UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 20, 1999

MEMORANDUM TO: C. William Reamer, Chief
HLWB/DWM/NMSS

FROM: Neil Coleman, Program Element Manager
Geosciences Section
HLWB/DWM/NMSS

SUBJECT: TRIP REPORT - ROTATIONAL ASSIGNMENT TO NRC ONSITE REPRESENTATIVES OFFICE, SUMMERLIN, NEVADA

From September 7 to 28, 1999 I worked as an NRC Onsite Representative (OSR) in Nevada. This was an exceptional opportunity to learn the duties and operation of the OSR office and to participate in key oversight activities. Without reservation, I recommend this job rotation to other staff. It is a chance to be immersed in the full range of site activities, which have resumed after a lengthy safety stand-down. Highlights of my rotation are summarized below. Additional details are in Attachment A. I also provided input for the OSR report for the month of September.

- Observed a QA surveillance on the qualification of existing data (drillcores); DOE appears on track to qualify a number of cores collected before 1991 (see Attachment B - DOE's record of surveillance)

- Discussed DOE's qualification of Nye County data; based on our meetings with them, DOE staff intend to qualify the Nye data that will be used in a possible license application for Yucca Mountain

- At the Hydrologic Research Facility, reviewed data from those portions of the east-west drift that have been isolated from ventilation; this pertains to our subissue on deep percolation and dripping phenomena; moisture conditions in the east-west drift have not yet fully re-equilibrated and may not do so until early next year

- Met with DOE staff to arrange future entry by NRC and Center staff to the east-west drift to study moisture phenomena under ambient, unventilated conditions

- Observed Nye County's field trip where they relocated some of their new wells to more favorable sites; was briefed on Nye County's plans for their next well drilling campaign; possible locations for a valley-fill tracer test facility would include Nye County wells 2D, 19D, or 22S

- Traveled to Sample Management Facility to observe Nye County samples and learn about the archiving of these samples; we learned that samples left over after archiving can be shipped to the CNWRA for our future analysis

- Received briefing on Process Model Reports and Analysis/Model Reports (see Attachment C) and reviewed available drafts

NH16.
102.2
WM-11

- Field trip with Center staff and contractors to Fortymile Wash and exposures of pre-Quaternary rocks north of Mercury, NV; we saw no evidence of Holocene fault displacements in a long exposure of alluvium located in Fortymile Wash near well J-13

- Information-gathering visits to the Desert Research Institute, DOE's Remote Sensing Laboratory at Nellis Air Force Base, and the Nevada Test Site Historical Center and reading room, located on Energy Way in north Las Vegas

- Received an outstanding briefing on computer security from Louis Numkin (NRC/OCIO); he provides periodic security briefings to the OSR staff

I wish to thank our OSR staff, Bill Belke, Chad Glenn, and Vivian Mehrhoff, for making me feel at home in their office and sharing their valuable experiences with me. All of the DOE staff and contractors that I interacted with were prompt and helpful in providing the information needed to support my OSR duties.

Attachments: As stated

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Attachments: As stated

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2) This document is related to the HLW program - place in the LSS NC 10/ 20 /99.

Attachment A

QUALITY ASSURANCE

On September 28, 1999 DOE performed a quality assurance surveillance on an activity that seeks to qualify drill cores collected in pre-1991 boreholes. The surveillance team met at the Sample Management Facility near Yucca Mountain to discuss the data qualification plan and to review approaches used by DOE staff and contractors to qualify the data. Large intervals of the drill cores must be qualified in order to qualify other data. For example, it is important to qualify points of origin of core samples used in mineralogy and petrology studies. The study is looking at cores from the following drillholes: UE-25 a#1, b#1, p#1, J-13, USW G-1, G-2, G-3, G-4, H-5, and H-6. A key to qualifying drill cores is to confirm depths of drilling at which they were collected. Hundreds of original-run logs from older boreholes have recently been qualified as Q data based on the method of equivalent procedure, and these are used to help corroborate depth intervals. Downhole camera logs are also available for some holes. Lithophysal zones show up particularly well in the images and can help establish lithologic contacts. Most of the uncertainty in core depths appears to stem from core losses during drilling. Sometimes portions of core are broken up and are not captured in the end of a core sampling tube. These broken portions are then re-cored during the next run. One interesting outcome of the work to date is that M&O staff expect to qualify all samples collected from the cores after 1989. Some samples taken from earlier cores may also become qualified. The surveillance was effective in reviewing key aspects of this work in progress. Implementation of controlling procedures and the Data Qualification Plan are adequate.

