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Mr. Joseph C. Vozella
Assistant Area Manager
U.S. Department of Energy
Los Alamos Area Office
528 35th Street, MS A 316
Los Alamos, New Mexico 87544

SUBJECT: GROUNDWATER INTEGRATION TEAM EXTERNAL EVALUATION GROUP SEMI-ANNUAL REPORT

Dear Mr. Vozella:

On August 17-18, 1998 the first meeting was held by the Groundwater Integration Team's (GIT) External Evaluation Group (EEG) at Los Alamos National Laboratory. The EEG was formed by the GIT to provide an independent review of the GIT's implementation of the Laboratory's Hydrogeologic Workplan. Presently, the EEG is comprised of six (6) members with diverse technical and professional backgrounds that compliment the GIT's desire to obtain a broad technical review of the Laboratory's Hydrogeologic Workplan activities and methods. The GIT plans to add two additional EEG members in FY99 to further strengthen this multi-disciplinary peer review group.

I have enclosed a copy of the EEG's Semi-Annual Report for your review. Also, I have attached a brief biographical description of the EEG members to provide you with insights regarding each members professional credentials and background. Please feel free to contact me at 665-4681 should you wish to discuss the EEG's report.

Sincerely,

Charles Nylander

Charles Nylander
Water Quality and Hydrology Group

8170

John K

CN/mm

Enclosures: a/s

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R. Burick, DIR, w/enc. MS A100
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J. Holt, NWT-PO, w/enc., MS F629
B. Stine, NWT-PO, w/enc., MS F629
T. Baca, EM-DO, w/enc., MS J591
J. Canepa, EM/ER, w/enc., MS M992
A. Pratt, EM/ER, w/enc., MS M992
J. Ordaz, DP-13, w/enc., DOE/HQ, MS A316
T. Taylor, LAAME, DOE/LAAO, w/enc., MS A316
B. Koch, LAAME, DOE/LAAO, w/enc., MS A316
WQ&H File, w/enc., MS K497
CIC-10, w/enc., MS A150

Semi-Annual Report
Groundwater Integration Team (GIT)
External Evaluation Group
Los Alamos National Laboratory

Meeting dates - 17,18 August 1998

Reviewing Group

Elizabeth L. Anderson, Sciences International, Inc.

John C. Butler III, Putnam, Hayes & Bartlett

Robert W. Charles, Consultant, Geochemistry and Management

Robert M. Powell, Powell & Associates Science Services

Jack D. Powers, Consulting Engineer

David C. Schafer, ARCADIS Geraghty & Miller, Inc.

The External Evaluation Group (EEG) for the Water Quality and Hydrology Group (ESH-18) of Los Alamos National Laboratory met 17-18 August, 1998 at Los Alamos National Laboratory for the first semi annual review of activities proposed under the Hydrogeologic Workplan (Workplan) developed at the Laboratory. The Group studied the written document, the most current annual report, the response to a request for information from the New Mexico Environmental Department (NMED), listened to a number of introductory and technical presentations, and participated in a field trip covering some of the geologic setting including wells currently in operation under the plan. The reviewing team consisted of Elizabeth L. Anderson, John C. Butler, Robert W. Charles, 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. The document is organized into management and technical sections. Management deals with the overall breadth of the Workplan, integration of the Workplan with the laboratory and DOE, relationship with the regulators, and relationship with other interested parties. Technical aspects include comprehensiveness of the technical approach, the process of data collection, appropriateness of the drilling technology, appropriateness of sampling techniques and analyses, overall cost effectiveness, and modeling efforts. At the end of each section some suggestions are compiled.

