



G.R.I.P.S. COMMISSION

CALIFORNIA JOINT POWERS

RST STREET, NAPA, CALIFORNIA 94558,

MASTER

GRIPS PLAN

July 31, 1978

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GRIPS PLAN

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FOREWORD

PLAN IS PROCESS. This GRIPS PLAN is therefore only one step in a series of activities which together will become the orderly plan for the development of an effective environmental data base for use by the counties of Lake, Mendocino, Napa and Sonoma, the State of California, and the United States Federal Government in making specific decisions about the possible development of geothermal resources in The Geysers-Calistoga Known Geothermal Resource Area. The plan, as it is reported herein, is based on an objective assessment of available data and suggests elements dealing with data acquisition, public participation, and administration of these efforts.

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Part one:

SUMMARY AND INTRODUCTION

SUMMARY

INTRODUCTION

The GRIPS Commission was established by a Joint Powers Agreement between the California Counties of Lake, Mendocino, Napa, and Sonoma on February 7, 1978 after nearly four years of increasingly formal planning. The objectives of GRIPS are primarily to develop and use a cooperative environmental data collection and use system including natural, social, and economic considerations to facilitate ther independent decisions and those of State and Federal agencies related to the environmental effects of geothermal development. This GRIPS Plan was prepared from a wide range of studies, workshops, and staff analyses. The plan is presented in four parts:

PART ONE: SUMMARY AND INTRODUCTION

PART TWO: ENVIRONMENTAL DATA STATUS REPORT

PART THREE: PLANNED PROGRAMS

PART FOUR: BUDGET

DATA AVAILABILITY AND RESEARCH NEEDS

A survey of the adequacy of existing environmental data to meet the needs of the four counties indicates that the following listed data gaps exist and are of relatively high priority to meet the needs of decision makers associated with geothermal development in the counties:

High Priority Issues:

Hydrogen Sulfide Emmission Control Noise Control Land-Use Conflicts Landslides and Soil Erosion Rare and Endanagered Species

Medium Priority Issues:

Data and Information Storage
Hydrogen Sulfide Effects on Agriculture
Long Term Ecosystem Effects
Fiscal Impacts
Cooling Tower Drift Effects
Economic Impacts
Demographic Impacts
Groundwater and Hot Spring Degradation

Lower Priority Issues:

Health Effects of Hydrogrn Sulfide Accidental Spills Water Resources Management Parciculate Emissions Subsidence and Seismicity Noise Effects on Wildlife Weather Modification

DATA ACQUISITION PROGRAM

The GRIPS data acquisition and data management program consists of five elements. These elements, which are described in more detail in the following sections, are:

<u>Data Acquisition Projects</u>: GRIPS will prepare a list of priority projects to support or participate in research activities to fill identified environmental data and technological needs;

Region-Wide Environmental Assessment Projects: GRIPS will establish appropriate procedures for, and will develop the capability to produce, a Master Environmental Assessment for the Geysers-Calistoga KGRA. GRIPS will also develop the capability to produce the EIRs and EISs need for geothermal development in the four counties;

Mitigation and Technologic Projects: GRIPS will suggest a series of recommended projects needed for filling the existing data gaps related to those geothermal development problems which have adverse environmental consequences;

Research and Data-Gathering Coordination: GRIPS will seek cooperative programs with Federal, State and other local government agencies as well as with private industry, the general public, and academia to coordinate research efforts; will establish formal contracting procedures; will serve as a Committee for quality control of research in the region; and will serve as the regional program integration body; and

Data Base Management: GRIPS will use existing library facilities to handle the initial data base management, and will explore the suitability and feasibility of the development of a specific GRIPS computerized data base management system to accomplish the above purpose.

PUBLIC PARTICPATION PROGRAM

GRIPS' ultimate success will be measured by how well it provides essential information needed by local, state, and federal decision makers, and by how well it satisfies the concerns of industry and citizen groups. GRIPS will continue an active program for the identification of the various affected publics using both mass and focused (key-group) approaches. Citizens involvement will be accomplished through the establishment of a permanent Citizens' Advisory Council to the GRIPS Commission which will also have the capacity to assemble Citizens' Study Committees as temporary bodies to study special technical matters or geographic areas. A variety of communication means will be incorporated into the program including: public education, libraries, and schools; the media; open telephone channels; mailing lists; newsletter and questionnaires; and public announcements. The effectiveness of all communication efforts will be assessed annually. Initial public involvement efforts are planned for:

review of the GRIPS PLAN,
review of GRIPS operations,
periodic review of GRIPS progress, and
review of GRIPS research projects.

ADMINISTRATIVE PROGRAM

GRIPS will be staffed to support the Joint Powers Agency. The functions of the organization will be as follows:

GRIPS Commission: one elected county supervisor selected from each of the four counties formulate and accomplish GRIPS policies;

Citizens' Advisory Council: representatives of identified citizen groups to serve as a forum for the discussion of issues and the evaluation of research work. The Citizen Advisory Council is appointed by and is advisory to the GRIPS Commission; and

Executive Director: an employee selected to manage the day-to-day operations of GRIPS and directly responsible to the commission;

Staff Advisory Committee: one or more staff members from each county and associated Federal or State agencies to provide advice to the Commission and Executive Director.

The Executive Office of GRIPS, to be located in one of the member counties, will consist initially of a 3-person staff: Executive Director, Secretary/Office Manager and clerk-typist.

BUDGET

The estimated budget for GRIPS administrative operations, assuming a phased hiring program, is estimated as: \$111,100 for FY 1978-79; \$153,900 for FY 1979-80; \$154,140 for FY 1980-81; \$159,900 for FY 1981-82: and at approximately the same level for FY 1982-83. Estimated research budgets are discussed in the technical sections of the plan.

CHAPTER I: INTRODUCTION

On February 7, 1978, a Joint Powers Agreement was entered into by the four California Counties of Lake, Mendocino, Napa, and Sonoma for the creation of an entity to prepare a "Geothermal Resources Impact Projection Study" (GRIPS). That entity, which is governed by the "GRIPS Commission" was created as part of a series of efforts by the counties, both singly and together, to prepare for the future possible expanded development of the geothermal resources of the Geysers-Calistoga Known Geothermal Resources Area (KGRA)*. This report presents the initial plan of operations for GRIPS.

A. OBJECTIVES

As specified in the Agreement, the objectives of the GRIPS Commission are four-fold:

To document and integrate the interests of Federal, State, and local agencies in planning the development of a common information base for integrated assessment of geothermal resource impact projections;

To develop a specific management structure and technical plan for creating, assembling, and utilizing a common information base;

To implement the common information base and integrated assessment system for geothermal resource impact projections; and

To create a system to make data available for coordinated policy determination and decision making among governmental jurisdictions.

Furthermore the Counties agreed on the following operational objectives for development and use of the common information system:

To improve the basic methodology of determining the proper balance between environmental consequences, social needs, energy demands, land-use policies, and the allocation of costs, revenues, benefits and responsibilities;

^{*}Unless otherwise indicated "KGRA" will mean The Geyses-Calistoga KGRA throughout this report.

To create a method to improve the evaluation of environmental consequences;

To reduce the costs and time for compliance with Federal, State, and local environmental legislation; and

To utilize skills, facilities, and equipment available within the member entities to optimize the combined effort as well as to maximize the utility of the common information base and system for use by the individual member entities for their own unique uses.

B. SCOPE

This document, the GRIPS PLAN, presents a status report on the availability of needed environmental data and a series of programs for additional data acquisition, for citizen involvement, and for the administration of GRIPS. A preliminary budget for the programs is included. It is not intended that the suggested program be the final plan; indeed since it is evident that plan is process, this report should be considered as only one is a series of continuously evolving steps that together will constitute the GRIPS PLAN. This report is only one of a sequence of events which have already occurred, and which will continue to take place as the GRIPS programs are implemented.*

C. LIMITATIONS

The present plan is limited to the work reflected in the five areas discussed in the following paragraphs:

The Geysers-Calistoga geographic region;

Previous Reports;

GRIPS/LLL and GRIPS workshops;

Budgetary support and in-kind contributions; and

Personnel and Consultants.

^{*}For a chronology of the development of GRIPS, the reader is referred to the County of Lakes, Planning Department, staff file on "GRIPS Historical Mileposts."

1. The Geysers-Calistoga Geographic Region

The region designated as The Geysers-Calistoga Known Geothermal Resources Area (KGRA) is the focal point of the GRIPS PLAN. Officially the entire counties of Lake, Mendocino, Napa, and Sonoma fall within the scope of GRIPS. By mutual understanding, however, the actual planning area is focused on the KGRA and related areas as delineated in the Figure I:1.

2. Previous Projects

GRIPS and some of the staff members of the associated counties, sponsored or participated in the preparation of several projects, the work and reports from which have been used for the development of portions of the GRIPS PLAN. The key projects, which are included herewith by reference, were:

"Research Proposal: Environmental Implications of Dry-Steam Geothermal Development"; Tetter-proposal dated July 11, 1974 to N.S.F., Advanced Energy and Technology Division, from Ignazio A. Vella, Chairman, Sonoma County Board of Supervisors.

Geothermal Resource Impact Projection Study (GRIPS), "Planning Document," January 9, 1978; by Sociotechnical Systems, Inc., including a comprehensive bibliography provided separately and to be published by GRIPS;

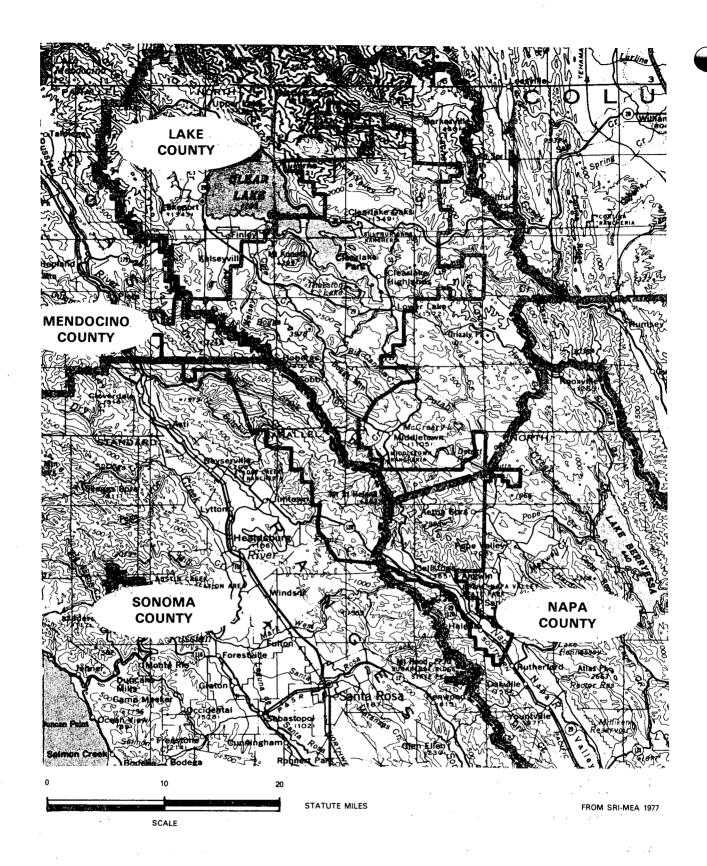
GRIPS Air Pollution Study Flan, February 1978; by Fayne Tucker et al, Lake County Air Pollution Control District;

GRIPS Plan Report, April 3, 1978; edited by Thomas Cordill, Environmental Coordinator, County of Sonoma; and

GRIPS Plan Report, June 15, 1978; edited by Thomas Cordill Volume I: Text and Volume II: Appendices.

3. GRIPS/LLL and GRIPS Workshops

Concurrent with the GRIPS effort, the Lawrence Livermore Laboratory of the University of California (LLL) is preparing "An Overview of



THE GEYSERS-CALISTOGA GEOTHERMAL AREA

Environmental Issues: The Geysers-Calistoga KGRA" as part of a separate contract for the Department of Energy (DOE). The results of their work were published in a preliminary draft for review purposes on February 28, 1978 and is currently being edited for general circulation through DOE.

As part of the combined effort, a series of joint GRIPS/LLL workshops were conducted on important environmental topics related to geothermal development in the Geysers-Calistogia KGRA. The purposes of each workshop were to:

identify baseline environmental data availability, determine environmental data needs,

assess available data collection methodologies to fill the needs; and recommend data collection programs and methodologies.

Joint GRIPS/LLL workshops were held on the following subject areas: air quality, ecosystems, water quality, geology, noise, health effects, and socioeconomics. The LLL Overview Report on their project and the individual workshop results were used as basic reference documents for the technical section of this plan.

In addition to the combined workshops, GRIPS held a series of public workshops, one in each of the four member counties during the period October 24 to November 3, 1977. The purpose of the workshops was to ask for the assistance of local residents and local organizations in identifying the issues and objectives of GRIPS. The results of the public workshops appeared as in Appendix D of the aforementioned "Planning Document" by Sociotechnial Systems, Inc.

4. Budgetary Support and In-Kind Contributions

To the present time, the GRIPS effort, and that of the preceding activity, sponsored by the County of Lake, has received the following financial support:

County of Lake for Phase "O", pre-planning study support for formalization of a specific proposal for GRIPS for presentation to the four counties: \$10,000;

Department of Energy (formerly Energy Research and Development Administration) grant for Phase I planning and program development: \$20,000 (Grant No. EG-77-G-03-1566); and

California Energy Commission (aka California Energy Resources Conservation and Development Commission) contract for Phase I planning and program development: \$30,000 (File Number 500-073).

In-kind support services by the four counties during the Phase I effort (\$10,000) and during the period from May 1, 1976 through July 15, 1977 totalled approximately \$32,400. Since July 15, 1977 the counties have contributed extensively through staff and Board of Supervisors involvement and miscellaneous services.

D. PERSONNEL AND CONSULTANTS

The GRIPS PLAN is not a product of any one person or a single group; it is the combined result of the Commission as a whole, its consultants, and the staff members associated with the individual counties. The GRIPS Program concept was originated by Lake County in May 1976 through the principal efforts of Glen Spencer, Sociotechnical Systems, Inc., and Don Johnson, Lake County Planning Director. Since that time, the concept and organization has changed and grown to include the following individuals:

GRIPS COMMISSION:

Dr. Dowell Martz, Chairman

Napa County Board of Supervisors, Chairman

Will Johnson

Chairman
Sonoma County Board of Supervisors

Robert M. Jones

Jim Eddy / Ted Galletti

Susanne Reed / Dr. Evan Hughes Art Follette

Lake County Board of Supervisors,
Chairman
Mendocino County Board of
Supervisors
California Energy Commission
Department of Energy, Division of
Geothermal Energy, Pacific
Region Team

GRIPS PROJECT COORDINATOR:

Tom Cordill May 1977 - Sept. 1977

Dr. James Roberts Sept. 1977 -

April 1978

Jim Hickey April 1978 - present

Sonoma County Planning

Consultant

Napa County Planning Director

GRIPS STAFF ADVISORY COMMITTEE (principal members):

Stephen Rae
Jerry Heath
Tom Cordill
Larry Vollintine
Dave Hill / Dr. Robert Giacosie
Thomas Heenan

Napa County Planning
Mendocino County Planning
Sonoma County Planning
Lake County Planning
California Energy Commission
Department of Energy, Division of
Geothermal Energy/SAN

In addition, many other individuals have been directly involved in assisting the development and success of the GRIPS Program. Special thanks is extended to:

Mike Tolmasoff Fayne Tucker

Debra Watt

Mark Walters
Robert L. Bridges
Franab Chakrawarti
Robert Nelson
Nan Aurich
Don Elmer

Art Wilbur

Mary Jadiker Cynthia Bickford

Northern Sonoma Co. APCD Lake County Air Pollution Control District Lake County Air Pollution Control District Lake County Planning Lake County Counsel Sonoma County Planning Director Napa County Planning California Energy Commission Department of Energy, Division of Geothermal Energy / Washington Department of Energy, Division of Geothermal Energy / SAN Lake County Energy Council Sonoma County Staff Consultant

Sections of the GRIPS Plan included herein are essentially the work of the individuals listed in Table I:l plus many other contributors. General editing has been done by Tom Cordill, Dr. James A. Roberts, and Dr. Robert Giacosie. For more detailed content and recommendations of each section, the reader is urged to contact the GRIPS staff or Chairman to arrange to review the full draft of the materials prepared by the individuals and used for this report.

TABLE I:1

PRELIMINARY CONTRIBUTORS TO GRIPS PLAN

Section

Principal Author or Editor

Other Contributors

General Summary &

Introduction:

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to GRIPS

Air Quality:

Fayne Tucker, LCAPCD

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Mark Walters, Lake Co. Planning

Terrestrial Biology:

Dr. Phil Leitner, St. Mary's

Stephen Rae, Napa

Aquatic Biology:

College

Co. Planning

Agricultural Ecosystems: Dr. Robert Giacosie, CEC

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Research Priorities:	Don Ermak, LLL Dr. Robert Giacosie, CEC	
Data Acquisition & Management:	Dr. James Roberts, Consultant Glenn Spencer, Sociotechnical Systems Consultant to GRIPS Tom Cordill , Sonoma Co. Planning	
Master Environmental Assessments:	Dr. Robert Giacosie, CEC	
Public Participation Program:	Connie Wade, Sociotechnical Systems, Consultant to GRIPS	
Administration Program:	Dr. James Roberts, Consultant	
Budgets:	Dr. James Roberts, Consultant	

E. PLAN ORGANIZATION

As indicated in the statement of Scope, the plan is presented in four parts. Those parts, with individual chapters are:

Part One: Summary and Introduction

Summary: a brief summary statement of the GRIPS PLAN:

Chapter I: Introduction: this introduction to the plan;

Part Two: Environmental Data Status Report:

Chapter 2: Environmental Data Availability and Needs: a statement of the availability of data, recommended studies, and preliminary estimates of costs associated with each substantive environmental area. It must be noted that all cost figures are broad estimates not yet reviewed by the full GRIPS organization;

Chapter 3: Priorities for Data Acquisition: a preliminary assessment of the data needs and priorities and discussion of a methodology for future prioritizing of data needs;

Part Three: Planned Programs:

Chapter 4: Data Acquisition and Management Program: a discussion of projects for data acquisition, region-wide environmental assessment, mitigation and technology, research and data-gathering coordination, and data base management;

Chapter 5: Public Participation Program: a discussion of the GRIPS program for public involvement in the planning and subsequent GRIPS activities;

Chapter 6: Administration Program: the delineation of the organization, personnel, location, and facilities for management of GRIPS; and

Part Four: Budgets

Chapter 7: Budgets: a brief outline of the Budgets for GRIPS initial five years of operations.

