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UTAH GEOTHERMAL COMMERCIALIZATION PLANNING

SEMI-ANNUAL PROGRESS REPORT

January 1, 1979 - June 30, 1979

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Utah Geothermal Planning Project - Midterm Report

1.0 Introduction

1.1 Purpose of the Project

The State Geothermal Planning Project is supported by funding by the U. S. Department of Energy and the Four Corners Regional Commission. The purpose of the project is to provide DOE and the participating states with planning data and to initiate a program for fostering geothermal commercialization in the states. Geothermal commercialization would be encouraged both by initiatives by the federal government and the states, and also by increasing public awareness of the advantages of geothermal utilization.

1.2 Objectives

The general objectives of the State Geothermal Planning Project are to gather and analyze pertinent data so that projections of geothermal energy utilization can be made and the degree of market penetration can be estimated. The planning information will be available both to DOE, for use in regional planning operations, and to state and local agencies. A program to inform the public and provide other services is carried out in conjunction with the planning work.

These objectives will be accomplished by the completion of specific tasks. Planning is done on three levels of detail - by general area (Area Development Plan), by single site (Site Specific Development Plan), and by specific project (Time Phased Project Plan). The results of the planning effort will be aggregated to show projected level of commercialization for the whole state.

An important task in the project involves the documentation and analysis of institutional factors which affect geothermal commercialization in each state. This task includes the analysis of state and federal regulatory procedures, permitting requirements, and estimates of the time involved in each step of the developmental process. The

analysis of the state institutional factors will be incorporated into a handbook which will serve as a guide for developers.

Public awareness is to be enhanced through an outreach program, using the information assembled in the other tasks as tools. The outreach program serves both to disseminate information to those who request it and to actively inform others who might affect or be affected by geothermal commercialization.

An important part of the outreach program in Utah has involved the drafting of geothermal legislation. Although the legislation did not pass the 1979 legislature, the effort is continuing.

1.3 Technical Approach and Team Members

The Utah Geothermal Planning Project is being conducted by the Utah Division of Water Rights, which is the state regulatory agency responsible for geothermal exploration and development. Team members are Stanley Green, Directing Appropriations Engineer for the Division and Director of the State Geothermal Planning Project, and L. Ward Wagstaff, Geothermal Studies Specialist.

The approach taken by the state planning team has been to gather the necessary data from the most direct source available and to analyze it using standardized methods and assumptions. The results are made available to the public through the outreach program. The outreach program is used to provide information and other services to the public as well as guidance to the state, in particular regarding legislation.

1.4 Benefits of the Project to the State and DOE.

The Utah Geothermal Planning Project has both direct and indirect benefits to the state. Direct benefits include the project products, i.e., planning reports, energy supply and demand projections, assessments of specific and general potential for geothermal commercialization, analysis of the institutional factors involved with geothermal development in the state (which will be included in the institutional handbook), and the services of the outreach program. The state has also benefitted through the assistance of state team members in the drafting of geothermal legislation.

Indirect benefits to the state are more difficult to evaluate even though they may be quite evident. One indirect benefit has been through the involvement of various agencies in the institutional analysis, whereby some of them have become aware of their interaction with geothermal development. The project has been instrumental in developing in-house expertise in key state agencies.

The primary goal of the Department of Energy with regard to geothermal energy is the commercialization of geothermal resources. DOE programs and projects are intended to work towards that goal. The state planning project fulfills part of that goal through its benefits to the states, i.e., the states are better prepared to foster geothermal commercialization. The primary benefit of the state planning project to DOE is that it provides DOE with data which it needs for its own planning. The data generated by the project include projections, both specific and general, of the magnitude and location of geothermal development. Also included are analyses of the actions which must take place in order for commercialization to occur, and recommendations from the states on ways to facilitate commercialization. The outreach program associated with the project provides DOE with a mechanism to promote geothermal development at a local level.

2.0 Summary of Project Tasks and Work Accomplished

2.1 Task A - Prospect Identification and Application Analysis

A large number of geothermal prospects are found in Utah. Depending on the criteria used for defining a prospect, they range from confirmed geothermal reservoirs, such as Roosevelt Hot Springs, through warm springs areas, to areas where the only indication of a resource is developer interest as expressed by leasing records. The resource identification task, as undertaken by the Utah Geothermal Planning team, is not to verify the presence of actual resources at any of these sites, but rather is to maintain records of the potential resource sites, based on various indicators, and to update these records as new data become available. This has been accomplished through contacts with the Utah Geological and Mineral Survey, which acts as the state Resource

Assessment Team, and with developers or researchers involved with exploration or resource analysis. Current information on leasing, exploration statistics, and general results have been gathered from the appropriate state and federal agencies. As this information is gathered, it is made available to interested members of the public, in particular those involved in planning or analysis projects, such as NMEI, EG&G, and DOE.

An analysis of potential geothermal applications in Utah will also be carried out. This analysis will be conducted on a county or multi-county basis, and the results will be aggregated to show projected levels of geothermal development for the state. The application analysis will focus on the potential for geothermal use as indicated by energy demand projections. These projections will be as area-specific as possible, i.e., the projected applications and growth rates will be analyzed for compatibility with the respective area. The expected temperature of the resource is a factor in the applications analysis, but the capacity or energy content of the resource will not be. The end result of this analysis will be a projection of the potential for geothermal utilization with time, both for the individual areas and for the state as a whole.

The first area development plan (ADP) of the type described here is for Salt Lake County (Jordan River Valley). Data pertaining to energy demand, present and projected, have been gathered. However, some of the critical data, particularly population projections, are in the process of being updated; thus, the information presented in the plan is still preliminary and will be updated as more current data become available to the state team. Nevertheless, the data gathered thus far do indicate that considerable potential for geothermal use does exist in Salt Lake County. Population and industry are concentrated in the area, and geothermal resources are known to be present in some parts of the valley and are postulated in others. Planned utilization projects include two federally-assisted PON projects, one at the Utah State Prison near Crystal Hot Springs, the other at Utah Roses in Sandy City. Utah Roses is also planning a greenhouse operation, independent of the PON projects, near Crystal Hot Springs. The preliminary data generated by the Jordan River Valley development plan also indicate that a large

potential for heat pump applications exists in the valley, although the constraints to that type of development have not yet been fully examined.

2.2 Task B - Site Specific Development Plans

Sites where development is planned or is a real possibility, as determined in the area development plans, are candidates for site specific development plans (SSDP's). The SSDP's will go into greater depth of detail with regard to development at individual sites, to the extent of projecting specific uses at each site. The analysis will include descriptions and time estimates for those actions which will have to be completed in order for development to occur, outlined in moderate detail; the SSDP should thus identify specific restraints or prohibitions to the development as well as provide a basis for estimates of development with time. The aggregation of site specific development plans will indicate the overall scale of geothermal development. The results of the SSDP's will be made available to planners and developers within the state as well as to DOE and NMEI.

Preliminary site specific development plans were developed as part of the first year's effort. However, the methods used to create these plans were crude and quite subjective, and the results do not represent realistic projections. No new site specific development plans have yet been developed during the current contract year; however, the methodology has been standardized so that future results should be more consistent and reliable than the preliminary effort.

2.3 Task C - Selected Project Plan

Much of the effort of the Utah geothermal planning project during the first half of the current contract year has been directed towards the time phased project plan for Roosevelt Hot Springs. This plan follows the procedures of development in detail, both for historical and future activities. The format for presenting the plan is a time line network of activities, accompanied by a narrative which is keyed to the time line and which describes the activities in detail. Sections

dealing with the history of the thermal area, the development which has occurred to date, and a summary of data for the site are also a part of the plan document. Maps showing the location, leasing, drilling, and geological features are included, as well as other supporting charts and tables.

The Utah geothermal planning team developed the plan using information from the sources most directly involved, insofar as such information was available. The resulting plan does not represent definite plans by the developer or by specific agencies, since firm industry plans for the prospect are still evolving at this time. However, the plan should give a good indication of the steps, time frames, and patterns which development might follow if a 55 MWe plant were to be brought on line.

The analysis of the Roosevelt Hot Springs project required a considerable amount of institutional information; in fact, one of the main benefits of the plan is that it shows relationships between regulatory requirements and developer activities. The gathering of this institutional information overlapped with the task of institutional analysis, and much of the information generated by the Roosevelt plan will be applicable to geothermal development in general.

Although the plan was somewhat outdated even before it was completed, due to constantly evolving plans by the developers, several important aspects were emphasized by the project plan. One such aspect which needs to be considered in development planning is the role of negotiations between different developers as well as those between field developers, utilities, and plant operators. A major hurdle at Roosevelt Hot Springs has been the lengthy and difficult unitization negotiations. The nature of the reservoir and the framework of Utah water laws made unitization very desirable; however, the companies involved (Phillips Petroleum Company, Thermal Power Company, AMAX Exploration, Inc., and O'Brien Resources, Inc.) had numerous difficult issues to resolve before an agreement could be reached. At this time, they are apparently very close to an agreement.

Another hurdle which was indicated by the experience at Roosevelt was that of development and operation contracts between the field developer (Phillips), a utility or other market for the power, and a

plant constructor/operator. Phillips has conducted serious negotiations and analytical studies to assess potential partners in the development as well as to determine the most attractive approaches to development.

Other potential impediments to the development are associated with certain regulatory procedures, particularly those involving extensive environmental investigations. These environmental requirements are generally accepted as part of the development process, except where the delays or requirements are unreasonable or where the required analysis might be duplicative. The two main permits/approvals which appear to have the most impact on future development are the siting/right-of-way approvals by the BLM and the EIS associated with the loan guaranty program. The full impact of these requirements is not yet completely clear, but has already had a major influence on the proposed mode of development.

The net effect of these impediments has been to impose major delays on the development. When the Utah Geothermal Planning project began to consider Roosevelt Hot Springs as part of their overall study, in the early spring of 1978, plans were announced for up to two 55 MWe plants to come on line at the prospect in 1982; currently it appears that the industry is considering a 20 MWe plant to come on line in 1982, with 55 MWe plants following about 1985 and 1986.

2.4 Task D - Scenario Aggregations

The results of the three types of project plans - area wide, site specific, and detailed time phased - will be aggregated to show estimated energy on line as a function of time through the year 2020. These aggregations should indicate the estimated level of geothermal development throughout the state for all types of utilization which are likely to occur.

The state aggregations will be used by NMEI in their analysis of market penetration for geothermal energy, and by DOE in their regional planning and commercialization activities. They will be made available to state agencies, and should give them an indication of the potential level of development and how such development would affect and be affected by each agency. In many cases, the estimates of development

Assessment Team, and with developers or researchers involved with exploration or resource analysis. Current information on leasing, exploration statistics, and general results have been gathered from the appropriate state and federal agencies. As this information is gathered, it is made available to interested members of the public, in particular those involved in planning or analysis projects, such as NMEI, EG&G, and DOE.

An analysis of potential geothermal applications in Utah will also be carried out. This analysis will be conducted on a county or multi-county basis, and the results will be aggregated to show projected levels of geothermal development for the state. The application analysis will focus on the potential for geothermal use as indicated by energy demand projections. These projections will be as area-specific as possible, i.e., the projected applications and growth rates will be analyzed for compatibility with the respective area. The expected temperature of the resource is a factor in the applications analysis, but the capacity or energy content of the resource will not be. The end result of this analysis will be a projection of the potential for geothermal utilization with time, both for the individual areas and for the state as a whole.

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will underscore the need for clarification or changes in regulatory policy; particularly in Utah, it might indicate the need for state geothermal legislation to deal with heretofore unresolved and unclear issues.

2.5 Task E - Institutional Analysis

Institutional requirements are frequently cited as major barriers to geothermal development. An important task of the state geothermal planning effort is to identify and analyze the various statutes, permits, and regulations which are or might be associated with geothermal development. Part of the analysis will be an attempt to assess the impact which these institutional requirements might have on the development of geothermal resources.

Much of the groundwork for the institutional analysis for the geothermal planning project in Utah was completed during the first year of the project. The necessary permits were identified, sequences were defined, and preliminary estimates of process times were made. The results of this analysis were tabulated, along with information about application procedures and approval conditions.

Efforts in this task for the second year focused on refining the analysis of the first year. The institutional data were updated as new permitting requirements were issued and as the need for these permits became evident. Individual permits and requirements were analyzed in greater depth, and internal flow charts of the agencies' approval processes were formulated. However, the information gathered was not uniformly detailed, and further analysis will be required.

The results of the institutional analysis will be used to compile a state handbook of geothermal regulations later in the contract year. The handbook will contain lists of involved agencies, personnel, permits, and procedures, and will be available to the public.

The results of the institutional analysis for Utah appear to indicate that, in general, federal requirements impose much greater restrictions on geothermal development than do state requirements; of course, in most cases the federal requirements apply only on federal lands or on projects where federal funding is involved, i.e., the PON program or the loan guaranty program.

The primary state regulatory agency for geothermal development in Utah is the Division of Water Rights (State Engineer's Office). At the present time, geothermal activities are regulated under Utah water law, which is based on the doctrine of appropriation. Although questions regarding water rights have been major issues in several geothermal development projects, they are overshadowed by other difficulties. Water rights themselves apparently influence development strongly and impose constraints but do not appear to impose unreasonable delays.

Another state agency which regulates geothermal development is the Branch of Environmental Health of the Division of Health, Department of Social Services; this agency is responsible for issuing environmental permits and construction permits. The environmental permits issued by the state are based more on health standards than aesthetic standards. These requirements also do not appear to impose major impediments to geothermal development.

2.6 Task F - State Outreach

State outreach for Utah has involved two main activities. One, of major importance, was to assist in providing guidance in the preparation of geothermal legislation for consideration by the Utah Legislature; the other was to provide information and service to those inquiring about geothermal development in Utah.

Legislation dealing with geothermal development is needed in Utah. Existing legislation, enacted in 1973, is very brief and does little more than to give regulatory authority for geothermal exploration and development to the Division of Water Rights. Notably lacking are a definition of geothermal resources, clarification of the extent of the authority of the state engineer, and statutory directives from the legislature.

In the fall of 1978, under the direction of the Joint Interim Legislative Committee on Energy and Natural Resources, an effort was made to formulate geothermal legislation for consideration by the legislature. Responsibility for drafting the proposal was given to a group of consultants composed of representatives from the National Conference of State Legislatures, the Utah Office of Legislative

Research, the Division of Water Rights, and major developers and utilities active in Utah, with their legal advisors. After much work and several discussion drafts, a bill was introduced to the legislature near the end of the 1979 session. The bill passed the Senate without dissent and was sent to the House. An amended form of the bill passed the House, but because of the nature of the amendments and the lateness of the session, the bill was allowed to die without reintroduction to the Senate. Work on the legislation is continuing.

Information collection and dissemination has been conducted on a routine basis by the geothermal planning team. Private developers who have made inquiries to the state team have usually been interested in possible locations and quality of the resource, and also in the basic permitting processes and requirements. Researchers, often gathering information for studies by governmental agencies or contractors, have usually been interested in the proposed legislation, institutional information, and information about the status of development in Utah. In most cases, the state team has been able to answer the questions, although developers frequently have questions about the resource for which no data are available. Many questions are referred to other qualified sources for information beyond that available to the state team; such sources include the State Geothermal Resource Assessment team at the Utah Geological and Mineral Survey, the University of Utah Research Institute, EG&G Idaho, Inc., the Utah Energy Office, the U.S. Geological Survey, the Utah Division of State Lands, the Utah Division of Oil, Gas, & Mining, etc.

3.0 Specific Task Descriptions and Products

3.1 Geothermal Prospect Identification

Exploration in Utah for geothermal resources which might be suitable for electrical power generation has decreased since last year. This is probably due, at least in part, to disappointing results of exploration in the Cove Fort Area. Data for electrical prospects are presented in Table 3.1.1. These data are not new, but represent measured and published information.

Table 3.1.1
Electrical Prospects in Utah

<u>Prospect</u>	<u>Class</u>	<u>Measured Subsurface Temperature (°C)</u>	<u>Notes</u>
Roosevelt Hot Springs	Proven	265 (1)	Estimated potential of at least 300 MWe
Cove Fort	Potential	170 (2)	4 Wells drilled - no commercial resource located.
Thermo	Potential	177-205 (3)	1 well drilled - commercial resource not yet proven
North Cove Fort	Inferred		1 well drilled - commercial resource not yet proven
West Cove Fort/Black Rock Desert	Inferred		Extensive temperature gradient surveys - no deep wells.

(1) From Lenzer *et al*, 1977.

(2) From Case Study Report, Union Oil Company, 1978.

(3) From Smith *et al*, 1978.