EXPLORATORY STUDIES FACILITIES AND NRC KEY TECHNICAL ISSUES

Enhanced Characterization of the Repository Block (ECRB)

The status of conditions in the ECRB was discussed with DOE staff and contractors. Two sections of this tunnel have been isolated from the rest of the underground facility by the construction of sealed bulkheads. One is located about half-way into the ECRB, tunnel and the other is near the western end just east of the Solitario Canyon fault. No forced ventilation occurs beyond the bulkheads, except during brief entries to collect data and perform maintenance. This is a passive test designed to allow the isolated parts of the tunnel to return to ambient moisture and temperature conditions. It appears that moisture conditions in the tunnel have not yet fully re-equilibrated. Hundreds of heat dissipation probes were previously placed in the tunnel walls at depths of up to 2 meters. Probes placed more than 1.5 m beyond the tunnel walls are at ambient conditions, unaffected by tunnel ventilation. Those probes closer to the tunnel walls are slowly recovering but many months are expected before full re-equilibration.

The isolated parts of the ECRB tunnel are re-entered about every two months to do maintenance on a tunnel boring machine and to obtain neutron moisture logs through

boreholes in the tunnel walls. This re-entry results in several days of ventilation, but the effects on long-term re-wetting of the tunnel walls appears small. Ventilation lowers the relative humidity in the tunnel to about 25%. Re-sealing the bulkheads causes the relative humidity to rise to about 85% in just several days, and it rises gradually over the following weeks to 96% or greater.

We have requested authorization from DOE to enter the isolated parts of the tunnel under unventilated conditions to observe first-hand whether natural dripping of water occurs when the tunnel is at ambient conditions. This entry may require use of self-contained breathing apparatus because high radon levels have been detected in unventilated underground facilities. This entry should take place sometime between January and April of 2000 after equilibration has been achieved.

Exploratory Studies Facility

During a trip to the Exploratory Studies Facility we made what may be an important observation in the main tunnel outside Alcove 1. This alcove is the site for an ongoing induced infiltration experiment. We observed streaks on the overhead and walls of the main tunnel just outside the portal for Alcove 1. It appears that some infiltration from the surface application site has migrated laterally as far as the main tunnel. This is important because it suggests that the infiltrate is migrating through a highly diffuse fracture network, and has traveled a significant lateral distance equal to the depth of Alcove 1 below the land surface.

Surface-Based Testing

Nye County Drilling and Testing:Program:
According to a Nye County representative, the next phase of well drilling is expected to begin in October 1999. Current plans are listed below, but these are subject to change as the drilling progresses, subject to any difficulties that may be encountered in the fieldwork. Wells 2D and 3D will be deepened until carbonate rocks are encountered. Well 2D is blocked by a portion of stuck well casing. If this cannot be removed, the plan is to drill a new well nearby. Wells 7S and 20D will be drilled at locations previously identified. Well 12S will be replaced by a deep well, 12D. The site for well 19D will be moved northward to just outside the southwest corner of the Nevada Test Site. Well 22S will moved west-northwest to the eastern bank of Fortymile Wash. Well 14S will be cancelled as it is no longer needed given the other new well locations. Finally, deep well 4D will be replaced by shallow well 4S, which will be constructed with two piezometers. The monitoring tubes will be placed above and below the clay layer that is expected to be in this well.

NEVADA TEST SITE PUBLIC READING FACILITY

I visited the Nevada Test Site History Center and DOE reading room in building B-3 on Energy Way. This is an excellent source of historical information about the NTS,

including EIS information, maps, photo archives, worker exposure histories, data on human experiments, and a history of nuclear tests at the NTS and elsewhere, such as in the Pacific islands. I met the project manager responsible for the history center. She gave me a tour of both the visitor history center and the adjacent reading room. Four computers are set up for folks to access DOE websites, print out materials, and view CD-Rom records. VCR tapes are available for purchase or for viewing at the reading room at no charge. The history center and reading room are excellent forums for public outreach. DOE should probably advertise their availability more widely in the local community because I saw only one other person visiting their reading room.

