

John

Los Alamos
NATIONAL LABORATORY
memorandum

Risk Reduction and Environmental
Stewardship Division (RRES-DO)

To/MS: Distribution *Charlie Nylander*
From/MS: Charlie Nylander, RRES-DO, MS K497
Phone/Fax: 5-4681/5-8190
Symbol: RRES-DO: 02-25
Date: June 10, 2002

**SUBJECT: MINUTES FROM THE HYDROGEOLOGIC CHARACTERIZATION
PROGRAM ANNUAL MEETING HELD APRIL 10-12, 2002 AND THE EAG
SEMI-ANNUAL REPORT**

Enclosed please find the minutes and the Semi-Annual Report by the External Advisory Group from the Los Alamos National Laboratory's (LANL) Hydrogeologic Characterization Program Annual Meeting, held on April 10-12, 2002. Several of the discussions at the meeting resulted in the identification of action items. The action items are listed below with responsible parties in parentheses.

1. Drill and complete the following wells in FY03: R-2, R-11, R-24 (DP funded wells) and R-4, R-18, R-27 (Environmental Restoration funded wells). (LANL)
2. Conduct quarterly sampling and analysis in completed wells. (LANL)
3. NMED requested that LANL suspend falling-head slug tests. LANL is evaluating hydrologic testing methods and will respond to the NMED. (LANL)
4. LANL has requested a recommendation from the EAG regarding hydrologic testing methods (see #3 above). (EAG)
5. Distribute the Hydrogeologic Characterization Program Annual Report before the annual meeting. (LANL)
6. Distribute Buckman Wellfield Report to stakeholders who request it. (LANL)
7. Provide necessary support and guidance to the Core Team. (LANL, NMED, DOE)

Please review these minutes for accuracy. If you identify substantive changes that should be made, please submit your comments to me in writing, or via e-mail at nylander@lanl.gov, or by telephone at 665-4681.

CN/am

Attachments: a/s



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K. Henning, HSR-63, MS K498, w/enc.
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RRES-DO File, MS 591, w/enc.
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MEETING NOTES

**from the
Los Alamos National Laboratory's**

5th ANNUAL HYDROGEOLOGIC CHARACTERIZATION PROGRAM MEETING

MEETING PURPOSE, ATTENDEES, AND AGENDA

The Los Alamos National Laboratory Groundwater Integration Team (GIT) met with the New Mexico Environment Department (NMED), the Department of Energy (DOE), the External Advisory Group (EAG) peer reviewers, and stakeholders on April 10-12, 2002 for the 5th Annual Hydrogeologic Characterization Program Meeting. The meeting was held at Bishop's Lodge, Santa Fe, 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 Materials Bureau
- NMED-Groundwater Quality Bureau
- NMED-DOE Oversight Bureau
- New Mexico Attorney General
- DOE-Environment, Safety, and Health
- DOE-Environmental Management
- DOE-Defense Programs
- San Ildefonso Pueblo
- Northern New Mexico Citizen's Advisory Board
- Concerned Citizens for Nuclear Safety
- University of California
- Los Alamos County
- External Advisory Group (EAG)
- 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:

Wednesday, April 10

Introduction

Subcommittee Reports

- Information Management
- Well Construction
- Geochemistry
- Hydrology
- Modeling

FY03 Work Plan and Planning Session

Technical Presentations and Poster Viewing

Status of Groundwater Protection Plan

Single-Well Testing of R Wells at LANL

Discussion of Regional Aquifer Modeling Results with Reference to the Buckman Well Field

Vadose Zone Geochemistry

Permeable Reactive Barrier in Mortandad Canyon

Incorporating Uncertainty in the Regional Aquifer Modeling

Groundwater Pathways Assessment

Well Development Survey

Thursday, April 11

Technical Presentations and Poster Viewing

WQDB and ER Databases

Updated 3-D Geologic Model

Seismic Hazards Program Results

TA-16 High Resolution Resistivity Survey

Permeability of Fault Zones

Fracture Characterization of the Bandelier Tuff in Canon de Valle for Seismic Hazards and Flow and Transport Analysis

Stakeholder Session with EAG

LANL Response to Stakeholder Issues

Friday, April 12

EAG/Managers' Closeout Session

EAG Debrief to GIT

SUMMARY OF PRESENTATIONS AND DISCUSSIONS

Introduction

Attendees were welcomed to the fifth Annual Meeting for the Los Alamos National Laboratory Hydrogeologic Characterization Program. The Annual Meeting reviews accomplishments over the past year and planning for FY03. The Hydrogeologic Characterization Program Annual Report reflects changes in the conceptual model.

The External Advisory Group (EAG) is a peer review group that reviews the program every six months. The EAG provides recommendations semiannually for continuous improvement.

Subcommittee Reports

Information Management Subcommittee

LANL provided a progress review of the year. Efforts throughout the year have focused on software development, data import and migration, ER/WQH data exchange, and report development. As a result, development processes take less time and the data are now in a consistent format allowing easier exchange of data between the Environmental Restoration Database (ERDB) and the Water Quality Database (WQDB). LANL will continue to work on making the development processes more efficient.

Regarding software development, a sampling chain of custody can be produced from the WQDB and sampling events can be planned and tracked through the database. Data validators conduct electronic QA/QC and add flags to the sampling events in addition to lab qualifiers. LANL plans to develop a web form for validators to enter flags directly into the WQDB.

With respect to the import/migration of FY2001 data, water levels for 27 wells were added to the WQDB last month, so that it now represents 10 years of data. The WQDB 2001 analytical chemistry was accessed and used to develop the LANL Environmental Surveillance Report. The web-based WQDB now has data from 1995; LANL plans to include 30 years of data soon.

Data exchange between the ERDB and the WQDB included:

- Well construction 5 wells (R-9, R-9i, R2, R15, R19)
- Geophysical logs 5 wells
- Chemistry ER is conducting QA on data; this data will be pushed over soon

WQDB reports for chemistry, well construction, water levels, and sample tracking have been developed. The first three reports are available on the web.

Upcoming issues will include:

- More WQH/ER data exchange – well construction, geophysics, and chemistry in R-wells
- Migration of R-well water levels
- Development of a web-based data entry tool
- Development of a web-based screening tool
- Incorporate invoice tracking
- GIS (depending on funding)

Within 60 to 90 days, chemical analyses will be available on the external web site (<http://wqdbworld.lanl.gov>). LANL anticipates another year of development work on the WQDB.

The design work for most data is almost complete; however, the design for hydrologic tests has not yet been developed.

NMED asked whether all water data could be compiled by RRES-WQH (formerly ESH-18) and be made accessible through the WQDB. Could this include water data from other organizations, such as EPA? Other organizations' data can be accommodated. NMED would eventually like to have AIP data on the web. LANL can now include AIP data because the format is quite close, but incorporation of other organizations' data would take more work.

The EAG asked about the level of interest and level of funding for GIS data. There is a high level of interest. LANL has one individual dedicated to deploying GIS, and has identified Laboratory resources. However, this is quite expensive. Another obstacle is the terrorism concern; at present, no maps are allowed on the LANL web site.

Well Construction Subcommittee

LANL reported that efforts have focused on improving drilling techniques. Currently there is a drilling hiatus while threatened and endangered (T&E) species checks proceed.

Drilling

Drilling accomplishments include three HWP wells (R-5, R-13, R-8/8a) and three investigation wells (MCOBT-8.5, MCOBT-4.4, CDV-R-37-2). Current funded drilling activities include R-14, R-21, and other wells as funding allows. Drilling will start once the T&E season ends.

Sampling

Sampling activities continue to be successful. Each well is sampled four times and a geochemical report is then written. Nine R-wells and one investigation well have been completed.

Reports

Reporting was a major focus for the drilling team. Well completion reports for R-25, R-31, and R-22 were published. The well completion report for R-7 has just gone through peer review and will be available this month. LANL has published two geochemical reports (R-15 and R-9i).

Drilling Tool Box and Strategy

LANL is currently trying to improve the drilling process and is getting input from DOE and NMED.

New tools include:

- Bentonite-based mud drilling with rotary drilling
- Permanent placement of thin-wall casing with sealing in zones is causing trouble. This method is used in the drilling industry and is not new; however, it has not been used in this program. LANL looks forward to discussing this issue with NMED.

New drilling strategies are:

- Start drilling with an air-rotary or down-hole hammer
- Stop at 100 ft above the regional aquifer water table and conduct geophysics
- Continue with air until the water table is encountered, then measure the water level
- Switch to a mud rotary in the regional aquifer, with the hole stabilized by mud
- LANL is considering how to fit in geophysics in the regional aquifer
- Finish the well with either single completion or multiple completion

- If problems are encountered in the vadose zone, it is possible to switch to a mud rotary

R-8 borehole problems were discussed. Good progress was made at that well to about 1000 ft. Then the formation bridged above and tools broke off in the hole. It was not possible to get the tools out, and the hole was abandoned. LANL then moved to R-8a and used casing advance. The casing got stuck; a casing cutter was used for recovery, but it was possible to recover only 250 ft of casing. The drillers continued drilling through the casing to complete the well. The casing that was left in the borehole was in the vadose zone.

Issues associated with mud drilling include well development, mud disposal, and loss of mud to the formation. There will be very aggressive well development to remove the mud from the formation. The mud will be analyzed to understand the chemistry so that it will be possible to know when the water is representative of the formation. It was agreed that there is a need for aggressive well development. The EAG offered the opinion that no matter how the wells are drilled, it will probably be two to three years before water representative of the aquifer is produced by the well. The question was asked about the length of time for wells to clean up. A screening strategy is in place to look for residual drilling additives. Most of the screens are cleaning up. One to two screens still have residual mud and it is anticipated that they will be cleaned up in two to three years. The chemistry of the mud will be analyzed before using it. In addition to the four initial sampling events per well, the wells will continue to be sampled as part of institutional monitoring, and geochemistry data will continue to be reviewed.

Data collection includes logging the cuttings, looking for water, and running geophysics in the upper portion of the borehole. All parties should agree on the data collection before drilling starts so that the appropriate equipment can be in place. Once that occurs, it is necessary to stick with the agreed plan. In most of the recent wells, core has been replaced with geophysics; however, if deep coring is decided on, the rig will be outfitted with the appropriate equipment.

NMED believes that the vadose zone has been neglected. It was thought five years ago that the Canyons Group would look at the vadose zone. But the group has not and now neither has the HWP. LANL replied that it has addressed the vadose zone. Geophysical data, water samples, and screens have been collected in the vadose zone. This approach to drilling wells will identify perched zones through geophysics, but will allow sampling of those zones only if water is coming up with the cuttings. The perched zones will be interrogated later with an intermediate depth well.

Geochemistry Subcommittee

LANL reported on geochemistry efforts in the following areas: scope of the Geochemistry Subcommittee, characterization sampling results, and R-9i geochemistry.

The scope of the Geochemistry Subcommittee is to provide input and technical information on:

- **Characterization:** This entails providing geochemical support for selecting well locations, drilling methods, well construction, and characterization sampling; determining baseline groundwater conditions at LANL; and identifying and evaluating chemicals of interest present in groundwater.
- **Analytical Methods:** This includes identifying and evaluating analytical methods for inorganic and organic analytes, and ensuring consistency in analytical methods.
- **Geochemical Input Parameters for Transport Modeling:** This involves input parameters (speciation, adsorption, and mineral solubility) based on field, experimental, and literature citations for geochemical and reactive transport simulations.

- **Geochemical Calculations:** LANL performs geochemical calculations quantifying water-rock interactions as part of characterization, monitored natural attenuation, pathway analysis for risk assessment, and groundwater remediation (e.g., permeable reactive barrier technology).

There are a number of observations gained from characterization sampling. Tritium in R-8 and R-9 is consistent; some of the groundwater is less than 60 yrs old. In R-12, tritium is found in both perched and regional aquifers. In R-13, tritium is 0.64 pci/L, indicating very old water and no new water. No other contaminants were noted. R-15 tritium indicates some new water; there was also detection of strontium-90, nitrate, and possible perchlorate (near the detection limit). R-22 tritium activity is decreasing, in contrast to the other wells where it has been constant. Originally this borehole had detectable technetium-99, but since then that has been below detection; there is reason to believe that the technetium-99 was a near-detection-limit phenomenon. Uranium in R-22 had a natural uranium ratio and has dropped off. R-25 has moderately consistent tritium values, consistent with the conceptual model of recharge from Sierra de Los Valles. There is a high explosives plume in the perched zone, but in the regional aquifer the high explosives value has dropped. It is believed that the high explosives in the regional aquifer were pulled down from perched zone during borehole drilling.

Findings from R-9i geochemistry include the following: R-9i nickel was above the MCL in both upper and lower perched zones. There are no known Laboratory-introduced sources of nickel. However, there is a natural source of nickel. Olivine, in the Cerros del Rio basalt, had oxidized to iddingsite where nickel was partitioned. It is believed that the drilling broke up the nickel-bearing mineral. The first three samples had nickel approaching or above the MCL, but the fourth sample showed nickel below the MCL. The hole was drilled dry with EZ mud, but the Total Organic Compounds level was below 0.1. There was some evidence of reduction; it is possible that the EZ mud provided reductants. A comparison of water at the LA Weir and R-9 shows that iron, manganese, and nickel are higher at R-9.

Hydrology Subcommittee

Hydrological issues included the following:

Water level

Water level data is being used in calibrating groundwater models and is available on the WQDB. Not all well data is up to date, but will be in the next few weeks. The subcommittee is currently re-evaluating the water level data collection strategy.