Prospects where direct thermal uses are planned and where the resource has been investigated are shown in Table 3.1.2. Proven prospects are those where sufficient subsurface exploratory work has been done to verify the presence of a resource suitable for the planned utilization. Potential prospects are those where exploratory work has been done and has indicated the probable presence of a viable resource. Inferred resources are those where the presence of a resource is indicated by the presence of surface manifestations or in other ways, but where exploratory work has not been conducted, or, if it has, the results are not available.

General areas of possible direct thermal use are listed in Table 3.1.3 and shown in Figure 3.1.1. These resources are classified as inferred.

State geothermal leases are listed in Table 3.1.4. These data are updated to July, 1979, but do not necessarily reflect assignments.

3.2 Area Development Plans

3.2.1 State Geothermal Planning Areas

Area development plans will cover single - or multi - county areas. Criteria for choosing the boundaries of the planning areas included the types of resources in the counties, the types of industry, and the existence of multi-county planning districts. As frequently as possible, those counties within a planning district were included together for the area development plans. In some cases, a county was purposely singled out; Salt Lake County was one county which was considered separately, primarily because of the large industrial, commercial, and residential energy demands and because the Jordan River Valley is a convenient hydrologic unit. The substate areas to be considered are listed in Table 3.2.1.1 and shown in Figure 3.2.1.1.

The first area to be considered for an area development plan was the Jordan River Valley, consisting of Salt Lake County. Other areas to be considered are, in order of priority, Southwest Utah, the Sevier River Valley, Northern Wasatch Front, Utah Valley, and West Central Utah. Other areas, not prioritized but which will eventually be considered, are Northern Utah, Northern Mountainlands, the Great Salt

Table 3.1.2

Direct Thermal Prospects

<u>Prospect</u>	<u>Class</u>	<u>Maximum Measured Subsurface Temperature</u>	<u>Notes</u>
Monroe H.S./Red Hill H.S./ Johnson H.S.	Proven	77	Production Well Drilled
Crystal H.S. (South Salt Lake Co.)	Potential	86 ⁽¹⁾	Exploratory Work Planned
Wasatch H.S./Beck's H.S./ Hobo H.S.	Potential	55 ⁽¹⁾	Temperature Gradient Survey
Midway	Potential	44 ⁽¹⁾	Operational Geothermal System, Temperature Gradient Survey Conducted
13 Ogden H.S./Hooper H.S.	Potential	62 ⁽¹⁾	Operational Geothermal System Production. Well to be drilled at Hill AFB; Exploratory Work Conducted
Udy Hot Springs	Potential	54 ⁽¹⁾	Operational Geothermal System. Resort - Temper- ature gradient survey conducted.
Newcastle	Proven	108 ⁽²⁾	Greenhouse Operation planned - further ex- ploratory work to be conducted.
Beryl	Proven	149	

(1) Data from Pete Murphy; Utah Geological and Mineral Survey

(2) Data from USGS Circular 790.

Figure 3.1.1
Areas of Hot and Warm Water in
Utah

From Goode, 1978.

TABLE 3.1.3

Areas of Inferred Direct Thermal Resources

<u>Prospect</u>	<u>Maximum Recorded Water Temperature (°C)</u>
Lower Bear River Area	105
Bonneville Salt Flats	88
Cove Fort - Sulphurdale	77
Curlew Valley	43
East Shore Area	62
Escalante Desert	149
Escalante Valley	85
Fish Springs	61
Grouse Creek Valley	42
Heber Valley	44
Jordan Valley	86
Pavant Valley/Black Rock Desert	67
Sevier Desert	82
Sevier Valley	77
Utah Valley	46
Central Virgin River Basin	42
Uintah Basin	55
Beaver Valley	24
Blue Creek Valley	28
Cache Valley	49
Canyonlands	28
Cedar City and Parowan Valley	21
Cedar Valley	27
Northern Juab Valley	20
Park Valley	23
Promontory Mountains Area	25
Rush Valley	27

TABLE 3.1.3 (Cont.)

<u>Prospect</u>	<u>Maximum Recorded Water Temperature</u>
Skull Valley	24
Snake Valley	27
Tooele Valley	32
Tule Valley	23
Wah Wah Valley	29
Castilla Hot Springs	40
Como Warm Springs	25
Diamond Fork Warm Springs	20

Table 3.1.4

State Geothermal Leases - Utah

COUNTY	SIZE, ACRES & (NO. OF LEASES)	LOCATION	DATE ISSUED
BEAVER	44,762.00 (61)		
Amax Exporation	4,198.31 (6)	T26-30S, R7, 9, 11 & 13W	Various
American Oil Shale	1,920.22 (3)	T26S, R9W	8/6/73
Atlantic Richfield	80.00 (1)	T26S, R10W	2/13/79
R. C. Barr	1,238.57 (3)	T26, 30S, R7, 9W	4/25/77, 5/9/77
J. E. Blankenship	56.77 (1)	T26S, R8W	2/7/77
M. Bradshaw	130.32 (3)	T27, 28S, R9W	6/10/74, 2/3/75, 10/26/76
W. O. Darley	600.00 (1)	T27S, R9W	3/10/75
Davon Inc.	621.18 (1)	T26S, R8W	12/17/73
C. J. Folmar	2,672.52 (3)	T26, 28, 29S, R7, 9, 14W	1/12/76, 2/13/79
M. F. Justice, Jr.	2,464.16 (5)	T26-28S, R7, 9, 11W	7/15/74, 2/23/76, 3/8/76
S. V. McCormick	2,052.66 (3)	T27, 28, 30S, R12, 13W	8/6/73, 6/19/78
McCulloch Geothermal	80.00 (1)	T26S, R10W	2/3/79
S. L. McGarry	3,549.84 (3)	T26, 28S, R8W	5/20/74, 4/7/75
C. A. Marks	361.24 (1)	T27S, R8W	5/27/75
M. S. Papulak	2,241.36 (4)	T27-30S, R10, 17W	4/25/77, 5/9/77, 5/15/78, 2/13/79
Phillips Petroleum	13,462.77 (2)	T26, 27, 29, 30S, R10-13, 15, 16W	8/6/73, 8/1/75
W. A. Stevenson	2,610.11 (6)	T26, 27, 30S, R8, 10, 11W	8/6/73, 10/1/73, 10/3/77
Supron Co.	640.00 (1)	T29S, R12W	12/20/76
Thermal Power Co. of UT	5,052.25 (4)	T26, 27, 30, 31W, R9, 11, 12W	8/6/73
Thermogenics	90.00 (1)	T27S, R9W	5/3/78
A. B. Thomas & C.D. Shurtleff	640.00 (1)	T29S, R16W	1/30/78

Table 3.1.4 (Cont.)

COUNTY & LESSEE	SIZE, ACRES & (NO. OF LEASES)	LOCATION	DATE ISSUED
<u>BOX ELDER</u>	3,303.00 (7)		
Robert Feinstein	615.00 (1)	T8N, R7W	4/30/79
Diane Katz	2,047.00 (5)	T7, 8N, R7, 8W	4/30/79
R. E. Puckett	640.56 (1)	T9N, R4W	12/3/73
<u>IRON</u>	55,146.00 (47)		
Amax Exploration Inc.	622.80 (1)	T32S, R12W	4/18/77
R. C. Barr	680.00 (2)	T31S, R10, 11W	4/25/77
J. W. Covello	5,453.28 (6)	T32-34S, R13-17W	10/1/73, 7/15/74
Earth Power	766.44 (1)	T31S, R11W	8/9/76
Geothermal Kinetics Inc.	8,233.12 (5)	T33, 34S, R15-17W	12/22/75, 2/2/76
18 C. L. Golding	12,338.55 (10)	T31, 32, 34-36S, R13-16W	7/15/74, 11/11/74, 11/12/75, 2/9/76 2/23/76
M. F. Justice Jr.	4,348.29 (4)	T35, 36S, R14-16W	2/23/76
J. A. Murphy Jr.	2,167.48 (1)	T31S, R14W	7/1/74
Phillips Petroleum Co.	8,910.52 (5)	T31, 32S, R12, 14, 15, 16W	8/6/73, 6/23/75, 6/30/75, 8/1/75
W. A. Stevenson	320.00 (1)	T31S, R13W	4/18/77
Supron Co.	743.05 (1)	T31S, R7W	5/3/77
Thermal Power Co. of UT	3,202.52 (3)	T30 & 31S, R11-13W	8/6/73
U.V. Industries Inc.	6,259.02 (7)	T34-36S, R15-17W	2/23/76
<u>JUAB</u>	35,771.00 (29)		
American Oil Shale Corp.	2,240.50 (1)	T13, 14S, R8, 9W	8/6/73
S. R. Anderson	3,237.02 (3)	T11, 12S, R2, 3W (One lease partially in Utah County)	4/4/77
Brush Wellman Inc.	3,199.88 (2)	T12, 13S, R12, 13W	6/26/78
G. C. Harrison	2,823.80 (2)	T13, 14S, R7, 8W	9/2/75
P. V. Kendell	320.00 (1)	T14S, R8W	11/12/75

Table 3.1.4 (Cont.)

COUNTY & LESSEE	SIZE, ACRES & (NO. OF LEASES)	LOCATION	DATE ISSUED
<u>JUAB Cont.</u>			
S. V. McCormick	1,160.00 (1)	T14S, R8W	4/7/75
Phillips Petroleum Co.	5,174.10 (4)	T11, 12, 13S, R15, 16W	3/5/79
R. E. Puckett	5,760.00 (5)	T13, 14S, R7-9W	12/3/73
Resource Leasing Corp.	638.76 (1)	T14S, R8W	8/6/73
Steam Corp. of America	1,767.88 (2)	T14S, R8W	8/6/73, 5/20/74
<u>MILLARD</u>	69,931.00 (74)		
Amax Exploration Inc.	3,374.21 (4)	T22, 23S, R6-8W	9/20/76, 4/18/77, 4/25/77
American Oil Shale Corp.	1,405.82 (3)	T22, 24S, R6, 7W	5/20/74
D. E. Armstrong	760.00 (1)	T15S, R7W	10/17/77
R. Barnes	640.00 (1)	T25S, R8W	12/23/74
R. C. Barr	160.00 (1)	T22S, R6W	4/25/77
C. F. Beckstrom	8,122.54 (8)	T19-21S, R5-9W	8/11/75, 12/21/77
J. E. Blankenship	1,158.89 (1)	T21S, R6W	10/25/77
J. G. Brown	4,306.18 (3)	T22, 23S, R5, 7W	5/31/77
J. K. Chatwin	1,468.32 (1)	T19S, R6W	1/27/76
Chevron Oil Co.	3,225.37 (3)	T24, 25S, R8, 9W	8/6/73
Davon Inc.	2,428.96 (2)	T19, 20, 23S, R7, 8W	12/17/73
D. F. X. Finn	4,452.36 (4)	T20, 21S, R8, 9W	3/5/74
G. C. Harrison	4,319.08 (2)	T19, 20S, R8W	12/15/75
A. N. Henderson	640.00 (1)	T23S, R8W	1/12/76
Intercontinental Energy	363.64 (1)	T24, 25, 26S, R7W (Partially in Beaver County)	5/27/75
E. A. Justice	480.00 (1)	T24S, R5W	6/23/75
M. F. Justice Jr.	640.00 (2)	T24, 25S, R5, 11W	1/21/74
J. K. Letts	1,374.88 (2)	T25, 26S, R7W (One lease Partially in Beaver County)	5/20/74
Magma Power	2,000.00 (1)	T17S, R9W	10/26/76
S. V. McCormick	8,203.65 (7)	T25, 26S, R9, 10W	8/6/73, 4/7/75, 8/1/75

Table 3.1.4 (Cont.)

COUNTY & LESSEE	SIZE, ACRES & (NO. OF LEASES)	LOCATION	DATE ISSUED
<u>MILLARD</u> Cont.			
S. L. McGarry	2,881.53 (5)	T24, 25S, R6-8W	5/29/74, 7/19/76
Phillips Petroleum Co.	7,157.46 (7)	T15, 18, 19, 24, 25S, R6-8W	8/6/73, 9/22/75, 1/12/76, 2/9/76
R. E. Puckett	8,456.50 (7)	T15, 16, 23S, R5-9W	12/3/73
Resource Leasing Corp.	634.68 (1)	T14S, R8W	8/6/73
Steam Corp. of America	560.00 (1)	T25S, R3W	8/6/73
Thermal Power Co. of UT	717.24 (1)	T26S, R8W	8/6/73
<u>PIUTE</u>	1,280.00 (1)		
Moly Minerals Inc.	1,280.00 (1)	T28S, R1W	7/16/79
<u>SANPETE</u>	2,358.00 (3)		
R. E. Puckett	2,358.01 (3)	T15, 16, 18S, R1-3E	12/3/73
<u>SEVIER</u>	4,455.00 (9)		
J. E. Blankenship	680.00 (1)	T26S, R3W	10/16/78
E. A. Justice	480.00 (1)	T26S, R5W	6/23/75
M. J. Justice Jr.	360.29 (1)	T25S, R5W	8/8/77
S. V. McCormick	2,735.80 (5)	T24, 25S, R3, 4W	10/21/74, 4/7/75, 4/21/75, 5/6/75
Steam Corp. of America	200.00 (1)	T25S, R3W	5/20/74
<u>UTAH</u>	21,683.00 (16)		
R. Barnes	2,281.29 (4)	T10, 11S, R1, 2W (One lease partially in Juab County)	1/20/75
R. E. Puckett	19,401.31 (12)	T5-7, 9-11S, R1, 2W	12/3/73
<u>WASATCH</u>	3,363.00 (4)		
R. E. Puckett	3,363.49 (4)	T3, 4S, R4, 5E	12/3/73

Table 3.1.4 (Cont.)

COUNTY & LESSEE	SIZE, ACRES & (NO. OF LEASES)	LOECTION	DATE ISSUED
<u>WASHINGTON</u>	5,514.00 (7)		
M. F. Justice Jr.	1,299.50 (3)	T37S, R15, 16W	2/23/76
G. W. Nevins	160.00 (1)	T40S, R16W	11/8/76
R. E. Puckett	800.00 (1)	T41S, R12W	12/3/73
M. W. Smith	3,253.81 (2)	T40S, R17W	10/26/76

Figure 3.2.1.1
Substate Areas To Be Considered
In Area Development Plans
Utah

Table 3.2.1.1

Areas to be Considered in Area Development Plans

<u>Area</u>	<u>Counties</u>
<u>Jordan Valley</u>	- Salt Lake
<u>Southwest Utah</u>	- Beaver Iron Washington
<u>Sevier Valley</u>	- Sanpete Sevier Piute Wayne
<u>Northern Wasatch Front</u>	- Davis Morgan Weber
<u>Utah Valley</u>	- Utah
<u>West Central Utah</u>	- Juab Millard
<u>Northern Utah</u>	- Box Elder Cache Rich
<u>Northern Mountainlands</u>	- Summit Wasatch
<u>Great Salt Lake Desert</u>	- Tooele
<u>Uintah Basin</u>	- Daggett Duchesne Uintah
<u>South Central Utah</u>	- Garfield Kane
<u>Southeastern Utah</u>	- Carbon Emery Grand San Juan

Lake Desert, the Uintah Basin, South Central Utah, and Southeastern Utah.

3.2.2 Salt Lake County Area Development Plan

The first area development plan (ADP) for Utah is for the Jordan River Valley, i.e., Salt Lake County. Much of the data which have been gathered are preliminary, i.e., some essential information was in the process of being updated. The data were tabulated and partially analyzed; these data are presented in Tables 3.2.2.1 through Table 3.2.2.5.

Population and industrial growth projections were run with data which has since been updated. The industrial projections are based on information from the Directory of Utah Manufacturers for 1977-78; the 1979-80 edition became available in July. The population estimates are based on projections by the State Planner's Office; finalized projections should be available late in August. When these data are available, the Salt Lake County ADP will be updated.

An estimation of the projections of industrial energy consumption reveals two problems. The first is that energy use in Salt Lake County is dominated by a few major industries, and growth by smaller industries becomes obscured. The second is that growth rates were projected through the year 2020; however, it is unlikely that high industrial growth rates will continue that long. As a result, the data presented in Table 3.2.2.5. and Figure 3.2.2.1. must be considered very cautiously.

3.3 Site Specific Development Plans

3.3.1 Candidate Geothermal Sites/Applications

During the first year of the project, a preliminary effort was made to tabulate possible sites for future geothermal development and to postulate the type of use likely at each site. The results were quite subjective and did not reflect any real plans by developers; however, they do provide a point of beginning for subsequent work. A listing of these sites is found in Table 3.3.1.1.

