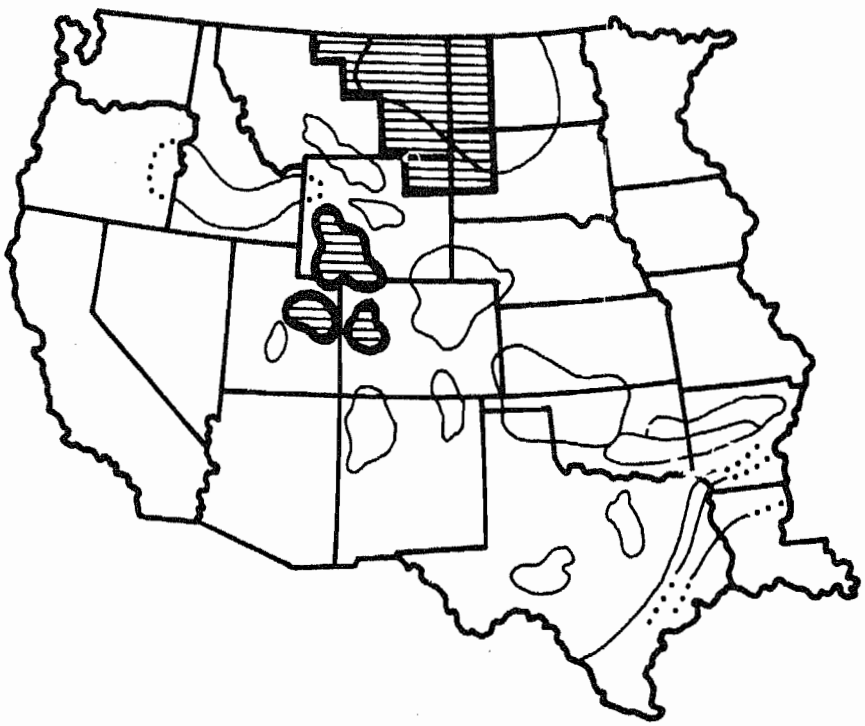
DB1101

Western Gas Sands Project

Project Plan Document FY 1979



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Prepared for
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1. SUMMARY

The Department of Energy (DOE) is continuing a program to accelerate the development of domestic energy resources. One project under this program is the Western Gas Sands Project (WGSP) which is directed toward development of new and improved techniques for recovering natural gas from low-permeability reservoirs currently not economic. The principal activities that comprise this project are:

- Project Management
- Resource Assessment
- Research and Development by Energy Research Centers and National Laboratories
- Field Tests and Demonstrations

Project Management assures coordination between the various activities and furnishes technical and financial monitoring of the projects. An economic analysis will be prepared on each area utilizing available field data, but since this is an ongoing evaluation throughout the project's duration, all such analyses will be interim. Periodic progress reports will be prepared to summarize project activities and an information management system will assure timely dissemination of useful data to the public.

Resource Assessment includes geological and geophysical studies performed mainly by the U.S. Geological Survey (USGS). Efforts will continue to upgrade logging tools and interpretation techniques with emphasis being placed on field testing of the new gravimeter under development. Cores will be obtained from "wells of opportunity" under cost-sharing contracts with operators in areas of interest. Routine core analyses will be performed by a commercial laboratory and special analyses will be performed by the USGS, Bartlesville Energy Technology Center (BETC), LLL, and others.

Drilling and exploratory activities in the Northern Great Plains Province, and the Uinta, Piceance, and Greater Green River Basins will be monitored by the Technical and Administrative support contractor for the WGSP Project Manager. Monitoring of the other areas of interest will be done when activities in these areas are of interest to the WGSP.

Research and development activities funded by DOE are being directed toward new and improved exploratory and diagnostic tools and instrumentation systems, rock mechanics, reservoir modeling and data analysis. These activities are performed primarily by DOE's Energy Technology Centers, National Laboratories and the USGS. BETC is monitoring a contract with Sandia Laboratories which involves the development of an improved pressure coring tool. BETC is also involved in a research effort to improve performance by determining how frac fluid-proppant systems can be made more effective in the target reservoirs. The amount of formation damage due to invasion of hydraulic fracturing fluids is a part of this investigation. Evaluations will be made of potential productivity of low-permeability formations by applying new or innovative logging techniques and interpretations.

LLL has a research program aimed at understanding stimulation processes. Sandia Laboratories, through their mineback program at the DOE's Nevada Test Site, is engaged in direct observation of fractures for evaluation and determination of in situ stress distributions, fracture orientation and geometry and other fracturing results such as proppant distribution. Sandia will continue development of the surface electrical potential system for fracture orientation determination and will pursue the development of a down-hole seismic sensor which may offer a better measure of fracture height and orientation.

Contracts and grants to specialized companies and universities will be used for studies such as log analysis, reservoir modeling and parametric studies of the various reservoir and stimulation parameters.

Field tests and demonstrations comprise an essential part of the WGSP. In the field, application of new skills and techniques will be implemented for final evaluation and assessment.

2. INTRODUCTION

2.1 Background

The Department of Energy in Fiscal Year 1979 is continuing a program to accelerate the development of domestic energy resources. One of the projects under this program is the Western Gas Sands Project. It is directed toward the development of new and improved techniques for recovering gas from low-permeability reservoirs that currently cannot be economically produced.

Geologic studies have indicated that an immense resource of natural gas exists in these reservoirs in a number of geologic basins scattered throughout the western states (Figure 2-1).

The low-permeability gas sands are interbedded with shale throughout intervals thousands of feet thick. Potentially gas productive sands within these intervals might number a hundred or more and may range in thickness from a few feet to more than 100 feet. In addition, the lateral extent of these sands is quite variable, and they may either be "blanket" type deposition of large areal extent, or be lenticular of limited but unknown size.

Studies by the Federal Power Commission (FPC) in 1973, supplemented by the United States Geological Survey (USGS), and by Lewin & Associates in 1978 have identified four areas which are large in areal extent, contain a large fraction of known low permeability reservoirs and have a sizable existing data base (Table 2-1).

The project, as currently conceived, spans eight years with the Federal Government's contribution being estimated at $150 million (in 1977 dollars).* The rate of technological development depends upon the yearly budget levels.

2.2 Project Objectives and Strategy

The purpose of the project is to encourage and supplement industrial efforts in developing technology and demonstrating the feasibility of economically producing natural gas from these reservoirs.

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*Section 7.7, Western Gas Sands Project Plan, August 1, 1977

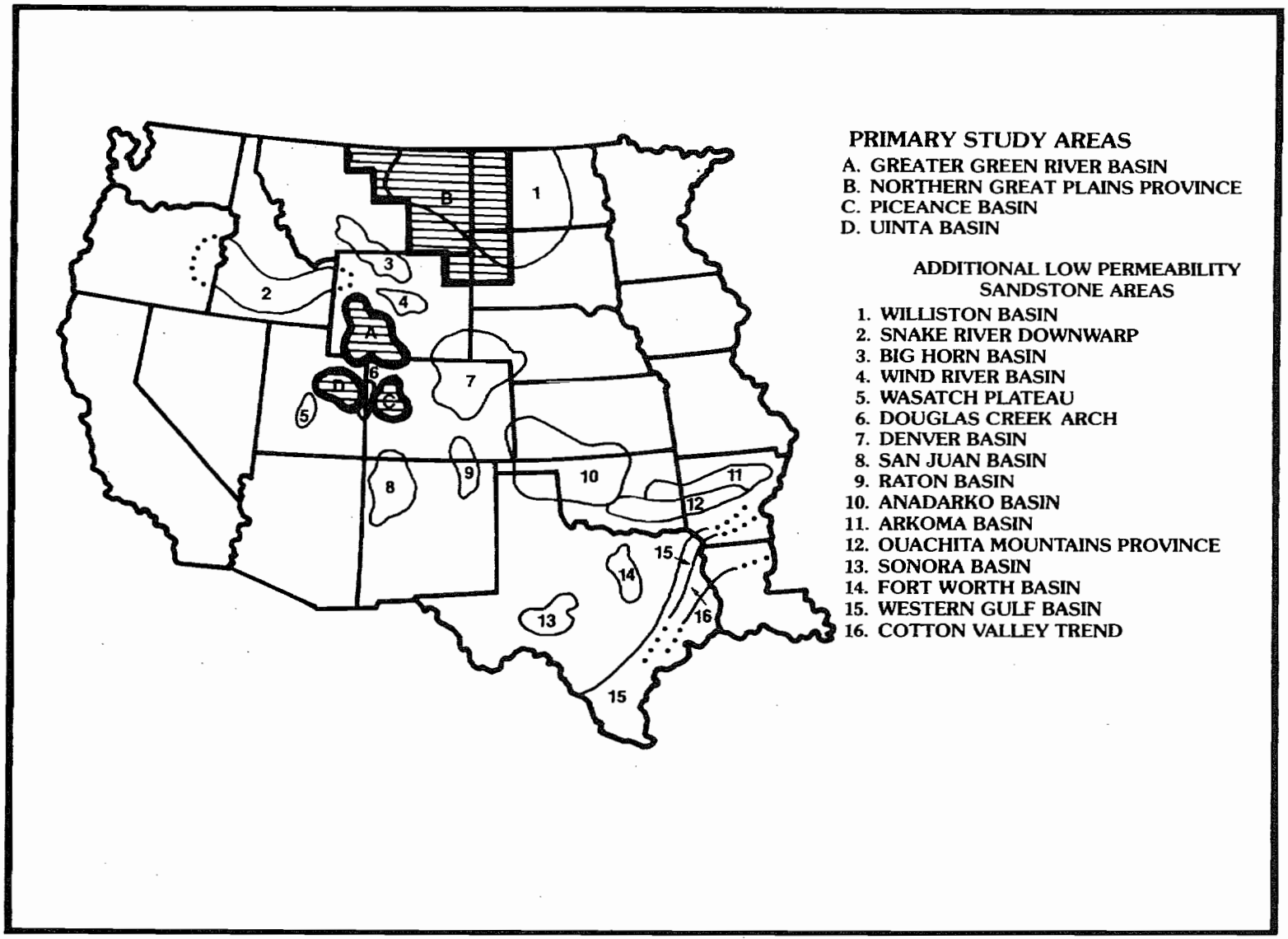


Figure 2-1 Map of Western United States, Showing Areas of Interest

Table 2-1 Principal Study Areas and Resource Base Estimates

AREA	STATE	ESTIMATED RESOURCE (TCF)* FPC & USGS ESTIMATES	LEWIN & ASSOC. INC.**
Greater Green River Basin	WY	240	91
Northern Great Plains Province	MY, WY, SD, ND	130	53
Piceance Basin	CO	210	36
Uinta Basin	UT	150	50
	TOTALS	730	230

*Trillion Cubic Feet

**Does not include "speculative" areas

The project objectives are:

- To accurately define the resource base.
- To determine physical and chemical properties of the reservoirs.
- To determine appropriate stimulation technology.
- To assess potential gas reserves and demonstrate economic productivity to encourage industrial development of the resource.

Achieving these objectives will require:

- Continued use of the Petroleum Information Well Data Bank Program by the USGS and utilizing new and revised geological information to determine optimum drilling sites for resource confirmation and production research activities.
- Cost-sharing field tests with industry to characterize the reservoirs and to test and refine production stimulation technologies, particularly massive hydraulic fracturing.
- Maintaining an effective research program in government, industry and academic institution laboratories for enhanced gas recovery from low-permeability reservoirs.
- Incorporating and building upon the R&D results.
- Economic analyses and technology transfer.

2.3 Project Elements

Figure 2-2 shows a breakdown of the project by elements. Figure 2-3 identifies activities that will be accomplished both concurrently and sequentially. Some field tests are dependent upon the outcome of resource assessment as well as laboratory evaluations, while others can be conducted immediately.

2.3.1 Project Management

The Western Gas Sands Project is a multi-year effort involving Federal agencies, National laboratories, State organizations, universities and industry. The Project is managed through a project office consisting of

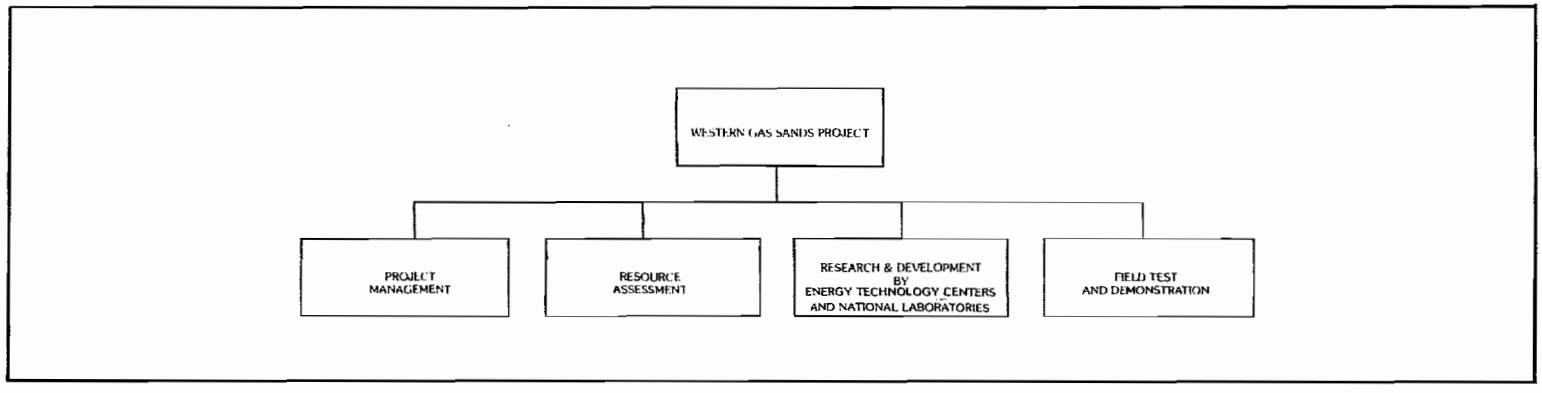


Figure 2-2 Elements of Western Gas Sands Project

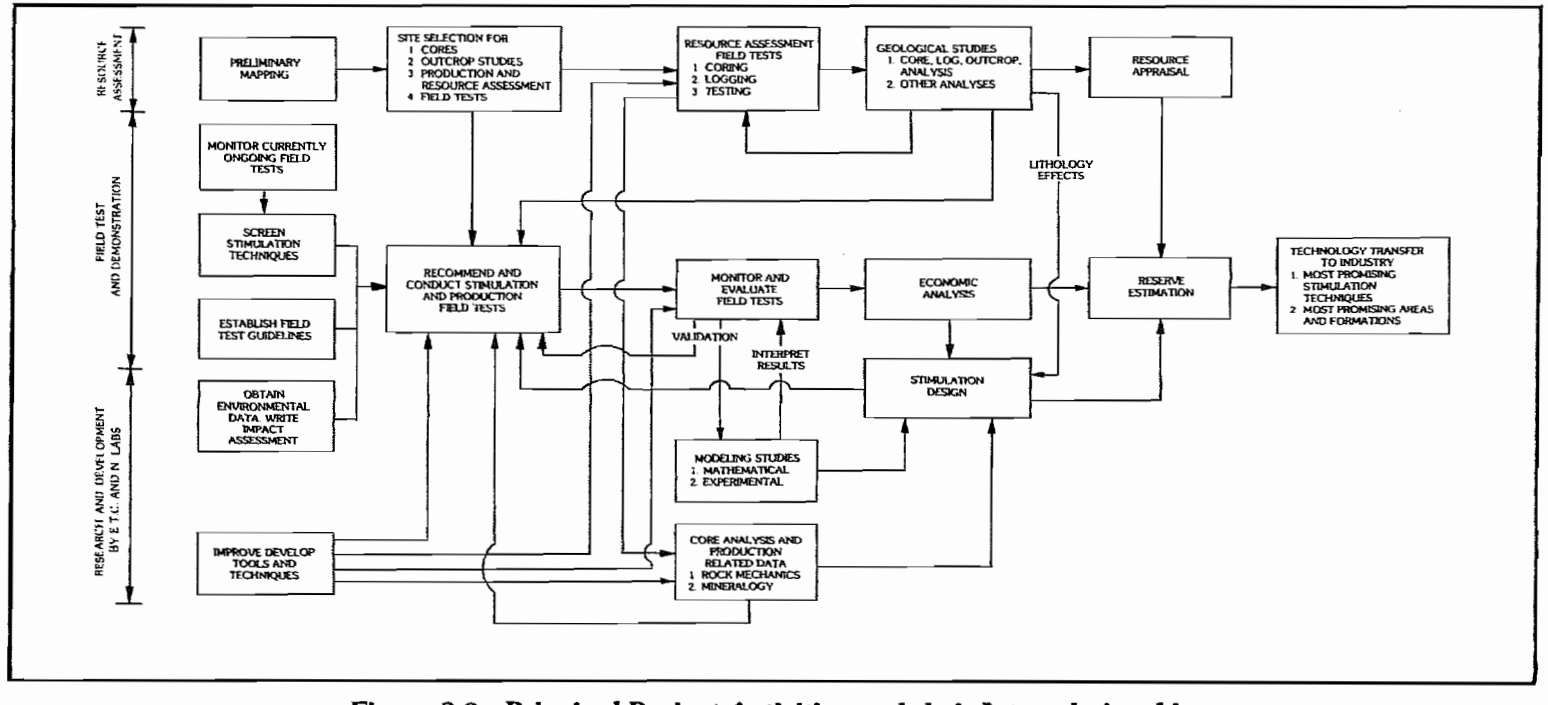


Figure 2-3 Principal Project Activities and their Interrelationships

a project manager, and selected consultants with contractual support from the DOE Nevada Operations office and BETC.

The roles and responsibilities of the project participants are summarized in Table 2-2. The roles and responsibilities are traditional with the exception of the project office, which must operate as the interface between DOE and contractors. During the year the project office will monitor project activities and perform reviews on technical adequacy, technique and results.

Routine monthly status reports, required from all participants, are summarized by the project manager and submitted to the appropriate DOE offices and participants. They are available to the public from the Technical Information Center (TIC). The reports summarize progress on all activities. In addition, cost data and activity schedule information are reported in a separate document for internal use.

In addition, use of technical forums, symposiums and workshops, publications in technical journals, and other means of disseminating information will ensure technology transfer to industry.

As cost and production data become available, the economic viability of commercial development can be calculated, based on both prevailing and projected price structures.

2.3.2 Resource Assessment

Resource assessment includes geological and geophysical studies to better understand the target resource base. One of the tasks will be to continue the gathering and synthesis of available well data taken from an existing computerized data bank along with other available information. Continued effort in general and detailed mapping in particular are needed to improve the understanding of the gas bearing formations and trapping mechanisms. This work will lead to selection of sites where subsurface information is needed from cores, geophysical logs, and gas-production tests. Some of these sites will likely become the locations for field tests; and when sufficient information is accumulated, resource and reserve estimates will be possible. The appraisals will delineate and characterize the reservoirs in each area that are the most promising for economic development.

2.3.3 Research and Development by Energy Technology Centers and National Laboratories

Research and development effort is continuing in conjunction with field tests with the principal effort directed toward developing equipment and techniques required for accurate resource evaluation and effective stimulation technology. This includes development and refinement of

Table 2-2 Roles and Responsibilities of Western Gas Sands Project Participants

HEADQUARTERS	Develops and defines division budget requests Formulates policies encompassing project content, goals and objectives Approves project plans Monitors project progress, evaluates results, initiates project reviews and modifies project direction as appropriate
BARTLESVILLE ENERGY TECHNOLOGY CENTER	Provides project manager (resident at NV) to staff project office and supports the project with in-house and contracted R&D
PROJECT OFFICE	Executes technical direction to contractors and agencies participating in the project within the guidance originated by headquarters Participates in the planning, review, evaluation and overall guidance of the project Assists in contract work statement preparation, proposal evaluations and technical negotiations Is responsible for contract technical performance Certifies contractor expense vouchers for NV payment
NEVADA OPERATIONS OFFICE (NV)	Prepares and negotiates contracts, performs related contractual administrative activities, and makes necessary payment to contractors Forwards financial plan documents originated by headquarters to project office
CONTRACTORS AND AGENCIES	Execute contract work Maintain proper interface with project office and its representatives on technical matters Interface with NV on financial, legal and contract administration matters
ENERGY TECH CENTERS AND NATIONAL LABORATORIES	Perform and direct research and development in various areas of expertise

techniques for recovering cores at reservoir conditions, improving logging instrumentation and interpretation, and improving production testing techniques. Equipment and techniques will be developed to better estimate induced fracture geometry and orientation. Other laboratory support includes reservoir simulation and computer use to provide a basis for conducting statistical, parametric and prediction analyses. Test data will be used to validate the models, which in turn, may be used in the interpretation of subsequent test results.

Innovative stimulation technology will be evaluated. Core samples will be analyzed to obtain rock mechanics data and other formation properties needed to improve stimulation technology.

Energy Technology Centers and National Laboratories participating in FY 79 are the Bartlesville Energy Technology Center, Lawrence Livermore Laboratory, and Sandia Laboratories. Los Alamos Scientific Laboratory is also involved in fracturing research activities which could be relevant.

The Bartlesville Energy Technology Center is handling R&D tasks associated with logging research, rock-fluid interactions, instrument development (such as new coring and logging tools) and will provide various other support as the project develops. Lawrence Livermore Laboratory primarily is pursuing modeling and computer applications associated with fracturing processes and rock mechanics studies applicable to fracturing. Sandia is developing instrumentation systems to determine fracture orientation and geometry and new coring tools to obtain pressurized cores. They also are evaluating fracturing by mining through induced fractures in formations at the Nevada Test Site.

2.3.4 Field Tests and Demonstrations

Field tests and demonstrations comprise an essential part of the WGSP. The selection of future test sites and promising new technical approaches in FY 79 will utilize the experience gained from laboratory and field tests conducted during FY 78. There will be a continuing effort to improve the effectiveness of stimulation treatments. Data will be taken before and during field tests for analysis of the potential environmental impact of large scale commercial development.

3. PROJECT MANAGEMENT

The Western Gas Sands Project is in the management structure of the Division of Fossil Fuel Extraction at DOE Headquarters which will provide overall program guidance. A project office has been established consisting of a Project Manager provided by DOE's Bartlesville Energy Technology Center and project consultants. DOE's Nevada Operations Office will handle the major procurement actions and contract administration. Because of the desirability to maintain close liaison between the project office and the contract and procurement functions, the project manager is officed at the Nevada Operations Office in Las Vegas. A breakdown of the various elements involved in the project management function is shown in Figure 3-1.

The funds allocated to the Western Gas Sands Project in FY 79 are distributed as shown in Table 3-1.