Part two:

ENVIRONMENTAL DATA STATUS REPORT

CHAPTER II: ENVIRONMENTAL DATA AVAILABILITY AND NEEDS

This chapter presents the results of a series of reviews of the environmental data on the KGRA. While there are some variations in internal format, primarily because of the varied approaches taken by the different authors noted in the preceding chapter, each section contains three essential elements:

a review of the adequacy of and needs for available data;

a set of recommended studies to fill identified data gaps; and some very preliminary estimates of the ranges of costs for the recommended studies.

The chapter is presented in ten sections dealing with:

air quality,
water quality,
terrestrial biology,
aquatic biology,
agriculture,
geology,
noise,
archaeology,
health effects, and
socioeconomics.

These ten topics obviously are not independent and mutually exclusive, hence these discussions often over lap to the point of being repetitive.

A. AIR QUALITY

Orderly development of the geothermal potential available in the GRIPS region requires careful consideration of the impact of the activity on air quality. Research in abatement procedures is continuing but the development of fully effective systems in the immediate future is doubtful. In the meantime, sufficient information and understanding of

meterology and air quality must be developed to allow the appropriate regulatory agencies to control adequately the increased drilling and construction activity planned in the area without serious impact on the surrounding air environment.

The principal air quality pollutant of concern in the Geyser's area is Hydrogen Sulfide (H₂S) from cooling tower operations or natural seeps. Many odor complaints have been recorded in the area as the result of increased public awareness as well as increased development activity. Releases of aerosols, their chemical characteristics, and the potential weather modification effects of cooling towers are future parameters which also must be considered.

l. Available Data

The GRIPS area is severely data-limited in terms of available information for the assessment of potential air quality impacts. In addition, the terrain is complex and simple Gaussian diffusion models are frequently not adequate to predict in advance the air pollution associated with full field development.

The meteorological and air quality data network in the GRIPS area consists of ten full air quality stations, eight of which were established in the spring of 1976 by Stanford Research Institute (SRI) and operated for the Pacific Gas and Electric Company (PG&E) and participating steam developers. Only a small portion of the total GRIPS area is covered by the SRI network.

In late autumn 1976 a total of 18 weather stations were established by the Lake County Air Pollution Control District to monitor regional

ground based meteorological regimes in the area. These stations provide observations of temperature, wind speed, and wind direction but do not include air quality. This network extends into Napa, Sonoma, Mendocino, Colusa, and Yolo Counties in addition to the stations in Lake County.

The balance of the air quality or meteorological observations in the area come from individual locations and cover brief, unrelated periods as required by specific developers and local interests. These observations together with the longer-term, more consistent records are being inventoried, assembled, and analysed in a study supported by an association of steam developers in the area (Geysers Geothermal Environmental Committee). The available air data for the GRIPS region are presently being integrated into coherent analyses of the air quality and meteorological characteristics of the area in sufficient detail for adequate impact assessment using three dimensional modeling.

2. Recommended Studies

An air monitoring program is recommended that recognizes the need for maintaining and supplementing the existing air quality and meteorological monitoring networks. The available data must then be integrated and interpreted into terms suitable for the requirements of environmental impact assessment both for individual and cumulative analyses. Finally, predictive models should be developed which will permit the impact projection of potential releases from future developed sites. The purpose of the study program is to provide the data base and general understanding needed so that individual developers and regulatory agencies will have sufficient information upon which to base sound development decisions.

Particular attention has been given in this proposed study to those topics whose immediate urgency is such that work must be carried out and preliminary information obtained during the first year of the program. Other topics which are considered important but not as time-critical are included as later phases of the program. In many cases, the relative importance of some of these latter topics may become more significant as additional knowledge of the area is gained during the first year of the program. The priority topics to be considered in the first year are:

Regional Meteorology Studies: analyses of existing data from the region surrounding the GRIPS area to understand better the large scale meteorological processes which control the local meteorology in the GRIPS area;

Local Meteorology Studies: analyses of existing data within the GRIPS area to develop a detailed, local understanding of flow patterns and diffusion and to identify significant gaps in the knowledge of the local meteorology;

Expanded Micro-Meteorological Network: continuation and expansion of existing wind and temperature network to obtain longer climatological records and to answer questions raised during the Local Meteorology Studies;

Expanded Air Quality Network: continuation and expansion of air quality network to obtain better spatial coverage and a longer period of observational records for model validation. A well-conceived quality assurance program must be followed in this task;

<u>Field Tracer Studies</u>: performance and analysis of detailed tracer studies to obtain specific concentrations from releases at potential development sites;

Rough Terrain Air Dispersion Modeling: continuation of on-going modeling studies and evaluation of potential for use of predictive models in the GRIPS area; and

<u>Data Bank</u>: development or utilization of an appropriate data bank to make these data available to potential users. Where possible, all data should be stored on magnetic tape. A separate more sophisticated computer will be required for data manipulative purposes.

The topics which are considered to be of importance in developing a thorough evaluation of the impact of geothermal development activity but which are of somewhat lower priority are:

Source Emission Inventories: evaluate existing source data and information to be acquired during the next year. Develop, if needed, a methodology for accurate source testing of wells, steam-by-pass and cooling tower operations. Consider development of continuous monitoring systems for those operations;

<u>Aerosol Chemical Analysis</u>: analyze aerosols generated by the geothermal activities for mass concentration, chemical content, and potential impact on the environment;

Cooling Tower Effects: analyze effects of cooling tower operations through weather modification and local drift drops;

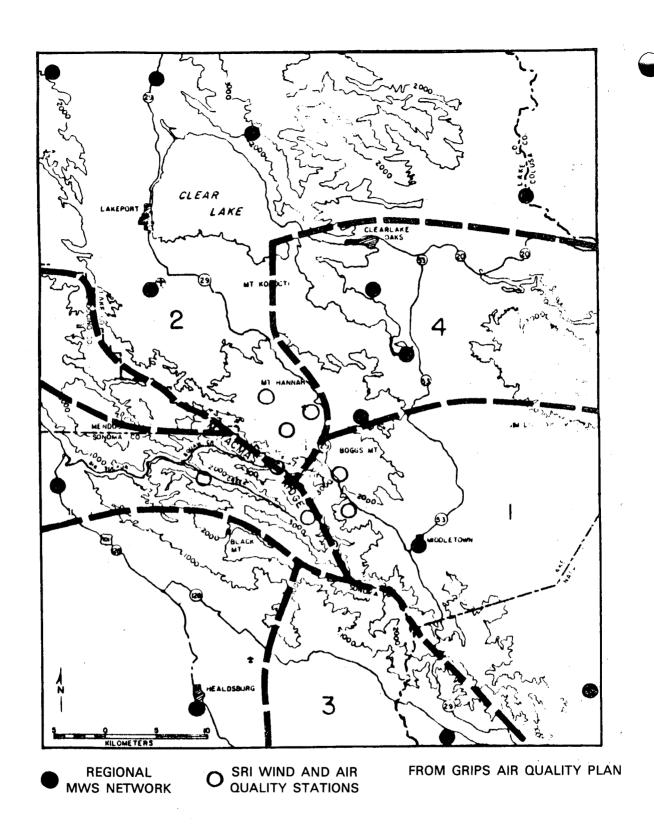
Wind Tunnel Modeling Studies: evaluate and utilize, if desirable, wind tunnel modeling studies to evaluate wind flow characteristics in the GRIPS area; and

Effects on Mammals (Including Human's) and Vegetation: investigate effects of low levels of H₂S on mammals and vegetation in the area.

The first year of the proposed study should concentrate on the high priority items above. During the second year those topics would be continued as necessary but additional topics from the lower priority list would be initiated wherever deemed appropriate.

In view of the geographical extent and complexity of the GRIPS area, a phased approach is recommended with priority being given to a few site-specific, "sub-regions" where more intensive analysis should be concentrated first. All sub-regions should have minimal analytic coverage while the priority regions should have more detailed coverage. The advantages of the phased approach are:

priority areas will be studied first since they represent areas where maximum permitting delayed acceptance or rejection might otherwise be expected;



GRIPS AIR QUALITY SUB-REGIONS

phasing offers maximum flexibility to alter subsequent studies based on knowledge obtained in the previous phases. This leads to higher quality and more cost effective studies;

phasing allows for evaluation of the analytical system to be of most generic value, a fact which is recognized by funding agencies; and

studies can be concentrated on those specific priority parameters necessary for environmental reports and permit decisions.

Criteria for selection of priority sub-regions are the following:

development potential in the subregion;

proximity to population; and

terrain and meteorological heterogeneity.

Figure II:1 shows the proposed division of the GRIPS area into sub-regions. Regions 1 and 2 represent the top priority areas from the standpoint of development potential and population proximity. The present study describes a one year program which will be required to define adequately the detailed air quality/meteorology characteristics of these two areas together with a more general understanding of the remaining sub-regions. During the second year, sub-regions 3 and 4 will be considered in detail. A third year is recommended to complete the analyses of the remaining sub-regions.

The proposed study will provide a thorough and complete background and analysis of the air quality impact problem in the GRIPS area and will provide the data resources necessary for potential developers and regulatory agencies to evaluate potential site-specific development plans.

3. Preliminary Budget Estimates

The preliminary estimated budgets for the proposed studies are presented on Table II:1.

TABLE II:1 ESTIMATED BUDGET SUMMARY, AIR POLLUTION STUDIES

ITEM - High Priority Studies	<u>lst Yr.</u>	2nd Yr.	3rd Yr.	4th Yr.
A. Regional Meteorology Studies	\$ 50,000	_	_	-
B. Local Area Meteorology Studie	es 52,000	- .	_	_
C. Air Quality Summary	11,000	_	_	_
D. Source and Emissions Inventor	ries 15,000	?	?	?
E. Air Monitoring Program (and				•
quality assurance program)				
Purchase or acquisition	of			
eight (8) additions	a1 ·			
air quality station	ıs,			
and expanded comput	ter			•
capability	615,000	_	-	
Operation, Maintenance				
and Field Work of	existing			
8 SRI stations (con	ntinuation)			ε
and 8 newair qualit	y stations			
(total 16).	425,000	425,000	425,000	425,000
Including data capt	ture,			
analysis and comput	ter			•
printout and retrie	eval.			
Acquisition of 15 additi	ional			
meteorology station	as 45,000	-	-	-
Digitizer Analysis				
(one person full ti	ime) 12,000	12,000	12,000	12,000
Quality Assurance*	80,000	60,000	60,000	60,000
All aerometric data	1			
including source	•			
testing data.				
Technical Data Managemen	<u>nt</u>			
(Consulting Services)	20,000	20,000	20,000	20,000
Maintenance & Operation				
(33 metrol. stations)	68,000	58,000	58,000	58,000

^{*} The quality assurance program might better be budgeted to include all analytical data (such as water or land).

ITE	<u>EM</u>	lst Yr.	2nd Yr.	3rd Yr.	4th Yr.
F.	Special Field Tracer Studies				
	Data Analysis	97,000	97,000	65,000	?
	Field Effort	177,000	177,000	80,000	?
G.	Dispersion and Airflow				
	Modeling	140,000	75,000	75,000	?
	Includes				

Includes:

Continuation of on going "NEWEST" (Impact/Depict Model) rough terrain modeling since limited comparison with field tracer studies has shown some promise of becoming a practical tool to assess proposed power plant impacts.

A model evaluation and design study for a thorough objective analysis of the potential use of models for predictive impact assessment.

Н.	Interpretation and Presentation				
	of Results	60,000.	60,000	60,000	60,000

Total \$1,867,000 \$ 984,000 \$ 855,000 \$ 635,000

ITE	M: Medium Priority Studies	lst Yr.	2nd Yr.	3rd Yr.	4th Yr.
A.	Source Emissions Inventory Field				
	Studies	-	70,000	?	?
В.	Aerosol Chemical Analysis	-	50,000	-	-
C.	Cooling Tower Effects on Weather				
	and Vegetation	-	60,000	-	-
D.	Wind Tunnel Modeling Studies	-	30,000	10,000	10,000
E.	Effects of Low Levels of Hydrogen				
	Sulfide on Mammals and Plants	70,000	-	-	-

Total 70,000 210,000 10,000 10,000

Grand Total \$1,937,000 \$1,194,000 \$ 865,000 \$ 587,000

B. WATER QUALITY

GRIPS has not yet finalized its analysis of the adequacy of environmental data related to water quality. The following information, therefore, may be subject to substantial revision in the forthcoming months, particularly when the final results of the GRIPS/LLL workshops are published* The following paragraphs should be considered for preliminary evaluations. Some of the key issues regarding water quality have been included in the discussion of research priorities because they were also considered in the sections on terrestrial biology, aquatic biology, and agricultural ecology. No costs have been developed to date for the recommended water quality studies.

The five issues which emerged in the workshop are:

erosion and sedimentation; accidental spills; cooling tower drift deposition; groundwater use and contamination; and hot water-dominated (as compared to steam-dominated) resource development

1. Available Data

a. Erosion and Sedimentation

As noted in report on the LLL/GRIPS workshop, considerable background information on the soils of the KGRA are summarized in Freeman, et al* including the general distribution of soils with a high erosion potential.

^{*}R.E. Freeman, R.K. White, L.A. Cavanaugh, K.M. Clark, D.T. Dick, M. Duffey-Armstrong, B.R. Halt, M.E. Ivory, C.A. Kroll, S.J. Mara, D.R. Myers, S.R. Pierce, R.E. Ruff, J.M. Steinberg, B.L. Walton, and D.R. Zoellner, Environmental Analysis for Geothermal Environmental Assessment, (Stanford Research Institute, Menlo Park, California 94025) State of California Energy Resources Conservation and Development Commission (1977).

The Mayacmas Mountains region, which consists almost entirely of these erodible soils, is the primary location of existing geothermal resources developments. The large geographic extent of erodible soils and the disturbance of soils caused during all phases of development indicate the scope of potential erosion problems and, therefore, its prominence in being identified as a problem.

Erosion and transport of soil materials into streams can have consequences for a variety of downstream users. Most notably, siltation may affect fish and other aquatic animals, especially if sedimentation alters spawning substrates. In addition, increased turbidity may be detrimental to municipal, agricultural or industrial users downstream. Where persistent siltation occurs flooding problems may be aggravated.

Short-term studies have not demonstrated measureable impacts on downstream water users. Long-term comprehensive studies on sedimentation and erosion have not been conducted. Therefore, cumulative effects cannot be evaluated or predicted at the present time.

b. Accidental Spills

Discharge to water-ways of any waterborne wastes or stream condensate is prohibited in the Geysers-Calistoga KGRA. However, pollution incidents do occur because of equipment failures or malfunctions, natural catastrophes, human errors and other such cases. Four well blowouts have occurred at The Geysers. Sump failures, pipeline leaks, and vehicle accidents can also occur.

The North Costal Regional Water Quality Control Board reports 21 accidental spills in the Geysers area during the last four years.

Accidental spills have led to occasional fish kills and steam condensates can be toxic to fish species. However, no permanent damage by accidental spills to aquatic species or water quality has been documented.

c. Cooling Tower Drift Deposition

Water droplet emissions from cooling towers contain many of the constituents found in the original condensate. Water droplets which settleout of the plume leave deposits of materials such as boron, ammonia, and heavy metals on soil and vegetation surfaces. These materials can be transported by runoff into surface and groundwaters leading to contamination of these waters. The constituents of primary concern are boron, ammonia, and heavy metals.

PG&E reports that the cooling towers are being designed to produce drift of no more than .008% of the total cooling tower flow and measurements suggest that .004% has actually been achieved in the field. However, these apparently low values do not guarantee prevention of water quality problems. The total emissions may still be significant and little is known about the actual magnitude and chemical form of the contaminants actually emitted from a tower. Distribution, chemistry, and fate of droplets and their constituents needs to be better understood to assess the need for and effectiveness of mitigating measures. Such information is likely to be highly site specific and dependent on local atmospheric precipitation, and soil conditions for a particular cooling tower and its particular condensate.

d. Groundwater Use and Contamination

Problems related to groundwater were discussed at the LLL/GRIPS Water Quality Workshop, particularly potential problems in aquifers in the undevelopment hot-water resource area north and east of the current Geysers production field.

Existing regulations governing reinjection are apparently effective in preventing communication between geothermal fluids and groundwater basins under normal operating conditions. Accidental spills, leaks, well blowouts, and cooling tower drift deposition are all possible sources of effluents which could eventually affect groundwater through percolation. However, in the area developed to date at The Geysers, no known cases of groundwater contamination from geothermal activities have been reported. However, in the hot-water-dominated resource, where many more aquifers exist that are used both for domestic and agricultural water supplies, greater sensitivity to the potential for contamination of shallow groundwater resources by geothermal development will be required.

Overdraft of groundwater reservoirs for geothermal development also is of concern. Certain developers have contracted with local ranchers and property owners for groundwater from wells for mixing of drilling muds and road construction. Small perched groundwater bodies and small aquifers in small alluviated basins have been depleted of their groundwater supplies by such pumpage and not recharged due to the drought in California. This could also affect the water quality in those aquifers. In particular, the question arises as to whether or not overdraft can induce recharge from geothermal sources.

e. Hot-Water-Dominated Resource Development

Most known geothermal resources are of the so-called hot water dominated type rather than steam-dominated, of the sort currently being developed at The Geysers. Although only steam-producing reservoirs have been developed to date at The Geysers, data collected by the USGS and others suggest extensive hot-water-dominated reservoirs exist in the KGRA.

Little information exists in print regarding the size and extent of the hot water resource that is suspected to stretch from the stream field at The Geysers northward and eastward to Clear Lake and beyond. Also, little is known quantitatively about the surface water and groundwater in this region. Little baseline data exists for trace metals which may be important if high salinity brines are encountered in drilling geothermal wells. For these reasons, regional studies were suggested to document the surface water and shallow groundwater hydrology of this area, and to characterize the energy, nature, and extent of the hot water resource itself. Before even cursory knowledge of the magnitude and extent of the resource is known, little can be done in planning for rational water quality management as development of the hot water resource proceeds.

