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**FY 1992 WORK PLAN
AND
TECHNICAL PROGRESS REPORTS**

DESERT RESEARCH INSTITUTE
Contract Number DE-AC08-90NV10845

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U.S. Department of Energy
Nevada Field Office
Las Vegas, Nevada

NOVEMBER 1992

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**Richard D. McArthur
Desert Research Institute**

NOVEMBER 1992

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ABBREVIATIONS AND ACRONYMS

ACHP	Advisory Council on Historic Preservation
AIRFA	American Indian Religious Freedom Act
BECAMP	Basic Environmental Compliance and Monitoring Program
CEP	Containment Evaluation Panel
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE/NV	U.S. Department of Energy, Nevada Field Office
DRI	Desert Research Institute
EPA	U.S. Environmental Protection Agency
GCP	Groundwater Characterization Project
GIS	Geographic Information System
HRMP	Hydrology/Radionuclide Migration Program
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LTHMP	Long-Term Hydrologic Monitoring Program
NTS	Nevada Test Site
NDHPA	Nevada Division of Historic Preservation and Archeology
ORERP	Off-Site Radiation Exposure Review Project
OTD	Office of Technology Development
REEC _o	Reynolds Electrical and Engineering Co., Inc.
RSN	Raytheon Services Nevada
TTR	Tonopah Test Range
USGS	U.S. Geological Survey

INTRODUCTION

The Desert Research Institute (DRI) is a division of the University of Nevada System devoted to multidisciplinary scientific research. For more than 25 years, DRI has conducted research for the U.S. Department of Energy's Nevada Field Office (DOE/NV) in support of operations at the Nevada Test Site (NTS). During that time, the research program has grown from an early focus on hydrologic studies to include the areas of geology, archaeology, environmental compliance and monitoring, statistics, database management, public education, and community relations. The range of DRI's activities has also expanded to include a considerable amount of management and administrative support in addition to scientific investigations.

DRI's work plan for FY 1992 reflects a changing emphasis in DOE/NV activities from nuclear weapons testing to environmental restoration and monitoring. Most of the environmental projects from FY 1991 are continuing, and several new projects have been added to the Environmental Compliance Program. The Office of Technology Development Program, created during FY 1991, also includes a number of environmental projects.

The NTS Archaeology Program has expanded in scope to consider sites and structures of historical as well as prehistorical significance. Consequently, the name of the program has been changed to *NTS Cultural Resources Program*. The major task of this program is to conduct surveys of cultural resources at sites where land-disturbing activities are planned. If cultural resources are found at a site, they will be evaluated and data recovery will be planned and performed as necessary. Surveys and related activities will be conducted at numerous locations, including drilling sites and sample units on Pahute and Rainier Mesas, sites of wells to be drilled for the Groundwater Characterization Project, and other sites of proposed activity on the NTS, the Tonopah Test Range, and Yucca Mountain.

Other work to be carried out under this program includes analyzing and curating artifacts, upgrading the NTS archaeological collection, monitoring sites to ensure that cultural resources remain undisturbed, preparing a draft of a comprehensive NTS Cultural Resources Management Plan, and providing worker education and public relations programs. Several activities outlined in the American Indian Religious Freedom Act Consultation Plan will also be carried out. Finally, a new project will study the historical significance of facilities related to nuclear testing at the NTS.

The *Community Radiation Monitoring Program* is essentially unchanged from FY 1991. DRI will schedule and coordinate presentations to groups in several communities and will manage, supervise, and help train station managers and alternates. Communities in the off-site area will be visited regularly to maintain contacts with local officials and other residents and to continue the independent verification of data collected at the stations. Other activities will include overall coordination of the program and preparation of reports summarizing important program activities.

DRI's representative on the *Containment Evaluation Panel* will provide expert judgment to the panel on the hydrologic implications of every nuclear test to be conducted on the NTS. He will also be responsible for security activities related to the panel's mission, including an inventory of classified documents stored at DRI and an annual security inspection.

The *Office of Technology Development Program* includes several studies in support of the Land Surface Cleanup of Plutonium project. DRI will take a lead role in developing protocols for sampling and analyzing soil from contaminated sites and will develop a database for results from tests of various methods for plutonium cleanup. Other work to be done under this program includes further development of the robust cubic spline method of surface estimation, an investigation of the feasibility of using remote sensing to detect and characterize hazardous wastes, and an educational outreach program.

In addition to supporting the other DOE research programs, the *Statistics and Data Management* group has major responsibilities in two projects. The Off-Site Radiation Exposure Review Project is nearing completion, and DRI's activities for that project will consist primarily of documenting and archiving previous work and finishing reports. DRI will also provide statistical and database management support to the Basic Environmental Compliance and Monitoring Program.

The major activity for the *Yucca Mountain Project* will be archaeological surveys and related work. Other projects will study the climate at Yucca Mountain by examining the composition of prehistoric and modern animal populations and by using satellite data to evaluate the performance of regional climate models. A project to develop a method of drainage design to protect railroads from flooding on alluvial fans will also continue.

This document contains the FY 1992 work plan and quarterly technical progress reports for each DRI project. Each progress report has five components:

1. **Project Description** gives background information and outlines the major goals of the project.

2. **Progress on Tasks** describes the important activities and accomplishments that occurred during each quarter. The quarterly reporting periods for FY 1992 were as follows:

First Quarter	October – December 1991
Second Quarter	January – March 1992
Third Quarter	April – June 1992
Fourth Quarter	July – September 1992

3. **Status of Deliverables** lists all major deliverables for FY 1992 as Submitted, Delayed, or Completed. Additional information, such as reasons for delays and revised due dates, is included when provided by the principal investigator. If a project's deliverables are on an "as required" basis, as with some of the archaeology projects, this section is replaced with a list of the reports completed during the year.

4. **Problems Encountered** describes any problems that occurred and what was done to resolve them. This component is omitted if no problems were reported.

5. **Budget Summary** shows the financial status of the project at the end of the year. Note that some projects received funding through more than one account.

NTS CULTURAL RESOURCES PROGRAM

People first started living in southern Nevada about 11,000 years ago. The prehistoric occupation of this region appears to have been nearly continuous since that time, although there have been several major shifts in how prehistoric peoples used the available resources and how they were influenced by surrounding cultural developments. The earliest occupants of the NTS area are thought to have been primarily hunters of large game animals; later tribes structured their lives around the seasonal availability of both game and wild plants. Agriculture was probably never developed in this arid region, but evidence suggests that agricultural tribes from other parts of the Southwest and the Great Basin visited the area, or at least traded with the indigenous hunters and gatherers there. Thus, artifacts from several different prehistoric cultures can be found on the NTS today.

In historical times, settlers of European descent exploited the region primarily for its mineral resources. Abandoned mines and mine workings are common in the area, and several ghost towns remain on the NTS and surrounding Air Force Range. More recently, nuclear testing at the NTS has resulted in the construction of houses, bridges, and other structures that are of possible historical significance.

The purpose of the NTS Cultural Resources Program is to help DOE preserve the resources of cultural significance on the land it manages in southern Nevada. Most of the program's effort is directed at ensuring compliance with various stipulations and regulations of the National Historic Preservation Act, the National Environmental Policy Act, and the American Indian Religious Freedom Act (AIRFA) related to protection of cultural resources.

Since the NTS Cultural Resources Program began in 1978, a total of 2,949 separate cultural resources sites have been identified through 277 separate surveys conducted on lands managed by DOE. Of those resources, 548 occur on the Tonopah Test Range and surrounding Nellis Air Force Range, 590 occur on lands being studied under the Yucca Mountain Project, and the remaining 1,811 occur on the NTS proper. A total of 24 separate data recovery projects have been conducted on the NTS to mitigate the potential adverse effects on historic properties through scientific study.

In FY 1992, the NTS Cultural Resources Program will assist DOE through several related, but separately funded, components:

- BECAMP Archaeology addresses the identification, evaluation, limited mitigation, and monitoring of potential effects of DOE activities on historic and prehistoric cultural resources on the NTS. It also provides curatorial and other record-keeping services to meet government archival requirements. Overall management and administrative support for the NTS Cultural Resources Program is included in this component.
- Tonopah Test Range Archaeology provides services similar to those of the BECAMP component for activities on the Tonopah Test Range.
- The Pahute and Rainier Mesas Long-Range Study Plan is a project to mitigate potential adverse effects of land-disturbing activities on the two mesas through a single comprehensive data recovery program.

- The NTS AIRFA Compliance Program is designed to help DOE comply with the AIRFA through protecting the inherent rights of Native Americans to believe, express, and exercise their traditional religions.
- A new project, Historical Structures on the Nevada Test Site, is proposed for FY 1992. This project is in response to increasing encouragement from the Nevada Division of Historic Preservation and Archeology (NDHPA) for DOE to inventory the cultural resources associated with the nuclear testing program. Although these resources are less than 50 years old, they may qualify as "historic properties" eligible for nomination to the National Register of Historic Places because of their association with events that are significant in our nation's history.

The FY 1992 activities planned for the Yucca Mountain Archaeological Program, Archaeological Support for the Groundwater Characterization Project, and Archaeological Studies at Contaminated Sites are described in other sections. Detailed descriptions of the other components of the NTS Cultural Resources Program follow.

Pahute and Rainier Mesas Long-Range Study Plan

Lonnie C. Pippin, Colleen M. Beck

Project Description

Many of the nuclear testing activities carried out at the NTS take place on Pahute and Rainier Mesas, areas relatively rich in cultural resources that could be affected by those activities. To eliminate the need for an expensive and time-consuming data recovery project before every planned test, DOE has developed a single comprehensive data recovery program, the Pahute and Rainier Mesas Long-Range Study Plan. This plan is part of a Programmatic Agreement with DOE, the NDHPA, and the Advisory Council on Historic Preservation (ACHP). Its details are outlined in the *Long-Range Study Plan for Negating Potential Adverse Effects to Cultural Resources on Pahute and Rainier Mesas, Nevada Test Site, Nevada* (December 1990).

The objective of the Long-Range Study Plan is to study, based on modifications to the existing sample of surveyed areas, a geographically representative 11 percent sample of all cultural resources on Pahute and Rainier Mesas. This objective will be achieved through a series of data recovery programs at drill holes already scheduled for nuclear events and from selected sample units representing all geographic areas on the mesas. Interim reports will be prepared for each data recovery effort at selected drill holes and for each geographic sample unit. A final summary report will be prepared after the entire sample has been studied.

Consultations with the NDHPA and the ACHP concerning the plan will be held annually, before modifying any sample recovery programs, and on completion of each report. However, consultations no longer will be required prior to land-disturbing activities at individual drill holes outside of the proposed sample. Once the sample of cultural resources has been studied through data recovery programs and the NDHPA and ACHP have concurred with the results, DOE will have fulfilled its obligations for the mitigation of potential adverse impacts to cultural resources on Pahute and Rainier Mesas.

The Long-Range Study Plan is envisioned as a 10-year study. However, this schedule may be modified as necessary through consultation with the NDHPA. FY 1992 is the second year of the program.

Progress on Tasks

Task 1. Conduct laboratory analyses of artifacts recovered from the FY 1991 field investigations and curate these artifacts.

First Quarter: The inventory, data entry, and laboratory analysis of the artifacts from Sample Unit U19ax was completed. The inventory for the materials from Sample Unit U19aq is finished, with the data entry and tool analysis in progress. The inventory of the artifacts from Sample Unit UNLV 122 is in progress.

Second Quarter: The artifact inventory and the entry of information into the database have been completed for Sample Units U19aq, UNLV 122, U19ad-PL, and U19ao. The

detailed laboratory analyses of the artifacts were finished for Sample Unit U19aq. Data entry and tool analysis are in progress for the materials from Sample Units U19an, U19ad-PL, UNLV 122, and U19ao.

Third Quarter: The laboratory analysis and data entry were completed for the artifacts, pollen samples, and radiocarbon samples from Sample Units U19ax, U19aq, U19an, UNLV 122, and U19ad-PL. The Sample Unit U19ao inventory is almost complete for FY 1991 collections. Draft reports for units U19ax, U19aq, and U19an were submitted to DOE/NV and are in review at the NDHPA and the ACHP.

Fourth Quarter: The inventory of the artifacts from Sample Unit U19ao has been completed and the data entry is almost done. The analysis of the tools from this sample unit is in progress. The artifacts from Sample Unit UNLV 122 will be analyzed after the FY 1991 U19ao materials. The draft technical reports for units U19ax, U19aq, and U19an have been reviewed. The draft technical report for Sample Unit U19ad-PL was submitted to DOE/NV and also has been reviewed by the NDHPA and the ACHP. The changes requested by the reviewers will be incorporated into the final reports.

Task 2. Begin investigations at sample units as specified for Year 2 in the Study Plan.

First Quarter: Two sample units from Year 1 (U19ao and UNLV 122) will require additional field work in FY 1992. Field work at Year 2 sample unit U19arP4 was completed in November. Work at the other Year 2 sample units will begin in the third quarter.

One survey was conducted for cultural resources which would qualify for inclusion in the National Register of Historic Places under criteria which address sites of historical, but not necessarily archaeological, significance. The survey was at the proposed road and well pad location of characterization well ER 20-2 in Areas 19 and 20.

Second Quarter: Draft data recovery plans have been completed for Sample Units U19ao and UNLV 122. Year 2 sample unit U19arP4 artifacts have been inventoried and analyzed. Survey and data recovery at the other Year 2 sample units may not begin until the fourth quarter. The date of initiation of the field work will be determined by the State Historic Preservation Officer and DOE/NV.

Third Quarter: Data recovery plans have been submitted for Sample Units U19ao and UNLV 122. Surveys of four more Year 2 sample units will begin in the fourth quarter.

Fourth Quarter: Sample Units 12-20, 19-22, 20-06, and 20-12 were surveyed and testing was conducted at sites in 12-20, 20-06, and 20-12. Testing was not done at the sites in

19-22 because the sites have little or no depth. The artifacts recovered from the test pits were processed by the laboratory. Survey reports incorporating the testing data were submitted to DOE/NV for Sample Units 12-20 and 19-22. After the survey and testing, DOE/NV removed 20-06 and 20-12 from the list of priorities. A survey report containing the testing information is in preparation for each of these units. However, data recovery plans for these units will not be prepared at this time. The data recovery plan submitted for Sample Unit U19ao was approved. The collection of artifacts and shovel scrapes at U19ao was completed. Seventy-five percent of the excavation of the rock shelter is done. In September, three monitors chosen by the Native American tribes were present during the data recovery at Sample Unit U19ao. The data recovery plans for Sample Units UNLV 122, 12-20, and 19-22 were submitted to DOE/NV. The plan for UNLV 122 was approved by the NDHPA and ACHP and the other two are still in review. Data recovery at UNLV 122 was initiated in September. The draft report for Sample Unit U19arP4 was submitted to DOE/NV. The report was approved by the NDHPA and ACHP.

Task 3. Prepare interim reports and other supporting documentation for the Long-Range Study Plan, and provide technical assistance to DOE in consulting with the Nevada Division of Historic Preservation and Archeology and the Advisory Council on Historic Preservation.

First Quarter: The annual report for the first year of the Long-Range Study Plan, summarizing the field studies for the first year and discussing discrepancies between the Programmatic Agreement and the Plan, was submitted. Other documentation was provided to DOE as requested.

Second Quarter: The annual report was revised. DRI participated in a meeting with the State Historic Preservation Officer, the ACHP, and DOE/NV regarding the plan. Several changes were made in the plan to correct conflicts with the Programmatic Agreement. Other documentation was provided to DOE, as requested.

Third Quarter: The revisions requested by DOE/NV and the NDHPA for the annual report were completed. All DRI NTS archaeologists and DOE/NV participated in a meeting with the NDHPA concerning Section 106 compliance and the requirements of the Programmatic Agreement and the Long-Range Study Plan. Other documentation was provided to DOE as requested.

Fourth Quarter: The Long-Range Study Plan was revised and updated in response to a request from DOE/NV to address concerns of the NDHPA. In September, a peer review of this program took place with participation by two Great Basin scholars, an archaeologist from the Bureau of Land Management in Nevada, and a National Park Service archaeologist from Washington, D.C. Prior to the meetings, the panel reviewed the study plan. For one day the panel toured archaeological sites on Pahute and Rainier Mesas with NDHPA, DRI, and DOE/NV personnel. A

second day was devoted to discussing and clarifying issues related to this program. The peer review panel submitted their recommendations to DOE/NV. Other documentation was provided to DOE/NV as requested.

Task 4. Maintain an interpretive display in the Mercury Cafeteria.

First Quarter: Plans for a new exhibit in the cafeteria were completed.

Second Quarter: A preliminary exhibit was completed. The exhibit is too large for the case and will have to be reduced in size.

Third Quarter: The new exhibit is near completion.

Fourth Quarter: The new exhibit is on display and summarizes a study that shows the origin of the obsidian used for artifacts on the NTS and near Yucca Mountain.

Reports Completed

1. SR072591-1: "A Class III Cultural Resources Reconnaissance of Eight Ground Motion Stations, One GRMPY Van Location and the Associated Cable Routes, Sample Unit DNA-2, Area 12, Nevada Test Site, Nye County, Nevada."
2. SR070991-1: "A Class III Cultural Resources Reconnaissance of Sample Unit U19ax, Area 19, Nevada Test Site, Nye County, Nevada."
3. SR070991-2: "A Class III Cultural Resources Reconnaissance of Sample Unit UNLV 122, Area 19, Nevada Test Site, Nye County, Nevada."
4. SR071291-2: "A Class III Cultural Resources Reconnaissance of Sample Unit U19aq, Area 19, Nevada Test Site, Nye County, Nevada."
5. SR072292-1: "A Class III Cultural Resources Reconnaissance of Sample Unit 12-20, Kawich Valley, Nevada Test Site, Nye County, Nevada."
6. SR072892-1: "A Class III Cultural Resources Reconnaissance of Sample Unit 19-22, Kawich Valley, Nevada Test Site, Nye County, Nevada."
7. Data Recovery Plan for Site 26NY1441, Sample Unit 19-22, Kawich Valley, Nevada Test Site, Nevada.
8. Data Recovery Plan for Sites 26NY8083, 26NY8084, and 26NY8085, Sample Unit 12-20, Kawich Valley, Nevada Test Site, Nevada.
9. Technical Report: "Archaeological Investigations at Sample Unit U19aq, Nevada Test Site, Nye County, Nevada."
10. Technical Report: "Archaeological Investigations at Sample Unit U19ax, Nevada Test Site, Nye County, Nevada."

11. Technical Report: "Archaeological Investigations for Sample Unit U19an, Nevada Test Site, Nye County, Nevada."
12. Technical Report: "A Gabled Wooden Lodge in an Archaeological Context: Archaeological Investigations at Sample Unit U19adPL, Nevada Test Site, Nye County, Nevada."
13. Technical Report: "Prehistoric Spatial Patterning and Subsistence Studies: Archaeological Investigations at Sample Unit U19arP4."

Problems Encountered

Second Quarter: Field work for Year 2 of the Long-Range Study Plan cannot begin until the conditions set forth in the meeting discussed under Task 3 are met.

FY 1992 Budget Summary
Mesas Long-Range Study Plan

Nevada Test Site AIRFA Compliance Program

Lonnie C. Pippin

Project Description

The American Indian Religious Freedom Act of 1978 directs federal agencies to consult with Native Americans to determine how best to protect their inherent rights to believe, express, and exercise their traditional religions, including access to sites, use and possession of sacred objects, and freedom to worship through traditional ceremonial rites. Compliance with AIRFA is required for each separate activity conducted by DOE. The NTS AIRFA Compliance Program is designed to help DOE expand its compliance with AIRFA to include all NTS activities. The initial emphasis of the program will concern those activities associated with nuclear testing projects.

The program has two overall goals. The first is to solicit, on behalf of DOE, Native American comments regarding the effects of DOE's activities on historic properties of Native American value and on the expression and exercise of traditional Native American religions. The second is to provide recommendations for DOE concerning potential mitigation measures for any possible adverse effects on Native American religious values and freedoms. The program is conducted with the assistance of two subcontractors, Dr. Katherine Fowler (University of Nevada – Reno) and Dr. Richard Stoffle (University of Arizona), who have established relationships with the Native Americans involved in this program.

The program began in FY 1990 with the development of a baseline document and study plan. During FY 1991, a plan, *NTS American Indian Religious Freedom Act Compliance Program, Complying With AIRFA: The Consultation Plan*, was developed that outlined the purpose, goals, and scope of the program. In addition, initial contact was made with 17 Native American groups that will be involved in the initial phases of consultation about weapons testing on Pahute and Rainier Mesas and on Yucca Flat. Activities to be conducted in FY 1992 include Tasks 3.0 through 6.4 outlined in the Consultation Plan. They include an orientation visit to the NTS for tribal leaders, initial interviews with key cultural experts, investigative research concerning ethnohistory and ethnobotany on Pahute and Rainier Mesas and Yucca Flat, the training of official tribal contact representatives, and one of two site visits by Native Americans.

Progress on Tasks

Task 1. Prepare for and conduct an on-site orientation visit for tribal leaders.

First Quarter: Two meetings with DOE, DRI, and the subcontractors were conducted to prepare for the visit which was conducted in December. Fifteen of the 17 tribes attended and made recommendations to DOE regarding the conditions of their participation in the AIRFA Program. In response to their concerns, a second site visit for tribal leaders was scheduled for February to discuss their participation in the Long-Range Study Plan.

Second Quarter: A second on-site meeting was conducted in February. Fifteen of the 17 tribes attended and made recommendations to DOE/NV regarding their participation in

the Long-Range Study Plan. In consultation with DRI, DOE/NV responded to their proposals. A meeting to finalize the program is scheduled for May.

Third Quarter: In April, DOE/NV issued its response to the Native Americans' proposal for participation in the Long-Range Study Plan. DOE/NV discussions with DRI centered around the logistics of hiring monitors and the nature of their participation. In May, DOE/NV, DRI, and its subcontractors met with the Native Americans for final discussions concerning participation of the Native Americans. It was decided that the Native Americans would be hired as DRI hourly employees and be required to comply with DRI employee requirements and DOE/NV regulations, but would be independent in terms of their obligation to represent the tribes and their consultation with the tribal councils. Three monitors and their alternates are to be selected by the tribes and they will be with the archaeologists during data recovery on the mesas.

Fourth Quarter: No orientation visits were scheduled. The recommendation by the tribal elders that Native American monitors be part of the Long-Range Study Plan data recovery program was implemented. The 17 tribes designated three monitors who have overseen the data recovery at one sample unit on Pahute Mesa.

Task 2. Prepare for and conduct two on-site visits with tribal elders.

First Quarter: Planning for the first visit (to obtain information about environmental features on Pahute and Rainier Mesas) began. The visit is scheduled for spring of 1992.

Second Quarter: The first visit was rescheduled for June due to the Long-Range Study Plan meetings. Planning is proceeding on schedule.

Third Quarter: The ethnobotanical study with the Native Americans was conducted with participation by the Western Shoshone, the Southern Paiute, the Chemehuevi tribes, and a representative from the Las Vegas Indian Center. The ethnographers spent 18 days at the NTS taking rotating groups of Native Americans to 8 locations in Areas 12, 19, and 20. Interviews were conducted with each of the Native Americans at each locale. Plant identifications were verified by a botanist from the Community College of Southern Nevada with other support provided by DRI and the DOE/NV Office of External Affairs. The second visit by the tribal elders to archaeological sites is scheduled for August.

Fourth Quarter: The Native American ethnoarchaeology visits to the NTS were conducted between August 11 and August 27. There were four three-day tours with tribal representatives visiting 10 archaeological sites on each tour. Ethnographers from the University of Arizona and DRI interviewed each of the tribal representatives at every site. Archaeologists from DRI accompanied the ethnographers. The ethnographers prepared two reports for DOE/NV, one providing an analysis of the

Native Americans' interpretations and recommendations regarding the Area 16 Cave Site and one giving a synopsis of the Native American on-site visits.

Status of Deliverables

1. Letter report describing the results of the orientation trip (3/31/92). Completed
This report was prepared and distributed by R. Furlow, DOE/NV.
2. Progress and draft reports concerning the results of the environmental on-site visit (9/30/92). Completed
Progress reports on the AIRFA program and the results of the ethnobotanical visit were issued to DOE/NV by DRI and its subcontractors.

Problems Encountered

Second Quarter: Schedules had to be changed to accommodate the Native Americans' interest in actively participating in the Long-Range Study Plan.

FY 1992 Budget Summary AIRFA Compliance

BECAMP Archaeology
Lonnie C. Pippin, Colleen M. Beck

Project Description

The Basic Environmental Compliance and Monitoring Program (BECAMP) was established by DOE/NV in 1986 to provide information needed for NTS compliance with applicable environmental laws and regulations. BECAMP researchers study a range of topics, including the movement of surface-deposited radionuclides, the ecological recovery of disturbed areas, and the status of endangered species and other wildlife populations on the NTS.

The major objective of the BECAMP Archaeology program is to mitigate the effects of NTS operations on archaeological sites on most of the NTS. (Sites on Pahute and Rainier Mesas are covered under the Long-Range Study Plan.) The program includes several activities:

- Cultural resources surveys and data recovery.

Before any project which may disturb the ground surface or alter standing structures can begin, a cultural resources survey of the proposed area of impact is required. If cultural resources are not found, then DOE documents that a study was done and that the project will have no adverse affects on cultural resources. The project is then allowed to proceed. If cultural resources are found, each resource must be evaluated and plans must be devised to mitigate adverse impacts on sites considered potentially eligible for the National Register of Historic Places. Most archaeological sites and historic structures can be avoided by DOE projects on the NTS, but occasionally it is not possible to avoid significant cultural resources. If a site cannot be avoided, the adverse impacts to the site are mitigated through scientific study and data recovery at the site before it is disturbed. These data recovery projects are done in consultation with the NDHPA and the ACHP.

The cultural resources surveys generate permanent records containing the survey and site information. This information is entered into a database and becomes the basis of the cultural resources reports distributed to the appropriate agencies. The data recovery projects generate artifact collections which require inventory, analysis, and archival of the collected materials as well as management of the records associated with the collections and analyses.

- Preparation of the NTS Cultural Resources Management Plan.

Since 1978, DOE/NV has been involved in various programs for protecting the cultural resources on the lands it administers. However, there has been no integrated plan that describes both the history, applicability, and interrelationships of these different programs and the policies and procedures that have been developed to manage cultural resources on the NTS. It is in DOE's interest that such a plan be developed to give continuity to the program and guidance to all interested parties.

- Upgrade and inventory of NTS archaeological collections.

Federal regulations mandate that archaeological collections, such as those which have been collected by DRI at the NTS, be curated in a prescribed manner. These regulations specify general requirements for handling and preserving the collections and records. While the recording and collection procedures that DRI has used meet many of the requirements, there are two problems.