3.1 Technical and Administrative Support

CER Coroporation currently is under contract to DOE to provide technical and administrative support services. The programatic support activities to the Project Manager is in the following areas:

- Provide technical summaries of significant developments related to the WGSP.
- Maintain liaison with industry and remain current to the extent possible on stimulation technology of various projects conducted outside the DOE programs, identifying any innovations for investigation and possible inclusion in the DOE programs.
- Conduct routine visits to State and Federal offices to obtain drilling and completion information in order to monitor work currently being performed in low-permeability reservoirs in the western United States.
- Recommend key wells being drilled by industry for coring contracts.
- Monitor specific field activities as requested and assist in developing criteria and specifications in such areas as coring, logging and production testing.

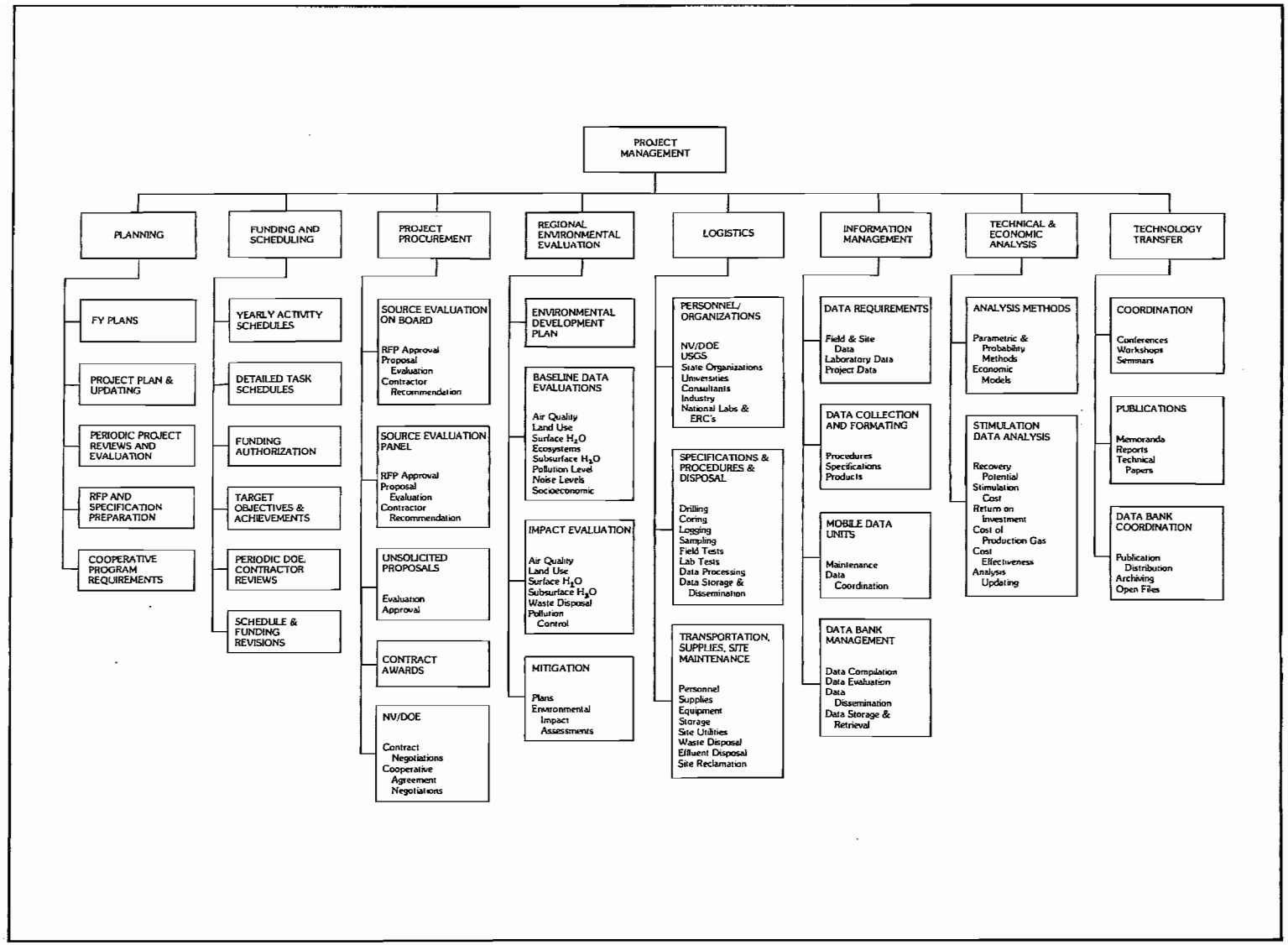


Figure 3-1 Project Management

Table 3-1 WGSP Projected FY 1979 Budget

PROJECT TECHNICAL AND ADMINISTRATIVE SUPPORT FOR PROJECT MANAGER INCLUDING OPERATION OF MOBILE WELL TEST FACILITY	$ 670,000 (10 mo.)
INFORMATION TRANSFER (TO BETC)	50,000
BARTLESVILLE ENERGY TECHNOLOGY CENTER (LABORATORY R & D)	800,000
CORING, LOGGING AND TESTING WELLS	500,000
USGS	870,000
ADDITIONS TO ONGOING AND NEW FIELD WORK	2,360,000
IN SITU PERMEABILITY TESTS BY LLL	50,000
TOTAL	5,300,000

- Provide technical information requested for the development of RFP's.

- Evaluate solicited and unsolicited proposals as requested and provide recommendations.

- Develop a program to investigate log interpretation techniques including plans for specific experiments. This would include logging techniques for multi-well experiments as described in the WGSP.

- Operate and maintain DOE-owned mobile well test facility.

3.2 Activity Coordination and Planning

Technical monitoring of the various projects, both laboratory and field, will be an ongoing function, but coordination between the various activities will be emphasized. A detailed schedule of all activities and a project schedule of future activities will be maintained along with the associated funding requirements. CER is responsible for monitoring and evaluating currently identified tasks, such as a multiplicity of laboratory R&D tasks being handled by BETC. The project manager will assess the relevance and desirability of any proposed tasks under general guidance provided by DOE Headquarters.

In addition to the monitoring of ongoing activities, the project manager will assist in evaluating RFP responses and unsolicited proposals and recommend appropriate action. RFP's for new field tests will be released when funding permits. Several procurement items will be initiated; some of which will be add-ons to industry activities, such as obtaining cores in areas of interest. Technical details for future RFP's will be developed.

Planning will continue in FY 79. These planning activities will consider modification of current activities as needed and new laboratory and field R&D programs, and will include project review meetings plus routine liaison and coordination with DOE Headquarters, the energy technology centers, the national laboratories, the USGS, technical contractors and participating universities. The areas of laboratory R&D conducted this year will support and complement current and future field projects. Specific technical goals and requirements for future field projects will be identified as well as regional locations for their performance in anticipation of the development of RFP's for FY 80. In some cases, specific areas will be identified which are dependent on the technical goals and geologic resources. Where additional resource assessment or other desired information can be gained, add-on experiments will be recommended. In addition, new requirements for cores will be developed and specific areas identified, as has been done for FY 78.

3.3 Information Management

A WGSP monthly report is prepared having two main features; one section reporting technical progress, the other covering costs. A combined report of both sections receives limited distribution, primarily to DOE Headquarters, DOE Nevada Operations Office (NV) and Bartlesville Energy Technology Center. The technical portion of the monthly report receives wider distribution and is available to the public from TIC. The types and numbers of reports and reporting schedules for individual tasks of field projects are dependent on the nature of the activity. For instance, during peak field activity, a daily drilling or test progress report is provided the Project Manager. Final reports will conform to the DOE requirements and will receive wide distribution. Wherever possible, special study groups can utilize project information and reports, as Lewin & Associates did recently for their enhanced gas recovery study. As a result of the planning activities, the Project Plan Document FY 80 also will be prepared. Other special reports such as the Preliminary Regional Environmental Report, and if sufficient data becomes available, Reservoir Evaluation Report, and an Economic Analysis Report also will be prepared.

A master project file containing the available project information including such items as raw data and logs has been established and will be maintained by the Technical and Administrative support contractor. It is available for inspection in their office. Those reports available through the TIC will be identified. If information is unavailable through NTIS, all reasonable requests for copies will be fulfilled. Most of the information is also available at BETC and the Project Offict at NV. Electrical logs, for example, may not be found at all locations.

4. RESOURCE ASSESSMENT

The majority of the resource assessment work is being performed by the USGS. There are other activities providing input data and support to their work, primarily in the area of field tests, obtaining core samples and special core tests. A breakdown of the various items is contained in Figure 4-1.

4.1 United States Geological Survey

The WGSP is being carried out in two phases by the USGS. Phase One involved a one-year (FY 78) reconnaissance of geological, geophysical and engineering properties currently known about the tight gas sands of the Rocky Mountain sedimentary basins. Preliminary work on the various project task elements (see Objectives) has been initiated during the first year reconnaissance phase. Phase Two, FY 79 and on, of the project will involve a four-year comprehensive program to define the resource base and to better characterize the mechanical and chemical properties of the reservoirs.

4.1.2 Phase Two Objectives

Starting in FY 79, USGS will:

- Develop and evaluate the total gas resource in the Rocky Mountain sedimentary basins (Northern Great Plains, Greater Green River, Uinta and Piceance Basins) by using a combination of stratigraphic, structural, geochemical, and reservoir engineering parameters.
- Combine the data generated by the project with ongoing research in stimulation techniques. These data will guide present and future research aimed at estimation of the gas reserves.
- Identify other areas having major gas resources present in low-permeability reservoirs.
- Encode and store all generated data in an automated data processing (ADP) system.

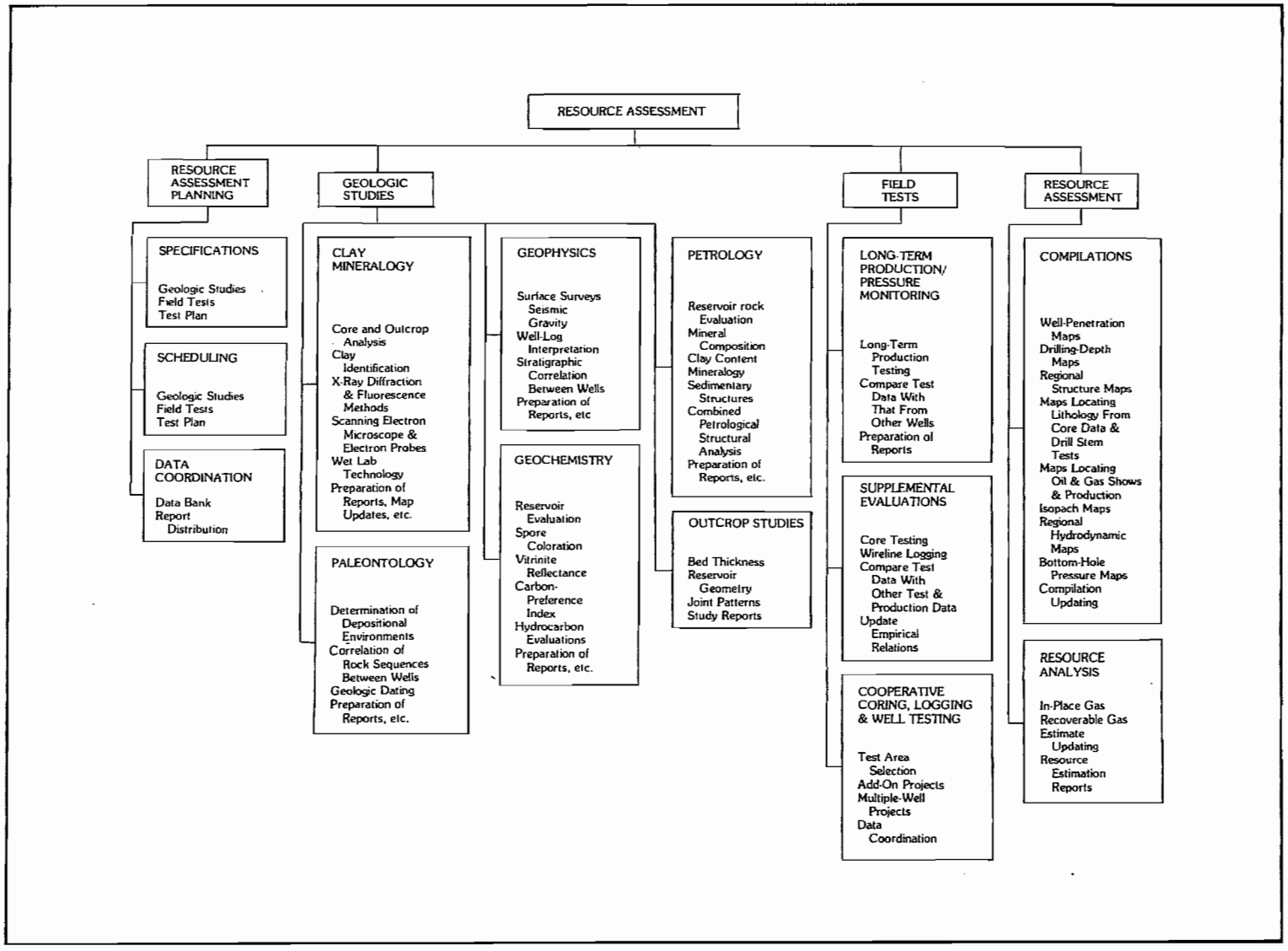


Figure 4-1 Resource Assessment

- Publish all project results as rapidly as possible in order to effect a transfer to technical information to private industry.

A milestone chart, reflecting the tasks for each study area, is shown in Figure 4-2.

4.2 Core Program

The USGS has advised the DOE of the need to obtain core samples from critical areas and is providing personnel and facilities for processing and storing of the cores. Where needed, special core analysis will be performed by the USGS and others. Routine core analysis will be done at a commercial laboratory. The Core Program Document, released in January, 1978, identifies core aquisition and testing plans. The sequence of events for core aquisition and testing are shown in Figures 4-3 and 4-4.

Core aquisition plans during FY 79 will be limited to specific areas within each basin. The USGS has the lead in the identification of these core areas, which are described below.

4.2.1 Greater Green River Basin

The Greater Green River basin (see Figure 4-5) has a large amount of section with gas potential in Upper Cretaceous and Tertiary rocks. However, based on current USGS evaluations, there are areas (listed below) that contain a large amount of tight but essentially untested section which should be the primary study areas in the Greater Green River Basin for the Western Gas Sands Core Program.

1 The crest of the Wamsutter Arch in Sweetwater and Carbon Counties, the northern edge bordering the Red Desert Basin and the southern edge occupying part of the Washakie Basin, T17N, to T21N, and R91W to R26W. The Section below the commercial Almond and Ericson (Mesaverde) is of primary interest in this area.

2 The area east of the Big Piney/LaBarge Field in Sweetwater and Sublette Counties, running north and south through the Pinedale area and to the northern edge of the Green River Basin. These areas skirt the edge of the Wind River Range. Production here is primarily Frontier, with some Mesaverde and Ft. Union.

This large area has been broken down into four sub-areas. The specific locations are:

