PROJECT PLAN FOR RESEARCH ON TECTONIC PROCESSES IN THE CENTRAL BASIN AND RANGE REGION

Prepared for

Nuclear Regulatory Commission
Contract NRC-02-93-005

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Revision 0
Change 6

March 1994

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES	Revision: 0 Change: 6 Date: March 1994

Title: PROJECT PLAN FOR RESEARCH ON TECTONIC PROCESSES IN THE CENTRAL BASIN AND RANGE REGION

EFFECTIVITY

Revision 0 of this document became effective on December 9, 1992.
This document consists of the pages and changes listed below.

Page No.	Change No.	Date Effective
Title Page	6	03/15/94
ii – iv	6	03/15/94
v	3	07/30/93
vi	0	12/09/92
1 – 16	0	12/09/92
17 – 20	6	03/15/94
21 – 22	1	03/19/93
23 – 24	6	03/15/94
25	5	12/10/93
26	3	07/30/93
27	0	12/09/92
28	6	03/15/94
29	0	12/09/92
30	6	03/15/94
31	0	12/09/92
32 – 36	6	03/15/94
A-1	4	09/25/93
A-2 – A-9	6	03/15/94

Supercedes: Revision 0, Change 5 - December 1993

Director of Administration	Date: 3/14/94	Deputy Technical Director for SE&I	Date: 3/12/94
Director of QA	Date: 3/12/94	Technical Director	Date: 3/12/94

CNWRA Form QAP-15-1 (8/91)

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES	Revision: 0 Change: 6 Date: March 1994

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Revision 0 of this document became effective on December 9, 1992.
This document consists of the pages and changes listed below.

Page No.	Change No.	Date Effective
A-10 – A-17	4	9/25/93

Supercedes: Revision 0, Change 5 - December 1993

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3.1.4 Task 4: Field Investigations to Assess Estimates of Late Neogene and Quaternary Strain and to Support Development and Assessment of Alternative Models of Late Neogene through Quaternary, and Contemporary Tectonic Development of the Central Basin and Range Region

3.1.4.1 Objective

The primary objectives of Task 4 are to utilize field investigations to: (i) assess estimates of late Neogene and Quaternary rates and patterns of distributed crustal-scale extensional deformation in the central Basin and Range region, inclusive of the Yucca Mountain area; (ii) use geodetic measurements to assess existing estimates of contemporary rates and patterns of distributed crustal deformation; (iii) support development and assessment of alternative models of faulting and seismo-tectonic processes; (iv) identify and describe areas within the central Basin and Range region which may be useful as structural/tectonic analogs of the proposed Yucca Mountain site; (v) determine the type and extent of tectonic deformation associated directly with the 1992 [M_s7.5 (surface-wave magnitude)] Landers earthquake and determine implications for Yucca Mountain; and (vi) identify and describe possible field localities for analysis of coupled faulting and dike intrusion. This task will focus on development of a well documented regional-scale model of the tectonic evolution of the Central Basin and Range area, including Yucca Mountain. Special emphasis will be on identification and description of tectonic processes operative through the late Neogene and Quaternary geologic history of the region. Changes in the style and rates of tectonic processes important to assessment of contemporary conditions and to estimation of probabilities of future conditions will be investigated. Critical field tests of certain existing concepts of faulting and extensional tectonics, and of models developed or considered in Task 6 of this research project will be developed and applied.

3.1.4.2 Justification

Task 4 field work will directly support development and assessment of regional-scale alternative tectonic models in Task 6 of this work plan, and will contribute substantially to structural models of faulting and associated deformation of Yucca Mountain being developed in Task 3 of the FY93-94 CNWRA Operations Plan for the DHLWM Geologic Setting Element. Effective models of tectonic processes and events and of resultant structural deformation of earth's crust must include consideration of both evolution and current state of the system. The present-day structural configuration of Yucca Mountain, including the shape and distribution of faults and rotated fault blocks, is the net result of processes that have operated over a period of about 20 my. To estimate probabilities of recurrence of geologic patterns of faulting versus development of new patterns in response to changed conditions, applicable models must include changes of *in-situ* strain conditions and displacement patterns. Assessment of uncertainties related to changes in extent, direction, and patterns of *in-situ* stress, strain, and displacement conditions will depend strongly on studies conducted to refine details of regional and local tectonic evolution.

Late Neogene and Quaternary strain rates and displacement patterns within the Yucca Mountain area may be better constrained by determining the age and patterns of structural separation of correlative piercing points formed by the intersection of certain types of geologic features (such as faults, fold axes, stratigraphic markers and volcanic flow structures), and by integrating field studies and models of fault geometry and evolution. Such studies in the Death Valley and Central Basin and Range regions have been successful in estimating Cenozoic rates and magnitudes of extensional tectonic deformation (Hamilton, 1988; Wernicke et al., 1986; Wernicke et al., 1988a; Kruse et al., 1991). Field studies of fault shape and displacement patterns in tectonic domains that are structurally analogous to Yucca Mountain may play an important role in development, review and assessment of alternative models of tectonic deformation. Further, these studies will elucidate, and perhaps substantially resolve, some of the uncertainty inherent in application of interpreted subsurface information to scenario development and IPA. Field studies of coupled faulting and dike intrusion at different levels in intrusive and volcanic systems may help to clarify our understanding of factors that control coupling of faulting and intrusion, which may aid in evaluation of both seismic and volcanic risks at Yucca Mountain.

Field studies conducted to assess estimates of critical tectonic parameters, and to assist in development of alternative models and scenarios of tectonic deformation will help to provide the necessary basis for reviewing DOE's study plans, data and models. Confirmatory field studies also may assist in identifying key tectonic data and models that may be of particular use to the NRC for independent performance assessments.

3.1.4.3 Activities

Focused field investigations will be conducted to support assessment of estimated rates, patterns, and styles of extensional deformation in the Yucca Mountain area. Specific field activities may depend on results of the literature review, data assessment, and modeling tasks of this project.

CNWRA and NRC staff may participate in an on-going, NRC-funded GPS project managed by Brian Wernicke (California Institute of Technology). Geodetic surveys are being conducted by Wernicke to assess estimated rates and patterns of contemporary strain. This work consists of placement and periodic position measurements of a set of geodetic benchmark stations in a transect across Yucca Mountain. The GPS system is utilized to precisely determine the position of the benchmark stations through time. Participation in this project is initially for one year (FY94). Continued participation or expansion of involvement in the project will be evaluated at the end of this initial year. Based on this evaluation, a research project plan may be proposed for GPS-based geodynamic research in the central Basin and Range region. It is estimated that about 5 to 10 years of measurements are required for reliable resolution of the instantaneous displacement field. Thus, decisions based on the initial involvement in the project will have long-term implications. Data acquired by this activity may be very important in evaluating potential natural hazards due to fault rupture, earthquake seismicity, and igneous activity. Seismic and aseismic fault slip, and igneous eruptive activity may be directly related to rates and patterns of strain accumulation.