First, with the exception of some perishable artifacts, materials are not stored in containers of archival quality (e.g., acid-free boxes). Second, a systematic inventory and inspection of the materials has not been conducted. In FY 1992, DRI will conduct an inventory and inspection of all archaeological materials collected by and stored at DRI prior to October 1, 1991, and in the process, store them using archival quality materials.

- **Management of the NTS Cultural Resources Program.**

A number of management activities are essential for DRI to be able to provide on-call assistance to DOE concerning management of their cultural resources. These activities include hiring and managing personnel, preparing cultural resource management reports and recommendations, assisting in the development of Programmatic Agreements and Memoranda of Understanding, responding to requests from DOE for information and support documents, attending meetings, assisting in consultations with other federal, state, and private agencies, and assisting in public relations and communication concerning NTS cultural resources. All such support activities will be funded under the BECAMP Archaeology component of the Cultural Resources Program.

Progress on Tasks

Task 1. Conduct and document on-call cultural resources surveys, limited site testing, and data recovery projects, as needed.

First Quarter: Four surveys for cultural resources were conducted: Area 23 – Grenade Range E, Area 3 – U3kv Powerline Corridor, Area 3 – U3kv access road, and Area 1 – U1e project area. No significant cultural resources were found during these surveys.

Second Quarter: Five surveys were conducted: drill hole U3ml, U7cd powerline reroute, U3ml power and fiber optic routing corridors, U7cd water line, and GRMPY arrays for U9cd. No significant cultural resources were found.

Third Quarter: Sixteen surveys were conducted: the Saddle Mountain project, U20ax GRMPY locations, T tunnel drill hole, P tunnel extension, the A3 Radioactive Waste Management Site, Ue10j skid trail realignment, A6 decontamination ponds, U19bh post-shot hole area for the MEXIA event, U2gj drill hole, U2gj power corridor, U10c power corridor, Area 16 grave site, Area 16 cave site, Tiny Tot event, Piledriver event and Piledriver extension, and the Hardhat event locations. The cave and the grave site were recorded at DOE's request.

Fourth Quarter: Nine surveys were conducted: seismic work at Dining Car, drill hole U1g, additional area at drill hole U19bl, seismic corridor at U3ml, the Area 6 Decon Facility yard expansion, the U7cd fiber optic line, seismic stations for N Tunnel, the skid trail at U7cd, and the U19bl bypass road.

Task 2. Assist in the preparation of DOE's cultural resources management plan.

First Quarter: No work was done on this task because the funding status was unclear.

Second Quarter: DRI conducted background research on format and content for cultural resources management plans in various regions of the United States, emphasizing current DOE requirements and completed plans for other DOE installations.

Third Quarter: DRI has completed an outline of the Phase I cultural resource management plan and is in the process of writing the review draft document.

Fourth Quarter: The draft cultural resources management plan continues to be in progress with the goal of producing the final document by the end of FY 1993. Work on this project has been delayed while DOE/NV awaits guidance from DOE Headquarters for the final format for cultural resources management plans.

Task 3. Inventory and upgrade the NTS archaeological collections.

First Quarter: No work was done on this task because the funding status was unclear.

Second Quarter: Work procedures for the inventory and upgrade were developed. Shelving was placed in the new storage area and all DOE/NV artifacts were moved into the new facility. Twenty percent of the DOE/NV collections were reboxed.

Third Quarter: All of the DOE/NV collections were reboxed and sorted into numerical order by site number in accordance with the electronic database for all sites. Each of the site collections has been sorted by material class (e.g., historic, chipped stone, ceramics). The Phase I rebagging with the trinomial site number on acid-free paper for organized group bagging has been completed.

Fourth Quarter: The Phase I upgrade of the collections in Reno was completed. In September, the DRI curation facility was inspected by the NDHPA and the DOE/NV.

Task 4. Provide curatorial and other record-keeping services for the NTS Cultural Resources Program.

First Quarter: The cultural resources inventory files and site record maps were updated to include the information from the completed projects (three sites and four survey areas). No artifacts were collected on BECAMP projects.

Second Quarter: The inventory files and site record maps were updated to include the information from the completed projects (five surveys and eight sites). No artifacts were collected on BECAMP surveys.

Third Quarter: Sixteen surveys and 11 sites were added to the inventory files and site record maps.

Fourth Quarter: Thirteen surveys (including Long-Range Study Plan), 11 new sites, updates of 5 previously recorded sites, and 19 isolated artifacts were put into the inventory files and site record maps.

Task 5. Manage and administer the NTS Cultural Resources Program.

- First Quarter:* Activities included attending the two-day BECAMP meeting, DOE budget meetings, and conferences concerning work tasks. All preliminary project activities, field work, analyses, and report preparation have been organized and supervised by the appropriate personnel.
- Second Quarter:* Management of the Cultural Resources Program included attendance at the DOE workshop in Charleston, South Carolina, a meeting with the program manager at DRI in Reno, and various discussions regarding work tasks.
- Third Quarter:* Program management included meetings with DOE/NV regarding projects and compliance matters, a meeting with the NDHPA, and a meeting with the program manager at DRI in Las Vegas.
- Fourth Quarter:* The administration of the program involved meetings between DRI and DOE/NV concerning specific projects and general issues. There were two meetings with the program manager, one focusing on subcontract approvals and problems and the other addressing plans for FY 1993.

Status of Deliverables

1. Draft cultural resources management plan (9/30/92).
The plan should be completed in FY 1993.	Delayed
2. Report on the status of NTS prehistoric and historic materials and associated records (9/30/92).
The report should be completed during the first quarter of FY 1993.	Delayed

Reports Completed

1. SR092091-1: "A Class III Cultural Resources Reconnaissance of Three Primary Well Locations, Three Alternate Well Locations, One Trench Location, and Access Roads Around the RWMS, Area 5, Nevada Test Site, Nye County, Nevada."
2. SR092691-1: "Historic Inventory and Assessment of Impact for the Underground Parking Garage, Area 5, Nevada Test Site, Nye County, Nevada."
3. SR092791-1: "Historic Inventory and Assessment of Impact for the BREN Tower, Area 25, Nevada Test Site, Nye County, Nevada."
4. SR110891-1: "A Class III Cultural Resources Reconnaissance of the Proposed 40mm High Explosive Grenade Range E, Area 23, Nevada Test Site, Nye County, Nevada."
5. SR120991-1: "A Class III Cultural Resources Reconnaissance of the Proposed Drill Hole U1e, Power Corridor and Access Road, Yucca Flat, Area 1, Nevada Test Site, Nye County, Nevada."

6. SR020692-1: "A Class III Cultural Resources Reconnaissance of the Proposed U7cd Water Line, Yucca Flat, Area 7, Nevada Test Site, Nye County, Nevada."
7. SR010992-1: "A Class III Cultural Resources Reconnaissance of the Proposed Drill Hole U2gk, Yucca Flat, Area 2, Nevada Test Site, Nye County, Nevada."
8. SR010992-2: "A Class III Cultural Resources Reconnaissance of the Proposed Drill Hole U7cd and Associated Skid Trail, Yucca Flat, Areas 2,4 and 7, Nevada Test Site, Nye County, Nevada."
9. SR110691-1: "A Class III Cultural Resources Reconnaissance of the Proposed U3kv Access Road, Yucca Flat, Area 3, Nevada Test Site, Nye County, Nevada."
10. SR110691-2: "A Class III Cultural Resources Reconnaissance of the Proposed U3kv Power Line, Yucca Flat, Area 3, Nevada Test Site, Nye County, Nevada."
11. SR022792-1: "A Class III Cultural Resources Reconnaissance of the Proposed U3ML Power and Fiber Optic Routing Corridors, Yucca Flat, Area 3, Nevada Test Site, Nye County, Nevada."
12. SR050492-1: "A Class III Cultural Resources Reconnaissance of the Proposed Saddle Mountain Project, Area 14, Nevada Test Site, Nye County, Nevada."
13. SR041092-2: "A Class III Cultural Resources Reconnaissance of the Realignment of the Ue10j Skid Lane, Yucca Flat, Area 8, Nevada Test Site."
14. SR051592-1: "A Class III Cultural Resources Survey of Four Station Lines for the Placement of Eight Ground Motion Canisters and One GRMPY Van near U20ax Drill Pad, Pahute Mesa, Area 20, Nevada Test Site, Nye County, Nevada."
15. SR061792-1: "A Class III Cultural Resources Reconnaissance of the Proposed Primary Power Line Corridor for Drill Hole U2gj, Yucca Flat, Area 2, Nevada Test Site, Nye County, Nevada."
16. SR061792-2: "A Class III Cultural Resources Reconnaissance of the Proposed Placement of the Power Supply at the U10c Crater Sanitary Landfill Located in Area 9, Yucca Flat, Nevada Test Site, Nye County, Nevada."
17. SR052292-1: "A Class III Cultural Resources Reconnaissance of the Proposed Placement of a Geologic Exploratory Drill Hole above T Tunnel, Aqueduct Mesa, Area 12, Nevada Test Site, Nye County, Nevada."
18. SR062592-2: "A Class III Cultural Resources Reconnaissance for Seismic Activities at Hardhat U15a, Area 15, Nevada Test Site, Nye County, Nevada."
19. SR062592-1: "A Class III Cultural Resources Reconnaissance for Seismic Activities at Tiny Tot 15e, Area 15, Nevada Test Site, Nye County, Nevada."
20. SR062492-2: "A Class III Cultural Resources Reconnaissance of the Area 3 Radioactive Waste Management Site (RWMS)."

21. Technical Report: "Inter- and Intrasite Analyses of Cultural Materials from U20aw, Nye County, Nevada."
22. Technical Report: "Archaeological Data Recovery at Drill Pad U19ax, Nye County, Nevada."
23. Technical Report: "Archaeological Data Recovery Related to the U20at Project, Nye County, Nevada."
24. Technical Report: "Temporary Camps at Drill Hole U19aq on Pahute Mesa, Nye County, Nevada."
25. Technical Report: "Archaeological Data Recovery at Drill Hole U19az."
26. Technical Report: "Fire on the Mesa: Archaeological Investigations at the U19an Borrow Pit on the Nevada Test Site."
27. Technical Report: "The Archaeology of Drill Hole U20bc, Nevada Test Site, Nye County, Nevada."
28. Technical Report: "Lithic Reduction Trajectories: Archaeological Investigations at Drill Hole U19bg, Nevada Test Site, Nye County, Nevada."
29. Technical Report: "Lithic Technology Studies: Archaeological Research at Drill Hole U19ba, Nye County, Nevada."

Problems Encountered

First Quarter: Work could not begin on the cultural resources management plan and the artifact inventory until funding was confirmed.

Historical Structures On The Nevada Test Site

Lonnie C. Pippin, Colleen M. Beck

Project Description

Since the NTS was established in 1950, the nuclear research, development, and testing program has produced unique cultural resources that document events, people, and technological achievements that are important in our history. The State of Nevada's Historic Preservation Plan states that these resources represent one of the most significant events ever to occur in Nevada and the United States. In accordance with federal regulations, any districts, sites, buildings, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and that are associated with events, people, or architectural (artistic) achievements that have made a significant contribution to the broad patterns of our history, are eligible for nomination to the National Register of Historic Places. Under the National Historic Preservation Act, it is DOE's responsibility to identify and inventory these resources and to develop plans for their protection and preservation.

Many of the facilities associated with nuclear testing still exist on the NTS and may be eligible for inclusion in the National Register because of their association with historical events of exceptional importance. However, no surveys have been conducted to locate and evaluate these resources.

This program is a multi-phase project focused at helping DOE inventory and interpret the cultural resources and evaluating them for eligibility to the National Register. The process will begin with the compilation of an overview of the history of nuclear testing in Nevada. This overview, which will build on the existing overview developed by the NDHPA, will be the basis for interpreting and evaluating the cultural resources. The scope, methodology, and schedule for the resource inventory will be contained in a study plan, and work will be conducted in accordance with a Programmatic Agreement with the State Historic Preservation Officer and the ACHP.

Eventually, this project will also address the historical significance of the buildings and locales associated with ranching and mining activities in the area before the NTS was created. This work will not begin until FY 1993 at the earliest.

Progress on Tasks

Task 1. With the assistance of an architectural historian, provide an initial list of post-1950 buildings and structures on the NTS which are potentially eligible for the National Register of Historic Places.

First Quarter: After notification of funding was received in December, a draft Scope of Work was prepared for the architectural historian (who will be a subcontractor to DRI).

Second Quarter: The scope of work for the architectural historian was completed. The subcontract was submitted to DOE/NV for review and approval.

Third Quarter: DOE/NV returned the subcontract for the architectural historian to DRI with a request for additional information. DRI then resubmitted the subcontract to DOE/NV for review and approval.

Fourth Quarter: The first phase of the background research for the subcontractors, Carey and Company, was completed and several people were identified for follow-up interviews after the field visit by the architectural historian.

Status of Deliverables

1. Initial list of potential historic sites associated with nuclear testing (9/30/92).

Delayed

Problems Encountered

First Quarter: Work could not begin until funding was confirmed.

Second Quarter: Work cannot begin until the subcontract is approved.

Third Quarter: Work cannot begin until the subcontract is approved. As a result, the due date of the deliverable may have to be revised.

Fourth Quarter: Due to the delay in the approval of the subcontract, the program manager approved an extension of this project to the end of the first quarter of FY 1993.

FY 1992 Budget Summary BECAMP Historical Structures

TTR Archaeology
Lonnie C. Pippin

Project Description

The TTR Archaeology program is focused at extending DOE's compliance with various environmental regulations to the Tonopah Test Range. This program is managed and administered through the BECAMP Archaeology program. Overall project coordination is handled through DOE's Site Manager of the TTR; funding is provided through a separate contract with Sandia National Laboratories.

Activities in FY 1992 will consist primarily of cultural resources surveys and data recovery projects similar to those conducted for the BECAMP.

Progress on Tasks

Task 1. Conduct and document on-call cultural resources surveys, limited site testing, and data recovery projects, as needed.

The only survey in FY 1992 was conducted in April.

Task 2. Provide curatorial and other record-keeping services.

First Quarter: Map and site files were updated with the information from three sites and one survey area recorded during the fourth quarter of FY 1991.

Second Quarter: Map and site files did not have to be updated because no surveys were conducted during the first and second quarters.

Third Quarter: Map and site files were updated to include the survey information and 13 sites recorded during the field work.

Fourth Quarter: The map and site files are up to date.

Report Completed

1. SR041992-1: "A Class III Cultural Resources Survey of Gold Flat Playa, Nye County, Nevada."

FY 1992 Budget Summary
TTR Archaeology

Community Radiation Monitoring Program

Nate Cooper

Project Description

Since the inception of nuclear testing at the NTS, the U.S. Government has made a strong commitment to protect the health and safety of the residents in the area surrounding the NTS. Part of that commitment has been a continuing program of monitoring airborne radiation. Off-site radiation monitoring has been done by various groups and agencies since testing began, with that responsibility now resting with the U.S. Environmental Protection Agency (EPA).

One component of DOE's Off-site Radiation Safety program is the Community Radiation Monitoring Program. The concept of the Community Radiation Monitoring Program grew from experience gained in handling the Three Mile Island accident. Over the last 11 years, this concept has been developed and modified by a group of knowledgeable and dedicated professionals.

The major objective of the Community Radiation Monitoring Program is to increase the off-site residents' understanding of activities at the NTS. There has been evidence of serious and long-term concern among these residents about the negative effects of radiation releases that may have resulted from the weapons testing program. This concern has been exacerbated by lack of knowledge and understanding of anything related to nuclear energy. A great deal of work has been and is being done in the areas of safety, health, and the environment, and every effort must be made to make that work known to the general public.

Another objective of the program is augmenting the collection of airborne radiation data in the long-established EPA off-site monitoring network. Monitoring stations have been upgraded in 19 communities near the NTS to facilitate this part of the program. Radiation levels are reported continuously and automatically through a satellite link from the pressurized ion chambers at each Community Monitoring station and several remote EPA sites to the Las Vegas EPA laboratory.

A third objective is to improve communication by increasing the participation of the residents of the off-site area. Local residents have been hired to manage the monitoring stations and have been afforded extensive training and information as program representatives in their communities. They are responsible for collecting samples, recording and forwarding data, reporting equipment problems, and acting as a liaison between the DOE and the public.

The work done by DRI for the Community Radiation Monitoring Program is accomplished through close cooperation with DOE, EPA, and the University of Utah. It includes several major responsibilities:

- Acting as the liaison between DOE and target audiences in communities throughout the off-site area in arranging public education presentations. In the last couple of years, the "town hall meeting" concept has been replaced by programs aimed at more carefully targeted audiences. Emphasis is being placed on reaching students in school assemblies or classrooms, with school officials choosing the topics to be presented. Other presentations are aimed at service clubs, such as Chambers of Commerce, Lions, and Kiwanis, and at parent-teacher groups.

- Disseminating information on radiation monitoring and related subjects to Station Managers, Alternates, and the public.
- Hiring and managing the Station Managers and Alternates, and assisting with their training.
- Developing and maintaining contacts and communication with local citizens and officials by personal visits, correspondence, telephone calls, and tours of the NTS.
- Verifying selected data collected and analyzed by EPA at representative monitoring stations. In FY 1992, the data verification will be more closely coordinated with the EPA, but the analyses will still be done independently.

Support activities are also provided on a continuing basis. These include writing activity reports, assisting the Station Managers, coordinating various aspects of the program, and assisting in such things as station moves, training, and program management and direction.

Progress on Tasks

Task 1. Schedule and coordinate presentations to target groups in off-site communities.

First Quarter: On October 3, Bama McKnight presented "ABC's of Radiation" to 60 students and 4 teachers at the Caliente Middle School. The program was so well received that Brent Perkins, the Alternate Station Manager, arranged for a presentation to the combined schools at Panaca next April. On November 13, David Wheeler appeared at the Moapa Valley Rotary Club and presented "Downwind Radiation Exposure" to an audience of 12 people. Daryl Thomé also addressed a group of 12 at the club on December 12. His subject was "Off-site Radiation Monitoring."

Second Quarter: Four presentations that included all of the students at the Tonopah Junior High School were made on February 25. David Wheeler addressed 101 students and three teachers on "Downwind Radiation" and "The Sheep Kill." The night before, Jerry Martin made a presentation to 13 members of the Alpha Sigma Phi college women's sorority in Tonopah on "Consumer-related Radiation." On March 4, Ken Giles talked to 23 people at the Pahrump Rotary Club luncheon on "NTS Deer Study." Two other presentations scheduled for Tonopah Junior High School had to be postponed because the presenter had an unanticipated conflict.

Third Quarter: On April 7, Ken Giles gave presentations on his NTS Deer Study to 80 Lincoln County Middle School and 25 Lincoln County High School students in Panaca. Bob Jones, DRI archaeologist, talked to 20 members of the Tonopah Rotary Club on April 20 about the archaeological research being done at the NTS. Three presentations were made by Bama McKnight on April 24 to 50 Tonopah Middle School and 37 Tonopah High School students. His subject was "The ABCs of Radiation."

On May 15, Paul Buck, Kerry Varley, and Jim Cullen from DRI participated in the

Beatty High School Career Day activities. Paul and Kerry talked about careers in archaeology and archaeologic activities at the NTS and in Egypt. Jim spoke on careers in geology and hydrology and his experiences with the NASA astronaut program. Approximately 125 students were involved in the all-day program.

Ken Giles presented his Deer Migration Study to six adults at the Complex I facility in Coal Valley on June 1. On June 9, Charles McWilliam made his presentation on the Joint Verification Operation and his experiences traveling in the Soviet Union to the Tonopah Rotary Club at its weekly luncheon. There were 19 members present.

The DOE/NV Office of External Affairs arranged a one-day tour of the NTS for Regents and officers of the University and Community College System of Nevada on June 24 that included 63 people.

Fourth Quarter: Ken Giles made a presentation on July 14 detailing the NTS Deer Migration Study to 16 members of the Tonopah Rotary Club. A presentation was made to 32 students and three teachers in combined Government classes at Indian Springs High School by Bob Taft on September 16. Arrangements were completed for six presentations in Cedar City on October 12 and 13, and other presentations are being planned for Indian Springs and Tonopah for late October or early November.

Task 2. Assist in organizing and presenting Station Manager training sessions.

First Quarter: Arrangements were completed for the training session to be held at the Rio Hotel in Las Vegas on January 4 and 5, 1992.

Second Quarter: The winter training session was conducted on January 4 and 5. Twenty-seven of 34 Station Managers and Alternates attended what was judged by some as "the best yet." The concept of holding the winter session on a weekend in early January was endorsed by almost all present, which will probably have an influence on next year's planning.

Arrangements for the summer training session have been made at the Brian Head Hotel for the week of August 3-7. This facility should prove to be much better than the place we have held our other training meetings. The agenda for the summer session has been discussed, and should be finalized early in the third quarter.

Third Quarter: Arrangements for the summer training session at Brian Head, Utah, have been completed, including the almost final agenda from Gary Sandquist. Indications are that at least 50 people will be there for training, including our people, the Rocky Flats contingent, and a number of guest teachers.

Fourth Quarter: The summer training session was held at the Brian Head Hotel on August 3-7. There were 30 Station Managers and Alternates, 10 Station Managers and Alternates from Rocky Flats, and 9 guest high school teachers from Nevada and Utah in attendance. The transcript of the Station Manager reports is in draft form and a summary of the session is being prepared for the annual report.

Preliminary discussions and planning have occurred on the winter training session, to be held in Las Vegas on January 9-10, 1993. A tour of the NTS is included in the plan.

Task 3. Maintain contacts and communication with community leaders and other local residents.

First Quarter: Officials and citizens in the off-site area were visited, called, and corresponded with as part of the routine data-verification trips and other project operations.

Second Quarter: Contacts and conversations with key people in the off-site area were continued in routine fashion.

Third Quarter: Visits and other contacts were made with various community leaders and citizens in the off-site area as opportunities occurred on trips and on the telephone.

Fourth Quarter: Contacts and visits were continued with various community leaders and citizens in the off-site area as opportunities occurred.

Task 4. Continue the data verification program to independently verify and evaluate data collected by EPA.

First Quarter: Thermoluminescent dosimeters (TLDs) were collected and installed on a slightly different schedule to make the DRI data easier to compare with those collected by EPA. There is still some question about the continuation of our deal with Arizona State University, but the matter should be resolved in the second quarter.

Second Quarter: The arrangement for TLD analysis has been firmed up for continuation. TLDs were installed and collected at appropriate locations on the network.

Third Quarter: All TLDs that were in the field were collected and shipped to ASU for analysis. A complete new set is scheduled for installation early in the fourth quarter.

Fourth Quarter: Plans are completed for installing a complete set of TLDs (all Stations) in October, as soon as the TLDs are received from ASU.

Task 5. Hire, terminate, assist, and supervise Station Managers and Alternates, as required.

First Quarter: The full complement of Managers and Alternates was maintained, but with some changes. Larry Goins, the Pahrump Alternate, resigned in August because of other business and was replaced by Dan Donnelly, who teaches science at the Pahrump Middle School. In Las Vegas, Roy Reeder resigned as Manager and Don

Curry was promoted from Alternate to Manager. David Peltz, a science teacher at Valley High School, was selected as the new Alternate in late December.

Second Quarter: No changes were required in Station Manager or Alternate status.

Third Quarter: No changes were required.

Fourth Quarter: Employment contracts for FY 1993 were prepared, signed, and completed for all 34 Station Managers and Alternates. A change was made in the status of the Station Manager and Alternate in Cedar City, effective October 1, 1992. Donald Newman, the Alternate Manager, has accepted the Station Manager position, and Glade Sorenson, the former Station Manager, will serve as the Alternate Manager.

Task 6. Prepare and distribute a summary report of significant program activities within two weeks of occurrence.

First Quarter: Summary memos on the public meetings were prepared and distributed, albeit somewhat late. The transcript of the Station Managers' reports from the summer training session was found and is being printed for distribution.

Second Quarter: The final transcript of the Station Managers' reports was completed and distributed, and summary reports of outreach activities were prepared and distributed. Beginning March 1, a monthly activities report was initiated and submitted to the Program Manager at DOE.

Third Quarter: The FY 1991 Annual Report draft was submitted to DOE and EPA for review and will be printed and distributed in July.

Fourth Quarter: The FY 1991 Annual Report is being held pending approval from DOE to print and distribute.

Task 7. Continue program coordination activities as required.

First Quarter: The periodic news clipping service and notification of nuclear tests were continued. Various meetings concerning program operations occurred. Help has been given to both Hanford and Rocky Flats in their efforts to establish programs similar to this one at those facilities. This included participating in a Station Manager training session at Rocky Flats.

Second Quarter: Program coordination activities continued, including the clipping service, notification of test activities, and assisting other DOE facilities in their monitoring programs. Meetings and conversations occurred with various people in the agencies involved in the program.

Third Quarter: These activities continued as required, with much of the effort devoted to preparation for the summer training session. Dr. Sandquist met with all of the principals in the program. Other activities were accomplished routinely.

Fourth Quarter: Coordination activities continued, including the clipping service, notification of nuclear tests, and periodic meetings and conversations with program principals.

Status of Deliverables

1. Draft report of FY 1991 program activities (3/31/92).	Submitted
2. Transcript of pertinent portions of the winter training session (3/31/92).	Completed
3. Transcript of pertinent portions of the summer training session (9/30/92).	Delayed

Problems Encountered

Fourth Quarter: An overexpenditure of approximately \$7,000 resulted from unanticipated costs incurred during the summer training session.

**FY 1992 Budget Summary
Community Monitoring**

Containment Evaluation Panel

Roger L. Jacobson

Project Description

DOE organized the Containment Evaluation Panel (CEP) following the venting of the Baneberry test in 1970. The panel is composed of experts in geology, hydrology, physics, engineering, nuclear weapons testing, and related scientific fields. Its purpose is to evaluate the containment design of each proposed nuclear test and to advise DOE's Manager of Nevada Test Operations on the technical adequacy of the design.

The DRI member of the panel is primarily concerned with analyzing the hydrologic and geologic implications of each test, although he may consider other aspects of the test as well. Each proposed underground test has unique features which may require different kinds of analyses. The analysis of a test includes an in-depth review of the information prepared for the test, and may also include computer analyses of data from past tests, analyses of the geology and material properties at the site of the test, comparison of these properties with those at other sites, and evaluation of hydrologic conditions at the test location.

The DRI panel member or a designated alternate is required to attend all regular and special CEP meetings. Travel to the sponsoring laboratories for special meetings or discussions is also required occasionally.

Included in this project are security activities related to the mission of the CEP, including a periodic inventory of classified documents at DRI and an annual security inspection.

Progress on Tasks

Task 1. Attend all meetings of the CEP.

First Quarter: Drs. Paul Fenske and Gilbert Cochran represented DRI on the tunnels tour and DNA preview briefing on December 3 and attended the CEP meeting on December 4.