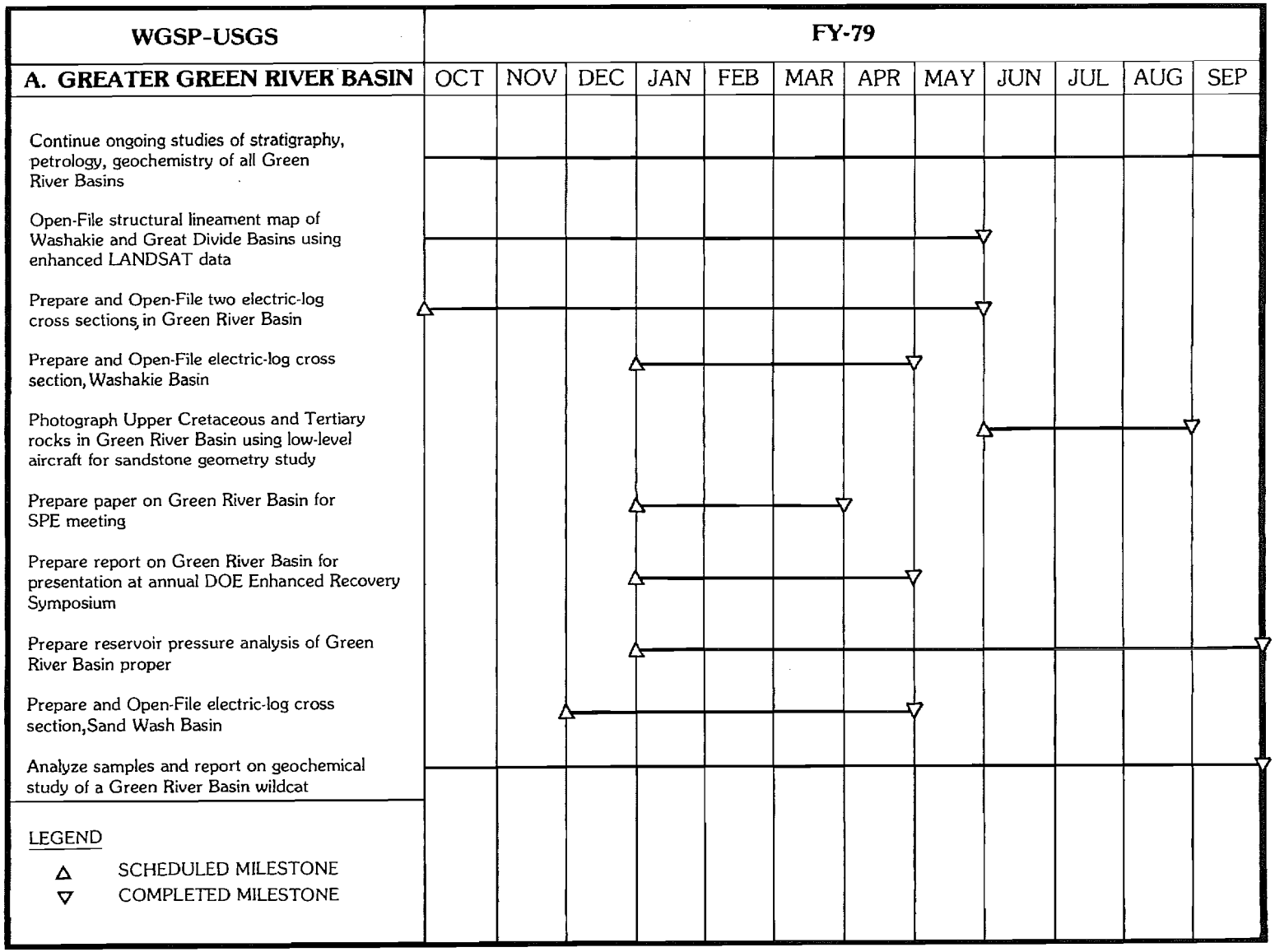


Figure 4-2 Milestone Chart—USGS

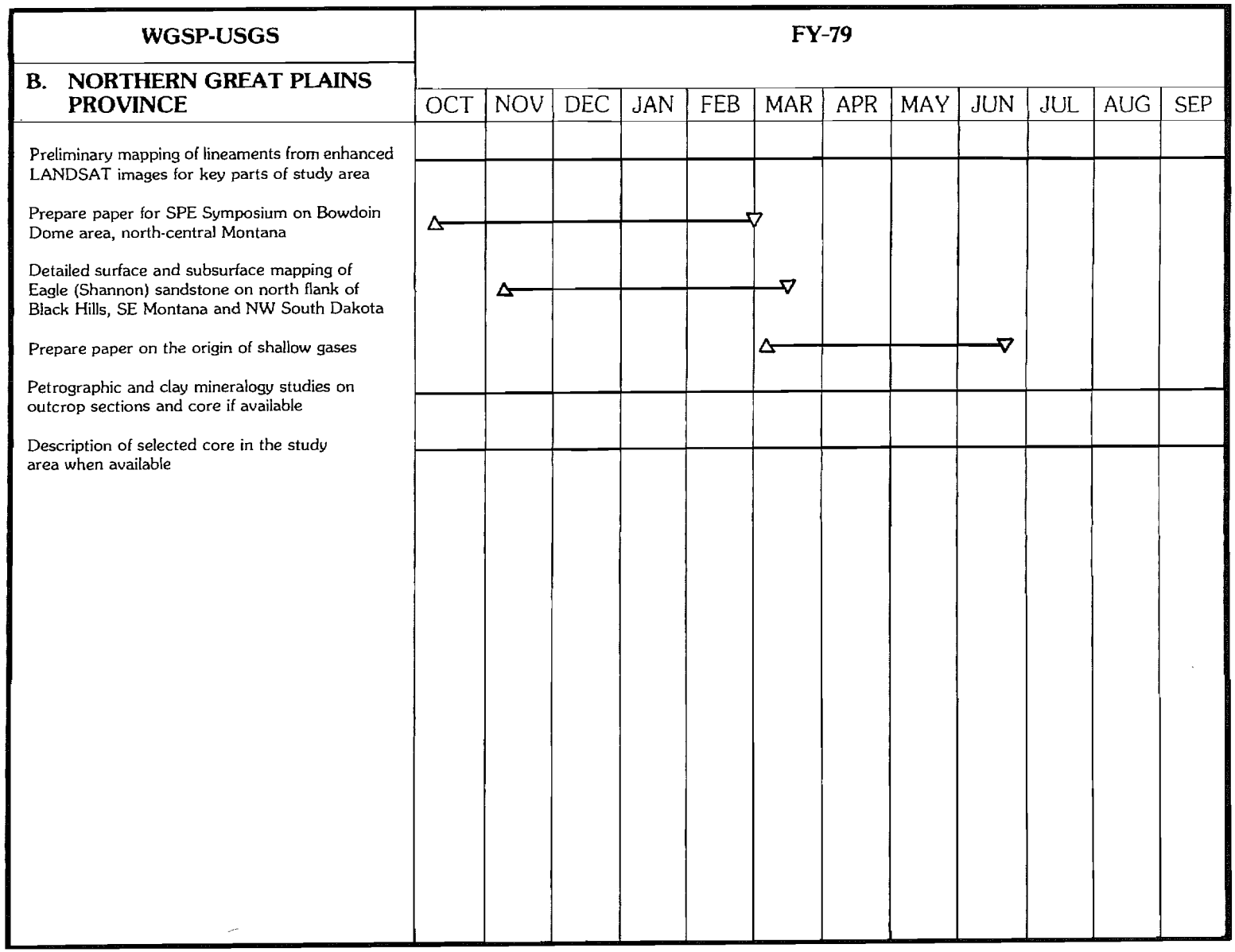


Figure 4-2 Continued

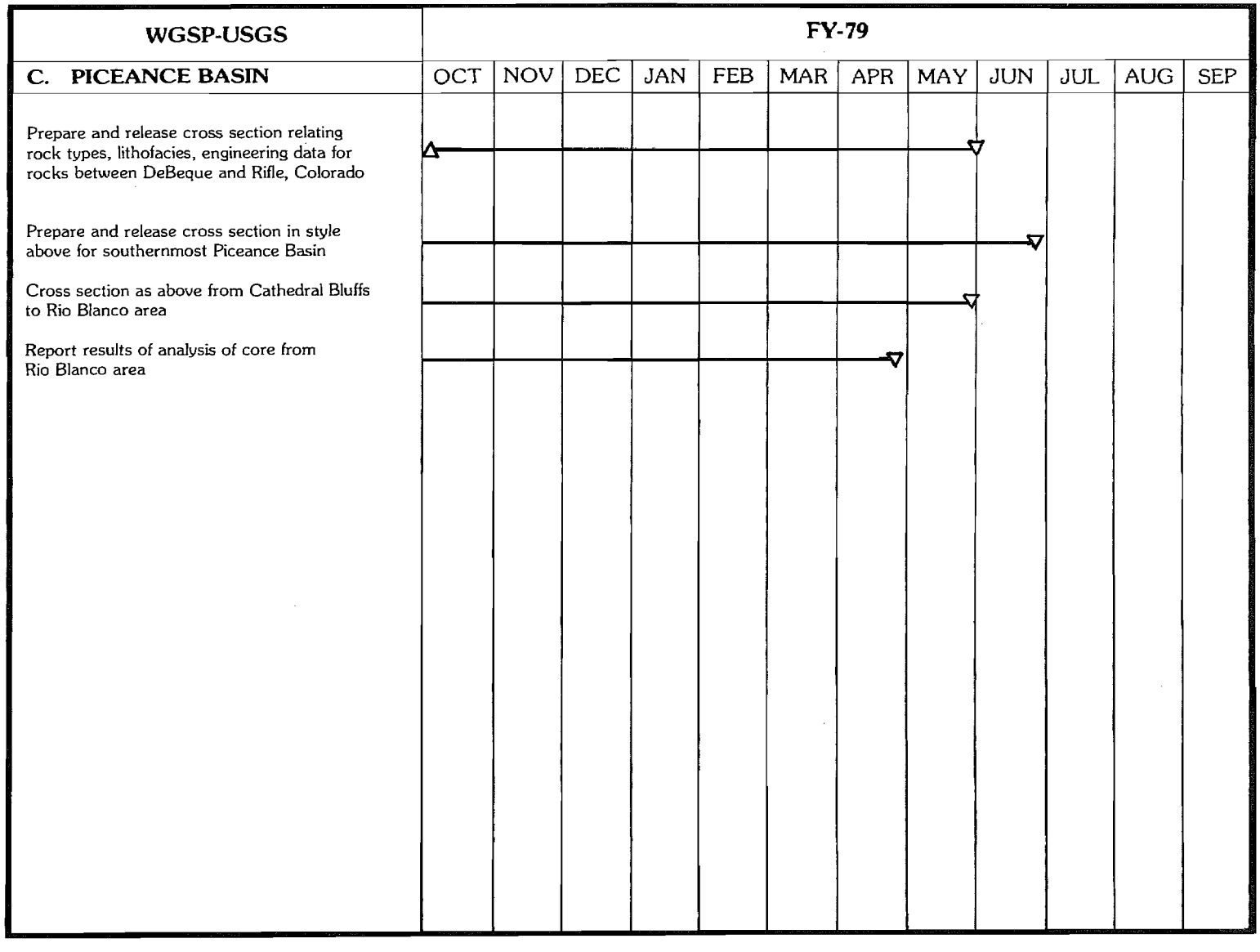


Figure 4-2 Continued

WGSP-USGS	FY-79											
D. UINTA BASIN	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Prepare and release cross section relating rock types, lithofacies, engineering data for rocks from Wasatch Mountains to southcentral Uinta Basin												
Investigate mineralogy and stratigraphy, and rock properties of core from Southman Canyon region of Uinta Basin												
Analyze data from San Arroyo Wash surface exposures of Cretaceous and Tertiary units of the southeast Uinta Basin. Report results as they become available												
Prepare report on "tight gas" reservoirs in Tertiary rocks of southcentral Uinta Basin. To be published in SPE volume												

Figure 4-2 Continued

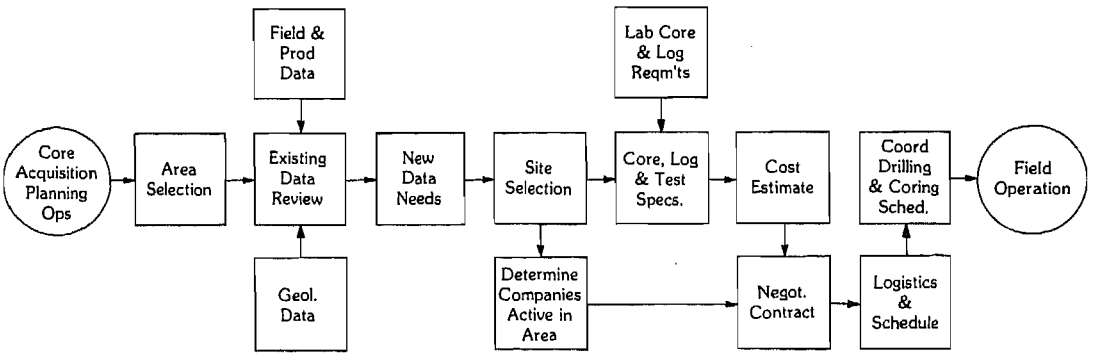


Figure 4-3 Event Sequence for WGSP Core Acquisition Planning

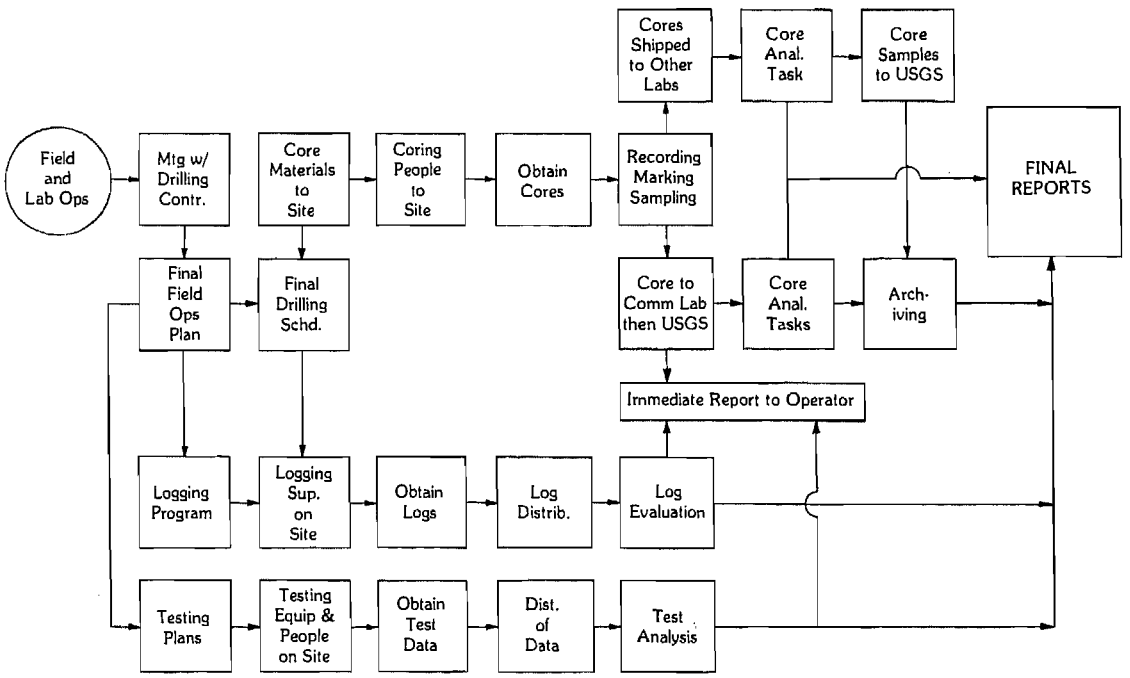


Figure 4-4 Event Sequence for WGSP Field and Laboratory Core Operations

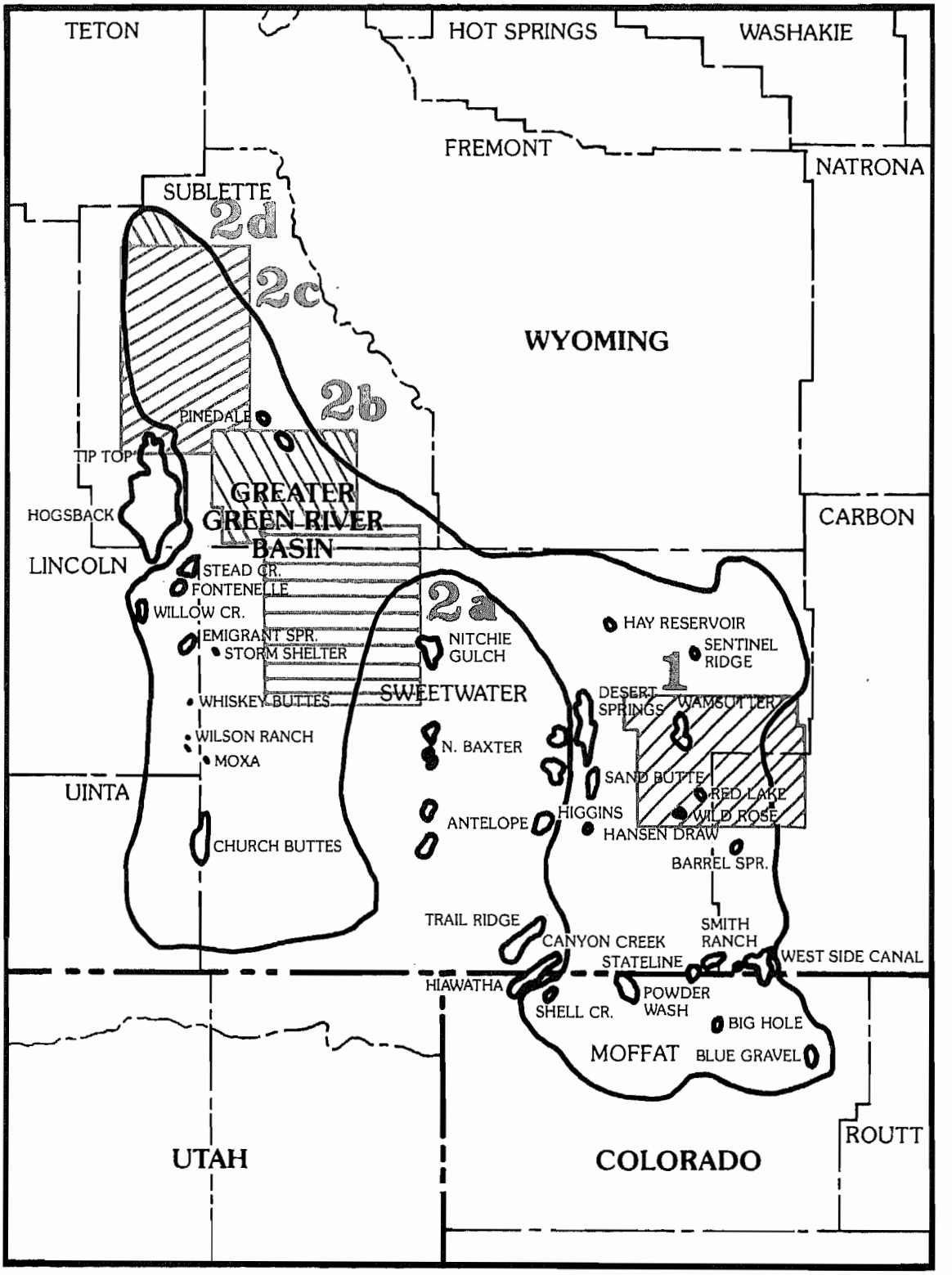


Figure 4-5 USGS Designated Core Areas, Greater Green River Basin

2a West of R104W to R109W and from T22N, north to T28N

2b R106W to R111W and from T27N to T31N

2c R108W to R112W but not including development drilling, and T30N to T35N

2d North edge of Green River Basin; north into the Hoback Basin, T36N to 39N and R112 to 114W.

4.2.2 Northern Great Plains Province

The USGS has delineated a large area of western North and South Dakota, Montana, and northeastern Wyoming as having tight gas potential. This area is called the Northern Great Plains Province and comprises an area of about 125,000 square miles (Figure 4-6). The western boundary is based on the out cropping of potentially productive Upper Cretaceous units or where these units have developed into porous and permeable shoreline sandstones. The northern boundary is on the Canadian border and the southern boundary is along the north end of the Powder River Basin. South of this boundary the units are too deep for significant biogenic gas accumulations. The eastern boundary is based on the eastern limit of tight clastic reservoirs in the Upper Cretaceous units. However, there are chalks in the Upper Cretaceous Niobrara, Carlile and Greenhorn units in the eastern part of the province. These chalks have high porosities but low permeabilities and are considered to have excellent shallow gas potential. The eastern boundary of the province probably will be extended well beyond the present location when the extent of the chalks becomes known.

The USGS has chosen four areas where core data are needed in the Montana segment of this province to evaluate the Upper Cretaceous section (see Figure 4-7). Specific formations in each area are included along with the approximate coring intervals needed to effectively evaluate each location.

1 Powder River County
T5S, R52 and 53E
Judith River 200 ft
Eagle 400 ft
Niobrara (chalk) 200 ft

2 Custer and Prairie Counties
T10 and 11N, R48 and 49E
Judith River 200 ft
Eagle 400 ft

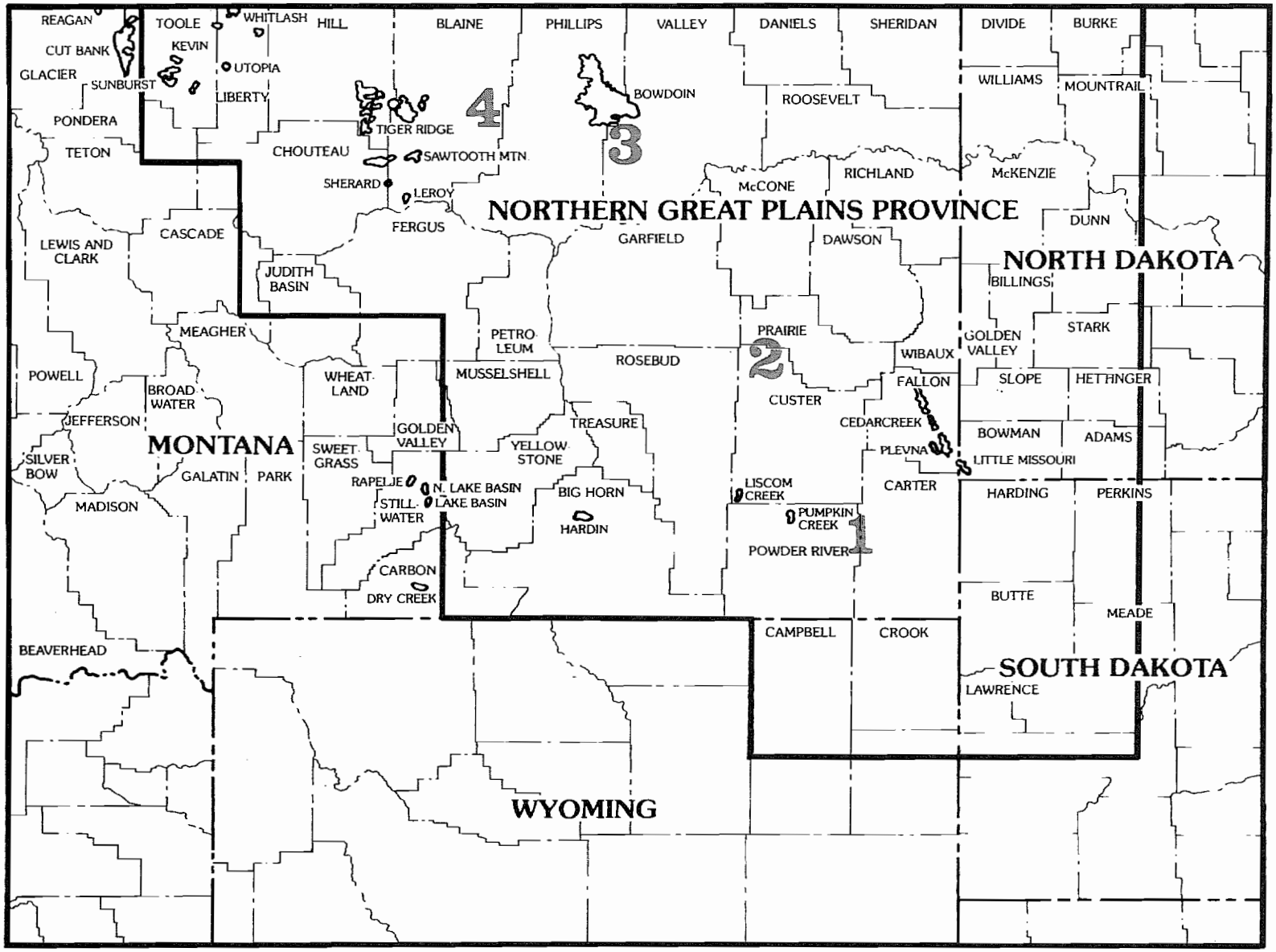


Figure 4-6 USGS Designated Core Areas, Northern Great Plains Province

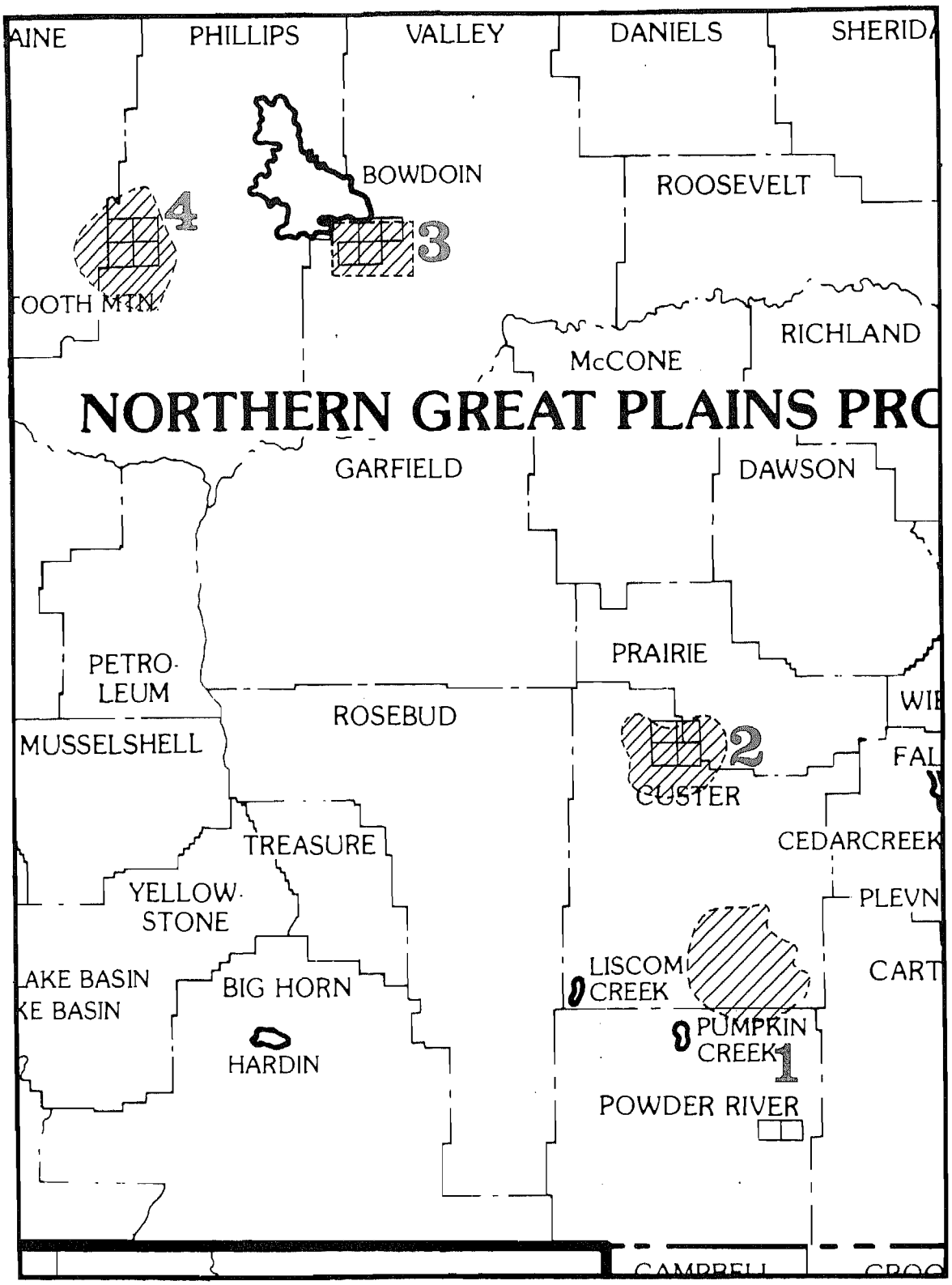


Figure 4-7 Detail of USGS Designated Core Areas, Northern Great Plains Province

3 Valley County (fractured reservoir)
T29N and 30N, R35, 36 and 37E
Eagle through Upper Mowry 1,450 ft

4 Phillips County
T29 and 30N, R26 and 27E
Eagle through Upper Mowry 1,400 ft

These areas were evaluated by DOE contractors and modified or expanded to some degree. The dotted lines in Figure 4-7 show these areas. The outlined location immediately north of the USGS Area No. 1 was chosen primarily to take advantage of some Upper Cretaceous porous sands that might be of more immediate interest to industry.

Areas 1 and 2 were chosen to evaluate the Judith River, Eagle and Niobrara (Chalk) sections and Areas 3 and 4 offer evaluation of the Eagle through Mowry section. All of the Areas are outside commercial production and have two or more potential reservoirs as well as adjacent source beds to test. Additionally, there are fractured reservoirs along a lineament zone in Area No. 3.

