in continuing the wells in the Workplan. DP doesn't want to put in sentry wells without knowing they are in right place.

John Young (NMED) said the money is not flexible because can't change which program pays for a specific well. Chris Hanlon – Meyer (NMED) suggested that the wells with greater priority could be drilled by the program that has the funding. Charlie Nylander (LANL) said we will drill an intermediate well in LA Canyon in FY2000. Have some criteria on when to drill intermediate to discuss this afternoon. When developing the Hydrogeologic Workplan we originally had intermediate wells, but chose to go to regional aquifer because that would provide much more information for the characterization of the groundwater system. Additionally, this approach saved $10 million. We recognize the need to monitor intermediate zones and there is a philosophical commitment to intermediate wells. By early Fall FY2002 hopefully will have met intermediate well needs for the 3 locations with R-wells now.

Special Presentations

TA-16 investigations

Brent Newman (LANL) presented material on the investigations at TA-16 to look for groundwater contaminant sources. A hydrogeologic conceptual model for TA-16 showed many possible flow paths by which surface water could be migrating downward and many possible sources of HE contamination on the TA-16 mesa top. He discussed that the alluvial aquifer in Cañon de Valle, water from the Jemez, ribbons of saturation within the mesa above the level of the canyon bottoms, water within the surge beds of the Tshirege Member, the bedding contact between units 3 and 4 of the Tshirege Member, and fractures are all possible sources and pathways by which surface water can reach perched zones and possibly the regional aquifer. He discussed that the alluvial system in Cañon de Valle is the most important pathway for contaminant transport from the 260 outfall.

Hydrologic properties of the Bandelier Tuff beneath TA-16 showed that significant variations (5 orders of magnitude) in permeability existed within and across bedding units with highest permeabilities associated with partially welded beds and surge beds. HE screening results from boreholes showed that hits were random with depth.

A viewgraph of concentration vs. daily flow at SWSC spring showed that, in the case of RDX, concentrations vary with flow volume, i.e., decreased concentrations with higher volume. Four boreholes were drilled on the mesa top to look for the sources of water feeding springs. The Martin Spring Borehole (16-2665) hit HE-rich water at 100 ft. $\delta\ ^{18}O$ concentrations suggest that this water is from an evaporated surface source such as an evaporation pond. Lack of correlating Cl concentrations supports this hypothesis. The isotopic ratios of water found at depth are similar

to those found in water in the 90s-line pond suggesting the pond as the source. Similar HE concentrations support this hypothesis.

John Young (NMED) asked if isotopic composition of borehole water had been compared to that of the springs. Brent Newman (LANL) said it had been done and that the isotopic compositions were very different.

R-25 Status

David Broxton (LANL) gave a brief summary of the status of the R-25 borehole and the stratigraphy encountered at TA-16. The borehole is scheduled for completion as a multiple-port well with nine sampling ports. Broxton discussed that the stratigraphy encountered varied significantly from that expected. The original borehole depth was to be 1550 ft. The borehole's final depth is 1940 ft. Neither Santa Fe Group sediments nor the Tschicoma formation were encountered as expected. The Puye Fm was much thicker than expected and the borehole will be completed in the Puye Fm. The borehole is expected to be completed by the end of April, 1999.

R-25 Geochemistry

Pat Longmire (LANL) reiterated that HE was found in R-25. Compounds found included RDX, HMX, and TNT. RDX does not adhere to the aquifer materials but instead moves at the same rate as the groundwater. Two zones of RDX contamination were found in R-25, one in the perched zone and one in the regional aquifer. The nitrate found is from a nitric acid source associated with the manufacture of TNT and RDX.

An age date for the water in R-25 is still needed. Robert Powell (EEG) asked why there was a zone at 1300 ft where all the contaminants were reduced. Pat Longmire (LANL) said that currently they don't know why. Pat Longmire (LANL) said vertical gradients affect the concentrations of contaminants found in the aquifer and that the vertical gradient in R-25 is downward.

R-25 Water Levels

Bill Stone (LANL) said that the regional aquifer was encountered 600 ft higher than expected but that the water level is consistent with water encountered during the drilling of SHB-3. One explanation for the unexpected water level is that the discharges of liquid waste over the years has created a ground-water mound.

The next issue is to determine whether the high water level encountered in R-25 is perched water or a mound in the regional aquifer. Normally the way to do this is to use a group of piezometers (tubes open at the bottom). A well in which the casing is being advanced while drilling is an infinite set of piezometers. There is considerable water level data for R-25 but it is "noisy".