The Black Mountains area of the Death Valley region has been suggested as a possible tectonic analog to the deep structural setting beneath Yucca Mountain (Wernicke, personal communication). The Black Mountains are in a strongly extended tectonic domain, and thus have been rotated and deeply eroded. Consequently, deep structural levels of the fault block are now exposed at the surface. Preliminary field studies may be conducted to determine the applicability of the Black Mountains as an overall structural geologic analog of the Yucca Mountain area. The initial approach will be a reconnaissance survey of the Black Mountains to determine the type and extent of geologic structures observable in outcrop. Special emphasis will be placed on fault geometry and interactions between igneous systems, particularly mafic dikes, and the faulting process. Based on the preliminary survey, specific field sites may be identified for more detailed study. The primary objective here is to observe the style and distribution of faults and associated igneous intrusive structures that may be similar to those in the subsurface below Yucca Mountain. These observed field relationships will be an important part of alternative tectonic model development and assessment.

A timely and perhaps unique opportunity is presented by the 1992 Landers earthquake because the overall geometry and slip pattern of faults in the Landers area may be similar to the a northern Death Valley-Furnace Creek fault zone. The Landers event caused right-lateral slip of an *en echelon* array of strike-slip (transform) faults in the Mojave Desert northeast of the San Andreas fault. Also, the Landers rupture triggered slip on nearby fault systems and may have resulted in distributed extensional deformation east of the rupture zone. Deformation associated with this earthquake may be similar to that expected for a comparable event on the northern Death Valley-Furnace Creek fault zone, approximately 50 km southwest of Yucca Mountain. In conjunction with review of the emerging literature, a field study program will be conducted to survey the orientation and distribution of slip on faults east of the Landers rupture. The Landers earthquake may be the single best modern tectonic-deformation process analog currently available for the Yucca Mountain region.

Several potential field localities are under consideration for studying coupled faulting and dike intrusion. The Black Mountains were mentioned earlier as a possible location to study interaction between faults and mafic dikes interpreted to exist beneath a volcanic field. Other possible locations to study fault and dike interaction are the Saline Range (California) and the Reveille Range (Nevada). The relationships between faults and cinder cones at the surface can be studied in Owens Valley (California) at the Coso and Big Pine Volcanic fields, and at Cima Volcanic field (California), southeast of the eastern surface termination of the Garlock fault. The Mesa Butte cinder cone on the Mesa Butte fault in San Francisco Volcanic field (Arizona) appears from areal photographs to be a well-exposed example of the surface manifestation of fault and dike interaction and has been chosen as a strong candidate for detailed field study. A field program will be carried out to identify and study examples of coupling of faulting and dike intrusion processes which could be used to test conceptual and finite element models of fault and dike interaction, to improve our understanding of regional tectonic processes in the Central Basin and Range, and potentially to develop new or improved models. An increased understanding of fault and dike interaction will assist in the evaluation of seismic and volcanic risk at Yucca Mountain. Scenarios of fault-dike interaction currently being considered are: (i) fault surface as conduit for magma ascent; and (ii) fault slip associated with magma intrusion into the fault zone. The goal is to improve our ability to determine the extent to which processes of faulting and dike intrusion may interact and thus effect estimates of occurrence and consequence.

Based on the results of model development in Task 6 of this project, additional field studies may be defined to test certain hypotheses. It is anticipated that alternative models of tectonic deformation developed or refined as part of this research project will have some predictive utility. That is, such models may predict certain geologic relationships or conditions that are observable in the field. Data required to test such models may not be available from the literature, or may not have been acquired. Thus, directed field investigations would be necessary to properly evaluate the models. Reconnaissance field studies may be conducted to identify sites appropriate for detailed field investigations. A detailed work plan will then be prepared for approval of the NRC project officer.

The results of field studies conducted in support of ongoing data assessment and modeling work will be reported in scheduled CNWRA semi-annual reports on research activities.

3.1.5 Task 5: Assessment of Geochronological Methods for Dating and Characterizing Fault Slip and Seismic Events

3.1.5.1 Objective

The primary objective of this task is to assess the utility and reliability of methods used to determine the slip history of faulting and to estimate the ages of seismic (earthquake) slip events on faults. Assumptions, sources of uncertainty and limitations related specifically to field methods employed to determine fault slip will be thoroughly documented. In particular, this task will focus mainly on field geological methods used to determine direction and magnitude of slip on faults and fault zones, and on the subsequent use of dates and ages of geologic materials to establish a chronology of slip along fault systems.

This task will depend in part on results of a task in Volcanism Research (Major Milestone 20-5704-123-010) to critically review dating techniques. The Volcanic Systems Research Project task will focus on analytical methods used to determine isotopic, radiogenic and other types of absolute and relative ages of rocks. The Tectonics Research task will review and assess the use of these ages in conjunction with field studies of fault zones to determine fault slip chronology.

3.1.5.2 Justification

NRC staff may need to assess uncertainties in estimates of the ages of fault slip and earthquake events. Such age estimates may be an important part of seismic and ground-rupture hazard assessments. Estimating probabilities of future seismic slip and fault rupture on any specific fault system depends in part on knowledge of the amount, direction and rate of slip along the fault surface. Moreover, characterization of the slip history of a fault system is an important source of uncertainty in estimates of risk due to potential fault rupture and earthquake seismicity. Quaternary faulting at Yucca Mountain is investigated primarily by mapping fault patterns exposed in trenches excavated into Quaternary alluvium. Fault patterns mapped in unconsolidated or weakly indurated alluvium are often complex, and it is difficult to relate the pattern to the geometry and slip history of the underlying bedrock fault. The mechanics of propagation of bedrock faults through overlying alluvium, and therefore related problems in determining slip history, is considered to be a Key Technical Uncertainty in the Compliance Determination Strategy (CDS) on Potentially Adverse Condition - Structural Deformation [10 CFR 60.112(c)(11)].

Conceptually, fault systems may be envisioned to accumulate slip in either continuous (creep) or episodic (stick-slip) modes. Earthquakes result from large scale stick-slip movement along faults. Historic earthquake rupture of a fault system is strong evidence that the fault moves characteristically by stick-slip, and a record of historic events may be used to establish a characteristic time period over which earthquake events recur along a specific fault system. However, interpretation of prehistoric earthquake rupture requires detailed study of disrupted soil and stratigraphic horizons within and adjacent to the fault. Field methods are not available to reliably identify slip mode, or even to distinguish between end-member modes of fault slip. Interpretation of the occurrence and periodicity of prehistoric earthquake slip often depends heavily on studies of fault-scarp degradation, discernment of rupture-related sediments adjacent to the fault, dating of secondary mineralization within the fault zone, and measurement of average slip rates. Average slip rate is generally calculated by dividing a measured increment of slip by the time period over which the slip accumulated. Average slip rate alone may be a significant indicator of seismic risk; instantaneous rates, which may have been seismic, are generally not directly discernable. There are two main sources of substantial uncertainty in estimates of average slip rate. The first is in measurement of the total and incremental slip vectors (i.e., direction and magnitude) determined from relative displacement of geological markers offset by the fault. The second is in estimation of the age of these markers. In essence then, uncertainties in ages of fault movement may be classified as related either to i) the geology of the site, or ii) the analytical methods used to obtain absolute dates of rock samples.