4.2.3 Piceance Basin

The Piceance Basin of northwestern Colorado (See Figure 4-8) has a large amount of tight Upper Cretaceous and Tertiary gas sands, such as Castlegate, Sego, Corcoran, Cozzette, Iles, Williams Fork, Ft. Union and Wasatch Formations. Some of these units are producing gas in active fields such as Cathedral, Piceance Creek, Trail Canyon, Thunder, Mancos A and B in Dragon Trail and Texas Mountain. However, outside of these fields, very little information is available on these units due to a limited amount of drilling activity. For instance, in the Piceance Creek Field, there is also interest in, but little data on, rocks below the commercial Wasatch. This becomes even more evident when attempting to find suitable core data for these rocks. The USGS has indicated key areas in the Piceance Basin with a significant amount of "tight gas" sections but limited control. These areas will be used initially to acquire the needed information specified by the WGSP Core Program. The following is a list of these areas:

1 East of Rangely Field in Rio Blanco County, T1S to T2N, R98W to R99W.

2 Piceance Creek Field area, Rio Blanco County, T2S, R96W to R97W.

3 Garfield and Mesa Counties, T5S to T8S, R95W to R99W in the north tapering down to R98W on the southern part of the area.

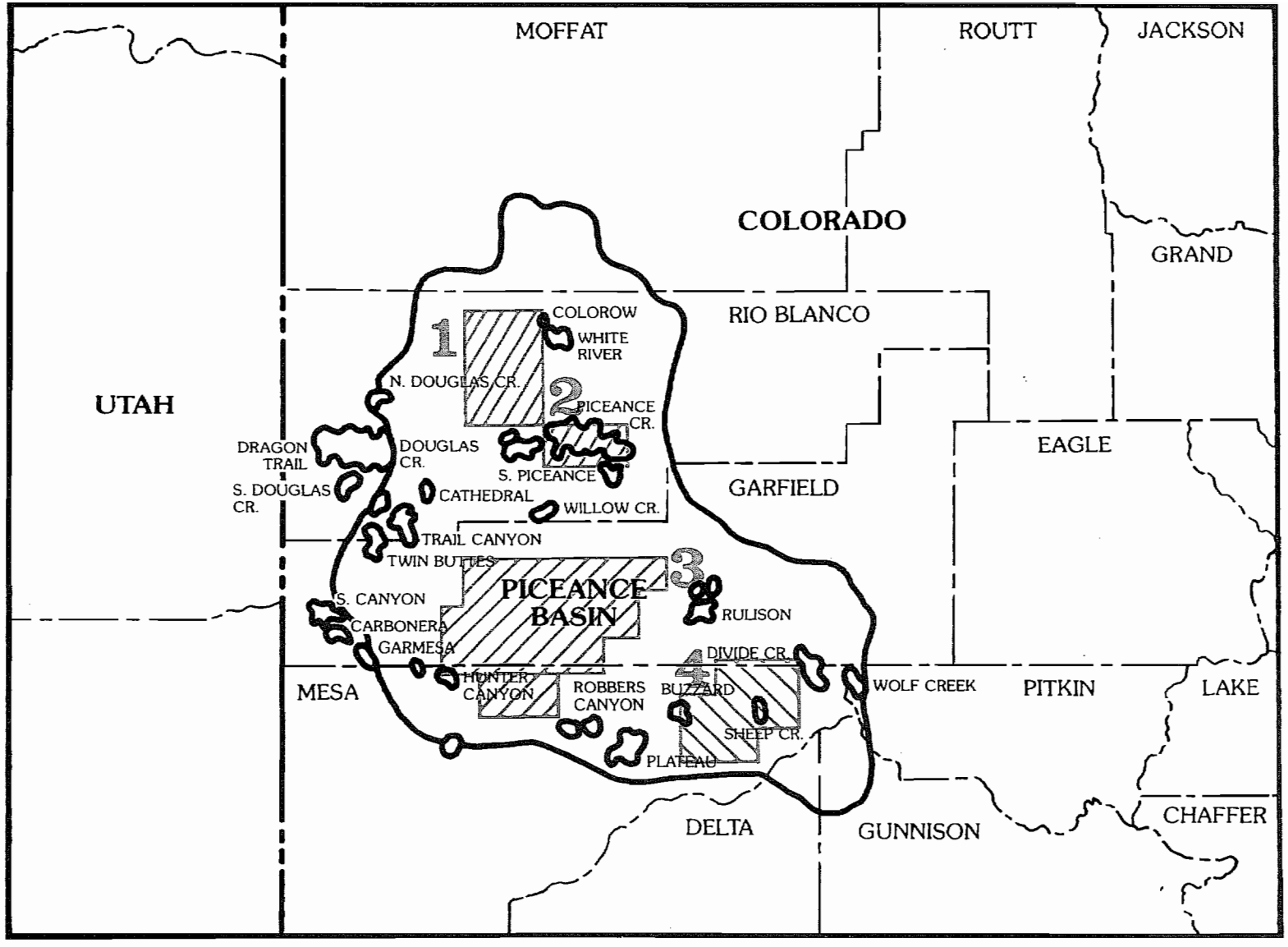


Figure 4-8 USGS Designated Core Areas, Piceance Basin

4 Garfield and Mesa Counties, T8S to T10S, R92W to R94W (this area is flanked on the northwest and southeast by the Grand Mesa National Forest).

Operators active in these areas will be contacted for possible participation in DOE's core program.

4.2.4 Uinta Basin

The boundaries of the Uinta Basin (see Figure 4-9) enclose a large area of northeastern Utah with potential "tight gas sand" production. The potentially productive formations range in age from Upper Cretaceous to Tertiary. Examples of Cretaceous rocks are the Price River, Castlegate, Blackhawk, Sego, Neslen, and Farrer. The Tuscher, Wasatch, North Horn and the Green River are examples of Tertiary rocks. The USGS has recently outlined specific areas of this basin for the acquisition of core in the WGSP Core Program. These areas, listed below, have limited core data from the potentially productive sections of interest.

1 Wasatch and Duchesne Counties - T4S to T7S, R5W to R11W; in Wasatch County, T9S to T11S, R7, 8 and 9E; in Carbon County, T11S to T12S, R7E to R13E.

2 Duchesne and Uintah Counties - T3S to T4S, R2E to R2W and parts of T8S, R16E to R18E.

3 Uintah County - T8S and T9S and R23, 24 and 25E.

4 Uintah and Grand Counties - T10S, R18E; T11S to T16S, R18E to R25E; and in T17S, T18S, and T19S, R21E and R22E.

These areas are outside the productive fields of the Uinta Basin, of which the most activity is in the Natural Buttes and Red Wash Fields where production is primarily from the Wasatch, Mesaverde and Green River Formations.

These areas will be monitored and operators will be contacted for possible cost-sharing coring contracts. While proposers will have the technical competence to carry out the coring project, DOE will maintain continuous liaison with the contractor and will participate in technical progress review meetings.

Logging operations will be conducted in accordance with a mutually acceptable log quality control checklist, prepared by the Technical and Administrative support contractor. Both coring and logging operations will be observed by Technical and Administrative support contractor personnel and assistance provided if requested by the operator.

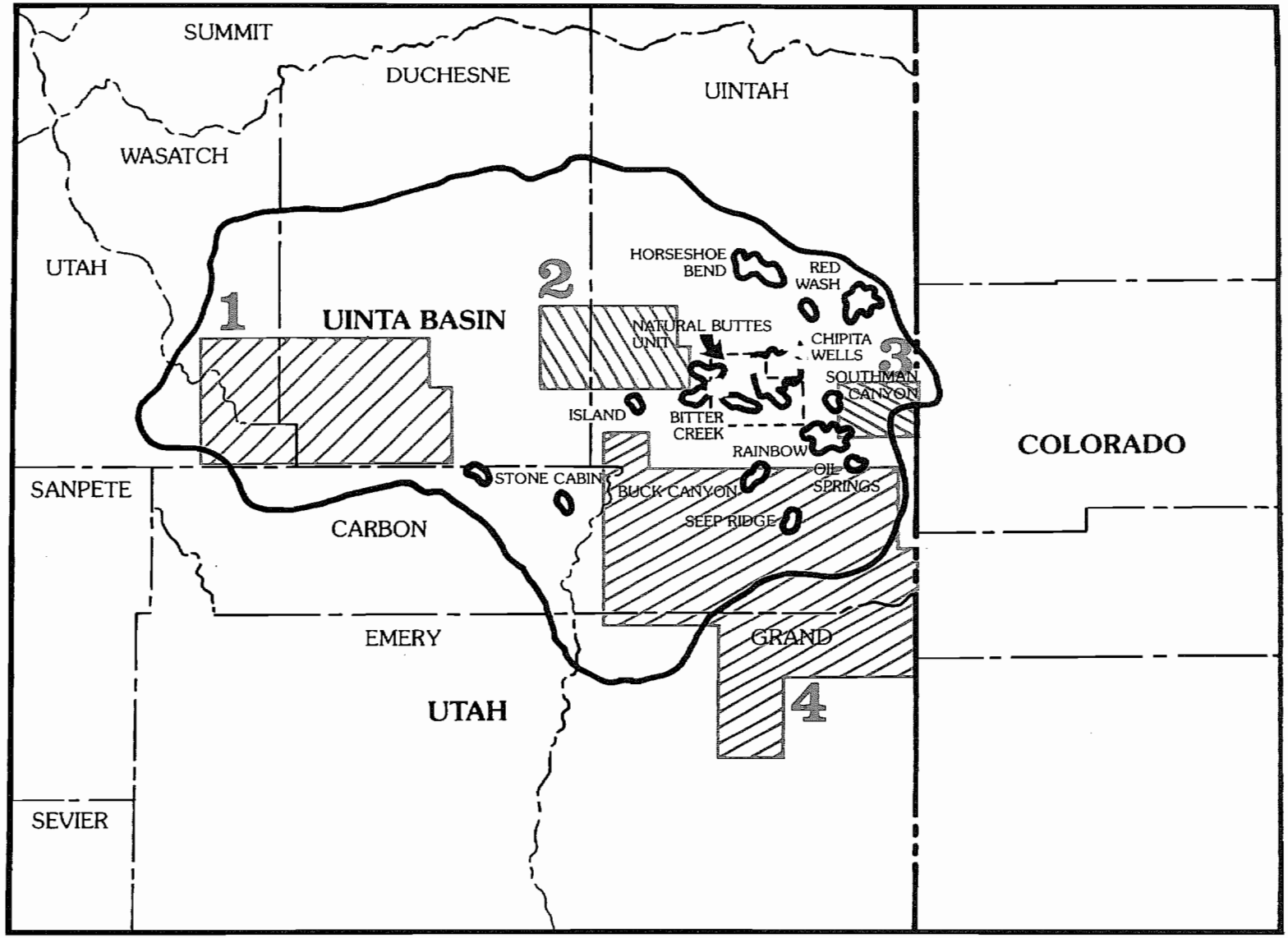


Figure 4-9 USGS Designated Core Areas, Uinta Basin

4.3 Basin Activities

CER Corporation, as the FY 1978 Technical and Administrative support contractor, through review of the Petroleum Information Corporation's Rocky Mountain Reports and other sources of information, is continuously monitoring drilling and exploratory activities in the four primary study basins.

Each WGSP monthly status report will contain a brief summary of basin activities, and a Quarterly Basin Activities Report will be issued documenting the number of wells being drilled and the operators involved. Well locations, key formation tops, production tests, perforated intervals, fracture treatments and results will be included in the quarterly report. This activity will continue during FY 79 with emphasis being placed on those areas that show possibilities of successful MHF treatment demonstrations.

5. RESEARCH AND DEVELOPMENT BY ENERGY TECHNOLOGY CENTERS AND NATIONAL LABORATORIES

Laboratory R&D activities are directed toward new logging and coring tools, rock mechanics investigations, mathematical modeling, core analysis, and fracturing technology advances. These activities have primarily been performed by DOE's Energy Technology Centers, the National Laboratories, and the USGS. Figure 5-1 lists the subjects to be investigated.

5.1 Bartlesville Energy Research Center

Projects in progress will be continued during FY 79 and additional investigations initiated as needed to increase the effectiveness of massive hydraulic fracturing for stimulating production. Currently under study are: frac fluid effect on permeability, proppant effectiveness, logging methods, and well test data interpretation.

Determination of frac fluid interaction with reservoir rocks, both chemically and physically, as well as chemical interaction with formation water, will provide information for improving the design of future MHF experiments. Effects of these interactions upon formation and fracture permeability will be examined to provide a theoretical model that can be used in improving fracturing fluid/proppant efficiency.

Investigations will include examining the validity of applying electrical, neutron, accoustic and density logging techniques and interpretations developed for high-permeability, high-porosity formations to the very low-permeability, low-porosity reservoirs. Where needed, new theoretical and/or empirical relationships will be developed for interpretation of these logs.

Other laboratory and contractor-performed support will include simulation and modeling to provide a basis for conducting statistical, parametric, and prediction analyses. Test data will be used to validate the models which, in turn, may be used to aid in the interpretation of test results. A milestone chart reflecting these tasks is shown in Figure 5-2.

5.2 Lawrence Livermore Laboratory

Lawrence Livermore Laboratory (LLL) is working to obtain an understanding of stimulation processes, including how formation properties affect these processes. The program is primarily investigative with no field programs proposed. The major lines of endeavor are:

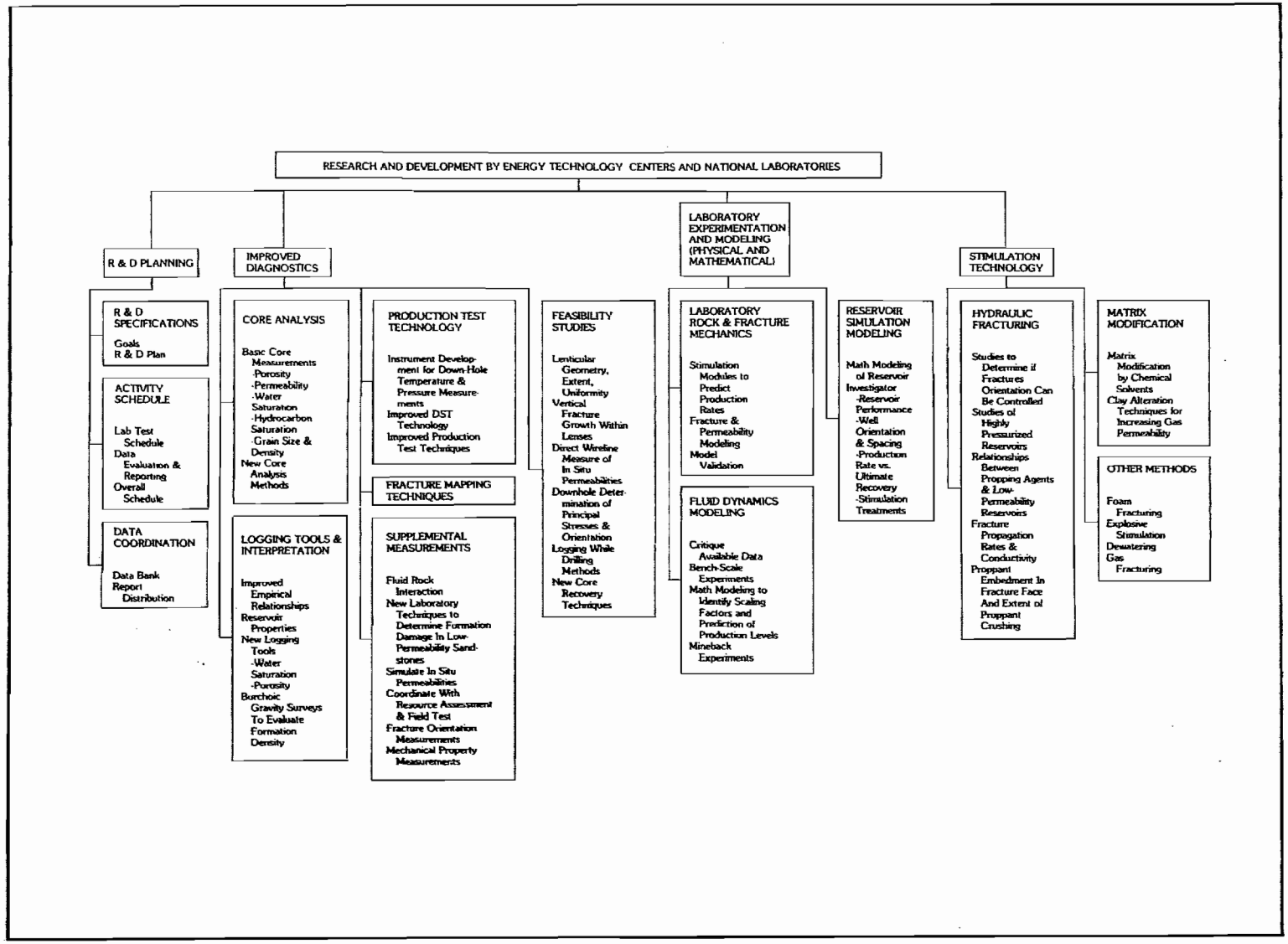


Figure 5-1 Research and Development by Energy Technology Centers and National Laboratories