The water level data from R-25 was filtered by 1) length of open hole, 2) Pre-measurement activity in the hole, and 3) time elapsed between activity and measurement. The implications are that the gradient is variable being gentle at the top, steep in the area where unsaturated conditions are observed, and gentle again at depth. Further work is still needed. The filtered water level data will be used together with water level data at nearby down-gradient well to construct isopotentials in cross section and determine the hydraulic gradient and calculate flow velocity.

R-25 Implications on CMS Plan

Brent Newman (LANL) said that the findings of HE in R-25 did not alter planned Corrective Measure Study activities in any major way. R-25 results reinforce the need for the Phase III activities described in the CMS Plan, i.e., identify the impacts of the 260 outfall source removal and better characterization of vadoze zone and alluvial system contaminant inventories and pathways.

The CMS plan activities will be expanded to address deep subsurface issues. The CMS team is evaluating whether the best way to do this would be to add an addendum to the existing plan or to do a separate CMS.

The CMS team is currently developing DQOs for additional deep boreholes at TA-16 to define the extent of contamination in the perched zone and regional aquifer and to establish contaminant and water flow directions and rates. Candidate sites for the boreholes include the source area for the 260 outfall, K-site, and TA-15.

Jim Horner (NMED) asked about the HE detections in samples from the bottom of the well. Michael Dale (NMED) asked about the appearance of foam and its indications of cross contamination between groundwater zones. Bob Gilkeson (LANL) said that it was not "foam" but rather a cellulose material and it was found between 1300 and 1500 ft depth. He went on to explain that the hole was drilled with three telescoping casings and that the method to prevent cross contamination was to keep the annular space plugged. When the last casing started to bind, they did back reaming which showed communication between zones because the "foam" that was placed in the second saturation zone showed up in the cuttings. He said that the best samples for analyzing for HE are collected during drilling.

Los Alamos-Pueblo Canyon Model Update

Bruce Robinson (LANL) presented the updated LA-Pueblo Canyon Model. He said the model now includes vadose zone pathways and most work has been done in lower Los Alamos Canyon. The objectives of the modeling project include: simulation of observed and potential contaminant transport, examining alternative conceptual models, linking canyon flow and transport models to more detailed models, and producing a model to use for risk assessment.

Conceptual model issues that still need to be resolved include: fracture vs. matrix flow, interconnection between perched zones and the regional aquifer, structural controls on the

intermediate perched zones, transient flow and transport in the alluvial perched zones, and aqueous and colloid transport. A specific sampling technique is needed to provide the appropriate data to resolve the colloid transport issue. Robert Powell (EEG) expressed concern about sampling techniques. He said it is important that the appropriate sampling technique be done to in address transport issues.

Bruce Robinson (LANL) showed the 3-D model grid development. The synthesis of water budget study shows areas of recharge to be along the canyon bottoms. The initial steady state flow model has been developed, transport pathways have been simulated, and available data assessed. Future activities will include: developing the 3-D model, 2-D transient simulations, incorporation of additional R-9 data, perched water modeling, and compiling contaminant source terms.

David Schafer (EEG) asked what code was being used. Bruce Robinson (LANL) said they were using the FEHM code. Robert Powell (EEG) asked if they had adequate resources to accomplish all the planned activities. Bruce Robinson (LANL) said that the modeling program moves at the same speed as the data becomes available and that things will get done when they get done. Bill Holman (EEG) asked if actual hydraulic properties for the intermediate perched zones had been plugged into the model other than just from R-9. Bruce Robinson (LANL) said not in lower Los Alamos Canyon but that they could get information from other older wells upgradient that had hit perched zones.

Geophysical Logging of New Guaje Wells

Rick Lewis (Schlumberger) presented a large well log plot for Well GR-2 which included logs for borehole size; washouts; gamma ray; resistivity curve; porosity by 1) density measurements, 2) neutron source, 3) sonic log; mineralogy; lithology; permeability; fracture locations due to porosity of open fractures; spinner log; fracture orientation; magnetic resonance imagry for pore size; porosity components.