Management and Global Issues

Breadth of the Hydrogeologic Workplan

The Workplan appears as a logical response to the two main drivers presented in the Executive Summary: First, the New Mexico Environmental Department's (NMED) letter of 17 August 1995 expressing concerns over groundwater contamination and protection at the Laboratory as well as basic broad geological issues of characterization which did not appear to be understood to the satisfaction of NMED. Second, the NMED letter of 30 May 1995 which denied the Laboratory's request for waivers of ground water monitoring requirements. These documents lead to a series of expected outcomes shown on pages 1-1,2 addressing issues of basic geology and hydrology, monitoring, and contaminant transport. The vision for the current Workplan then was resolved to characterize the regional aquifer with respect to recharge, flow, and movement of possible contaminants as this aquifer is thought to have the most influential impact upon the regional water supply of parties down stream from the Laboratory. The mission is to drill, partially core, and otherwise characterize up to 32 deep aquifer wells over, perhaps, the next decade. These wells were selected and prioritized based upon eight criteria presented on pages 4-1,2 and in greater detail in Appendix 5.

The EEG finds the Workplan does a remarkably thorough job of developing an approach for characterizing the subsurface and its waters throughout the large volume of very complex rocks encompassed within the boundaries of LANL. The plan appears to be sufficient to accomplish its projected mission without unnecessary overlap with other areas such as the Monitoring Well Installation Project (MWIP) and the Environmental Restoration Program.

Relationships

The EEG notes that there is the appearance of improving relationships among the principal stakeholders: LANL, DOE, NMED. The multitude of socio-political issues, technical issues, and varying agendas was a basis for difficult relations among the major parties in the past. Several observations lead to the EEG's finding of improving relationships. The substantive observation is the tentative approval of the plan by NMED, with albeit, some reservations even though a previous draft met with numerous, possibly, contentious areas of disagreement. The response to these issues by LANL and DOE resulted in tentative approval of the Workplan less than a month later. Also, the fact that LANL first drilled a well that was not the top priority well could have had some negative effects upon the relationship, but effective communication may have relieved this concern. The agreement to follow an iterative approach is also evidence of an improved relationship. The relationship among stakeholders has been greatly improved through effective communications by, particularly, the Groundwater Integration Team (GIT) with external and internal interested parties. The formal annual and quarterly meetings are supplemented by informal communications which develop a better team atmosphere.

The EEG notes areas of controversy remain. One area is the use of MCL's to help determine actions. Most states apply these only to major aquifers used for drinking water use. Continuing negotiations among LANL, DOE, and NMED are being pursued to resolve this issue.

To a first approximation, the Workplan seems to be well-integrated within and among the various DOE/LANL environmental programs. As shown in the recommendations below, we would like to understand these relationships better. Clearly, the number and relationships of the stakeholders is complex. For internal use a stakeholders information map may be useful for managing these relationships. This is a bookkeeping exercise which allows the decision makers to rapidly evaluate relationships and act accordingly to the most current information. In addition to the beneficial interactions among the personnel, the cooperative funding arrangements for completing the suite of wells in both the alluvium and the regional aquifer is very positive, promoting the attainment of a successful hydrogeologic characterization that will benefit all the laboratory's environmental programs.

The EEG was very impressed by the LANL personnel, their enthusiasm, expertise, professionalism, and coordination with respect to the goals and issues of the Workplan. The entire LANL staff made the members of the external evaluation group feel welcome. The personnel seemed genuinely glad that we were there and anxious to provide us with the information necessary for us to fulfill our mission. We were all very appreciative of the hospitality of the entire LANL staff. We would also add we noticed the respect with which the staff treated each other. One's abilities to support the mission was respected regardless of title or position.

The activity seems to be operating in an effective safety envelope, at least upon cursory inspection, as evidenced by the safety indoctrination we encountered and the absence of lost time injuries. This is particularly salient in such potentially dangerous operations as drilling deep wells. The respect for LANL security was also apparent during our tour of R-25.

Suggestions/Comments/Requests - Management Issues: These are issues we would like to discuss with the appropriate people at Los Alamos before or during our next visit in addition to any agenda items LANL has.