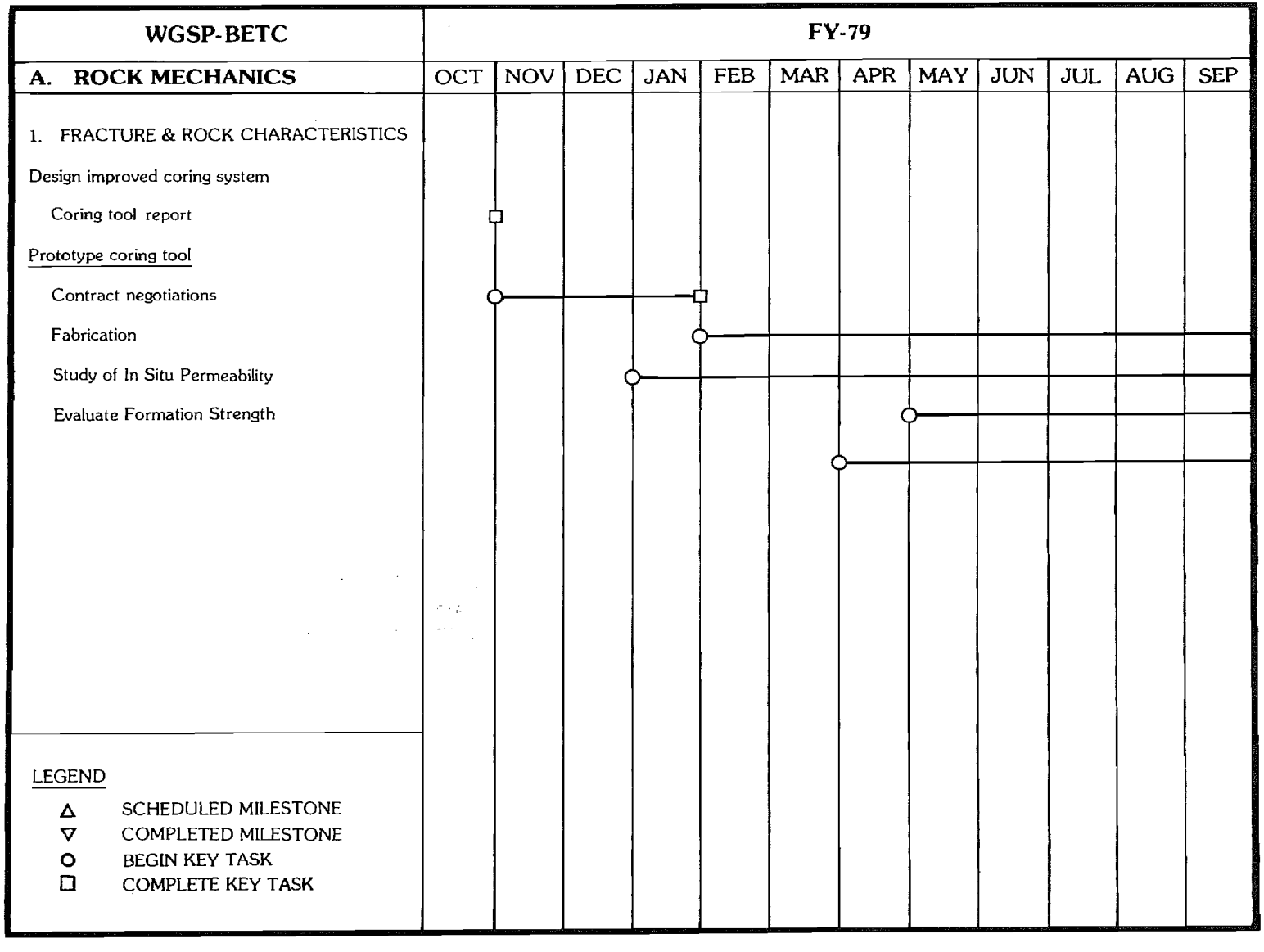


Figure 5-2 Milestone Chart— BETC

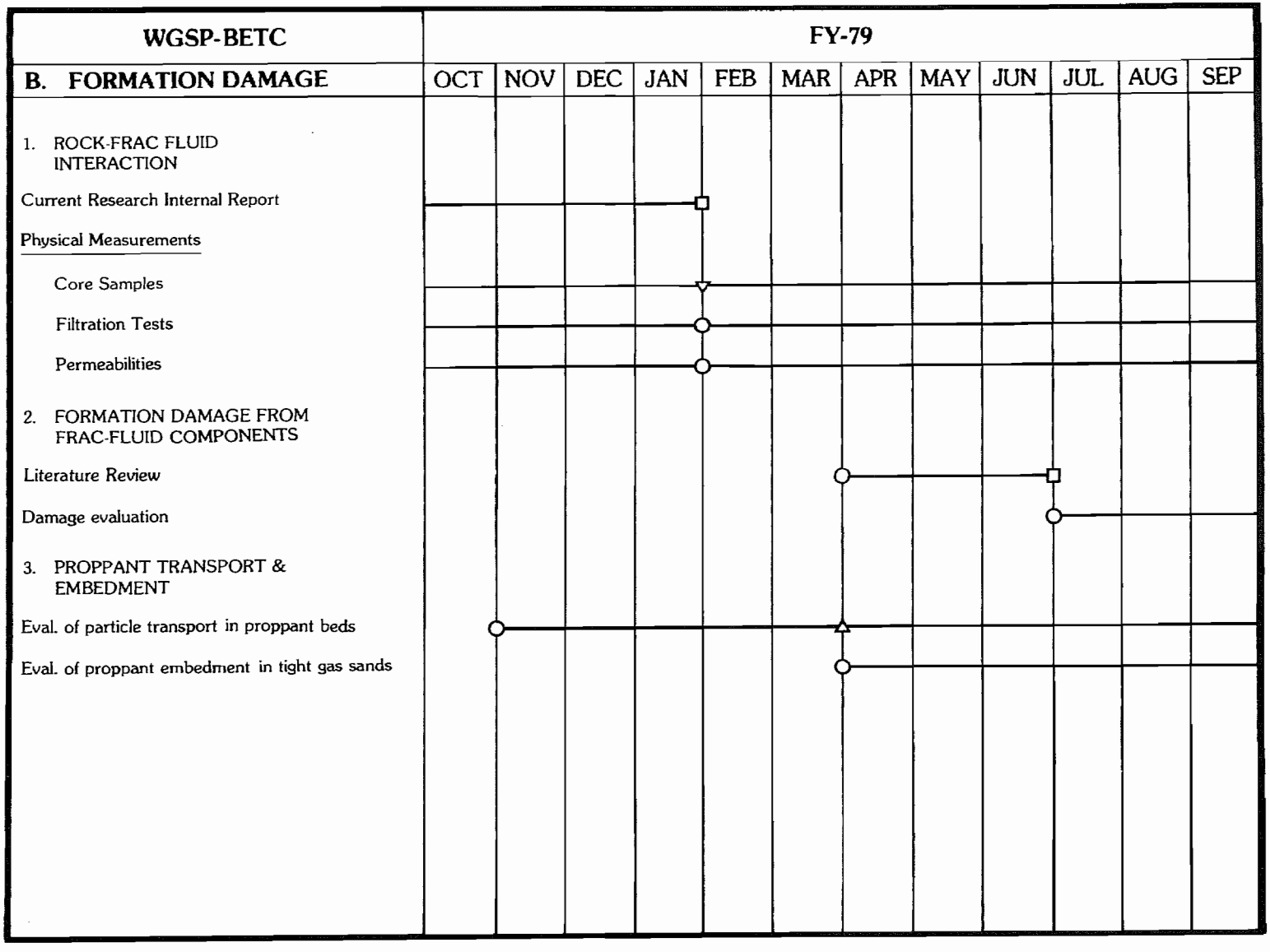


Figure 5-2 Continued

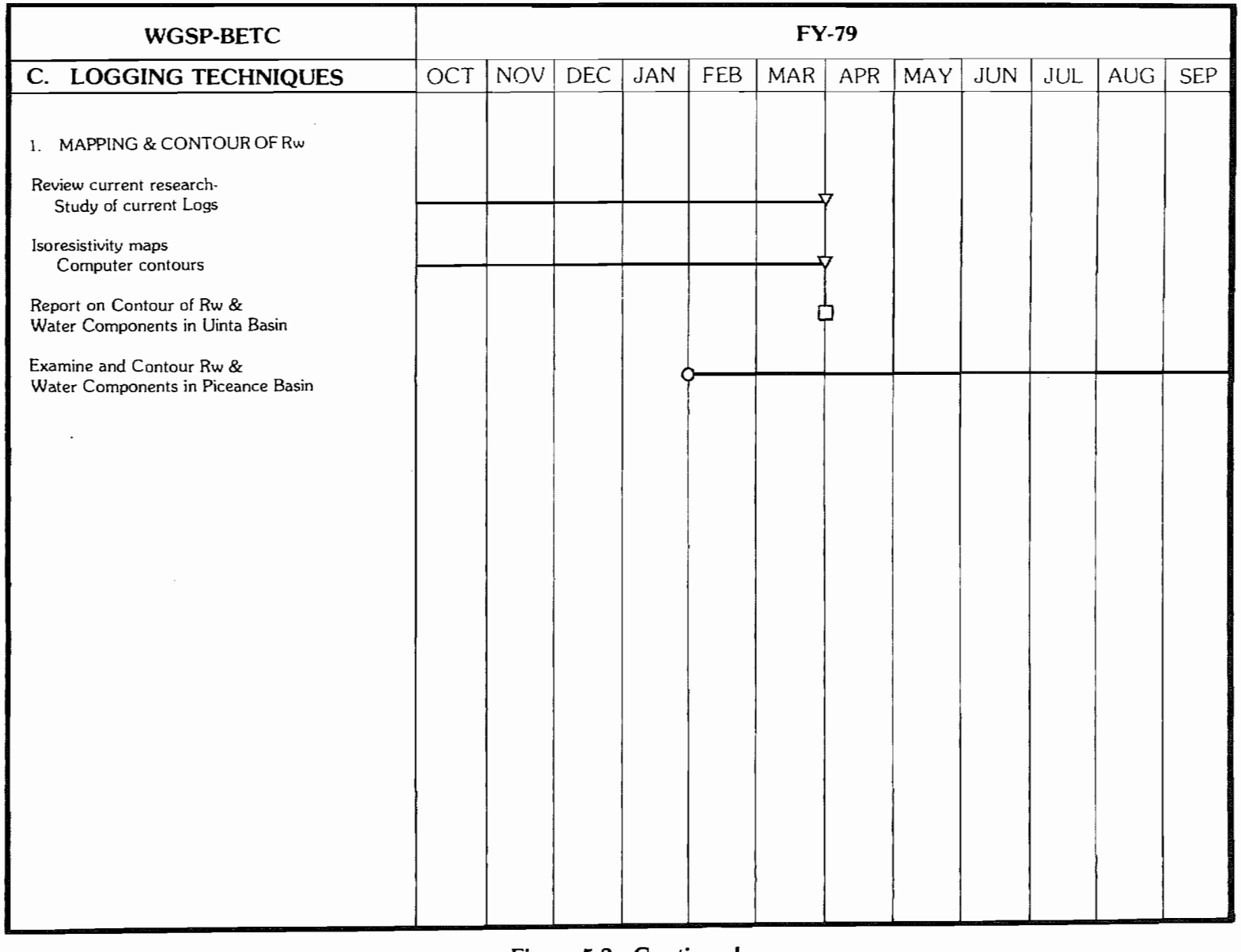


Figure 5-2 Continued

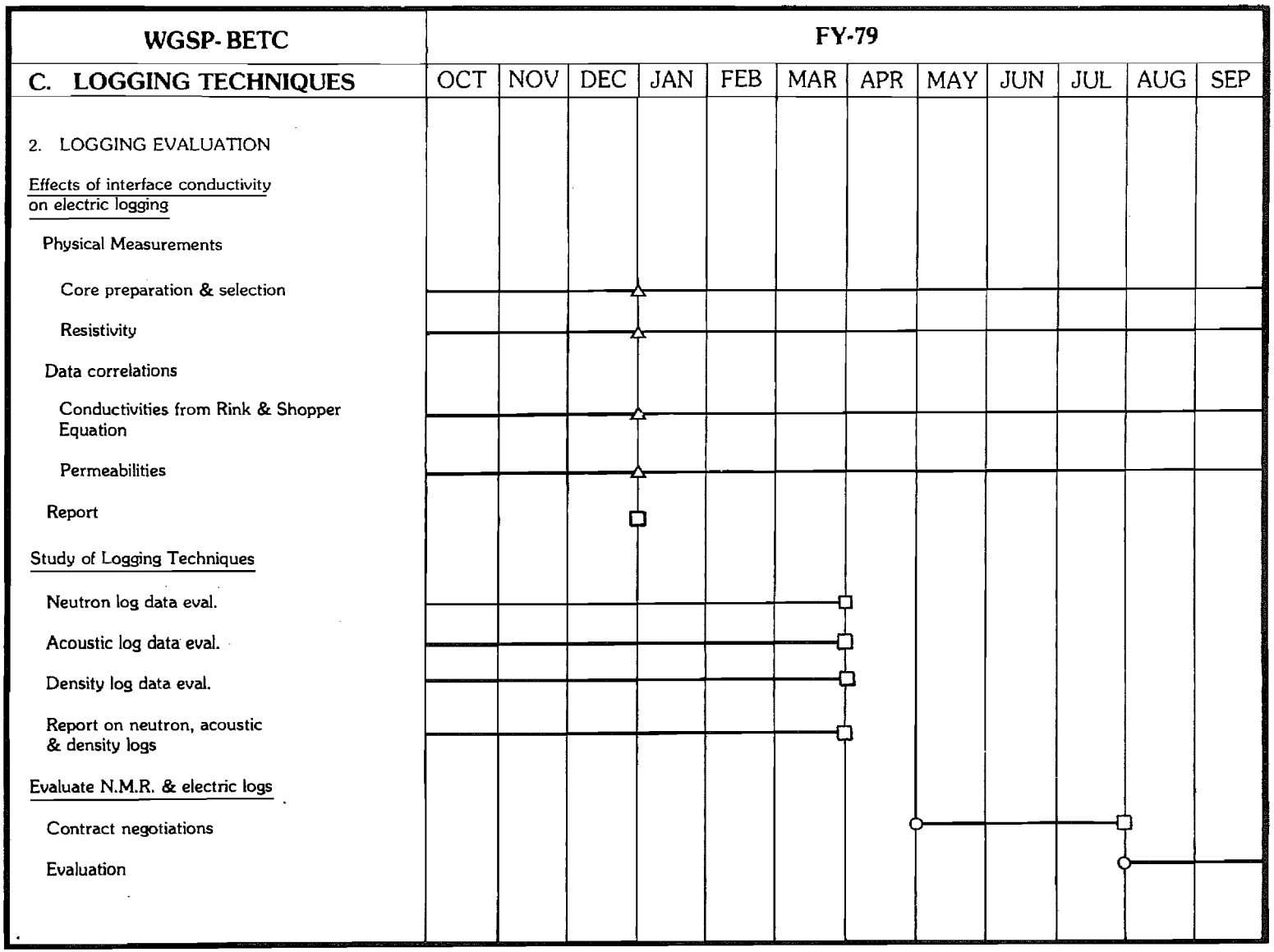


Figure 5-2 Continued

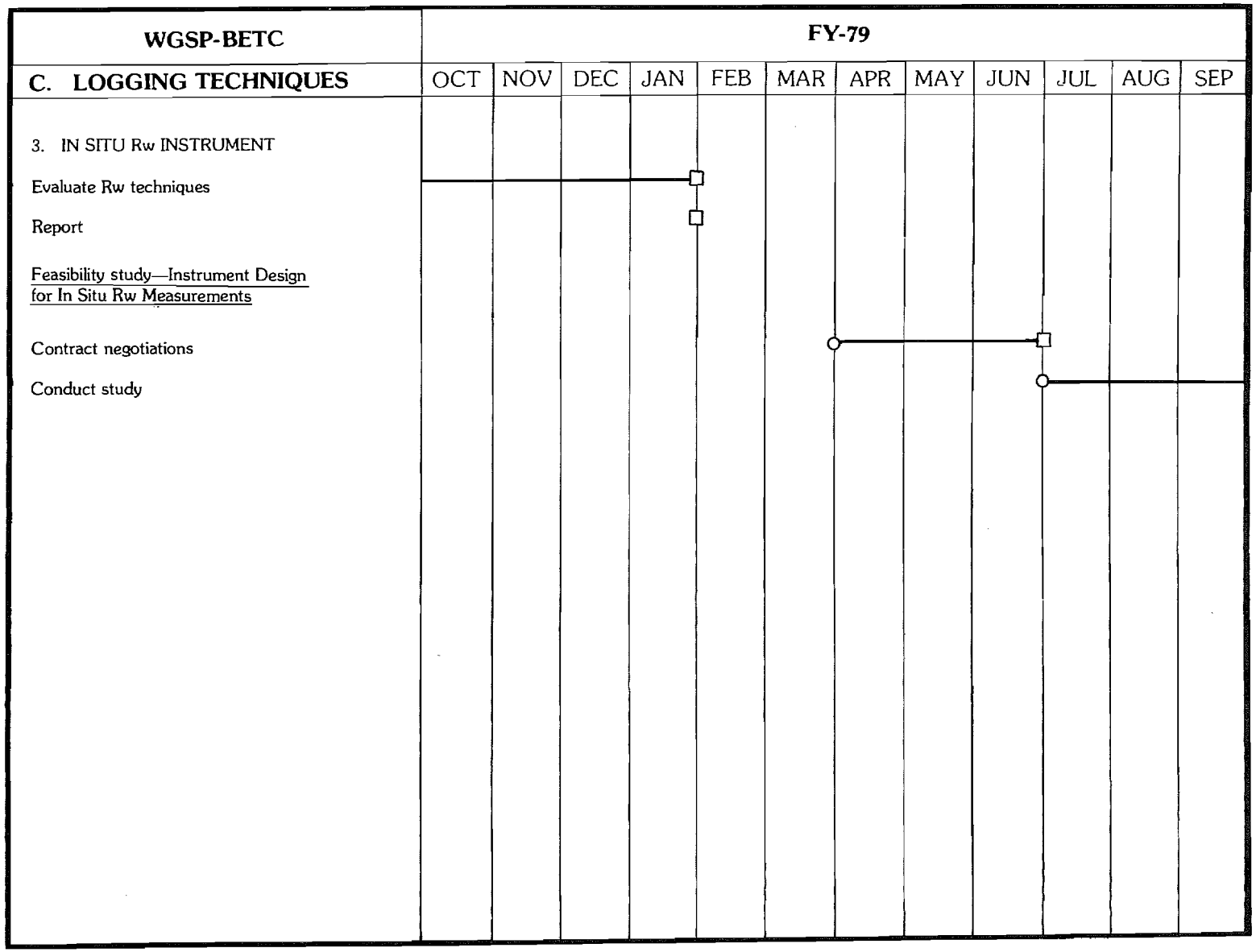


Figure 5-2 Continued

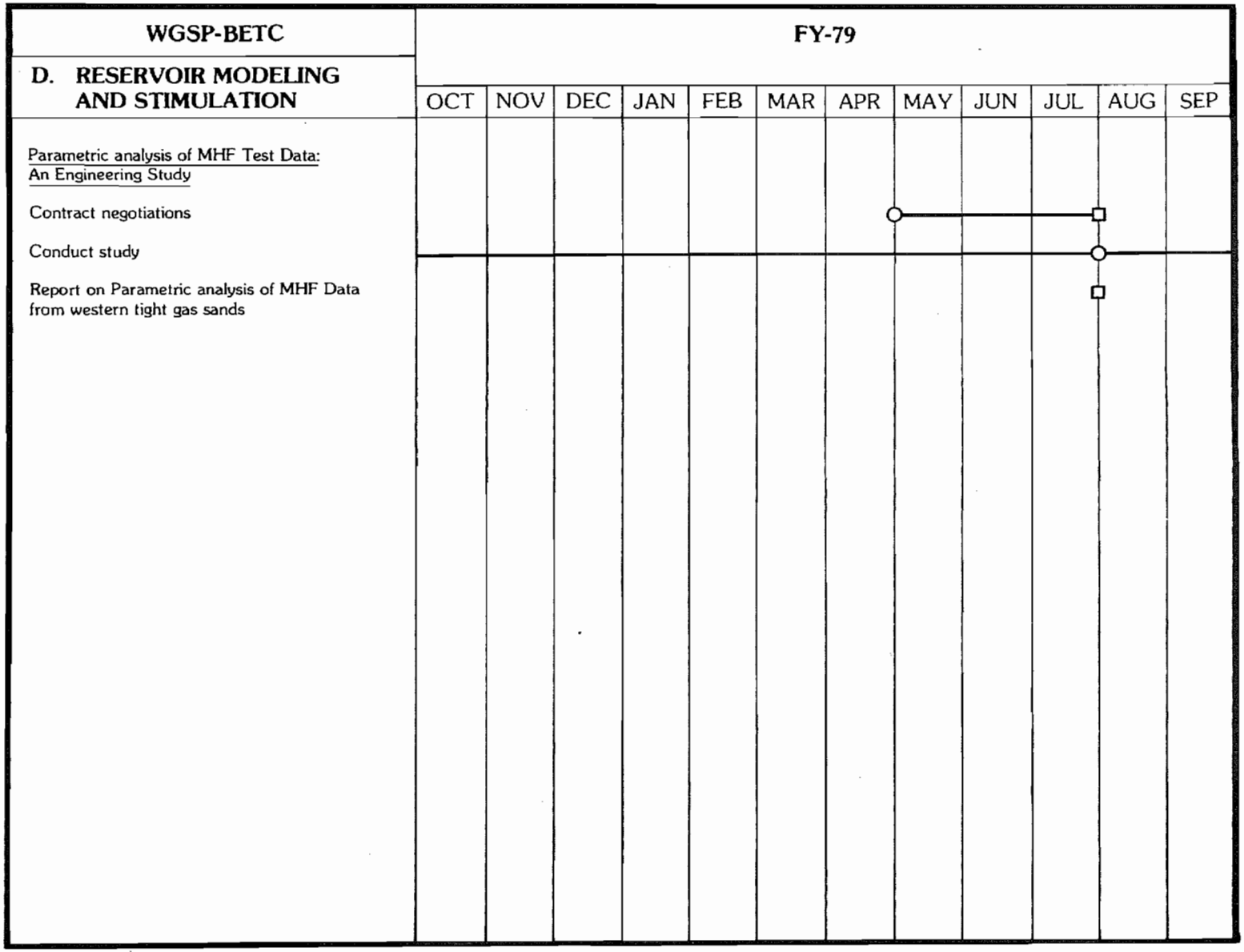


Figure 5-2 Continued

- Theoretical modeling of the hydraulic fracturing process.
- Measurement of reservoir properties.
- Cataloging and evaluation of geological and geophysical reservoir data.
- Hydraulic fracturing laboratory experiments.
- Logging tool development and application and the analysis of log data.
- Reservoir analysis.
- Environmental assessments.
- Evaluation of other stimulation techniques.

LLL will attempt to gain a more complete understanding of the MHF process through theoretical and laboratory modeling, data analysis, reservoir analysis, and the development and application of new logging techniques.

Development of the three-dimensional reservoir simulation model will be continued. Use of the two-dimensional model will continue with analysis of fracture propagation across layer interfaces. Analytic simplification of the models will begin in order to reduce computer storage and time requirements.

The acquisition of reservoir data will continue and the characterization of parameters which affect stimulation will begin. LLL will continue to analyze well test data to interpret results and predict fracture area. Environmental assessments will be made for DOE's gas production stimulation program.

Mechanical properties and fracturing characteristics will be determined using available cores. Tests on the interfacial material and the interbedding shales will be included. Permeability measurements will be made on cores at reservoir pressure under both hydrostatic and non-hydrostatic conditions. Log data will be correlated with core measurements for both mechanical properties and flow characteristics. The LLL sonic logging tool will be used to locate near-wellbore fracturing in selected wells.

Interaction with industry and other laboratories and organizations is important in the implementation of the LLL program. Duplication of existing measurements and effort will be avoided. Progress will be reported in monthly reports and formal quarterly reports. Important conclusions and completed segments of the work will be summarized in separate formal reports. Figure 5-3 is a milestone chart of these tasks.