Second Quarter: Drs. Paul Fenske, Roger Jacobson, and Gilbert Cochran attended the January 22 meeting.

Third Quarter: Drs. Paul Fenske, Roger Jacobson, and Gilbert Cochran attended meetings and categorized shots on April 22 and May 20 and 21.

Fourth Quarter: The 200th CEP meeting, originally scheduled for July 8, was rescheduled twice, to August 12 and then to September 2. The meeting is now scheduled to take place on October 14.

Task 2. Carry out all necessary security activities.

First Quarter: Final business details for the 6th Containment Symposium were completed. An in-house survey of the DRI classified security program was conducted, and

necessary revisions to the Facility Security Plan are under way. Provisions for a technical surveillance countermeasures program are being outlined to meet DOE Orders.

Second Quarter: Preparations for the yearly DOE/NV survey of the DRI security program were carried out in February and March. The survey was completed on March 24. Operations Security documents related to the DRI work on the CEP were completed.

Third Quarter: All necessary security activities were carried out. Details are not available due to the retirement of the security officer.

Fourth Quarter: On July 1, Russell Cullison began transitioning into the position of DRI Security Officer to replace Barbara Salmon, who is scheduled to retire on September 1. A formal file plan was established for the security administration office. Cabinets housing sensitive unclassified documents were fitted with security hardware. The organizational security clearance application process is under review with the intent of establishing more efficient procedures. All DRI security programs are being reviewed and overhauled as necessary to ensure that all requirements are being met. Planning is under way to administer unclassified security briefings to all personnel during October and November.

FY 1992 Budget Summary Containment Evaluation Panel

ENVIRONMENTAL COMPLIANCE PROGRAM

For many years, DOE's status as a government agency with a defense-related mission meant that it generally did not have to comply with many environmental regulations. However, recent legislation has largely eliminated those exemptions. DOE is now attempting to conduct its operations in compliance with applicable environmental laws and regulations.

In November 1988, DOE issued Order 5400.1 describing its general environmental protection program. That program was developed in response to numerous pieces of legislation, including the Resource Conservation Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Endangered Species Act. Many of the federal laws have led to additional state and local laws and regulations with which DOE must also comply. As a result of Order 5400.1, DOE/NV has been giving greater attention to problems of environmental protection and restoration resulting from operations at the NTS.

The DRI Environmental Compliance Program consists of various projects directed at providing DOE with information needed for compliance with environmental protection policies. Projects carried out under this program in the past include an assessment and hazard ranking of sites on the NTS subject to CERCLA regulations, an environmental assessment of a mixed waste management site in Area 5, and an evaluation of groundwater monitoring programs at nuclear test locations outside the NTS. The major effort in FY 1992 will be the Groundwater Characterization Project, an on-going program to study the hydrogeology of the NTS. Other projects will include an assessment of contamination at the tunnel ponds, groundwater studies at the NTS and other nuclear test sites, the development of methods for choosing the locations of monitoring wells, and other studies to aid compliance activities.

Groundwater Characterization Project

Charles Russell

Project Description

Groundwater is a potential pathway for transport of contaminants from the region near a shot cavity to surrounding geologic formations. Groundwater contaminated with radioactive and hazardous materials could eventually discharge at off-site locations or be intercepted by water supply wells, and thus become accessible to man and the environment.

The groundwater flow system of the NTS has been studied on a regional scale by various investigators. The scale of these previous studies gives only a broad picture of the NTS hydrology. Additional information on groundwater flow, hydrogeologic conditions, contaminant transport, and source term analysis is needed for detailed site characterizations, risk assessments, and remediation.

The Groundwater Characterization Project (GCP) is an attempt to characterize the hydrogeology of the underground nuclear test areas of the NTS. Current project plans call for about 100 wells to be drilled on the NTS over the next nine years. Several different kinds of data will be obtained from these wells:

- Subsurface stratigraphic, lithologic and structural data supplied by geologic cores, cuttings, and downhole geophysics
- Potentiometric head data supplied by depth-discrete pressure transducers
- Permeability, transmissivity, and estimates of storativity derived from hydraulic tests, tracer tests, and possible geophysical logs
- Groundwater flow paths and contaminant transit times derived from aqueous geochemistry, trace metals, stable and radioactive isotopes, and potentiometric and hydraulic parameters.

These data will be used to characterize the hydrology of the NTS, identify contaminant sources and potential transport pathways, and support the assessment of the risks to humans and the environment created by underground nuclear testing. They will also help to define the scope of the Remedial Investigation/ Feasibility Study of the NTS, to be conducted within the next few years by DOE and an environmental contractor.

DRI has an important role in the management of the GCP. One of its primary responsibilities is advising DOE and NTS contractors on various aspects of well drilling: where the wells should be drilled, what materials and techniques should be used, and what personnel will be needed. Assistance is also provided in obtaining the necessary field equipment and personnel. DRI also provides drilling engineers and hydrogeologists for each drilling operation and helps conduct the required hydrologic and chemical tests as the well is being drilled. Once the drilling program is under way, DRI will also help write a completion report for each well and manage and analyze the data collected by the program. Finally, DRI will work with the other contractors and DOE to refine the program objectives, as necessary.

Progress on Tasks

Task 1. Provide scientific and engineering support for drilling operations.

First Quarter: A break in activity at ER-12-1 extended from early November through December, so the only field activities conducted were in October, during which a development plan was revised and completion zones were chosen. In addition, DRI initiated and provided guidance for reworking existing wells on the NTS. Wells worked on during this period included 5A and UE19h.

Second Quarter: The break in drilling activities continued. Field activities at ER-12-1 consisted of running casing and gravel packing and cementing five completion zones. The large casing size and relatively small borehole size, presence of drilling mud and polymers in the borehole, lack of casing centralizers, and faulty NAIL logs created a situation where isolation was not achieved and two screened zones where cement was found in the gravel pack. Raytheon Services Nevada (RSN) is conducting an investigation into the cause.

In addition, DRI initiated and provided guidance for reworking existing wells on the NTS. Specific wells worked on during this period include PM-3, WW3, WW2, UE20e#1, U9its, UEU22, WW5a, UE11a, and UE19h.

Third Quarter: No drilling was conducted. Biological and archaeological surveys and site preparation activities were conducted on the future locations of ER-6-1, ER-20-1, ER-20-2, ER-19-1, and ER-6-2 in anticipation of drilling beginning next quarter. Site locations for the first 17 GCP wells were refined and finalized by the technical working group. The data collection activities to be conducted at ER-12-1 were finalized and submitted to DOE for approval.

Several existing wells were reworked. The wells and activities include deepening into the pre-Tertiary basement rocks and conducting aquifer tests at UE-1q, developing piezometer tubes at UE-4t, checking fluid levels at Test Well B, and preparing to drill and deepen UE-6e.

Fourth Quarter: Scientific and engineering support was provided for field activities at UE-1q, ER-6-1, ER-20-1, UE-4t, ER-12-1, and UE-19c. Meetings were attended, one on July 8 to discuss design of deep water level sampler, a second on July 22 to discuss photo-documentation of the Environmental Restoration Sites, and one on July 28 to review ER-20-1 drill plans. GCP working group meetings were attended on July 29 and September 30, Area 1 drilling meetings were attended bi-weekly and a technical working group meeting was attended in Denver on September 8 and 9. Documents reviewed or written include the USGS conceptual model for the NTS, predictive reports for ER-20-2, ER-6-2, and ER-19-1, and the ER-20-1 and ER-6-1 workplans.

Task 2. Prepare standard operating procedures for carrying out the Information Management Plan.

First Quarter: The plan was finalized and procedures were partially developed for storing, handling, and verifying data. The procedures for information management will be finalized next quarter along with all other standard operating procedures.

Second Quarter: The standard operating procedures for information management were finalized.

Third Quarter: The standard operating procedures and other documents prepared by DRI for the GCP were formally transmitted to IT Corporation on June 1.

Task 3. Collect and analyze data from each characterization well.

First Quarter: Geologic and geophysical data have been collected from ER-12-1. These are the only data collected so far. Both data sets were sent to DRI. An initial synthesis of the data was conducted by Lawrence Livermore National Laboratory (LLNL) geophysicists and RSN geologists.

Second Quarter: Geophysical data generated during the completion of ER-12-1 and from the reworked wells were collected and transmitted to DRI for archiving. Several water samples were collected for health and safety purposes from ER-12-1 and PM-3. The results show that water from these wells meets all State of Nevada guidelines.

Third Quarter: Samples were collected from UE-6e and UE-1q. Both wells meet Nevada Safe Drinking Water Act guidelines. A multiple-rate aquifer test was conducted at UE-1q and hydrologic tests were conducted at UE-4t to determine if the piezometers are in hydraulic communication. The results indicate that UE-1q has a large specific capacity and the piezometers at UE-1q do not seem to be hydraulically connected.

Fourth Quarter: Aquifer tests were conducted at UE-1q and geochemical samples were taken. Testing of the time domain reflectometry probes for detecting the water level was initiated at ER-6-1 and continued at ER-20-1. Water levels were measured at UE-4t. A multi-rate aquifer test was conducted at ER-6-1 and static water levels were determined. Well development was conducted at ER-12-1, and drill stem tests were initiated at ER-12-1. A radon sample was collected at UE-19c to replace a sample which was lost at the laboratory.

Task 4. Verify the data collected in Task 3 using established quality assurance procedures, and create and maintain a project database.

First Quarter: The data were collected according to LLNL and RSN protocols and quality assurance procedures. Field monitoring of the collection activities revealed few or no problems. Details of the monitoring activities are contained in the ER-12-1 Field Activity Logbook maintained by DRI.

Second Quarter: Geochemical data were collected according to DRI protocols and procedures. Geophysical data were collected according to DRI and RSN protocols and procedures. Field monitoring of the collection activities indicated few problems. Details of the data collection and monitoring activities are contained in the logbook maintained by DRI and the Standard Operating Procedures archived at DRI.

Third Quarter: Geochemical and hydrologic data were collected according to DRI protocols and procedures as in previous quarters.

Fourth Quarter: Geochemical and hydrologic data were collected according to DRI protocols and procedures as in previous quarters.

Task 5. Prepare well completion reports containing all data for individual boreholes and other reports as required.

First Quarter: Progress will not be made on this task until field data collection is completed during the second quarter.

Second Quarter: Progress will not be made on this task until field data collection is finished during the third quarter.

Third Quarter: Progress will not be made on this task, for the main GCP wells, until field data collection is completed. Data on the workover wells are transferred to IT Corporation as requested for inclusion into their well completion reports.

Fourth Quarter: Hydrologic data from the aquifer test at UE-1q were prepared and formally transmitted to IT Corporation. The geochemical data from this well and well UE-4t are in preparation.

Task 6. Refine the various conceptual models of groundwater flow systems on the NTS as data become available.

No progress was made on this task until the U.S. Geological Survey (USGS) revised conceptual model became available.

Fourth Quarter: The USGS conceptual model was reviewed. Once revisions are incorporated, the model will be used as a baseline for further refinement.

Status of Deliverables

1. Sample and analysis plan (3/31/92).	Completed
2. Information management plan (3/31/92).
Publication #45092, "Information Management Plan for the Nevada Test Site Groundwater Characterization Project,"
was published in December 1991.	Completed

3. Groundwater characterization work plan (6/30/92).

Completed

The plan was informally transmitted to IT Corporation on July 25.

Problems Encountered

Second Quarter: Problems were encountered during the casing, stemming, and cementing of well ER-12-1.

FY 1992 Budget Summary Groundwater Characterization

Archaeological Support for the Groundwater Characterization Project

Lonnie C. Pippin, Colleen M. Beck

Project Description

The Groundwater Characterization Project is a 10-year program to try to characterize the hydrogeology of the NTS. The current plan is for about 100 wells to be drilled for this project. As with other land-disturbing projects on the NTS, drilling activities at each well site will have to be preceded by cultural resources surveys and possibly data recovery projects. Details of this pre-activity work are given in the BECAMP Archaeology section.

Progress on Tasks

Task 1. Conduct and document on-call cultural resources surveys, limited site testing, and data recovery projects, as needed.

First Quarter: The road to well ER-20-2 will affect Long-Range Study Plan Sample Unit U19ao. Over two months of field work was conducted at this sample unit with 32 test pits remaining to be excavated. At least one rock shelter will require full-scale excavations. In addition, a cultural resources survey was completed for the entire area of impact. A rock feature near the well pad location will have to be avoided by the road construction.

Second Quarter: Surveys were conducted for two well locations near Yucca Flat, Ue10j and ER-6-1. One archaeological site was found at each location. The site at ER-6-1 had to be tested to determine its potential for eligibility to the National Register of Historic Places, but no subsurface cultural materials were present. No significant cultural resources were identified during these surveys. Also, a field trip was conducted to meet with the surveyors to determine the correct alignment of the road to ER-20-2. A draft data recovery plan for the rock shelter at Sample Unit U19ao was completed and will be submitted to DOE/NV in early May. Laboratory analysis of the artifacts from this sample unit is in progress.

Third Quarter: A survey was conducted for one well location north of Buckboard Mesa Road, ER-18-1. An extension of a previously recorded site, 26NY4892, encompasses the entire project area (pad and road). This site is considered eligible to the National Register of Historic Places. After consultation with the Nevada Division of Historic Preservation and Archeology, a data recovery plan may have to be prepared for this site. A data recovery plan for the rock shelter at Sample Unit U19ao was completed and submitted to DOE/NV. Laboratory analysis of the artifacts from this sample unit is in progress.

Fourth Quarter: Five surveys were conducted at well locations and associated access roads and borrow pits: ER-6-2 (one significant historic site), ER-19-1 (six significant sites), the realignment of the road to ER-19-1 (no significant sites), ER-EC-1

(no significant sites), and ER-EC-2 (no significant sites). The historic site at ER-6-2 is the only EMP tower remaining from the days of above-ground testing. It will be roped off and avoided by the construction. The realignment of the road into ER-19-1 avoided the significant sites that were outside the Long-Range Study Plan area. Surveys of Long-Range Study Plan Sample Units 19-22 and 12-20 and testing of the sites in these units were completed. The laboratory inventory and analysis of the artifacts was finished, and the short reports and data recovery plans for these projects were prepared and submitted to DOE/NV. The data recovery plan for the rock shelter at Sample Unit U19ao (associated with ER-20-2) was reviewed and accepted by the Nevada Division of Historic Preservation and Archeology. Work continued on Sample Unit U19ao and the field crew completed 60 percent of the excavation at the rock shelter. The inventory and analysis the artifacts from this unit will continue for several months.

Task 2. Provide curatorial and other record-keeping services.

First Quarter: All data records were updated to include the archaeological work conducted during the quarter. In addition, all the artifacts recovered from Sample Unit U19ao were sent to Reno and are awaiting laboratory analysis.

Second Quarter: The databases were updated to include the two surveys and the information on the two sites recorded. No artifacts were collected during these two projects.

Third Quarter: The databases were updated to include the survey of ER-18-1 and the additional site information obtained during the field work.

Fourth Quarter: The databases were updated to include the 11 new sites, the revision of 1 previously recorded site, and the 6 isolates recorded during the five surveys.

Reports Completed

1. SR032092-1: "A Class III Cultural Resources Reconnaissance of the Proposed Groundwater Characterization Project Well ER 6-1 and Access Road, Yucca Flat, Area 6, Nevada Test Site, Nye County, Nevada."
2. SR072292-1: "A Class III Cultural Resources Reconnaissance of Sample Unit 12-20, Kawich Valley, Nevada Test Site, Nye County, Nevada."
3. SR072892-1: "A Class III Cultural Resources Reconnaissance of Sample Unit 19-22, Kawich Valley, Nevada Test Site, Nye County, Nevada."
4. SR080692-1: "A Class III Cultural Resources Reconnaissance of the Well Pad, Borrow Pit, and Access Road for Ground Water Characterization Well ER-EC-2, Oasis Valley, Range 71, Nellis Air Force Base, Nye County, Nevada."

5. Data Recovery Plan for Site 26NY3621, Sample Unit U19ao, Pahute Mesa, Nevada Test Site.
6. Data Recovery Plan for Site 26NY3621, Sample Unit U19ao, Pahute Mesa, Nevada Test Site.
7. Data Recovery Plan for Site 26NY1441, Sample Unit 19-22, Kawich Valley, Nevada Test Site.
8. Data Recovery Plan for Sites 26NY8083, 26NY8084, and 26NY8085, Sample Unit 12-20, Kawich Valley, Nevada Test Site.

Problems Encountered

First Quarter: Field work on the sample unit ceased due to weather conditions and will not resume until late spring. The archaeological materials in this unit are very dense and will require additional field work and months of laboratory analysis.

**FY 1992 Budget Summary
Groundwater Characterization Archaeology**

Tunnel Ponds Assessment Project

Charles Russell

Project Description

Rainier Mesa is one of the primary locations where weapons effects tests are conducted. Most devices tested within Rainier Mesa are detonated in tunnels mined in zeolitized tuff, relatively impermeable rock that acts as a perching unit for water moving down through the mesa to the underlying regional groundwater table. Groundwater traveling along faults from the surface accumulates within fractures in the rock. As tunnels are mined into the mesa, these fractures may be intercepted, creating groundwater discharge. The water is drained from the tunnel to ponds or to the wash at the base of the muckpile at the tunnel portal.

Following an underground nuclear detonation, water near the shot cavity may come into contact with radionuclides. Tritium, which is highly mobile, is the dominant radionuclide in the water. Tritiated water has been consistently found in samples taken from U12e, U12n, and U12t tunnel ponds. In addition, mining and related activities are being conducted in U12n tunnel and have been conducted at all of the other tunnel systems in the past. These activities can release heavy metals and volatile, semivolatile, and nonvolatile organics, as well as radionuclides, to the tunnel effluent.

Before any remediation of potential hazardous substances in the tunnel effluent is attempted, the effluent parameters must be characterized to determine the extent of the problem and to help design an effluent treatment system. The parameters of interest include discharge rates, turbidity, general chemistry, and the nature, concentration, and temporal variability of any dissolved or suspended contaminants. Most previous samples taken from the tunnel ponds were analyzed primarily for radionuclides. Only one set of samples, collected from the tunnel ponds and effluent lines in August 1987, was analyzed for heavy metals and semivolatile and volatile organics.

One purpose of the Tunnel Ponds Assessment Project is to monitor the rate of discharge, pH, temperature, specific conductivity, turbidity, aqueous chemistry, radioisotopes, heavy metals, and organic compounds at U12n, U12e, and U12t tunnel effluent lines. These tunnels are the only ones with permanent discharges. Effluent monitoring stations were installed at these tunnels in FY 1991 and are now in operation. They will collect data for one year to characterize the flow and identify possible hazardous constituents in the effluent.

The sampling regimes will be varied to determine how much temporal variability exists within the parameters of interest. The sampling regime at U12e tunnel will be designed to identify background concentrations from a tunnel that has been abandoned for over 10 years. The sampling regime at U12t tunnel will be designed to identify background concentrations from a tunnel that has been recently deactivated. The sampling regime at U12n tunnel will be designed to identify hazardous constituents in the effluent that are generated specifically during periods of mining, underground testing, and limited activity.

The results of this study will supply a comprehensive set of data upon which a monitoring program or other remedial strategy can be built. Once the characterization phase is complete and the

results have been reported, it is anticipated that some data and sample collection will continue so the success of remediation attempts can be monitored.

In FY 1991, work on this project included the preliminary design of a sampling grid for the tunnel muckpiles. However, that task has been assigned to another contractor by the Defense Nuclear Agency, and no work by DRI on assessing contamination in the muckpiles is planned for FY 1992.

Progress on Tasks

Task 1. Collect samples and data from the U12e, U12n, and U12t tunnel effluent monitoring systems.

First Quarter: Monitoring of pH, electrical conductivity, discharge, temperature, and turbidity to establish baseline conditions continued, as did environmental sampling. The samples were analyzed for volatile organics, acid and base/neutral semivolatile organics, polychlorinated biphenyls, metals, and anions.

Second Quarter: Monitoring of pH, electrical conductivity, discharge, temperature and turbidity continued. Environmental sampling also continued.

Third Quarter: The monitoring and environmental sampling was completed. Additional monitoring and sampling is being conducted in support of efforts to acquire a permanent discharge permit for U12n tunnel.

Fourth Quarter: An additional 22 monitoring and sampling events were conducted in support of the discharge permit for U12n tunnel.

Task 2. Compile and analyze the data from Task 1 to characterize the tunnel effluents.

First and Second Quarters: Previously collected data were compiled, checked as specified in the quality assurance plan, and analyzed. The results are to be released during the fourth quarter.

Third Quarter: Data collected this quarter will be compiled, checked for quality assurance, and analyzed during the fourth quarter. The results are to be released at that time.

Fourth Quarter: Data for the project were compiled and analyzed. The results are being formulated into a review draft. The report is delayed owing to the time consumed on the project for collecting the 22 samples in support of the discharge permit.

Status of Deliverables

1. Report on characterization of tunnel effluents (9/30/92). Delayed

Problems Encountered

Second Quarter: Design changes to the effluent discharge system in U12t tunnel in December have decreased the flow by an estimated 80 to 90 percent. The reduced flow

necessitated a design change in the flume. Replacement of the flume has been delayed pending authorization by the Defense Nuclear Agency. Turbidity meters at both U12n and U12t tunnels malfunctioned due to high humidity and low temperatures during winter. Both meters are being repaired. Approximately three months of discharge data from U12t tunnel and two months of turbidity data from U12t and U12n tunnels were lost as the result of these problems.

Third Quarter: The flume at U12t tunnel was replaced with a smaller flume and the turbidity meters at U12n and U12t tunnels were replaced in April. Discharge and turbidity data collection from U12t tunnel and turbidity data collection from U12n tunnel have resumed. Environmental sampling and monitoring have continued beyond the 6/18/92 completion date at the request of D. Elle (DOE) and W. Griffith (Defense Nuclear Agency). The purpose of the continued data collection is to satisfy requirements specified by the State of Nevada temporary discharge permit for U12n tunnel.

Fourth Quarter: The time required to collect the additional 22 samples required to support the temporary discharge permit for U12n tunnel has delayed the deliverable. It is anticipated that the report will be submitted by the first part of December.

FY 1992 Budget Summary Tunnel Ponds

Off-Site Hydrologic Evaluation

Jenny Chapman

Project Description

The eight underground nuclear test sites distant from the NTS (Shoal and Faultless in Nevada, Tatum Dome in Mississippi, Amchitka Island in Alaska, Gasbuggy and Gnome in New Mexico, and Rulison and Rio Blanco in Colorado) are being considered by DOE as inactive hazardous waste sites under CERCLA. DRI performed initial evaluations of these sites and submitted a Preliminary Assessment report in FY 1989. In FY 1990, DRI prepared a report (DOE/NV/10845-07) evaluating the groundwater monitoring programs at the sites. In FY 1991, DRI began a study of the Shoal site in an effort to determine gross groundwater flow directions from the cavity.

In FY 1992, DRI expects to participate in three different activities pertaining to the off-site areas: continued hydrologic investigations at the Shoal site, an investigation of the status of chimney infilling with groundwater at the Faultless site, and remedial investigations and feasibility studies at the other sites.

Shoal: Fundamental uncertainties remain about the groundwater flow system at Shoal. In particular, the position of the groundwater divide relative to the Shoal site is unknown. Hydraulic investigations suggested that groundwater moves east to Fairview Valley, while geochemical data suggested that flow was to the west and Fourmile Flat. Hydrochemical sampling in FY 1991 was directed at characterizing the groundwater in both valleys in hopes of identifying a preferred flow direction.

During the sampling, problems were noted at some locations. In one important location, Well H-3, the pump was above the water level in the hole, so that sampling was impossible. There is some question as to the status of the water level in the hole, as DRI was unable to sound it with a water-level meter. However, EPA recorded a level of 328 feet below land surface earlier in the year and the DRI tape may have been caught on the pump assembly. This year, the pump could be removed and either discarded (leaving the hole open for grab sampling) or replaced.

Other wells in the area also need some attention, as the power sources for two wells (Spring Windmill and Hunt's Station) have been removed, and another (HS-1) was locked. These wells need to be revisited for sampling with a generator and the key to HS-1, if it can be found. Well H-2 should also be sampled, and will require the DRI downhole sampling/logging truck from the NTS. As before, the goal is not only to improve the current monitoring program, but also to lay the groundwork for future activities.

Faultless: Hydrologic issues at Faultless relate to the interaction of the cavity with the regional hydrologic system and the magnitude and direction of vertical flow. The water infilling of the Faultless chimney was unusual, with a perched water table developing in the cavity between 1968 and 1974. At the end of 1974, the water level began to rise and by 1983 had reached the top of the rubble chimney. Initial estimates of great lengths of time to pre-shot conditions were revised: the new estimate was that water would reach its pre-event level between 1993 and 2018. Once that level is reached, the possibility of lateral transport of contaminants is greatly increased.

The Faultless chimney has not been monitored since 1983. It has been proposed that several organizations conduct another field excursion to the Faultless site in FY 1992 similar to the one made in 1983. During the trip, the water level in reentry hole UC-1-P-2SR will be measured, temperature logging should be performed, and samples will be collected for radiologic analysis. It is assumed that EPA and USGS field sampling vehicles would be available to support the effort, as they were in 1983. Water level measurements and sampling may also be performed in wells HTH-1 and HTH-2, located within a mile of the event.

General Off-Site Scientific Support: Though investigations at Tatum Dome and Gnome are directed by other organizations, DRI expects to provide scientific support for those activities, potentially including review of pertinent documents and plans, aid in selecting well locations, and some analysis of test results. Despite the relatively small number of man-hours devoted, DRI believes it can make significant contributions to understanding the groundwater transport of radionuclides at these off-site areas.

Progress on Tasks

Task 1. Plan and conduct continued field activities at the Shoal site.

First Quarter: At Well H-2, fluid samples were collected and downhole logs of temperature and specific conductance were obtained. Three other wells which were thought to be defunct (Well H-1, Hunt's Station, and Spring Windmill) were found to be available for sampling. The ranchers who own these wells run their cattle in the area only during the winter, and remove the power sources from the wells in the summer. Discussions are under way with DOE/NV and EPA and the owner of Well H-3 regarding rehabilitating that well. Current plans are to pull the pump and evaluate both the pump and downhole conditions during the second quarter.

Second Quarter: At DOE's request, DRI began refurbishing Well H-3, west of the Shoal site. After the existing pump and associated equipment were removed by a drilling contractor, DRI determined the depth of the hole and depth to water. On the basis of this information, an action plan was developed that includes cleaning sediment out of the well, installing a new pump 100 ft below the static water level, installing an access tube in case the pump ever fails, and securing the well with a locked housing. Sampling was also performed at well HS-1, which could not be sampled previously because of its seasonal use.