2. Data Adequacy

A difficulty that arises in evaluating the adequacy of available evaluating data is that we never have complete, perfect knowledge about a particular problem. So, it is always possible to identify studies that could be undertaken to reduce uncertainty, to fill in data gaps. The question we should ask is: Is this information useful to water quality managers? Management decisions must always be made in the face of

uncertainty. What additional information is likely to enhance the effectiveness of management actions? The data needs described below are suggested in response to this question. Innumerable other programs of data collection and analysis could be suggested. However, they are not presently perceived as contributing substantively to water quality management in The Geysers-Calistoga KGRA. We have relied heavily on input from workshop participants to identify information needs.

3. Recommendations

The recommended studies are based on the apparent magnitude and importance of related water quality problems, the degree of concern expressed during the water quality workshop, and the extent to which present studies are attempting to address the need for information.

a. Hot-Water-Dominated Resources

A great deal of uncertainty and concern exists regarding hot water resource development in The Geysers-Calistoga KGRA. Water use and disposal and effects on existing water uses (hot springs, surface water, and groundwater) are virtually unknown. Until the extent and development potential of the hot water resource is known, little can be said to reduce uncertainties and alleviate concerns about potential development. Therefore, four recommendations are made involving development of the hot water resource:

collect and analyze sufficient data to estimate the extent and nature of the hot water resource;

obtain sufficient data concerning the hot water resource and the energy conversion technologies that are likely to be used in its development to predict future cooling water requirements, effluent volumes, and effluent chemical characteristics;

collect and analyze sufficient data to establish baseline conditions in the water environment of the hot water resource area; and

conduct studies to determine transport and fate of chemicals in soil, sediment, and water storage compartments of the environment before development proceeds, including effects caused by naturally occurring geothermal activity.

b. Steam-Dominated Resources

With respect to steam-dominated resources, successful mitigating measures do exist and the existing management practices, in spite of certain difficulties, have been successful in reducing water quality problems during the past ten years. Therefore, most agreed that studies in this area should not be given first priority. However, the studies suggested below can help resolve existing controversies and help quantify the extent and magnitude of certain potential impacts. Therefore the following studies should be considered and ranked with others to determine this appropriate priority:

measure and analyze plume drift contributions of boron, ammonia, mercury, and arsenic to soil and vegetative surfaces;

measure accumulation of these chemicals in soils near cooling towers and compare with areas nearby not affected by cooling tower drift;

make measurements or collect existing data to estimate chemistry of geothermal fluids involved in accidental spills that have occurred in the past at The Geysers;

measure present levels of boron, ammonia, mercury, and arsenic in soils affected by those spills in order to assess long term effects;

conduct laboratory soil transport studies with representative fluids and soils to calculate transport coefficients; and

develop guidelines and criteria for the design of field studies to differentiate natural and development-related contributions to water quality.

C. TERRESTRIAL BIOLOGY

The key issues in terrestrial biology are (a) to assemble an adequate baseline of data on terrestrial ecosystems, (b) to determine the impacts of possible geothermal developments on those systems, and (c) to develop adequate monitoring studies. The available data and recommended studies, including budgetary estimates of costs related thereto, are described in the following pages.

1. Data Adequacy For Baseline Data

The first issue related to terrestrial biology is: What is known of the terrestrial ecosystems of the geothermal region; i.e., species composition of plant and animal communities, abundance and ecological relationships of these species, and location of critical habitat for rare and endangered species?

a. Natural Vegetation and Soils

Various portions of the four-county area which includes The Geysers-Calistoga KGRA have been covered by soil and vegetation surveys. These investigations have been conducted for a variety of purposes, at different scales and levels of detail, and with different classification systems in many cases.

Most of the earlier vegetation survey work is of limited value at present. In many areas lumbering, fire, and natural succession have brought extensive changes; the original mapping was not very accurate, and the vegetation classification was primarily designed to evaluate the potential for commercial timber production. However, it does provide the best available baseline for the detection of vegetation changes that may have occurred since the inception of geothermal development at The Geysers.

The vegetation-type mapping carried out by Comarc Design Systems* for PG&E forms an excellent starting point for additional work. Although highly useful for many purposes, it also has certain limitations: (1) vegetation types were subjectively defined, (2) cells were not always accurately classified, (3) type boundaries were not always correctly drawn, (4) ground surveys were inadequate, and (5) the area covered is not sufficient since geothermal development is extending into areas more distant from The Geysers.

Plant community classification and mapping as conducted for specific geothermal leasehold EIRs is valuable for detailed planning and impact assessment and provides a basis for revegetation and management programs. It is at best semi-quantitative and not amenable to statistical evaluation. The careful quantitative vegetation analysis carried out in site-specific PG&E studies is, on the other hand, very localized in extent.

There is no generally accepted system for the recognition and classification of vegetative communities in The Geysers-Calistoga KGRA. Several different schemes are in use by various organizations and individual investigators. A complete inventory of the plant species characteristics of various communities is not available. Although extensive data have been collected, there is no published regional flora which lists the species present, indicates their geographic and ecological distribution, and provides a guide to their identification.

^{*}Comarc Design Systems, 1977. The Geysers KGRA: A Vegetation and Wildlife Habitat Mapping. Prepared by Comarc Design Systems and Envicom Corporation under contract to PG&E and Union Oil Co. of California and in cooperation with the California Department of Fish and Game and the U.S. Fish and Wildlife Service, San Francisco, CA.

Detailed soil survey work has not been carried out as yet in many wildland and mountain areas, especially outside of Sonoma County.

Mapping has often been done in a very general way, with poorly defined boundaries in some cases and insufficient differentiation of soil complexes into specific soil mapping units. There are apparently several unclassified mountain soils which have not been characterized or named.

b. Wildlife Habitat

With the exception of a classic study of the most important game species, the black-tailed deer, very little was known of the wildlife resources of the geothermal region prior to 1974. Since then, mapping and inventory of wildlife habitat types has been undertaken by several organizations in order to provide baseline data for geothermal development projects.

The Comarc mapping study has provided a useful framework for additional wildlife studies. It has served well in the identification of general wildlife habitat types for geothermal facilities planning and siting activities and for the selection of census areas in The Geysers Wildlife Study*. However, the maps produced do have some deficiencies: (1) vegetation types were defined subjectively, (2) ground checking was inadequate in some cases to accurately delineate vegetation type boundaries, and (3) rating of vegetation types as wildlife habitat was done subjectively in the virtual absence of field data. Nevertheless, the data management system allows ready correction and updating as new information becomes available from field studies.

The Geysers Wildlife Study has generally furnished an adequate inventory of wildlife resources in the upper Big Sulphur Creek

watershed. It is particularly useful because of the large number of animal groups studied and because sampling was carried out through an annual cycle for most groups. With proper caution, the results can be extrapolated to similar habitat types in adjacent portions of The Geysers-Calistoga KGRA. It was not possible to obtain quantitative data on the status of certain wildlife species because of insufficient resources or lack of an appropriate sampling technique: these include the larger mammalian carnivores such as mountain lion and bear, diurnal birds of prey, and owls. A number of habitat types were not sampled because they are not represented to any extent in the upper Big Sulphur Creek watershed: these include yellow pine, knobcone pine, montane chaparrel, and serpentine chaparral.

Subsequent baseline investigations in other parts of the geothermal region have generally utilized sampling techniques employed in The Geysers Wildlife Study. This should allow reliable comparisons of results between study areas and provides the beginning of a regional wildlife data base. These additional studies are less complete than The Geysers Wildlife Study, however, in that relatively few species groups have been sampled and in no case has it been possible to document the full range of seasonal variation in wildlife distribution or abundance.

c. Rare and Endangered Plant Species

At least 37 plant species that have appeared on lists of rare, threatened, or endangered flora are known to occur in The

PG&E, 1977. The Geysers Known Geothermal Resource Area Wildlife Study. The Distribution and Abundance of Wildlife Populations in relation to Geothermal Development: Interim Report. October 1977.

Geysers-Calistoga KGRA. Still others may occur in nearby KGRAs

(Knoxville, Witter Springs, Little Horse Mountain, Lovelady Ridge) and on

lands with geothermal potential which currently lie outside the boundary

of any KGRA.

Although some studies are now in progress or proposed, very little is known of the taxonomic status, distribution, or ecology of most rare plant species. This has already led to an expensive delay in at least one geothermal development project and to inadvertent destruction of some rare plant populations. Because of the special legal status of rare and endangered plants, an adequate regional data base is essential if serious problems of these kinds are to be avoided in the future.

Rare plants of The Geysers-Calistoga KGRA and adjoining areas are very inadequately known for purposes of planning geothermal development activities, siting facilities, or assessing impacts. In a number of situations there is considerable doubt about the true taxonomic status of species that have been listed or proposed as rare or endangered.

Distinct species or subspecies have been named which upon critical examination may not be separable from common widespread forms. In other cases, additional studies may recognize new subspecies of very limited distribution which should be added to the lists of rare plants. The rare plant studies by PG&E have not dealt with taxonomic problems, but simply have accepted as valid the species listed in the 1974 California Native Plant Society (CNPS) inventory. Work on the Strepthanthus morrisonii complex being carried out by Dr. James A. Neilson* is an example of the

^{*}Ecoview Environmental Consultants, Napa, CA.

type of analysis which should be extended to a number of other inadequately known species.

The ecological requirements of most rare plant species are known only in the most general way. Only in a few cases is there adequate information to determine critical habitat or to formulate a management plan for protection or restoration of the species. Data on regional geographic distribution are available from two main sources: the 1974 CNPS inventory and mapping and the KGRA Rare Plant Study by PG&E. The CNPS locality maps are based largely on information from herbarium labels, many of which are very vague and general. Most collections were taken along roads and thus the remote areas currently being developed were never visited by botanical collectors. PG&E investigators are attempting to visit all localities noted on CNPS maps and to identify new sites as well through field surveys. However, there are still many areas which have yet to be examined by qualified botanists.

d. Rare and Endangered Wildlife Species

The American peregrine falcon is the only endangered animal species resident within The Geysers-Calistoga KGRA. This is one of the few regions in the 48 contiguous states where peregrines still reproduce successfully. Their survival here as a self-sustaining population is therefore an issue which may be of national importance. Peregrine nesting activity is centered at eyrie sites on a few cliffs in the southeastern portion of the KGRA. These cliffs and their immediate surroundings have been recently designated as Critical Habitat for the species by the U. S. Fish and Wildlife Service.

A number of other wildlife species which may be of special concern occur within the general boundaries of the geothermal region. At least one other endangered species, the southern bald eagle, is found occasionally at Clear Lake and Lake Berryessa. Ospreys are reported to nest at Clear Lake. Golden eagles and prairie falcons are permanent residents of The Geysers-Calistoga KGRA and adjoining regions. The pileated woodpecker is known to occur in remaining areas of thick coniferous forest and the spotted owl may also be present in this type of habitat. Bears and mountain lions are rarely seen and the status of their populations is unclear. The nation-wide status of the bobcat and river otter, two of the smaller carnivores found in the KGRA, is currently under review by the U. S. Fish and Wildlife Service to determine whether they should be listed as threatened or endangered. Tule elk were reintroduced to the Cache Creek watershed in recent decades and have established themselves fairly successfully.

Through the efforts of the U. S. Fish and Wildlife Service and California Department of Fish and Game raptor specialists, the exact locations of peregrine falcon eyries in the Mt. St. Helena and Palisades/Table Rock areas have been determined. Critical Habitat Zones presently designated by the U. S. Forest and Wildlife Service constitute reasonable buffers around these nesting sites, although in themselves they provide no legal protection or sanctuary.

Two important kinds of data concerning the peregrine falcon are almost entirely lacking, however. First, there is no real understanding of the location and extent of critical habitat for feeding activities.

Second, there is no sound basis for predictions about either short or

long term effects of geothermal development on the survival of the local peregrine population.

There is no central source of information concerning other species which may potentially be of special concern. The tule elk population in the Cache Creek watershed is an exception in that its habitat requirements and geographic range are quite well known as a result of careful monitoring by BLM and CDFG wildlife biologists. Such data as exist on the other species are scattered and fragmentary.

2. Data Adequacy for Determination of Impacts

The most obvious impact of geothermal development on natural vegetation and wildlife is the loss of habitat to wellpads. roads. pipelines, and power plants. This not only brings about a long term reduction in regional biomass and productivity but often breaks up the remaining natural areas into small, semi-isolated parcels. The effects of development on vegetation and wildlife in these adjacent parcels of unaltered habitat have come under systematic investigation very recently. Hydrogen sulfide emissions from geothermal power plants have been suggested as potentially damaging to plant life. Traces of mercury are emitted in the vapor from geothermal facilities and could accumulate locally in the soil. Steam condensate droplets which escape as drift from power plant cooling towers may carry a number of water-soluble substances, including borates, sulfates, and arsenic. Finally, geothermal industry noise emissions and disturbance from increased human activity have been proposed as having adverse impacts on wildlife distribution and abundance.

a. Direct Habitat Loss

What is the magnitude of direct land requirements for geothermal facilities? How have recent changes in development procedures affected land requirements? The Comarc mapping study provided a useful first estimate of total current habitat loss on a watershed basis. There are several deficiencies inherent in the approach used, however: (1) to cite percentage of land surface developed for an entire watershed is misleading because none of the three watersheds mapped are completely developed as yet, (2) differences in land requirements between older and newer development procedures cannot be evaluated, and (3) additional land requirements (chiefly for makeup wells) within developed areas cannot be estimated.

The more recent PG&E study presents a significant advance in methodology. By considering individual generating units and their steam supply fields, it allows a more accurate assessment of land requirements. A further refinement of this methodology using larger-scale aerial photography and ground checking would allow for more reliable impact prediction and for more precise comparisons of different development policies.

b. Cooling Tower Emissions

What materials are released into the environment as a result of emissions from power plant cooling towers? How could these materials impact terrestrial ecosystems? Three problems are identified:

Cooling Tower Drift: the existing data strongly suggest that some local accumulation of boron is occurring adjacent to the cooling towers of at least the older generating units at The Geysers Power Plant. However, the kinds of materials emitted as drift from cooling tower stacks have not been accurately characterized. Their emission

rates, dispersal patterns, and rates of deposition and accumulation in the environment are poorly understood. The only effects which have been demonstrated thus far are largely limited to seasonal stress on a single native tree species in the immediate vicinity of certain generating units. The fact that no obvious impacts on shrubs or herbaceous vegetation have been noted is significant, but it is also true that no systematic studies to detect such effects have been carried out;

Mercury Emissions: mercury is known to be released in small amounts from The Geysers Power Plant and may accumulate in soils adjacent to certain generating units. The rates of deposition and accumulation are almost completely unknown, as is the distance to which measurable accumulation may occur. Nothing is known of possible rates or pathways of transfer from soils to vegetation, wildlife, or streams. Because rates of emission are quite low, it is doubtful that a serious problem exists; however, there is an obvious data gap concerning the fate of mercury leaving the cooling towers; and

Hydrogen Sulfide Emissions: data are adequate to indicate the general levels of hydrogen sulfide that may occur in ambient air at The Geysers. It is unlikely that any increase in these concentrations will occur with further geothermal development because of insistence by regulatory agencies that hydrogen sulfide abatement be carried out to meet the state standard of 30 ppb. Greenhouse investigations of the effects of these low levels on vegetation suggest that there will be no damage to natural ecosystems unless ambient hydrogen sulfide concentration exceed 100 ppb for weeks at a time. However, it should be noted that few native plant species have been tested; there may be some components of the natural vegetation such as lichens that are highly sensitive to hydrogen sulfide.

c. Geothermal Industry Noise Emissions

What are the changes in the acoustic environment that accompany geothermal development? How do increased noise levels affect the distribution, abundance, or behavior of wildlife species?

Studies of the kind conducted by Dr. P. Leitner, St. Mary's College*, present many methodological difficulties which complicate interpretation of the data. The lack of a pre-development baseline data made it impossible to conduct longitudinal studies on the same plots, so that

^{*}The Environmental Effects of Noise from Geothermal Development - Dr. Phil Leitner, Biology Dept., St. Mary's College, Moraga, CA. - NSF Funded Study. Reports in preparation.

paired noisy (developed) and quiet (undeveloped) study areas had to be compared. This raises the possibility that observed differences in wildlife abundance may be due at least in part to natural habitat differences between the two areas. Development itself introduces noise sources to previously quiet habitat, but it is also accompanied by other changes whose effects could be conpounded with those of increased noise. Even some standard census techniques depend to a certain extent on the ability to detect animal vocalizations, which is obviously reduced on noisy study plots. It may ultimately be impossible to separate adequately the effects of noise on wildlife in habitat adjacent to geothermal facilities from the overall impacts of all factors involved with the development process.

Another limitation of this study is the lack of definitive information on certain important wildlife groups, particularly the wide ranging mammalian carnivores and birds of prey. Their usage of habitat adjacent to geothermal facilities and their behavioral responses to the noise and disturbance which accompanies development have not been clearly established.

3. Data Adequacy: Monitoring Studies

Geothermal development obviously involves some unavoidable loss of habitat. Possible impacts on the wildlife and natural vegetation of physically unaltered habitat adjacent to geothermal facilities are also of concern. Chemical emissions from generating units and increased noise levels may over many years have cumulative effects on terrestrial ecosystems that could not be predicted from short term studies of particular stressing agents. Dissecting wildlife habitat with roads and

pipelines may decrease its value to many species. While such cumulative long term impacts seem unlikely on the basis of present incomplete knowledge, the issue should be addressed directly. At issue is the question: What are the cumulative long term effects on terrestrial ecosystems of the many environmental changes that accompany geothermal development?

The Geysers Wildlife Study was generally successful in suggesting differences in wildlife distribution and abundance between developed and undeveloped census areas. However, the absence of pre-development baseline data in The Geysers region makes it impossible to establish with certainty that these differences are caused by development and are not simply due to natural differences in habitat between paired census areas.

The other major limitation of The Geysers Wildlife Study is the lack of quantitative data for certain animal groups, particularly some of the wide-ranging mammalian carnivores and birds of prey. Their usage of habitat adjacent to geothermal facilities and their behavioral responses to the noise and disturbance which accompanies development were not clearly established.

Similar comprehensive studies of natural vegetation have not yet been carried out. Although considerable quantitative data were gathered on the vegetation of the paired census areas used in The Geysers Wildlife Study, the observed differences again cannot definitely be ascribed to geothermal development influences.

In general, no data are available to suggest the overall density and pattern of development that is compatible with long term maintenance of ecosystem integrity.