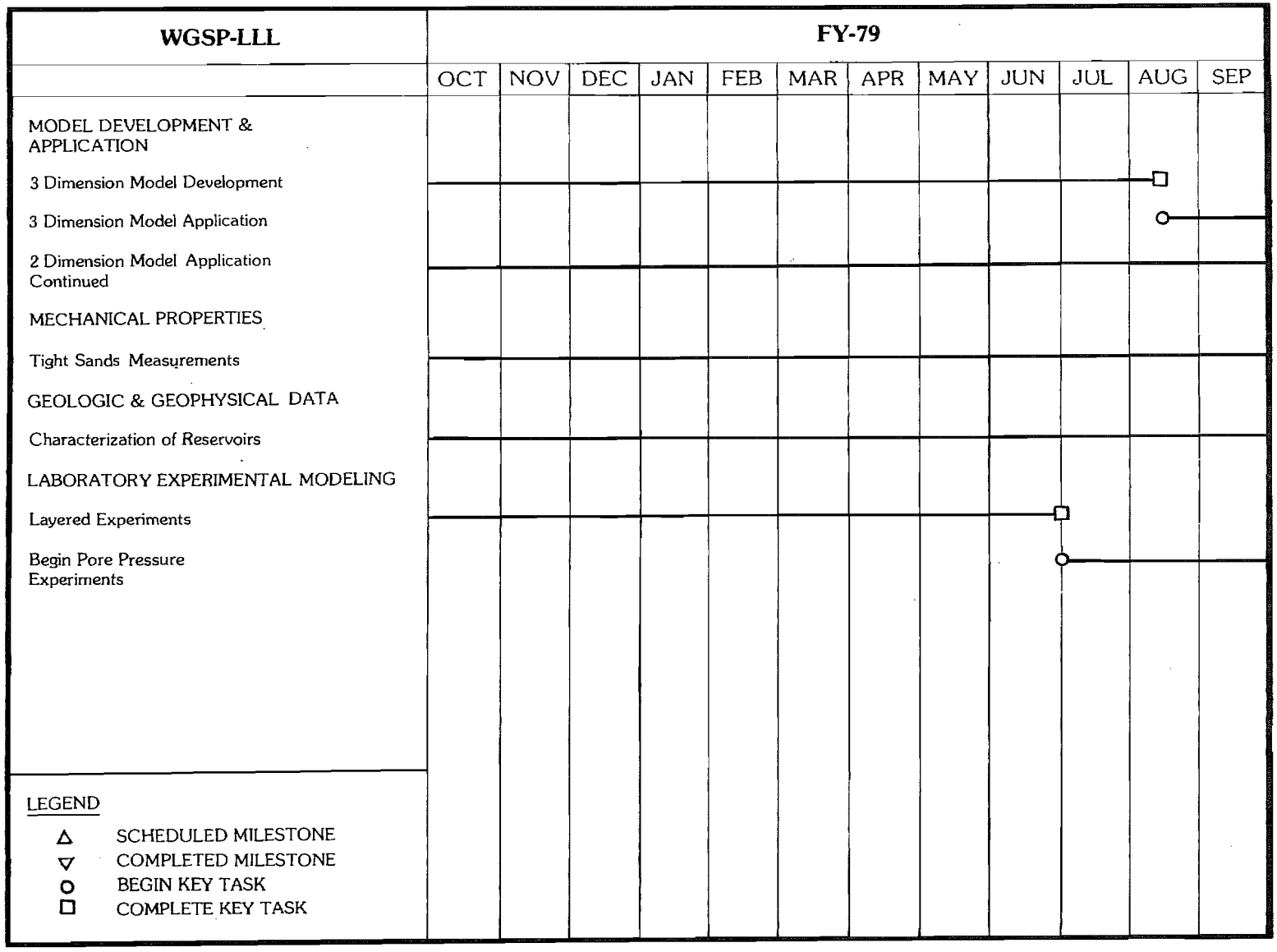


Figure 5-3 Milestone Chart—LLL

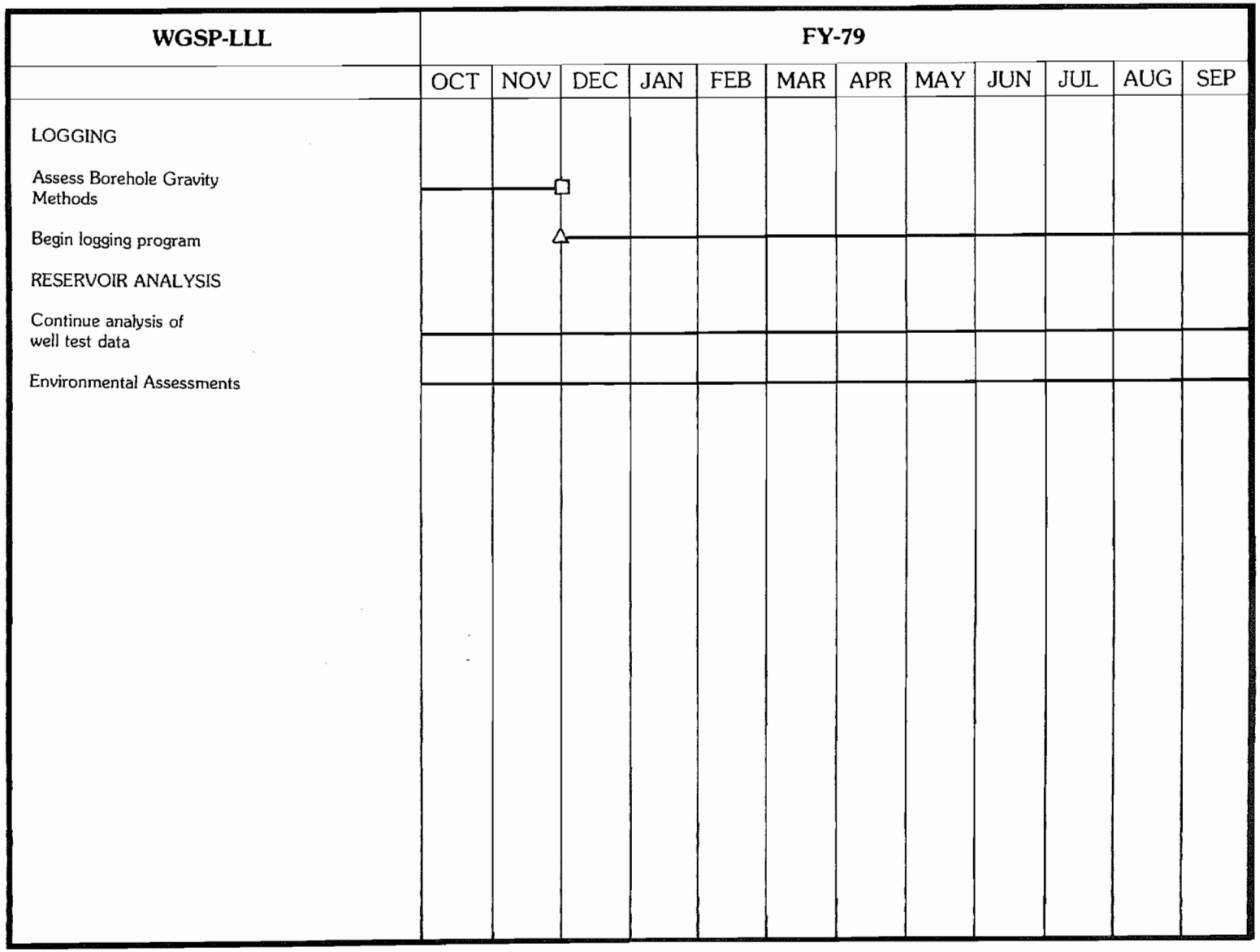


Figure 5-3 Continued

5.3 Sandia Laboratories

The goal of the Sandia Laboratories projects is to develop and apply diagnostic techniques to stimulation process evaluation and to reservoir/formation characterization. The detailed objective is the continued utilization and new development of geophysical diagnostic techniques to increase understanding of the stimulation techniques and for in situ formation evaluations. Significant accomplishments to date include determination of fracture orientations, fracture growth periods and fracture asymmetries. These accomplishments have been achieved through the deployment of the surface electrical potential technique and the analysis of the data collected during fracturing experiments. Other geophysical techniques are currently undergoing development and deployment to further increase understanding of stimulation techniques, fracturing dynamics, and in situ reservoir characteristics.

5.3.2 Massive Hydraulic Fracture Mapping and Characterization Program

The transfer of the technology to private industry for the electrical potential system should be completed in FY 79. The fracture mapping program will continue utilizing the borehole seismic system to further define fracture parameters. The vertical growth and containment criteria for fractures will be investigated along with fracture length and width parametric studies. New geophysical diagnostic tools for logging, stimulation effectiveness and formation evaluation will also be under design and prototype testing. Planning on techniques for measuring lenticular formation boundaries will also be under investigation. Figure 5-4 is a milestone chart of these tasks.

5.3.3 Stimulation and Mineback Experiment Project

The objective is to develop an understanding of the fracturing process for stimulation by conducting controlled fracture experiments which are accessible by mineback for direct observation and evaluation. DOE's Nevada Test Site provides this opportunity through use of an existing tunnel complex and support facilities. The site has from 1,200 to 1,500 ft of overburden made up of bedded and welded tuff formations that have similar strength and permeability characteristics to the low-permeability gas reservoirs of interest. Sandia has performed several hydraulic fracturing experiments and the feasibility of mineback and coring to delineate the fractures has been demonstrated.

The role of mineback testing is shown schematically in Figure 5-5. Mineback evaluation is based upon direct observation and comparison with measured material properties, fluid behavior and the operational parameters. This provides more information than can be obtained from gas production and pressure data.

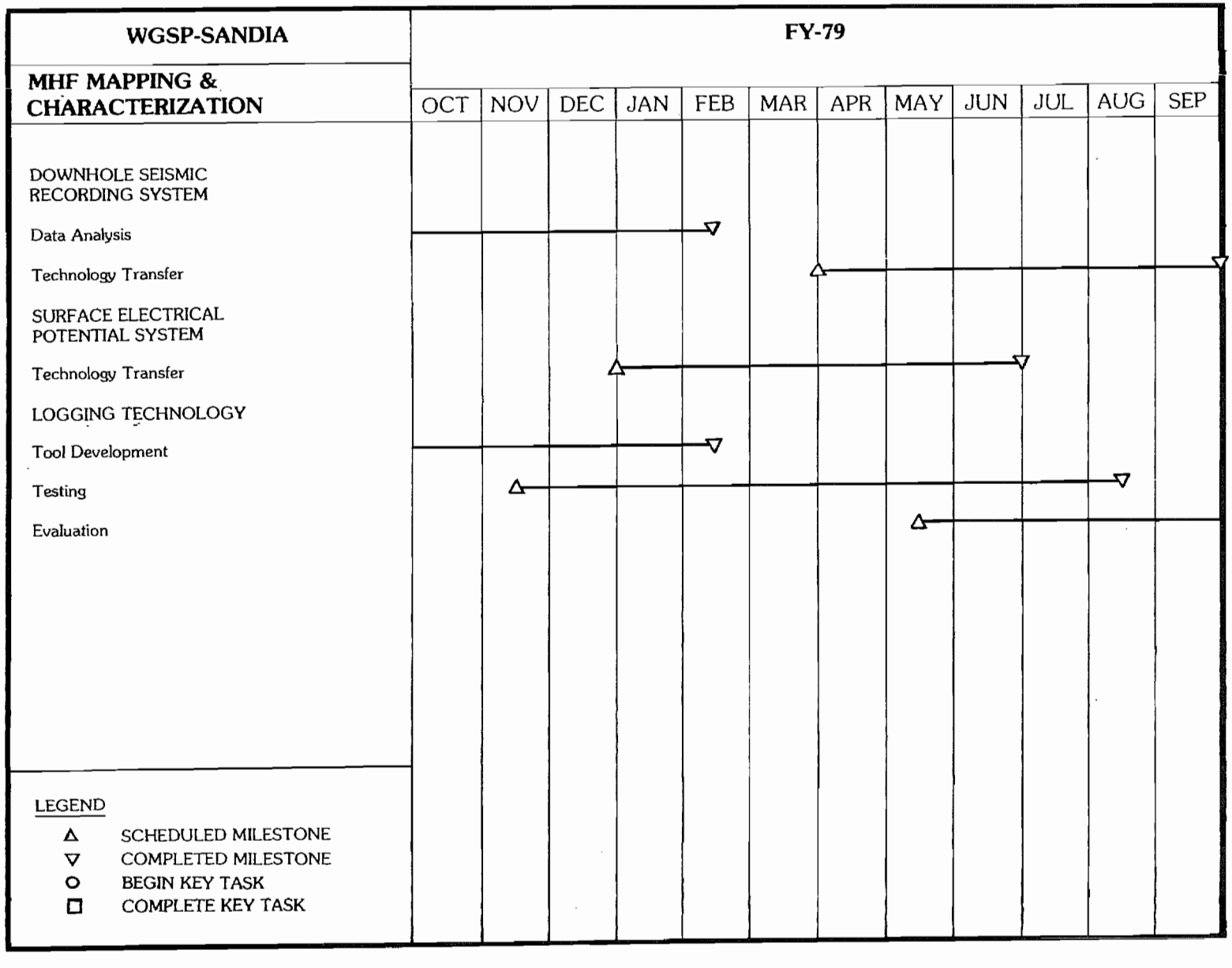


Figure 5-4 Milestone Chart—MHF Mapping and Characterization, Sandia

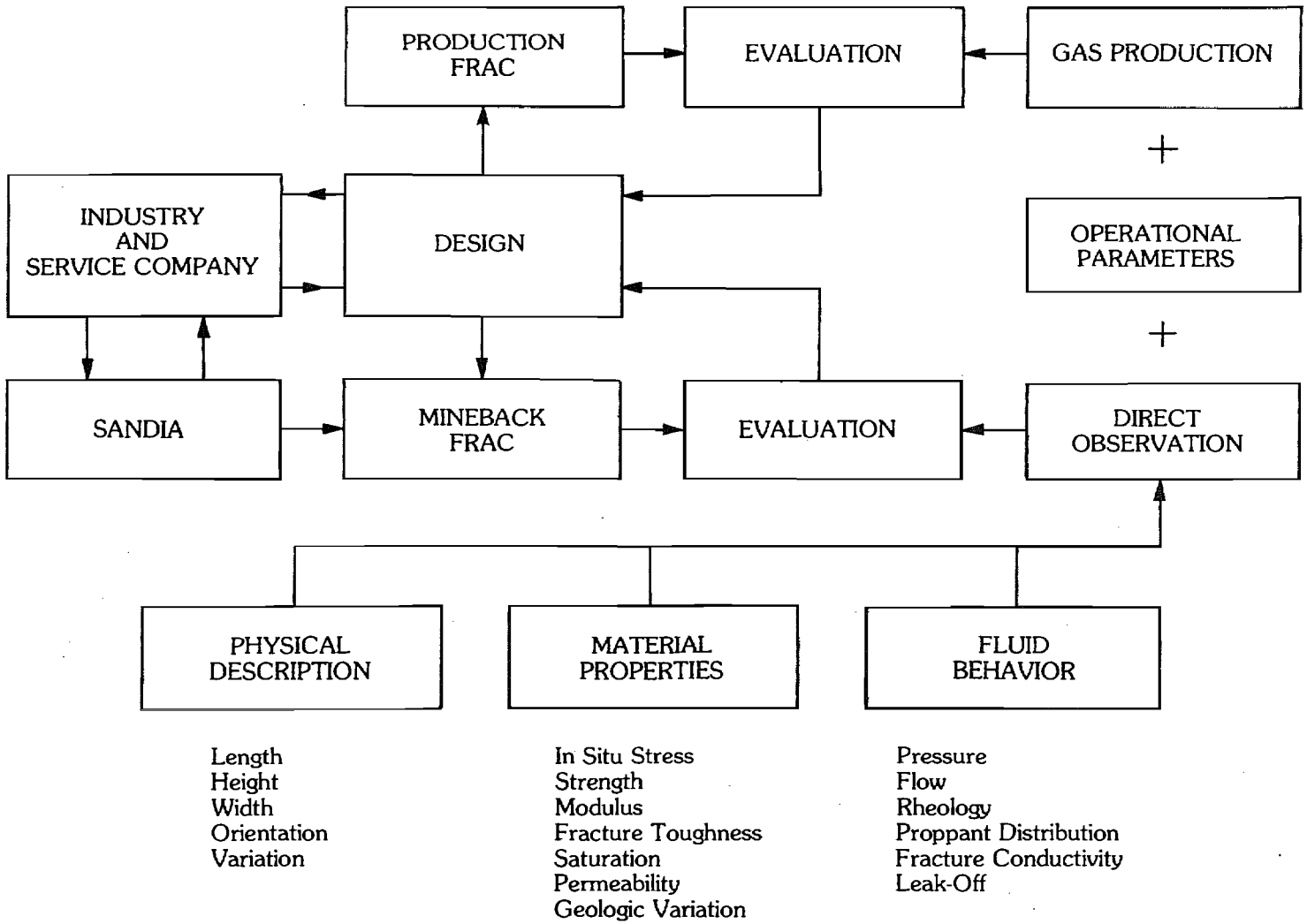


Figure 5-5 Schematic Showing the Role of Mineback Testing

Specific tasks include:

- Fracturing with mineback for direct fracture observation and evaluation.
- Supportive rock mechanics, fluid dynamics and geochemical studies required to interpret observed fracture behavior.
- Incorporation of the results into improved stimulation design models and calculations.
- Assessment and calibration of techniques for fracture mapping and characterization.
- Testing of innovative stimulation techniques.

Producing and fracturing service company personnel are assisting in the design and evaluation of these mineback experiments.

A general schedule of activities is shown in Figure 5-6. Specific activities in FY 79 are:

- Final evaluation and assessment of an experiment which examines the behavior of hydraulic fractures at a geologic formation interface.
- Define, perform, and initiate evaluation of a combined proppant distribution-fracture conductivity test.
- Initiation of a series of small tests which will investigate basic fracturing phenomena (in situ stress and alteration, crack propagation, fracture-formation interaction), applied technology (completion and perforation effects, proppant transport, various fluid effects), and other technology (high-energy gas fracture, in situ measurement of formation fracture toughness).
- Continued development of a small-volume hydraulic fracturing technique as a diagnostic tool to determine in situ stress distributions.
- Continuation of rock mechanics, fluid dynamics and other modeling studies which support project activities.
- Evaluation of experiments being performed as part of a nuclear containment program which provides information on the fracture systems, permeability, and changes in in situ stress produced by a contained explosion.

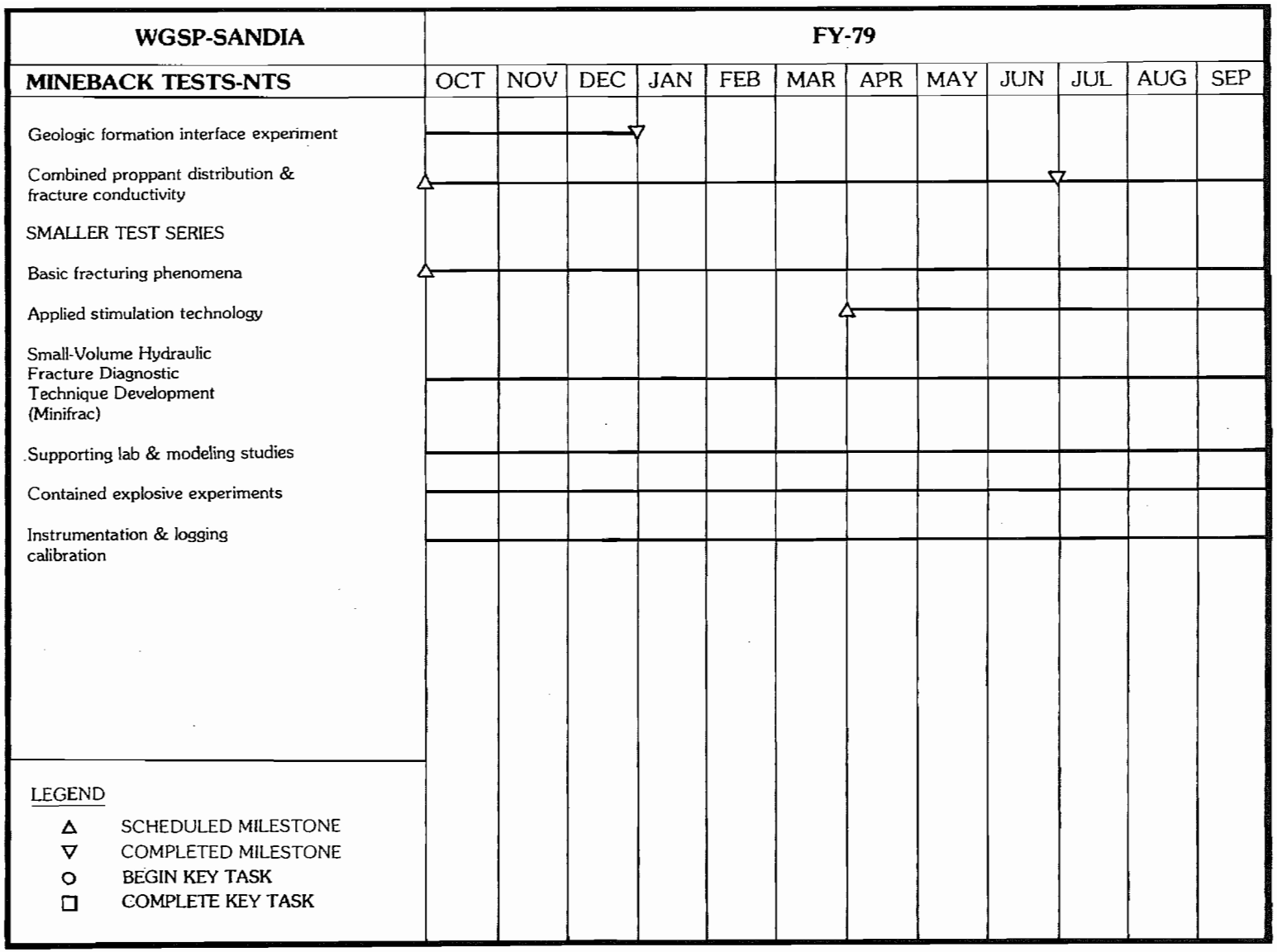


Figure 5-6 Milestone Chart of Mineback Tests—Sandia

5.4 Tiltmeter

During a portion of FY 78 the tiltmeter studies were carried out under the direction of the USGS - Menlo Park. The research has been continued by M.D. Wood, Inc. Several experiments in FY 78, performed under a variety of conditions, contributed to progress in develping the tiltmeter fracture mapping technique.

Research to date has been on mapping the surface deformations associated with hydraulic fracturing. The experiments have taken place in a variety of formations at depths up to 9,000 ft utilizing a considerable range of driving pressures. Environmental background noise was a major test consideration and weather conditions varied from those of the Mexican border to the Arctic Circle. These were challenging conditions for extracting a small signal from overwhelming noise. FY 78 fracture mapping research matured under these conditions, but a more balanced program is necessary between the theoretical analysis of the data and field experiments.

The FY 79 schedule (Figure 5-7) shows tentative work consisting of two experiments. Previous work illustrates what a set might include. For example, a three-well sequence spaced over distances comparable to the depth (1 mile) in Wattenberg Field, Colorado, was completed over a three-month period. Another example is a four-frac, one-well sequence which was executed between March 15 - May 15, 1978.

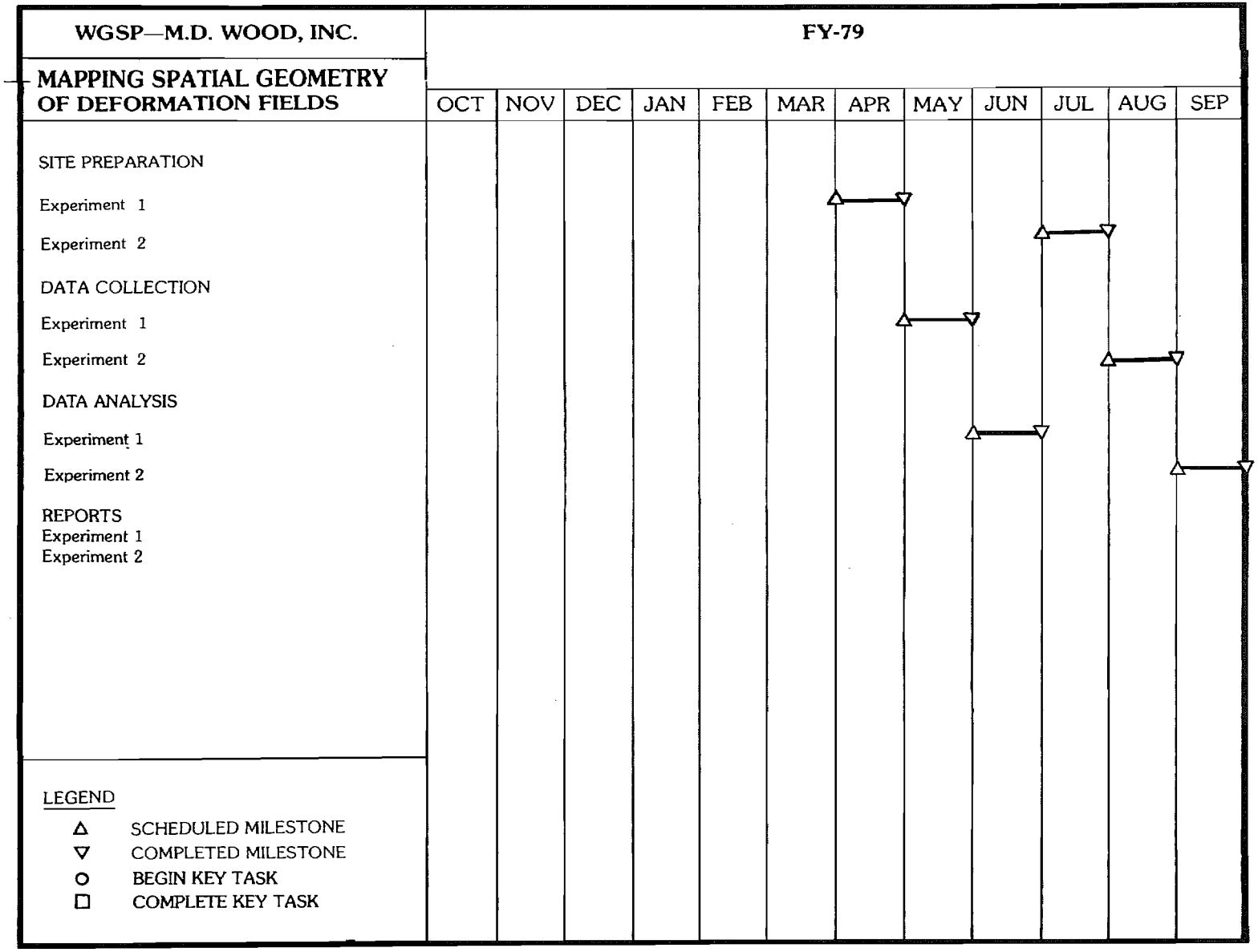


Figure 5-7 Milestone Chart (Schedule of Tiltmeter Activities—M.D. Wood, Inc.)