Third Quarter: Plans for rehabilitation work at H-3 continued, with purchase orders for materials being submitted and approved.

Fourth Quarter: Additional funding was received for this task, and well rehabilitation work was done during the week of August 24. Well H-3 was cleaned out and a new pump installed. The well was pumped and samples collected. A portable pump was installed in H-2 and a sample was collected from that well. In addition, the

generator at the Wightman Well was turned on and a pumped sample collected from it (the sample collected last year had been stored in an adjacent tank and there was concern that it may not have been representative of formation water). A report on the field work was prepared.

Task 2. Help plan and conduct a field investigation of the status of Faultless chimney infilling.

First Quarter: No work was done on this task.

Second Quarter: A letter from D. Duncan (DOE) was received indicating that the Faultless reentry hole, UC-1-P-2SR, should be sampled in FY 1992. Apparently LLNL is taking a lead role in this activity. DRI has informally received a copy of the LLNL work plan and is currently reviewing it. In addition to the proposed LLNL work, there would be value in logging two downgradient wells, HTH-1 and HTH-2, with the DRI borehole flowmeter. This work will be scheduled once the flowmeter has been validated and work using it on the NTS has been completed.

Third Quarter: Comments on the LLNL sampling plan were sent to LLNL on April 21. This resulted in a joint sampling plan being prepared by LLNL and DRI. Logging and sampling at Faultless are scheduled to occur during the week of July 27.

Fourth Quarter: The logging and sampling trip to Faultless occurred on schedule. Samples were collected from eight horizons in HTH-1 (opposite screened intervals) and two intervals in HTH-2 and were analyzed for major ions, with analyses for enriched tritium and stable isotopes pending. Problems occurred with the logging in the form of noise on the temperature log. It was suspected that the problem was in the slip rings, and the logging vehicle went back to Reno for repair. It returned to Faultless in August and logging was performed at HTH-1, HTH-2, and UC-1P-2SR. Based on the logging results, an additional water sample was collected from HTH-2. A report on the field work was prepared.

Task 3. Provide scientific support as required for off-site activities under the direction of other organizations.

First Quarter: No work was done on this task.

Second Quarter: A meeting was held at EPA on February 18 to discuss monitoring results from the Gasbuggy site. It is clear from the data that tritium contamination has reached an overlying sand aquifer sampled by a nearby monitoring well. This has prompted an intensive evaluation by DRI to determine reasonable scenarios by which this could have happened, so that plans for addressing the migration can be made.

The approach is similar to that being used for the risk assessment for radionuclide migration from Pahute Mesa: analyzing travel time by using the uncertainties in the input parameters to produce a distribution function so the probability of a

given travel time can be estimated. This approach is particularly suitable for the Gasbuggy case, where there is great uncertainty in the input parameters. It allows the reasonableness of several scenarios to be evaluated. The evaluation should be completed next quarter. A recommendation on Long-Term Hydrologic Monitoring Program (LTHMP) sampling at Gasbuggy this spring was sent to DOE on February 21.

Third Quarter: A draft letter report on tritium migration at the Gasbuggy site was sent to DOE on May 29. The report develops several scenarios that could explain the observed transport of tritium at the site, and presents a travel time analysis for transport in the Ojo Alamo Aquifer. The recommendations include several ideas to maximize the information obtained from the one accessible well at the site, but additional values of hydraulic conductivity are needed from other wells to be able to predict transport. The report will remain in draft form until comments are received from DOE.

Fourth Quarter: Comments on the Gasbuggy report were received on September 15. Suggested changes were incorporated into the final report.

Status of Deliverables

1. Letter report on work done at the Shoal site (9/30/92).
The report is in review and should be finished in October.	Delayed
2. Letter report detailing DRI activities in the Faultless investigations (9/30/92).
The report, "Field Investigations at the Faultless Site, Central Nevada Test Area" by Chapman, Mihevc, and Lyles, was submitted on September 25.	Completed
3. Letter report on the Gasbuggy analysis (9/30/92).
The report, "Tritium Migration at the Gasbuggy Site: Analysis of the Hydrologic Pathway," by Chapman was distributed on September 21.	Completed

Problems Encountered

Second Quarter: The unexpected events at the Gasbuggy site have required more personnel time on Task 3 than was anticipated. It is not yet clear whether the project budget can absorb this extra work or whether the scope of other tasks will need to be reduced.

Third Quarter: The funds designated for this project at the beginning of the year have not all been delivered, a situation made critical by the extra work done on Gasbuggy. Once the purchase orders for the Shoal rehabilitation work have been filled, the project is essentially out of money. It may be possible to squeeze in the personnel time to do

the rehabilitation, but it will not be possible to make the major investment of personnel time and analytical costs associated with the Faultless sampling unless the withheld funds are released.

FY 1992 Budget Summary Off-site Hydrology

FY 1992 Budget Summary Shoal Hydrology

Development of Methods for Optimum Well Placement

Elizabeth A. Jacobson

Project Description

In December 1990, DRI helped coordinate a DOE/EPA Workshop on Methods for Siting Groundwater Monitoring Wells. The proceedings of that workshop will contain information that represents the current techniques for siting groundwater monitoring wells. Most presented techniques were based on site-specific or data-specific concerns. In addition, the development of methods for optimum siting of groundwater monitoring wells is just in the formative state, especially for sites where no contaminant plume has been observed and hydrologic data are sparse. This project involves the development of methods for optimum siting of wells and for evaluating the sites that consider all available geologic, hydrologic, groundwater chemistry, and isotopic data.

Classic "forward" groundwater flow models calculate hydraulic heads based on transmissivity, recharge rates, and boundary conditions. At many field sites, there are not enough measurements of aquifer parameters, and knowledge of recharge rates and boundary conditions is too limited, to model the groundwater flow system. The inverse method (also known as parameter estimation) estimates aquifer characteristics based on hydraulic heads using a numerical model. Currently, inverse methods incorporate uncertainty in only hydraulic parameters. The proposed research will expand the inverse method to include uncertain boundary conditions, recharge, and the uncertainties based on geologic, chemical, and isotopic data. The integrated approach will involve developing statistical inverse methods and uncertainty analysis methods. The statistical inverse methods, together with an uncertainty analysis method, can be used to indicate the optimum location of wells to reduce uncertainty about the groundwater characterization or the plume interception.

The goal of the work is to develop methods for optimum siting of groundwater wells that will not only indicate the best location for regulatory purposes, but also minimize the number of wells needed. A well at the NTS can cost \$1 million or more, so optimum placement of wells to minimize the number may result in substantial cost savings. Another benefit expected from the research is the improved data collection due to maximizing the information obtained from better location of characterization wells.

This research and development work is expected to require approximately two years of effort with an additional year for testing and evaluation. In FY 1991, the current techniques were identified based on the proceedings of the workshop. A comparison of the proposed research to current techniques that appear to be similar was started and will be completed in FY 1992 and an informal report discussing the conclusions will be prepared. The identification and development of the inverse and uncertainty methods will start in FY 1992 and progress through FY 1993. The existing theories will be evaluated and expanded to include the new types of data. The development will involve identifying the most appropriate way to incorporate the information obtained from geologic, chemical, and isotopic data into a hydrologic framework that can be considered in an inverse approach. The integrated approach will allow synthesis of all measured data to develop an understanding and model of the site-specific groundwater flow with the associated hydrologic uncertainties. The information on the hydrologic uncertainties will then be used in an uncertainty

analysis method and the results will aid in the placement of wells. In addition, a part of this technique will be to evaluate whether the wells are optimally located.

Progress on Tasks

Task 1. Compare similar techniques to the proposed integrated approach to evaluate strengths and weaknesses.

First Quarter: The information on current techniques obtained from the Workshop on Methods for Siting Groundwater Monitoring Wells was reviewed for similarity to the proposed integrated technique.

Second Quarter: Various published approaches to network design have been collected and are being evaluated along with the approaches presented in the workshop. The letter report comparing similar methods to the proposed approach is in preparation. This report would have been an FY 1992 milestone under an Office of Technology Development project continuation but that project was not funded. Thus, the task was started in FY 1991 but is being completed under this project and the letter report deliverable was carried over from the FY 1991 work.

Third Quarter: The evaluation of the various published approaches is progressing slowly. Additional approaches are being included as they are located in the literature. A cut-off time is being considered and the letter report will be based on the approaches evaluated as of that time. The letter report will be completed next quarter.

Fourth Quarter: The letter report comparing similar methods to the proposed approach was further delayed because of the addition of new approaches identified in recent journals. These approaches are being included and the letter report will be available for internal review in early November and sent to DOE by the end of November.

Task 2. Start developing the theory of the integrated approach.

First Quarter: The principal investigator met with D. Duncan (DOE) in October to discuss the project, and gave a seminar to the well characterization group at DRI. A session on Optimization Methods for Porous Media Studies at the American Geophysical Union fall meeting included several relevant presentations. It was hoped that new information about how to include other types of data in parameter estimation methods would be obtained, but few investigators seem to be working on this specific topic.

Second Quarter: A graduate student in hydrology has been added to the project. It is hoped that his M.S. thesis will be developed under this project. A report on the USGS inverse code based on MODFLOW was obtained in March, and the code will be purchased in April. Pahute Mesa will be the first region to be modeled using the

integrated theory. All hydrologic data on this site have been compiled and evaluated. In addition, information is being collected concerning possible conceptual models for Pahute Mesa. One goal of the research is to apply the integrated theory to various conceptual models to find what data are most needed to evaluate each model. Preparations were started for designing a grid for the Pahute Mesa model, and the data will be added to the model next quarter for the preliminary inverse modeling of the area.

Third Quarter: The grid and collection of hydrogeologic data have been completed for the area to be modeled on Pahute Mesa. The parameter estimation method based on the development of Dr. Neumann of the University of Arizona is applied in the research inverse code that will be used for the first modeling of Pahute Mesa. This model has been modified for use on the Sun computer system at DRI. In addition, the USGS inverse code based on MODFLOW has been obtained and will be used for the next phase of the modeling. The preliminary inverse modeling will be conducted in July and August and the results presented in a progress report at the end of the fourth quarter. Additional funding for the fourth quarter was requested.

Fourth Quarter: Modifying the inverse program for use on the Sun computer required the acquisition of additional subroutines from a library package. However, it was discovered that the library package has been updated and changed, and these changes caused delays in completing the modification. The last change is being incorporated and once the inverse code is fully modified it will be tested and verified. The delay in completing the modification of the inverse code in September was caused by the need to start the progress report for this year's work.

The preliminary runs of the numerical model for Pahute Mesa will be conducted next quarter, given no further complications. In addition, the USGS inverse program MODFLOW is being loaded on the DRI computer and will be tested and verified next quarter.

A short progress report describing this year's activities will be completed for internal review before being sent to DOE in early November.

Status of Deliverables

1. Letter report comparing similar methods to the proposed approach (delayed from FY 1991) (3/31/92).
The report is in preparation.	Delayed
2. Progress report on the development of the theory of the integrated approach (9/30/92).
The report is in preparation.	Delayed

FY 1992 Budget Summary Well Placement

FY 1992 Budget Summary OTD Well Placement

Historical Hydrologic Data Compilation

Jenny Chapman

Project Description

The Hydrologic Database is a centralized repository for DRI's hydrologic and related data from the NTS. The database was first created in 1987. Through 1988, data from the chemical analysis of water samples from 1984–1987 and precipitation data from the NTS and surrounding areas were added. In FY 1990, a review of the database structure was begun because of major changes in the database management software. This review was completed in FY 1991 after several working sessions with researchers. The review included the definition of the tools that would be provided with the database to facilitate its use. The data from chemical analysis of water samples from 1988 through 1990 were also added in FY 1991.

Work in FY 1992 will include finalizing the structure of the database, developing the procedures for updating it, and continuing the addition of the most recent data. Documentation of the database system and the development of a user's manual will also continue.

Progress on Tasks

Task 1. Complete the Hydrologic Database and prepare database management procedures.

First and Second Quarters: Work on this project has been minimal because of the problems described below. Some time has been spent evaluating the impact of proposed database software changes on the DOE database and evaluating the best choice of software for the database's needs.

Third Quarter: Because the delay in obtaining new software was jeopardizing meeting project deliverables, work has proceeded using the old Unify database on a Sun in the Reno office. By restricting work to Standard Query Language (SQL) features rather than package-specific user screens, the results can be readily transported to a new system. Late in the quarter, it was decided to purchase the Ingres software as the new database system.

Fourth Quarter: All data sets were uploaded into the Unify database on the DRI/Reno computer. This required some data checking and reformatting to the SQL compliant forms. The USGS groundwater chemistry data set assembled for the Baseline Chemistry project was prepared for loading into the database, as was a regional chemistry data set for samples collected from the carbonate aquifer up- and down-gradient from the NTS. The Ingres Relational Database Software package has been installed on the DRI computer and personnel are familiarizing themselves with the procedures necessary for moving the Hydrologic Database into it.

Task 2. Prepare a user's manual and other documentation for the database.

First and Second Quarters: No work was done on this task.

Third Quarter: A user's manual is being prepared for the existing database, and it will simply be updated whenever the Ingres software is installed.

Fourth Quarter: The user's manual was completed and internally reviewed. It includes a listing of the data available in the database as well as a description of database management procedures.

Task 3. Develop procedures for adding historical data as funding permits.

No work was done on this task in FY 1992.

Status of Deliverables

1. User's manual for the Hydrologic Database
(delayed from FY 1991) (6/30/92).
The manual was sent to DOE on 9/9/92.	Completed
2. Letter report on data available in the database (9/30/92).
Information on available data was included in the user's manual.	Completed

Problems Encountered

Second Quarter: DRI recently upgraded its operating platform from a Sun 3 to a Sun 4. Unfortunately, upgrading Unify/Accell (the database software currently used for the Hydrologic Database) to make it compatible with the new system would cost about \$16,500, in addition to the several thousand dollars a year that DRI spends in its maintenance agreement. As this cost is comparable to that of purchasing a new database package, we are reevaluating our database needs. One inadequacy of Unify/Accell is that it cannot link directly to the Arc/Info geographic information system (GIS). This problem was not considered serious enough to revamp the entire database because data could be transferred, though somewhat awkwardly. Now that there are financial reasons as well, and given the increasing importance of GIS to DOE's data storage and retrieval, it seems prudent to consider changing the database software. A new database probably will not be chosen and installed until summer, so the project deliverables will no doubt be delayed. Work is continuing on aspects that are independent of the software, such as streamlining procedures for adding DOE chemistry data into the future database.

FY 1992 Budget Summary
Historical Data Compilation

Baseline Groundwater Chemistry

Jenny Chapman

Project Description

Contaminant transport through groundwater is a function of groundwater flow properties and physical and chemical characteristics of the water and contaminant. The last NTS-wide synthesis of groundwater chemistry and flow-system analysis was performed by Winograd and Thordarson in 1975 using data collected before 1970. Since that time, many more samples have been collected and analyzed, but as part of specific, focused projects that were not directed at transport issues for the NTS as a whole.

In FY 1991, the task of assembling water chemistry analyses performed by DRI on samples collected from the NTS between 1970 and 1990 was completed and the data were incorporated into the DOE Hydrologic Database. Comparison of the pre-1970 data with the newer data was begun and the preliminary results presented to DOE in a status report.

FY 1992 will see the completion of the comparison and interpretation of the hydrochemistry with regard to transport pathways and characteristics. This will include creating hydrochemical facies maps and possibly cross-sections. These maps will be compared with potentiometric contour maps, discrete-state compartment models, and other flow data to identify critical transport pathways. Interpreting the data in terms of flow paths and the chemical environment along flow paths will help determine what type and in what form various radionuclides may be transported and which pathways are most conducive to such transport.

The final report will present interpretations of flow paths and chemical environments based on the NTS hydrochemical database developed during FY 1991. The report will include an analysis of critical sources of uncertainty and recommendations as to how those sources can be minimized.

Progress on Tasks

Task 1. Complete the integration of the pre- and post-1970 chemistry data.

First Quarter: No work was done on this project because the principal investigator was on extended leave.

Second Quarter: No work was done on this project because the principal investigator was on extended leave for the first part of the quarter. Work will begin in the third quarter.

Third Quarter: Pre-1970 analyses of groundwater from NTS wells have been entered into a data file for comparison with the 1989-1992 data. Piper plots comparing analyses for wells with pre- and post-1970 analyses have been prepared. Of the 18 wells with both sets of analyses, about 10 have the same ionic percentages in both sets of data. The remainder are being analyzed to determine the cause of the differences. The data files have been imported to Arc/Info in preparation for additional spatial analysis.

Fourth Quarter: The pre- and post-1970 data sets were combined and average values for the constituents calculated for mapping. The average values were then divided into three groups depending on the formation the sample was collected from. Maps showing the areal distribution of dissolved ions were prepared for each group (alluvium, volcanic, and carbonate) using Arc/Info. Work proceeded on interpreting the data presented in the maps and graphs. Even within the discrete aquifer groups, there are no clear trends in ion concentrations along flow paths defined by hydraulic data, suggesting that these units do not behave as homogeneous aquifers but instead must contain multiple discrete flow units.

Status of Deliverables

1. Final report comparing and interpreting the pre- and post-1970 data (delayed from FY 1991) (9/30/92).
The report will be completed in FY 1993.

Delayed

FY 1992 Budget Summary Baseline Chemistry

HYDROLOGY/RADIONUCLIDE MIGRATION PROGRAM

The objectives of the Hydrology/Radionuclide Migration Program (HRMP) are modified from those of previous years because of environmental compliance activities, including a large drilling program to assess groundwater and radionuclide movement. As a result, the HRMP is now focused on specific needs related to the ongoing and future activities of the weapons program, rather than past activities that may have impacted NTS groundwater. These specific areas are long-range hydrologic studies, site-specific and post-test studies, history of the HRMP, and miscellaneous studies to help solve the NTS operations problems.

HRMP Support

Roger L. Jacobson

Project Description

The primary purpose of the HRMP Support project is to carry out the many different activities of the HRMP that are not directly related to the individual research projects in the program. Such activities include attending program planning, review, and coordination meetings; writing, editing, and reviewing project reports, work plans, proposals, and other documents; providing radiation safety training; and processing security badge requests, conducting security briefings, and preparing security plans and regulations. These and other general administrative, programmatic, field, and laboratory support activities will be performed as needed throughout FY 1992.

Two additional tasks will be performed as part of this project in FY 1992. One is to assist DOE in producing a new groundwater fact sheet that reflects hydrologic information obtained since the fact sheet was last updated. The other is to complete the elementary risk assessment started in FY 1991. In this assessment, the activities of radionuclides in groundwater at off-site communities are being predicted relative to detection limits and maximum permissible concentrations. The evaluation is being done under a worst case scenario, with radionuclides migrating to the accessible environment at the rate of movement of the groundwater.

Progress on Tasks

Task 1. Attend planning, review, and coordination meetings, and provide other support to the HRMP projects.

First Quarter: Numerous planning and review meetings were attended, including the quarterly HRMP meeting on December 18. Work on refining the FY 1992 scope of work and budget continued. Editorial work, including review, derivative classification, and submission of reports, also continued. A summary of the status of all technical and letter reports will be submitted periodically to D. Duncan (DOE).

Second Quarter: Numerous planning and review meetings were attended, including the quarterly HRMP meeting on March 9. Work on refining the FY 1992 scope of work and budget continued. Editorial work also continued.

Third Quarter: Numerous planning and review meetings were attended, including the quarterly HRMP meeting. Work on refining the FY 1992 scope of work and budget continued. Editorial work also continued.

Fourth Quarter: Several planning and review meetings were attended, including one in Albuquerque in July and one in Denver in August to discuss future work at Devil's Hole. Planning for FY 1993 activities began, and editorial work continued.

Task 2. Prepare a new groundwater fact sheet.

First Quarter: The existing fact sheet has been entered into the DRI computer system and additions and deletions are being made. The process is only about 25 percent complete because numbers and references must be carefully checked.

Second Quarter: The fact sheet, entitled "Radionuclide migration in groundwater at the NTS," will be sent to DOE early next quarter.

Third Quarter: A draft of the fact sheet was completed and sent to DOE.

Task 3. Complete the groundwater risk assessment for communities around the NTS.

First Quarter: Three working sessions were held jointly with LLNL in which calculations were made comparing the risks associated with all credible hydrologic flow paths. In addition, the uncertainty in radionuclide activity in time and space was assessed and the associated risk calculated. A first draft should be completed next quarter.

Second Quarter: A travel-time distribution approach has been developed to assess the risk associated with potential migration of radionuclides at the NTS. A first draft of a report has been completed. A paper entitled "Risk Assessment Analysis Using Travel Time Distribution Approach for Radionuclide Migration" has been reviewed and will be submitted to a professional journal early next quarter.

Third Quarter: The paper is still being reviewed at LLNL.

Fourth Quarter: The draft was returned from LLNL with comments. An abstract of the results was submitted to the American Geophysical Union for presentation at the December meeting. A draft journal article will be submitted in FY 1993.

Status of Deliverables

1. Draft of the groundwater fact sheet (9/30/92).	Completed
2. Draft report on the groundwater risk assessment (9/30/92).	Completed

Several other reports from previous HRMP projects were also completed in FY 1992:

"Studies of Infiltration and Lead-Soil Interactions at the Radioactive Waste Management Site in Area 5 of the Nevada Test Site," by C. Case et al. (revised by R. McArthur), Desert Research Institute Publication #45054.

"Characterization of Colloids Found in Various Groundwater Environments in Central and Southern Nevada," by L. Kingston and M. Whitbeck, Desert Research Institute Publication #45083, DOE/NV/10384-36.

"Hydrogeologic Characterization of Wells HTH-1, UE18r, UE63, and HTH-3, Nevada Test Site," B. Lyles, W.A. McKay, J. Chapman, S. Tyler, Desert Research Institute Publication #45087, DOE/NV/10845-08.

"Yucca Flat Hydrology, FY 1990," by T. Mihevc (letter report).

"Data Report: Nevada Test Site Well Sampling Program," by T. Morris and L. Huckins (letter report).

"NTS Mesa Recharge Study - FY 1991," by B. Lyles and T. Mihevc (letter report).

"A Deuterium-Calibrated, Discrete-State Compartment Model of Regional Groundwater Flow, Nevada Test Site and Vicinity," by W. Sadler, M. Campana, R. Jacobson, and N. Ingraham, Desert Research Institute Publication #45088, DOE/NV/10845-09.

"Hydrology/Radionuclide Migration Program and Related Research Projects Progress Report - FY 1986," DOE/NV-354, by DRI, Los Alamos National Laboratory (LANL), LLNL and USGS.

FY 1992 Budget Summary HRMP Support

Operational Support

Brad Lyles, Michael Whitbeck, Steve Wheatcraft

Project Description

This project is designed primarily to support weapons testing activities. The support is to help with operational problems as well as to aid with regulatory compliance. Three separate studies are planned: further development of infrared (IR) spectroscopy as a method of measuring free and bound water in tuff (Whitbeck); review of the potential impact of nuclear tests on groundwater (Wheatcraft); and a continuation of the NTS well validation program (Lyles).

The first study relates to the need to determine the amount of water in the rock pore space versus water bound in the mineral structure. Using IR spectroscopy, it is possible to determine in a quantitative manner the amount of free and bound water. In FY 1991, a laboratory method was developed to determine the amount of free and bound water in zeolitized tuff samples. In FY 1992, more samples with varying water and mineral content will be examined to determine if the technique has any substantial limitations. Also, a prototype downhole IR instrument will be designed. To build and test this instrument on *in situ* rock will require extra funds and additional information.

The second study pertains to the groundwater protection policy and plan adopted by DOE/NV. The policy states that DOE will conduct its operations safely and with minimal impact on the environment. A key element is the Standard Operating Procedure for the protection of groundwater at nuclear test locations. As part of this procedure, DRI will evaluate information provided by the sponsoring laboratories to assess the potential impact to the groundwater from underground tests.

The well validation program was begun in FY 1990 to develop techniques to measure the hydrologic characteristics of wells on the NTS. Many NTS boreholes and wells have not been completely evaluated hydrologically, and are poorly characterized with regard to aquifers penetrated, vertical hydraulic gradients, and vertical variations in water quality. Some of these are part of the LTHMP, while others are related to the testing programs. In all cases, additional site investigation is necessary to properly interpret the hydrogeologic data from these wells. The ultimate goal is to gain a thorough understanding of the parameters needed to interpret the source and fate of potential hazardous and radioactive substances that may be detected in these wells in the future.

The long-term goal of this program is to validate the hydrogeologic completion of all open holes on and near the NTS over the next five years. Ten to twelve wells will be investigated in FY 1992 and recommendations will be made regarding their incorporation in the LTHMP or abandonment as appropriate. The following wells that are currently sampled by bailing for the LTHMP will be evaluated in FY 1992: UE1c, UE11, UE5n, UE10its#3, Pluto 1, Pluto 3, Pluto 5, UE16f, UE17a, UE18t, and PM1.

As before, a two-phase approach will be used. Phase I will consist of reviewing available data for each well and measuring basic parameters such as temperature, electrical conductivity, and composition of water samples from discrete depths. In Phase II, testing zones will be identified for thermal flow meter measurements and for detailed geochemical sampling. Finally,

recommendations will be made regarding the well's suitability for the LTHMP, which zones should be sampled, and how often the wells should be sampled.

Progress on Tasks

Task 1. Complete laboratory testing of tuff with an IR spectrometer (Whitbeck).

First Quarter: Data from laboratory experiments are being compiled, and a report should be completed during the next quarter.

Second Quarter: Data from laboratory experiments are currently being compiled, and a report should be completed by the fourth quarter.

Third Quarter: Data from laboratory experiments are currently being compiled, and a report should be completed by the fourth quarter.

Fourth Quarter: Data from laboratory experiments are currently being compiled, and a report will be completed by the first quarter of FY 1993.

Task 2. Design a field prototype IR instrument (Whitbeck).

First Quarter: Work on this task will begin in the second quarter.

Second Quarter: A preliminary design has been accomplished.

Third Quarter: No work was done on this task.

Fourth Quarter: No work was done on this task. More information is needed from vendors before this task can be completed.

Task 3. Evaluate the potential impact of underground tests on groundwater (Wheatcraft).

No work was done on this task in FY 1992 because no specific problems arose related to groundwater protection on the NTS.

Task 4. Complete the development of well-testing procedures and equipment (Lyles).

First Quarter: Much effort was spent developing a thermal flowmeter. Construction and testing of this logging tool was completed, and a calibration tank has been constructed. Calibration and field testing will be done next quarter.

Second Quarter: The thermal pulse flowmeter has been tested at wells HTH-1 and ER-12-1. Several minor modifications were made to the tool to improve its field durability. Field testing will continue next quarter and the flowmeter will be outfitted with an inflatable packer for use in wells with greater than 6-inch diameters.