Jim Horner (NMED) asked if perched zones could be detected reliably. Rick Lewis (Schlumberger) said yes. Charlie Nylander (LANL) placed the viewgraph showing the general data needs identified for the boreholes to be drilled and asked if the geophysical tools used in logging could provide those data needs. Rick Lewis (Schlumberger) said can provide information on geochemistry by cation exchange capacity, bulk geochemistry, and microbial geochemistry. He said can also provide information on stratigraphy, lithology, water levels, hydraulic properties, and presence of perched zones. Charlie Nylander (LANL) said that methods might be prohibitive with telescoping casing and odex casing but that some data needs can be accomplished using geophysical logging. He said that the drilling schedule for FY00 is R-19, R-27, R-28, and R-5.

Sitewide Geologic Model

Greg Cole (LANL) presented the sitewide geologic model and the work that has been done thus far to get the model into its present condition. As many as eight sources of data dating back to 1964 have been merged spatially and by unit names. New data and fault offsets from FY97 were incorporated into the model. In FY98 the focus was mainly on resolution of geologic inconsistencies and incorporation of new drilling data and preliminary basalt data.

Greg Cole (LANL) discussed data extent and location. The largest number of points were from the 25-sheet surface geology maps of Rogers. The greatest areal extent was from Griggs. The base of the Tshirege and Otowi members of the Bandelier Tuff were from Broxton and Reneau. Drill holes provide data support for mid-mesa areas. Approximately 100 drill holes were used to QA the data.

In FY97, efforts included incorporation of fault data and new data to the southwest and northwest. Staff geologists evaluated the data to develop individual surfaces. Partial schematic model for the pre-Bandelier units was created. Also in FY97, efforts were focused on developing model visualization tools and outputs.

In FY98, efforts were focused on adding new drilling results and further developing the preliminary basalt model. Contacts were digitized and QA'd. The 3-D positions of surface outcrops and drill hole intersections were created using Data Explorer. Contours of subsurface unit surfaces generated using 2-D maps and borehole data.

FY99 efforts will include further study of pre-Bandelier data; model quality checks including data from R-9, R-12, R-25, and R-15; creation of a hydrogeologic atlas and web page, further development of the 3-D stratamodel incorporating data from the northwest corner of Lab, continued correlation with the Española basin model, and revision of the basalt and Tschicoma models based on chemical, petrological and age data.

Fiscal Year 1999 Plans

Charlie Nylander (LANL) presented the drilling plans for FY99. First complete R-25, next complete R-9, next drill and complete R-15. The current plans are to accelerate R-31 because it is close to the boundary and useful to the modelers. R-31 will be done in early October 1999. Some well switching will occur in FY00 due to endangered species areas and mating seasons.

John Young (NMED) asked when R-12 will be completed. David Broxton (LANL) said it is not scheduled for completion until late in FY00. There were no comments on the schedule for R-25, R-9, and R-15. Charlie Nylander (LANL) said there is concurrence on the drilling schedule for R-25, R-9, and R-15 and asked NMED to comment on the plans to drill R-31 in FY99. John Young (NMED) said they would need more time because this is the first they had heard of it. Robert Powell (EEG) asked if Fish and Wildlife comes in to do the endangered species surveys. Charlie Nylander (LANL) said no, that the Laboratory has their own group, ESH-20, that does the surveys. Michael Dale (NMED) asked about the finishing schedule for R-25. Charlie

Nylander (LANL) said that R-25 will be finished in April, then R-9 will be deepened by 60ft and completed. Chris Hanlon-Meyer (NMED) said that the NMED has not discussed the drilling schedule. Bob Charles (EEG) will compile the list of issues developed during the Open Forum meeting between the EEG and the State and Pueblos. Charlie Nylander (LANL) will develop and action plan to address the issues. Steve Yanicak (NMED) said the Open Forum issues for FY99 should be segregated out.

Westbay Multiple Completion Wells

Frank Patton (Westbay) gave EEG members an overview of the construction and installation procedure for a Westbay multiple port sampling system using the planned completion of R-25 as a specific example. Installation in R-25 will be inside a casing rather than in an open borehole. Each of the sampling ports will have an automated pressure probe. There will be a sampling probe for the well which is lowered from the surface down to each sampling port. There will be some error associated with the piezometric head measurements.

David Schafer (EEG) asked what the maximum outer diameter would be. Frank Patton (Westbay) said the well would be 5 inch outer diameter, 4.3 inch inner diameter.