6. FIELD TESTS AND DEMONSTRATIONS

Field tests and demonstrations comprise an essential part of the WGSP because through these, the application of new materials and techniques are implemented for evaluation. A breakdown of activities is shown in Figure 6-1.

Table 6-1 is a tabulation of completed and ongoing MHF projects. Figure 6-2 shows the location of active projects, and Figure 6-3 shows the generalized schedule of activities for the active projects for FY 79.

Scopes of work have been prepared for a first round of RFP's initiating new field tests in western low-permeability gas reservoirs. It is planned that groupings of these RFPs be released consistent with the availability of funds for new field test starts.

The areas in which the tests are located and an estimate of the appropriate DOE funding level, ranked according to priorities determined by the recent Booz-Allen study are:

	PRIORITY GROUP	DOE PARTICIPATION ($ Millions)
II	Green River Basin	3.7
II	Uinta Basin	3.5
III	Piceance Basin	1.8
III	Northern Great Plains Province	1.6
I*	Quachita Mt. Province	2.3
III	Pieceance Basin Shallow Multi-Well Prgm	1.0
III	Cotton Valley Trend - Smackover	1.1
		15.0

*Because the on-going Cotton Valley lime test with Mitchell Energy Corporation is in Priority Group I, another Group I test (Quachita Mt. Province) has been placed fifth.

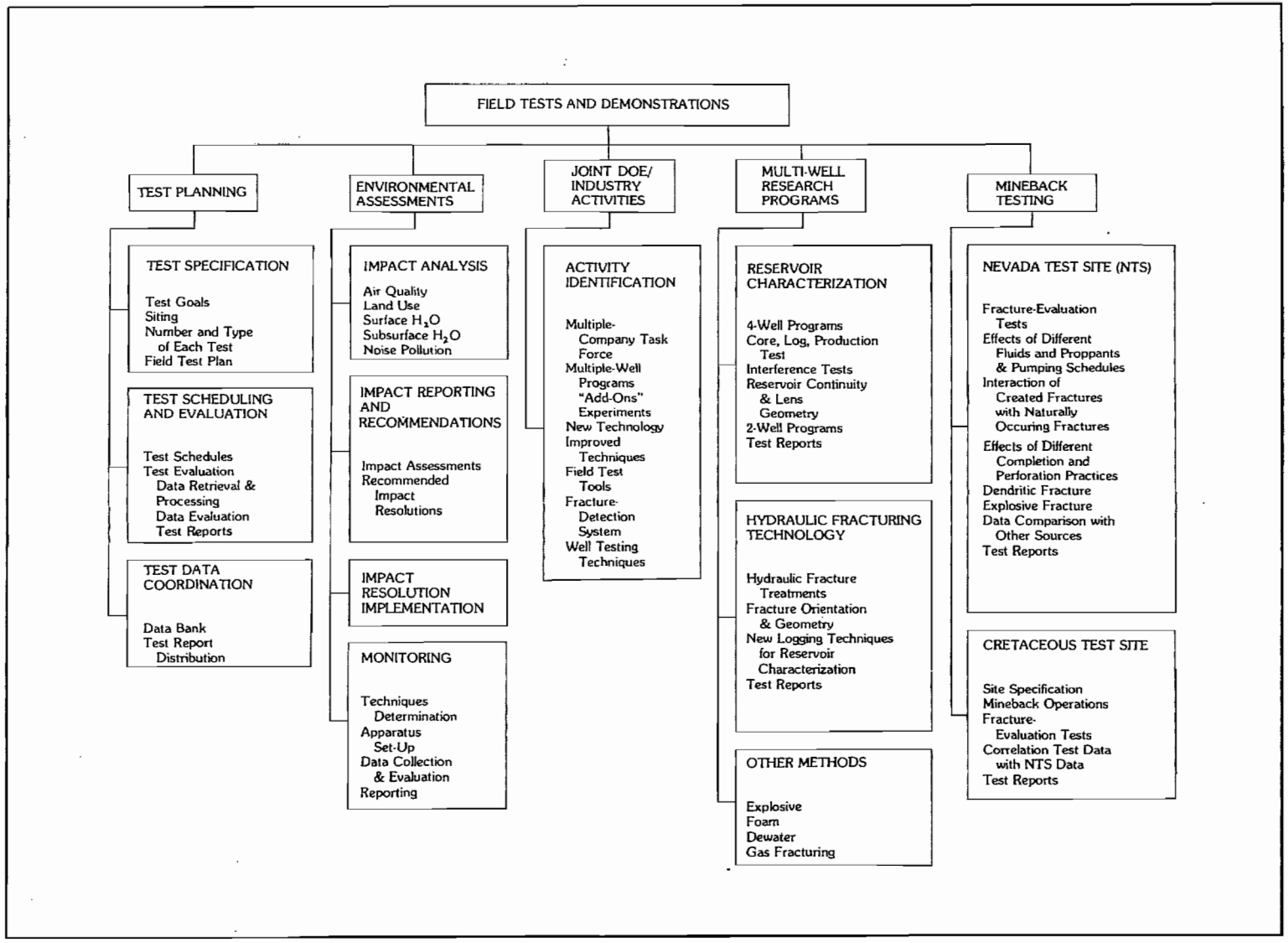


Figure 6-1 Field Test and Demonstration Activities

Table 6-1 MHF Contract Locations and Frac Data

COMPANY, BASIN AND FORMATION	LOCATION	WELL	INTERVAL FRACTURED	FRAC. DATE	FRAC. TREATMENT	FLUID INJECTED
	T / R / Sec		Feet		Lbs. of Sand	10^3 Gal.
AUSTRAL Piceance, Mesaverde	7S, 94W, S3 Garfield Co. Colorado	Federal 3-94	5,170- 6,333	8-25-76	1,140,000	542 Gel Gel H 0
CONSORTIUM MANAGED BY CER CORPORATION Piceance, Mesaverde	3S, 98W, S11 Rio Blanco Co. Colorado	RB-MHF-3	8,048- 8,078 7,760- 7,864 5,925- 6,016 5,851- 5,869	10-23-74 5- 2-75 5- 4-76 11- 3-76	400,000 880,000 815,000 448,000	117 Gel 285 Gel 400 Gel 228 Gel
GAS PRODUCING ENTERPRISES, INC. Uinta, Wasatch and Mesaverde	10S, 22E, S10 Uintah County Utah	Natural Buttes No. 18	6,490- 8,952	9-22-76	1,480,000	745 Gel
	10S, 21E, S21 Uintah County Utah	Natural Buttes No. 19	8,909- 9,664 7,224- 8,676	9-21-76 9-28-76	424,000 784,000	280 Gel 365 Gel
	9S, 21E, S22 Uintah County Utah	Natural Buttes No. 14	6,646- 8,004	3-15-77	1,093,000	544 Gel
	9S, 21E, S28 Uintah County Utah	Natural Buttes No. 20	8,498- 9,476	6-22-77	826,000	322 Gel
	10S, 22E, S18 Uintah County Utah	Natural Buttes No. 22	6,858- 8,550	11-21-77	1,091,000	479 Gel
	9S, 21E, S19 Uintah County Utah	Natural Buttes No. 9	5,661- 8,934	3-27-78	554,000	349 Gel
	10S, 21E, S29 Uintah County Utah	Natural Buttes No. 2	9,237- 9,653	6-22-78	170,500	203 Gel.
DALLAS PRODUCTION Forth Worth, Bend Cong.	Ben D. Smith Survey A-779 Wise County, Texas	Ferguson A-1	5,957- 6,794	9-10-76	506,000	139 Foam 198 Emul.
EL PASO NATL. GAS Northern Green River, Fort Union	30N, 108W, S5 Sublette Co. Wyoming	Pinedale Unit No. 5	10-950-11,180 10,120-10,790	7- 2-75 10-20-75	518,000 1,422,000	183 Emul. 8 Gel 459 Gel
MOBIL Piceance, Mesaverde	2S, 97W, S13 Rio Blanco Co. Colorado	F-31-13G	10,549-10,680 9,392- 9,534 8,765- 8,972	6-22-77 8-24-77 5-10-78	580,000 600,000 332,300	316 Gel 260 Gel 166 Gel
PACIFIC TRANSMISSION Uinta, Mesaverde	8S, 23E, S25 Uintah County Utah	Fed. 23-25	NO FRACS PERFORMED			
RIO BLANCO NATL. GAS Piceance, Mesaverde	4S, 98W, S4 Rio Blanco Co. Colorado	Fed. 498-4-1	6,150- 6,312 5,376- 5,960	10-22-76 11-30-77	766,000 243,000 + 22,500 Beads	276 Gel 164 Gel
WESTCO Uinta, Mesaverde	10S, 19E, S34 Uintah County Utah	Home Fed. No. 1	7,826- 9,437 10,014-10,202	12-21-76 10- 1-76	500,000 600,000	412 Gel 248 Gel

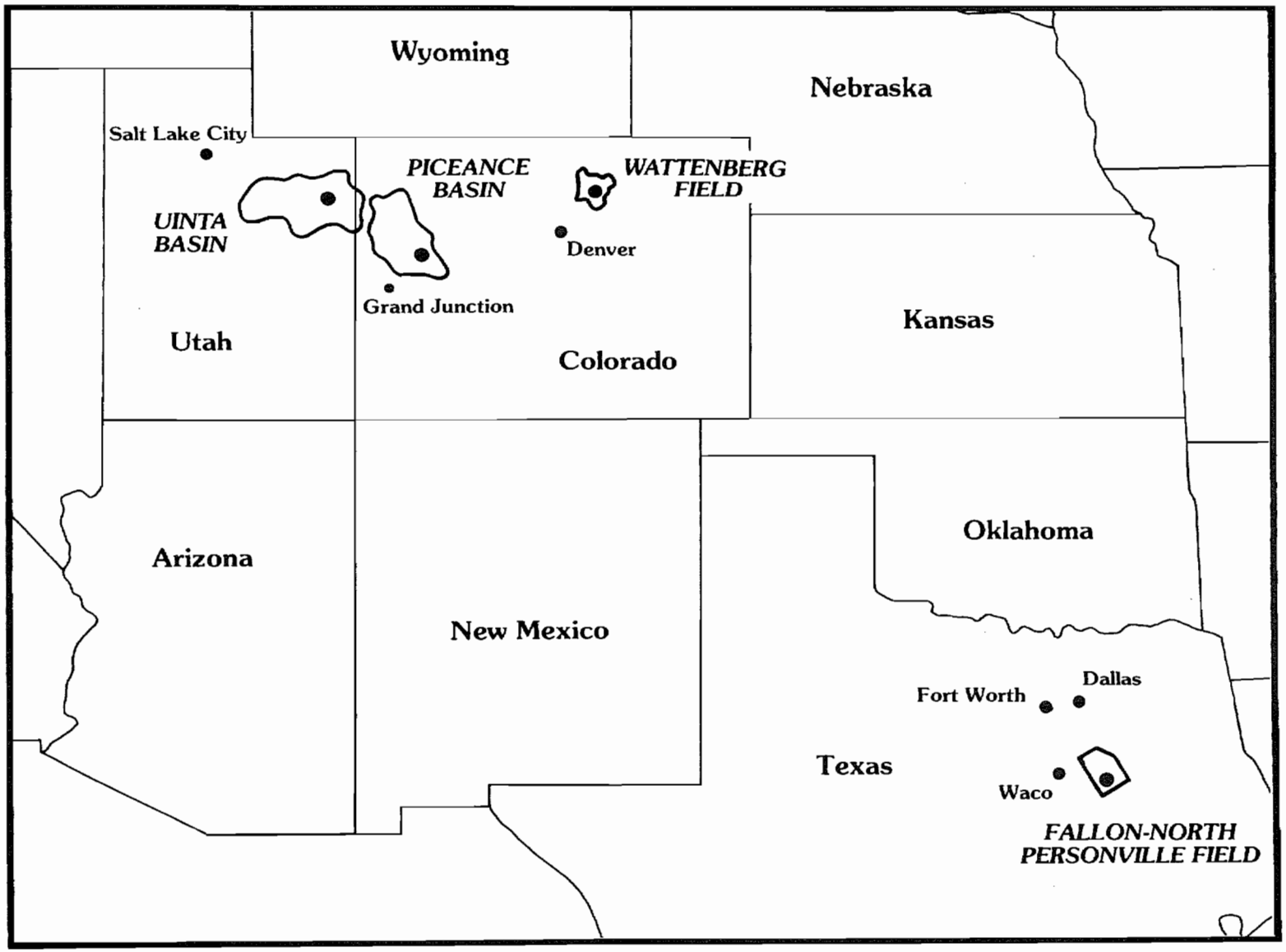


Figure 6-2 Location of WGSP Field Projects

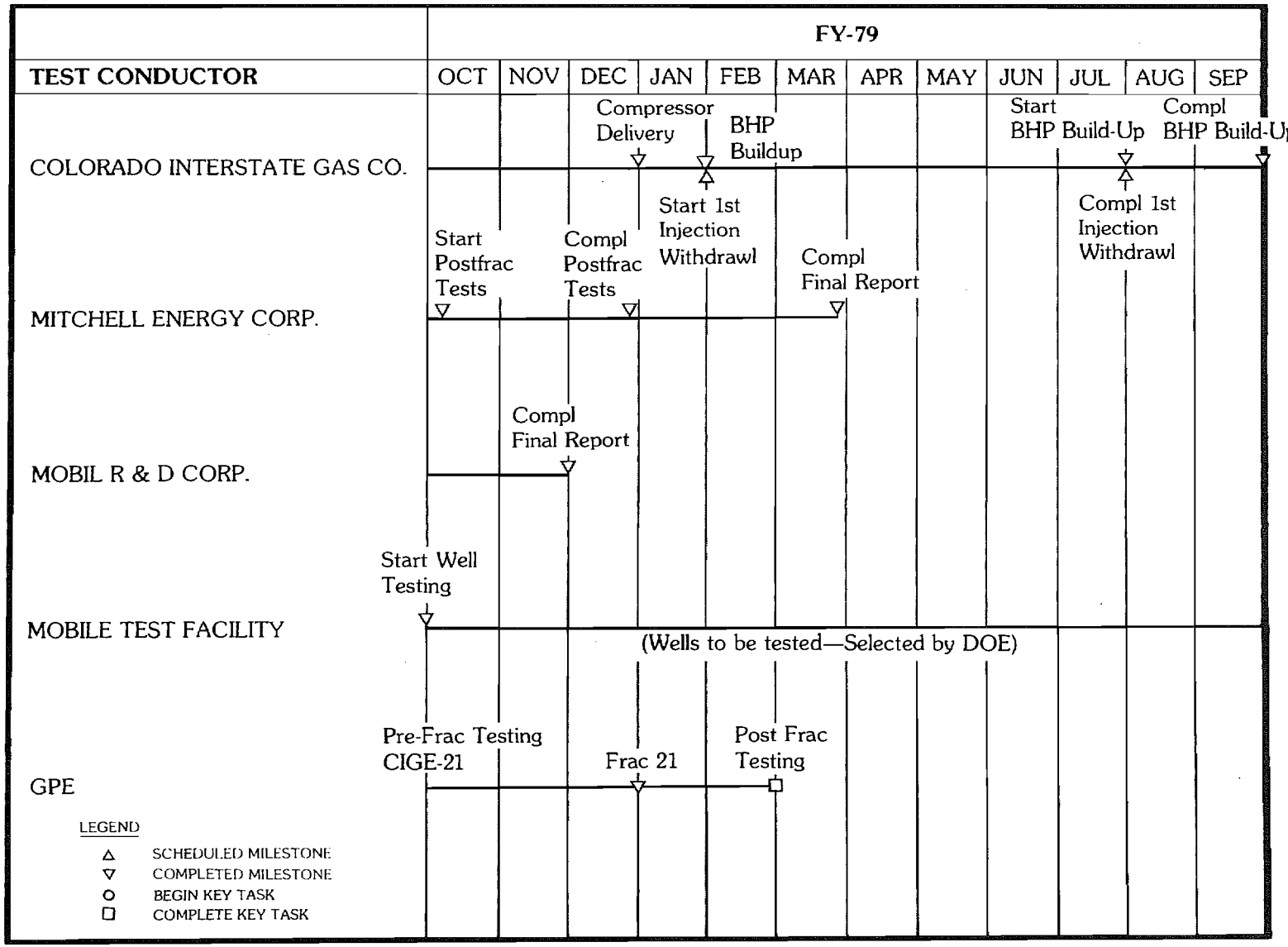


Figure 6-3 Schedule of Activities of Field Tests and Demonstrations

WATTENBERG FIELD

EY-77-C-08-1514

Colorado Interstate Gas Company
Colorado Springs, Colorado

Status: Active

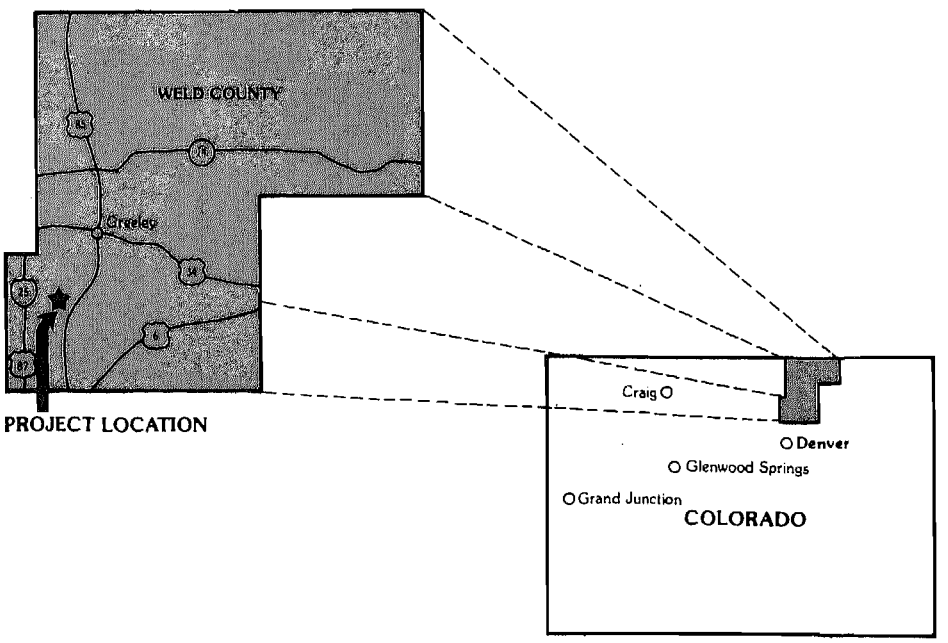
Contract Date: September 1, 1977
Anticipated Completion Date: March 1, 1981

Total Project Cost: (Estimated)	DOE	$ 75,000
	CIG	99,000
	Total	$174,000

Principal Investigator: Howard Fredrickson
Technical Project Officer for DOE: C. H. Atkinson

OBJECTIVE

Cyclic injection of dry natural gas is the method to be used to increase productivity of tight gas sands.



6.1 Colorado Interstate Gas Company

Colorado Interstate Gas Company (CIG) was awarded DOE Contract EY-77-C-98-1514 to determine if the productivity of wells completed in low-permeability natural gas reservoirs can be improved by reducing the interstitial water saturation around the wellbore.

The method used to accomplish this reduction of water saturation will be a cyclic injection of dry natural gas. In addition, cyclic injection of dry natural gas may improve the productivity through dehydration of matrix clays and the removal of formation damage adjacent to the surfaces of induced fractures.

The project location is in the Wattenberg Field of northeastern Colorado. The producing formation in this field is the Dakota J which has a potentially productive area of about 625 square miles.

CIG will utilize two wells which were contributed by the Machii-Ross Petroleum Company, both completed in the Dakota J sand for the project.

After the facilities are installed and operational, and the initial bottom hole pressure (BHP) buildup completed, the Miller No. 1 well will be put on production and the Sprague NO. 1 well will be set up to receive the produced gas. The produced gas, water saturated at wellhead flowing temperature and pressure conditions, will be dehydrated to a water content of 5 lb per MMCF before injection.

Mode 1 operations will be continued for seven days at which time it is estimated that the Sprague No. 1 wellhead injection pressure will be about 1,500 psi, and the Miller No. 1 wellhead flowing pressure at 50 MCFD will be about 300 psi.

After seven days, or when the wellhead injection pressure on Sprague No. 1 reaches 2,500 psi, mode 1 will be ended and the production and injection reversed for mode 2 operations. At the end of about six months, the wells will be shut in for a 60-day pressure build up. Based on seven-day intervals of operation in each mode, data will be available for 12 operating intervals in each mode. Changes in the interval of operation in each mode, however, may be required, based on dew point and pressure behavior. Figure 6-4 shows a generalized schedule of activities, dependent of decisions to continue.