4. Recommended Studies, Priorities and Costs

The following paragraphs summarize the recommendation in the areas of baseline studies, impact studies and monitoring studies.

a. Baseline Study Recommendations

Baseline studies are recommended in the following four areas:

Rare and Endangered Plant Species (Medium Priority): A comprehensive regional baseline study of rare and possibly endangered plants is critically needed to facilitate geothermal development. This study should be designed to supplement and extend the work now being carried out by PG&E and ECOVIEW. The area to be investigated should include not only The Geysers-Calistoga KGRA, but other parts of the four-county region where geothermal development activity can reasonably be expected by 1985. Estimated Costs: First year: \$160,000; Additional year; \$140,000 (2 year duration);

Rare and Endangered Wildlife Species (Medium Priority): although the general area currently utilized by peregrine falcons does not contain known commercial geothermal resources, there are active industry proposals pending for deep exploratory drilling. Environmentally sound decision-making will require additional studies as soon as possible to establish reasonable boundaries for critical habitat which include adequate foraging areas for peregrine falcons. The available data on other species of special concern in the region should be gathered from all possible sources: state and federal agency biologists, academic researchers, industry personnel, and amateur naturalists. Special field studies may be required in some cases; for example, a survey of the Cobb Mountain area to delineate spotted owl habitat is recommended. All available data should be compiled into a special report with a section devoted to the status and distribution of each species as presently understood. This information would be of great value in the preparation of accurate and definitive environmental impact documents. Estimated Costs: Peregrine Falcon Critical Habitat: First Year: \$60,000; Additional Year: \$40,000 (2 year duration); and Status of Other Wildlife Species of Special Concern: First Year: \$40,000; Additional Year: \$40,000 (2 year duration);

Natural Vegetation and Soils Mapping (Low Priority): Baseline data on natural vegetation are needed to facilitate planning and siting of geothermal facilities, impact assessment and monitoring, and effective renewable resource management. The following actions are recommended:

The classification, mapping, and inventory of natural vegetation should be extended to all parts of the region where there is a reasonable likelihood of geothermal development by 1985;

A comprehensive volume should be prepared describing the flora of The Geysers-Calistoga KGRA and surrounding areas. It should provide distribution maps, illustrations for species identification, and accounts of ecological requirements; Soil surveys and mapping should be accelerated in areas of Lake and Mendocino Counties with geothermal potential to assure adequate baseline data for management of potential erosion and revegetation problems; and

Baseline data on natural vegetation and soils should be gathered according to standardized procedures and techniques and entered into a regional data base (whether computerized or not).

Estimated Costs: Soil Surveys: First Year: \$50,000; Additional Year: \$50,000 (2 year duration); and Natural Vegetation Mapping and Inventory: First Year: \$150,000; Additional Years: \$240,000 (3 year duration); and

Wildlife Habitat Mapping and Inventory (Low Priority): a wildlife habitat mapping effort similar to the project carried out in 1976-1976 for the upper portions of the Big Sulphur, Kelsey, and Putah Creek drainages should be extended to all parts of the four-county region where there is a reasonable likelihood of geothermal development by 1985. Supporting data concerning natural vegetation, soils, and hydrologic features should be utilized. Adequate ground reconnaissance should be carried out in conjunction with the use of remote sensing data sources. Every effort should be made during this mapping study to identify habitat features of particular value to wildlife, such as springs, wetlands, tracts of snags, and nesting cliffs. Unique, sensitive or especially productive habitats should be careully identified and mapped. A two year baseline inventory of wildlife resources should be conducted in the upper Kelsey and Putah Creek watersheds. The seasonal distribution and abundance of major wildlife groups should be determined on a quarterly sampling schedule. Priority should be given to those habitats for which no data were collected during The Geysers Wildlife Study: yellow pine, knobcone pine, montane chaparral, and serpentine chaparral. Study methodologies should generally conform to those utilized in The Geysers Wildlife Study to ensure data comparability. Similar wildlife inventories should be carried out subsequently or simultaneously in other watersheds that appear to have significant potential for geothermal development and should be carefully coordinated with wildlife habitat mapping work. Estimated Costs: First Year: \$220,000; Additional Years: \$400,000 (3 year total duration).

b. Impact Studies

Impact studies are recommended in the following four areas:

Cooling Tower Drift (Medium Priority): Studies should be undertaken as soon as possible to accomplish three objectives: (1) define accurately the kinds of materials emitted in the form of drift from cooling tower stacks and the rates at which they are released, (2) determine the dispersion patterns for these materials; that is, how far do they travel, in what directions, and in what quantities, and (3) quantify rates of drift deposition and possible accumulation in soils in different directions and at different distances from cooling towers; and

Mercury Emissions (Medium Priority): Research should be initiated to determine levels of mercury and other heavy metals in soils adjacent to several generating units. Patterns of dispersion and deposition should be carefully defined with respect to wind direction and distance from source. Care should be taken to distinguish possible accumulation from geothermal power plant emissions from natural background levels in the soil. If significant accumulation is confirmed, further work should be done to determine mercury concentrations in vegetation and in various wildlife species. Transfer rates and pathways through terrestrial food chains should be determined: Estimated Costs:

Source Characterization and Transport: First Year: \$100,000; Additional: \$60,000 (2 year duration);

Accumulation of Pollutants in Soils and Vegetation: First Year: \$80,000; Additional: \$60,000 (2 year duration); and

Biological Effects of Drift Pollutants: First Year: \$200,000; Additional: \$200,000 (2 year duration);

Direct Habit Loss (Low Priority): Additional investigations of habitat loss should be carried out using an improved version of the methodology developed for the recent PG&E study. Documentation of leasehold land requirements for Geysers Power Plant Units 7-10 and 12-15 will indicate the range of variation to be expected with varying development policies and will provide a solid basis for impact prediction. This type of analysis should be applied during the planning and design process for additional units to evaluate the land use impacts of alternate development configurations and to test the effectiveness of measures intended to minimize land requirements. Estimated Costs: First Year: \$10,000 (1 year or less); and

Noise Impact Studies (Low Priority): The impact of geothermal noise and disturbance on the behavior and habitat utilization of raptors and mammalian carnivores could be effectively resolved through radiotelemetry tracking in conjunction with noise monitoring. It is recommended that a radiotelemetry study be undertaken of certain selected species such as the bobcat, gray fox, red-tailed hawk, and Cooper's hawk. This work could be organized as a part of a monitoring effort or as a separate impact investigation. The data would be widely applicable to impact prediction in other KGRA's as well. Estimated Costs: First Year: \$40,000; Second Year: \$40,000 (2 year duration).

c. Monitoring Studies

The long term impacts of geothermal development on natural vegetation and wildlife in adjacent unaltered habitat should be examined further through a carefully designed monitoring program. Adequate

pre-development baseline data for an entire leasehold or watershed is essential for such a study. Therefore, monitoring should logically develop from the mapping and baseline inventory studies recommended previously. By following control and developed plots through the life cycle of a geothermal project, it should be possible to detect any cumulative impacts and take corrective measures to protect the resource if necessary.

All major structural components of each regionally important vegetation type should be followed through the use of permanent plots of appropriate sizes. Key parameters would include species composition, percent cover, density, biomass, productivity, and incidence of disease and insect pests. The faunal monitoring effort should use techniques modeled after those of the Geysers Wilflife Study, with perhaps a reduction in the number of animal groups studied. As a minimum, wildlife species composition and relative abundance or density would be determined for each vegetation type. Once an adequate baseline is established for vegetation and wildlife, the frequency of sampling could be reduced considerably. However, sample size must be adequate to permit the detection of changes through generally accepted statistical techniques. Estimated Costs: \$150,000 per year for three years of monitoring spaced at three year intervals.

D. AQUATIC BIOLOGY

The following discussion on environmental data needs relative to aquatic biology is presented in three parts:

baseline data on aquatic ecosystems, impacts on aquatic ecosystems, and recommended studies.

1. Baseline Data on Aquatic Ecosystems

Lakes and streams represent two distinct types of aquatic ecosystems existing within the geothermal region. Clear Lake provides a significant recreational and commercial fishery and other lakes and reservoirs also receive important recreational use. Many permanent and intermittent streams are used as spawning and nursery habitat by steelhead— and rainbow—trout—populations and support a variety of other fish species as well. The primary issue is: What will be the impact of geothermal development on acquatic species? To answer this requires an answer to: What is known of the aquatic ecosystems of the geothermal region—species composition of aquatic communities, abundance and ecological relationships of fish, invertebrate, and microorganism populations, and location of sensitive, unique, or unusually productive habitats?

a. Stream Ecosystems

Prior to 1974, very little data existed on the biology of streams in this region. The only ecological information available was gathered in the course of stream surveys conducted by California Department of Fish and Game and kept on file at regional headquarters. In addition, a few fish collections had been made for taxonomic and distributional studies by various academic institutions.

Regulatory agency and public concern about the effects of geothermal development on fishery and other aquatic resources has led to a number of studies in the last three years. Standard methods have been developed for fishery inventory work and for measurement of water quality and physical stream parameters. Those methods have been systematically applied in many of the watersheds of the Geysers-Calistoga KGRA. However, data gaps exist in that surveys have not yet been carried out in most watersheds. Also, studies conducted during 1976 and 1977 may reflect the unusual drought conditions of those years; data should be carefully evaluated to determine if supplementary surveys are needed. Studies of benthic invertebrates are in progress at Big Sulphur Creek and in streams of northern Napa County. Methodologies are being developed and tested that will yield adequate quantitative data for baseline descriptions and monitoring. These organisms are important for at least two reasons: (1) they provide a food base for game fishes and (2) they can be sensitive indicators of impacts such as sedimentation and chemical pollution. There are serious gaps in our knowledge of benthic invertebrates since most watersheds in the region have never been surveyed and even a species list is not available for most streams.

No studies of stream microorganisms have been initiated. Although many types of algae, fungi, and bacteria undoubtedly occur and play an important ecological role as primary producers and decomposers, no species inventory is available and little is known of their biology.

b. Lake Ecosystems

Clear Lake is an aquatic resource of great concern in the region. It is one of the oldest lakes on the North American continent and supports a

highly productive eutrophic ecosystem. A great deal of attention has been focused on the blooms of bluegreen algae and swarms of the Clear Lake gnat which occasionally plague the lake. As a result, biological data are available in great abundance for certain components of the system. Because of changing conditions, much of the earlier information is mainly of historical interest. The Lake County Mosquito Abatement District has published a list of references to work done through 1970.

Existing baseline data are generally adequate to describe the current status of the Clear Lake ecosystem. Excellent quantitative data are available over many years for dissolved nutrients and phytoplankton populations. Other ecosystem components such as zooplankton, benthic invertebrates, and fish are well known in a qualitative sense. However, the kind of routine long term baseline information on densities of biomass needed for impact detection are not available. In general, the portions of the lake most likely to be affected by geothermal development (Oaks and Lower Arms) have not been sampled with as great intensity as the Upper Arm.

c. Aquatic Habitats of Special Concern

Certain types of aquatic habitat found within the KGRA are of special concern because of their vulnerability to disturbance, their importance for aquatic ecosystem productivity, or their possibly unique flora or fauna. These include important springs which help to maintain permanent stream flow, and unusual habitats such as hot springs and alkaline lakes.

Locations of springs which may contribute significant summer flow to streams are not known well enough to insure protection. Finally, the biota of unusual aquatic habitats of the region such as hot springs and alkaline lakes have not been adequately surveyed or inventoried. These habitats may support unique species of invertebrates and algae that are narrowly adapted and found nowhere else.

2. Impacts on Aquatic Ecosystems

Geothermal energy development in the California north coast region has the potential to adversely impact aquatic resources in several ways. Watershed alteration, including increased erosion and stream siltation, is considered to be the most serious potential development impact. Spills of toxic materials such as steam condensate and drilling sump contents and diesel oil have occurred, but the long term effects of these accidents have not been identified. Materials entrained in cooling tower drift, including boron and mercury, may accumulate in soil adjacent to generating units. It is not known if such materials are carried into streams by surface runoff, but this possibility should be considered because of the implications for various beneficial uses such as irrigation, domestic water supply and fisheries.

a. Watershed Alteration

What is the magnitude of physical changes in stream habitat that accompanies construction of geothermal facilities? How do these changes impact the stream ecosystem? The Pacific Gas and Electric Co. site-specific sedimentation studies represent a careful effort to document the major watershed impacts of power plant construction. They should provide useful information in the following areas:

Quantification of the erosion/siltation changes accompanying power plant construction to allow better impact prediction;

Evaluation of various protection measures;

Development of new techniques for erosion control; and Standardization of sedimentation study methodology appropriate to The Geysers region.

These studies are limited; they are designed to examine sedimentation resulting from power plant construction only. Since the effects of construction of drill pads and roads are not under study, the total impacts of the development process will not be detected. In addition, it may not be possible to extrapolate the results to other parts of the region for purposes of impact prediction because parent materials, soils, topography, rainfall, vegetation, and land use practices may differ considerably.

Sedimentation studies conducted by the California Department of Fish and Game in Big Sulphur, Squaw, and Kelsey Creeks are very useful in extending the PG&E work to other areas for baseline and monitoring purposes and in providing data on the impacts of all phases of development.

b. Accidental Spills

What materials are released into aquatic ecosystems as a result of accidental spills from geothermal facilities? How can these materials impact stream and lake ecosystems? Additional investigations of deposition of cooling tower drift and volatile heavy metals are needed. The current lack of adequate data on soil accumulation makes it impossible to evaluate the potential for transport of materials such as borates, sulphates, ammonia, mercury, or arsenic from the vicinity of power plants to nearby stream or lake ecosystems.

c. Thermal Pollution

What changes in temperature would occur in Clear Lake if its water were used for geothermal power plant cooling? How would such temperature changes impact the aquatic resources of Clear Lake? Clear Lake temperature data are certainly adequate to establish baseline conditions. Studies of thermal addition to lakes elsewhere should provide a basis for modeling temperature changes and predicting biological effects.

3. Recommended Studies, Priorities and Costs

The following baseline and impact evaluation studies are recommended in aquatic biology.

a. Baseline Studies

Eight studies are recommended for development of adequate baseline information on aquatic biology:

Fishery Studies (Low Priority): Conduct baseline fishery inventories using current methodology in certain additional watersheds that are undergoing geothermal development now or are likely to be developed in the near future: Maycama Creek/Briggs Creek, Dry Creek, and Upper Napa River. Determine if fishery inventories carried out in the two recent drought years should be supplemented by additional work during more normal stream flow conditions. Where appropriate, conduct site-specific baseline studies prior to the siting and construction of particular geothermal facilities. These studies should include inventory of all fish species and identification of stream habitat features of importance for fish productivity: spawning gravels, pools, and fish barriers. Estimated Costs: First Year: \$30,000; Additional Year: \$20,000 (2 year duration);

Benthic Invertebrate Studies (Low Priority): develop standard benthic invertebrates study methodologies and publish a handbook which would include sampling techniques, keys for species identification, and data analysis procedures. Determine the response of benthic invertebrates to change in the stream ecosystem so that selected species can be used as indicators of geothermal development impacts. Conduct inventories of benthic invertebrate fauna in watersheds that are undergoing geothermal development now or are likely to be developed in the near future:

Little Sulphur Creek
Squaw Creek
Kelsey Creek
Cole Creek
Upper Putah Creek

Dry Creek
Big Canyon Creek
Seigler Canyon Creek
Maycama Creek/Briggs Creek
Upper Napa River

Where appropriate, conduct site-specific baseline studies prior to the siting and construction of particular geothermal facilities. These studies should include inventory of all benthic invertebrate species. Estimated Costs: First Year: \$60,000; Additional Year: \$100,000 (3 year duration);

Studies of Aquatic Microorganisms (Low Priority): develop standard techniques for the study of aquatic microorganisms, including the following:

Sampling and identification procedures,

Techniques for assessment of density/relative abundance/biomass,

Measurement of metabolic activity--rates of photosynthesis/de-composition,

Impact detection by defining responses to changing stream conditions, and

Conduct baseline surveys of streams within the region to inventory aquatic microorganisms. Determine priorities among watersheds, parameters to be measured, and intensity of sampling required.

Estimated Costs: First Year: \$30,000; Additional Year: \$30,000 (2 year duration);

Trace Metal Analysis: Baseline (Low Priority): perform trace metal analysis of sediments, water, and biological samples in representative streams of the region. Biological samples should include phytoplankton, benthic organisms, and fish. Quantitative analysis of the amounts of trace heavy metals, such as mercury and arsenic, should be included. Estimated Costs: First Year: \$100,000; Additional Year: \$100,000 (2 year duration);

Aquatic Habitats of Special Concern (Low Priority): identify and map springs of importance in maintaining summer stream flow. Identify and conduct biological inventories of unusual aquatic habitats, particularly hot springs. Special emphasis should be placed on documenting and occurrence of highly specialized and ecologically restricted invertebrates, algae, and microorganisms. Estimated Costs: \$10,000 (one year or less);

Organism Baseline (Low Priority): Increase the number of algal sampling stations in the Oaks and Lower Arms of Clear Lake. Collect baseline data on all parameters currently being measured in the Clear Lake Algal Research Unit program. Continue this additional sampling for 1 or 2 years. Carry out quantitative sampling for zooplankton and fish in the Oaks and Lower Arms for 1 or 2 years. Gather baseline data on species present, numbers or biomass/species, and (for fish) population age structure. Conduct quantitative studies of benthic invertebrates in the Oaks and Lower Arms for 1 or 2 years to supplement previous work. Estimated Costs: First Year: \$30,000; Additional Year: \$20,000 (2 year duration);

Trace Metal Baseline (Low Priority): perform trace metal analyses of sediments, water, and biological samples in the Oaks and Lower Arms. Biological samples should include phytoplankton, benthic organisms, and fish. Analyses should include speciation for elements such as mercury and arsenic. Estimated Costs: First Year: \$75,000; Additional Year: \$75,000 (2 year duration); and

Lake Habitats of Special Concern (Low Priority): Identification of unusual or unique lake habitats, and the inventory of associate biota with special attention on endemic or narrowly adapted forms.