1. We recommend continuing the frequent, detailed, and exhaustive communication efforts to keep relationships on the upswing with the regulators and the community as well as the funding organizations.
2. A timely agreement with the state on MCL's (and ACL's) is in order.
3. It would be desirable to have representatives of NMED present during some portion the next meeting of the EEG.
4. It would be useful to have a better description of the relationship and support within LANL for the activity. How does the management of ESH, ER, NWT, etc regard the activity with respect to their other priorities?
5. It would be useful to have a more detailed stakeholders information map defining relationships other than the three to five major stakeholders.
6. The proper sequence of priorities should be consistent in Tables 4.1 and 4.2.

Technical Issues

Technical Approach

The technical approach of the Workplan seems to be thorough, although procedures listed in the Workplan are not generally highly detailed but are usually specified by reference. However, the qualifications and motivation of the LANL personnel are excellent and will certainly result in high quality completion of the tasks delineated in the Workplan. We recognize that, as a research institution, LANL is naturally inclined to let its research philosophy influence its approach to site investigation. Businesses usually take a more pragmatic approach and that is to provide the regulators only what they require. LANL may want to review the activities of its investigative staff to ensure their work is sharply focused on the goals of the investigation, the needs of the regulators to make informed decisions, and LANL's objective of cost effective site remediation which is protective of human health and the environment.

The three expected outcomes (p. 1-1,2) are ultimately going to require knowledge of contaminant transport through the intermediate zones, and the significance of these intermediate zones to any drinking water supply. The focus on the deep aquifer is appropriate at this time, but contingency for examination of the intermediate zones to some extent in the future is recommended. Further, as more data are developed, we would encourage LANL to work with stakeholders to evaluate the tradeoff between fewer deep wells and possibly more, shallow wells.

Process of Data Collection, Management, and Interpretation

Sampling techniques are not well defined in the Workplan document. We recommend the use of low-flow purging and sampling techniques for water-yielding wells, and passive sampling for poorly-yielding wells. However, we are aware of the problematic nature of implementing this approach due to the reluctance of NMED to accept these procedures for sampling metals. We are aware that NMED is one of the few regulatory bodies in the U.S. to prohibit the use of low-flow sampling techniques. They are specifically concerned that mobile colloidal-sized materials will not be captured by low-flow techniques, hence they require high-flow rate sampling for metals. Recent discussions with NMED in which part of our group have participated have led to more discussion in an attempt to get NMED to reconsider its position.

The EEG considers the corings and cuttings observations and analyses to be a very critical component of the site characterization process. In addition to providing information on the state of the stratigraphy with depth, including potential testing for permeability, etc., these materials can be used for determining sorption coefficients for the contaminants known or suspected to be present based upon the aggregate for which the well is being established. Hopefully the new drill head will allow these materials to be acquired with much less expense and time lost during the coring process. We would suggest that the corings be logged and evaluated as soon as possible after retrieval. Corings that will be used for parameter testing or sorptive potential should be stored in an intact state and tested as soon as possible. One successful procedure is to extrude the cores into a plastic core barrel, seal it at both ends with plastic caps, and refrigerate or freeze the core. Sorption studies in particular are best carried out using fresh, moist materials rather than materials that have been dried and subjected to atmospheric oxidation.

In our opinion, the present methods and equipment (Barber drill, specialized drill casing, continuous coring and push sampling) being used to drill Hole R-25 are paramount to obtaining the information necessary for evaluating the DQO. In addition, returning the cuttings to the surface allows for the completion of a suite of quality sampling procedures which will meet the technical characterization requirements developed through the DQO process. To our knowledge, there is no other such system in use to date that can meet the requirements outlined in the DQO for LANL. Mud-rotary drilling should be avoided where sample integrity will be compromised.

With regard to completion for sampling, some of the wells should be completed much deeper into the regional aquifer than appears to be currently planned. Well R-12, which is about 800 ft upgradient from supply well PM-1 is a good example. Normally, in shallow systems, nested or clustered multi-level sampling wells are recommended rather than multiple levels of sampling in a single completed system. This would still be a recommendation for the alluvial wells to be installed, for example. However, due to the extreme depth and expense of drilling the R-series wells, other possibilities must be considered. One of these possibilities is the Westbay sampling system.