Table 3.2.2.1
NATURAL GAS USE
SALT LAKE DIVISION
 (INCLUDES SALT LAKE COUNTY)

Residential/Commercial				
	<u>Total MCF</u>	<u>Avg. No. of Customers</u>	<u>Avg. MCF/ Cust.</u>	<u>Avg. Btu's/yr.¹</u>
1975	39,385,927	186,469	211	231 x 10 ⁶
1976	36,833,600	194,351	190	208 x 10 ⁶
1977	36,360,328	204,883	177	193 x 10 ⁶
1978	36,038,150	216,707	166	182 x 10 ⁶

Industrial (all classes)				
	<u>Total MCF</u>	<u>Avg. No. of Customers</u>	<u>Avg. MCF/ Cust.</u>	<u>Avg. Btu's/yr.¹</u>
1975	30,207,655	419	72,095	7.887 x 10 ¹⁰
1976	29,222,702	414	70,586	7.729 x 10 ¹⁰
1977	33,780,323	410	82,391	8.981 x 10 ¹⁰
1978	30,795,988	399	77,183	8.476 x 10 ¹⁰

¹Calculated using data from Mountain Fuel Supply - 1978 - 1097 Btu's per cu. ft. of gas; 1977 - 1090 Btu's per cu. ft. of gas; 1976 - 1095 Btu's per cu. ft. of gas; 1975 was averaged from the other three years.

Source: Mountain Fuel Supply - Annual Reports.

Table 3.2.2.2

ESTIMATED POPULATION AND HEAT USE

	<u>Total Population</u>	<u>No. of Households</u>	<u>Estimated Residential Commercial Heat Use Btu's x 10¹²</u>
1950 ⁽¹⁾	274,895	78,447	
1960 ⁽¹⁾	383,035	108,007	
1970 ⁽¹⁾	485,607	134,926	
1975 ⁽²⁾	511,000	150,000	
1980 ⁽²⁾	583,000	177,000	20.3
1985 ⁽²⁾	654,000	207,000	23.7
1990 ⁽²⁾	722,000	238,000	27.3
1995 ⁽²⁾	791,000	270,000	31.0
2000 ⁽³⁾	911,731	308,065	35.3
2005 ⁽³⁾	1,022,932	352,934	40.5
2010 ⁽³⁾	1,147,696	404,339	46.3
2015 ⁽³⁾	1,287,677	463,231	53.1
2020 ⁽³⁾	1,444,731	530,701	60.9

¹U.S. Census Records - Cited in "Wasatch Front Regional Planning Projections, "Technical Report Number 8, Wasatch Front Regional Council, Dec. 1976.

²Projections by Utah State Planning Coordinator's Office, using UPED Model. Cited in "Wasatch Front Regional Planning Projections," Technical Report No. 8, Wasatch Front Regional Council, Dec. 1976.

³Projections extrapolated from U.S. Census and UPED Data, using exponential curve fitting techniques, Utah Division of Water Rights, April 1979.

⁴Based on Natural gas displacement.
Average Residential/Commercial Use: 182×10^6 Btu's/year x 0.9 (use factor) x 0.7 (efficiency factor) = 114.7×10^6 Btu's per year residential/commercial customer.

Table 3.2.2.3

ESTIMATED HYDROTHERMAL ENERGY - SALT LAKE COUNTY

Ground Water⁽¹⁾ - Total Heat = 1.30×10^{15} Btu's.

Direct Thermal Capacity above 15.5°C⁽²⁾ - 0.4643×10^{15} Btu's.

Hot springs - Direct use.

	Max. Temp. ⁽³⁾	Flow Range cfs. ⁽⁴⁾	Estimated Beneficial Use Btu's x 10 ¹⁰ /year ⁽⁵⁾
Wasatch	40°C (104°F)	0.69 - 2.27	0.49 - 1.61
Beck's	55°C (131°F)	0.13 - 1.0	0.71 - 0.95
Crystal	86°C (186°F)	0.10 - 1.44	0.07 - 1.02
Hobo	37°C (99°F)	--	--

⁽¹⁾ Assumed 60×10^6 acre feet groundwater; 8° recoverable ΔT ; Heat = Volume of water x ΔT .

⁽²⁾ Calculated by methods used in USGS Circular 790, "Assessment of Geothermal Resources of the United States - 1978."

⁽³⁾ Data from Peter J. Murphy, Utah Geological and Mineral Survey.

⁽⁴⁾ Mundorff, J. C., "Major Thermal Springs of Utah", Water Resources Bulletin 13, September, 1970.

⁽⁵⁾ Assumed $\Delta T = 15^\circ\text{F}$; beneficial use factor = 0.24; Beneficial use = Flow x ΔT x 0.24.

Table 3.2.2.4

SALT LAKE COUNTY INDUSTRIES UTILIZING PROCESS HEAT

<u>SICI</u>	<u>Type of Industry (1)</u>	<u>No. of Companies (2)</u>	<u>Total Avg. No. of Employees (3)</u>
2011	Meat Packing	8	384
2013	Sausage/Prepared Meats	3	117
2016	Poultry Dressing	2	22
2022	Natural Cheese	1	37
2023	Condensed & Evaporated Milk	1	17
2026	Fluid Milk	10	1114
2033	Canned Fruits & Vegetables	1	5
2048	Prepared Feeds	4	96
2051	Bread & Baked Goods	9	784
2063	Beet Sugar	2	500
2075	Soybean Oil Mills	1	5
2077	Animal and Marine Fats	1	37
2086	Soft Drinks	6	511
2421	Sawmills & Planing Mills	1	150
2511	Wooden Furniture	10	114
2512	Upholstered Furniture	12	452
2661	Building Paper	2	22
2653	Fiber Boxes	1	150
2819	Chemicals	1	350
2834	Pharmaceutical Preparations	2	10
2841	Soaps and Detergents	5	86
2873	Urea	1	5
2892	Explosives	2	155
2911	Petroleum Refining	3	950
2951	Paving Mixtures	5	366
2952	Asphalt Felts & Coatings	1	17
3079	Plastics Products	29	494
3111	Leather Tanning & Finishing	1	5
3273	Ready-Mix Concrete	13	387
3295	Treated Minerals	4	277
3479	Galvanizing	3	27

¹Industries listed in Appendix A (Draft), RMB&R Regional Hydrothermal Market Penetration Analysis, found in Salt Lake County.

²Directory of Utah Manufacturers, 1977-1978.

³Calculated sum of the midpoints of the respective range of employees as listed in the Directory of Utah Manufacturers.

Table 3.2.2.5

Industrial Energy Demand
Salt Lake County

10^{12} Btu's/year

	<u>1978</u>	<u>1980</u>	<u>1985</u>	<u>2000</u>	<u>2020</u>
Industrial (Excluding Petroleum- related industries)	8.8	9.9	13.6	37.1	151.4
Total Industrial (Including Petroleum- related industries)	33.1	34.3	38.0	61.4	175.7

-Growth rates from Rocky Mountain Basin and Range Regional Hydrothermal Market Penetration Analysis, Appendix B., Updated January 23, 1979.

-Energy Consumption for 1978 obtained from Solar Energy Research Institute data, combined with data from 1977-78 Directory of Utah Manufacturers; energy demands for a few industries was estimated using data from the Rocket Research Company, Industrial Waste Heat for Adjacent Communities and Industrial Application Task 1, Dec. 1977, and data from the 1972 U.S. Census of Manufacturers.

-No growth rates were available for the Petroleum-related industries in Salt Lake County. Because of uncertainty in projecting growth for these industries, a constant usage was assumed.

Table 3.2.2.6

Summary of Residential, Commercial, and Industrial Heat Use

	Salt Lake County 10 ¹² Btu's/year			
	<u>1980</u>	<u>1985</u>	<u>2000</u>	<u>2020</u>
Residential/ Commercial	20.3	23.7	35.3	60.9
Total Industrial	34.3	38.0	61.4	175.7
Total	<u>54.6</u>	<u>61.7</u>	<u>96.7</u>	<u>236.6</u>

Figure 3.2.2.1 Estimated Energy Consumption in Salt Lake County:
Residential, Commercial, and Industrial Sectors.

Table 3.3.1.1

Candidate Sites for Site Specific Development Plans
Utah

<u>Site</u>	<u>Potential Application</u>	<u>Notes</u>
Abraham Hot Springs	Light Industry, mining, resort	Quite isolated; high temperatures, high flow.
Beryl	Agribusiness, agricultural, greenhouses	Agricultural region; large agribusiness complex was planned by McCulloch
Black Rock Desert	Agricultural, greenhousing	Somewhat isolated; near agricultural area; explored extensively, some surface manifestations
Cove Fort/Sulphurdale	Sulphur extraction, greenhouses, multiple uses.	Near agricultural area; unsuccessful electrical exploration; mining in the area.
Crystal Hot Springs	Space heating (State prison); Greenhouses (Utah Roses).	Separate projects now planned; space heating prison is PON project, greenhouses are independent operation.
Crystal (Madsen's) Hot Springs	Space heating, recreation, greenhouses	Near Honeyville; recreation facilities now using thermal waters; may be expanded.
Joseph Hot Springs	Greenhouses; district heating	about 1 mi. from Joseph high temperature, very low flow.

Table 3.3.1.1 (cont.)

<u>Site</u>	<u>Potential Application</u>	<u>Notes</u>
LaVerkin Hot Springs	Recreation, space heating	Resort in use Possible small additional use
Meadow Hot Spring/ Hatton Hot Spring	Agriculture, greenhouses, space heating, light industry	Near rural agricultural area
Midway	Space heating, recreation, greenhouses, fish hatchery	Extensive warm water aquifer; several homes and spas now heated with thermal water.
Newcastle	greenhouses, agriculture	Greenhouse operation planned by Christensen Bros.; agricultural area; further exploration planned.
Ogden Hot Spring/Utah Hot Spring/Hooper Hot Spring/ Hill AFB	Space heating, greenhouses recreation	Greenhouses in use at Utah Hot Spring; space heating planned for Hill AFB; further exploration planned.
Red Hill Hot Spring/ Johnson Hot Spring	Greenhouses, space heating	Red Hill is hot, about 1 mi. from Monroe.
Thermo	Cascaded industrial or agribusiness uses.	Hot, good quality water; somewhat isolated, not far from agricultural area.
Tintic	Industrial, mining	Intensive mining area; hot water flows from mines.

Table 3.3.1.1 (cont.)

<u>Site</u>	<u>Potential Application</u>	<u>Notes</u>
Veyo Hot Spring	Recreation, spaceheating, greenhouses.	Used for swimming pool; could be further developed.
Wasatch Hot Spring/Beck's Hot Spring/Hobo Hot Spring	Space heating, industrial	Close to industrial area, North Salt Lake; some industrial use suggested

In some cases, much of the data required for the site specific development plans has already been gathered, i.e., permitting, institutional factors, known resource data, etc. This information will be incorporated into the site specific development plans as they are completed.

3.4 Time Phased Project Plans

A major effort during the first half of the current contract year was devoted to a time phased development plan for the Roosevelt Hot Springs geothermal area. The plan has been completed and is included in this report as Appendix A.

Geothermal heating projects are planned and underway at several sites in Utah. These sites, particularly the PON projects, are candidates for time phased project plans. Table 3.4.1 is a listing and summary of these projects.

3.5 State Aggregation of Prospective Geothermal Utilization

The results of the various plans will be aggregated to show projected energy demand and projected use of geothermal energy. Work on the plans has not yet progressed far enough to make meaningful aggregations.

3.6 Institutional Analysis

3.6.1 Overview of State Laws and Regulations

Existing Utah Legislations, passed in 1973, gives regulatory authority for geothermal exploration and development to the State Engineer's Office (the Division of Water Rights). Other agencies which are involved in the regulation of geothermal activities include the Division of State Lands, which issues leases on state-owned lands, and the Branch of Environmental Health Services, which issues discharge and construction permits.

As mentioned in the summary section (2.6), geothermal legislation

Table 3.4.1

Geothermal Utilization Projects in Utah

<u>Site</u>	<u>Application</u>	<u>User</u>	<u>Measured Resource Temperature °C</u>	<u>Notes</u>
Crystal Hot Springs (Salt Lake County)	Space Heating	Utah State Prison	86	Initial phases of the project call for the heating of the minimum security facility, with later expansion to other buildings as the resource proves out. Funding assistance by DOE through the PON program.
Crystal Hot Springs (Salt Lake County)	Greenhouses	Utah Roses	86	Utah Roses has expressed interest in buying land near Crystal Hot Springs for a greenhouse operation, possibly involving up to 20 acres of greenhouses
Sandy City (Salt Lake County)	Greenhouses	Utah Roses		Utah Roses, an existing greenhouse operation in Sandy City in south Salt Lake County, is receiving funding assistance from DOE through the PON program. The project will include a wildcat well drilled up to 4000 ft.
Hill Air Force Base (Davis County)	Space heating	Hill Air Force Base (U.S. Air Force)		Exploration is underway to determine the presence of of a resource beneath the base. Funding assistance

Table 3.4.1 (cont.)

<u>Site</u>	<u>Application</u>	<u>User</u>	<u>Measured Resource Temperature °C</u>	<u>Notes</u>
				has been provided by DOE. The exact site and the rate of heat usage will be determined by the location and quality of the resource.
Newcastle (Iron County)	Greenhouses	Christensen Brothers	108	An existing well produces good quality hot water at fairly shallow depths. The owners have initiated development of a hydroponic greenhousing operation to raise tomatoes.

is needed in Utah. A few issues which clearly require resolution through legislation are as follows:

- A definition of "geothermal resources". The existing law gives regulatory authority to the Division of Water Rights, implying that "geothermal resources" are part of the water resources of the state; but that is implied, not specified, in the legislation.
- A clarification of the authority of the State Engineer, particularly concerning the power to arbitrate and/or compel unitization and the power to make and enforce rules and regulations.
- A statement defining the relationship between "geothermal resources" and the waters of the state, particularly specifying the nature of rights to the resources.
- Clarification of the relationship between "geothermal resources", which are presently administered under Utah water law, and geothermal leases, in which geothermal is treated as part of the mineral estate.
- A clarification of the relationship between "geothermal" rights, correlative or property rights, and water rights.
- Directives on procedures and criteria for unitization.

Under the direction of the Legislative Joint Interim Committee for Energy and Natural Resources and with assistance from the National Conference of State Legislatures, a committee was formed to draft a proposed bill for the legislature to consider. The draft committee consisted of representatives from the National Conference of State Legislatures, the Utah Division of Water Rights, and the Office of Legislative Research of the Utah Legislature, together with administrative and legal representatives of several major developers and

utilities active in Utah. The drafting committee met several times to refine the proposed legislation, and, near the end of the legislative session, the proposed bill was presented to the legislature as S.B. No. 279.

The proposed bill contained the following provisions:

- A statement that the development of geothermal resources is in the public interest.
- A definition that a "geothermal resource" is (a) the natural heat of the earth at temperatures greater than 120°C, (b) the energy, in whatever form, associated with that heat, (c) the material medium containing the energy, and (d) the minerals, gases, or other substances which might be contained in the material medium.
- Directives to the Division of Water Rights concerning permitting requirements and procedures.
- A statement giving authority to the Division of Water Rights to require unitization, and directives concerning the criteria and terms for a unit agreement.
- A definition of "geothermal fluids" as being a "special kind of underground water resource" which may be related to other waters of the state; a requirement that geothermal owners file an application to appropriate geothermal fluids with the State Engineer; and a statement that correlative rights shall apply to owners of common geothermal resources.
- The establishment of enforcement and appeal procedures.

With regard to water rights, the proposed bill required that applications to appropriate be filed on geothermal resources, but stated that no priority would exist between owners of geothermal rights, although priorities would exist between the owners of geothermal rights and the owners of rights to water other than geothermal fluids.

The bill passed the Senate without dissent. In the House, however, the bill was amended. One amendment stated that the rights to geothermal fluids shall be appropriated only by geothermal owners, and that an appropriation or application to appropriate geothermal fluids does not establish ownership rights to the geothermal resources. The other amendment was a provision that holders of applications for geothermal fluids filed prior to enactment of the bill "shall be entitled to have such application processed and granted in accordance with the water law of the state existing at the time such applications were filed." Because of the large number of speculative applications which have been filed, the second amendment would in practice have negated the purpose of the act, as well as that of the first amendment.

As a result of this conflict, which appeared unresolvable in the last few hours of the session, the bill was not reintroduced to the Senate and died at the close of the session.

Work on a geothermal bill is continuing, and it is likely that a modified bill will be proposed to the legislature in the 1980 budget session."

3.6.2 Detailed State Institutional Procedures

A detailed analysis of state permitting regulations and procedures was conducted as part of the first year effort. More information has been gathered to refine this analysis, but it has not yet been completely integrated into the initial analysis. A summary of the institutional analysis is found in Appendix B.

3.7 Public Outreach Program

An important task of the state geothermal planning project is to provide an outreach service to the public. The purpose of the outreach program is to inform the public about the potential and the advantages of geothermal development, both in qualitative and quantitative terms. Furthermore, the philosophy of the outreach program is not to merely respond to requests for information but to pursue an active program of public awareness about opportunities offered by geothermal energy, both in a general sense and in specific cases.