ATTACHMENT E

Department of Energy
Washington, DC 20585

QA: QA

OCT 15 1999

D. R. Wilkins, Technical Project Officer
for Yucca Mountain Site
Characterization Project
TRW Environmental Safety Systems, Inc.
1261 Town Center Drive, M/S 423
Las Vegas, NV 89144-6352

ISSUANCE OF SURVEILLANCE RECORD LVMO-SR-99-021 RESULTING FROM THE OFFICE OF QUALITY ASSURANCE (OQA) SURVEILLANCE OF THE CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM MANAGEMENT AND OPERATING CONTRACTOR (CRWMS M&O) SAMPLE MANAGEMENT FACILITY (SMF)

Enclosed is the Record of Surveillance LVMO-SR-99-021, conducted by the OQA at the CRWMS M&O SMF facility at the Yucca Mountain Site and Las Vegas, Nevada, offices.

The purpose of the surveillance was to examine and evaluate processes for the qualification of "unqualified drill core" being conducted at the SMF in accordance with Administrative Procedure (AP)-SIII-2Q in support of the Integrated Site Model Process Model Report.

As a result of the surveillance, it was determined that the overall implementation of controlling procedures and Data Qualification Plan is adequate. The personnel implementing this "qualification" are trained and experienced professionals who demonstrated a high level of knowledge and expertise. The facilities are adequate for the work, and the use and control of materials and samples comply with project procedures. Access is controlled. Overall, it is believed that this qualification exercise will result in a credible product; e.g., "qualified data." A process recommendation was made relative to the AP-2.13, Technical Product Development Planning, documentation.

This surveillance is considered complete and closed as of the date of this letter. A response to this surveillance record and any documented recommendations is not required.

If you have any questions, please contact either James Blaylock at (702) 794-1420 or Kenneth O. Gilkerson at (702) 794-1486.

James Blaylock

Robert W. Clark, Acting Director
Office of Quality Assurance

OQA:JB-0084

Enclosure:
Surveillance Record LVMO-SR-99-021

cc w/encl:
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R. A. Milner, DOE/HQ (RW-2) FORS
R. N. Wells, DOE/HQ (RW-54) FORS
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OFFICE OF CIVILIAN
RADIOACTIVE WASTE MANAGEMENT
U.S. DEPARTMENT OF ENERGY
WASHINGTON, D.C.

Surveillance No. LVMO-SR-99-021

QUALITY ASSURANCE SURVEILLANCE RECORD

SURVEILLANCE DATA

1. ORGANIZATION/LOCATION:	2. SUBJECT:	
LVMO/Sample Management Facility (SMF)/ Yucca Mountain Site	Qualification of Unqualified Drill Core	09/27/99

4. SURVEILLANCE OBJECTIVE:
To examine and evaluate processes for the qualification of "unqualified drill core" being conducted at the SMF in accordance with AP-SIII.2Q in support of the Integrated Site Model (ISM) Process Model Report (PMR).

5. SURVEILLANCE SCOPE:
Determine through reviews of documentation (plans and procedures), examination of facilities and equipment, observation of qualification methodologies/protocols; and, interviews of cognizant personnel that the qualification process being used for unqualified drill core and related information meet QA program requirements. The activities to be evaluated are in-process and are being examined such that process recommendations or other constructive suggestions can be provided to ensure the adequacy of the results. Drill core being evaluated is from UE25a#1, UE25b#1, UE25p#1, UE25j#13, USW G-1, G-2, G-3, G-4, H-5, and USW-H-6.