Third Quarter: The flowmeter was modified in the laboratory and successfully tested in well ER-12-1. Plans were developed for a high-pressure pump housing and the

flowmeter was modified to accept a pump and packer. The pump and packer were bench tested. Field testing will continue next quarter and the flowmeter will be outfitted with an inflatable packer for use in wells with greater than 6-inch diameters.

Fourth Quarter: The flowmeter was tested again at the Faultless site. The high pressure pump housing failed and water flooded the electric motor compartment. The housing was modified and successfully bench-tested. It will be field-tested again during the first quarter of FY 1993. Machining of the hydro-chemical logging tool was completed by LANL. The tool will be assembled and tested during the first quarter of FY 1993. Currently, it is being configured to measure temperature, electrical conductivity, pH, dissolved oxygen, and bromide concentration.

Task 5. Continue the testing of wells on the NTS and make recommendations for each well regarding its suitability for the Long-Term Hydrologic Monitoring Program (Lyles).

First Quarter: Background data were reviewed for wells UE1c, UE5n, UE18t, and 5A. Data from these wells and wells ER-12-1, UE20bh, and UE19h will be evaluated during the second quarter. Preparation of a report on the FY 1991 well validation efforts continued, and the report should be finished next quarter.

Second Quarter: No wells were validated. Wells UE-12-1, UE20bh, and UE1q are scheduled for evaluation during April and May. A report on the FY 1991 well validation efforts will be completed during the third quarter.

Third Quarter: Well ER-12-1 was validated in April; scheduling conflicts prohibited the evaluation of wells UE20bh and UE1q as scheduled. Well UE1q and two wells at the Faultless site are scheduled for the fourth quarter. A report on the FY 1991 well validation efforts is now going to be combined with the results from FY 1992 and will be completed in the first quarter of FY 1993.

Fourth Quarter: Well UE1q was validated in April, three wells at the Faultless Site (HTH-1, HTH-2, and UC1) were validated in August, and well U7cd_satellite_1 was validated in September.

Status of Deliverables

1. Design of a field IR spectrometer (9/30/92).
The report is essentially complete, and should be turned in for typing in October 1992.	Delayed
2. Report on well validation findings from FY 1992 (9/30/92).
A combined report on the FY 1991 and FY 1992 findings will be completed in the first quarter of FY 1993.	Delayed

FY 1992 Budget Summary Operational Support

FY 1992 Budget Summary Well Validation

Site-Specific Studies

Tom Brikowski

Project Description

The purpose of this project is to investigate site-specific hydrology and post-test hydrologic response and radionuclide migration. Pre-test issues tend to focus on the occurrence of unexpected water levels and measurement of baseline hydrologic parameters, while post-test issues generally focus on the identification and evaluation of radionuclide migration away from shot points. Elevated water levels are a recurring problem at the NTS. In Yucca Flat, test-related increases in water levels are now a serious engineering problem. On Pahute Mesa, standing water is frequently encountered in emplacement holes well above the predicted water table. This water creates problems for drilling and testing, and provides a pathway for radionuclide migration.

This project will continue to focus much of its field effort on characterizing anomalous water levels on Pahute Mesa. Drilling methods for emplacement holes result in considerable injection of water into surrounding rocks, and the unexpected standing water in some holes may simply be drilling fluid returned from the formation. Unfortunately, there is virtually no difference in major ion chemistry between drilling fluids and naturally occurring formation waters at Pahute Mesa. Investigations of elevated water levels at Pahute Mesa in FY 1991 suggested that in many cases there is little groundwater flow past the emplacement hole, which is consistent with the hypothesis that the standing water represents a local, drilling-induced mound. An experiment which labeled drilling fluids in the bottom part of an emplacement hole suggested that if the standing water is drilling fluid, it is returning from much of the vertical extent of the formation. In other words, drilling fluids probably return from the formation over a considerable period of time, and water levels may reflect a complicated balance between vertical inflow and outflow of water in the emplacement hole. Chemical sampling suggests some contribution from the natural formation, either pre-drilling groundwater or salts dissolved from the formation by the drilling fluids.

In FY 1992, we hope to label the drilling fluids over the entire vertical extent of an emplacement hole on Pahute Mesa, and to measure the amount of water (estimated to be around one million gallons) injected into the formation during drilling. Chemical sampling and labeling of standing water in emplacement holes at Pahute Mesa will continue. In addition, a feasibility study will be made of proposed remediation strategies for elevated water levels (or, more accurately, pressures) in emplacement holes at Yucca Flat. This will include evaluation of current hypotheses of the origin of these elevated pressures and design of field experiments to better characterize the phenomenon and refine these hypotheses.

In previous years, theoretical studies have been made of the near-field hydrologic environment of below water-table tests. These have included algebraic solutions describing groundwater flow in collapse chimney-aquifer systems and providing first-order estimates of potential radionuclide transport in such systems. The solutions demonstrate that the maximum potential for transport occurs when a permeable collapse chimney connects two aquifers. In such a case, pre-test vertical hydraulic gradients can drive fluid through the chimney and flush dissolved radionuclides from the chimney into one of the aquifers. Numerical models that include the effect of weapon heat

demonstrate that thermal buoyancy can be equally important in driving flow through the chimney. If the pre-test hydraulic gradient is upward, the likelihood of groundwater flow and transport is increased since the thermal forces tend to almost double the total driving force for vertical flow. In FY 1992, more detailed three-dimensional modeling will be carried out, emphasizing the effect of permeability changes (fracturing) immediately outside the shot cavity. Estimated radionuclide transport will be determined for several HRMP sites using the algebraic solutions for transport. This technique may also be applied to select the most important sites for future groundwater monitoring.

Progress on Tasks

Task 1. Continue to evaluate elevated water levels in emplacement holes on Pahute Mesa.

First Quarter: Additional lithium bromide analyses were obtained for samples from the labeled drilling fluids experiment at U19bh. A report on this work is being prepared. Considerable effort was also devoted to planning hydrologic testing at the HRMP hole UE20bh. That testing was stopped due to lack of funding in November.

Second Quarter: Preliminary arrangements were made for a lithium bromide tracer experiment of the drilling fluids used in emplacement hole U19bj. Drilling at this site has already begun, but most of the hole can be drilled with labeled fluids if the proper equipment can be designed before drilling resumes. DRI is currently pursuing this task, although it may be shifted to another contractor if progress is not rapid.

Third Quarter: This task has been delayed until FY 1993 when the next Pahute Mesa emplacement hole is scheduled to be drilled. A brief evaluation was made of the suitability of U19bj, an emplacement hole spudded in January and scheduled for completion in May. The hole was begun before water labeling was possible, making the site unsuitable. As in other Pahute Mesa emplacement holes, drillers found it impossible to maintain the desired water level above the bit in the Timber Mountain tuffs (water could not be added quickly enough from a 6-inch water line). It is quite possible that massive injection during drilling in this formation leads to standing water in Pahute Mesa emplacement holes.

Fourth Quarter: A work order is being prepared for RSN to design and carry out a water-labeling scheme for the next emplacement hole. DRI is specifying the concentrations and measurements, with the basic design being done by RSN. There is some concern that high rates of fluid supply are required at some stages in drilling, making labeling with a constant concentration difficult. A report giving an overview of previous characterization efforts regarding "perched" water at Pahute Mesa is nearly completed.

Task 2. Review overpressure problems at Yucca Flat, develop possible remediation strategies, and design experiments to better determine the origin of the overpressures.

First Quarter: Preliminary reviews of the existing literature on the problem and analysis of the Faultless site as an analogous situation were begun.

Second Quarter: Final changes were made to a manuscript to be submitted to the *Journal of Hydrology* entitled "Flow Between Aquifers through Filled Cylindrical Conduits: Analytic Solutions and Application to Underground Nuclear Testing Sites." This manuscript describes analytic solutions for flow in collapse chimney-aquifer systems, and other similar geometries encountered in nature and man-disturbed environments. The derivations are somewhat modified from a paper presented at the 1991 Containment Symposium in Reno.

Third Quarter: Further research was performed into mathematical modeling approaches to the origin of Yucca Flat overpressure. A finite-difference model of the fluid pressure effects of radial compaction around underground tests is discussed in the literature and will be used in our calculations. Computation of the effects of seismically induced gravitational compaction can be made simply using the complete formulation for aquifer storativity.

Informal discussions were held regarding remediation strategies. Passive remediation approaches (i.e., drilling holes to lower pressure zones to allow water to "bleed" away from the emplacement hole) are feasible and have the advantage of needing no maintenance, but are expensive and the likelihood of success is unknown. Further exploration of this topic will be limited to active approaches, involving pumping of water from in and around the emplacement hole.

Fourth Quarter: The Faultless site was visited in July during HRMP sampling efforts. This site may provide an opportunity to test theories of the origin of overpressures at Yucca Flat. Two observation wells drilled into upper and lower aquifers show "permanent" rises in water level of 3-7 m. Elevated levels have remained constant for almost 20 years. Transient fluid pressure increases caused by compression of pore space are the usual explanation for overpressures related to testing, but cannot explain permanent pressure changes. If the water level changes at Faultless are truly permanent, then the cause must be changes in permeability that influence the regional flow system. Work proposed for FY 1993 will evaluate this theory, as well as gravitational and radial-compression theories for the origin of overpressures.

Preliminary discussions were held in Reno regarding overpressures encountered in emplacement hole U7cd. A chemical sampling program was proposed for immediate implementation, and various remediation strategies were discussed.

Task 3. Apply algebraic transport solutions at current HRMP sites to estimate potential radionuclide transport.

First Quarter: Analyses for the Bullion and Cheshire sites made in FY 1991 were refined.

Second Quarter: Additional development of a general analytic element computer program was made. This program is intended for use in simple regional modeling and

sensitivity analysis of saturated zone flow at the NTS. The program currently treats areal and line source-sinks in regional flow (representing areal recharge and boundary fluxes). Validation of the code against published analytic solutions was also carried out.

Third Quarter: Final versions of manuscripts describing the algebraic transport solutions were prepared and submitted to peer-reviewed journals. The manuscript "Flow Between Aquifers through Filled Cylindrical Conduits: Analytic Solution and Application to Underground Nuclear Testing Sites" was submitted to the *Journal of Hydrology* in March, and "Estimating Movement of Groundwater from a Pond or Large-Radius Conduit" was submitted to *Ground Water* in April. A report evaluating potential tritium plumes at the Bullion site, "Constraints on Potential Radionuclide Migration at the Bullion Site, Pahute Mesa," was submitted to DOE in May.

Fourth Quarter: Additional effort was put into modifying the analytic element computer program developed for this task. The program can be used in areal simulations to estimate flow rates or transmissivity distributions required to reproduce observed head distributions. In effect, it is a quick and simple inverse program, designed to investigate the system, not necessarily to produce detailed accurate simulations. The first application of this program will take place in FY 1993 in investigations of the permeability changes required to produce observed water level changes at the Faultless site.

Task 4. Continue numerical modeling of the near-field environment, including the effect of permeability changes outside the cavity.

First Quarter: Initial versions of a computer code were developed employing the analytic element method. The primary use of the code will be in subregional hydrologic flow models for the NTS, but it can be modified to treat vertical chimney flow. The code can be used to determine probable aquifer or chimney parameters given head values in the chimney and surrounding aquifers. The specific case to be treated in this way will be the Bilby site.

Second Quarter: The manuscript "Estimating Movement of Groundwater from a Pond or Large-Radius Conduit" was completed and submitted for DOE review. This paper discusses transport constraints for the case of a pond or large cylindrical conduit in an aquifer. The latter case applies to collapse chimneys that intersect multiple aquifers at the NTS. The solutions were presented in an NTS-specific form at the 6th Containment Symposium in September 1991. In the manuscript, they have been modified to a much more general form that is applicable in a wide variety of settings.

Third Quarter: Further development of the analytic element computer program took place. Modification of the three-dimensional compressible fluid flow code HST3D was

made to allow visualization of output on a Silicon Graphics Workstation. Solution information is now output in a generic format and translated by a separate program into a format readable by the commercial program Data Visualizer. HST3D has also been modified to run on a Cray computer, and preliminary evaluations of its utility on that machine are being made.

Fourth Quarter: Some further refinements of the HST3D computer program and its graphical output were made.

Status of Deliverables

1. Report describing the emplacement hole drilling fluid experiment and results, if a suitable site is found (9/30/92).
A suitable site was not found in FY 1992. Further work is planned for FY 1993.	Delayed
2. Report describing possible remediation strategies for Yucca Flat overpressures and the feasibility and design of future characterization experiments (9/30/92).
Relatively little progress was made on Task 2 in FY 1992, especially with regard to remediation strategies. Work is expected to continue in FY 1993.	Delayed
3. Report on first-order estimates of potential radionuclide transport at Pahute Mesa HRMP sites (9/30/92).
See the Containment Symposium paper "Estimation of Hydraulic Transport of Radionuclides from Below Water Table Tests Using Analytic Models" (10/91). Also, a manuscript entitled "Flow Between Aquifers through Filled Cylindrical Conduits: Analytic Solution and Application to Underground Nuclear Testing Sites" was submitted to the <i>Journal of Hydrology</i> .	Completed
4. Report on numerical modeling results (9/30/92).
The manuscript "Estimating Movement of Groundwater from a Pond or Large-Radius Conduit" was accepted for publication in <i>Ground Water</i> .	Completed

FY 1992 Budget Summary
Site-Specific Studies

Long-Range Hydrologic Studies

Richard H. French

Project Description

One of the important questions regarding the NTS groundwater flow system is: Where and under what conditions does groundwater recharge occur on the NTS? Previous studies have suggested that infiltration may occur along washes, through exposed bedrock, or through coarse fan deposits. In this study, recharge associated with wash environments and high elevation will be investigated.

Over the past several years, recharge in the high areas of Pahute and Rainier Mesas has been monitored. Four sites have been monitored on the mesas since FY 1989: Camp20 (at Area 20 Camp), North20 (at the north end of Area 20), Dead Horse (at Dead Horse Flat in Area 19), and Rainier (at the highest point of Rainier Mesa in Area 12). Basic meteorological data (precipitation, temperature, and relative humidity) are collected at each site along with soil temperature at various depths and relative soil moisture. Volumetric moisture content is also measured at the North20 and Dead Horse sites using time-domain reflectometers (TDRs).

Weighing bucket precipitation gauges have been installed at each of the mesa recharge stations for comparison to the heated precipitation gauges. The preliminary data suggest that the weighing bucket gauges must be modified to communicate with the Campbell data loggers. Weighing bucket precipitation gauges are more sensitive to small snowfall events than the heated gauges. Therefore, the weighing bucket gauges will continue to be compared at the Camp20 and Rainier sites, while the other mesa sites will be equipped with weighing bucket gauges for snowfall and unheated tipping bucket gauges for rainfall. Samples will be collected from both types of gauges and analyzed to determine isotope ratios. This may enable the cause and extent of the difference in the collection efficiency of the two gauges to be determined.

Progress on Tasks

Task 1. Collect data from the recharge monitoring stations.

First Quarter: The stations were checked to ensure that all equipment was operational for the winter snow season. The data logger at Dead Horse was replaced due to a dead output channel that limited the amount of TDR data being sent. Two new stations were installed in Fortymile Wash, one (Lower Fortymile) in Area 29 and one (Upper Fortymile) in Area 30. Both are equipped with sensors for precipitation, air temperature, and relative humidity. The Upper Fortymile station also has sensors for net solar radiation and wind speed and direction. Soil moisture sensors will be installed at both sites. Daily precipitation data for past years have been obtained and reduced for entry into the DOE-DRI precipitation database.

Second Quarter: Four recharge monitoring stations on Pahute Mesa were maintained and data were retrieved via phone modem. The Lower Fortymile site was visited and the data

were collected via lap-top computer. The Upper Fortymile site could not be visited. A recharge monitoring station was installed at Whiterock Spring. Due to ground disturbance and the movement of equipment into the vicinity of the recharge station at Camp 20, it has been determined that this station is no longer collecting representative data. Therefore, the station will be moved to complement the station at Dead Horse.

Third Quarter: The four recharge monitoring stations on Pahute Mesa were maintained and data were retrieved via phone modem. The Upper and Lower Fortymile sites were not visited. The Whiterock site data were retrieved via lap-top computer.

Fourth Quarter: One recharge monitoring station was installed: crater U3fd was instrumented with an anemometer and air temperature, relative humidity, net solar radiation, and non-heated precipitation sensors.

The Upper Fortymile site was outfitted with a TDR, multiplexer circuitry, and 11 TDR probes. Six probes were installed in a soil pit in the streambed, and five probes were installed in a soil pit in the bank.

Data collection was conducted via phone modem from the four sites on Pahute Mesa (North20, Camp20, Dead Horse, and Rainier) and via lap-top computer from the other four sites (Upper Fortymile, Lower Fortymile, Whiterock Spring, and Crater U3fd). Data from Whiterock Spring were incomplete due to disruption of equipment by wild horses; attempts are currently being made to correct this problem. Data collection problems were also encountered at Dead Horse Flat – it appears that this site was affected by a nearby lightning strike. The data logger was replaced in August and is currently functioning, but the TDR is not in service yet. The propane heated tipping bucket gauge at the North20 site was replaced with a solar electrically heated tipping bucket gauge.

Task 2. Compare snowfall amounts and isotopic ratios in the weighing bucket and tipping bucket precipitation gauges at the Camp20 and Rainier sites.

First Quarter: The equipment needed for this task was ordered last August, but has not yet arrived. Delivery is expected next quarter.

Second Quarter: The installation of the hardware in the weighing bucket gauges is not yet complete.

Third Quarter: No progress was reported on this task.

Fourth Quarter: The tipping bucket precipitation gauges at North20, Camp20, and Rainier sites have been modified for isotope sample collection; the Dead Horse gauge will not be modified until October, when the propane heated gauge will be replaced with a solar electrically heated tipping bucket gauge.

The weighing bucket gauges at Camp20 and Rainier Mesa have been modified so weight changes can be logged by the data logger. The weighing bucket gauge at Dead Horse Flat has been modified, but is not connected to the data logger yet. This gauge will be reconnected in October. There are currently no plans to modify the gauge at the North20 site.

Task 3. Evaluate the potential use of the hydrometeorologic and soil data from Pahute and Rainier Mesas to calibrate a groundwater recharge model.

First Quarter: No work was done on this task.

Second Quarter: An examination of the database has resulted in the North20 and Dead Horse recharge stations being selected to test the CREAMS model. Vegetation data for these stations are being collected.

No further work was done on this task in FY 1992 due to lack of funding.

Status of Deliverables

1. Letter report summarizing the FY 1992 data from the recharge stations (9/30/92). Delayed
This report will be completed during the first quarter of FY 1993.
2. Letter report comparing weighing bucket and tipping bucket precipitation gauges (6/30/92). Delayed
The report has been delayed until the third quarter of FY 1993 because the equipment was not received from the vendor in time to modify the gauges prior to the winter of FY 1992-93.
3. Letter report on recharge model results (9/30/92). Delayed
Work on this task should resume in FY 1993.

Problems Encountered

First Quarter: See Task 2 above. Also, the raw data records from selected National Weather Service precipitation gauges on the NTS are now available, but they can only be reviewed at DOE/NV. This essentially requires a Q clearance and will limit the amount of analysis that can be done.

Fourth Quarter: The Dead Horse Flat datalogger was zapped by lightning, causing the TDR to malfunction and data to be lost. The new solar electrically heated precipitation gauge was not installed at the Dead Horse Flat site due to scheduling limitations; modifications should be completed by October 1992. The Area 5 recharge monitoring station was not installed due to a hold-up

by the Reynolds Electrical and Engineering Co., Inc. (REEC) Waste Management Division. The installation should be completed by the first quarter of FY 1993, assuming there are no further delays.

FY 1992 Budget Summary Long-Range Hydrologic Studies

History of the HRMP

Marjory Jones

Project Description

The events leading up to the Cold War precipitated a debate between the civilian-administered Atomic Energy Commission and government heads over the development of a "super" weapon based on the thermonuclear or fusion principle. In December 1950, a decision was made to proceed with the development of a thermonuclear device and to establish a continental site for testing. Nevada was selected because of its sparse population and the remoteness of the proposed site, some 65 miles north of Las Vegas. So, testing began in Nevada and continued in the Pacific.

The first nuclear weapon tested in Nevada was dropped over the Nevada Proving Grounds (later to be called the Nevada Test Site) in January 1951. Aboveground tests continued for several years until, in 1957, the first underground test in Nevada took place. Atmospheric and underground testing continued until October 1958 when the United States announced a moratorium on testing. The Soviet Union also observed the moratorium for almost three years; they resumed testing and within two weeks the United States followed suit. In the coming years, there would be two treaties signed between the United States and the Soviet Union to further define the limits of nuclear testing, one to restrict tests from being conducted in the atmosphere, outer space, and underwater, and the other to limit nuclear yield to less than 150 kilotons.

By the mid-1960s, with the underground testing program now firmly established on the NTS, increased concern for health hazards arose from both the public and scientific community, eventually prompting the establishment of a program of environmental studies. With the advent of underground testing at the NTS in 1957, the transport of radionuclides by groundwater became a focus for a series of investigations. Today, groundwater studies continue as part of the HRMP, formerly known as the Ground Water Program and then the Radionuclide Migration Program. The DOE contracted this work to various agencies with the scientific expertise that would be required to fully understand the subsurface effects of the weapon testing program.

The History of the HRMP project will result in an archivable narrative history of the groundwater studies on the NTS, from the beginning to the present. It will document the events and people that led to the creation and continuation of the program, provide highlights of significant activities, and list significant research products of this work. To accomplish these objectives, an attempt will be made to locate and interview scientists, administrators, and other significant individuals who were involved with the program in the early days, and to search the literature, work plans, project reports, and other documentation for information.

Progress on Tasks

Task 1. Continue searching the literature, work plans, project reports, and other documents for information on early nuclear testing activities and associated groundwater and other studies conducted at the NTS.

First Quarter: Work largely focused on a list of about 500 NTS hydrology/radionuclide migration-related documents available at REECO's Coordination and

Information Center. Dr. Fenske reviewed the list and highlighted documents which should be read, especially those that would provide information on the early days of the NTS groundwater studies where there appears to be the least documentation. Copies of all the highlighted documents were obtained and reviewed. Selected information from the documents was then added to the draft text, which is currently in the form of an expanded outline. Another request for documents will be sent in January 1992.

Second Quarter: Review of HRMP-related documents continued. Five boxes of reports, books, and files stored at DRI's Southern Nevada Science Center were reviewed for pertinent information. A meeting was held with D. Duncan to discuss a variety of HRMP-related subjects. Ms. Jones also met with personnel of the DOE Office of External Affairs and some photographs of various NTS activities and events were examined for use in the report. A copy of the draft chronology of NTS radionuclide migration studies was given to Dr. Fenske for review.

Third Quarter: Review of HRMP-related documents continued. On June 4, Paul Fenske, Marjory Jones, Doug Duncan, and Fred Penrod met in Las Vegas to discuss progress made thus far, and to review the kinds of resources that might be available from which to acquire photographs and other useful information. Writing and compilation of the report began.

Fourth Quarter: Review of HRMP-related documents continued. The draft history is being written and compiled; photographs and illustrations are being selected.

Task 2. Conduct interviews to gain information on people and events important to the history of the groundwater studies program.

No interviews were conducted in FY 1992.

Status of Deliverables

1. Draft narrative history of the HRMP (9/30/92).
The history will be completed in FY 1993.

Delayed

FY 1992 Budget Summary HRMP History

Exchange of Tritium between Water and Vapor

Neil L. Ingraham

Project Description

This project is designed to develop a method to remove tritium from water without evaporation. The effects of isotopic exchange between liquid and water vapor will first be determined experimentally. The process is most easily studied when the water and overlying vapor have isotopic compositions in considerable disequilibrium. Determination of the fundamental factors of isotopic exchange will significantly advance the theory of isotopic fractionation, and will have direct application to studies of controlling water with elevated tritium levels on the NTS.

When water undergoes a change in phase, such as evaporation, the isotopes are separated according to fractionation factors. During this process, a small degree of isotopic re-equilibration occurs. Molecules of water in the atmosphere also enter the liquid water, which qualitatively explains the degree of isotopic enrichment that can be attained in bodies of evaporating water. However, this is not a *volume* flux, only an *isotopic* flux. It occurs in both directions, and is simply a molecular exchange between the atmosphere and the evaporating body. In a closed system of water and water vapor, the isotopes will redistribute themselves according to the fractionation factor, regardless of what phase initially had higher concentrations. Most waters, however, are generally in isotopic equilibrium with the overlying vapor.

Tritium is subjected to the process of isotopic exchange as well as other oxygen and hydrogen isotopes. The tritium concentrations of some of the water found on the NTS are in extreme isotopic disequilibrium with ambient vapor. Therefore, the isotopic compositions of the waters will be driven toward equilibrium with respect to tritium. Equilibrium with respect to tritium is attained when the water in the atmosphere has approximately 11 percent less tritium than the evaporating water.

The first phase of the experiment will be to determine the effect of volume and surface area on the rate of exchange; the second phase will be to determine how to augment exchange. The effect of volume and surface area on isotopic exchange will be explored by sealing two waters of different isotopic compositions in exchange chambers. Containers in one chamber will have different volumes with the same surface areas, another will have different surface areas and the same volumes, while another will have different volumes and different surface areas. The waters will be periodically sampled for stable isotopes since these require a minimal amount of water for analysis allowing more samples to be taken without affecting the amount of water remaining.

Each water will be an end member for both D/H ratios as well as tritium concentrations. One will be depleted in deuterium and enriched in tritium, while the other will be enriched in deuterium but depleted in tritium. The rather opposite values with respect to stable and radioactive isotopes will aid in studying the effects of isotopic exchange.

Progress on Tasks

Task 1. Design and construct several isotopic exchange chambers.

First Quarter: Experimental apparatus is being constructed to facilitate isotopic exchange to determine whether the process is fast enough to be useful. An experiment will be conducted soon using tunnel drainage water from the NTS.

Second Quarter: Several isotopic exchange chambers were designed and constructed to aid in determining the effect of surface area and volume on the isotopic exchange between liquid and vapor. Additional chambers are being designed to determine the effect of temperature on the isotopic exchange.

Third Quarter: This task has been completed.

Task 2. Conduct several concurrent laboratory experiments.

First Quarter: Two experiments were conducted to study isotopic exchange. In the first, Cambic Ditch water with over 300 nCi/l of tritium was reduced to 120 nCi/l in 76 days. Two other waters which initially had less than 32 pCi/l were increased to 61 nCi/l by the end of the experiment. This experiment was designed to quantify, not facilitate, exchange, so the results were encouraging. The second experiment was designed to determine the effects of volume and surface area on exchange. The results are not yet available.