Estimated Costs: \$10,000 (one year or less).

b. Impact and Monitoring Studies

Five studies are recommended for development of adequate information on possible impacts of geothermal development on aquatic biology:

Watershed Alterations (Medium Priority): a policy goal in every geothermal development project should be to keep watershed alteration to an absolute minimum in order to protect stream habitat. This can be accomplished if the following specific recommendations are followed:

Preparation of maps of erosion hazard (including slope stability) for the region at an appropriate scale to facilitate advance planning and the prescription of needed protection measures,

Development and evaluation of new techniques to protect the watershed during and after construction activites,

Earlier and more effective implementation of measures to reduce erosion, siltation, and disturbance of streambeds,

Expansion of sedimentation studies using currently accepted standard methodology to high priority watersheds where extensive development is planned. These studies should be carefully designed to examine the effects of development of the entire leasehold, not just the power plant site. The approach should document baseline sediment loads, evaluate changes which accompany development, and provide continued monitoring as needed, and

Development and testing of techniques for the measurement of runoff rates on a watershed basis, along with the determination of suspended solids, turbidity, and chemical composition (especially phosphorus, nitrogen and zinc) of runoff. Implementation of a program to follow such parameters in conjunction with sedimentation studies is recommended in at least one watershed on a pilot basis.

Estimated Costs: First Year: \$100,000; Additional Years: \$160,000 (3 year duration);

Cooling Tower Emissions (Medium Priority): studies should be undertaken as soon as possible to determine whether there is any accumulation of materials toxic to aquatic organisms in the soil adjacent to cooling towers. The older generating units (Units 1-6) should be compared to the newer units whose cooling towers have been designed to more stringent drift elimination standards. An adequate range of materials should be investigated, including boron and heavy metals. The pattern of accumulation around cooling towers should be investigated with respect to wind direction and distance from source. Results could be represented in the form of a "pollution rose". If significant accumulation in soils is demonstrated, additional work will be required to determine the rates at which effluents are transported to streams. Modeling studies may be of value in providing a general estimate of the magnitude of transport processes. Estimated Costs: Previously estimated under recommended Impact Studies for Terrestrial Ecosystems;

Accidental Spills (Lower Priority): Priority should be the protection of stream habitat by preventing accidental spills; the need is for continued effort in applying what is known about spill prevention and in developing more effective procedures and systems to accomplish this. Since steam condensate can differ significantly in its chemical composition from one generating unit to another, it would be useful to have analytical data made available periodically. This would make it possible to predict to some extent how serious a spill from a particular unit might be. Acute and chronic toxicity bioassay work should be extended to benthic invertebrates and possibly microorganisms to provide a basis for more accurate prediction of the impacts of spills on all elements of stream The major potential effluents to be tested should include steam condensate and drilling sump wastes. As liquid-dominated reservoirs are developed within the KGRA, toxicity bioassays could be conducted to determine the effects of geothermal fluids from these sources on stream and lake biota. Impact assessment studies would be useful in determining the actual effects of spills in a field situation. These investigations should involve comparisons of pre- and post-spill conditions in a particular stretch of stream or comparisons of control and impacted stream sections after a spill. In addition to a documentation of immediate effects on stream organisms, the transfer, cycling, and accumulation of potentially toxic trace elements in the biota, sediments, and waters should be followed. Estimated Costs: First Year: \$100,000; Additional Years: \$140,000 (3 year duration);

Thermal Pollution (Low Priority): routine temperature sampling should be continued in Clear Lake, especially in the Oaks and Lower Arms.

As resource data becomes available from exploratory geothermal drilling in the vicinity of Clear Lake, studies of possible power plant cycles should be undertaken to examine the question of cooling requirements. Estimated Costs: \$20,000 annually (seven years duration); and

Aquatic Ecosystem Monitoring (Low Priority): permanent stations should be established in carefully selected locations within major regional watersheds and at important lakes and reservoirs. Undeveloped watersheds can provide control stations. Baseline sampling should be conducted over at least two years. Key parameters include water quality, physical stream and lake conditions, and fishery/aquatic invertebrate/phytoplankton inventories. Estimated Costs: \$150,000 per year for three (3) years of monitoring spaced at three year intervals.

E. AGRICULTURAL ECOSYSTEMS

The relationship of the agricultural industry to geothermal energy development is only now beginning to emerge as an important issue. Until very recently geothermal development projects were confined to sections of the Mayacmas Mountains remote from prime agricultural land. Now that geothermal exploration is under way or proposed at locations far removed from The Geysers, there may be a much greater potential for interactions with agriculture.

Geological studies suggest that the vapor-dominated geothermal field currently being exploited for the generation of electricity is restricted to a 5-6 mile wide belt running northwest from near Mt. St. Helena along the crest of the Mayacmas Mountains toward the southeastern corner of Mendocino County. This area can probably be fully developed without any significant effects on agriculture. Geothermal resources existing outside this zone and therefore closer to agricultural districts are very likely of the liquid-dominated or hotwater type. The exact locations and commercial values of such hot-water reservoirs have not yet been determined. This will require additional exploration including the drilling of deep test wells. Applications for permits to drill such test wells in or near agricultural areas could meet opposition because of uncertainty about the impacts of large scale geothermal development. This poses a dilemma because the physical and chemical properties of geothermal fluids and the reservoir characteristics must be determined in order to make valid predictions about the kinds and magnitudes of impacts to be expected. This cannot be done without drilling deep exploratory wells.

To resolve this dilemma it may be necessary to initiate certain technical studies at The Geysers now on the assumption that the results will be applicable to liquid-dominated fields. This would apply to research on cooling tower emissions, spills of geothermal fluids, cooling water requirements, reinjection capacities, and investigations of H₂S effects on crops. It will also be important to collect, assess, and make readily available as much data as possible on the nature and location of hot-water geothermal resources.

1. Baseline Data on Agricultural Ecosystems

What is known of the agricultural resources of the geothermal region-types of crops grown, acreages and production data, mapping of agricultural land uses, types and properties of agricultural soils, description of agricultural practices for each crop, including tillage patterns, fertilizer and pesticide applications, and irrigation requirements?

In general, baseline information regarding agricultural resources is readily available and fully adequate for purposes of environmental decision-making. Most of the data are organized and presented on a county-by-county basis. This may pose a problem in those cases in which it is necessary to have information for particular districts, as for example, Alexander Valley (Sonoma County) or Big Valley (Lake County). The more site-specific the data needs, the less likely that published sources will suffice and the more likely that interviews or other field investigations will be necessary. However, unlike the situation with respect to natural ecosystems, the essential facts about managed agricultural systems are available in one form or another.

2. Impacts on Agricultural Ecosystems

Thus far, geothermal development projects have been confined to mountainous areas remote from prime agricultural lands. Consequently, possible adverse effects of geothermal development on the agricultural industry have not been a serious issue. As geothermal exploration moves closer to valleys with extensive vineyards and orchards, a number of questions will have to be addressed. These include the land use requirements for geothermal installations, possible long term effects of chemical emissions on the quantity and quality of crops, effects on the availability of groundwater, and the potential for local weather changes as a result of water vapor emissions from cooling towers. At the same time, there will be great interest in direct beneficial uses of geothermal resources for growing and processing agricultural products.

a. Land Use

What are the direct land requirements for geothermal power plants and their associated wells, roads, and pipelines? The methodology recently developed by PG&E provides a way of accurately assessing land use requirements for geothermal power plants and their associated facilities. Total land needs should be somewhat less in agricultural areas because existing roads could be used for access in many cases and much of the area around each wellhead installation could be restored to crop production. Land use is also addressed in Socioeconomics.

b. Accidental Release of Geothermal Fluids

What materials could be released into the environment in the event of accidents such as spills of condensate and drilling sump contents, well

casing failure, or well blowouts? How could these materials impact agricultural operations?

Adequate data on the composition of any material which might be released in an accidental spill could be obtained from the geothermal developer responsible for the project. Constituents of major concern are likely to be boron and heavy metals such as mercury and arsenic. The effects of particular spills on soils, crops, or livestock could be estimated in a general way by reference to the agricultural literature. However, there are presently no data available on which to base predictions of the behavior of toxic components in the event of a spill under actual field conditions.

c. Cooling Tower Emissions

What materials are released into the environment as a result of emission from power plant cooling towers? How could these materials impact agricultural operations? The existing data suggest a real possibility that significant accumulation of boron and heavy metals is occurring adjacent to the cooling towers of at least the older generating units at The Geysers. Present information is insufficient to characterize accurately the kinds of materials emitted from cooling tower stacks, their emission rates, or the magnitude of accumulation in the surrounding environment. If these facts were available, it should be possible to estimate the effects on surface waters, soils, crops, or livestock that might be exposed to drift.

Data on ambient H₂S concentrations at The Geysers plus methods available for the prediction of such levels in other situations should provide an adequate basis for estimation of crop exposures. The studies

carried out by Dr. Thompson* suggest that ambient H₂S concentrations likely to be experienced in agricultural areas will not have adverse effects. However, some uncertainties still exist. For example, the effects of long term (through one or more complete growing seasons) exposure to low levels of H₂S have not been tested on wine grape varieties or orchard crops. Possible synergistic interactions of low levels of H₂S with stressing factors such as high temperature or smog have not been investigated. More subtle problems such as the effects of H₂S exposure and sulphur accumulation on the oenological properties of premium wines have not been examined.

d. Weather Modification

What local changes in weather conditions can be expected as a result of water vapor release from power plant cooling towers, such as increased frequency of fogging or icing? How could these changes impact agricultural operations? Theoretical analyses and field observations suggest the likelihood of increased local fogging under certain weather conditions. However, the actual frequency or magnitude of such changes at The Geysers is presently unknown. The possible impacts of this phenomenon on important regional crops are also unknown.

3. Recommended Studies, Priorities, and Costs

The following studies are recommended in the baseline impact and monitoring areas in relation to agricultural ecosystems:

^{*}Thompson, C.R., 1976 Studies on the Effects of H₂S on Plant Growth. Geothermal Environmental Seminar - '76. October 25, 27, 1976, Lake Co., California.

Regional Agricultural Baseline Studies (Lower Priority): no regional studies of agricultural resources appear to be needed; however, certain types of currently available information relating to agriculture should be incorporated into a regional resource data base and mapping system for geothermal development planning purposes. They are:

Agricultural Land Use: existing land use classification mapping should be reviewed, and where appropriate, incorporated into the regional resource data base,

Agricultural Water Supply: existing data on the location, extent, and quality of significant ground water reserves on surface water storage facilities should be assembled, reviewed, and incorporated into the regional resource data base, and

Agricultural Soils: existing data on the classification and properties of agricultural soils, as well as the results of soils mapping efforts, should be assembled, reviewed, and incorporated into the regional resource;

Estimated Costs: \$25,000 (one year or less);

Cooling Tower Emissions (Medium Priority): studies should be undertaken as soon as possible to define accurately the kinds of materials emitted in the form of drift from cooling tower stacks and the rates at which they are released. The older generating units (Units 1-6) should be compared to the newer units whose cooling towers have been designed to more stringent drift eliminating standards. Additional studies are necessary to determine the patterns of dispersion, deposition, and environmental accumulation of drift constituents and mercury in the vicinity of cooling towers of both older and newer design. Particular attention should be focused on accumulation with respect to wind directions and distance from source. The results could be displayed in the form of a "pollution rose". If significant accumulation of materials potentially toxic to plants or animals is demonstrated, additional site-specific work at The Geysers will be required to evaluate rates of uptake by native forage plants, cattle, and game animals. Typical agricultural crop plants of the KGRA can be brought to the site in containers for field exposure studies. These approaches can give some indication of possible rates of uptake, cycling, and accumulation in food chains leading to man. At the same time a comprehensive search of the agricultural literature should be carried out to locate and assess existing data relating to (1) the uptake of boron from soils and its effect on important regional crops and (2) the accumulation of heavy metals in meat, eggs, and dairy products as a function of intake in feed. Further studies should not be undertaken until results from the site-specific field investigations at The Geyers and the literature search are carefully evaluated. The need for additional work should be determined in part by the likelihood that significant

geothermal resources are located in or near prime agricultural areas. Representatives of the agricultural community should be involved in study design throughout these investigations.

It can be assumed that relatively low ambient levels of HaS (30 ppb or less) will occur in the vicinity of future geothermal power plants. Nevertheless, certain unanswered questions about the long term effects on perennial crops from chronic exposure to these concentrations should be directly addressed. The crops which appear to be of greatest concern are the various wine grape varieties and certain orchard trees such as pears and walnuts. Long term effects studied by their very nature will require years to complete. Research should be initiated as soon as possible so that results will be available in time to assist in regulatory decisions about geothermal projects in agricultural areas. A number of different approaches to this research problem could be devised, but the basic need is to assess the potential for effects on crop growth and yield and on the quality of the product. It is essential that important segments of the agricultural community, including growers, county agriculture departments, and university scientists, be involved in study design. The experience at the dry-stream field in Lardarello, Italy, where agricultual operations have apparently coexisted successfully with geothermal development for over 60 years might provide a useful perspective.

Estimated Costs:

Cooling Tower Emissions (Medium Priority): Previously estimated under recommended Impact Studies for Terrestrial Ecosystems,

Hydrogen Sulfide Effects on Primary Wine Grape Varieties and Assorted Orchard Crops

Estimated Costs: First Year: \$80,000; Additional Years: \$210,000 (4 year duration);

Accidental Spills (Lower Priority): adequate data on the composition of condensates, brines, and other fluids which may be subject to accidental spills should be collected by the developer and made available to responsible regulatory agencies. The chemical and physical behavior of toxic components of these fluids should be investigated in typical agricultural soils of the KGRA. Additional work on the uptake, transfer, and accumulation of these materials in crops and livestock is recommended in order to allow predictions of possible impacts of spills and development of contingency plans for clean-up and reclamation. Estimated Costs: not available at this time;

Land Use (Lower Priority): any geothermal development proposed for agricultural areas should be carefully planned to minimize land use and disruption of farming operations. Since many site-specific

factors can influence land requirements, a careful analysis of the plans for each project will be necessary to determine the actual area which will be taken out of agricultural production. Such analysis should be conducted in conjunction with the required environmental review procedures for each project proposed. No additional expense need be incurred; and

Agricultural Ecosystems Monitoring (Lower Priority): permanent study plots should be established in carefully selected locations representative of major regional crops. Control plots as well as plots near geothermal development should be included. Baseline sampling should be conducted over at least two years. Key parameters include crop yield and quality, chemical composition of products, and the properties of soils and waters. Estimated Costs: \$75,000 per year for three years of monitoring spaced at three year intervals.

F. GEOLOGY

Seventy-one geoscientists met on November 28 and 29, 1977 to discuss the geotechnical needs in the Geysers-Calistoga KGRA. These geoscientists were brought together by a steering committee selected by the GRIPS staff and Lawrence Livermore Laboratory. The participants were divided into four groups; Geologic Mapping, Slope Stability and Geologic Hazards, Subsidence and Seismicity, and Groundwater Hydrology. The concensus achieved by these groups is presented below in four parts related to:

geological mapping,
slope stability and geologic hazards,
subsidence and seismicity, and
groundwater hydrology.

1. Geologic Mapping

The following recommendations are made in regard to geologic mapping:

Scale of Mapping: The best scale for planning is 1:24,000, but $\overline{1:62,500}$ is also useful. The best scale for site-specific studies varies from 1 in. = 100 ft. to 1 in. = 500 ft., depending on use;

Aerial Photography/Remote Sensing: An index of available material would be useful. There is no critical gaps in the material, but proprietary release may pose a problem at detailed scales. A wide variety of material is available; various types, dates, and scales (especially 1:12,000 or less). Useful types include color, false color, black-and-white low sun angle, infrared, satellite and U-2 photography, and side-looking radar (SLR). SLR imagery is available for the entire Geysers area. VTN and Cartwright photographs are available for most of the area of interest. The county tax departments have maps of each county at 1:24,000;

Slope Stability: Slope stability problems are related to the geologic units. The Clear Lake volcanics pose fewer problems in this respect than the Franciscan rocks. Mapping of the Clear Lake volcanics is essentially complete. The preliminary geologic map and cross section of the Clear Lake volcanic field, USGS open-file map 76-751, by Hearn, Donnelly, and Goff, will be available in six

months. The California Division of Mines and Geology has mapped all of Sonoma County. When published, the mapping will be available as an open file report, SR-120. Robert McLaughlin will map the area toward Wilbur hot springs and around the periphery of the volcanics. Other areas that need to be mapped are the Saint Helena, Calistoga, and Lower Lake quads; southeast of the Clear Lake volcanics; southeast of the Lower Lake quad; and northeast of Coyote Valley;

Heat Flow: There is little hope of obtaining proprietary heat-flow data, and most of the data is propietary. Spring water chemistry can provide some information; Julie Donnelly of the USGS expects this data to be released within a year. All water samples in the volcanic areas are mixtures of cold surface water and hot underground water;

Critical Areas to Be Mapped:

Wilbur Springs

South of Anderson Springs, near the Collayomi fault,

Island of volcanics, south of Clear Lake,

The Manhattan mine/Grizzly Peak area,

The Harbin Springs/Barceloux Ranch area, near mapping by Robert McLaughlin,

Cache formation,

Tyler Valley/Cloverdale Peak area, extending mapping by Robert McLaughlin,

Witter Springs area, and

Gaps in the mapping from north of Boggs Lake to the Highland Springs area; and

Types of Maps Required:

Small landslide areas,

Gaps in geologic mapping,

Soil maps. These are available for Sonoma County, and they will be available for Lake County in 1979. The coverage of Napa and Mendocino Counties is unknown,

Active or potentially active faults (Collayomi, Konocti, and Maacama fault zones),

Hydrothermally altered zones,

Geophysical maps (gravity, magnetic, spontaneous potential, resistivity, magnetotelluric, seismic, sound), and

Lease maps (for planning). The counties have some of these. It is not necessary to identify leaseholders. These maps would be used to identify areas of future development.

The estimated costs for geologic mapping are:

Cost of Mapping: \$250/person/day, plus expenses for consultant. Site-specific maps are now paid for by the developer. Estimated total cost: \$135,000, and

Cost of Air Photography: \$5-10/photograph. Black and white is the least expensive; false color is the most expensive. Government black and white photographs are available for \$3 apiece. Side-Looking Radar: Coverage of The Geysers would cost roughly \$1,000, if obtained from government sources.

2. Slope Stability and Geologic Hazards

A number of possible geologic hazards exist. For some of these, action is not judged to be appropriate. While well blowouts can be caused by the movement of earth materials during earthquakes, they are due principally to poor construction. No need was seen for a regional study. Abandoned mercury mines in the area pose hazards because of the presence of old tailings and the possibility of groundwater contamination. The locations of these mines are already known, however; they are shown on Robert McLaughlin's map and in a report to be published by Trinda Bedrossian. Renewed volcanism was considered, but the probability of an eruption is very low.