At Yucca Mountain, Quaternary fault slip is currently being investigated by detailed cross-section mapping of trenches emplaced across fault zones. Consequently, stratigraphic horizons within the depositionally complex Quaternary alluvium must be correlated across an equally complex array of subsidiary faults and fractures that constitute the fault zone. Slip rate calculations are uncertain because it is difficult to determine the direction and amount of displacement of subtle stratigraphic markers in the alluvium. Once a displacement pattern is established, ages of displaced strata can be used to estimate average slip rates. Uncertainties related to determination of absolute ages will be addressed in the Volcanism Research task mentioned above. Accordingly, the focus of this task is on critical evaluation of the data and field methods available to characterize and distinguish seismic and aseismic slip of Quaternary fault systems.

independent development of alternative models of faulting, seismicity and coupled effects and independent assessment of faulting and tectonic deformation using these models are essential activities for the NRC to undertake.

3.1.6.3 Activities

Data on fault slip, earthquake seismicity and crustal-scale strain will be analyzed to determine if correlations exist on various spatial and temporal scales. Correlations are needed to estimate probabilities and effects of faulting and associated earthquake seismicity based on relationships to regional crustal scale strain determined from satellite and geodetic data. Alternative models of tectonic deformation and faulting also will be developed for the central Basin and Range region. These models will incorporate all data pertinent to the issue of future faulting and tectonic deformation in the vicinity of Yucca Mountain. Magnitudes and potential effects of changes in *in-situ* conditions will be investigated using information on the tectonic evolution of the area, contemporary conditions, and forward modeling. In particular, existing models of earthquake seismicity and faulting, and tectonic models used to assess hazards due to earthquakes and fault rupture will be tested against the database and models developed by this project. An important focus of this task is to produce quantitative models, and to utilize or develop methods to quantify uncertainty.

Analog modeling will be evaluated as a potential tool to aid in understanding 3-dimensional fault interaction within complex extensional and strike-slip fault systems. Recent use of x-ray tomography between stages in the incremental deformation of compressional analog models has revealed unsurpassed detail on the initiation and 3-dimensional evolution of faults in analog models (Colletta et al. 1991; Wilkerson et al. 1992). The x-ray tomography technique will be investigated along with analog modeling of extensional and strike-slip structures for use in improving understanding of extensional and strike-slip fault systems and to refine tectonic models of the Central Basin and Range region and the Yucca Mountain vicinity.

Results of this task will be reported in the scheduled CNWRA semi-annual report on research activities. The report will discuss analyses of data, and the development and utilization of resultant models.

3.1.7 Task 7: Semi-Annual Research Report Preparation

3.1.7.1 Objective

The objective of this task is to keep the NRC and the broader technical community informed concerning progress of this research project and to publish progress reports and results of the research in a timely manner. In addition, these reports also disseminate information to the public and to professional peers outside the NRC. This task is primarily intended to support cost of preparation and production of input from the research project into the CNWRA Semi-Annual Research Reports. This task will also support preparation of papers published in journals or proceedings, or presented at symposia and meetings.

3.1.7.2 Justification

Timely dissemination of information generated by CNWRA research projects to NRC and the scientific community is important, since the information may prove useful to other scientists and engineers working in HLW programs. Timely dissemination can provide CNWRA investigators with more rapid feedback from peers and other potential users of their results.

3.1.7.3 Activities

Reports on progress and results of this research project will be prepared and incorporated into the semi-annual *NRC High-Level Radioactive Waste Research at CNWRA* which is submitted to NRC. For the duration of this project, results will be reported in each of the CNWRA semi-annual research reports. The first report is scheduled for August of 1993. The last scheduled report will be in February of 1997. Each semi-annual research report will include project results and accomplishments for the previous six-month reporting period. Thus results of separate tasks may be included in a semi-annual report. In addition, papers will be prepared to publish significant results on approximately an annual basis.

3.2 SCHEDULES, MILESTONES, AND DELIVERABLES

Specific deliverables related to the tasks are listed in Table 3-1, with accompanying milestone number, milestone type, and completion date. In general, results of work done under specific tasks will be reported in the CNWRA Semi-Annual Research Reports, each of which is a scheduled Major Milestone. However, significant research results will be published as soon as possible. Publication of results in peer-reviewed journals or conference and symposia proceedings will meet Intermediate Milestones with dates to be determined (TBD) upon acceptance of the publication. The project is anticipated to generate one paper per year. This project is planned to extend from FY93 through FY96. Consequently, the project ends in February of 1997 with delivery of the final semi-annual research report, or with publication of the final paper.

Program Element. The manager of the Geologic Setting Program Element will have overall management responsibilities for this research project. Mr. Stephen R. Young will be the Principal Investigator.

This research project is to be conducted in seven tasks as described in the preceding sections. Support staff for both management of the project and execution of technical tasks are shown in Figure 4-2. Consultants are included to provide technical input and independent review of technical papers and reports generated as a result of this research project.

4.2 QUALITY ASSURAN

This research project will be conducted in accordance with applicable portions of the Center Quality Assurance Manual (CQAM) and applicable Operating Procedures. Quality Assurance (QA) requirements applicable to project activities are identified in the Quality Requirements Application Matrix,