Second Quarter: An apparatus was designed to determine how to facilitate isotopic exchange and to determine whether the process is rapid enough to be useful in reducing levels of tritium in waters found on the NTS. The first experiment was conducted using Well 8 water spiked with Cambic Ditch water. In this experiment, the water was exchanged with water vapor produced from sea water. The initial composition of the mixed water was 14 nCi/l and after 43 days of isotopic exchange, the tritium level of 30 l of water was reduced to below 8 nCi/l.

Third Quarter: This task has been completed.

Status of Deliverables

1. Letter report discussing results of the experiments (9/30/92). Delayed
The report is in DRI review.

Three additional publications have been produced from this research:

Ingraham, N.L., R.E. Criss, and T.P. Rose, 1991. The Effect of Kinetic Fractionation and Isotopic Exchange During the Evaporation of Water. *EOS* Vol. 72, No. 44.

Ingraham, N.L. and R.E. Criss, 1992. Effect of Surface Area, Volume (and Temperature) on the Isotopic Equilibration of Water. To be submitted to *JGR - Atmos.*

Ingraham, N.L. and R.E. Criss. 1992. The Effect of Volume and Surface Area on Isotopic Exchange Between Water and Vapor. Submitted to AGU 1992 annual fall meeting, San Francisco.

Problems Encountered

Second Quarter: DRI is not yet licensed to possess water with elevated tritium levels in the new office building. The permit for the old office building is not transferable. The experiment must thus be conducted using water below drinking water standards.

FY 1992 Budget Summary
Tritium Removal

FY 1992 Budget Summary
Tritium Exchange

Drilling and Testing Support
James J. Cullen

Project Description

Well UE20bh #1 will be constructed to monitor potential down-gradient migration of radionuclides from the site of a future underground nuclear detonation. DRI drilling engineers will supervise construction and testing of the well. The testing phase will include a series of geophysical logs and one aquifer test. Additional aquifer tests are planned to evaluate the hydraulic and transport characteristics of the formations penetrated by the well.

Progress on Tasks

Task 1. Supervise construction of the well (UE20bh #1).

First Quarter: Construction of the well was completed on October 3, 1991.

Task 2. Conduct hydraulic testing of the well.

First Quarter: A multiple-rate flow test (step-drawdown type) was conducted on November 18. In general, the test was successful. However, the well pump surged 40 minutes into the fifth step from material sloughing off the borewall, invalidating the data from this one step.

Task 3. Complete the well.

No work was done on this task in FY 1992.

Task 4. Purge and sample the well.

No work was done on this task in FY 1992.

Status of Deliverables

1. Well completion report (9/30/92).

Delayed

Sections of the text are in draft form, and some results of the geophysical logging and the multiple rate test are available. However, the report cannot be finished until the well is completed.

Problems Encountered

First Quarter: This well afforded the first opportunity to test the Centri-Lift vari-drive unit. Electrical problems with the unit delayed the start of the hydraulic testing. In addition, the vari-drive did not provide the advertised range of flow rates for a given pump. Project funding levels prohibited execution of a long-term aquifer test. The well remains open and unsampled at this time.

Third Quarter: No further work can be done on this project because all the money has been spent.

FY 1992 Budget Summary Drilling & Testing

OFFICE OF TECHNOLOGY DEVELOPMENT PROGRAMS

The Office of Technology Development (OTD) of DOE's Office of Environmental Restoration and Waste Management (ERWM) is responsible for the development of techniques, procedures and equipment to efficiently and effectively operate ERWM programs. Within this function is the responsibility for determining DOE's ERWM human resource requirements and developing and implementing programs for acquiring and maintaining a skilled work force.

The management and administration of the DRI OTD program initiatives and approved tasks will be conducted through Program Support. This will include monitoring of the Science and Technology Education Program programs started in FY 1991.

The projects for plutonium soil cleanup will address aspects of soil analysis and the development of a database prototype. The Soil Analysis and Sampling Protocols project encompasses the development of standardized soil analysis protocols, identification of methods and procedures to collect representative soil samples, and the presentation of a test protocol to evaluate equipment which will simultaneously minimize the amount of plutonium in the tailings and minimize the volume of the concentrate. The Archaeological Studies at Contaminated Sites project will develop methods to survey the cultural resources at sites to be cleaned up. The Plutonium Database and Plutonium Cleanup Decision Support projects will develop prototype databases and analyze previously collected data to estimate the amount of land surface requiring cleanup. In another project, a new method for estimating data curves and surfaces will be tested on problems of interest to DOE. The method, Robust Bicubic Surface Estimation, is believed to have significant advantages over kriging or spline estimation as a way to model environmental contamination. The Hyperspectral Remote Sensing project will investigate the feasibility of using high-resolution scanning of land surfaces to help identify hazardous waste materials.

Soil Analyses and Sampling Protocols

Forest L. Miller, Jr.

Project Description

The integrated demonstration of methods for removing heavy metals from soils has as a first step a project to prepare soil analysis and soil sampling protocols. The soils used to evaluate the candidate cleanup methods will come from different facilities: Fernald, Hanford, the Idaho National Engineering Laboratory, LANL, the NTS, and Rocky Flats. In order to compare the competing methods and to infer their cleanup ability on soils not included in the demonstration, it is necessary to characterize the soils to be used.

A task group of soil scientists familiar with the facilities has been formed and will develop soil characterization and soil sampling protocols. If consistent protocols and procedures are used, the soils from the facilities can be compared and the characterization data can be used as covariates in the comparisons between the competing cleanup methods. The data used to characterize the soils will also be useful in the study of the soil and cleanup method combinations which yield either unusually good or unusually bad results.

The procedures to be used to compare the competing cleanup methods will be specified before the trials begin. A quality assurance program will be designed for the episodic nature of sample submissions for analysis, as one cleanup device after another is brought to the NTS and samples are sent through it.

During FY 1992 the candidate cleanup methods will be tested at the NTS with soil from the NTS and other sites.

A three-acre plot in Area 11 on the NTS will have soil collected as part of the integrated demonstration. The soil will be processed to remove particulate plutonium. Protocols and procedures need to be written for this process that will emphasize the safest and cheapest techniques. Specific tasks that require protocols and procedures include floral and faunal population surveys, general quality control and assurance, characterization of initial radiological conditions, soil removal, chemical analyses, material mass balance, and revegetation methodology.

Progress on Tasks

Task 1. Specify the methods and procedures to be used to compare the cleanup methods.

First Quarter: The soil characterization protocols were decided upon and ranked as to importance. Criteria for soil sampling methods were accepted and dates for soil sampling were received from each site.

Second Quarter: The soil characterization protocols have been converted to REECO format in draft form and distributed for comment. Small round-robin experiments are being planned for several of the protocols to estimate variability and to check for accuracy. A report documenting the protocols is in preparation.

Third Quarter: This task is complete.

Task 2. Develop a quality assurance plan for the measurements and analyses to be performed in analyzing and comparing the effectiveness of the cleanup methods.

First Quarter: A draft was partially completed.

Second Quarter: The quality assurance plan has been drafted in compliance with DOE Order 5700.6C and is in internal review.

Third Quarter: The quality assurance plan has been reviewed by project participants, has been reorganized and improved, and is being readied for a final review.

Fourth Quarter: The umbrella quality assurance plan has been completed.

Task 3. Observe the cleanup method trials and ensure that the analysis and quality assurance samples are collected properly.

First Quarter: The trials are scheduled to begin next quarter.

Second Quarter: The AWC process will be tested next quarter if an operation permit is issued for the test facility.

Third Quarter: Subject to the repair of earthquake damage and the issuance of permits, the AWC process will be tested in the fourth quarter.

Fourth Quarter: The AWC process will be tested during the first quarter of FY 1993.

Task 4. Evaluate the candidate cleanup methods and rank them.

Work on this task cannot begin until the trials are completed.

Task 5. Develop protocols and procedures for the various activities related to the Area 11 soil plot.

First Quarter: The translation of soil characterization protocols into REECof format was begun.

Second Quarter: The soil characterization protocols have been converted to REECof format. The additional protocols needed for the demonstration cleanup in Area 11 will be defined in July.

Third Quarter: No work was done on this task.

Fourth Quarter: The development of protocols for the pilot cleanup has been delayed because of the delay in testing the candidate separation processes.

Status of Deliverables

1. Report containing the protocols for soil characterization and methods for soil sampling (3/31/92).
The report will be completed by the end of October 1992.	Delayed

<p>2. Report on cleanup method analysis and comparison strategy, to be given to the proponents of the cleanup methods for comments (3/31/92).
The test plan for the AWC Truclean process has been approved. Test plans for the Campbell Centrifugal Jig and the Air Sparged Hydrocyclone have been started.</p>	Submitted
<p>3. Report on the cleanup method trials, the comparison of cleanup methods, and the quality assurance program (9/30/92).
The report awaits completion of the trials.</p>	Delayed
4. Report containing the protocols and procedures for the Area 11 soil plot (9/30/92).	Delayed

Problems Encountered

Fourth Quarter: The delays in the project because of difficulty in satisfying permit requirements have delayed testing of separation devices.

FY 1992 Budget Summary Soil Protocols

Hyperspectral Remote Sensing

David A. Mouat

Project Description

This project is designed to assist EG&G Energy Measurements, Inc., in its efforts to characterize hazardous waste activities at various DOE facilities. Specifically, it is designed to establish the feasibility and utility of hyperspectral remote sensing in the direct and geobotanical discrimination of hazardous waste materials. Activities to be performed include a survey and evaluation of operational hyperspectral resolution airborne and satellite sensors, an examination of spectral characteristics of hazardous wastes, a survey of geobotanical responses to hazardous wastes, and a ground and laboratory spectral characterization of hazardous wastes.

Progress on Tasks

Task 1. Perform a literature review.

First Quarter: The report on airborne and satellite high resolution systems which have a potential for use by DOE for hazardous waste examination, analysis, and monitoring has been reviewed and submitted to DOE.

Second Quarter: Over 1,000 abstracts, articles, reports, and books have been gathered. Work continued on an evaluative article on sensor systems that will complement the previously submitted technical review.

Third Quarter: Progress continued as abstracts, articles, reports, and texts continued to be gathered, consulted, and reviewed. A list of references compiled to date for the literature review was submitted on June 30. This bibliography will be amended as more documents are encountered and will be included in the final report.

Fourth Quarter: Review and revision of the literature review continued along with the summary of field results. A draft of the literature review was completed in July. It is currently under review and will be presented in the final report.

Task 2. Examine spectral characteristics of selected hazardous waste materials.

First Quarter: Ground and airborne spectral data acquired over the Sacramento River associated with the toxic metam sodium railroad spill during the late summer have been processed and are being analyzed. Ground spectral data show significant relationships among vegetation species affected by the toxic by-products compared with control species. Definitive results have not yet been produced with the Compact Airborne Spectrographic Image data set, but an example of these data has been sent to an image processing software developer to develop high spectral resolution data analytical techniques.

Second Quarter: A preliminary selection of classes of contaminants to focus on was made after reviewing a draft report on chemical contamination at 18 DOE facilities. The

priority list includes fuel hydrocarbons, chlorinated hydrocarbons, radionuclides, metals, inorganic anions, and ketones. The list may be revised after a Liaison Working Group meeting in April.

Third Quarter: Several of the DRI project participants attended the "Third Annual JPL Airborne Geoscience Workshop: AVIRIS, TMS, and AIRSAR" in Pasadena, California, during the first week in June. The conference included the poster presentation by Zhikang Chen and Chris Elvidge of DRI entitled "Primary Studies of Trace Quantities of Green Vegetation in Mono Lake Area Using 1990 AVIRIS Data." This has direct applications for hyperspectral studies of DOE sites in arid locations. JPL expressed considerable interest in DRI's development of a spectral library for vegetation and offered their assistance.

Rough drafts of Technical Task Plans for FY 1993 were completed and submitted; review, comments, and revision suggestions to the FY 1992 project management plan were also provided.

Fourth Quarter: Arrangements were made to have an Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) overflight near Getchell, Nevada. The area contains a historic mill site that has left an arsenic plume downwind. An AVIRIS overflight of the Mono Lake basin was also arranged. DRI personnel were on site with the PS-II to collect coincident ground calibration data. Coordinating the overflights allowed work on the spectral library to begin and valuable hyperspectral data sets to be collected. These studies are part of the effort to characterize and discriminate vegetation properties in an arid environment.

The acquisition of capital equipment was arranged pending revisions in expenditure limits. Delays in the revision process limited the time available for field activities. The capital equipment funds were approved in September, and the GC/mass spectrometer, the PS-II, and one ecopod chamber were purchased with a few accessory items. The additional ecopod will be acquired in October.

Task 3. Survey geobotanical responses to hazardous wastes.

First Quarter: Progress was made on the use of AVIRIS to discriminate vegetation cover in arid environments. This could have potentially significant implications for NTS analysis. Progress was also made on the review article on the effects of toxic substances on vegetation and soils and on their spectral manifestations.

Second Quarter: Preliminary results of the spectral analysis of vegetation along the Sacramento River are still being analyzed, with a report to be completed next quarter. Work continues in the area of vegetation discrimination using AVIRIS with respect to hyperspectral data sets.

Third Quarter: DRI attended the Liaison Working Group meeting on April 8 and 9. The information gathered allowed focus on three sites, Savannah River, Oak Ridge,

and Los Alamos. The problems encountered and anticipated at these sites along with their natural vegetation cover lend themselves most to the spectral studies currently in progress.

Significant progress was made in the spectral evaluation of the effects of the Cantara accident on vegetation along the Sacramento River. Initial results are encouraging and will help direct future software development, laboratory experiments, and data evaluation techniques. Final results will be incorporated into the final report.

Fourth Quarter: During a return visit to the Sacramento River in July, spectra were collected of the same species at the same locations as in August 1991 following the metam sodium spill. The spectra will be compared with those collected previously and analyzed for features associated with the acute exposure to metam sodium and its by-products. Initial results of the analysis of the 1991 data were presented at a conference in Redding, California, which included researchers involved in the assessment of the effects of the spill.

Problems Encountered

Second Quarter: Approval of capital equipment funds for a PS-II and the Ecopods continues to be delayed. Because of the uncertainty regarding these funds, other research labs are being consulted for the possibility of controlled experiments from which library spectra may be gathered.

Third Quarter: Justification of the FY 1992 capital equipment needs was requested by and provided to J. Fiore (DOE). The information required included instrument specifics as well as intended use and the problems to be addressed. This information was submitted, and oral approval has been received for a portable spectrometer, two ECOPOD chambers, and a GC/MS.

Fourth Quarter: The final report, delayed due to the revision in contract budget limits and coordination of the AVIRIS overflights, will include the final literature review, the analysis of the Sacramento River Basin Data/Report, and a summary of the work accomplished in FY 1992 on the spectral library. The report should be completed during the first quarter of FY 1993.

FY 1992 Budget Summary Remote Sensing

Office of Technology Development Program Support

Roger L. Jacobson

Project Description

To ensure efficient management and administration of the DRI program initiatives and approved tasks for the OTD, provisions are made for reporting, monitoring, and managing responsibilities under this Program Support project. The development of technical task plans, attendance at required meetings, submittal of information to OTD, implementation of technical workshops, and response to OTD support needs are included in these responsibilities. Also included are the review of documents and coordination support for task administration on OTD projects.

Progress on Tasks

Task 1. Coordinate DRI's OTD programs, including the educational projects started in FY 1991.

First Quarter: On-going monitoring was provided for the FY 1991 Educational Outreach programs (STEP).

Second Quarter: A briefing on the status of the OTD programs was presented. On-going monitoring was provided for the Educational Outreach programs.

Third Quarter: A program briefing on the status of the DRI OTD programs was developed and presented to DOE on May 20. On-going monitoring for the STEP was provided.

Fourth Quarter: Additional requirements for the Plutonium in Soils Integrated Demonstration (PuID) monthly reports – budget summary graphs and percent task completed charts – were reviewed with the principal investigators and incorporated in the reporting process. On-going monitoring for the STEP continued.

Task 2. Attend program planning, review, and coordination meetings.

First Quarter: In addition to attending numerous project meetings and budget and planning sessions, the program manager and staff carried out the following activities:

- Participated in development of the Technical Task Plans for the PuID.
- Developed the collateral materials for the STEP Community College of Southern Nevada Technology Fair in December and attended the fair and a reception honoring the event's supporters and contributors.
- Prepared and submitted the Educational Outreach program inventory for 1990–91 STEP accomplishments and student–teacher impact.
- Presented the television publicity from the STEP Students Understanding Mathematics and Science (SUMS) to DOE.
- Met with the new project coordinator for the Community College of Southern Nevada to review the status of course development and equipment purchase.

Second Quarter: The technical program manager for the PuID project participated in the revision of the Technical Task Plans and related budgets. Project subtasks were developed and elements for the work breakdown structure were defined. All related project information for the FY 1990 STEP was collected for future reference. Materials for the FY 1991 STEP continue to be collected for reference volumes. A special seminar for the SUMS teacher was held in March. The seminar speaker was a DRI scientist who spoke about the importance of teachers in preparing elementary students for careers in math and science. The STEP principal investigator also attended a program evaluation seminar in Washington in March.

Third Quarter: The technical program manager for the PuID attended the technical support group meeting on May 12, participated in project management and budget meetings on May 18 and 19, and developed information for and attended the FY 1993 technical task plan planning session on June 15 and 16. DRI personnel attended the STEP Program Evaluation Workshop on March 30 through April 4 and the Education Program Peer Review on May 11 through 14. Two presentations were made in Nevada regarding the OTD Education Outreach Program, Project SUMS. On May 26, the Project SUMS principal investigator presented the activity and findings of Project SUMS to the Clark County School Board. On June 25, a second presentation – The Golden Apple – was made by Dr. Brian Cram, superintendent of the Clark County School District, to Dr. Clyde Frank, Deputy Assistant Secretary for Technology Development, in recognition and appreciation for the project funding.

Fourth Quarter: The technical program manager and principal investigators continued to develop the FY 1993 PuID technical task plans and produced the task lists for DOE Headquarters. Responses to the PuID needs list were reviewed and incorporated in the PuID FY 1993 information sent to headquarters.

The program manager also attended the Environmental Restoration Project Management course, "Baselining for the Future," and the Spectrum 92 Hazardous Materials Management Meetings in Boise in August. In addition, he attended meetings in Washington, D.C., and Cincinnati regarding the PuID.

New technical task plans were developed for OTD Hydrology and the National Environmental Research Park and submitted to DOE/NV.

In connection with the STEP Program, DRI representatives attended the Community College Network Program in Denver on September 22–23.

Task 3. Provide reports and information to OTD, as requested.

First Quarter: Monthly reports for the DRI OTD programs were prepared and submitted. Information on STEP was provided throughout the quarter as requested by DOE and Lamb and Associates.

Second Quarter: Monthly reports for the OTD programs were prepared and submitted. Information on the FY 1991 STEP was provided as requested.

Third Quarter: Poster materials were developed for the dedication of the Treatability and Testing Facility on June 26. A tour of the facility was provided for Dr. Clyde Frank on June 25. Updated STEP program inventory sheets were provided to the Environmental Education Point-of-Contact Officer. Monthly reports were prepared and submitted.

Fourth Quarter: Monthly reports were prepared and submitted incorporating the new information (percent task completed charts and summary budget graphs) requested by DOE/NV. Detailed budget information was developed, revised, and provided to DOE/NV to satisfy the requirements for adjusting the DRI budget limitations.

Problems Encountered

Second Quarter: The current budget has been expended.

Third Quarter: The current budget (carry-over from FY 1991) has been expended and the FY 1992 allocation has not yet been distributed to DRI due to the delays in the DOE process of lifting the DRI contract budget limit.

**FY 1992 Budget Summary
OTD Support**

Robust Bicubic Surface Estimation

Forest L. Miller, Jr.

Project Description

A new method for estimation of curves and surfaces has been developed. The method, called Robust Bicubic Surface Estimation (RBSE), has significant advantages over both bicubic spline estimation and kriging as a way to model environmental contamination because it is not necessary to make restrictive assumptions needed for the use of these methods to provide valid analyses.

The purposes of this project are to further the development of RBSE and to demonstrate its usefulness in a stand-alone mode, in comparison with kriging and spline estimation, and by applying the method to problems of interest to DOE. Project responsibility will be divided between DRI and the University of Nevada, Las Vegas (UNLV). The responsibility for the technical aspects of the project will be primarily with UNLV. Other project responsibilities will be assigned based partially upon the strengths of the graduate students involved in the project.

Progress on Tasks

Task 1. Complete development of software for RBSE, including graphics, to facilitate its comparison with splines.

First Quarter: Implementation and debugging of the visualization software, designed in FY 1991, continued. This software package is menu driven and will include a variety of surface estimation algorithms.

Second Quarter: Debugging of the visualization software is almost completed. An article describing a novel image compression algorithm has been written and submitted to DOE for review. This algorithm is a useful by-product of the research. A hybrid algorithm for surface estimation, incorporating the theory of splines and stochastically perfect interpolators such as kriging, has also been developed. An abstract of a paper has been cleared and accepted at a conference. The completed paper is being submitted for DOE review.

Third Quarter: Programs were written and debugged to implement a hybrid algorithm for surface estimation in the visualization system. Routines to compute three-dimensional wireframes with hidden line elimination, rotation along the major axis, and zooming in and out have been added to the visualization system.

Fourth Quarter: An algorithm for the generalized Bezier method has been added to the visualization program.

Task 2. Compare RBSE with spline estimation using both theory and field data sets.

First Quarter: Informal comparisons have been made, but more systematic comparisons will not be done until debugging of the program is complete.

Second Quarter: Debugging of the spline algorithm embedded in the visualization package is proceeding well.

Third Quarter: The comparison is nearly completed.

Fourth Quarter: Additional smaller studies are being performed because the decrease in execution time with no loss of accuracy is so large that the journal article will have to be more definitive to be accepted.

Task 3. Develop software for comparing RBSE with kriging.

First Quarter: Programming and debugging the software continued.

Second Quarter: The kriging algorithm of the visualization package has been debugged.

Third Quarter: This task has been completed.

Task 4. Compare RBSE with kriging using both theory and field data sets.

First Quarter: Work on this task cannot begin until Task 3 is completed.

Second Quarter: Comparison of kriging with RBSE has begun.

Third Quarter: The theoretical comparison of kriging and RBSE has been completed. A paper describing the comparison has been cleared and accepted for presentation at and publication in the proceedings of the Fourth International Geostatistics Congress. The practical comparison of kriging and RBSE is nearly completed.

Fourth Quarter: The comparison of kriging with RBSE using the Galileo ground zero data set and the Area 11 plutonium data has been completed. Some of the results were presented in a paper delivered in Troia, Portugal.

Status of Deliverables

1. Draft journal article comparing RBSE and spline estimation (6/30/92). Delayed
This journal article has been slowed by the need for side studies.
The article will be submitted for clearance before 12/31/92.
2. Draft journal article comparing RBSE and kriging (9/30/92). Delayed
The work on this comparison is completed and partially reported in a paper in the proceedings of the Fourth International Geostatistics Congress.
A more definitive paper will be submitted for clearance by December 1992.

Problems Encountered

Fourth Quarter: Preparation for papers delivered this summer slowed the completion and the publication of the comparisons.

FY 1992 Budget Summary
Surface Estimation

Plutonium Database

Carol B. Thompson

Project Description

The Plutonium Database will be the central repository for all data collected during the assessment of available processes for plutonium cleanup at six different sites. Each organization collecting data in this effort will be responsible for verifying and maintaining its own data. The database developed in this project will be used primarily by DOE/NV and its contractors (DRI, REECo, and EG&G).

The database is expected to be fully operational by the end of FY 1992. The first step in development of the database will be to determine what the potential users require. From these requirements, a plan will be developed to design the database and to coordinate the transfer of data from the processing contractors at the different sites. By the end of the second quarter, the database should be available for the initial transfer of data. Use of the database and the procedures to transfer data from other contractors will be tested against the requirements, and changes will be made as necessary.

Progress on Tasks

Task 1. Analyze the requirements and develop a plan for the database.

First Quarter: Some development of the conceptual design has been done.

Second Quarter: Based on preliminary information about the database requirements, a conceptual view of the database operation was made to the project committee. The impact of DOE Orders on computer security and information management was also addressed. Work began on a draft list of questions to be answered by the committee before requirements for the database can be more precisely defined. Work also began on identifying the hardware and software needs for the database.

Third Quarter: New personnel were assigned to this project and were introduced to the background and requirements. A preliminary data dictionary and model were developed, and minimum software requirements for development of the prototype database were specified. The process of getting approval for the acquisition of hardware and software is continuing.

Fourth Quarter: Approval for acquisition of the hardware and software was finally obtained. The prototype data model and associated lexicon were completed based on the requirements identified at this point.

Task 2. Develop a test version of the database and its retrieval capabilities.

First, Second, and Third Quarters: No work was done on this task.

Fourth Quarter: A general purpose table-driven screen editor and associated application generator were developed to supplement the database software. A prototype database

design and master data entry/editing screen for the reporting application were also developed.

Task 3. Coordinate and test procedures for transferring data to the database.

No work was done on this task in FY 1992.

Task 4. Finalize and document the database and procedures.

No work was done on this task in FY 1992.

Status of Deliverables

1. Requirements analysis and plan for the database (6/30/92).
This report will be completed in FY 1993.	Delayed
2. User's manual for the database (9/30/92).
The manual will be completed in FY 1993.	Delayed

Problems Encountered

First Quarter: The lack of information regarding the requirements for the database and the lack of available personnel have precluded further progress.

Second Quarter: The lack of available personnel has precluded further progress. Avenues are being investigated to address a solution to available personnel time.

Third Quarter: New personnel have been assigned to this project, so it should be possible to complete tasks 1, 2, and probably 3 this year. Task 4 will not be completed in FY 1992.

Fourth Quarter: Further work was not completed because not all of the specifications were available and because of timetable changes experienced earlier in the year. The paperwork for the acquisition of the hardware and software took considerable effort and time.

FY 1992 Budget Summary Plutonium Data Base

Plutonium Cleanup Decision Support
Richard D. McArthur, Carol B. Thompson

Project Description

An essential element in planning the cleanup of contaminated areas on and around the NTS is an estimate of the amount of land surface that is contaminated to a given level. A large amount of data on concentrations of plutonium in the surface soil was collected by earlier programs, primarily the Nevada Applied Ecology Group (NAEG) and the Radionuclide Inventory and Distribution Program (RIDP). These data need to be evaluated to see if they are adequate for estimating the total amount of land that is contaminated to the levels currently under consideration for cleanup (on the order of 10 pCi/g). Also, it is likely that additional measurements of plutonium will need to be made, at least in some areas. The new data will need to be entered into a database to make them readily available to potential users.

Note: Work on this project did not begin until the second quarter of FY 1992.

Progress on Tasks

Task 1. Analyze data collected by the Radionuclide Inventory and Distribution Program (RIDP) to estimate the extent of $^{239,240}\text{Pu}$ contamination on the NTS.