6. SURVEILLANCE TEAM:
Team Leader:
K. O. Gilkerson
Additional Team Member:
J. R. Doyle
D. A. Mitchell

7. PREPARED BY:		8. CONCURRENCE:	
K. O. Gilkerson	9/16/99	James Blaylock	9/16/99
Surveillance Team Leader	Date	Director, OQA	Date

SURVEILLANCE RESULTS

9. BASIS OF EVALUATION/DESCRIPTION OF OBSERVATIONS:
A surveillance was conducted the week of September 27, 1999 of the qualification processes for "unqualified drill core" being undertaken at the Sample Management Facility (SMF) in support of the Integrated Site Model (ISM) Process Model Report (PMR). This qualification would support input into the Mineralogy Model as part of the ISM PMR. The surveillance team methodology for this evaluation included reviews of documentation, examination of facilities and core samples in the SMF, interviews with cognizant personnel, and evaluations of procedures and scientific methodology used to conduct the work. The surveillance team prior to conducting this surveillance reviewed previous project work and surveillances relative to existing drill core data. It should be noted that this was a "real time" surveillance conducted on in-process work in an effort to provide constructive input to the process. While the surveillance was conducted primarily at the SMF on September 27, 1999, it was concluded with discussions in the Las Vegas, NV offices.

(Continued on page 2)

10. SURVEILLANCE CONCLUSIONS:

The overall implementation of controlling procedures and Data Qualification Plan is adequate. The personnel implementing this "qualification" are trained and experienced professionals who demonstrated a high level of knowledge and expertise. The facilities are adequate for the work and the use and control of materials and samples comply with project procedures. Access is controlled. Overall, it is believed that this qualification exercise will result in a credible product; e.g. "qualified data." A process recommendation was made relative to the AP2.13 Technical Product Development Planning documentation.

(Continued on page 2)

11. COMPLETED BY:		12. APPROVED BY:	
Surveillance Team Leader	10/22/99 Date	Director, OQA	10/14/99 Date

ENCLOSURE

9. BASIS OF EVALUATION/DESCRIPTION OF OBSERVATIONS: (Continued)

A Data Qualification Plan developed by the M&O as required by project procedure AP-SIII.2Q, Revision 0 *Qualification of Unqualified Data and the Documentation of Rationale for Accepted Data* was reviewed and examined as preparation for this surveillance. The plan was developed in accordance with AP-2.13Q, Revision 0, *Technical Product Development Planning*. Although procedurally adequate, a number of recommendations were identified to enhance the usefulness of this document, "Data qualification Plan: Drill Core, Core Samples, Lithostratigraphic Contacts, Core Photos and Downhole Video," Revision 1 (document control #103954). These recommendations were discussed with the Data Qualification Team Chairperson at the close of the surveillance and are addressed in Block 10 of this report.

The data qualification process is in process for the qualification of pre-1991 borehole drill core collected under previous Project QA programs. This pre-1991 drill core under evaluation is from boreholes UE25a#1, UE25b#1, UE25p#1, UE25j#13, USW G-1, G-2, G-3, G-4, H-5 and H-6. The surveillance team met with the Data Qualification Team at the SMF to evaluate the selected methodologies for qualifying the drill core. Members of the U.S. Nuclear Regulatory Commission (NRC) and OQA observed this surveillance. M&O technical support personnel and a representative of the Assistant Manager, Office of Project Execution also participated.

A Principle Investigator identified in the plan was assigned to actually perform the work based on his technical expertise and independence from the initial drill core activities. He explained his approach to the surveillance team and conducted a walkthrough of the SMF "lab." The methodology to qualify the drill core by corroborative data entails the use of downhole videos, reviews of existing geophysical logs and photographs.

Surveillance WMPO/NV-SR-86-022 was preformed in 1986, which identified conditions adverse to quality in the lack of traceability of core used for scientific investigations to where the borehole sample was collected rendering much of earlier drill core data as indeterminate. The current Data Qualification Plan for this early core identifies "corroborative data" as the qualification methodology selected to qualify this core. Some of this corroborative data comes from previous qualification efforts. A Technical Assessment of Borehole Geophysical Data using procedural equivalency (as a qualification methodology) was performed in accordance with project procedure YAP-2.1Q *Technical Assessment* during 1995 (Cuba et al) of selected boreholes drilled on the project. The assessment resulted in best case types of geophysical "paper logs" that could be qualified for site characterization studies. This activity was overviewed by Office of Quality Assurance personnel in surveillance YMP-SR-96-002. They concluded that the implementation process was effective for the data set qualified. Much of this data is being used as corroborative data for the current effort.