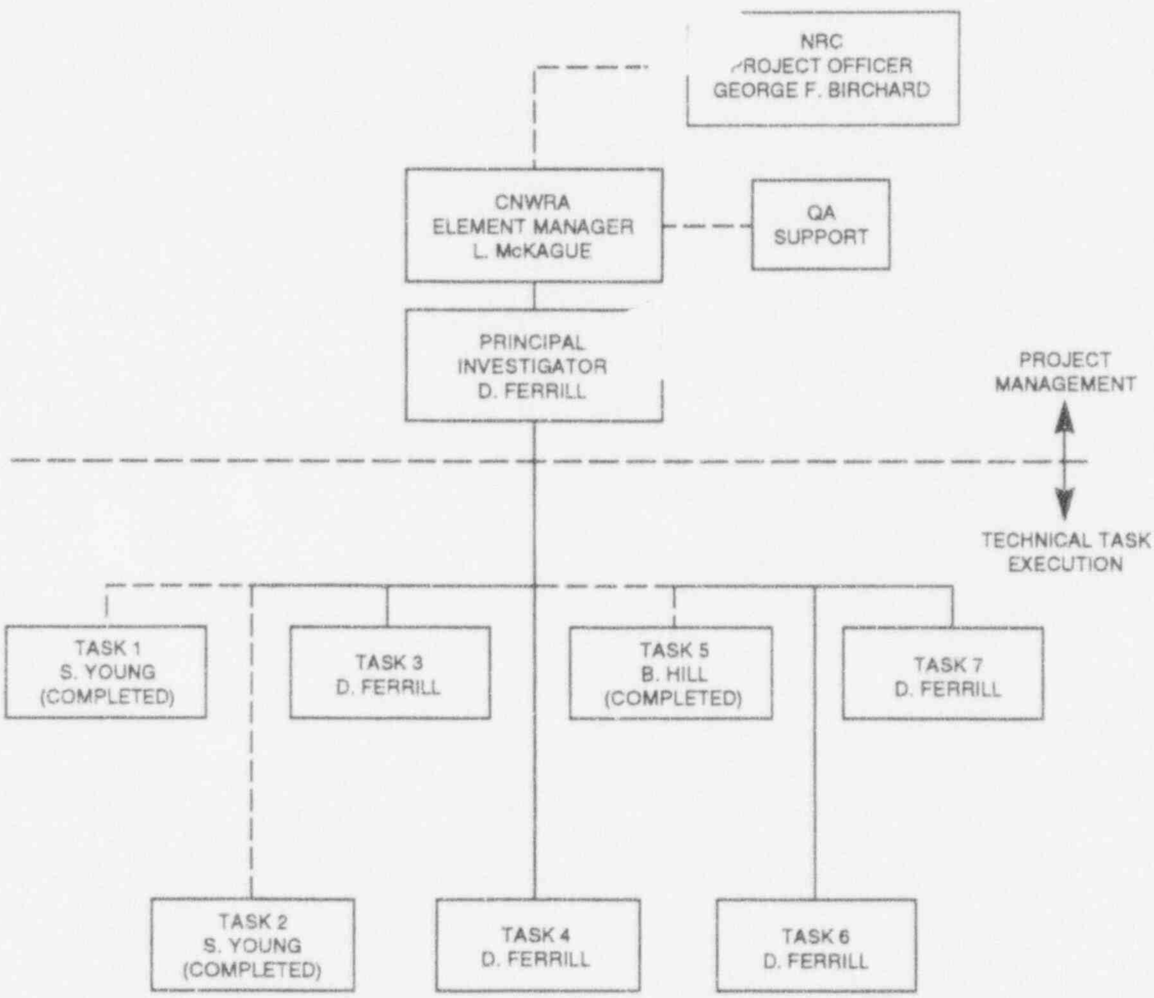

Figure 4-2. Project staff support

Repositories." Reports and supporting project documentation will be retained as QA records and maintained in accordance with QAP-012, "Quality Assurance Records Control."

4.3 PERSONNEL

A combination of Center staff and selected consultants will be required for execution of this research project through an approved project plan. The following CNWRA staff have been identified as essential personnel for successful execution of the work described in Section 3.1 of this project plan: Dr. H. Lawrence McKague (Project Manager), Dr. David A. Ferrill (Principal Investigator), Dr. Stephen R. Young, Mr. Renner Hofmann, Dr. David R. Turner, Mr. Ronald H. Martin, Dr. Brittain Hill, Dr. Charles Connor, and Dr. Bret Leslie. In addition, Dr. Kenneth Mahrer and Mr. Brent Henderson have been identified as important SwRI staff. Dr. Brian Wernicke, Dr. Kent Snow and Dr. Alan Morris have been identified as important consultants. Other consultants may be utilized as required. These individuals have broad experience and technical capability in geology, structural geology/tectonics, seismology, volcanism, modeling of geologic systems, statistical and numerical modeling and data evaluation. Levels of involvement in the project for these and other appropriate personnel are included for FY93 through FY96 in the labor plan tables in Appendix A (Estimated Cost Breakdown) of this project plan.

4.4 CORPORATE RESOURCES

4.4.1 General Resources

The resources of the following departments of SwRI may be used by this project:

- Computer and Telecommunications Center
- Library: including GEOREF, NTIS, and NEDC
- Publication services

4.4.2 Special Resources

Special computational, data management, and visualization capabilities are available at the CNWRA and via remote computing facilities to support this research project. The major computer resources provided and supported by a trained staff are:

- Computer and Telecommunications Center (CTC) which includes an IBM 4381 and VAX 8700 operating on a Fiber Optic network at SwRI with an INTERNET link to a variety of supercomputers;

- CNWRA Local Area Network (LAN) with Network File Server (NFS) and the TCP/IP protocol on the SwRI network with leased line connections to the NRC for High-Performance technical computing, database access and electronic communications;

Table 4-1. Project travel requirements

Purpose/Destination	FY94 No. Trips	FY94 No. Staff-Days/Trip	FY95 No. Trips	FY95 No. Staff-days/Trips	FY96 No. Trips	FY96 No. Staff-days/Trip
TECHNICAL PROGRAM REVIEW						
NRC, Washington, DC	4	3	4	3	4	3
CONFERENCES, SEMINARS, WORKSHOPS						
International Waste Management Meeting, Las Vegas	1	3	1	3	1	3
TECHNICAL INTERCHANGE						
NRC/DOE Technical Exchange, Las Vegas	2	3	2	3	2	3
FIELD WORK						
Black Mtns. Area (CA)	1	42				
Yucca Mtn Area (GPS)	1	7	1	35		
Death Valley/ Furnace Creek Region & Landers Area (CA)	1	42				
Owens Valley Area	1	21				
San Francisco Volcanic Field (AZ)	1	14				
TBD	5	7				

4.5.4 Field Work

Travel is necessary for members of the research project team to accomplish field investigations required to support development and assessment of tectonic models. Travel in this category may be required both to plan and carry out field investigations. One travel period to the Black Mountains and Yucca Mountain area has already occurred and five short trips are yet to be determined. Five field trips to the following areas are anticipated: (i) Black Mountains area; (ii) Yucca Mountain area for participation in ongoing GPS work; (iii) Death Valley/Furnace Creek region and Landers area; (iv) Owens Valley area; and (v) San Francisco Volcanic Field.

5 REFERENCES

Argus, D.F., and R.G. Gordon. 1991. Current Sierra Nevada-North America motion from very long baseline interferometry: Implications for the kinematics of the western United States. *Geology* 19:1085-1088.

Birchard. 1992. CNWRA Statement of Work for research on Tectonic Processes in the Basin and Range.

Bonilla, M.G., and J.J. Linekaemper. 1990. Visibility of fault strands in exploratory trenches and timing of rupture events. Geology, 18:153-156.