Water level data is now collected with transducers that measure the water level at three-hour intervals. Transducers are in:

- 8 regional aquifer wells and one former water supply well
- 5 intermediate perched zone wells
- 6 alluvial groundwater wells in Los Alamos Canyon
- 15 alluvial groundwater wells in Mortandad Canyon

Hydrologic properties

Hydrologic properties are being used in groundwater models. The geophysical logs from recent wells are being used to estimate hydrologic properties. Geophysical logs are included in the well completion reports for R-19, R-31, and R-22.

Hydrologic testing

NMED requested that LANL suspend falling-head slug tests due to concern about introducing water and diluting samples. LANL is evaluating hydrologic testing methods and preparing a response, and has asked the EAG for a recommendation.

Well development

LANL asked the EAG to evaluate whether LANL's well development procedures are up to industry standards. The EAG has prepared some recommendations and is finalizing its report. LANL had previously planned to utilize a dual packer device for development of multiple completion wells, but has not been able to obtain a device to fit LANL's wells.

Steps for primary development for each screen include:

- Wire brushing for coarse cleaning of the screen
- Bailing the well to remove material loosened by the wire brush
- Surging, jetting, or swabbing to further clean the screen
- Bailing to remove fines produced by these activities

Secondary development includes pumping to remove fines from primary development.

The effectiveness of development is determined by field parameters; a goal of development is reproducible turbidity <5 NTU. Development is halted when this goal has been reached or the turbidity cannot be further improved. This approach follows industry standards and EPA guidelines.

LANL's development has successfully cleaned screens and achieved low turbidity in the regional wells. Chemical development would be required to completely mitigate the effects of drilling fluids on water samples, but this would create undesirable impacts on water chemistry. LANL is looking into chemical development for mud-drilled wells; this is used routinely in water supply wells.

NMED stated that low turbidity does not mean the well has been developed correctly; for instance, there could be sticky particles on the screens. LANL responded that well development addresses the physical attributes of water, and not the chemical attributes. Video logging shows that the screens are clean. No hole drilling is perfect in terms of samples. Evidence from sampling shows that the effects are going away. Most of the screens are cleaning up and the water chemistry is becoming more representative.

NMED noted that the development process has varied from well to well, and asked if there are any methods in the industry that are better. The EAG responded that there are better methods, but the LANL wells are too deep to implement these methods.

Gradients have been measured in all the multiple completion wells and have been used in the model. This data is available on the web site.

Modeling Subcommittee

LANL provided a recap of the previous year's activities and provided information on recent work.

Regional aquifer modeling

There has been further development of facies models for the Puye Formation and the Santa Fe group. Predictive analysis has focused on how much flow might be entering/leaving the regional aquifer from the north, west, or south. Incorporation of recent water level data from regional wells has resulted in much better estimates of large-scale permeability in the Puye Formation. Travel time calculations and capture zone analyses were performed in support of the groundwater assessment project. In addition, a study is being conducted of the potential impact of Laboratory operations on the Buckman wellfield.

Predictive analysis

Predictive analysis assesses the range of possible behavior that a model would predict while remaining in calibration; for example, what is the minimum travel time from one point to another, or what is most northerly and most southerly path between a release point and a downstream location? The user-defined question is evaluated by making model predictions for a range of values of each uncertain parameter, and finding the extreme value of the prediction for all calibrated models.

Mathematical techniques are used in predictive analysis. For example, consider a point source at R-25 that may flow to PM-2. There are three equally possible flowpaths based on the data; the three pathways may be considered an envelope.

When asked what physical process makes different paths, LANL stated that if the heads are known exactly, the envelope could be made smaller. LANL simulated adding piezometers in different locations to see what would reduce the uncertainty, and water level data near the source, R-25, are most useful. Also, pumping wells have an effect. It would be easy to simulate flow with pumping and without to determine the difference.

Preliminary first order groundwater assessment

This is an examination of potential contaminants that might pose a risk to groundwater receptors on a site-wide basis. LANL uses GIS tools to synthesize information from contaminant sources and hydrogeologic data to assess transport times and pathways. Components of the analysis include:

- Contaminant sources – outline source term areas for key contaminants based on WQDB entries for the alluvial, intermediate, and regional aquifer wells.
- Percolation rates – categorize canyon drainages with respect to observable properties (location of headwaters, presence of alluvial groundwater, etc.), and assign percolation rates based on other modeling and data collection efforts.
- Vadose zone flow and transport – construct a simple vertical pathways model locally at a large number of locations across the Plateau, and compute vadose zone travel time to the water table at each location.
- Regional aquifer flow and transport – use the regional aquifer model to track pathways from municipal water supply wells back to the water source, identifying locations where recharging fluids might contain Laboratory contaminants.

Individual components will be kept simple and will handle things like lateral flow (perched zone) as uncertainties and expanding parameter values.

The goal of the groundwater pathways assessment project is to produce a report of model predictions (with uncertainties) of the concentration-time histories and plume locations for key contaminants in the regional aquifer, and estimates of the likelihood that these contaminants will be detected in the R-well network and/or existing water supply wells within a specified time frame. The report will also identify the most important conceptual models and parameters requiring further study to reduce uncertainties.

Current activities

Current activities include:

- Select contaminants of concern
- Document conceptual models
- Develop sub-models used to predict the behavior (with uncertainties) of:
 - Contaminant source terms
 - Vadose zone contaminant transport
 - Regional aquifer contaminant transport
- Construct systems model linking the sub-models
- Assign distributions for uncertain parameters
- Perform Monte Carlo simulations

Source terms are based on the WQDB. A question was asked about soil sources that could impact water. LANL is doing everything it can to constrain sizes and time history of release. ER source terms are included. Any canyon with contaminants of concern will be modeled. The focus has been on contaminants and not on individual canyons. Models will be focused on locations where there are contaminants of concern. Models will be developed recognizing uncertainties and will be used as a tool to prioritize data collection.

Modeling reports will be done in stages. Analysis of existing data will be released for reviews, input, and feedback. The content at the report at the end of the calendar year will include what is known now based on the data obtained so far, and what will be used in the model and what calculations will be used. The report will identify sensitive parameters that affect the model and will use statistical techniques.

Geochemistry is used as a major constraint: the model should not predict contaminants where there are none nor predict there are none when there are.

In order to make calculations, the Core Team needs to provide regulatory goal posts. These can include what time frame is of concern, what are the concentrations that cause concern, regional vs. perched, volume of water, etc. The Core Team also has to determine the level of uncertainty acceptable in the monitoring network, since it is not possible to achieve a complete 100% level of certainty.

The Core Team is a six-member team with DOE, LANL, and NMED representation, with technical support provided by their staffs. The team will be presented with a proposal on the groundwater protection criteria. It is anticipated that the team will meet for first time in next 30 days.

The CAB stated that it anticipates a public meeting before next quarterly meeting.

The EAG noted that there is a danger in defining regulatory levels without knowing where the program is. The levels should be achievable. LANL stated that there are published regulatory

standards but that the ER Project uses risk-based cleanup levels. Regulators need to help marry those two kinds of standards together.

With regard to public participation in this process, it was stated that when the Core Team has established criteria, the criteria will go through the RCRA/HSWA process.

FY03 Work Plan and Planning Session

LANL outlined the planned activities for FY03. Additional funding of \$4-6 million has been requested. It may be able to finish characterization wells around TA-54 in FY02.

Wells planned for FY03 include three NWT wells (R-2, R-11, R-24) and three ER wells (R-4, R-24, R-27).

Wells R-2 and R-4 are planned for Pueblo Canyon, which is important to investigate because it contains contamination, is wet, and has short travel times due to the rocks at the surface. Wells along the length of the canyon would be useful for demonstrating monitored natural attenuation. R-2 is a replacement for TW-4. Tb2 basalt is near the top of the water table, but is poorly constrained around R-2. TW-2A (perched zone completion) has had high tritium for a long time and a few indications of plutonium (not reproduced).

Well R-11 will be in Sandia Canyon, as a proposed sentry water well for PM-3. There is a need for a well to detect a pathway for contaminants found in R-12. The ER Project anticipates that R-11 will serve as a monitoring well in the future. R-11 could be located close enough to PM-3 to conduct cross-hole testing.

Well R-24 is planned for Cañon de Valle. Located west of the fault system, it will be useful to refine recharge and boundary flux estimates. The Pajarito Fault Zone could divert water to the south, and geochemical data is needed to determine flow paths. Hydrologic testing could determine if the fault was acting as a barrier to flow. R-24 is an anticipated ER Project monitoring well.

Well R-18 will be the first regional well placed in Pajarito Canyon. It will provide information on the presence and quality of perched zones and depth to the regional aquifer in a poorly understood part of the Laboratory. Due to access problems, R-18 cannot be drilled where it was shown on the Hydrogeologic Workplan map; it is being relocated to the confluence of Pajarito and Two-Mile Canyons.

Well R-27 is planned for Water Canyon. LANL and NMED have agreed to combine R-27 and R-28. Its purpose is baseline characterization of a poorly-known south-central part of the Laboratory, providing groundwater quality data upgradient of TA-49 and in the HE corridor.

Planned FY03 non-field activities include:

- Laboratory restructuring: the new Risk Reduction and Environmental Stewardship (RRES) Division combines E and ESH divisions in one division, in the operating directorate.
- Information management: strengthen ties between ERDB and WQDB. Information management may be elevated to the Division level and probably will probably receive an infusion of funding and resources.
- Groundwater pathways assessment will continue into FY03.

- Regional aquifer modeling: finalize capture zone analysis in the Pajarito Fault Zone with R-24
- Geologic model update
- Reports and meetings

On May 2, NMED is expected to issue a Corrective Action Order, which will be considered draft for a 60-day public comment period. This Order may supplant portions of HWP, but LANL does not know yet how it will affect the work done over the past five years.

In response to a question about the uncertainties in FY03 funding, LANL stated that NNSA funding is sufficient for three wells. Funding for EM well is still uncertain.

Testing a fault will be done with a deep well with multiple screens to measure vertical gradients and transducers to measure heads. R-24 and R-25 will be considered because they straddle the fault.

Status of Groundwater Protection Plan

LANL provided an update on the status of the Groundwater Protection Management Program Plan and its relationship to other groundwater documents.

The Groundwater Protection Management Program Plan (GWPMPP) is a high-level umbrella document required by DOE Order 5400.1. This document was approved by DOE in 1996. It has seven elements: characterization, potential contamination, monitoring, water supply, information management, quality assurance, and regulatory compliance. The document frames the entire groundwater program. The monitoring plan is in the appendix and describes the present surveillance network.

The Hydrogeologic Workplan (HWP) is updated on an annual basis through the Annual Report. The companion to the HWP is the Installation Workplan (IWP). The IWP addresses all of the corrective action programs. RFI workplans provide characterization and contaminant information. Field implementation plans describe DQOs for specific wells.

A Core Team was formed. Members are Beverly Ramsey (LANL), Scott Gibbs (LANL), James Bearzi (NMED), Greg Lewis (NMED), Joe Vozella (DOE), and Mat Johansen (DOE). The Core Team will elicit the current state of knowledge.

Single Well Hydrology Testing

LANL presented an overview of single well hydrology testing. The bad news is that there are constraints on testing. The good news is that there are some results despite these constraints. Determining hydrologic properties is important to the HWP. There are three major constraints on testing: (1) in the case of wells completed in more than one interval, each screen must be isolated for testing; (2) the regional wells are quite deep, most more than 1,000 ft; and (3) the production casing is small, only 4.5" ID. Although straddle packers can isolate screened intervals, an accompanying testing apparatus which permits interchanging transducers and pumping from considerable depth at a rate sufficient to stress a water-bearing zone, especially in the small diameters of production casing used, is not readily available. Thus testing of multi-screened wells has been by injection between straddle packers. Testing of wells in which there is a single screen, especially if the screen is below the water table, has been by traditional single-well pumping tests. Six wells have been successfully tested to date: R-9i, R-19, R-22,

and R-31 were tested by the straddle-packer/injection method, while R-13 and R-15 were tested by pumping.

The single-well test procedure consists of the following steps:

- Water level is allowed to recover after development
- Packer/Injection device or pump is installed
- Static water level is achieved
- Stress is applied (injection or pump)
- Flow rate is monitored by flow meter/stop watch
- Water level change is viewed in real time on a computer
- The test is halted when the water is back to a static/constant level
- Data are analyzed with computer programs.

Regarding confidence in single well testing data, the distribution of data is reasonable and compares favorably with other field data.

Discussion of Regional Aquifer Modeling Results with Reference to the Buckman Well Field

LANL discussed the regional aquifer modeling efforts with reference to the Buckman wellfield. This is an example of why modeling is a valuable tool.

This presentation has been given to County of Santa Fe, City of Santa Fe, and San Ildefonso Pueblo, and there have been some changes from previous talks, such as making calculations with the new version of the model. The general results remain the same, though some details are different.

The motivation for studying the Buckman wellfield includes the following:

- It addresses potential effects of LANL operations on public water supplies.
- The Buckman wellfield and planned Horizontal Collector Well are important to Santa Fe.
- Previous studies have suggested that the potential impact from LANL was negligible and no LANL contaminants have been found at the Buckman wellfield.
- DOE has encouraged a more quantitative evaluation.

The study featured a capture zone analysis of water supply wells to determine the likelihood that they would draw from the aquifer beneath LANL. The analysis is based on results obtained by the ongoing regional hydrogeologic study and modeling of the Espanola Basin. According to the model, there will be some interference between the Buckman wellfield and the horizontal collector well. The simulated three-dimensional capture zone of Buckman includes area both west and east of the Rio Grande and a portion of the Rio Grande itself; part of the zone is within the LANL boundaries. The simulated capture zone of the collector well also includes area west of the Rio Grande, but entirely outside (north of) the LANL boundaries.