EEG/GIT Discussion of Action Plan

Charlie Nylander (LANL) reviewed the EEG's recommendations from the EEG's Semi Annual Report and discussed how the LANL GIT is addressing them. The recommendations and GIT actions included:

1) Continue communication with stakeholders –meetings with the NMED occur quarterly and that the NMED is involved on a monthly basis with the drilling program. Other stakeholders have been and will continue to be invited to the quarterly and annual meetings.

2) Reach agreement with NMED on MCLs – Agreement has not been made with the NMED on MCLs although the issue has been raised at the last quarterly meeting. The Lab is currently determining background values upon which to base action levels.

3) Have NMED representatives at next EEG meeting – the NMED will be invited to the next EEG meeting.

4) Describe how the groundwater program fits in the Lab – Charlie Nylander (LANL) described how the groundwater program fits in the lab and the interrelation between the Hydrogeologic Workplan, the Groundwater Protection Management Program, and the Monitoring Well Installation Project.

5) Have stakeholder identification map – Charlie Nylander (LANL) showed a Groundwater Characterization Stakeholder Identification map showing funding stakeholders, Regulatory Stakeholders, Proximity Stakeholders, Concerned Stakeholders, and Tax Payer Stakeholders.

Bob Charles (EEG) said they wanted to see the structure of the internal stakeholders within the Laboratory such as ER and DP.

6) Sequence of priorities consistent with Tables 4.1 and 4.2 – Tables 4.1 and 4.2 from the Hydrogeologic Workplan will be updated annually to reflect the progress of the drilling program and any changes in well priorities or scheduling. The updated tables will be included in the Groundwater Annual Status Report each year.

7) Develop contingency for intermediate zones – The GIT recognizes the need to develop an approach for further investigation of intermediate perched zones when contamination is encountered.

8) Use low-flow purging and sampling and passive sampling – The laboratory currently uses sampling techniques consistent with those used in the past and that will produce the quality of data needed to meet the DQOs, and are satisfactory to the NMED and stakeholders. The GIT would need help developing a technically-convincing case for using these techniques to present to the NMED.

9) Log and evaluate core asap after retrieval – The GIT concurs. Currently, core is logged as soon as it comes out of the hole and sections that are of interest are preserved for future analysis.

10) Use cement seals if bentonite fails – Cement seals and other types of seals will be considered if the bentonite seals are not adequate. Currently the bentonite seals have been effective in the first three wells.

11) Review data needs and scope of characterization – Charlie Nylander (LANL) said that the DQOs needed to be revisited to make sure that we were collecting the data we needed and using efficient methods. A discussion of drilling methods needed to meet data objectives pursued and Jack Powers (EEG) said that at least 6 wells should be drilled before evaluating what changes are needed. Pat Longmire (LANL) said that, in the case of drilling satellite wells, not as much characterization would be needed and a faster drilling method could be used, especially if not expecting any contamination.

12) Avoid mud-rotary drilling – The GIT does not intend to use mud-rotary drilling in boreholes where sampling and core characterization are required. If on some wells it is decided that not as much characterization data is needed, then mud-rotary might be considered.

13) Westbay systems should be demonstrated and understood – Several steps have been taken to become familiar with the Westbay system including hosting Westbay representatives to explain the system and how it works, and visiting a site where the Westbay system is being used. The Westbay system is going to be installed in R-25 and potentially two or three other wells.

14) Incorporate historical data in FIMAD and improve accessibility –The GIT has been working on this issue and has made progress. A GIT data management subcommittee has been formed that Ken Mullen (LANL) is leading. The goal is for the data collected under this program to be

available through the internet. Ken Mullen's earlier presentation at the Annual Meeting gave the status.

15) Have back-ups for 3-person drilling crew – The GIT is in the process of building another drilling crew to help accommodate the ramped-up drilling schedule.

16) Complete wells with metal fittings – EEG members voiced support to use steel casing. David Schafer (EEG) will review the well construction for R-25 to verify the appropriateness for other wells. Currently, metal fittings are planned for all casings. The use of PVC fittings would be considered on a case-by-case basis and stakeholder input would be sought.

17) Place filter packs to account for settling – The GIT is using 5 feet of filter pack and sand above the screened interval. This should be sufficient to accommodate settling of materials.

18) Benchmark costs-to-date against similar activities – LANL will continue to benchmark costs. Costs will be compared to drilling programs at other sites. Charlie Nylander (LANL) and David Broxton (LANL) agreed that about 50% of well drilling and installation costs are for management and data analysis.