Colletta, B., J. Letouzey, J.F. Ballard, and P. Balé. 1991. Computerized x-ray tomography analysis of sandbox models: Examples of thin-skinned thrust systems. *Geology* 19: 1063-1067.

DeMets,C., R.G. Gordon, S. Stein, and D.F. Argus. 1990. Current plate motions. *Geophysical Journal International* 101:425-478.

DePolo, C.M., D.G. Clark, D.B. Slemmons and A.R. Ramelli. 1991. Historical surface faulting in the Basin and Range province, western North America: Implications of fault segmentation, *Journal of Structural Geology,* 13(2):123-136.

Dokka, R.K., and C.J. Travis. 1990. Role of the eastern California shear zone in accommodating Pacific-North American plate motion. *Geophysical Research Letters* 17(9):1323-1326.

Gans, P.B., G.A. Mahood, and E. Schermer. 1989. *Synextensional Magmatism in the Basin and Range Province: A Case Study from the Eastern Great Basin.* Geological Society of America Special Paper 233. Boulder, CO: Geological Society of America.

Glazner, A.F., and J.M. Bartley. 1984. Timing and tectonic setting of Tertiary low-angle normal faulting and associated magmatism in the southwestern United States: *Tectonics*, 3:385-396.

Hamilton, W.B. 1988. Detachment faulting in the Death Valley region. California and Nevada, in Investigations of the Geological and Geophysical Characterization of a Potential Nuclear Waste Disposal Site at Yucca Mountain, Southern Nevada. *U.S. Geological Survey Bulletin* 1790:51-85.

Harland, W.B., R.L. Armstrong, A.V. Cox, L.E. Craig, A.G. Smith, and D.G. Smith. 1990. *A geologic time scale 1989.* Cambridge University Press: Cambridge: 263.

Kruse, S.M., McNutt, J. Phipps-Morgan, L. Royden, and B. Wernicke. 1991. Lithospheric extension near Lake Mead, Nevada: A model for ductile flow in the lower curst. *Journal of Geophysical Research* 96(B3):4,435-4,456.

Lipman, P.W., H.J. Protska, and R.L. Christiansen. 1972. Cenozoic volcanism and plate tectonic evolution of the western United States; 1. Early and middle Cenozoic. *Royal Society of London Philosophical Transactions*, 271(A):217-248.

Minster, J.B., and T.H. Jordan. 1987. Vector constraints on western U.S. deformation from space geodesy, neotectonics, and plate motions. *Journal of Geophysical Research* 92(B6):4,798-4-808.

Ramelli, A.R., J.W. Bell, and C.M. Depolo. 1988. Evidence for distributive faulting at Yucca Mountain, Nevada. *Geological Society of America Abstracts with Programs*, 1988 Annual Meeting, Denver: A383.

Savage, J.C., M. Lisowski and W.H. Prescott. 1990. An apparent shear zone trending north-northwest across the Mojave Desert into Owens Valley, eastern California, *Geophysical Research Letters*, v.17 no. 12:2113-2116.

Scott, R.B. 1990. Tectonic setting of Yucca Mountain, southwestern Nevada. B.P. Wernicke, ed. *Basin and Range Extensional Tectonics Near the Latitude of Las Vegas, Nevada.* Geological Society of America Memoir 176:251-282

Shaw, H.R. 1980 The fracture mechanisms of magma transport from the mantle to the surface. Physics of Magamatic Processes. R.B. Hargraves, ed. Princeton. NJ: Princeton University Press: 201-264.

Stirewalt, G.L. and S.R. Young. 1992. A review of pertinent literature on volcanic-magmatic and tectonic history of the Basin and Range. Center for Nuclear Waste Regulatory Analyses Technical Report CNWRA 92-025. San Antonio, TX.

Swadley, W.C. and D.L. Hoover. 1983. Geology of Faults Exposed in Trenches in Crater Flat, Nye County, Nevada. U.S. Geological Survey Open-File Report 83-608:15.

Swadley, W.C., D.L. Hoover, and J.N. Rosholt. 1984. Preliminary report on late Cenozoic stratigraphy and faulting in the vicinity of Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-788:42.

Ward, S.N. 1990. Pacific-North American plate motions: New results from very long baseline interferometry. *Journal of Geophysical Research* 95(B13):21,965-21,981.

Wernicke, B. 1991. Cenozoic extensional tectonics of the U.S. Cordillera. The Cordilleran Orogen: Coterminous U.S., B.C. Burchfiel, P.W. Lipman, and M.L. Zoback, eds. *The Geology of North America G-3.* In press. Boulder, CO: Geological Society of America

Wernicke, B., G.J. Axen, and J.K. Snow. 1988a. Basin and Range extensional tectonics at the latitude of Las Vegas, Nevada. *Geological Society of America Bulletin* 100:1,738-1,757.

Wernicke, B.P., J.K. Snow, and J.D. Walker. 1988b. Correlation of early Mesozoic thrusts in the southern Great Basin and their possible indication of 250-300 km of Neogene crustal extension. *This Extended Land, Geological Journeys in the Southern Basin and Range*. D. L. Weide and M.L. Faber, eds. GSA Cordilleran Section Field Trip Guidebook: Las Vegas, NV: University of Nevada:255-268.

Wilkerson, M.S., S. Marshak, and W. Bosworth. 1992. Computerized tomographic analysis of displacement trajectories and three-dimensional fold geometry above oblique thrust ramps. *Geology* 20: 439–442.

Young, S.R., G.L. Stirewalt, and R.A. Ratliff. 1991. Computer-assisted geometric and kinematic analysis of subsurface faulting in the vicinity of Yucca Mountain, Nevada, using balanced geologic cross-section. *Proceedings of the Second Annual International High-Level Radioactive Waste Management Conference*, Las Vegas, Nevada 1:248-259.

Young, S.R., G.L. Stirewalt, and A.P. Morris. 1992. Geometric Models of Faulting at Yucca Mountain. Center for Nuclear Waste Regulatory Analyses Technical Report CNWRA 92-008. San Antonio, TX.

Zhang, P, D.B. Slemmons and G. Mao. 1991. Geometric pattern, rupture termination and fault segmentation of the Dixie Valley-Pleasant Valley active normal fault system, Nevada, USA, Journal of Structural Geology, 13(2):165-176.