The study also simulated the advective-dispersive groundwater transport of hypothetical non-reactive, non-decaying, aqueous species from the water table at five locations beneath LANL. Results suggest that groundwater originating from these locations will eventually be captured at Buckman, but the mixing factors at the wellhead are more than five orders of magnitude. Travel times in the regional aquifer are on the order of 1,000's of years. There would be no groundwater transport from beneath LANL in the direction of the horizontal collector well.

Predictions are sensitive to assumptions about (1) heterogeneity within the Santa Fe Group, Cerros del Rio basalts and Puye Formation; (2) hydraulic connectivity between surface and subsurface waters; and (3) spatial distribution of infiltration recharge. These aspects of the model cannot be improved at the moment, due to lack of sufficient data, but may be improved in the future based on the ongoing hydrogeologic characterization study of the region.

The conclusion that a portion of groundwater beneath LANL can mix with groundwater pumped at Buckman contradicts previously held beliefs that water would not cross the Rio Grande. LANL is continuing data collection; the results are considered preliminary. The model is limited to the regional aquifer and is therefore not exhaustive.

In response to a question about how the comparison is made to known data and what is the confidence in the model, LANL stated that the model is approved and tested. There is good agreement regarding accurately reflecting fluxes and water levels.

This study has been through internal LANL peer review and has been presented many times. The report will be complete within a week or two and will then be submitted to a peer reviewed journal.

If structural and stratigraphic heterogeneity is affecting drawdown, what data collection is being done to address this uncertainty? R-wells do not penetrate Santa Fe formation. Other data, such as outcropping, is used. It was noted that data collection focuses on the most important areas at LANL; e.g., the Puye Formation is more important and critical to capture heterogeneity.

Vadose Zone Geochemistry

One goal of the Hydrogeologic Workplan is to collect data to characterize and understand vadose processes on the Pajarito Plateau. The vadose zone includes the region between the ground surface and the top of the regional aquifer. This presentation addresses examples from two aspects of the vadose zone work at LANL, namely pore water anions (i.e., chloride, nitrate, sulfate, phosphate, and perchlorate) and stable isotopes. These results support differences in downward fluxes between mesas and canyons; are used to generate quantitative estimates of downward flux; help constrain the vertical extent of some contaminants and their vadose zone inventories; and are useful for pathway analysis.

Study conclusions include the following:

- There are significant differences in vadose zone characteristics between mesas and canyons. This is seen in results for average and maximum moisture content, chloride, sulfate, and probably oxygen isotopes.
- Mesas appear to have minimal downward fluxes/recharge. Chloride mass balance and other modeling suggest this might be less than a few mm/yr. However, there are exceptions due to areas of ponded water and along the mountain front.

Permeable Reactive Barrier in Mortandad Canyon

LANL reported on the permeable reactive barrier to be located in Mortandad Canyon. The effort started as a technology demonstration project focusing on a Mortandad Canyon site with uranium, strontium, plutonium, and americium in the groundwater. Most work on reactive

barriers has been with iron, and LANL wanted to find other natural materials that would also work.

The reactive media selected for study in the 2-D (two-dimensional) cell included polymer-coated volcanic basalt, Apatite®II, pecan shells, and limestone. Laboratory-scale treatability studies were conducted with reactive media to effectively reduce contaminant levels below regulatory limits for groundwater for a minimum of ten years. Reactive materials will be replaced at the end of each ten-year cycle. Previous 1-D column results indicated that a multiple layer treatment approach was necessary for optimal removal of the different contaminants. Porous media were contacted with contaminants using a kinetically limited 2-D aquifer cell. Apatite®II and pecan shells have shown significant propensity to remediate the contaminated groundwater used in column experiments and in a 2-D aquifer cell.

The microorganisms that proliferated on the surface of the pecan shells, sustained by organic matter leaching from the Apatite®II, reduced nitrate and perchlorate to undetectable levels for approximately 310 pore volumes (285 days of injection) in the 2-D cell. Prior to detection of nitrate and perchlorate in effluent of the 2-D aquifer cell, greater than 90% of the nitrate reduction and 70% of the perchlorate reduction was accomplished in the Apatite®II layer, while the remainder was degraded in the pecan shells. Geochemical modeling was conducted using the computer program MINTEQA2 to evaluate aqueous speciation and mineral equilibria within the 2-D cell.

The EAG stated that many people have tried sequential adsorption media and none have been successful because the first media changes the chemistry for the next media. LANL responded that with perchlorate and nitrate, 100% removal to 240 pore volumes resulted. The hypothesis is that below a pH of 8.5, perchlorate will adsorb to apatite. Microorganisms grow on apatite and give off electrons; perchlorate accepts electrons and is reduced to chloride. This is consistent with a decrease in perchlorate and an increase in alkalinity. However, more work is necessary.

Regarding a change in the permeability of the barrier, it was noted that fish bones were breaking down, but not to the extent of iron filings.

Incorporating Uncertainty in the Regional Aquifer Modeling

LANL presented a general overview of its approach to modeling the regional aquifer, with a summary of the basic data requirements for a robust model. What path the water will take is a frequently asked question. In a simple sandbox, this question could be easily answered. However, to answer this question, 3-D water levels, hydrostratigraphic relationships, and hydrogeologic properties need to be understood.

The latest water level dataset now defines the water table reasonably well. Information concerning vertical gradients, however, is still sparse in the northern portion of LANL. Permeability data continues to demonstrate considerable heterogeneity within defined hydrostratigraphic units; however, inverse model results show that large-scale, effective permeability of some units (Cerro del Rio basalts, Santa Fe Group rocks) is fairly well known. Improved understanding of the permeability within the Puye Formation continues to be a high priority. Borehole geophysics has provided some information about the porosity of the Puye Formation; although this data represents porosity at a very small scale, it does provide the first

site-specific information. This dataset suggests that much of the Puye Formation appears to have a very, very low porosity and permeability.

While in past years modeling studies have focused on uncertainty in flow directions due to uncertainty in permeability of aquifer rocks, this year's focus is on the influence of local recharge patterns. Results include an uncertainty analysis of transport from a site beneath Mortandad Canyon, which according to the calibrated model is within the capture zone of PM-5. The results suggest that flow directions downstream are fairly well known; however, changes in the magnitude of canyon-focused recharge can have a significant impact on the local geometry of the capture zone. The model predicted that 80% would end up at PM-5. But there was enough uncertainty that it was equally likely to be 100% to PM-5 or 0% to PM-5. The results depend on recharge rates and plume location in about 1000 yrs. The model assumes that all wells are pumping at rates equivalent to pumping rates within the last five years.

When there are some data, an envelope of possible answers can be generated. The width of the envelope is an indication of how much data are available. The Core Team must determine an acceptable uncertainty.

Groundwater Pathways Assessment

LANL reported on the groundwater pathways assessment efforts. The First Order Groundwater Assessment is nearly complete.

The goal of groundwater pathways assessment is to produce a report of model predictions (with uncertainties) of the concentration-time histories and plume locations for key contaminants in the regional aquifer, and estimates of the likelihood that these contaminants will be detected in the R-well network and/or existing water supply wells within a specified time frame. The goal is to also identify the most important conceptual models and parameters requiring further study to reduce uncertainties.

The steps involved in the groundwater pathways assessment are:

- Select contaminants of concern
- Document conceptual models
- Develop submodels used to predict the behavior (with uncertainties) of:
 - Contaminant source terms
 - Vadose zone contaminant transport
 - Regional aquifer contaminant transport
- Construct systems model linking the submodels
- Assign distributions for uncertain parameters
- Perform Monte Carlo simulations

The technical approach to the First Order Groundwater Assessment and the system model (Monte Carlo) were discussed. The overall system model includes the following steps:

- Link models together to enable calculation from source to potential receptor
- Establish range of parameter values for all uncertain parameters
- Use Monte Carlo approach to find the range of possible outcomes
- Determine which uncertainties control the uncertainty in the outcome

A series of meetings have been held to establish the scope of the project and to discuss the conceptual models to be included. Numerical modeling approaches for the vadose zone and the regional aquifer transport submodels have been developed.

It was noted that the challenge in this model will be selecting COPCs and narrowing the field. Some COPCs may not have health-based standards. The Core Team must decide upon criteria in order for simulations to become more focused. Until then, staff will structure the calculations based on scientific judgment, and will try to build flexible modeling approaches.

Well Development Survey

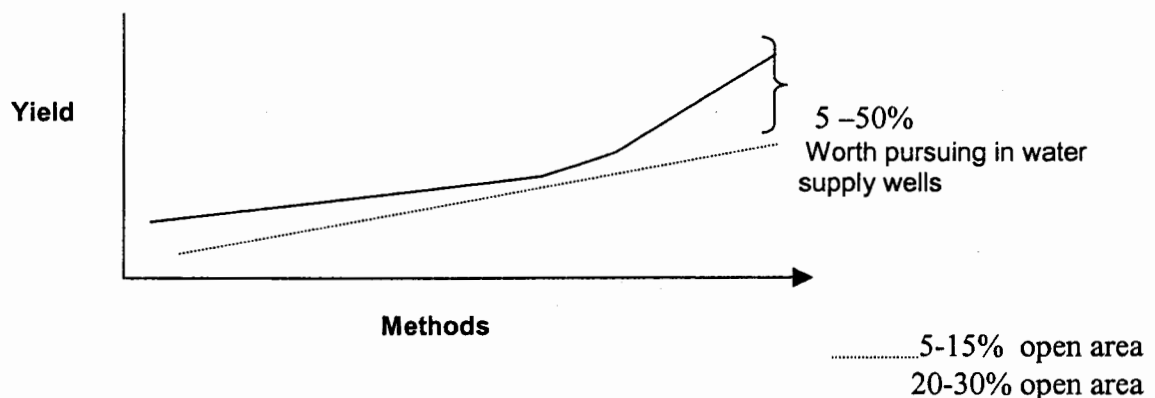
The EAG presented the results of its development methods survey. Well development procedures at LANL were compared to those procedures at other locations.

Well development objectives are to achieve:

- Low turbidity (important)
- High efficiency (moderately important, not as important in sampling wells as in water supply)
- Minimal drilling fluid residue (may be important if can remove mass of residue)

Well development methods

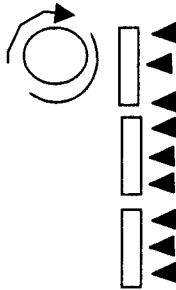
Effectiveness			
Least			Best
Pumping ↓	Backwashing / surging ↓	Air surging / pumping ↓	Jetting / pumping
needed with most other methods to clean up	reverse of pumping	difficult to air lift at depth	



Open area information

10 slot screen

Base pipe	8.75% used at Lab
Jacket	14.3 %
Rod base	6-8 %
Slotted PVC	2-6%



A pipe base screen offers benefits in tolerance and strength. The only development method not used at the Laboratory is a combination of jetting and pumping. The EAG does not know of any monitoring well developed with a combination of jetting and pumping.

The Idaho National Engineering and Environmental Laboratory and the Nevada Test Site develop open holes before placing casing and annular fill. The boreholes are more stable.

In regards to vertical gradient effects, in multiple completion wells, if the zones produce different rates, then pumping the entire well will take most water from most productive zones. It is advisable to set the packer to make sure the water pumped is out of that interval. Use packers above the pump in downward gradients and beneath the pump in an upward gradient.

There are no regulated, standardized techniques for well development. ASTM has guidance that includes all of the methods, but none are required. Well development should take into account what works at the particular well.

NMED stated that not all techniques have always been used here, and it is desirable to minimize equilibration time. The EAG responded that some experimentation could sometimes pay dividends by leading to effective combinations.

The EAG recommends a push to minimize filter packs. However, with short filter packs, aggressive development will mix filter pack and seal material or blow the filter pack away. Having longer filter packs allows better development. NMED noted that some early wells had filter packs of 70 feet, which NMED feels are too long.

Collaborative Database Design, Development, and Data Exchange

LANL reported on the efforts of the database design development and data exchange between the WQDB and the ERDB. The goal is to achieve an integrated repository for data generated during implementation of the HWP.

Project requirements include: streamlining access to all water data from two organizations (ER [RRES-R] and ESH-18 [RRES-WQH]); reducing duplication of effort; creating consistent data reports; and preserving the ability to retrieve data for compliance and other reporting. The data sharing agreement has identified the entities and attributes to be shared, and assigned responsibilities for shared lists of values.

Presently the ERDB presents data on well construction, sampling and chemistry, geophysics, and ER-specific data, while the WQDB includes data on well monitoring, sampling and chemistry, water levels, and RRES-WQH specific data. The aim is to maintain a data exchange area into which data can be pushed and from which it can be pulled. Ongoing or planned enhancements include:

- Implement push and pull in both directions
- Automate the push and pull
- Use more advanced technology for exchange to allow for differences in design
- Incorporate data from additional sources such as NMED

Updated 3-D Geologic Model

The present 3-D geologic model of LANL is based on data available in mid-1999. These data provided reasonable control for the surface geology at the Laboratory, and provide some 3-D control for the subsurface geology to the depth of the canyons dissecting the Pajarito Plateau. However, at that time, only a limited number of wells penetrated to depths sufficient for characterization of deeper units, and documentation of the geology for those holes was sparse. As a result, the geology of the saturated zone was poorly constrained, both conceptually and spatially.

A new 3-D geologic model is currently being developed which will incorporate a re-evaluation of many of the older drill logs, as well as new drilling and surface mapping data. New and revised data include:

- New R-, CdV-, and MCOBT-series wells
- Drilling and surface data for Areas G, H, and L
- Frijoles and Puye Quadrangle surface mapping
- Seismic hazards
- Age dates
- Large geophysical, topographical, and hyperspectral data sets

Changes and improvements will affect the entire 3-D geologic model. Most noticeable will be: (1) more accurate representation of pre-Bandelier units; (2) subdivision of portions of the Puye Formation previously described as fanglomerates into an upper fanglomerate and lower pumiceous unit; (3) changes in thickness and extent of the Cerros del Rio lavas; and (4) changes in thickness and extent of Totavi (and Totavi-like) river gravels.