In addition, the state planning team has acted in an advisory role on geothermal legislation for the state.

3.7.1 Outreach Mechanisms

Most outreach activities in Utah have been responses to information requests from various parties. The state geothermal planning team has initiated and maintained contacts with a number of individuals; some of these contacts were initiated to obtain information, some because of cooperation on similar research, and some as a result of work on various development projects.

Utah does not yet have an active public relations program to promote the use of geothermal energy. One reason for this is the regulatory nature of the Division of Water Rights, and the fact that it might be inconsistent for a state regulatory agency to promote the use of something which it regulates, particularly when it might be called upon to use its regulatory powers to restrict that usage. This apparent conflict of roles could possibly be resolved by subcontracting some of the outreach activities to another agency, such as the Utah Energy Office; this possibility is presently being explored.

Certain activities are basic to both the planning effort and to the outreach program. These include meeting with state and local agencies to discuss the results of the planning project and the potential for geothermal development within a specific area. The same is true for prospective developers and users of geothermal energy. Some of these activities will occur in the course of the project, but it is important to recognize and capitalize on opportunities.

The possibility exists for an organized public relations campaign to promote geothermal use in Utah. This may be investigated further, but so far no plans have been made for such programs.

The participation of Stanley Green, Director of the state planning team, on the draft committee for the state geothermal legislation is an important part of the outreach program. Mr. Green was instrumental in responding to the request of the legislative committee to initiate the effort, coordinating the meetings, representing the perspective of the state regulatory agency, and following the progress of the bill through the legislature. Similar important roles were played by Douglas Sacarto

and Ken Wonstolen of the National Conference of State Legislatures, also associated with the state planning project. The work of the draft committee, which is continuing, was a cooperative effort among all the parties involved.

3.7.2 Summary Listing of Contacts and Results

Table 3.7.2.1 is a listing of contacts through the outreach program and the nature of those contacts. The list is not complete, since not all contacts were noted; however, it is an indication of the kinds of contacts established through the outreach program.

3.7.3 Overall Prospectus for Future Geothermal Activity

Geothermal exploration and commercialization in Utah, at least for electrical resources, has suffered several setbacks. One of the major disappointments was the unsuccessful exploration at Cove Fort/Sulphurdale. The failure of this major prospect to prove out, along with an apparent industry pessimism about undiscovered resources in Utah, seems to have led to a substantial decline in the level of geothermal (electrical) exploration in Utah. Roosevelt Hot Springs is still a viable commercial prospect, but development there has progressed slowly.

In some aspects, exploration for direct use resources has also been somewhat disappointing; not so much because of a failure to locate a resource, but more because of a lack of the high quality resource hoped for, both in terms of temperature and quantity. This was illustrated by the project at Monroe, where temperatures of 77°C were encountered instead of at the hoped for 120°C. While these setbacks will by no means halt development, they may limit the extent.

Other problems encountered by direct use projects, particularly the PON projects, have been associated with the obtaining of rights to explore or develop on private land. This is a problem which has occurred both at Monroe and Crystal Hot Springs; these problems, though frequently frustrating, have been or are being resolved.

In spite of problems and setbacks, commercialization is proceeding and probably will accelerate. The Roosevelt Hot Springs area will probably be developed with a small (20 MWe) research and development

Table 3.7.2.1

Summary Listing of Contacts and Results

January 1979 through June 1979

<u>Contact</u>	<u>Purpose</u>
<u>Industry</u>	
Bill Bates, McCulloch Geothermal	Exploration at Roosevelt
Bill Berge, Phillips Petroleum Co.	Development at Roosevelt; legislation
Robert Catlin, Mountain Fuel Supply	Natural Gas Consumption
Jim Endicott, McCulloch Geothermal	Well drilling in Utah
Val Finlayson, Utah Power & Light	Development in Utah
Richard Foss, Magna Power Co.	Lease information
Don Harban, Phillips Petroleum Co.	Development at Roosevelt
Dick Lenzer, Phillips Petroleum Co.	Exploration at Roosevelt
Bill Long, Amax Exploration	Geothermal Exploration
Jordan McNay, McCulloch Geothermal	Drilling at Roosevelt
Bill Nowell, Phillips Petroleum Co.	Exploration in Utah
Clayton Parr, Martineau & Mack	Geothermal legislation
Grant Pendleton, Utah Power & Light	Electrical Consumption
Richard Sager, VanCott, Bagley, Cornwall & McCarthy	Geothermal legislation
Mike Shoaff, Union Oil Co.	Summary of development
Verl Topham, Utah Power and Light	Geothermal legislation
Brent Uibel, Gunther's Comfort Air	Heat pump systems
Ellen Woehrman, Mountain Fuel Supply	Natural Gas Consumption
<u>Agribusiness</u>	
Christensen Brothers, Newcastle	Greenhouses, hydroponics
Ralph Wright, Utah Roses	PON at Sandy City, Greenhouses
<u>Individuals</u>	
Carl Barnes	Geothermal potential, central Jordan Valley
Ariel Davis	Heat pump development, district heating
Scott Holmgren	Development, Udy Hot Springs
Hal Vanderwest	Geothermal potential, Escalante Desert
Paul Walton	Moderate temperature resources

<u>Contact</u>	<u>Purpose</u>
<u>Consultants</u>	
Roger Harrison, TerraTek	Monroe PON, Crystal Hot Springs PON
Jay Kunze, Energy Services	Utah Roses, Christensen Bros.
Norman Mork, Ford, Bacon & Davis	Beaver County Feasibility Study
Jim Whelan	Roosevelt Development
<u>Research</u>	
John Austin, University of Utah	Energy Consumption in Utah
Tom Cassel, University of Pennsylvania	Economic probability analysis
Dave Chapman, University of Utah	Geology of Roosevelt, Monroe
Tom Cheney, Petroleum Information Corp.	Geothermal laws and regulations
Irv Cox, Stafco, Inc.	Heating requirements
Phillip Ehr, Science Applications, Inc.	Water availability
Duncan Foley, UURI	Moderate temperature resources
Bob Grant, Energy Resources Explorations, Inc.	Geothermal laws, legislation
Lee Lyon, Petroleum Information Corp.	Drilling summary for Utah
Terry Nakai, Science Applications, Inc.	Institutional information
Marty Priest, Petroleum Information Corp.	Updated drilling information
Henry Serry, Brookhaven National Laboratory	Updated resource and development data
Debbie Struhsacker, UURI	Geothermal legislation
Rodger Weaver, University of Utah	Demographic data
<u>Federal Government</u>	
Ken Bull, USGS	Geothermal activities on federal lands
Dave Hartwell, BLM	Geothermal laws, regulations, policy
Joe Piani, BLM	Federal leasing, regulatory activities
Bob Pickering, BLM	Geothermal development on Utah lands.
<u>State Government</u>	
Jeff Burks, Utah Energy Office	PON's, General geothermal activities
Dennis Dalley, Branch of Environmental Health Services	Environmental Permitting

<u>Contact</u>	<u>Purpose</u>
<u>State Government</u>	
Lou Dibella, Four Corners Program	Four Corners studies and projects
Denise Dragoo, Attorney, Department of Natural Resources	Legal and regulatory aspects
Lynn R. Menlove, Bureau of Air Quality	Air discharge regulations
Peter J. Murphy, Utah Geological and Mineral Survey	State resource assessment program
Dr. Dale D. Parker, Bureau of Solid Waste Management	Construction permits
Jay B. Pitkin, Bureau of Water Pollution Control	Discharge and construction permits
Reed Searle, Utah Energy Office	PON's; general geothermal activities
Glade Sowards, Utah State Senate	Geothermal legislation
Thorpe Waddingham, Utah State Senate	Geothermal legislation
Jeannie Watanabe, State Planning Coordinator's Office	Demographic data

plant coming on line in 1982. That expectation seems very reasonable and attainable. It also appears that unitization issues will soon be resolved, which will greatly facilitate development.

Interest in direct use is apparently increasing in Utah. This interest is demonstrated by the number of inquiries concerning the potential for various uses at different sites. A more important indicator is the positive approach of developers themselves, particularly private developers, who often fund their own projects and hence are more aggressive about developing the resource.

During the summer of 1979 there has been a surge of interest in heat pump applications. This has been caused by a number of factors, including federal tax incentives, rising fuel costs, and a growing awareness of alternate energy sources. In addition, interest has been spurred by advertising campaigns by groundwater hot pump dealers along the Wasatch Front. Significant questions regarding heat pump usage in a given area need to be resolved, particularly those related to disposal of the fluids.

In the long term, it would appear that the commercialization of geothermal resources will continue, and that the pace can be quickened. Natural gas rates in Utah are still among the lowest in the nation; this might work against accelerated development. On the other hand, population and industrial growth is expected to continue, and, if the proper initiatives are taken, geothermal utilization will also continue to grow.

4.0 Summary of Major Findings and Recommendations

The efforts of the Utah geothermal planning project for the first half of the current contract year were concentrated on the Utah geothermal legislation, the Roosevelt Hot Springs time phased project plan and the Salt Lake County area development plan. Associated with these efforts were routine outreach activities, detailed institutional analysis, and updating of resource data. The findings of the project with regard to these activities are in most cases not new, nor are these findings exclusive to the project.

It has become evident from the project plan for Roosevelt Hot Springs and from the institutional analysis that delays caused by state permitting procedures are minor compared to those caused by federal permitting procedures, and that most of the delay associated with the federal procedures is taken up with environmental analyses. It has also become evident that not all delays are due directly to lengthy permitting processes, but that inter-industry and market negotiations can also cause major delays.

It has also become evident that the potential for direct use of geothermal resources in Utah is substantial. In some cases, it appears that the potential for commercialization is limited primarily by the capacity of the resource; for example, at Monroe and Crystal Hot Springs, it appears that much larger projects could be supported if the resource capacity were large enough. On the other hand, there are a number of sites where resources are apparently available but where no development is planned. This is partly due to the natural pattern of developing the most suitable resource areas first; but that should not preclude development at sites with a viable but less ideal potential for commercialization.

Preliminary findings indicate a potential for heat pump utilization, based on market interest and the existence of suitable groundwater conditions. Several issues should be resolved before extensive development begins to occur; some of the most important issues are associated with the appropriation of the water, the disposal of the water, and the economics of heat pump systems.

A list of recommendations, associated with the findings referred to above, follows:

DOE and Federal Sector

- Federal geothermal legislation should be passed. Two Geothermal Omnibus bills have been introduced to Congress. A discussion of the individual points of these bills and how they relate to development in Utah is beyond the scope of this report, and the impediments which are covered in the bills will not be discussed individually. However, the legislation will do much to alleviate unnecessary and unreasonable problems in Utah as well as in other states.

- DOE should continue the state cooperative resource assessment program. This program has been very valuable in Utah, primarily by generating resource data for significant sites; these data later provided the basis for commercializaion of the resource.
- Environmental requirements of DOE funded projects should be considered satisfied if those of the agency with administrative authority for the project are satisfied. The case in point is Roosevelt Hot Springs. The BLM and USGS, which administer the terms of the geothermal leases, operate under regulations which do not require a full EIS for a research and development plant such as the 20 MWe plant presently contemplated by Phillips. However, the environmental regulations of the DOE loan guaranty program may be interpreted to require a complete EIS even for a small R&D plant. It is not reasonable that the environmental requirements of the legal administrator of the lease terms (BLM) be subordinated to those of a DOE support program, since this would negate both the intent of the geothermal regulations which exempted small plants, as well as that of the loan guaranty program, which was established to aid and promote geothermal development. Duplicative environmental requirements are dealt with in the proposed federal legislation, but the legislation does not specify which requirements take precedence.

State and Local Governments

- Geothermal legislation for Utah should be passed. Work toward this goal is proceeding.
- Study of the problem of spent fluid disposal is needed. This applies primarily to direct use projects and heat pump applications. Acceptable and unacceptable methods should be determined, if possible; factors to be considered include the nature of the various aquifers and impermeable strata, the quality of the water, health regulations, water rights, and reasonable expense. These questions are particularly pertinent in heat pump applications, because disposal costs might be a larger proportion of the total cost for small projects. Currently, each case is judged individually, but some

investigation would certainly be beneficial, and perhaps a statement of policy would be appropriate. This same recommendation also applies to production of the fluids.

Private Sector

- Problems of negotiations within the private sector should be acknowledged. There are at this time no recommendations which could effectively remedy the problems of private negotiations without violating principals of free enterprise; but the private sector should acknowledge that such negotiations may pose barriers to development, and seek ways to avoid or overcome them. Negotiations of this type may include market negotiations, unitization or cooperative agreements, access negotiations, private leases, or agreements on the use and apportionment of a resource.

Appendix A

TIME PHASED PROJECT PLAN
FOR
ROOSEVELT HOT SPRINGS GEOTHERMAL AREA

Utah Division of Water Rights
Stanley Green
L. Ward Wagstaff

July 1979

Work Performed Under
DOE Cooperative Agreement No. DE-FC07-79ID12016
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Abstract

The area near Roosevelt Hot Springs in Beaver County, Utah, has been the scene of geothermal leasing and exploration since the late 1960's. The presence of a high grade, commercial resource was confirmed in April, 1975; it is apparently a fault-controlled hot water system, with low dissolved solids (TDS of about 7000 ppm) and high temperature (above 265°C). Major developers with leases in the confirmed producing area include Phillips Petroleum Company and a consortium composed of the Thermal Power Company, AMAX Exploration Inc., and O'Brien Resources. Initial plans for development called for 55 MWe plants by both developers to come on line by 1982, but that level of development has not materialized. Currently the most likely pattern of development would entail a joint effort between Phillips and the consortium, with a 20 MWe research and development plant coming on line by 1982, followed by 55 MWe plants in 1985 and 1986. The time phased project plan detailed in this report follows the development of a 55 MWe plant projected to come on line by 1984. It is an attempt to delineate the activities required in order for development to occur, to estimate the various time durations of those activities, and to define the relationships of precedence among them.

Update

July 1979

The time phased project plan for Roosevelt Hot Springs which is the subject of this report was based largely on information which became available in January 1979. The central assumption in the plan was that development would be in the form of a 55 MWe plant brought on line by 1984. That assumption was consistent with the planning assumptions obtained from Phillips Petroleum Company, the major operator at the prospect. However it now appears that a much more likely pattern of development will include a 20 MWe research and development plant, brought on line by 1982, followed by 55 MWe plants in 1985 and 1986. This mode of development is mentioned in the discussion but is not reflected in the plan itself. The initial installation of the 20 MWe plant offers a number of significant advantages, among them earlier power on line, earlier overall development, easing of the time pressures of permitting, and an opportunity to study the reservoir under operating conditions which will provide convincing evidence of the resource capabilities as well as important resource data.

Another central assumption in the plan was that development would be a joint effort between the major developers in the area, i.e., Phillips and the Thermal Power/AMAX/O'Brien consortium. It was assumed that unitization negotiations would be successfully concluded by mid-summer. At this time, an agreement on unitization has nearly been reached, but not yet finalized.

During the summer a question arose with regard to the environmental requirements of the loan guaranty program. Under the Geothermal Steam Act, which applies in this case to the BLM and USGS, the extensive environmental analysis which is required for a full sized power plant is not required for a small research and development plant (such as the 20 MWe plant currently contemplated). However, an Environmental Impact Statement (EIS) is required for approval of the loan guaranty. If the full EIS were required for the 20 MWe plant, thus superseding the USGS

and BLM requirements, the additional delay would negate the supposed advantages of the small plant. This would mean that either a different development pattern would be followed or the loan guaranty would not be used, thus eliminating some potential plant operators from consideration. This question has not yet been resolved.

Phillips has reported that they are currently conducting market feasibility studies to determine the best prospects for plant operators and energy markets. Apparently a number of parties are interested in building the plant, marketing the power, or both.

In late June, Bountiful City sold its lease on the 40 acre tract in the thermal area to Geothermal Power Corp. for \$125,000 cash. Geothermal Power has expressed intentions to conduct exploratory drilling on the tract. Several questions have been raised regarding the future exploration on the tract, and the overall effect of the changes in ownership of the lease is not yet clear.

Part 2

ROOSEVELT HOT SPRINGS HYDROTHERMAL AREA

Description of the Roosevelt Hot Springs Hydrothermal Area

The Roosevelt Hot Springs hydrothermal area is located in Beaver County, Utah about 10-15 miles northeast of the city of Milford. The thermal area is on the west boundary of the Mineral Mountains in the north part of the Milford Valley (sometimes referred to as part of the Escalante Desert). The Beaver River channel runs northward through the valley several miles west of the hydrothermal area although the channel is usually dry due to irrigation diversions above Milford.