Table A-1. Tectonic Processes in the Central Basin and Range Region Estimated Spending Plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	765	510	766	766	510	766	510	510	766	510	766	510	766	8,421
Center PI-3	1,779	1,821	1,588	2,247	1,821	1,782	0	194	194	194	0	194	194	12,006
Center PI-2	3,765	3,681	3,588	4,732	3,650	3,650	2,907	2,969	2,938	2,938	2,876	3,000	3,155	43,850
Center PI-1	2,123	2,088	2,131	2,642	2,110	2,110	2,280	2,238	2,280	2,259	2,280	2,238	2,280	29,059
Center Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Clerical	134	134	123	175	123	134	134	134	134	134	123	134	134	1,746
Center Labor	8,564	8,234	8,196	10,562	8,214	8,441	5,832	6,044	6,311	6,035	6,046	6,075	6,528	95,081
Center Burden	3,743	3,598	3,582	4,616	3,589	3,689	2,548	2,641	2,758	2,637	2,642	2,655	2,853	41,551
Center Overhead	8,246	7,927	7,891	10,169	7,908	8,127	5,615	5,820	6,076	5,810	5,821	5,849	6,285	91,544
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-1	151	170	151	189	170	151	151	151	170	151	151	170	151	2,080
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	151	170	151	189	170	151	151	151	170	151	151	170	151	2,080
SwRI Burden	66	74	66	83	74	66	66	66	74	66	66	74	66	909
SwRI Overhead	252	284	252	315	284	252	252	252	284	252	252	284	252	3,467
ADP Services	0	0	0	0	0	0	150	160	160	160	160	160	162	1,122
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	1,885	1,890	1,885	2,360	1,885	1,885	1,890	1,885	1,890	1,885	1,885	1,890	1,885	25,000
Quality Assur.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Report Services	353	352	353	441	350	353	353	352	353	352	353	352	353	4,670
Tphone & Tgram	10	10	10	10	10	10	10	10	5	10	10	10	10	125
Travel	0	1,886	0	1,886	0	1,886	2,923	5,692	0	1,886	0	7,595	0	23,754
Consultants	3,530	3,534	2,000	3,742	3,618	3,534	5,744	7,362	7,362	7,154	5,828	7,362	7,188	67,958
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	26,800	27,960	24,386	34,372	26,103	28,393	25,544	30,436	25,444	26,399	23,213	32,477	25,733	357,260
Center CFC	540	519	517	666	518	532	368	381	398	380	381	383	411	5,993
SwRI CFC	17	19	17	22	19	17	17	17	19	17	17	19	17	237
Tot Estimate Cost	27,357	28,498	24,920	35,059	26,640	28,942	25,929	30,834	25,861	26,796	23,612	32,879	26,162	363,490
Fee	2,143	2,237	1,951	2,750	2,088	2,271	2,171	2,587	2,163	2,244	1,973	2,761	2,187	29,526
Tot Cost with Fee	29,500	30,735	26,871	37,809	28,728	31,214	28,100	33,421	28,024	29,040	25,585	35,640	28,349	393,016
% Completion	7.51%	7.82%	6.84%	9.62%	7.31%	7.94%	7.15%	8.50%	7.13%	7.39%	6.51%	9.07%	7.21%	100.00%
Cumulative Cost	29,500	60,235	87,106	124,915	153,643	184,857	212,957	246,378	274,402	303,442	329,027	364,667	393,016	
Cumul Completion	7.51%	15.33%	22.16%	31.78%	39.09%	47.04%	54.19%	62.69%	69.82%	77.21%	83.72%	92.79%	100.00%	

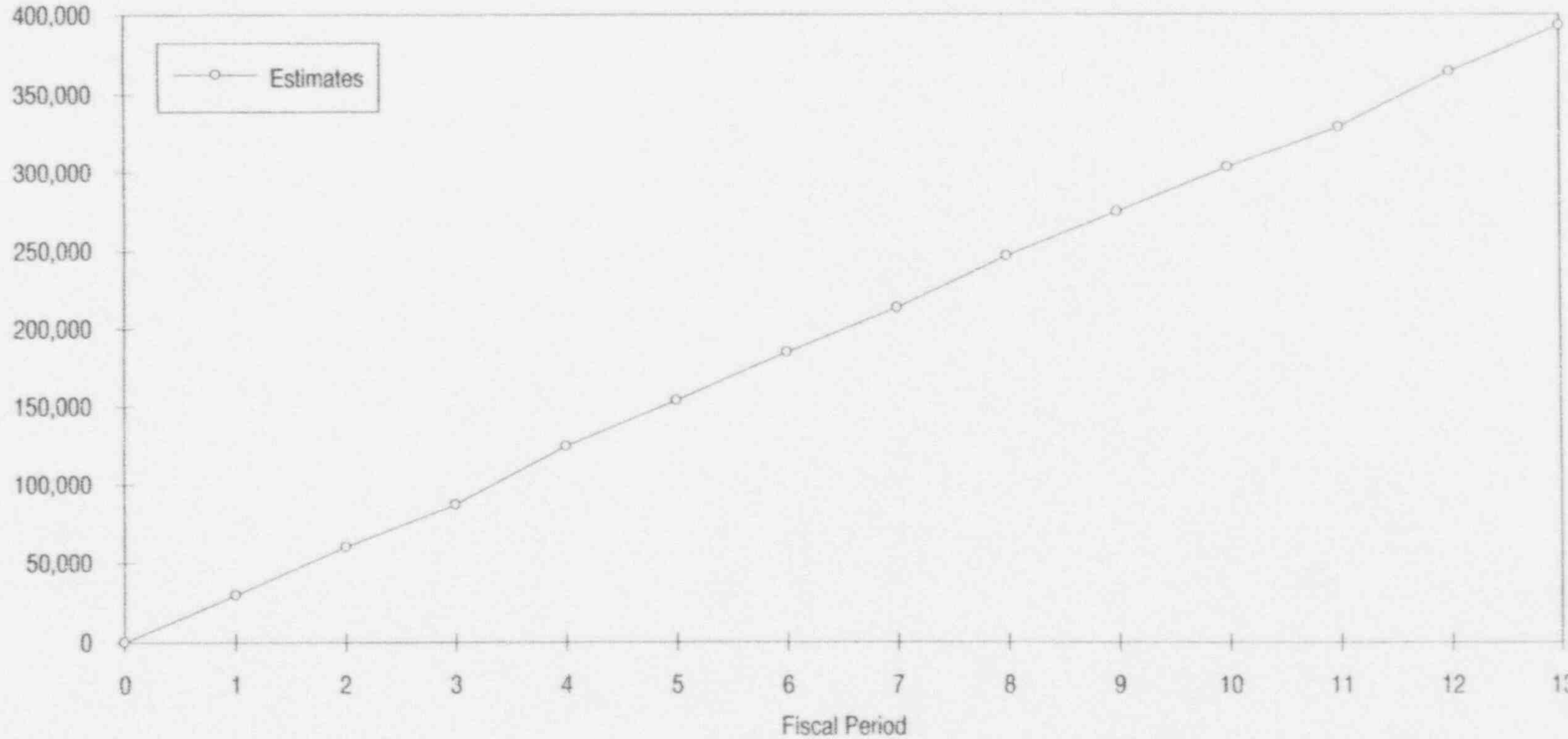

Figure A-1. Tectonic Processes in the Central Basin and Range Region Estimated Spending Plan, FY94