Creation of spatially-distributed physical attributes for the pre-Bandelier units will assist in modeling hydrologic variability within individual stratigraphic units. Properties being quantified include:

- Relative proportions of flow interior, open breccia, and clay-filled breccia for the Cerros del Rio lavas
- Percentage abundances of clay and glass in all subunits of the Puye Formation
- Percentages of Precambrian river detritus in the Puye river gravels, and
- Relative proportions of volcanic and sedimentary materials within Cerros del Rio and other basaltic units.

All of these property variations have potential hydrologic significance. Additional properties that may be significant include the amount and distribution of clay, carbonate, zeolite, and other mineralization in the >5 Ma deposits, but there are as yet insufficient data to map these distributed properties in the deeper units.

In response to a question about how well does resistivity match the well data, LANL answered that the data have not been adequately examined yet. In some spots there seems to be a good match. The inversion model used for the data by the contractor provides good x-y location of data, but the z direction might not be as good.

Geology of the Pajarito Fault System at LANL

The LANL Seismic Hazards Program has done detailed geologic mapping of the Pajarito fault system for several years to better understand the location and nature of faulting, which is essential to assessing ground motion and seismic surface rupture hazards at the Laboratory. LANL has developed a mapping technique using a total station for precise mapping of flow and cooling unit contacts in the 1.2 m.y. old Tshirege Member of the Bandelier Tuff. The technique enables LANL to locate faults that would be overlooked by conventional mapping techniques, and have as little as 15 cm of vertical displacement. Total station mapping has allowed LANL to define broad zones of small faults and varying styles of deformation along strike of individual faults in the Pajarito fault system. Total station bedrock mapping has been accompanied by conventional geologic and geomorphic mapping, shallow drilling on urbanized mesa tops, and paleoseismic trenching.

Within LANL, deformation in the fault system is distributed across a 1.8 to >3.5 km-wide, dominantly north- to northeast-trending, complex zone to the east of the main Pajarito fault escarpment. Along strike of the Pajarito fault zone can be expressed at the surface as a monocline, a large normal fault, or a distributed zone of deformation with >135 m of down-east vertical offset in the Bandelier Tuff. The associated zone of deformation to the east includes normal and strike-slip faulting and monoclinical folding, with 0 to >30 m of distributed down-west vertical offset in the Bandelier Tuff.

TA-16 High Resolution Resistivity Survey

LANL reported on the high-resolution resistivity survey conducted at TA-16. Groundwater infiltration at TA-16 was traced using electrical pulses. This was a pilot test to see if it is possible to use electrical means to trace water from surface to the regional aquifer, to help determine the optimal locations for monitoring and/or treatment of high explosives contamination found at TA-16.

This method of measuring high-resolution resistivity has not been used at LANL before. It is, however, used routinely in other places and is a well understood method. Data interpretation is site-specific.

Goals of the study were to:

- Evaluate the feasibility of the electrical resistivity technique
- Determine the lateral and vertical extent of the alluvial aquifer for flow modeling
- Evaluate reaches of water loss
- Evaluate the possible connection to deeper aquifers, i.e. perched and/or regional water tables

The direct current resistivity method creates current between two electrodes and measures the current at two interior nodes. Differences in resistivity in the intervening rocks will show up as differences in electrical current.

Four profiles were created - three across the canyon (one repeated a year later) and one along the canyon.

Profile 2659 is a middle profile across canyon. Two alluvial wells provide control. A conductive region is seen where the alluvial aquifer is limited to the northern half profile. Another conductive area is seen on the opposite side of the canyon from the alluvial aquifer. The hypothesis is that there is a blind seep.

Profile 2658 is furthest upstream (western) and cross-canyon. The highly conductive zone is similar to profile 2659. Another conductive area on opposite side similar to 2659, also hypothesized to be a blind seep.

Profile SP-16 has no surface water and is furthest downstream. The blind seep area shows up. There was a deeper conductive zone where the alluvial aquifer was upstream, but down below there is a high resistivity zone.

The longitudinal profile shows a west dipping resistivity zone about midway along the profile, about the area of MDA-P. Starting at MDA-P, downstream is highly resistant.

The results encourage the use of different electrical measurement techniques to further investigate groundwater infiltration at TA-16. Electrical techniques are a cost effective tool. They do not replace drilling. LANL would like to try sounding techniques to give a vertical profile, shallow borings for moisture measurements, and additional deep hole drilling with the location guided by vertical soundings.

It was stated that resistivity changes due to water alteration of the rock. This can be controlled. Los Alamos Canyon has zones where glass is altered to clays. It would be possible to use core samples to check the alteration.

Permeability of Fault Zones

This presentation addressed fractures and deformation bands and the implications for permeability of faults. It involved looking at faults with offsets on the order of centimeters and at the character of small displacement faults.

Fault character is controlled by the welding of the unit. Welding decreases permeability and porosity. Low porosity (welded) is indicated by open fracture, increased porosity, and saturated hydraulic conductivity. High porosity (non welded) is indicated by collapse and crushing of grains, decreased porosity, and saturated hydraulic conductivity.

Studies of deformation bands in sandstones found porosity decreased 25% and saturated hydraulic conductivity decreased three orders of magnitude. Similarity of deformation bands suggests perhaps similar results.

However, the connection of pore space in deformation bands may enhance fault parallel saturated permeability. In the vadose zone, the smaller pores in deformation bands may also enhance vadose zone flow.

Future studies will test the hypothesis that fault-zone structures control and significantly impact fault-zone permeability. There will be in-situ fault-zone permeability measurements with an air

minipermeameter, and dynamic experiments using neutron tomography to image fluid flow through deformation-band faults and fractures.

Will the tomography be a lab experiment with block removal and tested in the lab? It is hoped that this experiment will be done at UC Davis.

Will variation in fractures in addition to deformation bands be evaluated? Samples of all different types of fractures have been collected. These fractures appear to be shear zones with material crushed in place. Other fractures look like they were filled after.

Is there a feeling for range of permeability values? Measurements have not been done, but the investigators hope to talk to LANL about permeability that might be expected.

Fracture Characterization of the Bandelier Tuff in Cañon de Valle for Seismic Hazards and Flow and Transport Analysis

This presentation focused on fracture characterization in the Bandelier Tuff. A seismic hazards investigation and the need to understand hydrologic transport through fractured bedrock motivated fracture characterization in the Tshirege Member of the Bandelier Tuff (welded and non-welded units 3, #T, and 4) at LANL's MDA-P. The study measured 454 fractures along eight traverses to characterize fracture distribution, orientation, and aperture in three dimensions. Removal of over 50,000 cu yd of waste from MDA-P exposed 87% of the bedrock along traverses. Fractures show a preferred orientation of N15W with some scatter due to cooling joints. Background fracture density in the non-welded tuff is 20 fractures/100 ft, representing a tectonic signature. Apertures in all units are bimodal (0-4 mm and 10-14 mm); 79% of large apertures (20-110 mm) are in welded units 3 and 3T. Higher fracture densities (to 40 fractures/100 ft) and larger apertures in the welded tuffs demonstrate the influence of cooling joints. Only a few fractures are open; 89% are filled with clay and roots. The fractures dissecting MDA-P have a mean trace length of only 9.5 ft, and therefore are not large structural features. Geologic mapping adjacent to the study area indicates that fracturing may be related to monoclinial folding associated with deformation in the hanging wall of the Pajarito fault. Characterizing fractures at MDA-P also establishes a foundation for modeling flow and transport in fractured Bandelier Tuff.

It was stated that studies have suggested that fracture density is not related to permeability, so may not necessarily be reflected in changes to the model.

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LANL Response to Stakeholder Issues

There were complimentary stakeholder comments about the following:

- Groundwater pathways assessment
- Sampling for geochemistry
- Well prioritization and location adjustments
- A meeting for stakeholders
- Good presentations by Elizabeth Keating and Velimir Vesselinov
- Integration of other geophysical techniques
- Amount of detail in fractures studies
- Database
- Drilling techniques flexibility
- Time and efforts to put posters together
- Geochemistry presentation

The following is a list of stakeholder concerns/criticisms and LANL responses.

- (1) This was the first mention of the Core Team and its membership.

LANL: The EAG recommended a Core Team to define the end state of the HWP, since after four years of implementation it has been difficult to get that decision from NMED. LANL has been submitting information and getting no reply. There was concern that the staff level could not make a decision, thus it was important to raise the level of management. The same problems exist within the Laboratory and DOE. We felt that if the management got involved, they could get decisions made based on staff support. The groundwater protection criteria were needed to define the end state. The Core Team would be the right people to define the criteria and provide step-by-step decisions.

There is a comfort level with the Core Team defining end of HWP, but not with establishing the groundwater protection criteria without public comment and input. Once the criteria are established, they would become part of the RCRA process, which requires public participation.

- (2) Does LANL need to pay more fees to the State to have more people review LANL documents?

LANL: The State has to judge resource requirements, but review of HWP documents is not a huge effort. In general, the Department needs more resources.

- (3) There is persistent discomfort with modeling. Something needs to be done to make it more comfortable.

LANL: We will meet one-on-one with stakeholders to discuss modeling. Presentation scenarios will be the same every year to show the improvement.

- (4) At other sites, DOE has said that contamination would not reach water supply and it has been proven wrong. We need to compare models at other sites. The Buckman results were released to the press before they were explained to stakeholders. If there is a loss of trust because of mis-statements of DOE at other sites, it is important to find out if LANL is using the same tools. If so, that would engender a lack of trust here.

LANL: Regarding the Buckman wellfield data presented to Santa Fe County, they were interested in water supply issues and the press conference that followed was about water quantity. In the study, when shown that water is pulled across the river, the statement about water meeting standards was made. We are sensitive to concerns about saying something one year and potentially reporting something different the next year. We believe it is important to put out information as we get it. Sitting down with the CAB is a good idea; we hope that CAB members will go out in the community and bring back concerns and then take information back out.

The transparent model document will be ready in one to one and a half months. It will describe the assumptions, parameters, calibration, and sensitivity.

We can easily incorporate model improvements in annual report.

- (5) I have attended meetings for three years and I understand that LANL has presented the Buckman wellfield data numerous times; however, this is the first time I heard about it.

LANL: The study was just recently completed, and only a handful of presentations have been made, primarily to utility departments. Regarding the news media in general, LANL Public Affairs has talked to the newspapers about the often negative tone of newspaper coverage and LANL's concerns. We find it curious that the media does not contact a wider range of groups for reaction regarding LANL articles. The broader issue is that the day following the Buckman wellfield presentation to the utility departments, Santa Fe went to DC to talk to the Congressional delegation about money to divert Rio Grande surface water.

Water quality wasn't the primary thrust of the Buckman presentation, but that was how it was reported. We did not go down to Santa Fe and say, "Your water is safe." The media said that. Our goal is to take available data and provide an answer at the time; the answer could change with new data.

LANL will continue to find better ways to keep stakeholders "in the loop."

- (6) There are concerns about the drilling contract: costs, lack of competition, no public input, etc.

LANL: We will rebid the drilling program again with a new RFP by the end of FY. The previous competition was among the three ER contractors. We have been looking at contracting costs and want to use best, cost-effective drilling and contracting practices while staying true to the DQOs. Some of the new approaches to procurement will depend on our new division director.

Also, we have hired Mike Klahn as a drilling supervisor. He has a wealth of previous experience and will oversee drilling this summer.

The overall concern is that wells are too expensive and affecting other parts of the program. Due to many specific factors, the price of wells is much more than the drilling piece. Our drilling and total costs have continued to trend downward over the past four years.

- (7) What is the process for sampling?

LANL: When wells are completed, one sample is taken right away and analyzed for contaminants of concern and indicators. The well rests for three to six months, and then a full suite sample is taken. During sampling, the field parameters are checked. If a sample is turbid or smells bad, it won't be sent for full suite analysis. Sampling rounds two and three will potentially have smaller

analytical suites, depending what was detected in first sample. The fourth sample is again full suite. LANL will continue to set the analyte list and implement this policy. We have had a number of discussions with the State about this approach, and it makes good sense.

- (8) There is concern with drilling with mud that the equilibration will take longer, and the first sample should be flexible based on cleaning up.

LANL: The big concern is metals. We have to really watch and get good well development. We will see how it goes with the first mud rotary well. If there is a problem, we will go to the State and ask for a revision.

- (9) There are concerns about the prioritization of wells.

LANL: We started the HWP with a prioritized list of 32 wells. Over the years, the list has been reprioritized. The reprioritized list is at the back of the annual report each year. The NMED letter had a list that was different, but we don't know where that comes from. LANL's list is a proposed list; we are looking for input.

- (10) LANL should set the drilling schedule for a year and freeze it.

LANL: We agree. During the year, we develop a field implementation plan (sampling and analysis plan) for each borehole. We try to get it to the regulators two weeks before starting.

- (11) There has been concern that more core needs to be collected.

LANL: Most of the core that has been collected just sits and is not used. We are not eager to collect core just to do it. If there is a real data need, we will certainly collect more. Materials that can be hydrologically tested have already been tested. If there are materials that have not been tested, it is because the core recovery is too poor to conduct testing.

At R-8 we compromised on coring the top 300 ft. It was at the cost of \$160,000. We have to make sure the data are valuable and necessary. We will continue to core on a negotiated basis.

- (12) There is a time disconnect between the intention to have data collection meetings with NMED and actually doing it on a timely basis.

LANL: We will try harder and give them more time.

EAG/Managers Closeout

The Core Team is an important element of the program. The EAG encourages the Team to select a chair, hire a facilitator, and start meeting soon. Core Team objectives are to refine the HWP end state, define a monitoring system, and plan any follow-on activity.