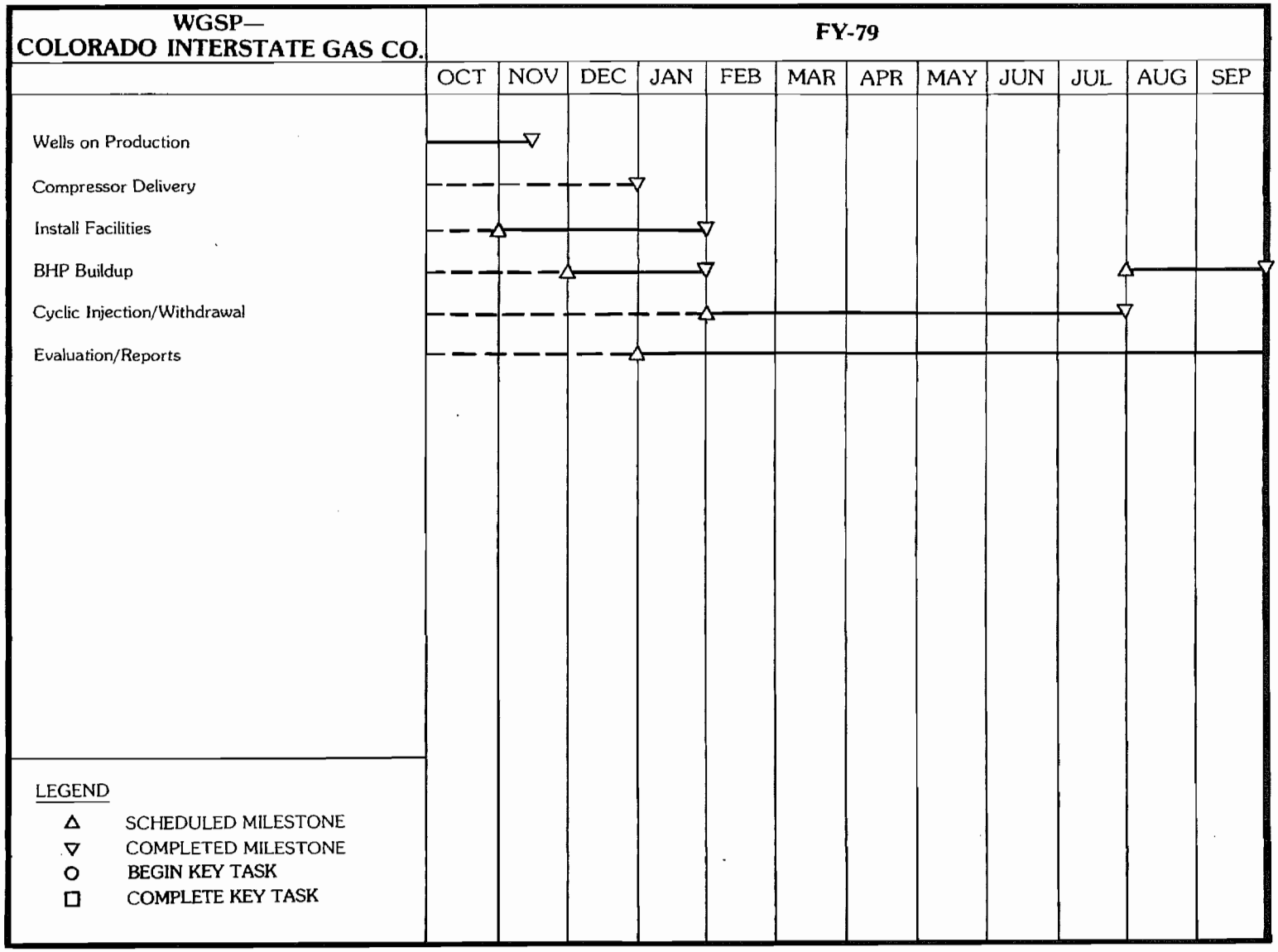


Figure 6-4 Scheduled Activities for Colorado Interstate Gas Company

NATURAL BUTTES UNIT, UINTAH COUNTY, UTAH MASSIVE HYDRAULIC FRACTURING DEMONSTRATION

EY-76-C-08-0681

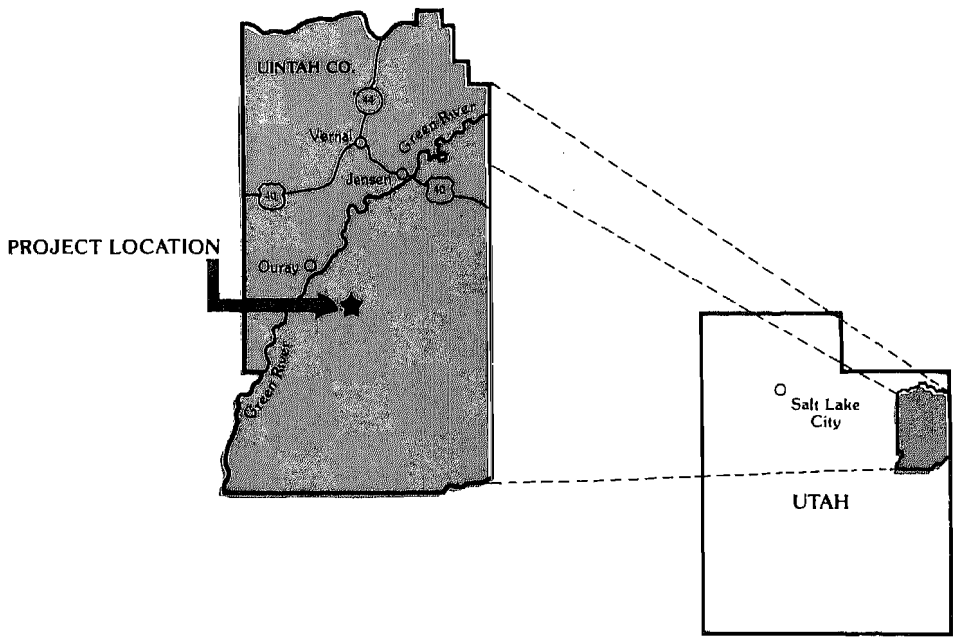
Gas Producing Enterprises, Inc.
Subsidiary of Coastal States Gas Co.
Houston, Texas

Status: Active

Contract Date:	July 1, 1976	
Anticipated Completion:	Sept. 30, 1978	
Total Project Cost: (Estimated)	DOE	$2,827,000
	Industry (prior costs)	1,881,000
	Industry (new costs)	3,051,000
	Total	$7,759,000
Principal Investigator:	W. E. Spencer	
Technical Project Officer:	C. H. Atkinson	

OBJECTIVE

To evaluate the effectiveness of massive hydraulic fracturing for stimulating natural gas production from thick, deep sandstone reservoirs having low permeability.



6.2 Gas Producing Enterprises Inc.

Gas Producing Enterprises was awarded DOE Contract EY-76-C-08-0681 in July 1976. Originally, two old wells, Natural Buttes Unit Wells 14 and 18, and four new wells, 19, 20, 21 and 22 were to receive MHF treatments. Three contract modifications have been entered into, adding one old well, Natural Buttes Unit No. 9, two new wells, 23 and CIGE 2-29-10-21, and increasing the scope of work for Natural Buttes Unit Well No. 21. The contract will be extended to cover work to be performed during FY 79 on No. 21.

Pre fracture testing of Natural Buttes Unit Well No. 21 will continue through December, 1978 with the MHF scheduled to be performed during January, 1979. Post fracture testing will be completed during March, 1978.

FALLON-NORTH PERSONVILLE FIELD, TEXAS, MASSIVE HYDRAULIC FRACTURING DEMONSTRATION

EF-78-C-08-1547

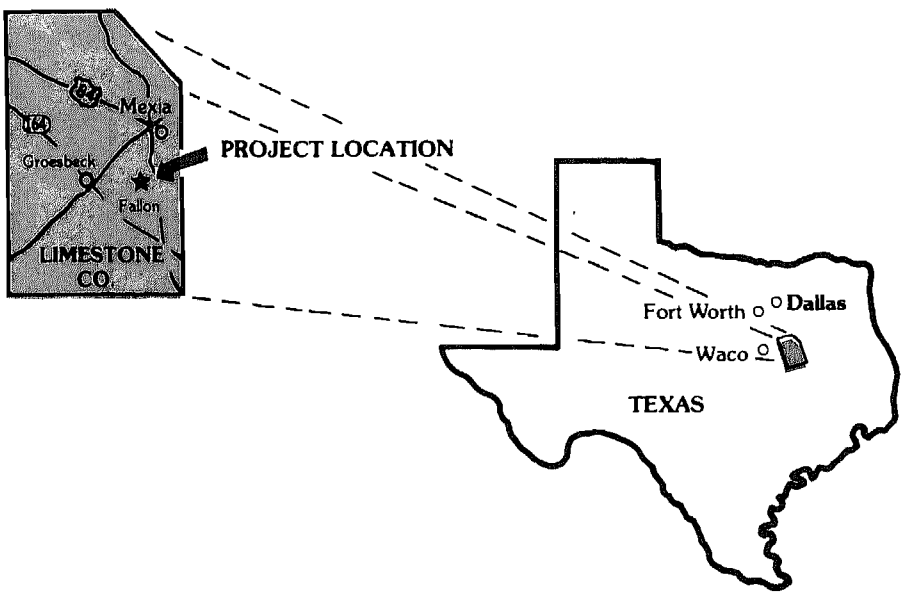
Mitchell Energy Corporation
Houston, Texas

Status: Active

Contract Date:	March 15, 1978	
Anticipated Completion:	April 30, 1979	
Total Project Cost: (Estimated)	DOE	$ 553,771
	Industry	1,074,550
	Total	$1,628,321
Principal Investigator:	F. D. Covey	
Technical Project Officer for DOE:	C. H. Atkinson	

OBJECTIVE

To investigate the reservoir, fluid characteristics and results of massive hydraulic fracturing in the Cotton Valley Limestone Formation



6.3 Mitchell Energy Corporation

Mitchell Energy Corporation was awarded DOE Contract EF-78-C-08-1547 for a MHF experiment in Limestone County, Texas.

A new well is to be drilled to a depth of 11,500 ft in the Fallon-North Personville Field. Cores obtained during the drilling operation, will be sent to commercial laboratories, USGS, Energy Research Centers and National Laboratories. A full suite of geophysical logs will be run prior to open hole formation breakdown tests, setting casing and perforation.

Pre frac production testing will determine the formation productive capacity, which must be 2 md-ft to qualify for DOE funds for the fracturing treatment.

The well is slated for a MHF treatment approximately October 1, 1978 and postfrac production logs and testing will be conducted for frac evaluation.

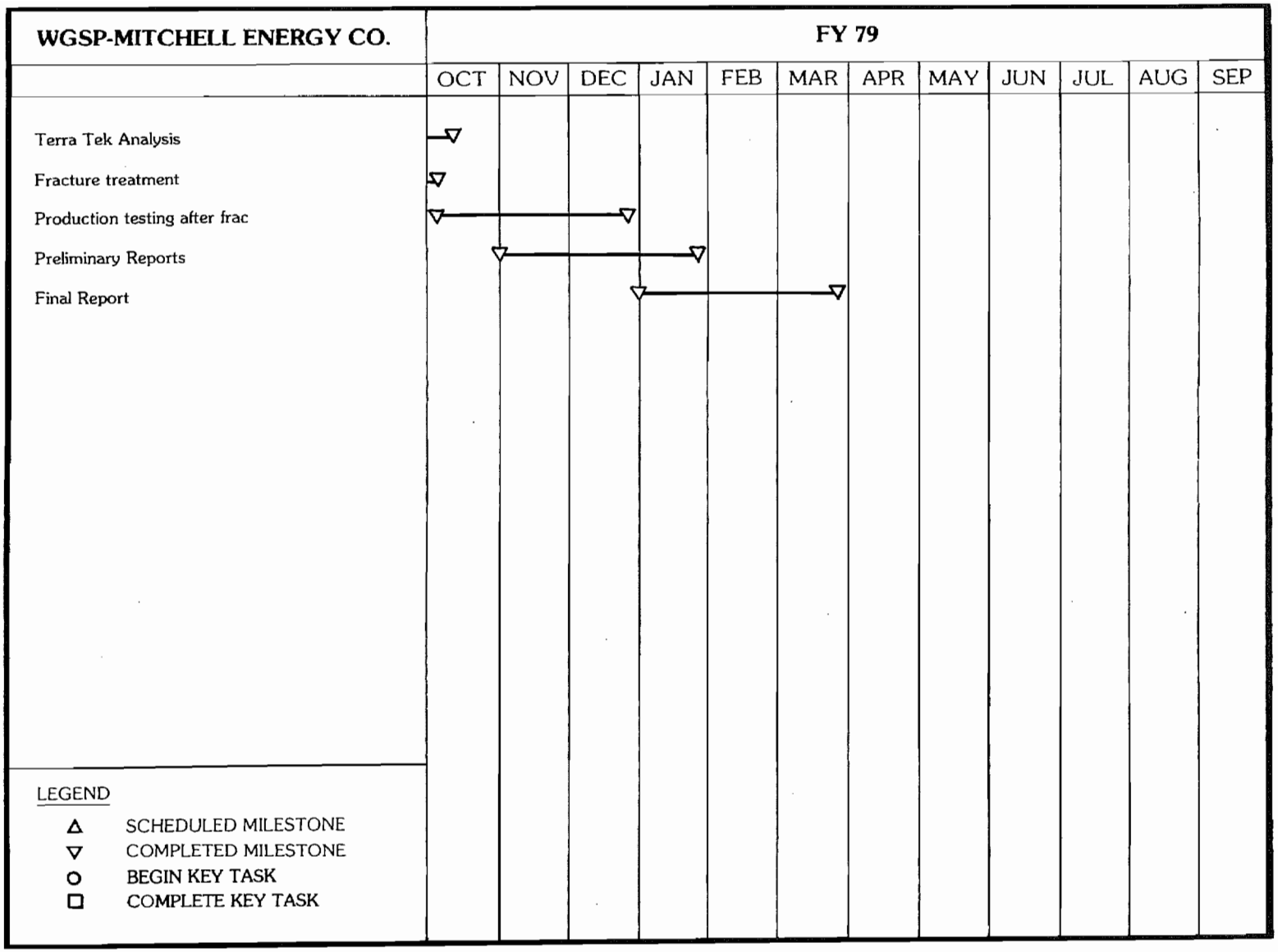


Figure 6-5 Scheduled Activities for Mitchell Energy Company

PICEANCE CREEK FIELD, COLORADO, MASSIVE HYDRAULIC FRACTURING DEMONSTRATION

EY-76-C-08-0678

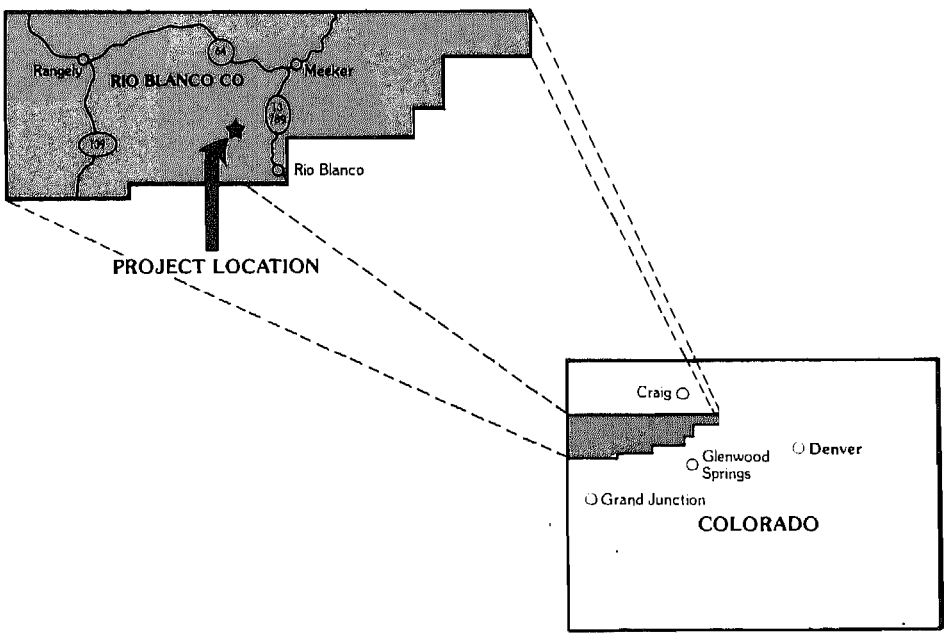
Mobil Research and Development Corporation
Dallas, Texas

Status: Active

Contract Date:	July 1, 1976
Anticipated Completion:	December 31, 1978
Total Project Cost: (Estimated)	DOE $2,510,000
	Contractor (prior costs) 2,376,485
	Contractor (new costs) 1,590,515
	Total $6,477,000
Principal Investigator:	John L. Fitch
Technical Project Officer:	C. H. Atkinson .

OBJECTIVE

To evaluate the effectiveness of massive hydraulic fracturing for stimulating natural gas production from thick, deep sandstone reservoirs having extremely low permeability.



6.4 Mobil Research and Development Corporation

Mobil was awarded DOE Contract EY-76-C-08-0678 along with Signal Drilling in the amount of $2.51 million for a MHF experiment in Rio Blanco County, Colorado. The well was drilled to 10,800 ft in 1977 by Signal Drilling Company under a separate DOE Contract EY-77-C-08-1504.

Dual induction, sonic caliper, long-spaced sonic, temperature log in casing, borehole televiewer (BHTV) and noise logs were run.

Zone 1, 10,549 to 10,680 ft, received 46 perforations with 35 holes substantiated by borehole televiewer. After breakdown and testing, a massive hydraulic frac treatment was performed, using 580,000 lb of sand and 316,000 gal of fluid.

Zone 2, containing four thin sands, was abandoned because of low capacity.

Zone 3, divided into 3A and 3B sands was perforated and broken down with 12,000 gal of 2 percent KCl water. The well flowed at 930 MCFD, declining to 799 MCFD in two days. The second MHF was performed using 600,000 lb of 20-40 sand carried in 232,000 gal of cross-linked guar.

Zone 4A and 4B were perforated and tested, but failed to meet capacity requirements.

After Zone 5 (8,765 - 8,972 ft) was perforated and broken down the initial flow was 800 MCFD, declining to 479 MCFD in two days. The third MHF planned to use 244,000 gal of gel and 600,000 lb of sand. Because of a rapid treating pressure increase from the beginning of the job, only 166,000 gal and 332,300 lb of sand were pumped before screen-out occurred.

Zones 6 (8,433 - 8,650 ft) and zone 7 (8,173 - 8,372 ft) were perforated and tested and both zones were included in the fourth MHF with a planned use of 900,000 lb of sand. A pressure increase was again observed from 1,100 psi initially to 2,600 psi just prior to screen-out. The frac was performed with 288,000 gal of fluid and 660,000 lb of sand.

The same procedure will be used in testing additional zones, i.e. perforate, run BHTV, breakdown with KCl water, flow, run noise/temperature logs and pressure buildup tests. Suitability of the zone for MHF will be determined from the test data. If the zone is found suitable for MHF, it will be fractured and tested in the same manner. If not, additional zones will be similarly tested until a suitable zone is found. Present plans call for the sixth and last zone to be fractured and the final report written during a four-month period. The last two months of this effort are during FY 79.

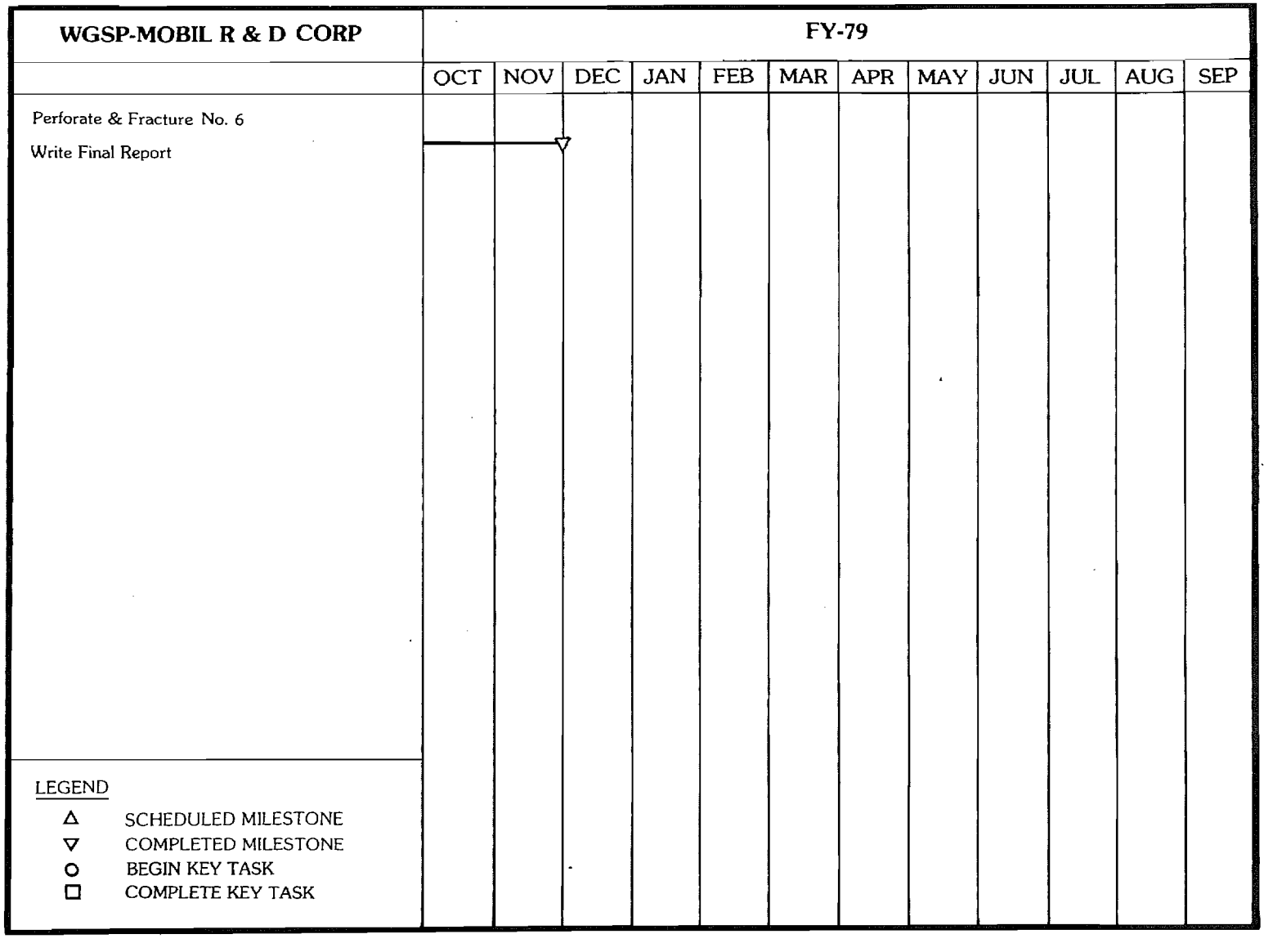


Figure 6-6 Scheduled Activities for Mobil Research and Development Corporation

6.5 Mobile Well Test Facility

FY 79 will be an active year for the Western Gas Sands Project Mobile Well Test Facility. Utilization of this facility will allow for accurate and consistent collection of pertinent data and evaluation of production and buildup test data in the field.

Primary instrumentation will include a Martin and Decker unit to record depth and cable strain, downhole pressure and temperature probes, surface instruments to measure flow rate, a gas chromatograph, a water analysis lab, and a PDP 11/10 mini computer.

Considerable use will be made of the foreground/background option of the PDP 11/10 mini computer system for program development and to perform real time data analysis. This option allows the computer to act in a timesharing mode which allows the operator to run a separate program or calculation while another portion of the computer is in the process of collecting test data.

Operating manuals and technical procedures will be finalized. Engineering details are also being developed which will allow monitoring of more than one test well at a time.

During FY 79, the Well Test Facility will be engaged in monitoring wells in the western tight gas sands area.