Table A-2. Tectonic Processes in the Central Basin and Range Region Estimated Labor Plan, FY94

Center Labor	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	15	10	15	15	10	15	10	10	15	10	15	10	15	165
Center PI-3	46	47	41	58	47	46	0	5	5	5	0	5	5	310
Center PI-2	121	119	116	153	118	118	94	96	95	95	93	97	102	1,417
Center PI-1	100	98	100	124	99	99	107	105	107	106	107	105	107	1,364
Center Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Clerical	13	13	12	17	12	13	13	13	13	13	12	13	13	170
Total Center Labor	295	287	284	367	286	291	224	229	235	229	227	230	242	3,426

SwRI Labor	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-1	8	9	8	10	9	8	8	8	9	8	8	9	8	110
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SwRI Labor	8	9	8	10	9	8	8	8	9	8	8	9	8	110

Table A-3. Tectonic Processes in the Central Basin and Range Region Task 2 Estimated Spending plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	39	39	0	39	39	39	0	39	39	39	0	39	39	388
Center PI-2	343	340	278	464	309	278	278	278	278	278	247	278	278	3,931
Center PI-1	976	938	980	1,193	980	959	980	938	980	959	980	938	980	12,782
Center Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Clerical	134	134	123	175	123	134	134	134	134	134	123	134	134	1,746
Center Labor	1,645	1,552	1,535	2,024	1,554	1,563	1,494	1,490	1,584	1,512	1,504	1,490	1,584	20,531
Center Burden	719	678	671	[illegible]	679	683	653	651	692	661	657	651	692	8,972
Center Overhead	1,584	1,494	1,478	1,948	1,496	1,506	1,439	1,435	1,525	1,455	1,448	1,435	1,525	19,767
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-1	151	170	151	189	170	151	151	151	170	151	151	170	151	2,080
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	151	170	151	189	170	151	151	151	170	151	151	170	151	2,080
SwRI Burden	66	74	66	83	74	66	66	66	74	66	66	74	66	909
SwRI Overhead	252	284	252	315	284	252	252	252	284	252	252	284	252	3,467
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	377	378	377	472	377	377	378	377	378	377	377	378	377	5,000
Quality Assur.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Report Services	131	131	131	164	130	131	131	131	131	131	131	131	131	1,735
Tphone & Tgram	2	2	2	2	2	2	2	2	1	2	2	2	2	25
Travel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Consultants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	4,927	4,764	4,663	6,082	4,766	4,730	4,566	4,556	4,840	4,607	4,589	4,616	4,781	62,486
Center CFC	104	98	97	128	98	98	94	94	100	95	95	94	100	1,294
SwRI CFC	17	19	17	22	19	17	17	17	19	17	17	19	17	237
Tot Estimate Cost	5,048	4,881	4,777	6,231	4,883	4,845	4,678	4,667	4,959	4,720	4,701	4,729	4,898	64,017
Fee	394	381	373	487	381	378	388	387	411	392	390	392	406	5,162
Tot Cost with Fee	5,442	5,263	5,150	6,717	5,264	5,224	5,066	5,065	5,370	5,111	5,091	5,121	5,304	69,179
% Completion	7.77%	7.61%	7.44%	9.71%	7.61%	7.55%	7.32%	7.31%	7.76%	7.39%	7.36%	7.40%	7.67%	100.00%
Cumulative Cost	5,442	10,706	15,855	22,572	27,836	33,060	38,126	43,181	48,551	53,662	58,753	63,874	69,179	
Cumul Completion	7.77%	15.47%	22.92%	32.63%	40.24%	47.79%	55.11%	62.42%	70.18%	77.57%	84.93%	92.33%	100.00%	

Table A-4. Tectonic Processes in the Central Basin and Range Region Task 3 Estimated Spending Plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	39	39	0	39	39	39	0	39	39	39	0	39	39	388
Center PI-2	312	309	278	402	309	278	247	247	247	247	247	247	247	3,622
Center PI-1	807	788	810	1,002	810	810	959	938	959	959	959	938	959	11,696
Center Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Clerical	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Labor	1,310	1,239	1,241	1,596	1,260	1,280	1,308	1,326	1,398	1,347	1,360	1,326	1,398	17,389
Center Burden	573	541	542	697	551	559	572	579	611	589	594	579	611	7,599
Center Overhead	1,262	1,193	1,195	1,536	1,213	1,232	1,260	1,277	1,346	1,297	1,309	1,277	1,346	16,742
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Burden	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Overhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	377	378	377	472	377	377	378	377	378	377	377	378	377	5,000
Quality Assur	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Report Services	131	131	131	164	130	131	131	131	131	131	131	131	131	1,735
Tphone & Tgram	2	2	2	2	2	2	2	2	1	2	2	2	2	25
Travel	0	0	0	0	0	0	2,923	0	0	0	0	0	0	2,923
Consultants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	3,654	3,483	3,489	4,467	3,533	3,582	6,574	3,692	3,866	3,743	3,773	3,693	3,866	51,413
Center CFC	83	78	78	101	79	81	82	84	88	85	86	84	88	1,096
SwRI CFC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot Estimate Cost	3,737	3,561	3,567	4,567	3,612	3,662	6,657	3,775	3,954	3,828	3,858	3,776	3,954	52,509
Fee	292	279	279	357	283	287	559	314	329	318	321	314	329	4,259
Tot Cost with Fee	4,029	3,840	3,846	4,925	3,895	3,949	7,215	4,089	4,282	4,146	4,179	4,090	4,282	56,768
% Completion	7.34%	6.76%	6.78%	8.68%	6.86%	6.96%	12.71%	7.20%	7.54%	7.30%	7.36%	7.21%	7.54%	100.00%
Cumulative Cost	4,029	7,869	11,715	16,640	20,535	24,483	31,699	35,788	40,070	44,216	48,395	52,486	56,768	
Cumul Completion	7.34%	13.86%	20.64%	29.31%	36.17%	43.13%	55.84%	63.04%	70.59%	77.89%	85.25%	92.46%	100.00%	