We recommend that the West Bay System be thoroughly understood and demonstrated to determine whether or not this system can allow for long term sampling at different depths of both perched water systems and the regional aquifer. Those on the EEG with some familiarity with the Westbay system find this or similar methods attractive as they prevent cross contamination from multiple fluid inputs because of the permanent packers installed above and below each sampling port. A cost and technical comparison should be made contrasting the Westbay system against alternatives.

Procedures for data collection, management and interpretation for a task of this magnitude are always difficult to implement in a manner where all necessary information is readily available to all personnel working on the project. FIMAD, which appears to couple an ArcInfo GIS system to an Oracle database, is a critical component of the Workplan for accessing and visualizing the data which will result from the characterization effort. Development of this database, and the incorporation of historic LANL site data into the system, should be a high priority. Because the historic data may be of unknown quality, and were certainly not collected in modern monitoring wells or by newer sampling methods, it might be best to incorporate the historic data into a separate layer(s)/database of FIMAD. Properly used, this

layer(s)/database could be overlain with the modern data, but it should require additional effort to combine the information with the modern data (and a warning to the user about the distinct sources of the data). It should be made impossible for an investigator's combined data file to be saved with either of the original file names. Eventually, should the historic data (or some portion thereof) prove verifiable with regard to accuracy, the data could be included in the database with the information source indicated. Following verification, the historic data could also be included in the coupled hydrogeologic models. We should all give some thought as to how the historic data could be verified for incorporation into the models.

We found the geologic and geochemical interpretations to have advanced a long way over the years. These yield a reasonable conceptional model for the formation of the Pajarito Plateau and its geochemical system. The investigators are not afraid to speculate as to flow paths and form hypotheses which will be confirmed or altered by further drilling.

Drilling Technology

Based on our discussions and observations, the drilling technology used at LANL is first-rate and innovative. Although drilling costs have been very high on the first two wells (R-9 and R-12), the drilling method technologies chosen for the project have been correct and appropriate. The challenging geologic terrain comprising alternate layers of hard rock and soft, caving materials, combined with the need to periodically sample perched zones during drilling, has mandated the use of casing advance drilling methods such as the Odex and Barber systems. It is unlikely that site objectives could be accomplished with any other drilling approach.

The rigorous requirements of sampling and sealing numerous perched zones, while drilling to great depths through the kinds of geologic materials present at the site, make this well drilling project truly unique. The inevitable learning curve associated with developing state of the art drilling procedures has resulted in some cost overruns on the first two wells. One area of cost overrun was the grouting of the perched zones. Some experimentation was required to develop a workable approach. Other high costs have been attributable to using somewhat undersized drilling equipment.

It appears that information gained from drilling the first two wells along with the upgrade in drilling equipment will result in faster, more cost efficient drilling. The grouting problem seems to have been remedied by applying special procedures. Also, the use of the larger, dual-drive Barber drilling rig should improve drilling efficiency. To our knowledge there is no other such system in use to date than can meet the requirements in the DQO for LANL. Well R-25 will provide an excellent opportunity to further evaluate the methods and procedures that are now in place.

It is data requirement rather than drilling approach that is driving the projected high cost of well construction. The labor costs associated with sampling and sealing each perched zone encountered during drilling are substantial. Likewise, coring 30 to 40 percent of the borehole length is quite costly. As the project develops, strategic decisions must be made regarding the need and value of perched zone data and core samples. If requirements for these items can be scaled back, drilling costs can be reduced substantially. If it is determined that each new well produces an increasing amount of predictable or redundant information, it may be possible to reduce the amount of cored footage and the intensity of perched zone analysis.

So far, perched zones have been grouted and sealed using bentonite. It is probable that the use of cement has been rejected because of possible effects on pH and water chemistry that could result from having cement grout at one elevation in the borehole while sampling the next perched zone below.