Products for the HWP are the number of wells, database to support modeling, and risk-based decisions. There is a need to make decisions that supplement the regulatory structure; technical results cannot do this, since it requires political negotiation. Decisions need to be based on consideration of each other's interests. NMED is withdrawing and holding LANL in a hostage situation with perhaps the help of DOE. The EAG will present technical comments after reading documents and discussions.

The presentations were targeted well at the audience. Stakeholders see the strength in modeling, but are uncomfortable about communication. A recommendation is to hold one-on-one meetings with modeling people, NMED, and the CAB to look at key data. Models should use consistent scenarios to show progress. With wells as data points, it is important to use models to connect the points.

Compliments include modeling geochemistry, sampling, well siting accommodation, integration of geophysics, fracture studies, database accessibility, flexibility of drilling techniques, and efforts put forth in the meeting.

Participation of DOE and LANL management was much less than in previous years.

There is substantial progress on the technical front, however an end state definition is desperately need.

DOE will do a follow-up call with stakeholders. It was noted that NMED did not stay for the responses and that NMED is currently short on resources.

In reference to modeling, technically the move to groundwater pathways assessment is very good and the stakeholders agree. It presents a good framework to do analyses and shows progress. Modelers need scenarios, and are looking to the Core Team for goal posts.

A transparent and accessible modeling report was requested.

At the stakeholders meeting, it was stated that there is unanimous concern that when DOE does modeling and makes a prediction of no impact, the prediction has always been wrong. The EAG suggests looking at the different DOE facilities and explaining differences.

The EAG tried to determine if there was advice on issues for the Core Team to address such as goals or objectives, risk of LANL operations, guide for current and future operations, and maintaining regulatory compliance. The bagel chart might provide some guidance in determining the objectives.

It was stated that the GIT has done a good job in defining the bagel chart. What would the Core Team do to it? The EAG responded that plateau-wide hydrogeologic characterization is a goal. But with limited resources, the Core Team could define a basic framework from which more focused investigations can start if contaminants are detected.

There is a question of what is "fairly good". The bagel chart has four questions; there needs to be a decision about whether the certainty in the answer is enough.

There is agreement between shareholders regarding the mission of the HWP. It was conceded that the Core Team is a good idea and will lead to greater clarity in purpose. Modeling is a necessary thing, and modeling communication is important. NMED may, by contract or hiring, acquire modeling expertise.

One-on-one discussions will help clarify the progress of the HWP work, but there may be some resource constraints within shareholder organizations. One-on-one meetings with NMED were previously successful until resource constraints developed.

The EAG stated that everything is risk-based. This program would not exist if there was not any risk, but it is not possible to eliminate 100% of the risk. The EAG feels that it is a terrible mistake to issue the Corrective Action Order (CAO). NMED responded that one compelling thing was that New Mexico

gets the short end of stick for EM funds. Other DOE facilities get more money because they have administrative orders. There was a growing concern that funds were going elsewhere and it is important to attract them to New Mexico. There is a lack of structure to programs at LANL and SNL. The HWP is only a small part of the CAO.

It is understood that communication may not always have been as good as it could be. With the CAO coming out soon, the resource issue won't be as limiting.

On the positive side, the EAG feels that in previous years there have been separate pieces to the program, now the pieces are being linked. Because there are limited resources, there will be tradeoffs in certainty, risk levels, etc. The Core Team will need to listen to the technical input.

Over the past four years of characterization work, there has been improvement in visualization, a better database, and the linkage with groundwater pathways. But some things have stayed the same over the four years – bounds and goals posts; and NMED, DOE, and LANL relationships and decision-making. It is hoped that the Core Team will solve these latter issues.

Concern about the CAO potentially stopping progress was noted. With the CAO, it is important to find a way to make the Core Team work.

EAG/GIT Closeout

The EAG began the closeout session with a review of the annual meeting.

Senior management issue is the Core Team. Core Team membership consisting of two each from LANL, DOE, NMED is encouraged to refine the end state of the Workplan. The Team may select monitoring wells and follow-on activities. Some end states may include the number of wells and modeling with specified certainty. The Core Team should not work in a vacuum but should have technical support. Perhaps the Team could focus on the bagel chart to resolve decisions. It is believed the Core Team will help resolve disagreements among DOE, LANL, and NMED.

Presentations were in a good format for the target audience and showed excellent progress. In regards to modeling, stakeholders appreciate the models, want a one-on-one meeting with LANL and stakeholders to explain modeling elements, and suggest successive models on specific areas as a communication tool. NMED is at a technical disadvantage and should have a modeling consultant.

There was discussion of the transparent modeling document. LANL is trying to get NMED to be part of the team developing alternate conceptual models. But NMED uses lack of resources as a reason.

The EAG would like to have the action plan before the annual meetings.

Concerns about sampling low flow and the Westbay closed system were noted. Also concerns about bentonite in wells were mentioned, but the EAG has confidence that LANL will track this issue.

There were suggestions for NMED involvement in modeling. NMED has had an offer to provide contract modeling expertise. LANL suggested that NMED/HWB use NMED/GWQB personnel with modeling expertise. NMED/HWB also has access to expertise in mining and mineral resources.

There will be competition in the next drilling RFP. It is good to increase the drilling toolbox. NMED's letter suggests they are encroaching in areas where they do not belong. Well development uses standard practices.

Pumping tests conducted with a single observation well will not yield more information than pumping tests in a single well. Multiple observation wells are needed. The design depends on what data are needed (vertical anisotropy, lateral anisotropy). These are true for a single aquifer, but it is more complex in multiple aquifers. LANL has pump test data for water supply wells, but has not had time to analyze the data.

The GIT would like to work on an appropriate approach for reanalyzing pump tests. In the next year, the GIT will probably not pursue a pump test.

The EAG believes that spinner tests in municipal wells should be conducted.

The EAG struggles with the concept of risk-based management with respect to the HWP. This needs to be resolved. Characterization would not be necessary if there were not a risk. In answering the two risk questions (how likely and how bad), the groundwater pathway assessment is great; all the pieces are there. The same approach could be used to focus on other parts. The Laboratory would benefit by having more say about the toxicity of COPCs. LANL should be in a position to comment and not be dependent on what others say. LANL should be sure that the issues being pursued are necessary to address the risk questions. The Core Team will not provide details, but could give guidance that focuses the details, e.g. ACLs. Regarding discussion of risk levels, information on

trade-offs needs to be provided. The Core Team should be given the questions that should be asked, e.g. a risk range, not a single risk level. EPA has supported the 10^{-4} to 10^{-6} range used in drinking water standards and the air program.

It is important to frame the program for the Core Team. Tell them the tools that will be used. Do not expect them to set the game plan, just the goal posts. The Core Team should not be setting the numbers of wells, but should be setting receptors and length of time.

The EAG is not clear on the interaction between groundwater pathway assessment and groundwater protection implementation. The bar is being set high: protect all receptors all the time with 95% certainty. The goal is to tighten the uncertainty. The EAG stated that the HWP is not a remedial activity, but a characterization activity. The purpose is to have an idea of what is going on to guide further characterization if required. Overall, it would be good to combine monitoring requirements and groundwater protection.

Simplifying the well design and increasing drilling tools will reduce costs. The costs have decreased already. Attempts from management to simplify the DQOs will help with drilling decisions. The Value Engineering team should be urged not to compare apples and oranges as LANL has more complex and deeper drilling. From an operational standpoint, compare one drilled hole to another.

The EAG will have a draft report in six to eight weeks. The Core Team may want to use the EAG report and previous EAG reports, the action plan, and the bagel chart.

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**Semi-Annual Report
to the
Groundwater Integration Team (GIT)
of the
Los Alamos National Laboratory
by the
External Advisory Group**

meeting dates - 9-12 April 2002

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EXECUTIVE SUMMARY

The External Advisory Group (EAG) for the Groundwater Integration Team (GIT) of Los Alamos National Laboratory met during the period April 9-12, 2002, in Santa Fe and Los Alamos, New Mexico. The following summarizes our major observations and comments.

Management and Global Issues:

- A Management Core Team has been formed to determine end states for the Workplan.
- This team needs to act promptly.
- The Management Section presents some suggestions leading to end states using logical extrapolations from current and proposed documents.
- Heavy staff involvement in these decisions is necessary for them to be effective.
- The Core Team should examine the specificity with which data quality objectives can be formulated.
- The Workplan should continue to be worked as planned while the Corrective Action Order is being formulated.

Technical Issues:

- The GIT subcommittees and teams should take the opportunity early in the Core Team process to clearly identify the specific points of guidance they have recently been seeking that will ultimately assist them in bringing Workplan activities to a successful conclusion.
- Geochemical modeling vignettes should be consolidated into a plateau-wide understanding.
- Geologic Modeling should focus on plateau regions of real importance to Workplan objectives regarding water flow and contaminants.
- Incorporation of uncertainty into modeling analyses, and development of scenarios to be modeled, should be focused on issues important to, and specifically identified by, decision makers.
- In the face of increasing regulatory pressure, the GIT should remain vigilant in retaining control over key design decisions such as drilling methods, development procedures, screen design, and so on.
- Use risk-based objectives to determine when characterization is adequate.
- Rank future data needs according to relative significance to the completion of the Workplan as defined by the Core Team.
- Clearly define the chemicals of potential concern and the associated toxicities, estimated quantities, physical/chemical properties as an integral part of the Workplan and to guide essential elements of the Workplan.
- Address the potential use of alternate concentration limits (ACL's) for characterizing contaminants.

1.0 INTRODUCTION

The Hydrogeologic Workplan (Workplan) describes activities proposed by Los Alamos National Laboratory (LANL) to characterize the hydrogeologic setting beneath the Laboratory, and to enhance the Laboratory's groundwater monitoring program. The EAG feels its broad goals should be repeated as often as possible to help with focus. As stated in Section 1.6 of the Workplan, the language implies a risk-based management approach:

“The goal of the Strategy [LANL Groundwater Protection Strategy] is to describe a dynamic approach to protecting the groundwater resource from unacceptable impacts resulting from past, present, and future operations.”

This protection strategy is “to protect...beneficial uses” including “potable water supply, irrigation, livestock, and wildlife watering.” The Workplan states that the “highest priority is the protection of groundwater of the regional aquifer because of its beneficial use as a source of drinking water.” The Workplan also states that “the regional aquifer also contributes flow via springs and seeps into New Mexico's surface water, e.g., the Rio Grande, which also has incumbent beneficial uses...”

The original Workplan provides a process for drilling up to 32 deep (aquifer-penetrating) wells and shallower wells as needed, including 51 alluvial wells, to 1) reduce hydrologic uncertainties; 2) reduce stratigraphic and structural uncertainties; 3) detect contamination of the water supply system; and 4) assess the nature and extent of potential contamination of the groundwater. Funding for the program is from Environmental Restoration (ER) and National Nuclear Security Administration (NNSA) Programs, depending upon the location and objectives of the designated well. With its inception in FY1998, the Workplan is managed by the Program Manager and the Groundwater Integration Team (GIT) matrixed with ER and NNSA Program Offices. An External Advisory Group (EAG) was formed in August 1998. The purpose of the EAG is to function as an independent peer review body, comprised of professionals with education, expertise and experience germane to the Hydrogeologic Workplan activities.

The current document represents the eighth semi-annual report by the EAG based on the meetings held in Santa Fe and Los Alamos on 9-12 April, 2002. The EAG heard technical presentations, viewed posters, facilitated Management and Stakeholders meetings, and participated in subsequent discussions with the GIT. The EAG reviewing team consisted of Elizabeth L. Anderson, Robert W. Charles, Charles F. McLane, Robert M. Powell, Jack D. Powers, and David C. Schafer. All participated in the review and the preparation of this document. This report summarizes the discussions, impressions, and recommendations of the EAG as of the date of the meeting.

2.0 MANAGEMENT AND GLOBAL ISSUES

2.1 PROGRAM MANAGEMENT

Positives:

- Semi-annual meeting of Senior Management.
- Patient, diplomatic Program Manager.

- Flexibility in Program Management.
- Realignment of Program Management and Environmental Restoration functions in the same, new Division.
- New annual report format with more interpretation.

The most pressing issue facing the program management is a definition of an end state or end states to the program. The program is flying. It needs landing gear. Technical measurements can only support but not supply such a definition. The decisions are managerial and administrative and must be agreed upon by upper management of, principally, LANL, DOE, and NMED with input from the other external stakeholders.

Expanding upon the statements in the introduction and paraphrasing such from the Workplan (p 1.1), the mission is to:

- Characterize the hydrogeologic system beneath the Laboratory adequately to determine the existence or nonexistence of contaminants in the groundwater.
- Characterize sufficiently for the siting of monitoring wells.
- Characterize sufficiently to satisfy Hazardous and Solid Waste Amendments (HSWA) portion of the Laboratory's Resource Conservation and Recovery Act (RCRA) operating permit.

That this mission is agreed upon by the Senior Management of the cognizant organizations, LANL, DOE, and NMED, is attested by the examination of the literature leading to the preparation of the Workplan. Annual Reports are meant to show Workplan progress and to reflect negotiated changes in Workplan directions. In effect the Workplan is supposed to be iterative which does not seem to be understood by some stakeholders, particularly NMED, who seem to want to focus only on contaminants and MCLs after agreeing to a risk-based characterization program by signing off on the Workplan; which is inherently based on risk concerns and their assessment.

Upper management identified the lack of a distinct, measurable end state as early as 15 October 1999. At this, the first Senior Management meeting facilitated by the EAG, the principals agreed to form a team to better define the 'mission.' At the 31 March 2000 meeting this body attempted to define the mission and agreed upon the following end states:

1. The wells themselves,
2. Plans for long term monitoring of the wells,
3. Robust, comprehensive models, and
4. Database sufficient to support the models.