Table A-5. Tectonic Processes in the Central Basin and Range Region Task 4 Estimated Spending Plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	1,160	1,123	1,123	1,433	1,162	1,123	0	39	39	39	0	39	39	7,320
Center PI-2	1,804	1,732	1,794	2,227	1,763	1,794	1,299	1,299	1,299	1,299	1,299	1,330	1,485	20,424
Center PI-1	212	234	213	277	213	213	213	234	213	213	213	234	213	2,897
Center Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Clerical	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Labor	3,328	3,192	3,284	4,090	3,240	3,284	1,614	1,674	1,704	1,653	1,665	1,705	1,890	32,324
Center Burden	1,454	1,396	1,435	1,788	1,416	1,435	705	732	745	722	728	745	826	14,125
Center Overhead	3,204	3,073	3,161	3,938	3,120	3,161	1,554	1,612	1,641	1,591	1,603	1,642	1,819	31,121
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Burden	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Overhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADP Services	0	0	0	0	0	0	160	160	160	160	160	160	162	1,122
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	377	378	377	472	377	377	378	377	378	377	377	378	377	5,000
Quality Assur.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Report Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tphone & Tgram	2	2	2	2	2	2	2	2	1	2	2	2	2	25
Travel	0	1,886	0	1,886	0	1,886	0	5,692	0	1,886	0	7,595	0	20,831
Consultants	2,574	2,576	1,000	2,680	2,618	2,576	4,786	6,404	6,404	6,300	4,828	6,404	6,230	55,380
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	10,940	12,502	9,259	14,856	10,773	12,721	9,200	16,653	11,032	12,692	9,363	18,631	11,306	159,929
Center CFC	210	201	207	258	204	207	102	106	107	104	105	107	119	2,038
SwRI CFC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot Estimate Cost	11,150	12,703	9,466	15,114	10,977	12,928	9,302	16,758	11,140	12,796	9,468	18,739	11,425	161,966
Fee	875	1,000	741	1,189	862	1,018	782	1,416	938	1,079	796	1,584	961	13,238
Tot Cost with Fee	12,025	13,704	10,207	16,303	11,839	13,946	10,084	18,174	12,077	13,875	10,264	20,322	12,386	175,205
% Completion	7.36%	7.82%	5.83%	9.30%	6.76%	7.96%	5.76%	10.37%	6.89%	7.92%	5.86%	11.60%	7.07%	100.00%
Cumulative Cost	12,025	25,729	35,935	52,238	64,077	78,023	88,106	106,280	118,358	132,233	142,497	162,819	175,205	
Cumul Completion	7.36%	14.58%	20.51%	29.82%	36.57%	44.53%	50.29%	60.66%	67.55%	75.47%	81.33%	92.93%	100.00%	

Table A-6. Tectonic Processes in the Central Basin and Range Region Task 6 Estimated Spending Plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	464	504	426	620	465	504	0	39	39	39	0	39	39	3,176
Center PI-2	1,181	1,144	1,175	1,485	1,144	1,175	1,021	1,021	1,021	1,021	1,021	1,021	1,052	14,481
Center PI-1	64	64	64	85	64	64	64	64	64	64	64	64	64	852
Center Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Clerical	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Labor	1,862	1,814	1,819	2,343	1,775	1,896	1,187	1,225	1,276	1,225	1,238	1,225	1,307	20,193
Center Burden	814	793	795	1,024	776	829	519	536	558	536	541	536	571	8,825
Center Overhead	1,792	1,747	1,751	2,256	1,709	1,825	1,143	1,180	1,229	1,180	1,192	1,180	1,259	19,441
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Burden	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Overhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	377	378	377	472	377	377	378	377	378	377	377	378	377	5,000
Quality Assur.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Report Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tphone & Tgram	2	2	2	2	2	2	2	2	1	2	2	2	2	25
Travel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Consultants	956	958	1,000	1,062	1,000	958	958	958	958	854	1,000	958	958	12,578
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	5,803	5,691	5,743	7,158	5,639	5,887	4,186	4,278	4,400	4,174	4,349	4,279	4,475	66,062
Center CFC	117	114	115	148	112	120	75	77	80	77	78	77	82	1,272
SwRI CFC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot Estimate Cost	5,920	5,806	5,858	7,306	5,751	6,007	4,261	4,355	4,481	4,251	4,427	4,356	4,557	67,335
Fee	464	455	459	573	451	471	356	364	374	355	370	364	380	5,435
Tot Cost with Fee	6,384	6,261	6,317	7,879	6,202	6,477	4,616	4,719	4,855	4,606	4,797	4,720	4,937	72,770
% Completion	7.64%	8.60%	8.68%	10.83%	8.52%	8.90%	6.34%	6.48%	6.67%	6.33%	6.59%	6.49%	6.78%	100.00%
Cumulative Cost	6,384	12,645	18,962	26,841	33,043	39,521	44,137	48,856	53,710	58,316	63,113	67,833	72,770	
Cumul Completion	7.64%	17.38%	26.06%	36.88%	45.41%	54.31%	60.65%	67.14%	73.81%	80.14%	86.73%	93.22%	100.00%	

Table A-7. Tectonic Processes in the Central Basin and Range Region Task 7 Estimated Spending Plan, FY94

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Center PI-4	153	102	153	153	102	153	102	102	153	102	153	102	153	1,684
Center PI-3	77	116	39	116	116	77	0	39	39	39	0	39	39	736
Center PI-2	125	155	62	155	124	124	62	124	93	93	62	124	93	1,393
Center PI-1	64	64	64	85	43	64	64	64	64	64	64	64	64	831
Center Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Clerical	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Center Labor	419	437	318	509	385	418	228	328	349	298	279	328	349	4,644
Center Burden	183	191	139	223	168	183	100	144	152	130	122	144	152	2,029
Center Overhead	404	421	306	490	370	403	219	316	336	286	269	316	336	4,472
SwRI PI-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI PI-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Tech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Burden	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SwRI Overhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADP Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machine Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material/Supply	377	378	377	472	377	377	378	377	378	377	377	378	377	5,000
Quality Assur.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Report Services	91	90	91	113	90	91	91	90	91	90	91	90	91	1,200
Tphone & Tgram	2	2	2	2	2	2	2	2	1	2	2	2	2	25
Travel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Consultants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cler Prem Pay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Svcs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Est excl. CFC, Fee	1,476	1,518	1,232	1,809	1,392	1,474	1,018	1,257	1,307	1,183	1,139	1,258	1,307	17,370
Center CFC	26	28	20	32	24	26	14	21	22	19	18	21	22	292
SwRI CFC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot Estimate Cost	1,502	1,546	1,252	1,841	1,416	1,500	1,032	1,278	1,328	1,202	1,157	1,279	1,328	17,663
Fee	118	121	99	145	111	118	87	107	111	101	97	107	111	1,432
Tot Cost with Fee	1,620	1,667	1,351	1,986	1,528	1,618	1,119	1,385	1,440	1,302	1,254	1,386	1,440	19,094
% Completion	7.91%	8.73%	7.07%	10.40%	8.00%	8.47%	5.86%	7.25%	7.54%	6.82%	6.57%	7.26%	7.54%	100.00%
Cumulative Cost	1,620	3,287	4,638	6,624	8,152	9,770	10,889	12,273	13,713	15,015	16,269	17,655	19,094	
Cumul Completion	7.91%	17.22%	24.29%	34.69%	42.69%	51.17%	57.02%	64.28%	71.82%	78.64%	85.20%	92.46%	100.00%	