The group noted the need for studies of several problems related to stability of earth materials, and it made the following four recommendations:

The most critical requirement is a landslide map based on a good topographic map at a scale of 1:12,000. This would provide a regional map containing very valuable information. Although much mapping information is already available, it exists as a jumble of

different scales, dates, and accuracies, spread out among numerous governmental and commercial organizations. A new map would be less expensive to produce than combining the existing data. Aerial photographic coverage at a scale of 1 in. = 500 ft. was recommended for slide areas in locations where future geothermal development is likely. The landslides should be classified according to age, stability, and type of movement (Cost: \$150,000);

An erosion map is needed. Erosion rates are closely linked to slides and weak soil areas. Detailed reports should accompany the map (Cost \$30,000);

An overall regional seismic study is needed because of the earthquake hazard. The existing USGS seismic net should be more closely spaced in the KGRA. Because stations are 10 km apart, it is difficult at present to determine epicenters accurately. Expected ground accelerations must be predictable. Pacific Gas and Electric Company claims that turbines cannot withstand high gravity loads (Cost: See Section 3.0 below); and

A centralized data bank is needed to store and disseminate all the information. The center might also update maps, collect pertinent environmental impact reports, and issue public announcements. Sonoma State College is a possible site. A computerized data bank under the USGS in Menlo Park is another possibility (Cost and discussion: See Part III, Chapter 4).

3. Subsidence and Seismicity:

A continuing research program to record events and surface changes as they occur with sufficient precision to develop a pattern that could be used to distinguish between natural and manmade changes and between changes in the geothermal production area and those in surrounding areas is recommended.

Most of the research and monitoring is being done by federal agencies, principally the USGS. The Corps of Engineers is studying the Maacama fault. Much of the microseismic and other geophysical work supported by industry is proprietary, and the information is not generally available. Existing studies already provide much of the needed baseline data. The following additional studies and research are recommended:

Geodectic Monitoring (High-Priority Projects):

Expand the existing network to outside areas with a high potential for development (e.g., Wilbur Springs). An estimated 40 miles (64 km) would be needed (Cost: \$18,000),

Establish several closely spaced, short lines for frequent precise resurveys to monitor for tilts and fault offsets (Cost: \$10,000),

Establish guidelines, equipment, and reporting forms for collecting and reporting fluid-production and reservoir data from industry (Cost: \$6,000);

Geodectic Monitoring (Low-Priority Projects):

Install tiltmeters to monitor tilts and fault offsets (Cost:
\$20,000/year);

Install extensometers to monitor changes in formations overlying the geothermal reservoir (No cost estimate); and

Seismicity:

What is the relationship between earthquakes at the extended Geysers steam field and the production activities of the past, present, and future?

What is the regional pattern of faulting, particularly in potential areas of development (e.g., Wilbur Springs) and in such major fault zones as the Maacama and Collayomi?

How much shaking may be anticipated from local and regional earthquakes, and what is the ground response at different locations in the production area and adjacent areas?

To answer these questions, the following work is recommended in order of priority.

Continuing the existing dense network (approximately 3-km spacing) at The Geysers to study the possible relation between earthquakes and production and to map possible extensions of the zone of intense earthquake activity with expanded development. There are approximately eight stations (Cost \$100,000);

Establishing a network of digital seismographs (strong-motion event recorders) in the production area to determine ground response to shaking and provide data for source studies. Earthquakes as small as m = 2 are routinely felt at The Geysers. About 12 stations are required, half of them permanently sited and half movable (Cost: \$100,000);

Extending the sparse (approximately 3-km spacing) regional network to the north and east to provide details of regional activity, including Wilbur Springs and the Maacama fault as far north as Laytonville. Approximately 12 additional stations are required (Cost of instrumentation and operation: \$100,000. Cost of calibration explosions and interpretation: \$50,000);

Establishing a roving network of portable seismographs (approximately eight) to provide detailed information on areas of interest within the regional network, fault-plane solutions, depth information, and a master event for relocation purposes (Cost \$100,000);

Making magnetic measurements (Cost: \$50,000); and

Making stress measurements from overcoring or hydrofracturing, using existing holes (no estimate).

4. Groundwater Hydrology

The primary environmental concern about groundwater is the overall graduation of the groundwater system, including reduction in the flow from hot and cold springs; lowering of groundwater piezometric surfaces; depletion of small groundwater subsystems; and reduction of groundwater quality.

The data needed for a comprehensive analysis of the groundwater systems at the KGRA are largely unavailable. The published data are almost exclusively from narrow, alluvium-filled valleys, and the information usually covers only a few years of well performance. The significant gaps in the available information preclude understanding the groundwater systems and subsystems. There is not enough information to understand how these systems respond even to natural phenomena, let alone to geothermal development. Thus, planners cannot make reasonable decisions governing proper geothermal development. To increase the understanding so that development can be controlled intelligently, the following is recommended.

Gathering water-quality data into a data bank, perhaps under the California Division of Water Resources (Cost: \$15,000);

Conducting a canvass of hot and cold springs and wells, perhaps under the California Division of Water Resources (Cost: \$65,000);

Studying the data and existing hydrologic/geologic investigations to provide an overall evaluation of the ground-water systems (Cost: \$65,000);

Performing hydrologic studies of future geothermal development and of specific rock formations and/or aquifers (Cost: Unknown);

Using geothermal monitoring programs currently being developed (Cost unknown); and

Establishing baseline monitoring programs for hot and cold springs and wells (Cost: \$50,000);

G. NOISE

The geothermal industry has pursued an active program aimed at reducing noise emissions. A number of important technological improvements in noise control have become standard practice in recent years. In spite of these advances, however, there are still circumstances in which large quantities of geothermal steam must be vented to atmosphere without effective silencing. This is by far the most serious remaining noise problem and its solution should be given a high priority. This section, therefore, deals exclusively with geothermal industry noise as it may impact adjacent communities and reduce public acceptability of the energy source. The discussion of noise is presented in two parts:

description of available data, and recommended studies, priorities and costs.

1. Available Noise Data

The following paragraphs describe the available data related to geothermally produced/induced noise.

a. Geothermal Noise Sources

What are the characteristics of geothermal noise sources—sound pressure levels, frequency spectra, and duration? Existing data are adequate to characterize the sound pressure levels, frequency spectra, and duration of the various geothermal industry noise sources. It is possible to identify readily the sources which are of greatest concern from the point of view of community acceptability. It is also possible to use current frequency spectrum data as a starting point for the design of improved noise control measures.

b. Geothermal Noise Propagation

How accurately can sound pressure level and frequency spectrum be predicted at different distances from a given geothermal noise source? Currently available methods appear adequate to allow reasonably accurate predictions regarding geothermal noise propagation. The effects of site-specific terrain factors such as barriers and differences in elevation between source and receptor can be calculated on the basis of known theoretical and empirical relationships. Local meteorological conditions such as winds and temperature inversions can also be taken into consideration in making predictions. Perhaps the most serious deficiency is the lack of extensive field studies to test the accuracy of predictions made for different sites under different meteorological conditions using somewhat different methodologies.

c. Community Noise Criteria

What are appropriate noise criteria for communities within The Geysers-Calistoga KGRA? Clearly defined community noise criteria are essential to the decision-making process for geothermal development projects. The EPA guidelines for residential areas provide a reasonable starting point, although as suggested in the draft Lake County Noise Element, they may have to be modified because of the quiet environment which exists in most parts of the KGRA. Thus, information currently available appears adequate to establish acceptable noise criteria for residential and open space areas. It is unlikely that a survey of community attitudes and responses to noise would furnish enough new information to be worthwhile.

d. Geothermal Noise Control

What are the problems and priorities in the development of noise control technology for geothermal industry sources? In spite of recent advances in noise control, a number of procedures during both the development and operation of a geothermal field still require the venting of large quantities of steam under conditions which preclude effective silencing. Extended production testing and clean-out of new wells, and clean-out of previously shut-in wells are the most common noise sources which can exceed 120 dBA at 50 or 100 feet. As geothermal development moves closer to residential areas this will be a problem of increasing concern. A muffling system which could attenuate this steam venting noise by at least 20-30 dBA is required. Such a muffler must be capable of handling rocks, debris, and water particles moving at very high velocities.

Although the sound pressure levels associated with mud and compressed air drilling are relatively low (80-90 dBA at 50 feet), complaints are sometimes received from persons living within 1,000-3,000 feet of a drill site. This is due in part to the continuous round-the-clock operation of these sources and in part to periodic noise peaks which occur when the drill string is raised or lowered. This noise pattern is common during the 30 to 60 days of drilling. Inexpensive methods of attenuating the low frequency components of noise from large diesel engines and compressors would be very useful.

2. Recommended Studies, Priorities, and Costs

The following studies are recommended in relation to development of information on the noise environment:

Noise Control Recommendations (Medium Priority) (Cost estimates are not available at the present time):

Steam-Vent Noise: the highest priority should be given to development of a muffling system that can be used during free venting of steam wells to the atmosphere. Several approaches to this problem should be considered;

Portable Rock Muffler: one developer has used a rock-filled muffler mounted on a flat-bed semi-trailer. While it be can moved by truck tractor from one well pad to another, it is extremely heavy and difficult to maneuver, especially on mountain roads. Improvements on this design might be effective for certain applications;

Stationary Rock Muffler: as an alternative, a rock-filled muffler similar to that developed for the generating units could be constructed on each well pad for use during venting. While these mufflers are quite expensive, they might be feasible when multiple wells are drilled from the same pad;

Conventional Production Test Muffler: some large metal test mufflers of conventional design are capable of attenuating venting noise to about 100 dBA at 50 feet. It might be worthwhile to investigate the possibility of new designs to achieve an additional reduction of 10-20 dBA during extended production tests;

New Design Portable Muffler: there is a real need for a lightweight, easily portable silencing device that could be used during well clean-out when conventional mufflers would be damaged by ejected rock and debris. NASA has investigated various jet nozzle configurations to reduce the sound pressure levels from aircraft and rocket engines and to shape the frequency spectrum. The application of this research to geothermal steam venting, in combination with the development of techniques for directing the steam flow away from receptors, could help to achieve a satisfactory level of noise reduction. A feasibility study should be initiated as soon as possible to determine the most promising approaches to the reduction of steam venting noise. This should be followed by the design, construction, and testing of prototype and standard muffling devices. Such an effort should be carried out in close cooperation with geothermal developers at The Geysers. entire program should take less than one year; and

Drilling Noise: Second priority should be given to the control of drilling noise. Techniques are available for the development of acoustic enclosures and better exhaust noise control for large engines and compressors, as well as improvements in cyclonic muffler design. Some of these advances are currently being implemented by geothermal developers. Further reduction

of drilling noise appears to be an appropriate area for industry initiative and does not require an extensive research and development effort;

Community Noise Criteria Recommendations (Medium Priority): Local regulatory agencies with permitting authority over geothermal development projects should make use of available information to establish acceptable noise criteria for residential areas within the KGRA. It should be recognized that such criteria should be selected so as to minimize annoyance and complaints, but that their complete elimination is not a realistic goal. Further surveys of community attitudes are not recommended. It is important to determine ambient noise conditions prior to geothermal development so that appropriate noise criteria can be selected. This can best be accomplished on a project-by-project basis, as has generally been the practice. this way the kinds of geothermal noise sources and their locations will be known and critical receptor sites can be identified with accuracy. Once acceptable levels are identified and reasonable standards are established, the issue is shifted to the area of noise control. Decisions concerning permits for particular projects would be based upon the demonstrated ability of the developer to control noise at the source to meet community criteria. No cost estimates are available at present;

Noise Source Recommendations (Medium Priority): no further collection of geothermal noise source data appears to be necessary for environmental assessment or decision-making purposes. However, much of the existing noise source information has been gathered very recently and is available only in scattered reports or is not yet published. To facilitate the preparation of more accurate environmental impact documents on a more timely basis, it would be useful to have all of these data brought together in a handbook for convenient reference. Preparation of such a handbook is recommended, particularly since it would be of value in other geothermal resource areas as well as at The Geysers. Estimated Costs: \$50,000 (one year or less in duration); and

Noise Propagation Modeling--Recommendations (Medium Priority):
existing noise propagation models are adequate for predictive and
decision-making purposes. No additional major research effort is
recommended; a continuing evaluation of alternative predictive
approaches would be useful, however, this would require a program of
field measurements to test site-specific noise propagation
predictions. Such a program would assist in the development and
refinement of a standard, comprehensive predictive model which would
be generally acceptable for future noise impact assessments. Such a
verified model would be of great assistance in the evaluation of
noise impacts in other geothermal resource areas and in connection
with other energy technologies as well.

Elaborate noise monitoring sytems are not recommended as a general rule. Occasional checking by regulatory agencies should be sufficient to establish compliance with standards. These agencies must be provided with adequate resources to carry out this function. Personnel and equipment are insufficient to respond adequately to noise complaints and to enforce the regulations within certain jurisdictions in the KGRA.

H. CULTURAL RESOURCES

The following pages present a summary of the survey of available archaeologic data, potential impact on archeologic sites, and related research needs for the KGRA.

1. Available Archaeologic and Historic Data

Much of the KGRA is known to have been heavily occupied since prehistoric times. The Clear Lake Basin was one of the most densely inhabited areas in California prior to the white man. In addition, the KGRA has had a rich historical past from the 18th century. However, few surveys and still fewer excavations have been completed in the KGRA to document the fill extent and nature of these cultures. Therefore, many archeological and historical issues are still unresolved. Much work is needed if cultural resources are to be understood and protected from destruction by geothermal development.

All completed excavations are situated in the Clear Lake Basin. The following list of excavations may be incomplete but it is indicative of the completed work:

- CA-LAK-36 The Borax Lake Site", Clearlake Park, Lake Co. (Major Excavation)
- CA-LAK-261 "The Houx Site", Excelsior Valley, Lake Co. (Major Excavation)
- CA-LAK-271 Kelseyville (Major Excavation)
- CA-LAK-291 Kelseyville (Limited-Minor Test)
- CA-LAK-405 Clear Lake State Park (Complete-Minor Test)
- CA-LAK-425 "The Sam Alley Site", Upper Lake (Major Excavation)
- CA-LAK-881 "The Slides Site", Lake Pillsbury (Complete-Minor Test)
- CA-LAK-589 Anderson Marsh (Limited Test)
- CA-LAK-741 Clearlake Highland (Minor Test)
- CA-LAK-742 Clearlake Highlands (Minor Test)
- CA-LAK-380 and 381 "The Mostin Site", Kelseyville (Major Excavation)
- CA-LAK-471 Clearlake Highlands (Minor Test)

About 94 square miles have been surveyed to date in connection with the preparation of E.I.R.'s for the development of geothermal resources. The 94 square miles include about 47 contiguous square miles in The Geysers/Cobb Mountain vicinity and an additional 47 square miles in scattered parcels. Surveys also have been completed in the Clear Lake Basin, including some 6,000 acres in the Mt. Konocti area, 800 acres of Anderson Marsh in Clearlake Highlands, several CEQA surveys of less than 50 acres, and many of the CALTRANS rights-of-way areas. Such surveys total more than 30 square miles within the KGRA.

More than 200 archeological sites have been identified on surveyed land. Site density varies. About 30 have been located near The Geysers proper, a frequency of about one site to every 250 acres. Elsewhere, site frequency averages about one site to every 2,000 acres.

The site distribution pattern suggests that the late period settlement system at The Geysers was characterized by a number of one and two household hamlets. These were commonly located near ridge terraces near a fresh water supply, on the south-facing slopes of Big Sulphur Creek. These hamlets were scattered within two miles of a central dance house site. The settlement system also included a number of small sites which may have been hunting sites and a few larger sites which may have been vegetable processing sites. It is also apparent that the natural hot springs of The Geysers area were a factor in attracting habitation to the area.

The data from these surveys is acknowledged to be extensive and of good quality; however, while survey data establishes settlement patterns, it does not generate temporal data. That is, survey data cannot be used

to construct a sequence of development. Further, none of these sites has been mapped precisely. Therefore, while the Clear Lake Basin prehistoric sequence is confirmed through completed excavations, the prehistoric sequences for large areas of the rest of the KGRA are unknown.

Little excavation is currently underway and none of it explores those areas of intensive geothermal development. Small excavations, sponsored by the Environmental Protection Agency, have been completed for highway widening or sewer projects. Other excavations were not associated with agency projects, e.g., Mostin Site, Borax Lake Site, but were done for purely scientific research.

Intensive surveys currently carried out are generally necessitated by the State Environmental Guidelines and CEQA. Those surveys associated with geothermal development have been generally confined to the Cobb Mountain or The Geysers proper area. Other surveys have been for land proposed for various residential and commercial uses.

The present archeological data base is clearly incomplete. The current data needs are: (1) temporal data from excavations which will establish prehistoric sequences for regions other than Clear Lake in the KGRA, (2) inventory data from intensive surveys in areas other than the currently developed geothermal area, (3) accurate maps from those areas already surveyed which will record surface features, e.g., house pits, and (4) impact data from sites already developed.

Given this incomplete data base, both known and unidentified archeological sites are endangered from future geothermal development. However, archeological surveys have been required prior to development of a geothermal leasehold. If the surveys are carried out early enough to allow reasonable planning, sites can be adequately protected.

2. Potential Impacts on Archeologic Sites

The possible impacts on archeological sites from geothermal resource development occurs during any development activity that results in the movement of earth. Below are geothermal development activities which commonly have such impact:

Constructing and/or widening roads,
Constructing and/or maintaining pipeline routes,
Constructing and/or using tractor mounting and loading areas,
Constructing sub-stations,
Constructing power plants,
Constructing administrative offices,
Constructing service centers,
Constructing waste disposal areas, and
Incidental parking and moving, e.g., by construction crews.

Sites within 1/10th of a mile of roads are most easily and most often impacted. Also, certain sites which do not contain archaeological remains still have ethnic and/or religious significance. No regulatory policy has been developed to evaluate such sites. The orderly and comprehensive prediction of impact and the mitigation of potential impact on cultural resources awaits a more complete archeological data base.