The senior managers agreed that the Workplan was well thought out and management was, in general, in tune with the major products. Stated another way, the Senior Management has no desire to restart the Workplan but prefers to negotiate some specifics in its implementation and final products.

There was no formal meeting of the Senior Managers in October, 2000. However, they planned to be more active. The next scheduled Senior Management meeting facilitated by the EAG was 19 March 2001. At this meeting the group struggled again with the definition of end states. One issue dealt with the transition of the Workplan to a Monitoring system. A working level core team was formed to make recommendations for this purpose. The EAG suggested a risk based approach would help bound the scope of the Workplan.

The Senior Management meeting on 9 April 2002 resulted in the formation of a Senior Management Core Team to define end states. The team is planning to meet sooner rather than later.

Thus far, management plans to help define end states have come to naught. The lack of a goal oriented team approach has lead to 'positions' by each organization:

- LANL - Proposed scope revisions keeping the long term focus of the Workplan.
- DOE - A Value Engineering Study proposing conclusion of the Workplan based on data already gathered.
- NMED - A 1 March 2002 letter rigidly adhering to outdated, unrealistic Workplan schedules and a planned Corrective Action Order to force the issue.

While there is some truth in all of these documents, the organizations have been unsuccessful in mediating their differences and are proceeding unilaterally. Negotiations have been halfhearted. The Corrective Action Order, in particular, may produce a rigid, legalistic, and, perhaps, an ossifying effect on the Workplan. The root cause is a fundamental disagreement on the mission of the Workplan in spite of acquiescence by each to proceed with the Workplan. In response to our recommendation 12-01-1, the GIT states that the mission is to understand the hydrogeologic system below the Laboratory as a technical basis for decisions related to protecting and preserving groundwater as a resource for future generations while the Laboratory continues to operate. The EAG agrees with this mission statement. It seems much more in tune with the original Workplan document.

What to do? Even in light of the administrative uncertainties, continue to work the plan. Both the Management and the GIT need to make some choices. Serious negotiations setting bounds should be initiated promptly. Be bold. Starting with the staff level, the PM and the GIT need to feed the technical data to their management to support bounds for the program. By all means the staff should start proposing bounds. This requires discipline not commonly found in talented, imaginative, research-oriented technical people. Such discipline is required for the successful conclusion of the program. Current bounds of time and funding may suffice, if aspects of the projects are presented as reaching some logical stage at the end of the program. Does this mean that characterization will end at the end of this program? Probably not, but it is time to take stock to conclude this chapter at the agreed upon date with useful although not totally detailed characterization products. The suggestion of a draft final report, made by many associated with the program as stakeholders, is a good one. It will show the holes that need to be plugged in the logic. It will be an informative device for management. The vehicle for such a draft could be modifications of the current annual report. The annual report contains more in the way of results and interpretation than has been the case in the past. The GIT appears agreeable to such a report (see 12-01-2 in most recent Action Plan for EAG Recommendations).

Perhaps the most graphic way of generating a pathway is found in section 6.0 of the current annual report. The 'Status of Aggregates with Respect to Decisions and Data Necessary to Resolve Decisions' Table 6.1 or the 'Bagel Chart' is a way of keeping score. When the six questions are answered, the project is over. For each aggregate:

1. Are there sources of sufficient magnitude to cause contamination of groundwater?
2. Are the alluvial sediments and uppermost subsurface water at contaminant concentrations greater than regulatory risk limit or risk level?
3. Is the intermediate perched groundwater at contaminant concentrations greater than regulatory limit or risk level?
4. Is the regional aquifer as affected by the canyon systems by contaminant concentrations greater than regulatory limit or risk limit?
5. What are the pathways for exposure to contaminants from alluvial sediments and uppermost subsurface water?
6. Are there sufficient source terms to cause contamination if moved along the pathways in 1000 years?

Is everyone going to accept these questions or their current resolution? Once again, probably not, but this is the place where the negotiation must begin. Agreements on these types of questions at the management level must be resolved with technical input from the staff, particularly in defining aspects of coming to closure for the many points listed in the 'data needs' section of the table. Risk based decisions form a common denominator aiding in decision support (see Section 3.6, this report), but these have not progressed as well as hoped by the EAG in the LANL case. One can clearly understand that terms such as 'sufficient' must be defined in the managerial arena with the best technical data available. Some more measurable bounds are presented in the following sections. See in particular 2.3, 3.2, and 3.6.

The EAG reiterates our understanding of the overall objectives of the Workplan which are to provide adequate characterization to help ensure that current and future operations of the laboratory will not result in unacceptable impacts to the groundwater resources at the LANL facility. The outcome of the Workplan program should serve multiple purposes including support to RCRA permitting, insurance that future activities at the laboratory are soundly founded on an adequate characterization program, and support to the ongoing remediation of legacy issues

The program is one of geologic, hydrologic, and geochemical characterization, not remediation, nor detailed contaminant mapping (plume chasing in the vernacular). Some of the external stakeholders seem confused on this issue. Of course, there is overlap in the short and long term goals, but it is a management prerogative to correct this unwarranted mission creep. If anything, the PM and the GIT have been too accommodating in trying to incorporate all things for all people.

Recommendation:

- *The primary recommendation is for the Senior Management Core Team to meet sooner rather than later and make some choices.*

Recommendations - Further action needed:

- *12-01-2 agrees to preparation of some final document draft. The new recommendation above reinforces 7-00-1 and 12-99-1 where commitment was made to define end states. The EAG does not recommend combining these various quests for end states.*

2.2 MANAGEMENT OF STAKEHOLDER ISSUES

Positives: (From Stakeholders):

- Some specific aspects of the modeling were well received: groundwater pathways assessment and regional aquifer modeling.
- Geochemical sampling and modeling.
- Integration of other geophysical techniques.
- Well siting accommodations reflecting NMED concerns.
- Amount of detail in the fracture studies.
- The database.
- Flexibility in drilling techniques.
- Stakeholder meeting itself.

The most recent meeting of the EAG with the external stakeholders (i.e. exclusive of LANL and DOE personnel) was held Thursday, 11 April 2002, in Santa Fe. Attendance was stronger than the previous meeting with representation from NMED, CCNS, CAB, the NM Attorney General's Office and the University of California. The Native American contingent was absent. The body was polled for burning issues that were discussed in the first part of the meeting. Then the PM for the Workplan and the GIT were invited to respond to comments from the stakeholders in the second part of the meeting.

Core Team: There was some apprehension by the stakeholders about the designation of a Management Core Team comprised of managers from LANL, DOE, and NMED to define end states for the Workplan including standards and action levels. The team was formally designated only two days previous to the stakeholders meeting and this was their first introduction to the formation of the team. Some were concerned that the team would make unilateral decisions without other input, such as from citizen's groups. The PM carefully reiterated the membership of the Core Team and its general goal of establishing the criteria for protection of human health and the environment with respect to ground water pathways that are needed to help define the end state of the Workplan. The management team must make thoughtful and negotiated managerial and administrative decisions in this regard. The mission is not appropriate for the "staff core team" loosely defined as the PM and GIT, NMED Staff, and DOE observers. The PM further stated that he believed once some guidance is proposed by the management Core Team, any requirements would become part of the RCRA process, which requires public participation.

Modeling: The EAG has noted continuing discomfort in general with GIT modeling efforts performed under the Workplan, with many of the problems relating to communication. Several Stakeholders requested the preparation and dissemination of more modeling reports to document the work completed thus far, while others suggested the publication of peer-reviewed scientific articles to provide an external review of and increased credibility for the modeling studies. Other issues revolved around the manner in which a recent modeling study was reported in the local press. The PM responded that the models and the results are being submitted for peer review, and that the authors are quite comfortable in discussing on a more one-on-one basis the models and their implications in whatever detail the stakeholders may wish.

The stakeholders also suggested that the modelers use consistent scenarios from meeting to meeting to show model improvement and help Stakeholders better understand the results. It was suggested that the scenarios might be structured around the Ground Water Pathways Assessment model. The issue is not so much a technical one, as an exercise in effective communication.

Stakeholders would also like to know how parameter values (key data) fit into the models, what they are and where they are. Additional stakeholder issues with modeling include wanting to know what production wells are at risk and the time frame of that risk, concerns that other DOE sites have over-estimated travel times, hence under-estimated risk, a lack of modeling reports, and a need for defining the purposes of the models. The PM stated that a 'transparent' modeling document will soon be ready that is intended to present to stakeholders in a clear and concise manner the assumptions, techniques, and results of the modeling studies.

Drilling Contract: Stakeholders felt that the public should have input into the RFP for drilling. Concern was voiced that drilling work is bid and compensated on an hourly rather than a "per foot" basis. It was also noted that the various bids by the general contractor involved the same drilling company which may show a lack of real competition. The PM plans to rebid the drilling program by the end of the FY with these concerns in mind. At that time, consideration may be given to mixing per foot and per hour approaches to maximize efficiency. The PM has hired a drilling supervisor with wide experience (Klahn) in order to help address these issues.

Sampling: Stakeholders expressed some apprehension that full sample suites of non-representative and potentially worthless data might result from working in poorly developed wells. Policy was clarified as to how to handle samples that may contain excessive amounts of masking drilling fluids. The PM and GIT noted that restricted analytical suites are used until the well is felt to be satisfactorily developed. One sample is taken shortly after well development for contaminants of concern and indicators. A field decision is made to take the sample for a full analysis. Later rounds of sampling may be similarly restrictively analyzed depending upon observed drilling fluid contamination. The final sample will be collected for full analysis.

Well Drilling and Prioritization: The Workplan started with a prioritized list of 32 deep wells. The plan as stated in the Workplan is to revisit this list and reprioritize periodically at the quarterly meetings. The current annual report lists the current plan. The GIT believes that NMED is holding to a different prioritization and an unrealistic schedule given the budget. LANL's most current prioritization is a proposed list, subject to comment but not endless revision, plus subsequent freezing of the schedule. Stakeholders suggested that there might be alternative uses for holes earmarked for plugging and abandonment. The PM explained LANL's position that an evaluation had indicated that the potential benefits of these uses were not strong enough to counter safety concerns and lack of economic benefit.

Data Collection: The stakeholders are concerned about a perceived lack of decision documentation about well drilling, data collection, DQO's, and overall goals. They would like to examine what data are planned for a given well perhaps nine months before the well is drilled. They would like to see a drilling schedule for a year that is frozen. The PM will continually work to define data objectives as early as possible and discuss them with the stakeholders. The issue of coring arose with stakeholders inquiring whether more core should be acquired. The PM has found through experience that more core has been taken than is needed. Most of the core just sits in an expensive repository. Nevertheless, he will entertain proposals for more core with appropriate justification.

Recommendations:

No new recommendations.

2.3 DATA QUALITY OBJECTIVES

Positive:

- *A Core Team of managers from LANL, NMED, and DOE has been designated to define the end state products of the Workplan,, which should increase the specificity with which data quality objectives can be formulated.*

The data quality objectives for the Hydrogeologic Workplan remain somewhat vague with respect to the level of accuracy and precision that must be attained in order to achieve Workplan goals. That is, although the parameters needed for site characterization (understanding the hydrogeologic framework), locating a monitoring well network (designing and implementing a detection monitoring program), and predictive modeling (defining potential contaminants, pathways and timelines) are known, the degree to which these parameters must be ascertained at a site wide scale remains somewhat undefined. The EAG anticipates that the issues of accuracy, precision and confidence levels for Workplan objectives will be addressed by the Core Team of managers in collaboration with the appropriate GIT scientists. Since it is impossible to absolutely define all parameters of consequence in a study such as the Workplan, management and stakeholder input is required regarding the degree of "completeness" that the program must attain and the information necessary to support their decisions about what is a sufficiently complete state for the Workplan. A decision on the degree of project completeness must be made by balancing numerous real-world factors, including:

- 1) Technological capabilities and limitations.
- 2) Regulatory requirements and public concerns.
- 3) Financial limitations and cost/benefit analyses.
- 4) Time constraints.

Completeness of the Workplan might be addressed for each of it's major components (installation of wells, database development, transport modeling) or objectives (stated above), or by determining the most critical/sensitive of these and basing the data needs on that component. For example, it might be determined that it is more important to adequately predict the transport and fate of specific contaminants beneath wet canyons over time, with some level of uncertainty, than it is to more fully understand percolation on mesa tops or to situate additional wells in uncontaminated areas.

Recommendation:

- *Convene the Core Management Team and quickly make program objective and goal decisions that allow the data quality objectives to be clearly defined and developed to the needed level of accuracy and precision.*

The Workplan has achieved a great deal of success at roughly characterizing the Pajarito Plateau and providing a fundamental understanding of the hydrologic processes that are occurring in the subsurface. Since both the time frame and the budget for the Workplan are finite, it is imperative that final decisions be made concerning program objectives and goals that will permit data collectors and analysts to determine the level of detail required for the parameters of importance. Even with a successful conclusion, the Workplan may not result in enough detail for fully comprehending the fate and transport of a detected contaminant in a given area but will provide regional parameter estimates and guidance that can then be used in a more detailed and specific contaminant assessment under the ER program.

Recommendations Requiring Further Action:

- *Reconsider the EAG recommendation that is addressed in the LANL Action Plan for EAG Recommendations (March 31, 2002) with the Proposed Action 12-01-5 for any subsequent DQO iterations, especially with regard to better documenting the rationale for the decisions and considering the process in terms of risk management decisions or drivers.*

The GIT argues in their response that the DQO process does not have to involve risk assessment or risk-management decision making. The EAG would counter this contention by stating that, in the context of environmental assessment procedures such as those underway in the Workplan, these risk considerations are the inherent drivers for the implementation of such a program. Otherwise it would merely be an academic exercise. The development and/or iteration of a DQO process in the absence of such considerations might not result in the right types or detail of information needed for decision-making with regard to environmental concerns.