Core is manually logged in accordance with Project approved stratigraphic nomenclature (Busch et al) by the PI and is entered into a laptop computer spreadsheet titled "Data Qualification Plan: Drill Core Samples, Lithostratigraphic Contacts, Core Video and Downhole Video," TDP-NBS-GS-000002. This spreadsheet contains depth interval, Code Designations, Drill Run, Feet Drilled and Recovered, % Recovery, Overdrill Footage, and Comments Concerning Drilling. This spreadsheet was verified at the SMF during the surveillance in both electronic and hardcopy formats. The use of the database was examined relative to QARD, Supplement V requirements. An exception to control of electronic control of data was performed in accordance with project procedure YAP S.V *Control of Electronic Management of Data*, "Process Control Evaluation for Supplement V," dated 9/22/99, and was verified during the surveillance.

Qualification of pre-1991 core is performed using the approved Data Qualification Plan for subject activity. This plan delineates the methodology of using multiple forms of independent corroborating data in the core qualification process. Boreholes are logged using the nomenclature as described above. Core photographs and videos are also utilized to visually confirm geologic contacts and features. The team verified this by examination of the geotechnical log for borehole UE-25 A#5 for the interval 440.2 through

447.0 to the boxed core samples located in box #34 to the downhole video. These geotechnical logs are then compared with the paper geophysical logs of the same borehole (e.g. density and resistivity) to determine depths to lithostratigraphic contacts (i.e. top of the Topopah Springs, basal vitrophyre of the Tiva Canyon) and gross lithological zones (i.e. Upper Lithophysial of the Topopah Springs). Tolerances for the contacts/tops are +/- 15 feet on the gross lithological features and +/- 5 feet on the vitrophere contacts. These tolerances were derived from surveys of the users of the Integrated Site Model (Lotus Notes R. Clayton to et al dated 7/7/99).

Core samples from LANL mineralogical and petrology and chlorine 36 studies will be compared through existing sample tracking documentation to the borehole in question. Samples will be considered from that borehole and falling into the tolerances mentioned above. For instance, we know from the sample documentation that this core came from USW G-4 and is located in the Upper Lithophysial Zone of the Topopah Springs within the depths of 780 feet +/- 15 feet. At the time of the surveillance, this process has not yet been performed.

In addition to the above qualification of per-1991 core samples, a data qualification plan, "Data Qualification Plan Logs of Geophysical Recording Runs," is being performed concurrently to qualify non-paper (digital logs collected from the same suite of logs) of the pre-1986 geophysical logs using the same AP-SIII.2Q.

Concerns were raised by the Data Qualification Team relative to the "use" of the data being qualified. The data being qualified has limits on its range and use. There was a concern that by "qualifying" the drill core data, it could be used without restriction. It was explained that any restrictions on the data be clearly identified and flagged in the documentation for data transmittal notices. Additional discussions were held relative to capturing the videos, logs, etc in the Technical Data Management System (TDMS). This concern was specifically recognized in audit M&O-ARP-98-20. The TDMS has the capability to identify "links" to other archived data and media such as logs and videos that are physically maintained in project records.

Personnel Contacted:

Clinton Lum, M&O [(Sandia National Laboratories (SNL)], Data Qualification Chairperson
Bill Zelinski, M&O (URS Greiner-Woodward Clyde), Data Qualification Team
Chris Lewis, M&O SMF/DD Manager/ SMF Curator
David Busch, USGS Principle Investigator (Integrated Site Model)
Robert Clayton, M&O (URS Greiner-Woodward Clyde), Principle Investigator (Integrated Site Model)
John Pelletier, M&O (SNL)
Mark Tynan, OCRWM AM/OPE
Daniel Neubauer, M&O/ TCO (SAIC)
Jack Kepper, Former SAIC(retired)

Observers:

Neil Coleman, Geologist, U.S. NRC
Harvey Dove, OQA Quality Systems
Rick Weeks, OQA Field Test

10. SURVEILLANCE CONCLUSIONS: (Continued)

Process Recommendation

A Process Recommendation was made during the surveillance relative to the AP2.13 *Technical Product Development Planning* document utilized for the "Data Qualification Plan: Drill Core Samples, Lithostratigraphic Contacts, Core Video and Downhole Video," TDP-NBS-GS-000002 Revision 1. Overall, this plan was found to be very satisfactory. This planning document was reviewed during the surveillance with the following comments and recommendations:

- Block 3 on the Development Plan Checklist Cover Sheet requires that the scientific approaches or technical methods used be addressed. This block points to Section 4.0 of the plan which identifies procedure AP-SIII.2Q, Revision 0 *Qualification of Unqualified Data and the Documentation of Rationale for Accepted Data* as providing the technical approach to qualify core, down photos, and downhole videos. This procedure provides administrative guidance only providing that a plan be created. This plan inappropriately points back to this procedure for technical direction. Section 4.0 of this plan should be rewritten to more appropriately address the methodology and approach and delete this reference to the AP.

- Block 4 on the Development Plan Checklist Cover Sheet requires that the implementing documents necessary to do the work be identified. The block checked yes for this block identifies procedure AP-SIII.2Q, Revision 0 *Qualification of Unqualified Data and the Documentation of Rationale for Accepted Data* and points to Section 5 of the plan which lists AP-SIII.3Q, NWI-GL-001Q, QAP-6.2Q and the QARD. While these project procedures provides administrative direction on requesting and initiating a data qualification exercise, submittal of data, and a review process, these documents do not provide specific direction for qualifying data. The plan itself describes that methodology, however other project procedures used in accomplishing this activity need to be identified. The AP-SII series procedures utilized at the SMF for sample custody controls should be addressed as well as any specific laboratory procedures (i.e. LANL sample control procedures).

- Block 9 on the Development Plan Checklist Cover Sheet identifies that no computer software is used to perform the work. While it is agreed that no software is used for analyses or computation, the Data Qualification Team is using commercial software and spread sheets. This block should be revised to show the commercial software being used and that it does not require qualification.

- The schedule identified in paragraph 16.0 of the plan is not accurate based on current status. Recommend that if the plan is revised that the schedule be identified as tentative and that it may be revised as necessary without revision to the plan. Future revision can be made and controlled in a method (i.e. Lotus Notes) outside of the plan.

- The revision of the plan being implemented is Revision 1, Revision 0, with a document control number was furnished during the audit. Revision 1 was in the Lotus Notes database but was not completely signed. Recommend getting signed and controlled documents at the workplace and in the database.