The use of bentonite grout has resulted in numerous costly delays during the drilling of the first two boreholes. Reliable seals have been difficult to achieve, particularly under high head conditions. Also, there have been some problems removing excess bentonite from the borehole prior to the resumption of drilling. The new procedures that are in place now appear capable of solving these problems. However, it remains to be seen whether the bentonite approach will work in every case (varying perched zone permeabilities, varying heads, etc.)

If the bentonite grout system continues to function adequately, its use should be continued. On the other hand, if it fails under certain circumstances, consideration should be given to using cement grout. It is possible that this could be done at one elevation and suitable samples could still be obtained from subsequent perched layers.

One concern regards use of the three-man drilling crew. While drilling consistency is maintained using the same crew throughout drilling, fatigue related problems may be an issue. Perhaps a second

crew would be reasonable for replacements whatever the reason. The safety record appears exemplary, but replacements may be needed for other reasons, illness, other assignments, etc. It would be good to examine what contingencies are in place.

There were a number of comments from the EEG concerning the use of PVC vs. metal for well completion. While PVC is more inert, its strength and elasticity could be a problem. On the other hand, galvanic corrosion of metal fittings may lead to degradation over time. A majority of the EEG feel that dissolved metal from metal casings would be relatively minor and can be offset by purging wells prior to sampling. Also degradation of metal should not be a problem in this environment. The consequent recommendation is that metal fittings be used. The GIT should advise the regulators of possible very minor metal contamination on the long term.

Another issue of well completion is the placement of the filter packs (sand packs) for the monitoring wells. These could be placed 10 to 20 feet above the well screens instead of the 2 feet planned. This will obviate any need to compensate for settling during well development and will not affect the source of water obtained from the well.

Cost Effectiveness

There was some concern as to whether the amount of coring was excessively large, as well as a discussion comparing the approach that might be used by a commercial business for such a characterization relative to that proposed by LANL. The Workplan has been well considered with regard to cost-effectiveness for the chosen tasks within the Workplan. The site is extremely large, sits upon highly complex stratigraphy, is very far in elevation above the ground water, has worked with extremely complex and hazardous materials, and seems to be directly upgradient of water supply wells for the city of Santa Fe. These considerations make the overall Workplan program cost appear reasonable, and the proportioning of the costs among tasks seems, to our understanding, to be appropriate. The conclusion is based upon the Workplan itself.

The cost effectiveness needs to be proven by carefully benchmarking against similar activities to justify costs which are of concern to some stakeholders. Thus, although the costs appear reasonable to a first approximation, we have not seen such benchmarking. A prerequisite for benchmarking is some form of projection of costs and needs (Gantt or other representation) particularly given the iterative nature of the program and the cost overruns on the first wells. We are unaware if these projections exists at least to the satisfaction of the various stakeholders. Discussion of variance in the cost projections might be part of the annual report.

It may be in the Lab's interest to occasionally rebid the drilling work on a competitive basis to ensure that drilling costs are maintained at reasonable levels. There may be an understandable tendency to resist doing this. Once the current contractor has overcome drilling problems and learned how to perform the work in a reliable manner, there is a reluctance to bring in a different contractor who is unfamiliar with the project demands and construction techniques required to be successful. However, in the long run, it may be in the Lab's interest to have more than one contractor capable of performing this work and to have a means of obtaining the best competitive price on an ongoing basis. Also, new contractors will bring a fresh perspective to the job, possibly offering new and innovative improvements.

In future bidding cycles, if the work is bid on an hourly basis, costs may be higher than necessary. A contractor being paid by the hour will not have the same incentive to be maximally efficient as will a contractor being paid on a footage basis. On the other hand, bidding this work by the foot is unworkable because of the substantial time spent sampling, sealing and tripping pipe in and out of the hole. Therefore, on future bids, it would be best to incorporate features of both methods of bidding–a per foot price for the drilling and coring, and an hourly rate for certain sampling and grouting tasks

It is essential that the data needs issue be revisited on a regular basis to optimize the cost/benefit ratio. There is risk, for example, that in our zeal to collect as much data as possible for the vadose zone modelers, we may collect more data than modelers will ever need or use.