2.4 ADMINISTRATIVE

Positives:

- *Management of meeting logistics.*
- *Collection of view graphs, notes for prior distribution.*
- *Name tags.*
- *Meeting location.*

The EAG is grateful to Suzanne Maez for her help with the logistics of the meeting. The compilation of the view graphs and abstracts was very helpful to the EAG. The EAG thanks Suzanne Maez, Kelly Bitner and the GIT for their efforts in the compilation. We thank Kelly Bitner, particularly, for prompt transmittal of the stakeholder minutes. We also found the necessary time for EAG caucus at the meeting.

Recommendation:

No new recommendations.

3.0 TECHNICAL ISSUES

3.1 DATA GATHERING AND DATABASE

Positives:

- *Development of consistent data formats for the WQDB.*
- *Most aspects of sample management/tracking now available in the WQDB.*
- *All ESH-18 chemistry data since 1995 are now included in the WQDB.*
- *Improvements in the exchange of data (data sharing) between ER and ESH.*
- *Reports on data gathering activities are progressing and being published.*

- *Collection of important data continues even in the absence of definitive Workplan end states, thanks to the expertise of GIT scientists.*

Development of the WQDB seems to be continuing and it is an important sign of overall progress on the Workplan. It seems that the development of consistent data formats has improved not only data entry but the interactions between ER and ESH with regard to being able to share data. The EAG is aware that data formatting and labeling is a major issue in any database project, no matter what the program, and realizes that the conjoining of two or more disparate databases is a major effort. It appears that the Information Management Subcommittee of the GIT is addressing this problem and managing it.

The fact that such a large amount of data is now included in the WQDB (with new information being added daily) makes it apparent that the characterization of the Pajarito Plateau is progressing well with respect to data acquisition and information gathering irrespective of the unknown value of the data in the absence of well-defined Workplan end states. With the development of the WQDB as a repository also for the legacy data, there is also some indication that, perhaps, more historic characterization information is available than previously realized or that, at least, it is now more readily accessible and usable.

It is encouraging to hear that reporting on the data gathering activities is a major focus for the drilling team and the geochemistry subcommittee, i.e., getting out the well completion and geochemistry reports. These reports should be very helpful to the GIT scientists as well as other internal and external stakeholder groups. They should help tie together information in the WQDB and serve to begin the interpretation of the accumulated data for the final products of the Workplan.

The online database is an extremely useful tool for both LANL personnel and external stakeholders but there is still room for improvement in certain aspects of its implementation.

Recommendation:

- *Establish a database mechanism whereby online reports can be generated for subsets of parameters rather than for all parameters or just a single parameter.*

Although the time the EAG has spent exploring the online database is limited, it seems that there are some aspects of the reporting functions that could be enhanced. In many or most instances of report generation, drop-down menus are used to select a location and a parameter for the report. Sometimes the option to report all parameters for a location is available but often all the parameters are not needed and this can really slow database search/display execution. Due to the nature of the HTML and javascript-based drop-down menus it seems impossible to select multiple parameters for the report (or at least it is not obvious to the user how to do so). For example, it is not clear whether there is a way to select a report that displays chloride, sulfate, and pH simultaneously for a location or sampling point/date. This would probably be relatively easy to correct within the user interface or may already be possible if instructions are provided to the user.

Recommendation:

- *Online database searching and displaying functions should be optimized for speed.*

Searching for and displaying information in report formats using the online database seems painfully slow sometimes, even with a single location and parameter selected. This is true even using high-speed Internet connections and state-of-the-art computer hardware to access the database, leading to the conclusion that the delays are on the database servers. There are a number of possible reasons for this that are beyond the scope of this document to address. The EAG is merely encouraging the Information Subcommittee to investigate whether all aspects of the database information delivery are optimized, including such things as whether the hardware is adequate with respect to software and connectivity demands, whether the best searching algorithms are being used, whether the hard disks have been optimized and the database compacted, etc., as a few possible suggestions.

Although the data reports are useful, summarization and comprehension of such large amounts of data are usually accomplished through the use of graphical techniques, such as GIS. The EAG is sensitive to the security reasons that LANL maps and, consequently, public GIS displays are not available at this time. There might be other means by which data relationships among various geographical points might be displayed, however, in the form of charts, graphs, and, perhaps, abbreviated cross-sectional subsurface-only depictions.

Recommendation:

- *Develop some methods for graphically depicting relationships between wells, flowpaths, etc, that are short of a GIS system but still allow stakeholders to better comprehend the data relationships.*

3.2 MODELING

3.2.1 Hydrologic Modeling

Positives:

- *Continued progress on Ground Water Pathways Assessment, with current goals of linking previously developed models, incorporation of uncertainty, and calculations of chemical concentrations in ground water for use in risk assessment and decision making.*
- *Use of "predictive analysis" (as defined by the GIT) to examine natural variability and uncertainty in model input parameters while constraining the models so as not to produce an unrealistically wide range of model responses.*
- *Progress in incorporating into the regional aquifer model recently collected data regarding water levels, vertical gradients, hydraulic conductivity, and porosity as a precursor to the next planned phase of uncertainty analyses for hydrostratigraphy, recharge rates, and boundary fluxes.*
- *Presentation to interested Stakeholders of results of the preliminary Buckman Well Field modeling analyses as an example of the use of ground water modeling to examine ground water pathways and to estimate dilution-and-attenuation (DAF) factors.*

Recommendation:

- *Evaluate impacts of recent diversions of GIT modeling resources from scheduled Workplan tasks, and adjust schedule as necessary.*

Modeling resources have in the past been diverted from Workplan program activities to analyze fire-related impacts on hydrologic processes, and most recently to analyze water supply issues associated with operation of Santa Fe's Buckman Well Field. To the extent that costly drilling and field data collection efforts continue on schedule, while modeling analyses are slowed, the analysts may be hindered in fulfilling their mission (as outlined in the Workplan) of guiding or providing input to data collection activities. If an evaluation suggests that field data tasks should be slowed, or that modeling tasks should be accelerated, funding and schedule adjustments should be implemented as required to bring these elements of the Workplan program into synchronization. These observations should be examined in the more general context based on the GIT response to the EAG's recommendation 6-01-1 where the GIT makes a general statement about determining which activities are 'out of scope.' A later statement in this report indicates some geochemistry activities that appear beyond the scope of the Workplan (see below).

Recommendation:

- *The GIT subcommittees and teams should take the opportunity early in the Core Team process to clearly identify the specific points of guidance they have recently been seeking that will ultimately assist them in bringing Workplan activities to a successful conclusion.*

The GIT modeling teams have been requesting the formation of a Core Team that can provide some specificity on regulatory issues and criteria that will establish bounds on, and goals for, the modeling analyses. These modeling analyses, as they are refined, will identify data needs and will provide input to Workplan data collection efforts. As these modeling analyses are concluded, they will provide information to Laboratory management, regulatory officials, and other stakeholders that will allow those reviewing the program to determine whether the Workplan program has successfully fulfilled its mission and, therefore, can be terminated. Now that the Core Team has been formed, it will require information from the modelers regarding the specific determinations and decisions the modelers need to be able to complete their assignments within the context of the final Workplan goals and products as promulgated by the Core Team. Iterations of this process might be necessary to stay on time and within budget while achieving useful goals. The modeling staff should take this opportunity to educate the Core Team on the role that modeling will play in the Workplan, the nature of their current and planned analyses, and the context and rationale for the decisions they are requesting.

Recommendation:

- *Incorporation of uncertainty into modeling analyses, and development of scenarios to be modeled, should be focused on issues important to, and specifically identified by, decision makers.*

At the April 2002 Annual Meeting, plans were announced to incorporate uncertainty into both the Ground Water Pathways Assessment analyses and into the regional aquifer model. At the same meeting, Stakeholders requested that consideration be given to developing modeling scenarios to provide a basis for the scoping of modeling analyses, and to provide a context for the presentation of modeling results. The EAG recommends that care be taken in developing scenarios, and in incorporating uncertainty into the modeling analyses, to ensure that reasonable results are generated. End uses of modeling results should be clearly understood at the planning and initiation stages of modeling projects within the Workplan program so that appropriate

technical approaches can be developed to address the stated concerns of various decision makers and the negotiated end state goals of the Core Team. This approach can avoid the creation of concerns over outcomes that are highly unlikely to occur. Analysts should work internally to develop methods for combining stochastic hydrologic process modeling and probabilistic systems-level risk assessment modeling to ensure compatibility of approaches. Analysts should interact with the newly formed Core Team to identify scenarios and uncertainties to be analyzed, and to educate the Core Team regarding the levels of certainty that can be achieved in complex natural systems within a reasonable characterization time frame and at a reasonable cost.

3.2.2 Geochemistry and Geochemical Modeling

Positives:

- *Excellent ongoing evaluation of the available data.*
- *Preparation and publication of geochemistry reports for the individual wells.*
- *Continuing assessment of data needs with respect to sampling procedures.*

The Geochemistry Subcommittee of the GIT continues to receive high praise from stakeholder groups for its diligence in trying to fully utilize all available data to better comprehend both subsurface geochemistry and drilling impacts on ground water sample quality. The publication of the first R-well geochemistry report (Characterization Well R-15 Geochemistry Report, LA-13896-MS, 2002) is a very positive point of progress.

Recommendation:

- *Carefully consider where tasks appropriate to the Workplan end and those associated with remediation (vis-à-vis the ER project) begin so that appropriate resources are utilized for each.*

It is unclear to the EAG how the currently planned pilot-scale permeable reactive barrier (PRB) fits into the LANL subsurface programs. As a pilot-scale test of remediation technology it seems outside the scope and purview of the Workplan. This is not to say that the project should not be pursued but, rather, if it is couched within the auspices of the Workplan and consuming Workplan resources, this does not seem appropriate.

Recommendation:

- *Show how the geochemical modeling comes together as a whole for the Plateau.*

While the modeling is well received and provides some useful insights, the product appears as a series of vignettes. It would be helpful if the modeling were presented in the context of a more complete plan.

3.2.3 Geologic Modeling

Positives:

- *The geologic conceptual model seems to have progressed very well since the last presentation on the subject to the EAG.*

- *Re-evaluation of the older drill logs, rather than just accepting their interpretation, along with interpretation of the new drilling and surface mapping.*
- *Incorporation of information such as that from the Seismic Hazards Program and the LIDAR and airborne electromagnetic survey to complement borehole and outcrop data in defining/re-defining geologic units, faulting, etc.*
- *Apparent understanding by the geologic modelers that, in the context of the Workplan, the most significant aspects of this work relate to the geologic impacts on hydrologic and geochemical properties of water flow and contaminant transport with a focus on uncertainty.*

The geological modeling seems to be progressing as new data are incorporated into the conceptual model and legacy data are re-evaluated. One illustration of this is the presentation viewgraph that showed significant variations in the predicted stratigraphy for well R-25 until the 1999 conceptual model, which corresponded with the actual borehole data fairly well. Evidently there are significant refinements of and additions to the information that have occurred since 1999 and an even better conceptual model is under development. It is good that the geologists have been seeking all possible data sources in an attempt to better refine and bound the conceptual model, especially within the context of the Workplan with respect to how the geology affects hydrologic properties at LANL.

Recommendation:

- *Focus geologic modeling efforts funded by the Workplan on areas of significant water infiltration and flow as well as trying to understand geological impacts on aqueous chemistry.*

It is important that Workplan objectives be the primary focus of projects funded by the Workplan. Undoubtedly a conceptual model of the geology of the Pajarito Plateau is fundamental to a characterization effort and an understanding of infiltration and ground water flow in this complex subsurface environment. It is possible that the conceptual model, on a site-wide basis might be sufficient for a first-order understanding of the system. If that is so, then it would be desirable to focus further model refinements on areas of high significance to the objectives of the Workplan. These would be, for example, infiltration through faults and fractures, understanding the depths, areal extents and porosity of various stratigraphic layers in the zones of infiltration and in the regional aquifer and, most importantly, those characteristics as they influence fluid flow and contaminant transport and fate beneath the wet canyons having known or potential contaminant source terms. It appears from the presentation that the geologic modeling has moved in this general direction. The EAG merely wishes to reinforce this concept due to our concerns about limitations of Workplan funds requiring all projects to be highly focused on Workplan objectives.

3.3 DRILLING AND WELL COMPLETION

Positives:

- *Increasing the number of tools in the well drilling "toolbox" by adding a mud rotary drilling option and the option of casing off troublesome zones above the aquifer.*
- *Doubling the 8.75 percent open area in the base pipe of the pipe base well screens to 17.5 percent on future screen orders. This will enhance slightly the effectiveness of well*

development of the screened zones and combat pressure to shift the well screen design to less desirable rod base screens.

- *Planning to arrange for competitive bidding among drilling contractors on future wells.*
- *NMED's letter recommending 10 feet of filter pack reservoir above and below the well screen interval. Ten feet of filter pack below the screen is sufficient. It is still slightly "skimpy" for the zone above the screen, but is a vast improvement over numbers like two and three feet that we were hearing a couple of years ago.*

Recommendation:

- *In developing wells with multiple screen zones, use dual packers to isolate individual screens for pumping with a submersible pump.*

The well development approach and methods used by LANL are adequate and appropriate, for the most part, and conform to industry standards. However, in multiple-screened wells with vertical gradients, it is important to isolate individual screen zones with packers, and pump via either airlift or a submersible pump. Without this step, the lower-head zones could go largely undeveloped. The EAG understands that the Field Support Facility has suitable equipment for accomplishing this with a submersible pump. For tight zones that don't produce enough flow to satisfy the submersible pump, this procedure will not be possible. However, for productive zones that have static water levels lower than the well average, isolation pumping will improve the development effectiveness significantly.