The Mineral Mountains, which border the thermal area on the east, are near the eastern edge of the basin and range province (Ward *et al*, 1978). The Mineral Mountains consist primarily of a tertiary granitic pluton about 20 miles (32 km) long and about 5 miles (8 km) wide. Volcanic activity has occurred frequently throughout the area, most recently from about 0.8 to 0.5 m.y. ago. Although major swarms of earthquakes occur 20 miles (32 km) to the northeast at Cove Fort, the Roosevelt Hot Springs thermal area appears to be only slightly active (Ward *et al*, 1978).

The springs at Roosevelt Hot Springs no longer flow, although a seep is located near the springs area. Mundorff (1970) reported that in 1908 the springs flowed 10 gpm (0.63 l/s) at 190°F (88°C), in 1950 the flow was 1 gpm (0.063 l/s) at 185°F (85°C), in 1956 the temperature was 131°F (55°C), and in 1966 the springs were dry (Mundorff, 1970). Mundorff also reported that the discharge contained up to 7800 ppm dissolved solids, with silica concentrations up to 405 ppm. The spring deposits are formed with siliceous sinter and minor sulfur, with altered and cemented alluvium surrounding the spring vents (Ward *et al*, 1978).

The hydrothermal system at Roosevelt Hot Springs is, from all indications, fault controlled (Lenzer *et al*, 1977). The Dome or Opal Mound fault runs north and south through the thermal area; it is intersected near the springs area by the Hot Springs or Nigger Mag fault. Numerous additional faults have been mapped in the area, using a variety of techniques (Ward *et al*, 1978; Lenzer *et al*, 1977). From the exploratory wells drilled so far, it appears that the producing zone is east of the Dome fault. The initial well drilled by Phillips was west of the fault, and was hot but dry.

Figure 2.1

Utah Geothermal Areas

From DOE et al, 1978.

Figure 2.2

Milford and the Roosevelt Hot Springs Unit Area
Beaver County, Utah

The anomaly at Roosevelt Hot Springs appears to be part of a trend of high thermal potential which extends from the Thermo and Lund regions on the south to the Cove Fort and Black Rock Desert areas to the north and east. Industry sources have been quoted as stating that seven significant hot spots occur in Iron, Beaver, and Millard counties (DOE, 1978).

Vegetation in the area of the thermal anomaly ranges from shadscale, rabbitbrush, and winterfat in the valley floor, through greasewood, sagebrush, and grasses on the benchlands and foothills, to the pinyon pine-juniper communities on foothills and mountains (Allan in White *et al*, 1978). Fauna in the area includes badgers, coyotes, mule deer, and mountain lions, as well as the smaller animals such as skunks, squirrels, rabbits, rodents, and invertebrates which are found throughout such desert habitats. Birds in the area may include several species of game birds, numerous songbirds, and some raptors, possibly including the bald eagle (Smith in White *et al*, 1978).

The major land use within the KGRA area, in addition to geothermal exploration, is livestock grazing. Opal for lapidary use has been mined from the opal dome areas. Recreation might include such activities as hunting, picknicking and touring (Smith and Sharda in White *et al*, 1978).

The hydrology of the Milford Valley was studied and documented by Mower and Cordova (1974) in a report published by the Utah Department of Natural Resources. They found that the groundwater normally moves northward through the valley and out through a narrow gap north of Black Rock. They reported, however, that in the years 1970 and 1971 recharge to the groundwater reservoir was estimated to average 56,000 acre-feet (69.1 hm^3), while discharge was estimated to average 81,000 acre-feet (100 hm^3). This imbalance, due primarily to the withdrawal of groundwater for irrigation, has resulted in a lowering of the groundwater level of up to 30 feet (9.1 m), which has in turn resulted in some land compaction and subsidence in the heavily pumped area south of Milford. Mower and Cordova also point out that the expanding cone of depression has tended to pull water back toward the center of the heavily pumped area, thus diverting back to the pumped area some of the water which would normally move northward; this has caused both a decline in ground-

water levels north of Milford and a deterioration of the groundwater quality.

Beaver County is in some ways economically depressed. Although Milford is a major cattle shipping center, other major industries have been lacking, and the trend has been for the skilled population of the county to migrate out (Smith and Sharda in White *et al*, 1978). Following the mining boom and decline in the late 1800's, the population of the county has decreased, although estimates for 1977 indicate an increase. Geothermal development could have major impacts, both beneficial and detrimental, particularly in Milford; most effect would probably be felt in public services such as education, public utilities, residential services, and the health services, as well as the social-cultural aspects of community life (Smith and Sharda in White *et al*, 1978).

History of Roosevelt Hot Springs

The area surrounding Roosevelt Hot Springs has been used by man since prehistoric times, although the extent of that use has not yet been fully established. Artifacts recovered from sites in Beaver and Juab counties have been linked to cultures existing more than 10,000 years ago. Hauck *et al*, (in White *et al*, 1978) found that

"An evaluation of the 385 known prehistoric activity sites has shown that the majority were (1) of a temporary nature, (2) primarily situated within the 5,000 and 6,000 foot elevations, (3) associated with obsidian resources, (4) primarily located within the pinyon-juniper ecozone, and (5) heavily clustered around the North Roosevelt Hot Springs."

The Mineral Mountains were a major source of obsidian for tools and weapons for prehistoric cultures. Hauck *et al* (in White *et al*, 1978) report that archaeological investigations have located a number of quarries, camp sites, and a habitation site as well as numerous lithic scatters and other types of prehistoric sites within the Roosevelt Hot Springs KGRA. They also found that obsidian quarrying and preliminary stages of tool manufacturing were the paramount activities in the area.

In 1875, silver was discovered in the San Francisco Mountains and a mining boom began which spread throughout the area around Milford, including the Mineral Mountains. The railroad line to Salt Lake City was constructed in 1880, and the area prospered until the mines failed, about the turn of the century (Hauck *et al*, in White *et al*, 1978).

The hot waters from the springs were used in connection with a resort which existed from early in the century through the 1920's. Whelan (1976) reported that the wash adjacent to the springs, Nigger Mag Wash, was named after a prostitute who resided in the area sometime during this period.

In 1959 A. L. McDonald filed and was granted a gemstone lease by the State of Utah on the opal domes on parts of section 16, T27S, R6W, an area which later proved to be a prime thermal area within the prospect (Utah Division of State Lands, 1979). In 1960 he staked two mineral claims on federal lands in section 9, north of section 16,

and attempted to obtain a mineral lease on the land; these actions later enabled him to obtain a federal geothermal lease on these lands by exercising "grandfather rights" when the tract was offered for sale as part of the KGRA (Whelan, 1976).

In December of 1967, Mr. McDonald and a friend, Dr. Eugene N. Davie, drilled an exploration hole in the opal pits. They hit hot water at 80 feet, abandoned the well, and moved 300 feet east to drill a second hole. This time they hit hot water at 165 feet, which flashed to steam. They managed to remove the drill tools and set a cement plug (Whelan, 1976).

In February 1968 Dr. Davie, Louis Cooper, and Austin B. Smith applied to the state for a geothermal lease on section 16. The lease was granted one week later on February 20, 1968 (Utah Division of State Lands, 1979).

In April 1968 Mr. McDonald and his son William filed several water right applications with the State Engineer's office. That same month Dr. Davie moved back on the "discovery well". At a depth of about 265 feet the well blew out. Additional blowouts developed 50 to 70 feet to the southeast of the well; after about two months of effort the blowouts were controlled (Whelan, 1976).

In May 1971, the Coda Corporation obtained geothermal leases on state lands in section 2, T27S, R9W, and in September filed for a lease on section 36, T26S, R9W, which was not approved until August 1973. In April 1972 the Coda Corporation assigned its leases on these two sections to the Thermal Power Company of Utah, which had been organized by Dr. Davie for geothermal development in southwest Utah (Utah Division of State Lands, 1979; Whelan, 1976). These sections were later included within the Roosevelt Hot Springs Unit boundaries.

The Geothermal Steam Act was passed in 1970, and in April 1971, eight sections in the Roosevelt Hot Springs thermal area were declared a KGRA by the USGS (Lenzer *et al*, 1977).

In the early 1970's, some state leases and extensive private leases in the Milford Valley region were acquired by the American Oil Shale Corporation, which later evolved to American Geothermal Enterprises and still later to American Geological Enterprises. (Bates, 1978; Walton, 1978). Some of these lands are in prime areas of the geothermal prospect.

Intensive geological mapping of the thermal area was begun in the summer of 1972 by Carol Peterson, a geology student at the University of Utah. The study was funded by the Utah Geological and Mineral Survey (Whelan, 1976).

Phillips Petroleum Company began actively investigating the geothermal area in 1972. Late in that year they commenced literature surveys and field reconnaissance, and in July 1973 they began temperature gradient surveys and other geological and geophysical surveys (Phillips, 1978). In May 1973 Phillips began leasing state and other non-federal lands (Phillips, 1978; Utah Division of State Lands, 1979).

Federal geothermal leases were offered for sale in 1974. In the January 1974 non-competitive leasing period, leasing activity in the Roosevelt Hot Springs was sufficient that the KGRA was increased from 8 to 36.5 sections on the basis of competitive interest (Lenzer *et al*, 1977; BLM Records, 1979). The lease sale was held July 30, 1974. Successful bidders were Phillips (18,871 acres for \$798,860), Union Oil Company (2,560 acres for \$51,993.60), and Getty Oil Company (1,920 acres for \$24,000.00). A. L. McDonald exercised the grandfather rights to a 40 acre tract mentioned earlier and obtained the lease for \$2,335.20 (BLM Records, 1979; Bulletin, Geothermal Resources Council, 1979).

In March 1974 Louis Cooper and Austin B. Smith assigned their respective 1/3 interests in section 16 to O'Brien Resources Corporation. In August 1975 the estate of Dr. Davie assigned his 1/3 interest in the section to the Thermal Power Company of Utah. The Thermal Power Company of Utah in turn assigned its interest in section 2 and 36, as well as other state leases in the area, to the Thermal Power Company, a subsidiary of Natomas Company, in July 1976 (Utah Division of State Lands, 1979). The result of these assignments was the formation of a consortium between the Thermal Power Company, O'Brien Resources, and AMAX Exploration, Inc., in which each company shared a 1/3 working interest in sections 16, 2 and 36.

The federal leases became effective October 1, 1974, and Phillips began active exploration, including drilling, shortly thereafter (Phillips, 1978).

The Department of Geology and Geophysics of the University of Utah began extensive geological, geophysical, and geochemical studies

of the Roosevelt Hot Springs thermal area in 1974 (Whelan, 1976; Ward *et al*, 1978). A bibliography of publications dealing with the geology of the Roosevelt Hot Springs area was published recently by the University of Utah Research Institute (UURI) (McKinney, 1978).

Summary of Development

Geological and Geophysical Surveys

The Roosevelt Hot Springs hydrothermal area has been studied extensively by a number of investigators representing a wide range of interests. These individual surveys are far too numerous to be discussed here. A report by McKinney (1978) published by the University of Utah Research Institute, Earth Science Laboratory (UURI/ESL), lists references about the geology of the area. For a discussion of the exploration by Phillips Petroleum the reader is referred to Berge *et al* (1976), Lenzer *et al* (1976), and Lenzer *et al* (1977). A summary of the results of investigations by the University of Utah, Department of Geology and Geophysics, is found in Ward *et al* (1978). Results of industry coupled case study investigations may be obtained from UURI/ESL.

Leasing

Phillips Petroleum Company, Getty Oil Company, and Union Oil Company obtained their federal leases in the competitive lease sale held July 30, 1974. The leases became effective October 1, 1974, and major exploratory activities began shortly thereafter. For a discussion of lease-related activities prior to the issuance of federal leases, see the section on the history of the thermal area.

A. L. McDonald had been granted the right to convert a mineral claim dating from 1960 to a geothermal lease on a 40 acre tract in section 9. That lease became effective November 1, 1974. In August and September of 1977 McDonald sold the lease to Bountiful City for \$127,500, plus the maximum reserved royalty allowed by federal law (BLM, 1979). Bountiful had apparently hoped to parlay the tract into a share in a power plant constructed at Roosevelt. Bountiful has negotiated with a few potential developers, and at this time is considering an offer by Phillips.

The early development of the AMAX/O'Brien/Thermal Power consortium is also discussed in the discussion of the history of the area. Following the assignment to O'Brien Resources of the two 1/3 shares in section 16 by Cooper and Smith, the assignment of Dr. Davie's

- ☐ Federal Lands
- ☐ State Lands
- ☐ Private Lands
- ☐ Unit Boundary

Figure 2.3
Leases within the Roosevelt Hot Springs Unit.

Table 2.1

Leases within the Roosevelt Hot Springs Unit

<u>Lease No.</u>	<u>Acres</u>	<u>Lessee</u>
<u>Federal Lease (BLM)</u>		
U-14990	40.00	City of Bountiful
U-27383	1,600.00	Union Oil Co. of California
U-27384	1,640.00	Phillips Petroleum Co.
U-27385	1,280.00	Phillips Petroleum Co.
U-27386	2,468.37	Phillips Petroleum Co.
U-27387	1,644.05	Phillips Petroleum Co.
U-27388	1,939.65	Phillips Petroleum Co.
U-27389	1,961.40	Phillips Petroleum Co.
U-27390	2,272.50	Phillips Petroleum Co.
U-27391	1,920.00	Getty Oil Co.
U-27392	2,560.00	Phillips Petroleum Co.
U-27393	1,280.00	Phillips Petroleum Co.
<hr/>		
Total Federal Lands	20,600.97	
<hr/>		
<u>State Leases</u>		
ML-25128	640.00	* O'Brien Resources Corp. (2/3) Thermal Power Co. (1/2) AMAX Exploration (1/6)
ML-27536	681.88	* Thermal Power Co. (1/2) AMAX Exploration (1/2)
ML-27796	520.00	Roosevelt Hot Springs Corp.
ML-27889	640.00	* Thermal Power Co. (1/2) AMAX Exploration (1/2)
<hr/>		
Total State Lands	2,481.88	
<hr/>		

* State leases ML-25128, ML-27536, and ML-27889 are controlled by a consortium of O'Brien Resources, Thermal Power Company and AMAX Exploration, Inc. Under the agreement, the three are equal partners, with AMAX acting as operator.

Table 2.1 (Cont)

Private Leases

	2,413.03	Roosevelt Hot Springs Corp.
	120.00	Union Oil Co. of California
	330.50	Unleased
<hr/>		
Total Private	2,863.53	
<hr/>		
<hr/>		
Total Acres	25,946.38	

interest in that section to the Thermal Power Company of Utah, and the subsequent assignment in 1976 of the holdings of the Thermal Power Company of Utah to the Thermal Power Company, the consortium was formed. The Thermal Power Company acted as operator, but each of the three shared equal 1/3 working interests in sections 16, 2, and 36. In 1978 AMAX became the operator for the consortium. In September and October of 1978 AMAX was assigned half the Thermal Power lease interests in these sections, which amounted to 16.6665% in section 16 and 50% in sections 2 and 36 (Utah Division of State Lands, 1979); however, the 1/3 equal operating interest among the consortium members remained in effect. As unit negotiations with Phillips continue, it is expected that the consortium will join the unit, probably in the summer of 1979.

Some state lands and extensive private lands in the thermal area and throughout the general region were leased by the American Geological Enterprises. In the fall of 1978, the leases in the Roosevelt Hot Springs area were transferred as assets to the Roosevelt Hot Springs Corporation, which was set up specifically to handle the Roosevelt leases. This corporation entered into an agreement with McCulloch Geothermal Corporation. The agreement provides that McCulloch has an option to 1) buy 10,000 shares of convertible preferred stock of Roosevelt for \$600,000 2) drill one to three wells during the first year (the first well has been drilled); 3) continue exploration and development at a rate of \$2 million per year. If and when McCulloch has spent \$12 million, each corporation would share equally thereafter in investment costs and revenue.

Exploratory Drilling

Phillips submitted applications to drill deep exploratory wells almost immediately after the leases became effective in October, 1974. The first wells drilled were deep observation holes, which were slim holes drilled to about 2000 feet and which yield important information about temperature gradients, stratigraphy, hydrology, alteration, drilling problems, and structure at only a fraction of the cost of a production type well (Lenzer, 1977).