19) Develop detailed Gantt charts – A Gantt chart has been included in the FY98 Groundwater Annual Status Report and will be updated as necessary and to be discussed at quarterly meetings and included in all annual reports.

20) Revise budget projections continuously – As of February, the budget projections are on target. LANL will continue to monitor budget projections as the characterization program continues.

21) Annual project review – The fall meeting will include an annual project review.

22) Consider re-bid of drilling – The GIT is considering their current drilling contract and whether it will be cost effective to extend the existing contract or to re-bid the contract to a new driller.

23) Use modeling as a tool for making decisions – The EEG is concerned that the NMED is leery of the modeling efforts and that they will be used in place of installing wells and to justify not characterizing pathways. There was much discussion about state concerns with LANL's modeling efforts.

The next EEG meeting at Los Alamos will be in fall, either September or October. The GIT will address this year's EEG Semi Annual Report recommendations in an Action Plan similar to last year's. The EEG Semi Annual Report and LANL's Action Plan will be distributed to the attendees of the annual meeting and other recipients of the FY98 Groundwater Annual Status Report.

Charlie Nylander (LANL) discussed an approach for addressing contamination in R-wells. The approach should be formalized in a regulatory document that outlines specific steps that will be taken and a schedule. Criteria should be developed for identifying the need for additional wells. Benefits would include: provided assurance that LANL is not ignoring contamination problems, clarification on roles and responsibilities within the Lab, and the approach can be flexible enough to allow for site-by-site solutions to contamination.

Ten criteria for drilling more wells could include:

1. Expected relative magnitude of contamination (high vs low concentrations, high vs low volume of water)
2. Location with respect to Lab boundary
3. Location close to usable water supply
4. Concentration/mass of contamination and mobility of contaminant
5. Threat to groundwater resource
6. Well construction issues (perched zone requires special construction)
7. Schedule for drilling nearby wells
8. Will wells facilitate finishing an RFI report
9. Political consistency
10. Budget/priorities

EEG members generally agreed that there was a need for a formalized approach in order to keep the technical approach on line. There was further discussion of criterion 4 to identify what contaminants there are and whether they are of concern or not due to attenuation to aquifer materials.

David Schafer (EEG) asked if it was too late to consider other bids. He said that all the appropriate information could be given to the new bidders so they could make appropriate bids. Charlie Nylander (LANL) said that one option is to extend the current contract with Tonto while still exploring other options "off street". The existing contract allows for mud rotary drilling.

Jack Powers (EEG) said he was concerned that the LANL project management would become overwhelmed as the drilling program increased. EEG members said it was important to benchmark costs against other drilling programs both government and private to provide solid cost comparisons.

Robert Powell (EEG) asked to revisit the issue of the release of draft data and said that, in his opinion, the Laboratory should not consider releasing unvalidated data to the state or to the public. Other EEG members were in general agreement.

The EEG asked for guidance on where to focus their attention with respect to compiling a Semi Annual Report. Charlie Nylander (LANL) asked the EEG to focus some attention on the four areas of DQOs, data gathering methods, modeling, and data management and the following questions: Are we still pursuing the right data quality objectives, are we still collection data with reasonable technology, are modeling and data management being utilized appropriately, how

might the EEG be better utilized both technically and advisory, and are additional members needed to fill in gaps in expertise.

Betty Anderson (EEG) suggested that further communication with Laboratory senior management and stakeholders might be beneficial. Charlie Nylander (LANL) asked if there were any other comments. Gene Turner (DOE) said that the Lab's new operating permit from the state would have more regulatory deliverables and schedule requirements.

CLOSING

The Annual Meeting came to a close mid-morning on March 31, 1999 allowing the EEG members time to compile their thoughts for the EEG FY98 Semi-Annual Report.

LIST OF ATTENDEES

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Groundwater Annual Status Report for Fiscal Year 1998

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GROUNDWATER ANNUAL STATUS REPORT
for
FISCAL YEAR 1998

by

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ABSTRACT

Groundwater protection activities and hydrogeologic characterization studies are conducted at LANL annually. A summary of fiscal year 1998 results and findings shows increased understanding of the hydrogeologic environment beneath the Pajarito Plateau and significant refinement to elements of the LANL Hydrogeologic Conceptual Model pertaining to areas and sources of recharge to the regional aquifer. Modeling, drilling, monitoring, and data collection activities are proposed for fiscal year 1999.

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