Modeling

The modeling effort is needed to complete the Workplan. Modeling provides the means by which predictions of future ground water conditions can be made. It is also an excellent tool for visualizations that can be presented to stakeholders and regulators. However, it should not be used to replace or substitute for a comprehensive database of actual data coupled to GIS display, rather it should be used to supplement such information.

Modeling should neither be carried out in the absence of sufficient data nor be delayed until all the data are available. It should be used interactively and iteratively to both benefit from and provide input to the data collection process. If possible, both numerical and stochastic modeling should be carried out. Data should be input into the model(s) as soon as practical following their collection, verification and incorporation into the FIMAD database. The model(s) should then be run and an evaluation made regarding whether the output has any significance for refining the number and location of upcoming wells. At some point in the evolution of the model(s), it may also be useful for determining whether any contaminants pose an imminent problem and for determining the effectiveness of alternative remedial solutions. We noted one of the presentations presented modeling results. We would like to see more at the next visit.

Suggestions/Comments/Requests - Technical Issues

1. We suggest reviewing data needs continually and reviewing the scope of the characterization program annually in light of what the regulators require.
2. The Workplan seems to leave open the possibility of mud-rotary drilling which should be avoided in order to preserve the pristine nature of subsequent samples.
3. Although the Westbay system appears useful, it should be demonstrated and well understood before acting.
4. We recommend that FIMAD more rapidly incorporate legacy data in some fashion and that the system be available for timely use by stakeholders.
5. In spite of the safety record, a three man crew for the drilling activities may be too small.
6. We recommend further consideration of well completion with metal fittings instead of PVC.
7. We recommend placement of filter packs greater than two feet above the top should the wells be used for monitoring.
8. We would like to see costs to date benchmarked against similar activities.
9. Is there a more detailed Gantt chart with scheduled deliverables? It is unclear how and when the results of the hydrologic investigation would be incorporated into specified RFIs and CMSs.
10. We suggest revising the budget to reflect current costs and update budget projections. This is particularly important as the plan will be changed in an iterative fashion.
11. We suggest an annual project review to identify mid-course corrections and ensure cost effective management and execution. Such a review would consist of performance reviews, costs to date, next years tasks and proposed budget.
12. We would like the GIT to consider periodic rebid of drilling work.
13. We would like to see more modeling results, and, where possible, use modeling results to evaluate the need for and location of future wells.

Path Forward for EEG

The external evaluation group should serve in an advisory capacity to the ongoing hydrogeologic characterization at the Los Alamos National Laboratory. The group should not attempt or be expected to direct the work effort. The external evaluation group should, however, provide clear, concise, and expedient advice and information to laboratory personnel whenever we or the laboratory personnel deem it necessary. This presentation of this advice and information could be relatively informal, i.e. in one-to-one exchange between laboratory and evaluation group members, but such exchange should not be construed as having either group or LANL approval. The results of such an exchange, should they have potential impact upon the hydrogeologic characterization effort, would have to be considered by the external evaluation group and approved by LANL. An increased level of formality would occur in contacts between the group chairperson, Robert Charles, and the board's LANL contact, Charles Nylander. These two persons would effect the formal transmission of group recommendations and queries, as well as requests made to the board by LANL.

The external evaluation group should meet at least twice per year to review progress of the hydrogeologic characterization, to assist in developing strategies to meet the upcoming objectives and prepare a written report of findings in a timely fashion. Within this context, the group could also serve as a conduit to the NMED and provide them with an additional source of information regarding the progress

and direction of the hydrogeologic characterization. To develop this relationship, it would be expedient to arrange meetings and interactions between the external evaluation group and the NMED during our next visit to LANL.