3. Recommendations

All archeologic recommendations are described below. Two organizational innovations should precede further archeological field work and mitigation procedures:

All data gained by excavation or survey should be filed with a single Regional Center of the California Archaeological Sites Survey. Regional Centers operate under contract on a cost sharing basis with the State of California to maintain archaeological records for their respective districts. Lake, Mendocino, Napa, and Sonoma Counties do use the Regional Center at Sonoma State College; the Center has on file virtually all archaeological data generated from geothermal resource development excavations and surveys. The Center assigns permanent site identification numbers and it catalogs, maps, and indexes all data received for rapid retrieval. If all new information were filed there, it would be a comprehensive information center (Estimated Costs: 0 - Minimal);

A regional Research Design for the larger KGRA should be developed. Using analyses of already collected materials and data, it should designate needed research and establish a framework for all research conducted in the KGRA. It would assist in the establishing of needed temporal sequences for regions other than Clear Lake. Technical studies, including obsidian hydration analysis and trace element identification of obsidians could contribute to the chronological ordering of prehistoric archaeological sites. (Other tests would include pollen analysis, radio carbon, x-ray fluorescence, amino acid racimication, neutron activation, archaeomagnetism.) This Research Design would also integrate new information with recorded data. The National Park Service, the Northwest Regional Center of the California Archaeological Survey, and the California State Office of Historic Preservation might create such a Research Design, or an archaeologist active in the KGRA might be selected to develop it (Estimated Costs: \$3,000).

Given the accomplishment of the above organizational innovations, the following issues must be considered:

Considering methods for mitigating or eliminating impact on archaeological sites, it has been recommended that GRIPS sponsor an in-field evaluation of the status of all sites recorded within the various geothermal leaseholds. Since more than 300 sites have been recorded, this evaluation would take at least two months, but it would generate the most thorough and knowledgeable recommendations for each specific site, making policy explicit concerning compliance monitoring, impact mitigation measures, site protection procedures, and other activities tied to the management of archeological sites (Estimated Costs: Up to \$5,000);

Until such time as the above "site-specific" guidelines are available, it is recommended that whenever construction is scheduled within 100 meters of a recorded site, an archeologist be retained to map and to flag the site boundaries. Estimated Costs: Up to \$200 per site to the contractor; and

Until such time as the proposed "Regional Research Design for the Larger KGRA" is developed, it is recommended that several clear data gaps be filled. To gain temporal data which will establish prehistoric sequences for regions other than Clear Lake, to gain inventory data from intensive surveys in areas other than the currently developed geothermal area, it is proposed that an individual finishing a doctorate in anthropology be hired to oversee (a) the excavation of a series of single component sites, (b) the excavation of a series of multicomponent sites, (c) the excavation of a series of special purposes sites, and (d) the survey of areas where no survey has been made (Estimated Costs: \$100,000).

Finally, two recommendations are made which concern the public:

It has been suggested that "cultural resource" be substituted for "archaeological site", While most sites already recorded in connection with geothermal development have been prehistoric, the "cultural resource" concept would also include historic sites and contemporary sites, e.g., the basketry-material gathering sites of contemporary Native Americans. The Federal Government currently uses the concept and the State Historic Preservation Office reviews EIR's with respect to cultural resources in general. The expansion of the concept would lead to an expansion of the collected data. Documented Native American groups could be asked to forward their cultural resource sites to the Regional Center of the California Archaeological Sites Survey at Sonoma State College, where they could be recorded and assessed with archeological sites (Estimated Costs: Unknown); and

Second, it is recommended that a public information program be instituted. Pamphlets on cultural resources would (1) explain a specific resource area, (2) be scientifically accurate, (3) be written for the educated layman, and (4) provide a factual background for assessing the significance of cultural resources. These pamphlets would be distributed to the general public, to libraries, and to those involved in the geothermal resources development process (Estimated Costs: Unknown).

I. HEALTH EFFECTS

GRIPS has not yet completed its analysis of the adequacy of environmental data related to health effects. The results of a workshop held jointly by GRIPS and LLL on April 6, 1978 will be used as the basis for specific data adequacy evaluations and recommendations for future work in this area. Preliminary conclusions and recommendations from the workshop are presented in the following paragraphs.

1. Adequacy of Available Data

The toxicologic and human health effects data relative to H₂S have been extensively reviewed and summarized. It is clear that H₂S is a potent toxicant and at high concentrations has produced human fatalities. The current data relating human response to H₂S exposure is incomplete in several respects. The health effects resulting from chronic exposure to low ambient concentrations of H₂S have not been clearly delineated. In addition, the long-term delayed response to brief high level exposure has not been adequately studied. Much of the human response data is recorded from accidental occupational exposures in which the actual H₂S concentration could only be crudely "estimated" thereby preventing the derivation of precise dose-response relationships. However, H₂S is routinely encountered in industrial operations and in chemical laboratories for brief periods (minutes to hours) without known adverse health effects.

When reviewing the literature to establish the existence of a "high risk" population, the reader must search for a high risk population in the general public who are exposed to ambient levels and the working population which is healthier and exposed to higher concentrations. Exposure to ambient concentrations (0.03 ppm) have not been documented as producing heightened effects in any special segment of the population. However, case studies and animal studies indicate that the young of the species are probably more susceptible to $\rm H_2S$. Questionnaire studies of asthmatics have noted that asthmatic attacks have been precipitated by the odor of $\rm H_2S$. This must be qualified by the fact that other odors which irrigate the respiratory tract cause the same conditions.

There is definitive evidence that in the population exposed to occupational levels (> 10 ppm), there is indeed a "high risk" population. From the many case studies of eye and respiratory effects, persons with chronic eye and respiratory problems should not be in the labor force exposed to H₂S. In agreement with findings from animal studies, acute intoxication by H₂S causes heightened sensitivity to the gas although some authors deny any acquired sensitivity. The lack of protection a respirator offered a person with a perforated eardrum should warn that this is a portion of the "high risk" population. Also, the neurosis aggravation demonstrated after acute intoxication by a person with neuropsychiatric problems, the lack of acquired tolerance following acute intoxication, aggravation of epileptic condition after acute intoxication and the synergistic effect of alcohol and H₂S should exclude persons with these problems from the population occupationally exposed.

Although the documented "high risk" population appears not to be as far reaching as has been suggested by some, the workshop committee does feel that there is definitely a "high risk" population in the work force

and the possibility does exist that a more sensitive population will be found in the general population.

2. Recommendations

Ambient concentrations of H₂S do pose a community nuisance problem. The committee feels that research is justified to investigate the effects caused by chronic exposure to low levels of H₂S. Air quality and complaints of infraction should be evaluated. Additionally, the effects of chronic exposure on behavior have not been defined and we feel that this information which should be accumulated through animal behavior studies, preferably in The Geysers area, is important.

The committee feels that epidemiological and occupational studies are indicated but would hope that air monitoring would be used in conjunction with these studies. Studies can be undertaken even with the small population involved which are relevant and competent. Epidemiological studies on morbidity and mortality may easily be accomplished drawing from the data assembled for the Savannah River Project.

Additionally, studies conducted at other geothermal plants may be extrapolated to The Geysers plants providing a larger data base so that morbidity and mortality of these workers may be assessed.

Although the committee sees the need for more information about not only H₂S, but also its possible synergism with other air pollutants, it feels that the effect of continued inhalation of the "rotten egg" odor of H₂S upon the quality of life in The Geysers area is the question which must be answered. We feel that H₂S at the ambient concentrations encountered in the populated areas is not generally a health problem, but rather a nuisance problem.

J. SOCIO-ECONOMICS

Socio-economic issues are those which affect people, either in their interaction with other people, or by impacting their land or pocketbook. At the prsent time, the negative environmental impacts such as air and noise pollution are perhaps the most significant. Yet, even if technological advances solve these problems, socio-economic impacts will continue. Therefore, special attention should be given to the long-term socio-economic aspects of geothermal development.

Socio-economic issues are of major concern to many people and institutions throughout the GRIPS Counties. People become involved in the geothermal process either as individuals, or as members of constituent groups representing particular interests or responsibilities. There are more than 100 identifiable constituent interest groups active in the four-county Geysers region. Some of these are traditional, general interest groups who have recently included geothermal energy in their programs (e.g., county and state governments, Sonoma County League of Women Voters, Sonoma County Tomorrow, and Sierra Club). Others are single issue groups that have sprung into being as a direct result of impending geothermal development (e.g., Geothermal Association for Lake County, Lake County Energy Council, Friends of Cobb Mountain, and Napa County Citizens Geothermal Task Force). Table II:2 presents a list of the constituent interest groups in the Geysers region and indicates the general type of socio-economic data that they use or produce.

The four main objectives of the GRIPS socio-economic effort are (1) to identify and contact as many of these constituent groups as possible and to involve them in the planning phase, (2) to develop a list of

Club, etc.

TABLE II:2

CONSTITUENT INTEREST GROUPS: THE GEYSERS KGRA

•	GROUP - MEMBERS	CONCERNS	DATA FUNCTION	USER NEEDS	
1.	Local political decisionmakers Board of Supervisors, Planning Commission, B.Z.A., etc.	All issues	Data user	Interpretive executive summaries	
2.	Local agency technical staffs, department heads Planning Departments, Welfare Agency, D.P.W., assessors, etc.	All issues	Data user, data producers report preparer	Technical analyses, raw data	
3.	State & Federal regulatory and management agencies E.D.D., Dept. of Finance BLM, USFS, and ERCDC.	All issues relating to State & Federal govern. gov. regulation, environ- metal constraints, land use of Fed. & State land	Data users, date producers, report preparer	Technical analyses, raw data	
4.	Educational organizations Local school districts, community colleges, etc.	Public education & involve- ment, cost/revenue and services	Data user	General summaries, interpretive executive summaries.	
5.	Laboratories & research LLL, LBL, JPL, STS, Ecoview, etc.	All issues	Data user, data producer report preparer	Raw data, technical analyses	
6.	Energy developers, utilities, financial institutions Union, PG & E, Aminoil, NCPA, etc.	Govern. regulation taxa- tion, environ. constraints on financial development	Data users, data producers report preparer	Technical analyses, raw data	
7.	Press Radio, newspapers, T.V., etc.	All issues	Data user	Interpretive executive summaries, general summaries	
8.	Development & environmental interest groups Energy Council, Geo. Assoc., Sonoma Co. Tommorrow, Sierra	All issues	Data user	Interpretive executive summaries, technical analyses	

TABLE II:2

CONSTITUENT INTEREST GROUPS: THE GEYSERS KGRA (continued)

÷	GROUP - MEMBERS	CONCERNS	DATA FUNCTION	USER NEEDS
9.	Resorts & religious Hobergs, Dawn Horse, etc.	Land use, environmental economic impacts	Data user	Interpretive executive summaries, technical analyses
10.	Large landowners	Economic returns, environ- mental costs-economic im- pacts, taxation	Data user	General summaries, interpretive executive summaries
11.	Business & taxpayers Chamber of Commerce, service clubs, taxpayers assoc., real estate boards, business community	Economic development taxation, governmental regulation	Data user	General summaries interpretive executive summaries
12.	Unorganized general residents	Environmental impacts- Quality of life, taxation	Data user	General summaries
13.	Unorganized seasonal residents and tourists,	Quality of recreational experience	Data user	General summaries

* User Needs General Data Types

- 1. Raw Data: Includes strip charts; computer printout; tabulated and mapped data of all kinds; (no analysis).
- 2. Technical analyses: Includes EIR's, EA's, EIR's, MEA's, Lab reports, Final reports of all technical studies, etc.
- 3. Interpretive Executive Summaries: Includes executive summaries of technical analyses, staff reports, some newspaper and magazine articles; interagency correspondence, etc.
- 4. General Summaries: Includes news articles, charts, pamphlets, films, displays, etc.

issues that are representative of the local concerns about geothermal development, (3) to obtain a general sense of the significance of each issue, and (4) to recommend studies to resolve these issues.

1. Scope and Issues

The mechanism utilized to achieve these objectives was a workshop on socio-economic issues co-sponsored by GRIPS and the Lawrence Livermore Laboratory.* The issues identified by the workshop participants, and subsequently synthesized and expanded by the staff, can be summarized in the following categories:

Social and Demographic Aspects:

Population Growth and Social Change:

description and basis of present trends; accurate baseline data and projections;

relative impact of all types (electric and non-electric) of geothermal development; relative impact of induced secondary growth; geographical distribution and movement; cyclical nature of impacts; growth inducement; change in community social structure; social conflict; nature and location preference of new people; and

optimum growth rate and total population; growth control.

Quality of Life:

visual impacts of geothermal development;

extent and rate of change and conflict with community values and lifestyles; effects on community social interaction;

environmental concerns of different socio-economic groups;

which socio-economic group(s) will benefit/be impacted the most? and

^{*}The workshop was held in St. Helena, California on June 9, 1978, at which some sixty participants engaged in identifying issues and outlining areas for potential research and information dissemination.

Public Opinion:

population growth; community values; environmental impacts; and regulation.

Private Sector Economic Aspects:

Prior to, or without, geothermal development: an accurate economic data base; existing and future economic sectors; available land and water resources for growth needs; pre-development speculation;

With geothermal development: local economic projections: labor needs (electric, non-electric, secondary related, attracted industries); labor market dynamics; labor skills of the unemployed; too many new move-ins for the available jobs; impact on or with other economic sectors-present or future (resorts, spas, retirement-2nd homes, property values-real estate sales, agriculture, tourism, etc.); boom-bust cycle; new industrial options with direct heat; increased income and royalty payments; impact on or constraint by housing and service needs; impact on economic interests of non-resident landowners; and

Resource development economics: capital purchases-foreign or domestic; labor/capital intensive development options; costs and compensations of development (opportunity, mitigation, land buffers, restrictions, pollution); steam pricing policies.

Public Sector Fiscal Aspects:

Primary direct impacts:

tax revenues, extent, duration, and equity; other potential fees or payments for services; priority given to and cost of geothermal regulation by local government; and

who pays the property taxes-lessee or lessor? does government subsidize the developers, or vice versa? local energy consumption options; municipal utility district; effect on quality and capacity of government regulatory and public services;

Secondary indirect impacts:

what are they? how significant?

impacts on special districts sewer and water projects; schools, traffic and transportation, solid waste, emergency and public health services; welfare costs; and

Potential complicating factors:

Jarvis Initiative: stimulus (attract capital investmentspeed up development plans), or inhibition (delay/deny permits-regulatory pre-emption by state government); shift of tax burden and tax base;

tax exempt development projects; in lieu of tax payments options;

SB 90 tax and expenditure limits;

pattern of different land/mineral ownerships: privatestate-federal;

stability and duration of tax revenue payments;

opportunity costs of foregone taxable land uses; and

different/conflicting geothermal assessment practices and tax policies.

Land Use Aspects:

Identify:

areas of possible resource existence, leasing, and potential development;

land use sensitivities, compatibilities, conflicts, additional classifications; pre-development baseline data; present and possible future land use commitments and unique resources; accurate and uniform land use mapping;

possible development scenarios, phases, and resource life; secondary land needs of development (dumpsites, transmission lines, parking, roads, field offices, etc.); land needs of induced indirect economic growth due to geothermal development (housing, roads, public services, commercial areas, etc.); and

possible multiple resource and land use options;

Regulation and Planning:

master planning for development; overlay geothermal zone; master environmental assessment-geothermal element;

landowner and local citizen input into decision making;

local control of land use, including transmission corridors;

incongruity of lease and project boundaries with natural physical (visual) boundaries;

visual and public safety aspects affecting nearby land uses; and

insurance of permit compliance and mitigation of impacts.

In addition to these basic socio-economic issues, a number of other concerns surfaced during the workshop that perhaps are better classed as political or regulatory, in contexts greater than merely The Geysers region. Briefly, they are:

because geothermal is a short term, rather small, energy source, perhaps its development is not worth all the negative and longer lasting impacts.

in the decision process, how much counter weight to economic factors should social, cultural, or environmental factors be given, or, should economics be the main, or only criteria for allowing development?

at what level of government should the benefit/cost - regulatory decision for geothermal development be made: local, state, or federal?

who should decide the rate of development and manage the resource?

should unspoiled rural areas be exploited to export energy to the urban areas?

why is so much attention and money being directed to goethermal energy?

who are, or will be, the people who:

benefit from development,

pay the costs of development,

control the development, and

influence the decision-makers?

there is a tremendous lack of public information and education about all phases of geothermal development, impacts, and regulation.

there is a general distrust of government sponsored energy "expediting" research.

there is a great deal of citizen frustration and alienation stemming from being kept out of the energy and environmental planning process.

These issues, and many similar ones raised during GRIPS Public

Involvement Workshops, do not lend themselves to easy incorporation into
a traditional scientific research program. Nevertheless, efforts must be
made to give them sufficient attention so they are not overshadowed by
natural science research questions. A public information/education
program and open planning process, in addition to basic environmental
research and data base operation, is necessary so that the broader issues
can be addressed.

2. Existing Data

Much socio-economic data already exists for The Geysers region

Counties. A brief tabular comparison of important socio-economic factors

for each Geysers County is presented in Table II:3. Table II:4 presents

a list of existing documents and data that relate, at least partially, to

potential socio-economic issues in the Geysers area. A preliminary

assessment indicates that the adequacy and accuracy of the data for each

County is highly variable. In some cases, extensive baseline data exists

and is fully adequate to project the impacts that may occur. In other

cases, accuracy and availability of baseline data is poor and inadequate

TABLE II:3

GEYSERS-CALISTOGA AREA STATISTICAL SUMMARY

County	Area l	Percent of Geysers- Calistoga KGRA	Estimated ² Population July 1, 1977	Density ¹ (pop/mi ²)	1977 Annual Average Unemployment %	1970 Median Family Income \$	1977-8 Total Assessed Value (\$1x10 ⁶)	1977-8 County Government Expenditures (\$1x10 ⁶)
Lake	1,261	63.2	28,700	16	11.3	6,551	175.9	14.9
Mendocino	3,511	4.3	60,700	15	11.2	8,867	290.5	28.8
Napa	788	16.4	91,700	101	9.4*	10,738	503.0	31.4
Sonoma	1,604	16.1	263,000	128	9.8	9,666	1,282.3	98.0
California	156,361	-	21,896,000	128	8.2	10,729	-	-
	Taxable Sales 1976 (\$1x10)	Gross Value Agric. 1976 (\$1x10 ⁶)	Agriculture	1977 Employment by Major Sectors Mining Manuf. Construction	T.C.U. ⁷ Trade F.I.R.E. ⁸ Services	Government		,
Lake	74.7	17.6	775	650	3,300	1,575		
Mendocino	222.9	26.1	1275	5,975	9,875	4,150		
Napa	278.9	31.8	2400	4,600	13,900	8,500		
Sonoma	884.4	127.1	4200	15,300	39,900	19,400	•	
California	83,185.4	8,900.0	, -	_	_	_		

^{1 1970} U.S. Census

"Population Estimates for California Counties," Population Research Unit, Department of Finance, Dec. 22, 1977

Employment Development Department; Napa-Solano SMSA only; Napa Co. figure N.A.