Recommendation:

- *Keep the 5-inch OD casing size as an option for completing the R wells.*

The EAG has reviewed information indicating that the 5-inch OD casing size might be abandoned in favor of 6 5/8-inch OD pipe because the larger size offers advantages in running larger development tools and pumping test equipment. However, the larger size would require a larger borehole for installation. It would work fine in wells that can be drilled open hole successfully or in wells in which 11 3/4-inch OD advance casing can be run to total depth. In these instances, the 6 5/8-inch size would be a great choice and superior to 5-inch OD. However, in wells that must be drilled with 9 5/8-inch OD advance casing, it will still be necessary to retain the 5-inch OD casing option to provide sufficient annular space for placement of backfill materials. If the 6 5/8-inch size is pursued, going forward, it may make sense to consider stocking two sizes of casing – both 5-inch OD and 6 5/8-inch OD.

Recommendation:

- *In the face of regulatory pressure, remain vigilant in retaining control over key design decisions such as drilling methods, development procedures, screen design, and so on.*

Based on the EAG's review of NMED's March 1, 2002, letter it appears the NMED may be infringing on design decisions that should remain within the purview of LANL. LANL should resist recommendations that would have a deleterious effect on the drilling program. Some of the issues are summarized as follows:

1. *Pipe base screens.*

NMED recommends using rod base, V-shaped wire screens instead of pipe base screens, citing the rod base screen as the industry standard. In truth, there is no industry standard monitoring well screen. Slotted pipe, punched pipe, rod base profile wire screens and pipe base screens all have been used in water wells for decades. For monitoring wells specifically, the vast majority of these wells are completed with saw cut, slotted PVC screen. Thus, if an industry standard were identified for monitoring wells, it probably would be slotted pipe. The pipe base screens used at LANL are superior to this "industry standard."

A comparison of well screen open area is constructive for evaluating the various screen types. For 10-slot screens (0.010-inch) the open areas are:

Base pipe currently used by LANL	8.75 percent
Base pipe in new LANL design	17.5 percent
Screen jacket for pipe base screen	14.3 percent
Heavy-duty rod base screens	6 to 8 percent
Slotted PVC	2 to 6 percent

In this comparison, the greatest open areas are those of the new proposed base pipe (17.5 percent) and the screen jacket used in manufacturing the pipe base screens (14.3 percent). Thus, there is no significant sacrifice of efficiency or "developability" associated with pipe base screens.

As a clarification of LANL's response to the NMED letter, well screen strength was not the overriding factor in the decision to use pipe base screens. After the R-25 screen failures, heavy-duty rod base screens were used successfully in R-9i, R-15 and R-31. Rod base screens can be used in wells up to about a mile deep, if designed and built properly. The primary advantages of pipe base screens over heavy-duty rod base screens are superior OD/ID tolerances, slightly thinner wall dimension (i.e., greater ID or smaller OD, or both) and straight, strong end fittings that make up easily in the field.

Screen strength does play a role, however, in the thought process. In pipe base screens, the theoretical vertical tensile strength is achieved 100 percent of the time, whereas the strength of rod base screens is dependent upon a manual weld of the end fitting to the screen body at the factory. Thus, for rod base screens, there is a small probability that a given joint connection will be defective (weak) due to human error in the welding process.

NMED's concern regarding trapped material between the base pipe and outer screen jacket is unwarranted. The only materials in this space are drilling fluids (liquids) and sediment that can pass a 10 slot (0.010-inch) screen opening. During development, these materials are readily flushed from the 1/8-inch wide gap between the pipe and screen jacket. Any remaining trapped material would be minor compared to material trapped in the interstices of the formation particles around the borehole.

Finally, it is inappropriate for components of these deep, complex, difficult-to-drill and difficult-to-complete wells to be chosen by bureaucratic dictate. It is preferable to leave design of the well components to well design experts.

2. Development procedures.

NMED has required that LANL submit for approval more stringent well development procedures that match or exceed industry standards. However, LANL is already using appropriate development procedures that meet industry standards. LANL has used wire brushing, surging, pumping and high-velocity water jetting to develop the R-wells. The EAG recommends that LANL add isolation pumping using dual packers and a submersible pump to the development techniques that it employs. Except for this modification, other changes in development procedures are unwarranted.

3. *Bid strategy.*

NMED recommends that LANL bid the R-wells on a per-foot basis rather than the current hourly rate. On the other hand, the DOE Value Engineering Study advises against using a footage rate, recommending a hybrid combination incorporating both footage and hourly rates.

The implication of the NMED recommendation is that the driller doesn't have incentive to drill, construct and develop wells as efficiently as would be the case under a footage-price contract and, thus, operates more slowly at the hourly rate than he would at a footage rate. It seems that this assumption is conjecture at this point and that it is not known if bidding a footage rate would decrease drilling costs or increase them.

Bidding a footage rate transfers the project risks to the drilling contractor. It is possible that by transferring additional risk to the contractor by requesting a footage rate, he would raise his bid price to cover unknowns. This idea is consistent with anecdotal results obtained from a trial bid in which contractors were asked for a footage price. As the EAG understands it, the incumbent contractor bid more than \$600 per foot (higher than current costs) and a second contractor would not even submit a bid.

The NMED recommendation, while well intentioned, seems to ignore the fundamental fact that well drilling on the Pajarito Plateau is extremely difficult, proceeds slowly and, as a result, is unusually expensive. Adjusting LANL's bid strategy will not alter this fact and it is a certainty that drilling costs will remain high, regardless of the contracting approach used.

Finally, from the perspective of the EAG, it seems appropriate that decisions regarding the contract terms remain within the purview of LANL, not NMED.

3.4 HYDROLOGY

Last year, plans were formulated to purchase dual packer equipment that would permit pumping individual screen zones while simultaneously monitoring water levels within the pumped zone. This would have allowed conducting constant-rate pumping tests on individual screened zones. The EAG has received conflicting information regarding the feasibility of having this equipment manufactured. We have heard from LANL that technical difficulties made implementation of such equipment impossible (possibly related to packer dimensions), yet we have been told by the manufacturer (Baski, Inc.) that it is possible. The EAG requests that LANL clarify their perspective on the application of this equipment and recommends proceeding with the purchase if suitable equipment can be obtained.

Recommendation

- *Continue to monitor the manufacture and utilization of a dual packer assembly for conducting packer pumping tests, or provide the EAG information on why this can't be done.*

Recommendations requiring further action:

- *The various types of hydrologic tests addressed in the last EAG report (Recommendations 12-01-16, 17 & 18) are still being discussed and debated among the GIT as of the April 2002 meeting. Informed management decisions from the Core Team may be necessary to resolve whether to proceed with certain, or any, of these proposed tests.*

3.5 GROUND WATER MONITORING

Positives:

- *Sampling of the completed wells is underway and is being done using the approach of designated sampling suites appropriate to the wells until better equilibration with the subsurface is achieved.*
- *There seems to be a growing awareness and consensus that low-flow purging and sampling techniques should be used whenever possible to improve sample quality.*
- *Efforts are underway to develop methods for sampling sensitive ground water parameters, e.g., dissolved oxygen and Eh, in the Westbay wells without first exposing them to the atmosphere.*

The establishment of designated sets of analytes for individual monitoring wells, until it can be shown that drilling fluid residues are of little impact on sample quality and that the wells are approaching pseudo-equilibrium with the surrounding aquifer, is a positive approach for a couple of reasons. First, it avoids consuming monetary resources for costly analyses that might be inaccurate because of physical in-situ considerations. Secondly, it avoids the confusion that might result from misinterpretation of those same analytical results.

It has been repeatedly and conclusively shown that low-flow rate purging and sampling techniques tend to improve data quality for most sampled wells and are not known to have been a detriment to data quality. Although the pumps currently being used in the single-completion R-wells at LANL are not appropriate for low-flow rate pumping, there seems to be a growing awareness that this is an issue that needs to be considered and potentially addressed. The Westbay wells being used at LANL are essentially sampled by relatively low-stress methods (pressure drop into an evacuated container) but currently have some caveats with respect to certain important measured parameters. This is because the sample must be drained from the sampling container via a valve into other vessels/containers for determination of field parameters and submission for laboratory analysis. This transfer can be problematic because certain parameters that are important for geochemical modeling and are participants in numerous geochemical reactions can be altered very rapidly by atmospheric exposure. These include dissolved oxygen, redox potential (Eh), pH, alkalinity, and others (temperature readings can also be affected, although this is a physical rather than a chemical impact). If these parameters are improperly determined, or if atmospheric exposure alters the chemistry of the sample, resulting in precipitation of iron compounds for example, interpretation of the data might become erroneous, impacting such issues as transport and fate modeling, etc.

Recommendation:

No new recommendations.

Recommendations Requiring Additional Action: The EAG is somewhat concerned with the GIT response to recommendation 12-01-19. The GIT merely disagrees with the need to carry out low-flow rate purging and sampling of the single completion wells without offering any rationale other than that the pumps that are currently installed are inappropriate for such sampling, a condition that might be correctable. The GIT then states that the procedures appear to be adequate because the samples are "consistent and representative of the aquifer." That sample consistency can be obtained in some wells by high flow rate sampling techniques is not surprising, but this is a matter of precision, not accuracy. The statement that the samples are "representative of the aquifer" does pertain to accuracy, but we would argue that it is impossible to know whether the samples obtained are truly representative of the aquifer in the absence of some sort of comparison to other sampling techniques, notably low-flow purging and sampling techniques.

3.6 RISK ASSESSMENT

In previous EAG reports, the need to develop a risk-based approach for implementing the Hydrogeologic Workplan has been a focus of our recommendations. These risk-based recommendations have emerged because of the EAG's understanding of the Workplan's goals and objectives, which are to characterize the underlying geology and groundwater at LANL. This characterization program must provide an adequate understanding of the site to ensure that the beneficial uses of groundwater now and in the future are protected. Perhaps the most meaningful way to determine when a "characterization" program is complete is to define it in terms of the adequacy of the program to reach these risk-based objectives, e.g., provide an adequate monitoring program backed up by a modeling program to ensure that there is an adequate understanding of groundwater movement to define the fate and transport of pollutants. In addition, the role of geochemistry to define site related contaminants and transport characteristics is necessary. Further, the adequacy of these various components of the Workplan also need to be augmented by a clear understanding of the potential quantities and toxicities of the contaminants of potential concern (COPCs). Finally, it is our understanding that the Workplan must be adequate to address the groundwater protection issues and estimated arrival times to protect against any potential, unacceptable impact on recharge to the Rio Grande or contaminant migration to supply wells.

In determining when characterization is adequate to help define the current and future uses of the LANL site and to provide valuable information to the ER program, the groundwater annual status report (FY 2001, February 2002) continues to present Table 6-1 entitled Status of Aggregates with Respect to Decisions and Data Necessary to Resolve Decisions. These decision objectives are associated with data needs and planned data collection to reach the goal of defining when various decision objectives can be adequately answered. The EAG agrees that this table does provide useful goals to define when the characterization program is adequate to answer these pragmatic questions posed as decision goals. The core committee may find these decision goals useful as goal posts in determining when the characterization program should be considered adequate. As in previous EAG reports, it is clear that the EAG recognizes that the questions posed are essentially risk-based questions. The data needs associated with these decision goals should be ranked according to their value in providing adequate characterization to answer each of the decision questions. A sensitivity analysis is useful in determining which

data needs will make the greatest difference to the overall characterization program. The EAG recommends that various data needs be presented with their cost, schedule for completion, and relative significance in providing adequate characterization to define these risk-based goals.

Recommendation:

- *Use risk-based objectives to determine when characterization is adequate.*

The term characterization needs to be defined as a practical matter to meet the risk-based objectives of the Workplan and to give the Workplan a definable set of parameters for determining when characterization is adequate to meet current and future goals of protecting the beneficial uses of the groundwater at LANL.

Recommendation:

- *Rank future data needs according to relative significance to the completion of the Workplan.*

As guidance to the core committee, the EAG recommends that in defining the term characterization, the core committee may want to use the decision goals articulated in Table 6-1 together with a review of the schedule and cost of future data needs and the associated research programs to assign a framework for ranking future data collection and research according to the relative significance of the work in improving the overall knowledge that defines characterization at the site.

Recommendation:

- *Clearly define the chemicals of potential concern (COPCs) and the associated toxicities, estimated quantities and physical/chemical properties as an integral part of the Workplan and to guide essential elements of the Workplan.*

Previous recommendations have outlined a program for defining the COPCs with a focus on COPCs, and the potential magnitude of the COPCs that could reach groundwater. This information will necessarily have to be coupled with the monitoring and modeling programs to determine when the various components of the characterization program have reached a level of adequacy to assure the current and future safety of the LANL operations. In addition, identification of COPCs, their potential magnitude and toxicities are a valuable guideline in determining future directions of the Workplan including the geochemical investigations, monitoring focus, and pollutant transport and fate. These discussions were originally introduced in the EAG's 1999 report.

Recommendation:

- *Address the potential use of alternate concentration limits (ACLs) for characterizing contaminants.*

In earlier EAG reports, the need to establish whether or not there is an expectation that on-site levels of contamination should reach drinking water standards or advisories (i.e., MCLs or health advisory levels) or whether some ACL would be acceptable which would recognize the length of time it would take a contaminant of any significant concentration to reach the fence line. The

details of an ACL program were presented in both 1999 and 2000 EAG reports. We recommend that the core committee consider addressing this issue. In reaching a determination of whether or not ACLs may be applicable to the site, the core committee may want to consider whether similar precedents have been set elsewhere.