Second Quarter: A file of the RIDP data was prepared for use with DRI's geographical information system (GIS). A preliminary analysis of plutonium levels at the Oberon site in Area 8 indicates that the total area exceeding 10 pCi/g is in excess of 15 square miles.

Third Quarter: The RIDP data were transferred to the GIS and work on contouring the data has begun. The GIS has several contouring algorithms available, and all are being tried to see which gives the best results. This process is taking somewhat longer than expected, but should be completed next quarter.

Fourth Quarter: The estimation was completed and a letter report was delivered to DOE in July.

Task 2. Determine the requirements for a database to contain measurements of plutonium levels in contaminated areas.

Second Quarter: No work was done on this task.

Third Quarter: A questionnaire was developed to determine the requirements for the content and usage of the database. A plan for the phased implementation of the production database system was proposed. Software tools for the conversion and transfer of data between the database software and the graphics and statistics software are being investigated.

Fourth Quarter: The "contents and usage" questionnaire was reviewed and revised. A plan, "Triplex Architecture," for management/migration of data among the database,

statistical analysis, and exporting software tools was developed. Entity relationship diagrams were developed and refined to help define the underlying database structure. Research of predeveloped software for subapplication areas in the database also continued.

Task 3. Develop a database and create procedures for adding and retrieving data.

No work was done on this task in FY 1992.

Status of Deliverables

1. Letter report on analysis of RIDP plutonium data (6/30/92).	Completed
2. Requirements analysis and plan for a plutonium data base (6/30/92).
Should be completed in FY 1993.	Delayed
3. Draft user's manual for the database (9/30/92).
Should be completed in FY 1993.	Delayed

Problems Encountered

Fourth Quarter: Task 3 had to be rescheduled to FY 1993 due to timetable changes in the pilot-scale testing schedule.

Archaeological Studies at Contaminated Sites

Lonnie C. Pippin, Colleen M. Beck

Project Description

In the near future, decontamination technology for plutonium-contaminated soils will be demonstrated in Plutonium Valley. State and federal laws and regulations pertaining to cultural resources will require that cultural resources studies be conducted at the proposed demonstration areas. DRI will be responsible for organizing and conducting these studies.

This pre-activity program will provide the necessary support and field studies and will include the activities described under the BECAMP Archaeology program. However, the cultural resources studies for this project will require more preparatory work than usual because the land surface is contaminated by plutonium.

To ensure the safety of the archaeologists and determine the feasibility of working in contaminated areas, a program will be developed to train the archaeologists in radiation safety, design field methods for working on contaminated soil, and conduct trial studies to test these methods. DRI personnel will work closely with the radiation safety experts through all stages of the program.

Progress on Tasks

Task 1. Provide radiation safety training for all DRI archaeologists.

First Quarter: One DRI archaeologist completed the 8-hour radiation safety course in anticipation of a small cultural resources survey of a contaminated area in Plutonium Valley.

Second Quarter: Four DRI archaeologists completed the radiation safety course.

Third Quarter: Five more DRI archaeologists received training.

Fourth Quarter: All of DRI's NTS archaeologists have received training.

Task 2. Develop and test field methods for working on contaminated soils.

First Quarter: Initial work began on the procedures for conducting cultural resources field work in contaminated areas.

Second Quarter: Work continued on the procedures.

Third Quarter: Work continued on the procedures. Contacts were made with archaeologists working at other contaminated locations to request information concerning methods. DRI archaeologists met to review data, discuss procedures, and outline safety concerns to be incorporated into the field methods design. A display on PuID research, including examples of the types of cultural resources expected to

be found in contaminated areas, was assembled for the Treatability and Testing Facility open house.

Fourth Quarter: Compilation of background technical information for the procedures and safety plan was completed and followed by meetings with the DRI safety officer and the quality assurance specialist. A draft of the plan for conducting cultural resources surveys in contaminated areas was finished and reviewed internally. Many suggestions and comments were received from the reviewers, and a meeting with RADSAFE personnel revealed that some procedures proposed in the draft plan are more extensive than what may be needed. The plan is still undergoing revision, and will go through at least one more review before it is submitted.

Task 3. Conduct surveys for cultural resources, as requested.

First Quarter: No surveys were requested.

Second Quarter: A small survey was conducted in Plutonium Valley in January. No significant cultural resources were found within the proposed area of impact.

Third and Fourth Quarters: No surveys were requested.

Status of Deliverables

1. Plan for conducting cultural resources studies in contaminated areas (9/30/92).
The first draft received more comment than anticipated, and further review is necessary. The plan will be submitted in the first quarter of FY 1993.	Delayed

Report Completed

1. SR011492-1: "Cultural Resources Reconnaissance of the Land Surface Cleanup of Plutonium Project B Site, Area 11, Nevada Test Site, Nye County, Nevada."

FY 1992 Budget Summary
Plutonium Archaeology

STATISTICS AND DATA MANAGEMENT

In the late 1970s, DRI assembled a team of statisticians at its Water Resources Center to manage and analyze the data from a radiological decontamination project at Enewetak in the South Pacific. In the following years, the statistics group continued to provide statistical expertise and database management for a number of DOE programs, including decontamination projects at the Kellex and Middlesex sites in New Jersey, the NTS Radionuclide Inventory and Distribution Program (RIDP), and the Nevada Applied Ecology Group (NAEG). Work on those projects emphasized the use of new methods for estimating the spatial distribution of radionuclides in soil, the development of efficient sample designs for estimating radionuclide inventories, and the development and management of project databases.

In FY 1992, work will continue on two other long-term programs, the Basic Environmental Compliance and Monitoring Program (BECAMP) and the Off-Site Radiation Exposure Review Project (ORERP). Other projects of the Statistics and Data Management group in FY 1992 include the Historical Hydrologic Data Compilation, the Plutonium Database, and data management support for the Groundwater Characterization Project.

BECAMP Information Management

Carol B. Thompson

Project Description

BECAMP is a revised and extended version of the NAEG. Its objectives are to assess changes in radiological and ecological conditions at the NTS and to help ensure that activities on the NTS are carried out in compliance with environmental regulations. DRI's role in the BECAMP includes developing and managing a database for the program and providing statistical and decision-making support to the researchers and program managers. Much of the work of the NTS Cultural Resources Program, described earlier, is also done under the auspices of the BECAMP.

Work on the BECAMP database dates back to the early 1970s, when a system was first developed for tracking the large amounts of data being collected by the NAEG researchers. Funding for the data tracking was cut off in 1977, bringing work on the database to a halt. In 1981, the NAEG database was re-funded under DRI, whose task it was to resurrect the old database, continue the tracking of the data, and make the data available to the researchers and DOE. This turned out to be a difficult task because both people and records had been shifted around and the tie was lost. Over the next several years, the 1977 database was reviewed, data from different contractors and laboratories were found and added, and an attempt was made to set up an accessible database. By the time the NAEG ended in 1985, the database had not been completed, primarily because of the amount of missing and incorrect data and secondarily because of the inadequate software available at that time on the DOE/NV computer.

When the BECAMP began in 1986, the need for a system of data tracking and an accessible database continued. A DOE-accessible computer with a relational database software package was found and the design of the database structure was reviewed and revised. In 1988, an effort began to add the data from the NAEG and the RIDP to the database with the new structure. At the end of FY 1991, the database structure was being reviewed and created on the computer, procedures for managing the database were being developed or refined, and the soils data from the NAEG were being reviewed and corrected to allow them to be added to the BECAMP database.

In FY 1992, it is expected that funding for work on the database will be considerably reduced. Efforts will be directed toward preserving the data collected by the BECAMP on tapes rather than in a database. Procedures for protecting the BECAMP records and files also need to be developed and put in place. Work may also continue on reviewing NAEG data and documentation if funding is adequate.

Progress on Tasks

Task 1. Develop a system to archive historical and current BECAMP data on tapes.

First Quarter: No work was done on this task.

Second Quarter: A meeting was held with the DOE Project Officer to clarify some questions and review some ideas related to the archival system. From that meeting, a document

identifying the requirements and detailing a plan for the system was developed. That document will be submitted next quarter. Also, data files from the computer at the Waste Management facility were cleaned up and archived. That computer will no longer be available for the BECAMP.

Third Quarter: Documentation to expand on the initial design of the archival system, requested by the Project Officer, and the outline for two additional steps, including user input forms, were sent for approval. Programming has been started on the system, using the design as presented but adding improvements as needed. A flow chart has been developed to show the design steps being followed.

Fourth Quarter: A meeting was held with the Project Officer to review the work thus far. Documents were given to the Project Officer to send to BECAMP researchers for input on catalog information they would provide with data sets to be archived. This part of the system was revised based on that input and testing is almost complete.

Task 2. Develop procedures to satisfy DOE requirements for protecting and safeguarding BECAMP records and files.

First Quarter: No work was done on this task.

Second Quarter: Security procedures and safeguards were among the issues discussed with the Project Officer at the meeting described under Task 1.

Third Quarter: Disk and tape file access permissions, methods for verifying the accurate transfer of data, lifespan of storage media, and protection of the software used in the system have all been considered as part of the security procedure package. The methods are evolving as all the options are being investigated.

Fourth Quarter: A conceptual procedure for archiving data sets was developed and some of the segments were implemented, especially those relating to the checking of data received and the development of the catalog.

Task 3. Review Nevada Applied Ecology Group data and documentation, as funding permits.

First Quarter: Review and checking of the NAEG soil data continued, and that task is now about 50 percent complete. In addition, files and documentation from previous work on the BECAMP database were reviewed as materials were being packed for DRI's move to a new building. In December, the BECAMP work plan was revised and work on this task was eliminated.

Status of Deliverables

1. Documentation and procedures for the archival system and a directory of the available data (9/30/92).	Delayed

2. Status report on security procedures (9/30/92).

Delayed

Problems Encountered

Fourth Quarter: There was not enough funding and personnel time available to complete the archival system. Comments by researchers on the documents and a change in DOE Project Officers, however, brought up the question of whether all data sets needed to be archived in this system or whether some could just be cataloged to save on costs. Also, since the level of funding for FY 1993 has considerably decreased, consideration is being given to development of a printed catalog of data sets and no central archival system.

FY 1992 Budget Summary
BECAMP Data Base

BECAMP Project Design Support

Richard D. McArthur

Project Description

The objective of this project is to provide statistical support to the BECAMP. In FY 1992, this support will probably be limited to reviewing the study plans and reports produced by other BECAMP researchers.

Progress on Tasks

Task 1. Provide statistical and general review of study plans and reports.

First Quarter: No work was done on this task because no documents were received for review. The principal investigator did attend a BECAMP meeting on October 17 and 18, at which the BECAMP was asked to help estimate the total amount of contaminated soil at some of the safety shot sites. Some work was done on that task under this project until the BECAMP FY 1992 work assignments were made in December. Subsequent work was done as part of OTD Program Support.

Second Quarter: The BECAMP Year-End Summary Report for FY 1991 was reviewed and returned to the author with comments.

Third Quarter: No work was done on this task.

Fourth Quarter: Five draft reports on various aspects of the flora and fauna monitoring (perennial plants, ephemeral plants, small mammals, wild horses, and spring utilization) were reviewed and returned to the authors at REEC Co. A draft of the BECAMP quality assurance plan was also reviewed.

Status of Deliverables

1. Year-end report (9/30/92).	Completed
The year-end report (in the form of a monthly report for September) has been completed and will be sent to DOE as soon as final budget figures are available (mid-October).	

Problems Encountered

First Quarter: The budget for this project is only about 45 percent of what was expected. The work done before the budget and work assignments were finalized has already used up a large portion of the money allocated.

FY 1992 Budget Summary
BECAMP Project Design

ORERP Data Analysis

Carol B. Thompson

Project Description

The ORERP was started in 1979 in response to charges that fallout from atmospheric testing affected the health of residents in the area around the NTS. It had two primary objectives: to collect in one location all available information about fallout from nuclear testing at the NTS and to estimate the radiation dose that off-site populations are likely to have received as a result of NTS testing. DRI was designated as the Data Analysis Task Group for the ORERP. Its responsibilities have included statistical analysis, quality control, and database management.

DRI has been involved in several activities for the ORERP:

- Developing and evaluating methods for interpolating data to be used in estimating exposure rates
- Coding and analyzing data from the Lifestyles Survey conducted in 10 counties near the NTS
- Developing protocols for encoding data in the Survey Meter Data Base and assessing the quality of the data
- Developing methods to estimate exposure rates and times of fallout arrival from contour maps and from survey meter data
- Creating a database of the estimates of exposure rate and time of fallout arrival (the Town Data Base)
- Helping to select sites, managing the data, and directing the quality assurance program for the Phase II Soils Program.

As the ORERP nears completion, most of DRI's remaining tasks are related to completing the above activities. Some work may also be done on the Individual Dose Assessment model, although whether the ORERP management will continue to support the model is not clear.

Progress on Tasks

Task 1. Document and archive materials relating to the Town Data Base.

First Quarter: Archiving the data and programs took longer than expected due to lack of adequate documentation of work on the 10KM Grid Data Base and problems using the DOE computer. This work has been completed and will be transferred to REEC Co next quarter.

Second Quarter: No work was done on this task.

Third Quarter: Work on reviewing and finalizing the documentation for the estimates in the Town Data Base has begun. The archived data and programs used in creating these estimates will be transferred to REEC Co next quarter. Some of the documentation is being used in checking the final estimates.

Fourth Quarter: Work on reviewing and finalizing the documentation for the estimates in the Town Data Base began at the end of the quarter. The archived data and programs used in creating these estimates will be transferred to REEC Co when this task is completed because some of that information is being used in checking the final estimates. About 40 percent of the estimates have been checked and documented.

Task 2. Complete the report on the Survey Meter Data Base.

First Quarter: The report was sent out for one more review. Comments were incorporated, and the report will be sent to EPA for printing after a final check.

Second Quarter: The report was completed and sent to EPA. The EPA's internal reviewer had several comments that need to be addressed before the report is printed.

Third Quarter: A letter was sent to EPA addressing the comments of the reviewer. No response has been received.

Fourth Quarter: The report and comments are being passed around within EPA for approval; no decision has been received as yet.

Task 3. Complete the report on the Town Data Base.

No work was done on this task in FY 1992.

Task 4. Document and archive the data and programs relating to the Lifestyles survey.

No work was done on this task in FY 1992.

Task 5. Complete a draft report on the Lifestyles Survey.

First, Second, and Third Quarters: No work was done on this task.

Fourth Quarter: Copies of the tables and histograms that had been developed for this report in FY 1991 were sent to Dr. Whicker at Colorado State University for review to begin preliminary work on this report.

Status of Deliverables

1. Final report on the Survey Meter Data Base (3/31/92).	Submitted
2. Final report on the Town Data Base (6/30/92).	Delayed
3. Letter report on the status of the archiving of the Lifestyles Survey materials (9/30/92).	Delayed
4. Draft final report on the Lifestyles Survey (delayed from FY 1991) (9/30/92).	Delayed
- This report will not be completed in FY 1992.

Problems Encountered

Second Quarter: Completion of the Survey Meter Data Base report has been held up because of the EPA's requirements for publishing it as an EPA report. The lack of available personnel time and any link to the DOE computer since DRI's move in December have precluded further progress.

Third Quarter: The lack of available personnel time held up progress until June, when additional resources were added to handle most of the estimate documentation.

Fourth Quarter: Dr. Whicker offered to take the lead on writing the Lifestyles Survey report. Lack of available personnel time precluded further work on Tasks 3 and 4.

FY 1992 Budget Summary Off-Site Radiation Exposure Review Project

YUCCA MOUNTAIN PROJECT

In the late 1970s, DOE began to study Yucca Mountain on the western boundary of the NTS as a possible site of a geologic repository for storing high-level radioactive waste. The Nuclear Waste Policy Act of 1982 directed DOE to develop such a site, and in 1986 DOE chose Yucca Mountain as one of three potential sites worthy of intensive study. Further legislation in 1987 specified that site characterization would be done only at Yucca Mountain.

DOE/NV is currently conducting site characterization studies as part of its Yucca Mountain Project. Many of these studies focus on the technical aspects of the site's suitability as a repository. They include investigations of groundwater flow, chemical and physical properties of the rock, and seismic activity in the region. Other research addresses the environmental, economic, and transportation issues associated with building and operating a repository.

Although DRI has considerable expertise in many of these areas, it has not had a major role in the Yucca Mountain Project. The State of Nevada, which opposes the siting of a repository at Yucca Mountain, conducted its own investigations at the site in the mid-1980s. DRI helped with some of these investigations and so could not take part in similar federal studies without a conflict of interest. Consequently, the only federally funded work DRI conducted at Yucca Mountain in the 1980s was to continue the archaeological studies that had been in progress since 1978.

In 1989, the State ended most of its Yucca Mountain research, and DRI began to contribute additional support to the DOE. A study of the faunal history of the Great Basin and a study of flood hazards along railway routes to Yucca Mountain both began in FY 1990; a project on climate modeling began in FY 1991. These studies and the archaeology program will continue in FY 1992. Other support may also be provided to the Yucca Mountain Project in the areas of geology, hydrology, engineering, biology, and meteorology.

Yucca Mountain Archaeological Program

David Rhode, Lonnie C. Pippin

Project Description

To minimize the damage that may occur to archaeological sites from the site characterization studies at Yucca Mountain, all land-disturbing activities are preceded by archaeological surveys. These surveys are required for compliance with the National Environmental Policy Act, the National Historic Preservation Act, and the Nuclear Waste Policy Act. They are also one of DOE's obligations specified in a Programmatic Agreement with the Advisory Council on Historic Preservation (ACHP) and the Nevada Division of Historic Preservation and Archeology (NDHPA)

DRI has conducted archaeological investigations in support of DOE studies at Yucca Mountain since 1978. These investigations have included large-scale archaeological surveys, limited test excavations, mitigative data recovery projects, and archaeological site monitoring programs. To date, over 500 archaeological sites have been identified in the Yucca Mountain region as a result of these studies, and archaeological analyses of artifacts collected from several of these sites are continuing.

This program will enable DOE to comply with the Programmatic Agreement and with the pertinent legislation protecting cultural resources during the site characterization at Yucca Mountain. In addition, a considerable body of valuable archaeological information from the Yucca Mountain area will be obtained, allowing scientists to address important research issues concerning the history and processes of human occupation and adaptation to arid environments. The data will also be useful in preparing an environmental impact statement and compliance plans for cultural resources protection if a repository is eventually constructed at Yucca Mountain.

The nature and extent of the current studies of the Yucca Mountain Archaeological Program have been described in the Environmental Field Activity Plan supporting the Yucca Mountain Project (DOE/NV-10576-16) and the Yucca Mountain Project Archaeological Research Design and Data Recovery Plan. The general tasks identified for the site characterization phase of the Yucca Mountain Project include the following:

- Identifying, recording, and evaluating cultural resources at sites prior to land-disturbing activities
- Evaluating potential adverse effects and recommending ways of mitigating them
- Monitoring sites periodically to ensure that unforeseen adverse effects are not occurring or to correct adverse effects that do occur
- Conducting data recovery programs at sites where disturbance cannot be avoided
- Analyzing data to address questions outlined in the Research Design
- Storing and maintaining artifacts and records
- Participating in the Yucca Mountain Project Quality Assurance program

- Providing other support to the Yucca Mountain Project Office, including developing worker education programs, giving public presentations and tours of archaeological sites, and participating in policy or design studies.

Any or all of these tasks may be required in any one fiscal year during site characterization. The specific tasks and deliverables scheduled for FY 1992 are listed below.

Progress on Tasks

Task 1. Help DOE monitor compliance with the Programmatic Agreement, including management of cultural resources and preparation of reports on implementation progress.

First Quarter: No specific work was done on this task separate from the activities described below.

Second Quarter: The annual report to the ACHP regarding implementation of the Programmatic Agreement during 1991 was prepared and submitted to DOE. DRI personnel also participated in numerous discussions concerning the role of state and tribal agencies in monitoring compliance with the Programmatic Agreement. Plans were developed for a site tour with tribal representatives.

Third Quarter: DRI personnel participated in a site tour with representatives from concerned Native American tribes, including a tour of the Southern Nevada Science Center and its archaeological facilities, to update these groups on compliance with the Programmatic Agreement. Several progress reports were prepared and submitted as part of Task 2.

Fourth Quarter: DRI personnel participated in a tour for young members of concerned Native American tribes to educate them on the Yucca Mountain Project and its archaeological studies. Several reports on implementation progress were prepared and submitted as part of Task 2.

Task 2. Conduct preactivity and sample archaeological surveys, record and evaluate archaeological sites found during those surveys, and recommend ways to minimize any adverse effects.

First Quarter: Eleven preactivity surveys were conducted, resulting in the recording and evaluation of 31 new archaeological sites. In addition, five preactivity survey short reports describing previous survey results were submitted to DOE.

Second Quarter: Field work was conducted on two preactivity surveys. In addition, nine preactivity survey short reports describing previous results were submitted.

Third Quarter: Field work was conducted on 11 preactivity surveys. In addition, three preactivity survey short reports for projects previously surveyed and two clearance letters for areas not requiring additional surveys were submitted.

Fourth Quarter: Field work was conducted on 12 preactivity surveys. In addition, four preactivity survey short reports for projects previously surveyed were submitted. Finally, one random sample survey unit was examined as part of the southern Yucca Mountain survey project.

Task 3. Prepare site-specific data recovery plans for review and approval by DOE and the Advisory Council on Historic Preservation and conduct field data recovery operations in accordance with those plans.

First Quarter: A large field data recovery program was conducted at the Midway Valley Quarry Site (26NY4759) in the eastern half of Midway Valley. This work was conducted in accordance with a data recovery plan approved by the ACHP in FY 1991. Field work was completed in mid-December, and laboratory analyses are ongoing.

Second Quarter: Mitigative data recovery was conducted at two small archaeological sites near Exile Hill and Fortymile Wash in accordance with an agreement between the DOE and the ACHP allowing collection of small surface artifact scatters. Laboratory analysis and report preparation continued on the materials collected from the Midway Valley Quarry Site (26NY4759).

Third Quarter: Analysis of artifacts collected from site 26NY4759 was completed, and a technical report of the investigations is being prepared.

Fourth Quarter: Work continued on the technical report for investigations made at site 26NY4759. This report will be completed in FY 1993.

Task 4. Monitor archaeological sites subject to potential project-related effects in the Yucca Mountain Project Area.

First Quarter: Archaeological sites at the construction area of Well JF-3 were monitored.

Second Quarter: Monitoring was conducted at 20 archaeological sites. Four new archaeological sites were also found during monitoring activities.

Third Quarter: Monitoring was conducted at two large archaeological sites.

Fourth Quarter: Monitoring was conducted at one large archaeological site (26NY3039) and three smaller sites (26NY5841, 5842, and 5843).

Task 5. Analyze data to support objectives of the Research Design. In FY 1992, the data analyses will focus on (1) a study to evaluate further data collection needs relative to small archaeological sites; (2) continuing progress on obsidian hydration and thermoluminescence dating; (3) continued geological mapping of areas where potential buried archaeological sites are likely to occur; and (4) further development of techniques for field analysis of chipped stone artifacts.

First Quarter: Analyses were conducted to determine the geochemical source of over 140 obsidian artifacts, to assist development of source-specific hydration rates, and to

identify patterns of raw material transport into the Yucca Mountain region. Thermoluminescence dating of ceramic artifacts was conducted for several sites in the region, and an assessment of the reliability of thermoluminescence dating using brownware ceramics from well-dated archaeological contexts was begun. A geological map of surface eolian sand deposits in the Yucca Mountain area was completed, which provides valuable information concerning the likelihood of buried archaeological deposits. Finally, techniques of field analysis of chipped stone artifacts are being developed and assessed during the field data recovery at the Midway Valley Quarry Site. A report on the importance of small sites and the need for further data collection at these sites in the Yucca Mountain area, recommended by the ACHP and requested by the Yucca Mountain Project Office (YMPO), is being developed.

Second Quarter: No work was done on this task.

Third Quarter: A second year's data on establishing effective hydration temperatures for use in obsidian hydration were collected. Coupled with the previous year's results, effective hydration temperatures may now be estimated for various elevations and environments in the Yucca Mountain area. Thermoluminescence dating of ceramic artifacts also was conducted for samples from several sites in the region, and from other dated archaeological sites in the Great Basin, to assess the accuracy of the method.

Fourth Quarter: Effective hydration temperatures for air and ground surface locations were collected. These results will help develop estimates of obsidian hydration rates for artifacts found on the ground surface. Thermoluminescence dating of ceramic artifacts also was conducted for samples from dated archaeological sites in the Great Basin to assess the accuracy of the method. These tests show that the technique appears to be a reasonably accurate indicator of absolute age for Great Basin brownware ceramics.

Also, portable field equipment was acquired to allow in-field analysis of chipped stone artifacts during archaeological monitoring. Analytic designs for this study will be developed during FY 1993.

Task 6. Develop and maintain appropriate quality assurance (QA) procedures for archaeological field work, artifact analysis, and curation.

First Quarter: Work instructions for archaeological survey, site recording, surface artifact collection, and excavation were modified to incorporate changes requested by Technical and Management Support Services (T&MSS) reviewers. These work instructions will be issued next quarter. Work instructions for lab analyses, artifact storage, and records keeping are currently being prepared and will be submitted for T&MSS review in the near future. Discussions were held with T&MSS

technical and QA staff regarding revision of the QA grading report to better reflect the requirements of the archaeological program. A revised grading report will be submitted to the Quality Review Board next quarter.

Second Quarter: A revised QA grading report for the archaeological studies was approved by DOE's Quality Review Board, to better reflect the non-quality-affecting character of these studies. Work instructions for archaeological survey, site recording, surface artifact collection, and excavation were issued. Work instructions for laboratory analyses, artifact storage, and record keeping were submitted for review. DRI personnel are currently being trained in these procedures.

Third Quarter: DRI personnel were trained in the implementation of approved work instructions as part of the QA program for archaeological studies.

Fourth Quarter: DRI described the status of its QA program to the T&MSS QA manager, in compliance with agreements between DRI and DOE concerning this issue. Currently, archaeological studies conducted by DRI are non-quality-affecting activities, but are conducted in accordance with professional standards under the auspices of the T&MSS QA Program, and subject to some of the procedures and directives of that program. Formal work instructions have been implemented for field activities, and work instructions for archaeological monitoring, lab analyses, and artifact and records management are under formal review. As part of this program, control of laboratory measuring and testing equipment (balances) was formally instituted.

Task 7. Maintain and update cultural resources inventory files, artifact collections, and site records maps.

First Quarter: All inventory files and maps were updated to include newly recorded archaeological sites and new information retrieved during monitoring. Records pertaining to recently inventoried artifact collections were updated to reflect changes resulting from that inventory, and a new system of records management was developed to integrate records filing in DRI facilities in both Reno and Las Vegas, as well as at the Yucca Mountain Site Office. Soil and faunal samples from previous studies in the Yucca Mountain area were inventoried as well.