In April 1975, Phillips drilled the first deep exploratory well, Rooseveltly KGRA 9-1. The well was drilled west of the Dome fault, and was dry with high temperatures. (In 1978 Phillips agreed to allow

- Phillips Petroleum Company
- Thermal Power/AMAX/O'Brien
- Roosevelt Hot Springs Corporation
- Union Oil Company
- City of Bountiful
- Getty Oil Company

- Producing Wells
- Non-Producing Wells
- Unit Boundary
- Major Faults

Figure 2.4
Deep wells in the Roosevelt
Hot Springs Unit

A-2.15

Table 2.2

Summary of Deep Exploratory Drilling
Roosevelt Hot Springs Thermal Area

Date Drilled	Location	Operator	Well	Status	Depth
Mar 1975	NENW Sec. 9, T27S, R9W	Phillips Petroleum Co.	Roosevelt KGRA 9-1	Dry Hole - logging Equipment Calibration	6885'
Apr 1975	SWNE Sec. 3, T27S, R9W	Phillips Petroleum Co.	Roosevelt KGRA 3-1	Idle - collapsed casing	2724'
Jul 1975	SWNE Sec. 3, T27S, R9W	Phillips Petroleum Co.	Roosevelt KGRA 54-3	Reservoir Tests	2882'
Aug 1975	NWNW Sec. 35, T26S, R9W	Phillips Petroleum Co.	Roosevelt KGRA 12-35	Idle	--
Oct 1975	SWNW Sec. 10, T27S, R9W	Phillips Petroleum Co.	Roosevelt KGRA 13-10	Idle	--
Nov 1975	NENE Sec. 33, T26S, R9W	Phillips Petroleum Co.	Roosevelt KGRA 82-33	Injection well for reservoir tests	--
Aug 1976	NWSW Sec. 15, T27S, R9W	Phillips Petroleum Co.	Roosevelt HSU 25-15	Idle	--
Sep 1976	SWNW Sec. 2, T27S, R9W	Thermal Power/Natomas	Utah State H-2	Idle	6108'
Oct 1976	NENE Sec. 16, T27S, R9W	Thermal Power/Natomas/ O'Brien	Utah State 72-16	Idle	1254'
Nov 1977	SWNW Sec. 36, T26S, R9W	Thermal Power/AMAX/ O'Brien	Utah State 24-36	Idle	6107'
Feb 1978	NWNE Sec. 21, T27S, R9W	Getty Oil Co.	USL 52-21	Idle	7500'
Apr 1979	SW Sec. 26, T26S, R10W	McCulloch Geothermal, Inc.	Acord #1-26	Testing	--

Figure 2.5

Heat flow map of the Roosevelt Hot Springs geothermal area. Solid dots and adjacent numbers indicate sites and heat flow values in mW m^{-2} . The outcrop pattern of the 10 m.y.-old Mineral Mts. pluton is shaded with the vents for the younger flows (0.8 m.y.), and rhyolite domes (0.5 m.y.) indicated by asterisks. Major fault patterns are indicated by heavy solid and broken lines. From Ward *et al*, 1978.

the DOE to use this well for the calibration of well logging equipment).

Late in April Phillips moved east across the fault and drilled well 3-1 in section 3. This well yielded steam and hot water, and is regarded as the discovery well. It is presently considered not suitable for production due to a partially collapsed casing.

Following the discovery well, Phillips drilled five more deep wells in 1975 and 1976. Of these five wells, four are considered producible.

In September 1976 the Thermal Power Company, as operator for the consortium, drilled well Utah State 14-2 on section 2, a state lease. The well produced hydrothermal fluids. In October Thermal Power drilled well 72-16 on section 16, also state land near the opal domes and the wells drilled by Dr. Davie. This well hit steam at shallow depth (about 100m). Problems with blowouts, both controlled and uncontrolled, were encountered. In a short-term test in April 1977, this well yielded more than 1.3×10^6 lbs/hr of steam and hot water at well-head temperatures up to 406°F (213°C) (Thermal Power Company, 1977). The consortium also drilled a well on section 36 which was dry.

In 1977 west central Utah was chosen by the DOE for the first project of the Industry Coupled Program. Among other things this program provided for the purchase of data from the Thermal Power wells by DOE and the release of this information to the public through the UURI/ESL. Funding assistance through this program was also provided to Getty Oil Company for the drilling of their well USL 52-21, a non-producing well drilled in 1978 in section 21, south of the opal dome area.

In April 1979 McCulloch Geothermal Corporation drilled a well in section 26, T26S, R10W. This location is on the valley floor west of main thermal area. Preliminary reports are that the well went over 12,000 feet deep.

Unitization Negotiations

Phillips began work on the unit agreement for the Roosevelt Hot Springs KGRA about the time that a commercial resource was discovered (April, 1975). The formal agreement for unitization was submitted to the USGS for approval in August 1975. In the fall of that year, Phillips invited the other working interest and royalty interest holders within

the proposed unit boundaries to join. At that time Union Oil Company and Superior Oil Company joined Phillips in the unit. The unit agreement was approved by the USGS on April 19, 1976.

The agreement for the Roosevelt Hot Springs unit was patterned after the federal geothermal unit agreement found in the Federal Regulations on the Leasing of Geothermal Resources; this model agreement was in turn patterned after the federal oil and gas unit agreement. In the Roosevelt agreement, costs and production revenues are proportionate to the acreage within the unit boundaries held by each unit member. Phillips, as the major lessee in the area, is operator for the unit. When the producing area had been more exactly defined by exploration, a "participating area" was outlined, and an agreement will be negotiated which will apply to development and production phases. This agreement will probably provide for costs and production returns to be allocated initially on the basis of acreage within the participating area, with provisions for later reallocation on the basis of proportionate amount of energy produced by each tract.

After the approval of the unit in 1976, Phillips continued efforts to arrive at an agreement with the remaining developers within the unit boundaries. The major developers were the Thermal Power/AMAX/O'Brien consortium, American Geological Enterprises (Now Roosevelt Hot Springs Corporation), and Getty Oil Company. Negotiations have continued, but to date a final agreement has not been reached. The two main parties involved, Phillips and the consortium, have been negotiating in depth since late 1978 and an agreement may be reached by mid-summer.

Market Negotiations

A companion problem to unitization has been that of negotiating contracts with a plant operator and a market for the power. In December 1978, Phillips, Utah Power and Light (UP&L), and Rogers Engineering signed an agreement for exclusive negotiations for a 55 MWe power plant at Roosevelt Hot Springs. Much work went into the negotiations but when the agreement expired in June 1979 no final marketing agreement had been reached.

The plan set forth by Phillips, Rogers, and UP&L called for Phillips to supply the steam, Rogers to construct and operate the plant, and UP&L to market the power, with an option for UP&L to buy

the plant after the reservoir had been proven. Rogers, an engineering firm, was small enough to be able to make use of the federal loan guaranty program, whereas both Phillips and UP&L are too large to default on a loan and hence could not use the loan guaranty. Phillips would sell steam, not power, and thus would remain an exploratory company and be protected from regulation as a utility. UP&L would be able to absorb the power into its distribution system.

When the initial negotiations failed to result in an operating and marketing agreement, Phillips resumed negotiations with other potential associates. In early 1979 Phillips began intensive market studies to determine the most advantageous types of arrangements and modes of development. Apparently their efforts have been fruitful, since Phillips has reported that a number of parties are interested in either building and operating the plant, marketing the power, or both.

Modes of Development

Early in 1978, both the Phillips/Rogers/UP&L group and the Thermal Power/AMAX/O'Brien consortium announced plans for 55 MWe plants to come on line by 1982. Neither plan materialized.

Later plans by Phillips would bring a 55 MWe plant on line early in 1984. These plans were not a public announcement of intent, but part of regular planning procedures. Development would follow a fairly conventional pattern. The time phase project plan which is the subject of this report represents this mode of development, though it does not necessarily represent specific plans by Phillips.

Phillips is currently considering the construction of a 20 MWe plant as a "Research and Development" project, to come on line in 1982. This small experimental plant would be followed by two 55 MWe plants in 1985 and 1986. This approach appears to offer several significant advantages. It would provide an opportunity to study the reservoir under operating conditions, particularly since the small plant could be operated for a year before a commitment is made to construct the second 55 MWe plant. The 20 MWe plant would enable the developers to avoid delays caused by lengthy federal permitted procedures such as siting and rights-of-way; in practice, the time-table for the larger plant is almost a normal schedule. This plan has received support from most of the com-

panies and agencies likely to be involved, and at this time appears to be the most probable mode of development.

Data Summary:
Roosevelt Hot Springs
May 1979

General Information

Location: T26 and 27S, R9W, SLBM; Beaver County, Utah

Areal Extent: 25,946.38 acres (10,500 ha) within the unit boundaries (Phillips, 1978).
23,392.00 acres Federal KGRA (Bulletin, Geothermal Resources Council, 1979).

Land Ownership (within unit boundaries)

Federal:	BLM: 20,600.97 acres (8,337.1 ha).
State:	2,481.88 acres (1,004.4 ha).
Private:	2,863.53 acres (1,158.9 ha). (Phillips, 1978).

Lessees (within unit boundaries) Federal (KGRA Acreage):

	Phillips Petroleum Company: 17,040.97 acres
	Union Oil Company: 1,600.00 acres
	Getty Oil Company: 1,920.00 acres
	Bountiful, a Municipal Corp.: 40.00 acres (Bulletin, Geothermal Resources Council, 1979; Phillips, 1978).
State:	AMAX Exploration, O'Brien Resources, Thermal Power Corp: 1,961.88 acres
	American Oil Shale Corp. (Roosevelt Hot Springs Corp): 520.00 acres (Utah Division of State Lands)
Private:	Roosevelt Hot Springs Corp: 2,413.03 acres
	Union Oil Company: 120.00 acres (Phillips, 1978).

Terrain: High desert, grading into the steep Mineral Mountains on the east.

Nearest Community: Milford, 10-15 miles (16-24 km) to the south-west of the prospect.

Access:

Highways:	State Highway 257 - 5-8 miles (8-13 km) west
Railroad:	Union Pacific - Major line passes through Milford
Airport:	Municipal Airport on north side of Milford; no regular service.

Resource Parameters

Fluid Temperature: 260°C (500°F) (Ward *et al*, 1978)
Maximum in excess of 265°C (509°F)
(Lenzer *et al*, 1977)
468°F (242°C) (Thermal Power Co. 1977)

Well Costs:

Well Life:

Steam Quality (per cent flash):

17-20% (Thermal Power Co., 1977)

Well Head temperature:

416°F (213°C) (Thermal Power Co., 1977).

Fluid Rate:

Excess of 1×10^6 lbs/hr (4.54×10^5 kg/hr)
(Lenzer *et al*, 1977)

Up to 1.4×10^6 lbs/hr (6.35×10^5 kg/hr)
(Thermal Power Co., 1977)

Average of 4.5×10^5 kg/hr per well (1×10^6 lbs/hr) (Ward *et al*, 1978)

Dissolved Solids:

About 5,000 to 8,000 ppm
(Lenzer *et al*, 1977)

Enthalpy:

467.4 btu/lb m (260 cal/g)
(Thermal Power Co., 1977)

Operational Parameters

Plant Size:

750 MWe hybrid (Burbank, 1977)
20 MWe Research and Development plant
or 52 MWe full-size plant (Phillips, 1974,
Berge, 1979).

Plant Cost:

\$35 Million for 50 MWe Plant
(Geothermal Energy Magazine, February, 1978).
\$15-20 million for 20 MWe plant
(Berge, 1979).

Heat Rejection:

Expected to be wet cooling, no cooling water
make-up required.

Field Baseline Data

Spring Water Temperature:

190°F (88°C) in 1908 to 131°F (55°C) in
1957 (Mundorff, 1970).
25°C (77°F) at existing seep
(Ward *et al*, 1978).

Spring Water Flow Rate:

10 gpm (0.63 l/s) in 1908 to 1 gpm
(0.063 l/s) in 1950; dry in 1966.
(Mundorff, 1970)
Small seep, no measurable flow (Ward *et al*,
1978)

Inferred Reservoir Temperature:

Na-K-Ca: 290°C (563°F). Na-K: 307°C (585°F)
(Lenzer *et al*, 1977)

Electrical Resistivity Low: 0.1 to $2\Omega\text{-m}$ (Ward *et al*, 1978).

Heat Flow: Up to 9 Wm^{-2} (Ward *et al*, 1978).

Thermal Gradient: Up to 960°C/km ($53^{\circ}\text{F/100 ft}$) (Ward *et al*, 1978)
Exceeding 40°C/100m ($22^{\circ}\text{F/100 ft}$) (Lenzer *et al*, 1977).

Gravity Survey: Indicates major faults as well as extensive faulting in the thermal area (Ward *et al*, 1978).

Magnetic Survey: Indicates lineament extending through Roosevelt Hot Springs area to Cove Fort and beyond (Ward *et al*, 1978).

Seismic Noise: Indicates that the Roosevelt Hot Springs area is only slightly active (Ward *et al*, 1978).

Well Test Data: Thermal Power Well 72-16, in a short (24 hour) test, April 4-6, 1977:
 $1.309 \times 10^6\text{ lbm/hr}$ ($5.94 \times 10^5\text{ kg/hr}$)
 $T_w = 416^{\circ}\text{F}$ (213°C) $P_w = 294\text{ psia}$ (20.7 kg/cm^2) (Thermal Power Co., 1977)

Depth to Production: 1254 ft (382m) to 6108 ft (1860m) well depths (Lenzer *et al*, 1977)

Producible Wells: 7 wells in the thermal area produce geothermal fluids, one of which is inoperative (Lenzer *et al*, 1977)

Injection Wells: Phillips ran an extended flow/injection test in 1977 and 1978; some problems were encountered with precipitation of minerals

Non-Produicable Wells: 4 dry holes

Environmental Aspects

Gas Data

H_2S : 0.0008% in fluid (VTN, quoted by White in White *et al*, 1978).
Less than 1 ppm in non-condensable gases (Geothermal Energy Magazine, February, 1978).

CO_2 : Probably a major component of non-condensable gases

Other:

Fluid Data: See Table

Subsidence: As much as 1.8 m (6 ft) subsidence in heavily pumped areas of the Milford Valley (Mower, 1974)

Reservoir Data

Recharge Source:

Probably deeply circulating meteoric water
Two possible sources for the
hot water are postulated:

- 1) Deep fractures into a 10 m.y. old pluton might tap an unusually high thermal gradient;
- 2) A partial melt zone or hot igneous mass may occur at depth. (Ward *et al*, 1978; also Meidav, 1976, quoted in National Geothermal Information Resource, Energy Conversion File, Roosevelt Hot Springs)

Reservoir Rocks:

Tertiary igneous intrusive granitics or pre-cambrian metamorphics (Lenzer *et al*, 1977).
Capped by altered and cemented alluvium (Ward *et al*, 1978)

Rock Porosity:

Almost no intergranular porosity or permeability; reservoir associated with faults and fracture zones (Lenzer *et al*, 1977)

Land Use Factors

Well Spacing:

Not yet determined; fracture-controlled reservoir makes spacing difficult to predict (Lenzer *et al*, 1977)

Land Improvements needed:

An improved road from the thermal area to the highway will be necessary (Phillips, 1979)

Existing Land Use:

Agriculture (mostly grazing); Recreation (picnicking, rock collecting);
Some mining in the vicinity

Climate:

Average temperatures: -3°C (-37°F) to 21°C (70°F);
Relative humidity: Summer 30%, winter 60-70%
Precipitation: 30 cm (11.8 inches)
(Energy Conversion File)
Precipitation may range up to 25 inches (63.5 cm per year at the tops of the Mineral Mountains (Mower, reported in White *et al*, 1978)

Water:

The geothermal reservoir is apparently separate from the groundwater basin (Mower, 1974; Mower, reported in White *et al*, 1978; Lenzer *et al*, 1977)

Proximity to Transmission
Lines:

15 miles (24 km) to 138 kv line; 46 kv line
within few miles (Utah Power & Light, 1978)
Existing R.O.W. available for required power
lines (Finlayson, 1979; Phillips, 1979).

Legal Aspects

Water Laws

Water Rights:

Applications pending before the State Engineer
by both Phillips and the AMAX/O'Brien/Thermal
Power consortium

Water Pollution Control:

Regulated by the Utah Branch of Environmental
Health, Bureau of Water Pollution control.
No major problems foreseen at this time

Reinjection Control:

U.S. EPA regulations and state regulations
administered by the Utah Branch of Environ-
mental Health in cooperation with the Utah
Division of Water Rights and the Utah Divi-
sion of Oil, Gas, and Mining.

Air Emission Control:

Regulated by the Utah Branch of Environmental
Health, Bureau of Air Pollution Control;
some uncertainty exists about federal stan-
dards of allowable H_2S emissions, which
might affect plant design.