The external evaluation group should also serve to review significant changes in the strategy and direction of the hydrogeologic characterization that might be proposed by LANL personnel. These recommendations for strategic change could result from significant data events, alterations in public perception, Tribal needs, NMED input, DOE concerns, or other impacts, all of which should be reported to the group for our evaluation of their real or potential impact on the hydrogeologic characterization.

At the next meeting. time should be set aside for the EEG in executive session to discuss other issues (1/2da.) including organization of the EEG, discuss any written comments by ESH-18 on this report, designated tasks for response by each individual, tenure, and rough draft preparation of the subsequent report for the visit.

Brief Biographical Description
of
External Evaluation Group
November, 1998

Robert Charles, Ph. D., Ranchester, Wyoming

Dr. Charles has a doctorate in geology with a specialty in geochemistry. He also has a Master of Arts degree in Organizational Management, and has more than twenty-five (25) years of experience in his disciplinary areas. Dr. Charles was particularly valuable in assessing the Laboratory's technical approach to implementing the Hydrogeologic Workplan, and the management structure utilized in the implementation. Dr. Charles served as chair of the EEG, and coordinated the out-briefing and final written report.

Jack Powers, P.E., Murray, Utah

Mr. Powers is a drilling consultant with more than forty-five (45) years of world-wide professional drilling experience. Mr. Powers was particularly valuable in reviewing and assessing the drilling technique and resulting costs in the Laboratory's implementation of the $ 50 million MWIP.

John Butler, M.S., Los Angeles, California

Mr. Butler has a Master of Science degree in Chemistry, with twenty-five (25) years of experience working for the U.S. Environmental Protection Agency, United Nations, World Health Organization, and Putnam, Hayes & Bartlett, Inc. His employment with Putnam, Hayse & Bartlett, Inc. as an environmental economist since 1980 has provided him with extensive experience in environmental liability issues. This wealth of experience was of great significance to the EEG in discussing benchmarking of the Laboratory's costs for implementation of the MWIP. Due to his national and international experience, Mr. Butler was valuable in addressing issues of cost reasonableness, and commenting on cost-effective strategies for implementing the Hydrogeologic Workplan. Because of the overwhelming DOE and public interest in the Laboratory's costs for implementing the MWIP, Mr. Butler was viewed as playing a pivotal role on the EEG, supplementing the EEG with extremely credible and current economic expertise regarding environmental liabilities and costs.

Robert Powell, M.S., Phoenix, Arizona

Mr. Powell has a Master of Science degree in environmental science with twenty-five (25) years of experience, with over thirty-three (33) publications on groudwater science. His eleven (11) years of experience with the U.S. Environmental Protection Agency" Office of Research and Development, and expertise in the field of environmental sampling significantly complimented the EEG in their technical evaluation of the Labortory's implementation of the Hydrogeologic Workpland and MWIP.

Elizabeth Anderson, Ph. D., Alexandria, Virginia

Dr. Anderson has a doctorate degree in organic chemistry, and more than twenty (20) years of experience in health and environmental science. Dr. Anderson is a nationally renowned expert in environmental risk assessment, and established the major national risk assessment programs at the U.S. Environmental Protection Agency. Dr. Anderson is an internationally recognized lecturer and consultant, and has published a prolific number of professional papers. Her role on the EEG

was critical to the assessment of the Laboratory's technical implementation methodologies regarding environmental and human health risk assessment.

David C. Schafer, M.S., Plainview, New York

Mr. Schafer is employed by Geraghty & Miller, Inc., and has over 25 years of experience. He is a recognized expert in the groundwater industry. He was a valuable member of the EEG because he has done extensive computer modeling using numerical models, analytic element models and proprietary analytical models that he has developed. He has demonstrated expertise in site characterization and remediation system design at CERCLA and RCRA sites across the country, and thus had a hands-on appreciation for the Laboratory's Environmental Restoration Project activities. He is a well-known author and lecturer on groundwater-related topics.