Process Model Reports and Analysis/Model Reports

Presentation to:
NRC On-Site Representatives

Presentation by:
Mike Lugo
Manager, Process Model Reports
M&O/TRW

September 23, 1999

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

ATTACHMENT C

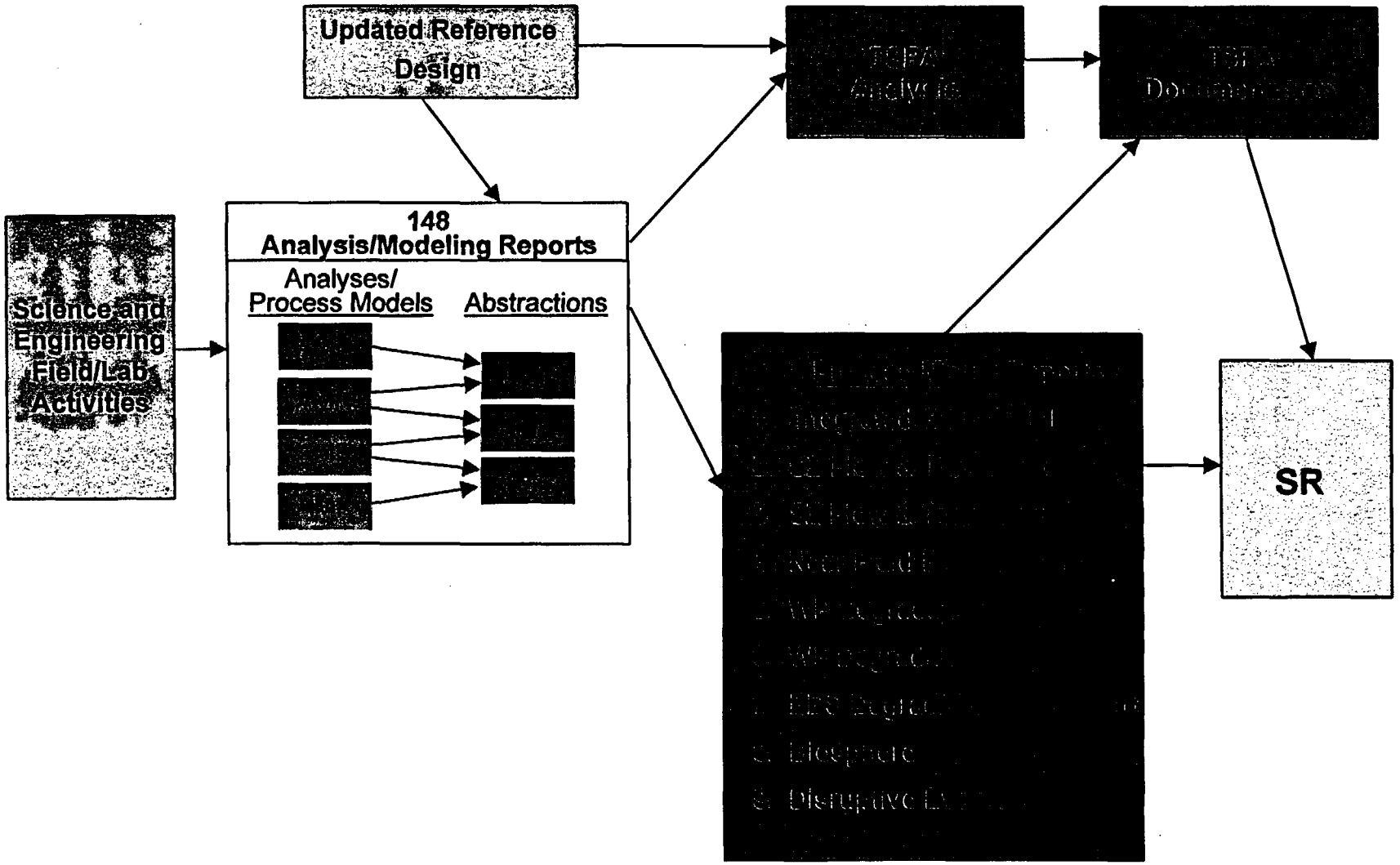
Process Model Reports (PMRs) Purpose

- The purpose is to document the technical basis supporting each TSPA process model
  - Supports the postclosure safety case for SR/LA
- PMRs will focus the development of technical information on what is relevant to developing a defensible TSPA
  - i.e., the information the Project is relying upon to demonstrate postclosure compliance
- The PMR development process will ensure transparency and traceability of data, information, and references