State Income Tax:

Not yet completely determined

Federal Income Tax:

Table 2.3

Selected Water Analyses of Roosevelt Hot Springs Geothermal Samples

	Roosevelt Hot Springs (Mundorff, 1970)	Roosevelt Hot Springs (Mundorff, 1970)	Roosevelt Seep	Roosevelt Seep	Well 54-3	Well 3-1
Date	11-4-50	9-11-57	5-9-73	8-15-75	8-26-75	5-25-75
Temperature ($^{\circ}\text{C}$)	85	55	76	17	> 260	> 205
Silica (ppm)	405	313	76	107	560+	560?
Calcium (ppm)	19	22	113	107	10.1	8.0
Magnesium (ppm)	3.3	0	17	23.6	0.24	0.01
Sodium (ppm)	2080	2500	2400	1800	2000	2437
Potassium (ppm)	472	488	378	280	410	448
Bicarbonate (ppm)	158	158	536	300	200	180
Sulfate (ppm)	65	73	142	70	54	59
Chloride (ppm)	3810	4240	3800	3200	3400	4090
Fluoride (ppm)	7.1	7.5	5.2	3.3	5.0	5.0
Nitrate (ppm)	1.9	11	TR	TR	TR	0.1
Boron (ppm)	-	38	37	29	29	25
Lithium (ppm)	-	0.27	-	17	19.0	20.0
TDS (ppm)	7040	7800	7506	5948	6442	7067
pH	-	7.9	8.2	6.43	6.5	6.3
Na-K-Ca Geothermometer ($^{\circ}\text{C}$) ($\beta=1/3$)	295	285	247	239	294	273
Na-K Geothermometer ($^{\circ}\text{C}$)	307	282	250	248	290	294

From Lenzer *et al.*, 1977

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ROOSEVELT HOT SPRINGS TIME PHASED PROJECT PLAN

Theory

Time phased development plans or development "scenarios" are quite commonly used as planning tools by developers, particularly where major projects are involved. Frequently the data for the project plans is computerized to facilitate the handling of large amounts of data and the drafting of complex diagrams. A development plan should specify the activities required to complete the project, the interdependencies between the activities, and the time frame in which each activity is expected to occur. It may also identify activities on the critical path, indicate float times, specify the entity conducting the activity, and adjust the schedule. Of course, the intended use of such a plan will determine the emphasis and the degree of detail.

Typical objectives of a planning scenario such as the one presented here would be to provide information as an aid to industry and government agencies in their planning activities. The scenario would probably be used to reveal and analyze potential problems and delays, with the ultimate goal of using the information to recommend changes which would facilitate the development.

The basic purpose of this particular development scenario for the Roosevelt Hot Springs Prospect was to outline in moderate detail the necessary steps in developing a geothermal prospect in Utah. The individual steps were also analyzed to some degree. In particular, the role of state agencies was examined.

One result of this operation was a tabulation of estimates of time involved in the various steps and the dependency relationships among them, gathered from the industries and agencies involved in the development at Roosevelt Hot Springs. This information, appropriately modified, can be used for further development plans in Utah or perhaps other states. The scenario should also provide a useful background as development at Roosevelt Hot Springs proceeds.

Assumptions

The possible development scenario presented here is based on several important assumptions. If any of these assumptions are not born out as the development occurs, the scheduling would be set back in time according to the delay.

The first assumption is that the geothermal reservoir is capable of supporting at least 55 MWe power plant without imposing extraordinary design or construction constraints. It is also assumed that the resource temperature, pressure, depth, etc., combine to make recovery of the source economically and technically feasible. These assumptions appear to be supported by experience at the prospect.

The second assumption is that the overall development will be economically advantageous to the developers. This assumption covers not only the recovery of the resource, but also assumes that financing will be available and the energy produced will be marketable.

The third assumption is that no new or unforeseen delays or constraints due to institutional factors will occur. This includes the assumption that permitting will be as prompt as in the past and no more restrictive. It also includes the assumptions that new regulations which might restrict development will not be added; that lawsuits concerning the environment, water rights, land disputes, mineral rights, or other issues will not occur; and that major environmental impact statements will not be necessary.

Sources

As much of the data for the scenario as possible was obtained directly from the entities involved, i.e., the agencies and developers involved. Invaluable assistance was provided by Phillips Petroleum Company; without it, the whole effort would have been meaningless as well as inaccurate. This does not imply that the development schedule herein presented is an accurate representation of Phillips' plans, nor does it in any way imply a commitment or intention by Phillips to follow a particular pattern or schedule of development. The information presented in this report represents a projection by the Utah Division of Water Rights of one of many possible development modes; the assumptions and estimates are considered reliable, but some variability is built into the plan.

Updating

The scenario as here presented will be updated periodically to reflect the current activity at the prospect. The format and timing for updating has not yet been determined.

Figure 3.1

DETAILED DEVELOPMENT SCENARIO
ROOSEVELT HOT SPRINGS, UTAH
PHILLIPS PETROLEUM COMPANY, FIELD DEVELOPER

Prepared by the Utah Division of Water Rights
April, 1979

LEGEND

— ACTIVE TIME
- - - FLOAT TIME
- - - EXTENDED LOW-LEVEL ACTIVITIES

● APPROXIMATE BEGIN/END DATE--KNOWN
○ APPROXIMATE BEGIN/END DATE--ESTIMATED
◆ SIGNIFICANT MILESTONES WITHIN ACTIVITY
1.1.2 REFERENCE TO TEXT

A-3.4

Table 3.1

Estimated Durations of Development Activities

Index Number	Projected Activities	Estimated Duration
1.1.6	Environmental Baseline Report	3
1.1.8	Consider/Approve Plan of Injection	6
1.1.9	Consider/Approve Plan of Utilization	9
1.1.11	Consider/Approve Siting & ROW Application	18
1.2.2	Approval of Water Rights	1
1.2.3	State Environmental Permits	3
1.2.4	Utah State PSC Approval	3
2.6	Reservoir Test & Characterization	-
3.2	Market/Financial Analysis	(5)
3.2.2	Preliminary Negotiations	3½
3.4	Contract Negotiations	5
3.5	Financial Negotiations	5
3.6	Loan Guaranty	6
4.2	Field Design	16
4.3.1	Development Drilling	18½
4.3.2	Production Tests	17
4.6	Field Deliverability Test	18
5.1	Preliminary Design	3
5.2	Prepare Plan of Utilization	9
5.3	Prepare Plan of Injection	6
5.4	Prepare Siting and ROW Application	3
5.5	Detailed Plant Design	-
5.6	Procurement of Power Plant Material	-
5.7	Power Plant Construction	24
5.8	Power Plant Start-up and Test	3
5.9	Operate Field	2½
6.1	Powerline Design	5
6.2	Procurement of Powerline Material	16
6.3	Powerline Construction	18½

TIME PHASE PROJECT PLAN
ROOSEVELT HOT SPRINGS, UTAH

Phillips Petroleum Company, Unit Operator

Prepared by the
Utah Division of Water Rights

April, 1979

1.0 Regulatory Activities

1.1 Federal

- 1.1.1 Permit for Pre-lease Exploration: NOI* submitted to surface management agency; statutory limit of 30 days for consideration and issuance. Required for most geological/geophysical investigations (non-surface-disturbing); applies to federal lands not leased by the applicant (1). **
- 1.1.2 Lease: Application filed with surface management agency (BLM, USFS); may be competitive or non-competitive; time of issuance ranges from 3-4 months to several years, with reasonable time of about 8 months (1). Required prior to surface-disturbing exploratory activities or use of resource.

The Geothermal Steam Act was passed in 1970, and geothermal leases on federal lands were issued beginning in 1974. Phillips has reported that their leasing activities began in May 1973 (2). The Roosevelt KRGAs originally consisted of eight sections, but in Jan. 1974, the KRGAs were increased to 36.5 sections as a result of competitive interest (3). The lease sale, held in July 1974, was the fifth lease sale under the Geothermal Steam Act and the first held in Utah (4,5). Successful bidders included Phillips Petroleum Co., Getty Oil Co., Union Oil Co., and A. L. McDonald (who later sold his 40 acre lease to Bountiful City) (4,5). The lease sale was closed July 31, 1974 (6).

- 1.1.3 Permit for Post-lease Exploration (non-surface-disturbing): NOI submitted to USGS; statutory 30-day time limit for consideration and issuance. Required for most geological/geophysical investigations on lands leased by the applicant, including temperature gradient surveys (1). Phillips had completed much of their geological and geophysical investigations before the 30 day statutory limit for issuance was instituted (1,2).

* See list of Acronyms.

** References are numbered for convenience in this section; the list of references is found at the end of this section.

However, the NOI's submitted by Phillips for which data were obtained appear to have been issued within the 30 day limit (6).

- 1.1.4 Permit for Post-lease Exploration, (surface-disturbing activities); P00 submitted to USGS; site-specific EA is required, conducted by USGS. Usual time of approval is 3-5 months, although it may be longer (up to a year) in environmentally sensitive areas or where little environmental work has been done previously (1, 7).

- 1.1.4.1 Permit for Deep Exploratory Drilling: P00, APD submitted to USGS; EA conducted; 3-5 months approval time.

Current practice is to apply for a number of wells (as many as practical) under the same P00, since the multiple application does not take significantly longer to process and approve. However, in the early stages of development at Roosevelt, Phillips usually filed applications on single wells or pairs of wells (6).

- 1.1.4.2 Permit for Extended flow test: P00 submitted to USGS, EA conducted, 3-5 months approval time (1). Required for long-term flow testing of reservoir, such as the long-term test of well #54-3.

- 1.1.5 Approval of Unit Agreement. Agreement submitted to USGS; estimated current approval time 3 months (1). The unit at Roosevelt KGRA was the first of its type; it was necessary for the agreement to be approved by the Secretary of the Interior (Kleppe), a procedure which has since been streamlined. The Roosevelt agreement was submitted on Aug. 6, 1975, and was approved April 19, 1976 (6).

- 1.1.6 Environmental Base Line Data: The Federal Regulations require that environmental base line data must be gathered for at least one year prior to the submission of a plan of production (8). Phillips began gathering base line environmental data in Oct. 1977, and terminated the program in Dec. 1978. The report was estimated to require about 3 months for preparation (9), and was assumed to be completed about June 1979. It was assumed that the information in the report will be part of the application for siting.

- 1.1.7 Consideration and Approval of Plan of Development: P00 submitted to USGS, EA conducted. Describes field development plans; approval required before drilling and development of production wells. Estimated time of approval 6-9 months (1, 7, 9); assumed 7 months for purposes of the proposed plan. Estimated time frame about Jan. 1980 to about Aug. 1980.

- 1.1.8 Consideration and Approval of Plan of Injection: P00 submitted to USGS, EA conducted. Describes injection plans and presents data; required before fluids may be reinjected. Estimated 5-9 months for approval (1, 7, 9); assumed 6 months for project plan. Estimated to take place from about April 1980 to Oct. 1980, preceding the detailed design.

- 1.1.9 Consideration and Approval of Plan of Utilization: P00 submitted to USGS; EA conducted. Presents plans for the operation of the project, including contracts, royalties, financial arrangements, operating agreements, etc. Required prior to construction of the plant.

Estimated to require 9-12 months for approval (1, 7, 9); assumed 10 months for project plan, from about Jan. 1980 to Nov. 1980.

Because some of the requirements overlap, the Plan of Utilization for Roosevelt will probably be submitted and considered simultaneously with the Siting and ROW application.

- 1.1.10 Consideration and Approval of Plan of Production: P00 submitted to USGS; EA conducted. Explains planned production system and includes well data. Estimated to require 6-9 months for approval (1, 7).

- 1.1.11 Siting and Right of Way (ROW): Application submitted to BLM; Extensive studies conducted; required prior to construction activities. Estimated to require about 18 months (9, 12); for scenario, assumed to occur from about March 1980 to Sept. 1981.

The siting permit is expected to be a major regulatory milestone, due in part to both the long approval time and the comprehensive nature of the information required (10). The rules and regulations for siting of geothermal power plans on federal leases were issued April 4, 1979.

1.2 State

1.2.1 Exploratory Drilling Permits

- 1.2.1.1 Permit for Temperature Gradient Holes: Letter application submitted to the Utah Division of Water Rights, describing locations, planned operations, etc. (13); test well permit issued. Required prior to drilling. Estimated time of approval about 2 weeks (14).
- 1.2.1.2 Permit for Drilling of Observation Wells: Letter application submitted to the Utah Division of Water Rights, describing locations, planned operations, etc. (13); test well permit issued. Required prior to drilling observation wells. These wells are often used for reservoir monitoring. Estimated time of approval about 2 weeks (14).
- 1.2.1.3 Permit for Deep Exploratory Wells: Letter application, including plan of operations, submitted to the Utah Division of Water Rights (13); test well permit issued. Required prior to deep geothermal exploratory drilling. Estimated 2-4 weeks for approval (14). Valid for 6 months from issuance with renewal on request.

The permit allows drilling of the well but does not imply the approval of water rights, a process which must be completed prior to the use of the geothermal fluids or to the drilling of development wells.

- 1.2.2 Appropriation of Water: Application submitted to the Utah Division of Water Rights; procedure follows the standard water appropriation laws (15). Approval secures the water right for the applicant and is required prior to drilling of development wells or use of water. Estimated time for approval about 6 months (14).

Phillips filed an application to appropriate water in Dec. 1974, shortly after their leases in the Roosevelt prospect became effective (16). The application was not processed according to the usual procedures because major questions were unresolved. The applications were advertised, and a public hearing was held in Milford in April, 1976 (2, 3, 14). Since that time, the Phillips applications have been held in limbo, as have all other similar applications. It is assumed that further processing of the applications will occur in the summer of 1979, and a fairly arbitrary approval time of one month was assumed.

- 1.2.3 State Environmental Health Permits: The Utah Division of Health Branch of Environmental Health Services, coordinates the permitting processes for the various bureaus within the Branch. When the plans for a project are fairly complete, they are submitted to the Branch with a Notice of Intent to Construct (NIC). Approval of the construction permit is granted by each bureau individually, but the issuance of the approvals is coordinated so that no construction can begin until all of the appropriate bureaus have approved (17).

- 1.2.3.1 Pre-design Conference: Recommended to aid the coordination of construction permits and plan approvals from the various bureaus within the Branch of Environmental Health Services. The conference would best be held during or prior to the conceptual design phase. The purpose of the conference is to clarify what information will be required, which agencies will be involved, and what problems are anticipated. Each bureau must be satisfied as to the feasibility of the project before actual consideration of the plans begins (17). The conference is informal and is scheduled at the involved parties' convenience (18).

- 1.2.3.2 Construction Permit--Bureau of Air Quality: NIC submitted along with project plans to the Branch of Environmental Health Services; plan review, publication of intended decision to approve or disapprove, and comment period conducted by the Bureau of Air Quality (17, 19). Approved permit required prior to construction. Estimated time of approval 2-3 months (19).

- 1.2.3.3 Construction Permit--Bureau of Water Pollution Control: NIC and project plans submitted to the Branch of Environmental Health Services; plan review and construction approval by the Bureau of Water Pollution Control. Approved permit required prior to construction (17). Estimated time for approval is 30 days (20).

The state construction permit is required in addition to the EPA discharge permit when water is discharged into a drainage (application for the EPA discharge permit should be made 180 days prior to the discharge) (20). Because the state has responsibility for groundwater, clearance from the Bureau of Water Pollution

Control will probably be required for systems which evaporate or inject water, e.g., geothermal developments such as power plants (20).

- 1.2.3.4 Plan Review--Bureau of Sanitation: NIC and project plans submitted to the Branch of Environmental Health Services; plan review and approval by the Bureau of Sanitation (17). Concerned primarily with plumbing and waste water disposal, with possible input to culinary water supply approval. Plan review and approval as part of the coordinated review process by the Branch of Environmental Health Services; applies only indirectly to most geothermal developments (21).
- 1.2.3.5 Plan Review--Bureau of Solid Waste: NIC and project plans submitted to the Branch of Environmental Health Services; review of plans and approval by Bureau of Solid Waste (17). Concerned primarily with disposal facilities for solid wastes, and may apply to disposal of some by-products of geothermal operations. Plan review and approval as part of the coordinated review process by the Branch of Environmental Health Services; estimated to require 1-2 weeks (22).
- 1.2.3.6 Plan Review--Other Environmental Health Bureaus: Review and approval of plans and NIC by the Bureau of Waterworks (which issues a plan approval letter), the Bureau of Environmental Epidemiology, and the Bureau of Radiation and Occupational Health (17).
- 1.2.4 Approval by the Utah Public Services Commission (PSC or PUC): Application submitted to the Utah Public Service Commission of the Department of Business Regulation. Applies only to regulated utilities in the state, and does not apply to small or experimental projects (23). For a geothermal power plant, the process involved will probably be an approval of the contract between the utility and their energy supplier, and is estimated to require about 4 months, with a statutory limit of 270 days on the decision (23). Rules and Regulations for geothermal power plant siting on federal lands require that the PUC approval of the contract be obtained prior to the operation of the power plant (11).

1.3 County Permits

- 1.3.1 Zoning: Established by the County Commission; Beaver County has been zoned for geothermal development (24).
- 1.3.2 Road Construction: Applications made to county and/or state for the construction of roads; assumed to be in progress(9).
- 1.3.3 Business Permit: Application made to county; required prior to commercial production of power (24).

- 1.3.4 Construction Inspection: Health code enforcement and building inspection required prior to use of buildings or other facilities.