Second Quarter: All inventory files and maps were updated to include newly recorded archaeological sites and new information retrieved during monitoring. Records pertaining to recently inventoried artifact collections were updated to reflect changes resulting from that inventory. Complete site and project files were prepared and sent to DRI's Las Vegas office. All artifacts collected as part of the Yucca Mountain Project were transported to a storage facility at DRI's Las Vegas office at the request of the YMPO. An updated inventory of those artifacts was finalized.

Third Quarter: All inventory files and maps were updated to include newly recorded archaeological sites and new information retrieved during monitoring. Artifact collections were maintained in the storage facility at DRI's Las Vegas office.

Fourth Quarter: All inventory files and maps were updated to include newly recorded archaeological sites and new information retrieved during monitoring. Artifact collections were maintained in the storage facility at DRI's Las Vegas office.

Task 8. Perform activities related to the public relations and worker education programs specified in the Environmental Field Activity Plan, including escort to archaeological resources and participation in public and professional presentations, as necessary.

First Quarter: DRI archaeologists participated in several public tours of the Yucca Mountain area, and also participated in the Yucca Mountain Project update meeting in Reno in November.

Second Quarter: DRI archaeologists participated in several public tours of the Yucca Mountain area. DRI also provided DOE with slides and other materials for use in exhibits and presentations. In addition, DRI scientists presented results of recent work at Yucca Mountain in a national DOE cultural resources management symposium in Charleston, South Carolina, and at the opening of the DRI Southern Nevada Science Center in Las Vegas.

Third Quarter: DRI personnel supported a tour for representatives of Native American groups (see Task 1) and a site tour for the Nevada Environmental Commission. Finally, DRI archaeologists participated in several public tours of the Yucca Mountain area, including the Amateur Archaeologists of Nevada.

Fourth Quarter: DRI personnel supported a tour of the site and of DRI's archaeological facilities for Native American youth (see Task 1). Support was also provided for the public tours of the Yucca Mountain area and for public talks and presentations.

Task 9. Assist DOE in preparing cultural resources management objectives and reports and coordinating cultural resources management plans with appropriate agencies, as required in the Programmatic Agreement.

First Quarter: Preactivity surveys were coordinated with the Bureau of Land Management (BLM), the Eastern California Archaeological Information Center, the Southern Nevada Archaeological Information Center, and with support contractors, as needed. Short reports of archaeological investigations were submitted to DOE as described in Task 2.

Second Quarter: DRI revised a draft of the Environmental Field Activity Plan for archaeological studies following an informal review of the document by DOE staff. This plan will be submitted for final review early in the third quarter. Preactivity surveys

were coordinated with the BLM, the Eastern California Archaeological Information Center, the Southern Nevada Archaeological Information Center, and with YMPO support contractors, as needed. Also, DRI submitted comments on the development of a DOE cultural resources management plan for the program.

Third Quarter: DRI personnel submitted a draft of the Environmental Field Activity Plan for archaeological studies for formal project review. Final comment resolution and issuance will be completed during the next quarter. Coordination of archaeological surveys was conducted with the BLM, the Eastern California Archaeological Information Center, the Southern Nevada Archaeological Information Center, and with YMPO support contractors, as needed. Short reports of archaeological investigations were submitted to DOE as described in Task 2.

Fourth Quarter: The Environmental Field Activity Plan for archaeological studies was formally issued. In addition, results of archaeological studies were submitted as part of the Environmental Monitoring and Mitigation Report and the Annual Site Environmental Review. Coordination of archaeological surveys was conducted with the BLM, the Eastern California Archaeological Information Center, the Southern Nevada Archaeological Information Center, and with YMP support contractors, as needed. Short reports of archaeological investigations were submitted to DOE as described in Task 2.

Reports Completed

1. SR050391-1: "A Class III Cultural Resources Reconnaissance of Proposed Radiological Monitoring Stations in Jackass Flats and near Yucca Mountain, Nye County, Nevada."
2. SR050991-1: "A Class III Cultural Resources Reconnaissance of 137 Orthophoto Panel Points for the Yucca Mountain Project, Southwest Nevada."
3. SR052891-1: "A Class III Cultural Resources Reconnaissance of 18 USGS Water Gage Stations for the Yucca Mountain Site Characterization Project, Southwest Nevada."
4. SR061491-1: "A Class III Cultural Resources Reconnaissance of a Proposed National Seismic Station on Shoshone Mountain, Nevada Test Site, Nye County, Nevada."
5. SR081391-1: "A Class III Cultural Resources Reconnaissance of the Small Mammal Study Plot Expansion in Crater Flat."
6. SR091391-1: "A Class III Cultural Resources Reconnaissance of NPS Monitoring Well JF-3, Fortymile Wash, Area 25, Nevada Test Site, Nye County, Nevada."
7. SR091991-1: "A Class III Cultural Resources Reconnaissance of a Prototype Bore Hole at the South End of Yucca Mountain."

8. SR100291-1: "A Class III Cultural Resources Reconnaissance of Six Proposed Neutron Bore Hole Locations Associated with the Yucca Mountain Site Characterization Project, Nye County, Nevada."
9. SR100991-1: "A Class III Cultural Resources Reconnaissance of the VH-1 Well Vicinity."
10. SR110891-1: "A Class III Cultural Resources Reconnaissance of Alice Hill Topsoil Storage Area for the Yucca Mountain Project, Southwest Nevada."
11. SR112691-1: "A Class III Cultural Resources Reconnaissance of Eight Additional Soil Pits near Lathrop Wells Cinder Cone, Nye County, Nevada."
12. SR120391-1: "A Class III Cultural Resources Reconnaissance of a Rock and Soils Testing Area in Support of the Exploratory Studies Facility on the East Side of Exile Hill, Area 25, Nevada Test Site, Nye County, Nevada."
13. SR121791-1: "A Class III Cultural Resources Reconnaissance of Vertical Seismic Profile Drillhole UE-25 UZ-16 (VSP-2) in Support of the Yucca Mountain Site Characterization Project, Southwest Nevada."
14. SR123191-1: "A Class III Cultural Resources Reconnaissance of Fortymile Wash Borrow Pit in Support of Soil and Rock Properties Investigations for the Yucca Mountain Project, Southwest Nevada."
15. SR121191-1: "A Class III Cultural Resources Reconnaissance of 11 Proposed USGS Seismic Stations on Bureau of Land Management (BLM) Stateline Resource Area Lands, BLM Tonopah Resource Area Lands, and the Nevada Test Site in Support of Yucca Mountain Site Characterization Activities."
16. SR042792-1: "A Class III Cultural Resources Reconnaissance of Proposed Pavement Studies on the West Side of Busted Butte, Nye County, Nevada."
17. SR043092-1: "A Class III Cultural Resources Reconnaissance of 52 Phase II Soil and Rock Properties Test Pit Excavations in Support of the Exploratory Studies Facility for the Yucca Mountain Project, Area 23, Nevada Test Site, Nye County, Nevada."
18. SR061192-1: "A Class III Cultural Resources Reconnaissance of the Bit Test Program Source Area in Support of Yucca Mountain Site Characterization Project, Nye County, Nevada."
19. SR062491-2: "A Class III Cultural Resources Reconnaissance of Yucca Wash, Sever Wash, Fortymile Wash and Portions of Tonopah Wash and Fortymile Canyon for USGS Flood Chasing Activities, Yucca Mountain Project Area, Nye County, Nevada."
20. SR042792-1: "A Class III Cultural Resources Reconnaissance of Proposed Pavement Studies on the West Side of Busted Butte, Nye County, Nevada."
21. SR043092-1-2: "A Class III Cultural Resources Reconnaissance of 52 Phase II Soil and Rock Properties Test Pit Excavations in Support of the Exploratory Studies Facility for the Yucca Mountain Project, Area 25, Nevada Test Site, Nye County, Nevada."

22. SR050592-1: "A Class III Cultural Resources Reconnaissance of an Area Proposed for a Surface Water Gaging Station Along the Amargosa River, Inyo County, County, California."
23. SR061192-1: "A Class III Cultural Resources Reconnaissance of the Bit Test Program Source Area in Support of the Yucca Mountain Site Characterization Project, Nye County, Nevada."
24. SR061692-1: "A Class III Cultural Resources Reconnaissance of Six Proposed Trenches in the Crater Flat and Yucca Mountain Area, Nye County, Nevada."
25. SR061892-1: "A Class III Cultural Resources Reconnaissance of Drill Hole UE-25 NRG-6 in Support of the Yucca Mountain Site Characterization Project, Nye County, Nevada."
26. SR062592-1: "A Class III Cultural Resources Reconnaissance of Four Specialized Water Sampling Stations in Support of the Yucca Mountain Site Characterization Project, Nye County, Nevada."

FY 1992 Budget Summary Yucca Mountain Archaeology

Characterization of Nevada Paleofaunas

Stephanie Livingston

Project Description

One feature of the Yucca Mountain area that makes it attractive as a potential repository site is the hot, dry climate. However, whether or not it is reasonable to assume that this type of climate will prevail for the next 10,000 or more years that the repository must remain intact remains to be established. One approach to addressing this question is to find out how the climate at Yucca Mountain has changed over the past 10,000 years. This information should give some indication of the climatic changes that might occur in the next 10,000 years.

Direct measurements of weather conditions in Nevada are only available for the last 150 years or so, not nearly long enough to provide a record of climatic cycles. Consequently, the long-term record of past climate change must be inferred from surrogate climatic data. Pollen profiles, woodrat midden contents, and tree-ring sequences are typically used as sources of surrogate climate data.

The goal of this study is to construct a history of mammals and other vertebrates that provides empirical evidence of past environmental and climatic conditions within the Great Basin. The study will be limited to characterizing the fauna of the Great Basin during the last 10,000 to 12,000 years, and will focus on monitoring faunal changes that relate to regional, rather than local, environmental conditions. Regional faunal changes routinely occur with changes in vegetation and other environmental indicators and reflect climatic change.

Vertebrate materials usable for monitoring environmental change are bones and teeth recovered from datable deposits. Small mammals are preferred because they can survive and reproduce only under relatively limited environmental conditions, and they cannot migrate long distances quickly in response to environmental stress. Also, their bones and teeth are relatively easy to identify and often occur in well-preserved deposits in large enough numbers to provide statistically reliable samples. Small mammal remains can be obtained from archaeological sites and paleontological sites. This project will focus on changes in the taxonomic composition of faunas from both types of sites in various parts of the Great Basin and on morphological change within individual taxa at specific localities. Such changes reflect the response of animals to changing environmental conditions.

Interpreting the changes observed in the paleofaunal record depends on understanding the circumstances under which similar changes occur in living animals. Data are being obtained from published records, modern museum specimens, and raptor pellets to provide a modern control for comparative studies.

This study, then, will provide an independent set of surrogate data for use in modeling future climate. When combined with evidence obtained from vegetation, sediments, and other climate-sensitive materials, the results should be useful for modeling changes likely to occur in the next 10,000 years and for estimating the effect of the changes on the hydrology of the Yucca Mountain area.

Progress on Tasks

Task 1. Complete a review of the literature on existing applications of faunal data to climatic studies.

First Quarter: A draft of the literature review is being reviewed at DRI and will be submitted to DOE after it is revised.

Second Quarter: The review is essentially complete, and it will be delivered whenever funding for this project is received from DOE.

Task 2. Collect data from existing paleofaunal and modern collections.

No work was done on this task in FY 1992 because funding was not received and QA requirements have not been determined.

Task 3. Collect modern, archaeological, and paleontological materials in the field to fill in data gaps.

First Quarter: The collection of field material was minimal because of uncertainties about funding and QA requirements.

No further work was done on this task in FY 1992.

Task 4. Determine the ages of any collected materials and conduct other special analyses, as necessary.

No work was done on this task in FY 1992.

Task 5. Make a preliminary compilation of the available data.

No work was done on this task in FY 1992

Status of Deliverables

1. Literature review of existing applications of faunal data to climatic studies (3/31/92).
Will be submitted to DOE as soon as project funding has been received.	Delayed
2. Report on the location and content of existing paleofaunal records and collections (9/30/92).	Delayed
3. Report on morphological variation among populations of the modern Great Basin species useful for monitoring changes (9/30/92).	Delayed

All deliverables were delayed because the lack of project funding postponed the start of work.

Problems Encountered

First and Second Quarters: Negotiations regarding the QA responsibilities of the project have not been completed. The funding available for conducting this project in FY 1992 is still uncertain.

Third Quarter: Funding still has not been received.

Fourth Quarter: Funding was not received until the last week of the quarter.

**FY 1992 Budget Summary
YMPO Faunal History**

Identification of Flood Hazard Zones along Rail Corridors

Richard H. French

Project Description

Alluvial fans, a common and often dominant landform in the arid and semi-arid southwestern United States, are cone-shaped accumulations of sediment at the bases of desert mountain ranges. Rainfall in the steep mountain watershed above the apex of an alluvial fan can result in high-velocity flash flooding in self-formed channels at random locations on the fan's surface. The goal of this project is to develop and verify a method of drainage design to protect the Yucca Mountain rail transportation system from flooding on alluvial fans.

In the previous two years of the project, the literature on the subject was reviewed and a drainage design methodology was developed. Two articles describing the method have been written and submitted to journals for publication. The project is now in the verification phase.

The strategy for verification is to identify a limited number of existing or historical railroad or similar transportation alignments that cross alluvial fans, then examine maintenance records to determine the performance of the drainage facilities protecting those alignments. The actual performance of the facilities will then be compared with the performance predicted by the design methodology. For example, if the drainage analysis using the design methodology shows that the drainage protection for an existing alignment is adequate, and the alignment has not been damaged, this is evidence that the methodology provides reasonable results. If the drainage analysis shows that the drainage protection is not adequate and the alignment has been damaged, this is also evidence that the methodology is valid. Conversely, if the predicted performance and the actual performance of the facility do not agree, this would suggest that the methodology is not valid. This approach to verification is both practical and cost-effective, particularly in the case of transportation alignments that have been in place for long periods and which have detailed maintenance records.

Progress on Tasks

Task 1. Complete the verification study of the drainage design methodology.

First Quarter: A preliminary database was compiled and drainage analyses performed for 20 potential study transportation alignments for verification and validation of the methodology. The potential sites include portions of the Union Pacific Railroad (UPRR), Southern Pacific Railroad, Coachella Canal, Colorado River Aqueduct alignments, and the Santa Fe Railroad. All sites have been field checked. Contact has been made with most of the relevant agencies to request the maintenance records for these alignments. At this time, records have been received for the UPRR and Coachella Canal. No records are available for the Southern Pacific Railroad alignments.

Second Quarter: This task has been completed.

Task 2. Prepare a report or journal article describing the drainage design methodology.

First Quarter: Two papers have been written and accepted for publication.

Task 3. Prepare a report or a journal article describing the results of the verification study.

First Quarter: Two papers have been accepted for presentation at the ASCE National Conference on Hydraulic Engineering. The proceedings are tentatively scheduled for publication in August 1992.

Task 4. Begin developing a generic process-oriented model to further understanding of the hydrologic and hydraulic processes that result in hazards to transportation alignments on alluvial fans.

This task was deleted due to budget limitations.

Status of Deliverables

1. Report or journal article on the drainage design methodology (3/31/92).	Completed

The following peer-reviewed papers have been published:

French, R. H., 1992. Design of Flood Protection for Transportation Alignments on Alluvial Fans. American Society of Civil Engineers, *Journal of the Irrigation and Drainage Division*, Vol. 118(2), pp. 320-330.

French, R. H., 1992. Preferred Directions of Flow on Alluvial Fans. American Society of Civil Engineers, *Journal of Hydraulic Engineering*, pp. 1002-1013.

2. Report or journal article on the verification study (6/30/92).	Completed

The following article has been submitted:

Flippin, S.J. and French, R.H. Verification of an Alluvial Fan Drainage Design Methodology for Transportation Alignments. Submitted to American Society of Civil Engineers, *Journal of the Irrigation and Drainage Division*.

Two papers will also appear in conference proceedings:

Flippin, S.J. and French, R.H., 1992. Verification of an Alluvial Fan Drainage Design Methodology for Transportation Alignments. In: ASCE, *Proceedings of the Hydraulic Engineering Sessions at Water Forum '92*, M. Jennings and N.G. Bhowmik, editors. pp. 575-580.

French, R.H. and Keaton, J.R., 1992. Successful Interactions between Hydraulic Engineering and Geomorphology in Identifying Flood Hazard Areas in the Southwestern United States. In: ASCE, *Proceedings of the Hydraulic Engineering Sessions at Water Forum '92*, M. Jennings and N.G. Bhowmik, editors. pp. 581-586.

3. Letter report and proposal on the development of a process-oriented model (9/30/92).

Cancelled

This report has been cancelled due to budget limitations.

Problems Encountered

First and Second Quarters: The budget remains in limbo. This situation is affecting work on the project.

FY 1992 Budget Summary
YMPO Flood Hazard

Enhancement of Regional Climate Modeling

Melanie Wetzel

Project Description

The Yucca Mountain Project climate program consists of studies designed to provide data on past, present, and future climate conditions and to determine the effects of climate change on the hydrology of the area. One objective of these studies is to predict values of climatic parameters for the Yucca Mountain area over the next 100,000 years, with emphasis on the next 10,000 years. These parameter values will then be used in the hydrologic modeling of the groundwater system and in the investigation of the effects of future climate on erosion.

An important tool for climate prediction is a regional-scale numerical climatic model, a mathematical description of the earth's atmospheric circulation based on equations of fluid flow and specific boundary conditions. Before being used to model future climates, a climatic model must be validated with data from past and current climates. The models under consideration for the Yucca Mountain Project are being validated in a two-step process. The first step is to establish that each model can adequately simulate current climatic conditions over the southern Great Basin. This step emphasizes the amounts and seasonal patterns of precipitation and other surface conditions. If the model is successful in these simulations, it is then tested against paleoclimatic conditions for periods for which adequate information is available. If it passes this second step, the model would be considered suitable for generating future climate scenarios for the Yucca Mountain area.

The Yucca Mountain Program is currently using the National Center for Atmospheric Research (NCAR) Community Climate Model (CCM) and the NCAR/Penn State mesoscale model (MM4) to simulate regional climate conditions during important periods, particularly El Nino events. With a 60-km resolution, the MM4 resolves topographic features such as the Sierra Nevada, which the CCM does not. The most critical aspect of the models is the accuracy of rainfall simulations. In simulations of storms during three winters, both the CCM and the MM4 overestimated the amount of precipitation at Yucca Mountain. This would lead to biases in the seasonal and per-storm estimates of soil moisture infiltration. The overestimates can be more easily understood and corrected by a combined analysis of the cloud and precipitation patterns observed during individual storm events, and a similar analysis over weekly and monthly time periods.

In this project, a climatological database of cloud cover information from meteorological satellites will be developed for the specific time periods and the grid area used with the regional climate model simulations. This database will then be used in testing and validating the climate model results.

The data for the database will be obtained from the satellite data archive of the International Satellite Cloud Climatology Project (ISCCP). Both climate model results and satellite data are available for time periods during 1983, 1988, and 1989. This study will focus initially on the latter half of 1988 in order to utilize some improvements in the climate model results. The region of study will be defined as the area enclosed by the four CCM grid points adjacent to the Yucca Mountain region (Sacramento, Bryce Canyon, Santa Barbara, and Phoenix). A spatial resolution of 30 km is

planned for this analysis, but ISCCP data at 10-km resolution are also available if necessary for detailed study of mesoscale summer convection. At a 30-km resolution, the area will include approximately 384 grid cells of cloud cover data.

The ISCCP data to be used are calibrated radiances in the visible and infrared taken at 3-hour intervals (00, 03, 06, 09, 12, 15, 18, and 21 UTC). The radiance data will be converted to cloud cover information with techniques established by the ISCCP to discriminate clear and cloudy conditions. These procedures include the use of radiance histograms, temporal and spatial variances, and bispectral (visible and infrared) radiance thresholds. Correlative data available from ISCCP as well as the DRI Western Regional Climate Center (WRCC) will be used to support the clear/cloudy identification. The ISCCP correlative data include vertical temperature and moisture profiles from NOAA's TIROS Operational Vertical Sounder, weekly snow cover analyses, ozone column concentrations, and three-hourly surface reports. The WRCC data archive contains higher-density regional surface measurements, including snow distribution data, hourly temperature and precipitation readings, and National Weather Service rawinsonde vertical profiles.

Once the cloud cover database has been created, it will be used in the validation of the regional climate model results. The analysis will entail a quantitative comparison of the areal extent of cloud coverage obtained from the satellite data with the model results. The differences between the model and satellite results will then be examined to give a qualitative description of the large-scale meteorological conditions under which the differences are significant. Both diurnal and day-to-day variation in the observed cloud fields will be related to the modeled occurrence of cloud systems. The high time resolution of the satellite data allows the entire evolution and passage of frontal systems to be compared to model results. Systematic errors in the generation of cloud cover may be identified, leading to modification of the model to improve precipitation estimates at individual sites.

The cloud cover climatology will be compiled at DRI. After the compilation is complete, about 10 days will be spent at NCAR incorporating the satellite data into the model validation effort. This phase of the project will be coordinated with Dr. Starley Thompson of NCAR, who is leading the regional climate modeling project.

The cloud cover database can also be useful in meteorological and paleoclimatic applications to the study region. It will provide a spatially homogeneous record of cloud occurrence, and thus can be related to the geographical distributions of factors controlling the production of clouds and precipitation, such as topography, or factors directly affected by cloud cover, such as vegetation distribution and evapotranspiration.

Progress on Tasks

Task 1. Purchase satellite image data from the ISCCP archive at the National Environmental Satellite, Data and Information Service, or other sources.

First Quarter: Additional satellite cloud cover data for the western U.S. have been obtained from Metsat, Inc., to provide case study data for comparison with the climate model results.

Second Quarter: No work was done on this task due to pending notification of continued funding from DOE. Funds are expected to become available during the upcoming quarter.

Third Quarter: The satellite cloud cover data sets which had been previously obtained are being used for the analysis tasks below. Additional data will be procured if needed.

Fourth Quarter: The GOES satellite cloud climatology data acquired during FY 1992 have been used to make analyses for one case study in the summer of 1988. We are in the process of acquiring data for at least three more case studies.

Task 2. Obtain NCAR regional climate model results and produce data fields of total cloud cover for times which overlap the satellite data.

First Quarter: Data arrays of cloud cover for the climate model gridded fields have been extracted from the NCAR regional climate simulation results for specific case studies. These data arrays have been transformed into raster images which can be displayed on the DRI Sun color workstations for analysis.

Second Quarter: No work was done on this task.

Third Quarter: Cloud cover data files have been produced from the NCAR climate model results, as planned. In addition, software has been written which produces scaled-value raster images of the cloud cover for use in color image display procedures. This task is now complete.

Task 3. Develop methods to process, display, and statistically analyze the satellite-derived cloud cover fields and the climate model data fields.

First Quarter: Software has been developed for initial processing of the satellite and climate model cloud cover fields. We have not yet determined whether GIS analysis software will be useful in comparing these data sets.

Second Quarter: No work was done on this task.

Third Quarter: The model-derived and observed cloud cover data sets have differing map projections and spatial resolution. Therefore, we have been evaluating possible methods of co-registering these data sets. We have found that the ARC/INFO GIS software is useful in registering multiple data sets, but provides little capability in image visualization. We have also begun evaluation of ERMMapper image processing software for the same purpose. The modeled and observed cloud cover can be viewed and treated as 8-bit image data without loss of information, due to the relatively small range of values for this parameter.

Fourth Quarter: Both the ARC/INFO software and image processing software have been used to display and interpret the climate modeling results and satellite cloud cover data. Each has advantages, with the GIS software providing diverse remapping

database manipulation and the image processing software allowing more adaptable color enhancement capabilities. The satellite data have been sampled to produce percentage cloud cover values within the map grid cells of the climate model results. The two data types have been remapped into a common (Lambert Conformal) map projection. Publication-quality plots can now be made of the gridded model results, satellite cloud cover, and other derived data fields.

Task 4. Develop procedures for comparing the cloud cover and precipitation fields for specific time periods, and evaluate the observed variability and differences in the data sets.

First Quarter: Software is being developed for statistical comparison of the raw cloud cover data fields. This software will include the presentation of histograms and bivariate relationships between the observed and model cloud cover as functions of elevation and time of day, because these parameters exert a large control over cloud development.

Second Quarter: No work was done on this task.

Third Quarter: Procedures for comparing the observed and modeled cloud cover will make use of areal differencing and statistical correlation. Parameters which have been chosen for the intercomparison include numerical summaries of the differences between areal cloud cover in the model-derived and observed data sets. Second, a correlation will be sought between the cloud cover difference field and surface elevation. Third, we will identify specific cloud features (such as fronts and isolated thunderstorms) which contribute to cloud cover differences.

Fourth Quarter: Comparison of satellite-observed cloud cover and climate model results has been made for a case study, using time differences of the areal distributions of cloud cover, correlations between observed and predicted cloud cover, between observed cloud cover and elevation, and between point differences (observed-predicted cloud cover) and elevation, and other parameters. Finally, subjective comparisons have been made between the development of summer convective cloudiness patterns in the observations and the model predictions. The initial comparisons show generally good correspondence between model and observed cloud cover for afternoon convective buildup in the Great Basin region. An abstract of this research has been accepted to the American Meteorology Society Conference on Applied Climatology, to be held in January 1993. The case studies now under analysis will be presented at this conference.

In addition to the cloud cover comparison, we have initiated work for a comparison between predicted and measured precipitation amounts for the case study days.

Status of Deliverables

1. Report on the availability of satellite climatology databases and supporting information (9/30/92).	Delayed
2. Report on the comparison of satellite-derived cloud cover and model-generated cloud fields within the time periods used for the Yucca Mountain climate simulations (9/30/92).	Delayed
3. Recommendations on possible modifications of the climate model so it better represents the distribution of clouds, precipitation, and atmospheric radiation (9/30/92).	Delayed

All deliverables have been postponed until FY 1993 because of the delay in funding for this project in FY 1992.

Problems Encountered

- First Quarter:* Work on this project has been slowed due to lack of funds. The work was officially authorized in the third quarter of FY 1991, but contract funds have not yet been provided by DOE. The research will be suspended if funds are not allocated this quarter.
- Second Quarter:* Work on this project has been suspended because funds have not been provided by DOE. Due dates for all deliverables have been revised to reflect the delay in funding.
- Third Quarter:* Work on this project has been slowed due to lack of fund allocation. According to the DOE Program Manager at DRI, funds will be available to complete the project during this fiscal year. Hence, we are continuing the research tasks on the assumption of pending funds.

FY 1992 Budget Summary
YMPO Climate Model