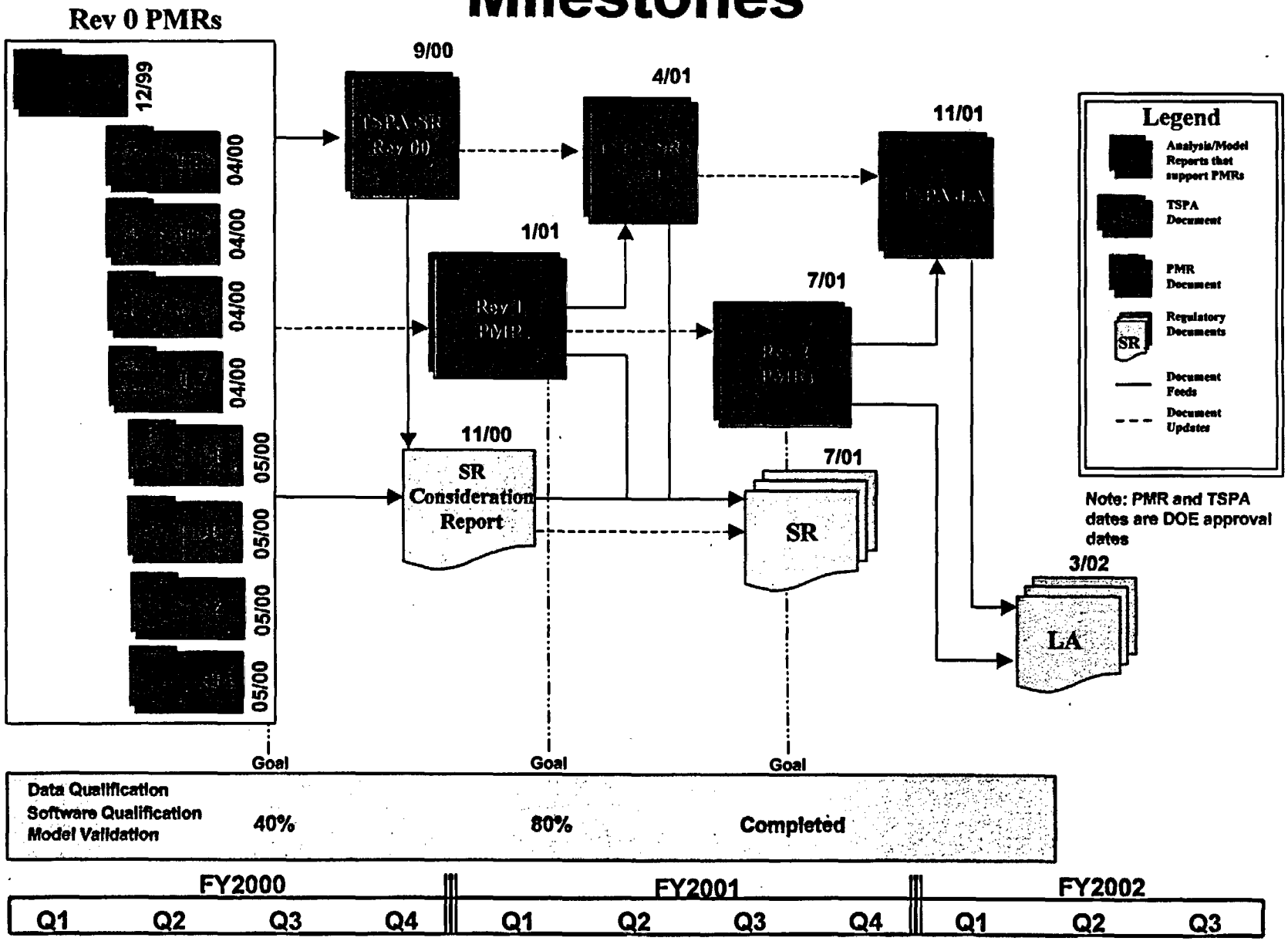
PMR Scope

- **PMRs will address:**
  - Descriptions of the models, submodels, and abstractions
  - Relevant data and data uncertainties
  - Assumptions and bases
  - Model results (outputs)
  - Software qualification
  - Model validation
  - Opposing views/alternative interpretations
  - Information to support regulatory evaluations

PMR/AMR/TSPA Relationship



Linkage of Major Programmatic SR/LA Milestones



PMR Team

PMR Manager – Mike Lugo

PMR Production Coordinator – Jeff Weaver

PMR	PMR Lead/ DOE Lead	PA Representative	Reg. Representative	QA Representative
1. Integrated Site Model	Clinton Lum/ Mark Tynan	Cliff Ho	Terry Crump	Harvey Dove
2. Unsaturated Zone Flow/Transport	Bo Bodvarsson/ Russ Patterson	Cliff Ho	Martha Pendleton	Harvey Dove
3. Saturated Zone Flow/Transport	Al Eddebbarh/ Russ Patterson	Bill Arnold	Augie Matthusen	Mike Eshleman
4. Near Field Environment	Dale Wilder/ Deborah Barr	Nick Francis	Pete Gaillard	Richard Powe
5. Waste Package Degradation	Joe Farmer/ Paige Russell	Joon Lee	Ali Haghi	Dan Tunney
6. Waste Form Degradation	Christine Stockman/ Paige Russell	Rob Rechard	Mike Scott	Dan Tunney
7. EBS Degradation/ Flow/Transport	Dwayne Chesnut/ Jaime Gonzalez	Bob MacKinnon	Jerry Self	Dennis Threatt
8. Biosphere	John Schmitt/ Russ Patterson	Tony Smith	Kayce Prince	Steve Swenning
9. Disruptive Events	Richard Quittmeyer/ Russ Patterson	Rally Barnard	Terry Crump	Steve Swenning