2.0 Resource Characterization

- 2.1 Preliminary Investigations: Conducted by developer and others interested in the prospect; may include literature search, field reconnaissance, etc.; indefinite duration. Phillips reported that they conducted these investigations in late 1972 and early 1973 (2, 3).
- 2.2 Geological/Geophysical Investigations: Conducted by Phillips and other interested parties, including industrial, academic, and governmental groups. Permit from surface management agency (pre-lease) or USGS (post-lease) (1.1.1, 1.1.3). Phillips began these activities early in 1973 (2, 3); it was assumed that activities of this type will continue indefinitely at the diminishing rate.
- 2.3 Shallow Exploratory Drilling: Includes temperature gradient surveys, which have been conducted by a number of entities, and the observation well system established by Phillips. Requires state and federal permits (1.1.1, 1.1.3, 1.2.1.1, 1.2.1.2). Observation wells are usually slim holes up to 2,000 feet deep; Phillips drilled two such wells in Feb. and Mar. 1975, two in Mar. 1977, and two in Aug. and Sept. 1978 (2, 3, 25). It was assumed that the system would be used to monitor the reservoir throughout development but particularly during extended flow testing.
- 2.4 Deep Exploratory Drilling: Phillips drilled the first deep exploratory well at the prospect in March 1975. The second well, drilled in April, was a discovery well. Between March 1975 and Aug. 1976, Phillips drilled 7 wells, 4 of which are potentially producible (2, 3). The Thermal Power /AMAX/O'Brien consortium drilled three wells, all on state lands; two of the wells were drilled late in 1976, and one in late 1977 (25, 26). Of the three wells, two are potentially producible. Getty Oil Co. drilled a well in early 1978 which was not a producible well (25, 26).

Depths of the wells vary from about 1,200 ft. to about 7,500 ft. (26, 27). Temperatures range up to 260°C (28). The drilling at Roosevelt may have been somewhat atypical in that Phillips drilled a number of wells in quick succession during the very early phases of exploration.

- 2.5 Flow Testing: Conducted by the operators following completion of the individual wells (2); provided preliminary information of the capacity and characteristics of each well, and may be used to gather reservoir data. Flow testing, like the exploratory drilling, was considered a continuous activity even though the tests were intermittent and varied in duration.
- 2.6 Reservoir Characterization: Conducted by the operator following the initial tests; consists of various tests, and provides reservoir data for use in field design, unit negotiations, financial/contractual negotiations, plans of development and injection, approval of water

rights, and other activities. May vary in approach and duration among different projects.

Phillips conducted an extended flow/injection test from Oct. 1977, to May 1978 (2, 10); observation of the reservoir through the deep wells and the observation well system is continuing. Phillips plans more reservoir conformation tests through 1979 and 1980 (9). The total testing program was assumed to extend until shortly before development drilling begins (about June 1980), although monitoring of the wells will continue through drilling and development.

- 2.7 Environmental Base Line Data: Gathered by operator; includes background data covering all environmental aspects which may be impacted by the development; one year of data required before a plan of production may be submitted (8). Phillips began gathering base line data in Oct. 1977 and suspended the program in Dec. 1978 (2, 10).
- 2.8 Reservoir Observation and Monitoring: Assumed to be part of an ongoing program of reservoir observation and characterization during the development drilling, testing, and as the field is produced. Assumed to begin as the field is operated and power is produced; used to provide data for subsequent plants.

3.0 Industry Interactions

- 3.1 Unit negotiations: Work on a unit agreement and negotiations for the unit probably began informally before the discovery well was drilled. The formal agreement for unitization was submitted to the USGS in Aug. 1975 and was approved in April 1976 (6, 29). During that time, Union Oil Co., Superior Oil Co. (which holds some mineral leases within the unit area), and Marjorie Rule (who owns some land within the unit area) joined Phillips in the unit (29). Negotiations with other lease holders and developers in the unit area have continued and probably will continue indefinitely. Phillips has for some time been making concerted efforts toward unitization; sometime in early- or mid- 1979 a decision point will be reached where the other major developers (particularly the Thermal Power/AMAX/O'Brien consortium) will either join the unit or Phillips will have to proceed with its own development.
- 3.2 Preliminary Market and Contract Negotiations:
 - 3.2.1 Initial Negotiations: Phillips, Rogers International, and Utah Power & Light made an agreement for exclusive negotiations which began in Dec. 1977 and ended in June 1978 (2, 28). No final agreement was reached.
 - 3.2.2 Preliminary Negotiations: Phillips plans to conduct market research and informal negotiations early in 1979 to examine and evaluate potential market and financial options (9, 10). These preliminary negotiations are estimated to last about 3-4 months (9, 10); they were assumed to begin about Jan. 1979, and to end about April 1979; it was also assumed that they would be followed by a period of analysis, evaluation, and more specific negotiations.

- 3.3 Pre-design Analysis: During the time that the initial negotiations were conducted (Dec. 1977-June 1978) some preliminary design and analysis was done, forming a partial basis for this and subsequent negotiations.
- 3.4 Contract Negotiations: Firm contract negotiations by Phillips and energy customers, prior to formulation of firm plans for the plant. It is reasonable to expect that certain negotiations must be completed before applications for certain permits can be submitted (10). It was assumed that contract negotiations would occur from about July-Dec. 1979 and that they must be completed before the application for the siting can be prepared (11), and before further preliminary (conceptual) design will be undertaken.
- 3.5 Financial Negotiations: Firm financial negotiations were assumed to occur simultaneously with the firm contract negotiations (9); same time frames and conditions were assumed to apply.
- 3.6 Loan Guaranty: The loan guaranty negotiations were assumed to be conducted by the plant owner and financial backers (10). The process was assumed to follow the signing of the contract and to require about 6 months for processing, or from about Jan. to July 1980.

4.0 Field Development

- 4.1 Prepare Plan of Development: Prepared by Phillips; includes field development plans; submitted to USGS upon completion. Estimated to require about 9 months for preparation (9); assumed to occur from about April 1979 to about Jan. 1980.
- 4.2 Field Design: The producing field will be designed by Phillips; field design includes siting of producing wells, injection wells, and some of the associated gathering and distribution system, although they are expected to be designed primarily by the plant contractor. Estimated to require about 16 months (9); assumed to be done from about March 1979 to about July 1980.
- 4.3 Development Wells
 - 4.3.1 Production Well Drilling: Contracted and supervised by Phillips includes production wells and injection wells. Estimated to require about 19 months (9); assumed to take place from about Aug. 1980 to about April 1982.
 - 4.3.2 Production Well Testing: Conducted by Phillips; testing is assumed to occur as the wells are completed. Estimated to require about 17 months (9); assumed to begin shortly after the development drilling, from about Dec. 1980 to about May 1982.
- 4.4 Injection System: Assumed to be designed as part of the field design; injection wells assumed to be drilled as part of the development drilling.
- 4.5 Gathering System: Assumed to be designed and constructed by the plant contractor (9); assumed to require about 17 months, lagging the drilling of development wells.

4.6 Field Deliverability Test: Testing should reveal problems and verify the ability of the field to produce the required energy. Design of the field deliverability test is assumed to begin about 3 months before the development drilling is completed; total test is estimated to require about 18 months (9), and was assumed to occur from about Feb. 1982 to about Aug. 1983; completion of the test is assumed to occur shortly before construction of the plant is completed.

5.0 Power Plant

5.1 Preliminary Design: Prepared by plant contractor; conceptual design assumed to follow the signing of the contract, and to incorporate input from reservoir testing and characterization, field design, environmental work, etc.; provides framework for detailed design. Estimated to require 3-5 months (9); assumed to occur from about March 1980 to about June 1980.

5.2 Prepare Plan of Utilization: Prepared by Phillips; assumed to require about one month (9). Plan of Utilization includes plans for the operation, including contracts, royalties, financial arrangements, etc. (1); Assumed to occur about Dec. 1979 and Jan. 1980.

5.3 Prepare Plan of Injection: Prepared by Phillips; defines plans for injection system and presents data. Assumed to incorporate data from reservoir tests and characterization, particularly injection tests; also prepared in conjunction with the field design. Estimated to require about 6 months (9); assumed to occur from about Oct. 1979 to about April 1980.

5.4 Conduct Siting Study and Prepare ROW Application: The siting study and the ROW application will be done by Phillips and were assumed to incorporate extensive data from the environmental base line study, reservoir tests and characterization, contract negotiations, unit negotiations, and other preceding steps. Preparation of siting and ROW application is estimated to last about 3 months (9); assumed to occur from about Dec. 1979 to about March 1980.

5.5 Detailed Design: Conducted by plant contractor; includes detailed plans for the plant construction as they evolve. Assumed to incorporate data from the field design, resource characterization, preliminary design, and other pertinent preceding steps. Detailed design was assumed to begin about 4 months prior to the beginning of procurement of power plant materials, and about 10 months before the beginning of construction (30). An arbitrary span of 22 months was assumed, although in fact the design will continue throughout the construction phase (9, 30). The detailed design was assumed to begin about Nov. 1980.

5.6 Procurement of Power Plant Materials: Conducted by the plant contractor; includes procurement of materials, equipment, and machinery for the power plant. Estimated to begin about 6 months before construction of the plant begins (30); assumed to begin about Mar. 1981; an arbitrary time span of about 18 months was assumed, although this activity will probably continue throughout the plant construction.

- 5.7 Plant Construction: Conducted by plant contractor; includes construction of the power generation plant and associated facilities. Construction was assumed to incorporate input from the detailed design, material procurement, and the necessary permits, particularly the siting permit. Construction is estimated to require about 24 months (9), and was assumed to begin as soon as the siting and ROW were approved, i.e., from Sept. 1981 to Sept. 1983.
- 5.8 Power Plant Start-up and Test: Conducted by plant contractor; estimated to require about 3 months (9); assumed to take place from about Sept. 1983 to Dec. 1983.
- 5.9 Field Operation: Conducted by Phillips, following the plant start-up and test. Estimated to require about 3 months (9); assumed to occur from about Dec. 1983 to March 1984. Followed by operation of the plant and power on line.
- 6.0 Power Transmission Line
- 6.1 Transmission Line Design: Conducted by electricity buyer; includes design of the transmission line. Estimated to require about 5 months (9); assumed to take place from about March 1980, to about Aug. 1980. It appears that a new transmission line will have to be constructed to handle the power from the Roosevelt prospect; however, it also appears that the right-of-way of the old power line will be available for use so that no new right-of-way need be procured.
- 6.2 Procurement of Transmission Line Materials: Conducted by the electrical buyer; estimated to require about 16 months (9). Assumed to take place from about Aug. 1980, to about Dec. 1981. Any Permits required were assumed to be approved during this time.
- 6.3 Transmission Line Construction: Conducted by electrical buyer; estimated to require about 19 months (9). Assumed to end shortly before the completion of the power plant. Assumed to begin about Dec. 1981 and to be completed about July 1983.

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Appendix B

Preliminary Assessment of Agencies and Permits Involved in Geothermal Development in Utah

	<u>Permit</u>	<u>Required Prior To:</u>	<u>Estimated Time For Issuance</u>	<u>Notes</u>
<u>County Agencies</u>				
County Planning Commission (1,2)	Zoning	Depends on county zoning ordinances	Variable	Already accomplished in some counties
County Clerk (1)	Business License	Sale of electricity		
County Commission or Health Department (1,2,3)	Health Code Enforcement Building Inspection	Use of buildings	Varies	
<u>State Agencies</u>				
Division of State Lands (4,5)	Lease State Lands	Exploration or use of lands	Few Days to 2-3 weeks	May be competitive bidding in some cases but that does not significantly increase issue time
	Special Use Permit	Surface disturbance (Construction of plant)	Not known--possibly about 2 months	Has not yet been applied for in Utah
Department of Transportation (6)	Encroachment Permits	Use of state highway lands for utility lines	Few days	Would be necessary for use of or crossing of State Highway Rights of Way with utility lines such as power lines, water mains, sewage pipes etc.
	Oversized Vehicles Permit	Use of highway for oversized vehicles	About a day	
Division of Water Rights (7,8)	Permits for Thermal Gradient Wells	Drilling of thermal gradient wells	Few days to few weeks	Letter of approval
	Permit for Exploratory "Test" Wells	Drilling of exploratory wells	Few days to few weeks	Letter of approval

	<u>Permit</u>	<u>Required Prior To:</u>	<u>Estimated Time For Issuance</u>	<u>Notes</u>
Continued from: Division of Water Rights (7,8)	Notification of Reser- voir Test	Reservoir tests		
	Appropriation of Water	Use of water	6 months or longer	May depend on how fast the developer wants approval
	Production and In- jection Wells			Covered by Appropriation of water if included in the Plan of Opera- tions
Environmental Health Services				
Bureau of Water Quality (3)	Construction Plan Re- view and Permit	Construction	About 2 months	Pre-planning workshop
	Public Water Supply Approval	Use of building	1 to 2 months	
	Draft and Certifica- tion of Discharge Permit (Sanitary)	Use of building	1 to 2 months	In conjunction with EPA which issues the permit
	Liquid Waste Disposal System Approval	Use of building	1 to 2 months	
Bureau of Air Quality (9)	Construction Plan Review and Approval	Construction	About 3 months	In conjunction with EPA
	Discharge Permit	Use of plant	About 3 months	Plant discharges
Bureau of Solid Waste Management (3)	Solid Waste Disposal			
Department of Business Regulation (10)	Certificate of Conven- ience and Necessity or Approval of Contract Between Utility and Electricity Producer	Sale of Electricity	3 to 4 months	Certificate of conven- ience and necessity if utility owns plant; if utility buys power, approval of contract is required

<u>Federal Agencies</u>	<u>Permit</u>	<u>Required Prior to:</u>	<u>Estimated Time For Issuance</u>	<u>Notes</u>
Bureau of Land Management (11,12,13)	Permit for Pre-Lease Operations	Non-surface disturbing exploratory activities on lands not leased by applicant	30 days	Includes geophysical/geological exploration, temperature gradient surveys, etc., 30 day time limit for approval
	Issue Lease --BLM Lands			
	Conducts EAR Conducts KGRA Lease Sales Issues Lease		About 5 months	
			Total: about 8 months (up to 18 months in Utah)	
	Plant Siting Permit	Plant Construction	Not known	None Approved yet
U.S. Forest Service (11,12)	Post-Lease Joint Approval with USGS of Plans of Operation			Site specific
	Special Use Permit for Pre-Lease Operations	Before exploratory activities on lands not leased by applicant	30 days	Includes geophysical/geological exploration, temperature gradient surveys, etc., 30 day time limit for approval
	Issue Lease--Forest Service Lands	Before major exploratory activities	About 17 months or longer	Lease obtains rights to the resources
	Conducts EAR KGRA Land Sales Approves Lease			
	Joint Approval with USGS of Plans of Operation			

	<u>Permit</u>	<u>Required Prior To:</u>	<u>Estimated Time For Issuance</u>	<u>Notes</u>
U.S. Geological Survey	Administers Terms of Lease			
	Approves Permit for Exploratory Activities	Before non-surface disturbing activities	30 days	Includes geophysical/geological activities, temperature gradient surveys, etc., 30 day time limit for approval
	Conducts Site-Specific Environmental Analysis and Approval of Plans of Operation			Plans of operation are site-specific
	Exploration	Before surface-disturbing activities	About 1 year	
	Environmental Baseline Data	Gathering of required 1-year's environmental baseline data	About 3 to 5 months	Must be completed at least one year before Plan of Production is submitted
	Development	Drilling and development of production wells	About 3 to 5 months	Define extent of field
	Injection	Drilling and development of injection system	about 3 to 5 months	
	Utilization	Construction of power plant	about 3 to 5 months	Sundry notices submitted for each phase. Includes contract and royalty breakdown.
	Production	Use of the resource for power production	about 3 to 5 months	Includes production data from wells and target date for completion
	Changes in Plans of Operation	Before implementation of changes in plans of operation	A few months	Sundry notices

	<u>Permit</u>	<u>Required Prior To:</u>	<u>Estimated Time For Issuance</u>	<u>Notes</u>
U.S. Environmental Protection Agency	Certify Air Discharge Permit		About 90 days	Air, water, solid waste permits are in conjunction with State Environmental Health Agencies.
	Issue Water Permit		About 90 days	
	Issue Solid Waste Disposal Permit		About 90 days	
	Review of EIS			
U.S. Fish and Wildlife Service	Advisory			Consults on lease sales (competitive and non- competitive), pre-lease and post-lease environ- mental analyses.
U.S. Department of Energy	Financial Assistance			
	State Cooperative Program			
	Industry Coupled Case Study Program			
	Loan Guarantee Program		About nine months	
	Demonstration Pro- grams		About nine months	
	Development of Lease Stipulations			
	Issuance of Lease			

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