Prior to all exemptions

State Board of Equalization

Agricultural Crop Reports

T.C.U. - Transportation, Communications, Utilities

F.I.R.E. - Finance, Insurance, Real Estate

TABLE II: 4

GRIPS/LLL SOCIO-ECONOMIC ELEMENT Issue Identification and Existing Data Tabulation and Assessment

ISSUE

- Social and Demographic Characteristics, Public Opinion
 - A. Change in social characteristics of local population
 - 1. Population growth, new people
 - 2. Age-old vs young
 - 3. Occupation-employed vs. retired
 - 4. Residence-transient vs longterm
 - Other characteristics (children, ethnicity, etc.)
 - 6. Recreation/consumption patterns

DATA

1970 Census, by MCD or ED
pop. estimates, yearly since 1970 (D.F.)
pop. projections, 5 year inter. to 2000 (D.F.)
special census: Sonoma Co.,
Napa Co., 1975, city, & unincorporated
City & Lakeport, 1978

1970 census
pop. projections - (D.F.)
Summary Manpower Indicators, (NTIS) 1970
Selected soc-econ char., (EDD)
Social Security Recip. (SSA) yearly
Calif. Stat. Abst., 1976 (DF)
Economic Surveys, Co. General Plan
Overall Economic Development Plan,
Lake Co. C.C., Lake Co. Economy, (LBL)
1976 Familty Budgets, (BLS)
public opinion polls (see below)
employment data (EDD) (see below)

- B. Change in the Character (Quality of Life) of the Geysers KGRA area
 - 1. direct visual impacts

 Lifestyle and "personality of the community; small retirement vs industrial; social fabric and friendships

C. Change in Puplic Opinion

- Towards geothermal development due to:
 - a) social impacts
 - b) environmental impacts
 - c) economic impacts and options
 - d) presence/absence of gov.regulat.
 - e) demographic, location factors

geothermal development land use maps photos
P.G.&E. - Comarc viewshed maps

Visual Impacts Analysis System (USFS)
Geothermal E.I.R.'s

nothing

Neilson "Speical Report" survey, 1974 So. Lake Co. U.C./LBL Surveys, 1975, Lake Co., Cobb Valley GRIPS Public Workshops, SSI, 1977 Vital Opinion Cross-Tab (VOX) Mendocino Co.

- II. Economic Aspects, Private Sector
 - A. Change in geothermal employment-elect/ non electric
 - 1. Number and types of new jobs
 - 2. Number/skills of local unemployed
 - Geothermal labor market charact's w/camp followers
 - 4. Possibility of job training
 - 5. Duration of boom cycle

Labor Market Newsletter (EDD)
Employment Sector Estimates (EDD)
Santa Rosa SMSA (Sonoma Co.)
Vallejo-Fairfield-Napa SMSA
(Napa-Solano Co.)
Mendocino Co.
Lake Co.
Covered Employment and Payrolls
each above SMSA and Co.
Unemployed skills (EDD local Co. office)
Lake Co. Economy (LBL)

ISSUE

B. Resources Development Economics

DATA

Geothermal Energy Resources in Calif. (JPL) Econ.Study for Low Temp. Geo. Energy (VTN-CSL Program Definition for Geo. Energy (JPL) Econ.Analysis of Geo.Energy Dev.in Calif.(SRI 2nd U.N. Symposium on Geo. (LBL) Resource Tech. Environ., at Geysers (LBL)

- C. Change in local economic infrastructures due to geothermal development
 - 1. Housing and commercial availability
 - 2. Increased personal income/royalties
 - Induced economic impacts: pos. and neg. multiplier effects on other existing economic sectors; need for expan resident, commer., indus.areas impact on property values
 - 4. Possible constraints on expansion of local infrastructure
 - a) Public services
 - b) Existing land use, zoning rest.
 - c) Shortage of capital/materials
 - d) Transportation
 - e) Private Utilities
 - f) Duration of boom cycle
 - 5. Synergistic effects with other exogenous variables
 - a) General growth-recreation 2nd homes, rural-urban commute
 - b) Gambling

Housing Element, General Plan
Calif. State Abst., (DF)
Personal Income, yearly by sector (DF)
Income Taxes (FTB)
Taxable Sales (SBOE)
Building permits by County
Agri. Crop Report, each County
Public Services Element, General Plan

III. Economic Aspects, Public Sector

- County and City Governments
 - 1. Revenues from geo. dev.
 - a) Assessment pract. and policies for geo. properties
 - b) SB 90, Jarvis tax limits
 - c) TCA's, rates, special dist's
 - d) Exclusions, exemptions, deferments
 - e) Federal tax and land policies depletion, Homestead, etc.
 - 2. Costs of geothermal development
 - a) Regulatory services (environadmin., monit., inspec.)
 - b) Maintenance of quality of general public services
 - 1) Roads and airports
 - Sewers, water, public health solid waste
 - 3) Police/fire emergency
 - 4) Welfare/unemployment
 - 5) Health/medical

Assessment Pract. of SBOE
Assessors cooperative policies
A.V., Assessors
Tax rates, Auditor
County Budgets
Maps of TCA's and special dist.
Geothermal tax data (Assessor)
Sonoma Co.
Lake Co.

County Budgets
Gov.Costs/rev., Imperial Co. (IVEP)
Public Welfare in Calif. (DBP)
Annual Traffic VLS., Caltrans
Roads Needs Study, Lake Co. (DMJM)
Regional Transport Plan
Sonoma Co.
Lake

Lake Napa Mendocino

Master Environ. Assess. (SRI)

Recreation Travel Study 1976 (ea Co)Caltrans Airport expansion Planning Grant Appl

Lake Co., DMJM

copies of legislation, govern. code etc.

Susanville Geothermal Project (VTN-CSL)

- 3. Cost/Benefit expenditures, Options
 - a) Tax rate reductions-SB 90
 - b) Expan pulbic services and recreational facilities
 - c) Public utility options
 - d) In-lieu tax payments-capital projects
 - e) Shift in tax base

B. School Districts

- 1. Change in ADA
 - a) Numbers
 - b) Social characteristics
- 2. Revenues
 - a) Revenue, tax rate, A.V. limits SB 90, Ab 65, Jarvis, etc.
 - b) Federal tax and ownership policies
- 3. Costs
 - a) Faculty and services
 - b) Facilities and materials

IV. Land Use Aspects

- A. Existing Conditions
 - 1. Land use

 - 2. Zoning3. Geothermal leasing
 - 4. Geothermal development
 - 5. Regulations and plans
- B. Potential future geothermal and induced development
 - 1. Short run
 - 2. Long run
- C. Potential conflicts or constraints on future development w/
 - 1. Land use
 - 2. Land use plans and regulations
 - 3. Environ. impacts

ADA figures (local dist.)

district budgets boundary maps

building bond proposals

General Plan elements: list

Ordinance codes etc. zoning maps

land use maps

geothermal lease maps (LBL, Munger Oilogram)

geothermal development maps

Lake Co., Sonoma Co., and E.I.R.'s

permit applications

Require for Accel. Geo. Devel. in Calif. (JPL)

Working Papers, Scenarios, (JPL)

V. Political & Regulatory Aspects, local, state, federal (region)

A. Characterization of present regulatory bodies and members and policies

Internal policy and summary papers (OPR)

Status of Geo. Dev. (JPL) Working Papers (JPL)

Regulatory Aspects (B)

Human Assessment (Churchman LBL)

Program Definition (JPL)

Geothermal Energy-Law (USC)

State Geothermal Task Force Report Internal policty and summary papers (CERCDC) for projection purposes. More specific evaluation of existing data is needed before any impact projections can be made.

3. Recommendations

The basic recommendation of the socio-economic element is to perform socio-economic data gathering and analysis. The workshop participants suggested that both regional, and individual county assessments be done. In addition, they wanted each phase of the development examined individually and cumulatively. They insisted that the information produced must satisfy the needs of the various constituent interest group users and the general public in the GRIPS region. Finally, the participants felt that periodic monitoring of changes should be carried out in order to revise impact projections as necessary.

Based upon results of a questionnaire answered by local participants at the workshop, it appears that the top priority socio-economic issue area is land use. Second priority was assigned to the public fiscal concerns. Third priority was given to social and demographic and private sector economic aspects. The survey results also indicated which single issues are the top priority; briefly listed, they are:

What will be the impact on the "quality of life?"

What will be the environmental-vs-economic effects on Lake County?

Are there conflicts with community values?

Local vs state vs federal regulatory controls and policy goals.

Impact of tax exempt development projects.

Identification and protection of and use sensitivities, compatibilities, commitments; zoning.

Control of emissions through insured compliance with use permit conditions.

Citizen awareness and input into planning decisions; who really controls the planning?

Geothermal energy steam pricing policies.

Local impacts of geothermal development.

Aesthetic impacts of roads and transmission corridors.

As can be seen from all the socio-economic issues, many are of a type that can be researched. However, some of the issues are not really researchable in a traditional dense, but are more related to political values, regulatory processes, and public information. The issues and their priorities are used to give direction and scope to both proposed research and improved processes discussed below.

It must be remembered that revision of the methodologies now used by state, federal, or local agencies is not recommended. Instead, as a better base data is generated by GRIPS, the respective agencies can incorporate them into their processes. Specific recommendations are made in the following areas:

geothermal development scenarios,

land use aspects,

public sector economic aspects,

social and demographic aspects,

private sector economic aspects, and

larger context political and regulatory aspects.

Estimated research program costs and priorities are presented in Table II:5.

a. Geothermal Development Scenarios

While the workshop participants did not specifically designate development scenarios as a top priority need, it is the recommendation of

TABLE II:5 Estimated Research Program Costs and Priorities

		Person Months	Approximate Cost
A.	Geothermal Development Scenarios	2	\$ 12,000
В.	Land Use 1. Existing and new data collection and mapping	9	50,000
	 Sensitivity classification Project land consumption Assess land use impacts Multiple resource and land uses Improve Planning process (See Sect. F) 	6 1	36,000 5,000 91,000
с.	Public Sector Fiscal 1. Data Collection 2. Public services impact assessment 3. Tax revenue generation 4. Tax revenue complications 5. Local energy use options	2 3 2 <u>3</u>	12,000 18,000 12,000 18,000 60,000
D.	Social and Demographic 1. Collect existing and new data 2. Projections without geothermal 3. Projections with geothermal 4. Community values profile 5. Visual impact analysis	17 2 3 4 26	106,000 12,000 18,000 25,000
E.	Private Sector Economics 1. Gather existing data-data base 2. Projections without geothermal 3. Projections with geothermal 4. Resource development economics 5. Impacts of multiple resource and land use options	3 3 1 1 8	15,000 15,000 5,000 5,000 40,000
F.	Political Values, Public Information, Regulation 1. Public information/education system 2. Review regulatory and improve planning processes (limited effort only) Total	(See Chaps 1 (approx.)	ter V)

GRIPS that a series of numerical development scenarios for the KGRA be produced. The scenarios (low, moderate, and high development), based upon a review and revision of development projections prepared by the USGS and JPL, would utilize only geophysical indicators to generate numerical projections and general locations of possible electric and non-electric geothermal development. These scenarios would then serve as the initial input, or "driver" for all of the impact calculations proposed below. One of the final products of the GRIPS analysis could be a thorough refinement of these scenarios based upon the impact analyses and development constraints.

b. Land Use Aspects

Six tasks are recommended related to land use:

<u>Task 1:</u> collection of all available baeline land use information for The Geysers KGRA and surrounding area likely to be impacted, and its depiction upon base maps of a standard scale for all four counties;

Task 2: classification or categorization of present and future land uses according to sensitivities to geothermal development;

Task 3: estimation and location of potential consumption of land from direct and indirect electric and non-electric geothermal development, induced commercial, industrial, and residential, and from "background" non-geothermally related land use changes. This would be based on the scenarios, and economic and population forecasts;

Task 4: incorporation of data from all of the above tasks, by assessing the potential land use impacts that might occur based upon the scenarios produced above, and to identify areas of land use conflict;

<u>Task 5</u>: suggestion and analysis of the feasibility of multiple resource and land use options available to the counties and to locate potential areas for implementation; and

Task 6: development of mechanisms to improve local land use master planning for geothermal development by completing zoning and revising general plan elements as needed, with continual emphasis upon an "open planning process." In addition, a review of past permit

conditions, compliance, monitoring, and enforcement should be undertaken.

c. Public Sector Economic Aspects

A cost-revenue study is recommended for the major public agencies and special districts in the Geysers region:

Task 1: data gathering phase: budgetary, cost, tax rate, assessment practices, applicable tax laws, engineering cost data, and facility/service load data should be collected for each agency and district to be studied;

Task 2: estimation of the increased load produced by geothermal development on the primary and secondary public facilities and services to be analyzed, and the relative priority that regulatory agencies give to the processing of geothermal permits or mitigating its direct or indirect impacts;

Task 3: estimation of increased and secondary induced urbanization, and a generic identification of who actually pays the property taxes;

Task 4: analysis of the potential complications or disruptions to tax revenue streams that may occur because of the Jarvis Initiative, SB 90, Serrano-AB 65, tax exemptions, cyclical economic events, different assessment practices and other such factors; and

Task 5: analysis of expenditure options for local government if geothermal development generates an excess of revenues over costs. A feasibility study for the formation of a geothermal municipal utility district (GEOMUD) should be included in this analysis.

d. Social and Demographic Aspects

Recommendations for the demographic assessment include the following tasks:

Task 1: collect and assess all available baseline data (coincident with the economic study below). Any baseline data necessary to the analyses which are not available, or inaccurate as presently collected, should be replaced by new data to be generated through surveys, sampling, or estimation as needed. Public opinion surveys may be included in this task to document attitudes regarding growth and community values, environmental impacts, and geothermal regulation;

Task 2: estimate population and other demographic variable trends and causes unrelated to geothermal development. All recommended independent survey and estimation tasks should be done in close conjunction with the Population Research Unit of the California Department of Finance;

Task 3: estimate changes in population (including cyclical events) and other demographic variables associated with primary geothermal (electric and non-electric) and secondary induced growth. Included should be an estimate of the residence and consumption patterns of geothermally related populations, particularly with reference to commuting and locally residing workers. As development proceeds, periodic monitoring of demographic changes should be done to revise the projections;

Task 4: develop a community value profile and assessment of the potential for social conflict between existing and newly arrived social groups. This analysis should address the difficult questions of what impact will geothermal development have on the local "quality of life," and which socio-economic groups stand to benefit or lose the most; and

Task 5: expand the P.G.& E. Comarc viewshed analysis program to other areas in the KGRA likely to experience development. Aesthetic amenities requiring protection and possible visual mitigation measures should be identified. A thorough visual impact analysis is recommended.

e. Private Sector Economic Aspects

The following five tasks are recommended in regard to private sector economic analysis:

Task 1: assemble all available economic, land, and water resources baseline data to build an accurate data base recommended for performance concurrently with each Task 1 above. In addition to standard federal government statistical sources, local government, employment, social and welfare agencies should be interviewed for unpublished information particularly concerning local unemployment and skills profile of the unemployed. Information should be sought from developers concerning job descriptions, requirements, and salaries;

Task 2: project economic growth for the four counties assuming geothermal development did not occur. This projection will serve as a baseline in time against which to compare the results of Task 3 below:

Task 3: estimate future economic conditions for the four county GRIPS region combined, and by individual county, assuming that geothermal development proceeded at each of the scenario rates. The projections should include all induced labor needs, including drawing from the present unemployment pool, and positive or negative impacts on existing and future non-geothermal economic sectors and property values. Thus, cyclical direct electric, non-electric, and induced effects need to be estimated over the timespans of the forecasts;

Task 4: would be an analysis of resource development economics as it actually operates at The Geysers. The relative impact of foreign vs. domestic equipment purchases should be investigated. Attention should be given to determining the various costs associated with development such as opportunity costs, mitigation costs, and pollution costs. An analysis of geothermal steam pricing policies should also be included in this section; and

Task 5: analysis of economic impact of direct heat, multiple resource, and multiple land use options proposed in Task 5 under Land Use. Many of these related industry options are either labor or capital intensive, which factor may largely determine the extent of the potential impact.

f. Larger-Context Political and Regulatory Aspects

The following paragraphs, relating to the larger political values and regulatory questions raised at the workshop, have been included in the socio-economic element of the GRIPS Plan:

Task 1: institute a wide spread public information/education system for The Geysers Region. Details of this recommendation are included in Chapter V. Such an information and participation system could be of great assistance in answering many of the questions about issues that have already been researched; and

Task 2: review geothermal regulation and planning in California, especially as it is done in The Geysers region, with emphasis upon improving and increasing the lead in local government regulation and management. Task 6 under the Land Use issue area (mechanisms for improving local planning and decision making in The Geysers region) could be expanded to include this recommendation. Proper incorporation of the resultant suggestions could do much in assisting government leaders in addressing the larger questions raised at the socio-economic and GRIPS Public Workshops. The successful completion of this effort and adoption by the GRIPS Commission would tie in well with the basic objectives and operation of the GRIPS program itself.

K. PUBLIC INVOLVEMENT WORKSHOPS

SOCIOTECHNICAL SYSTEMS, INC., under contract to GRIPS, and the four counties held four public workshops (one in each county) during the initial GRIPS planning phase. The purpose of these public workshops was to ask local residents, organizations, and institutions for their help in identifying their interests and concerns as issues and study objectives for GRIPS. The workshops were held as follows:

Mendocino County Veterian's Memorial Building Ukiah; Monday, October 24, 7:00 p.m.;

Napa County
Calistoga Community Center
Calistoga; Tuesday, October 25, 7:00 p.m.;

Sonoma County
County Administration Building
Santa Rosa; Wednesday, November 2, 7:00 p.m.; and

Lake County
Kelseyville Elementary School
Kelseyville; Thursday, November 3, 7:00 p.m.

The public workshops received wide publicity. The members of the GRIPS Staff Advisory Committee prepared the mailing list for the announcement of the workshops. Two hundred and fifty (250) individual announcements were mailed to local individuals, organizations, and institutions. Announcements were also made through local newspapers and radio stations. The newspapers printed the announcement either as Public Notices, Legal Notices, or full articles. The radio stations announced the workshops through either Public Service Announcements or newscasts.

KBLC Radio, Lakeport's local radio station, broadcasted a "Hot Line Program" Wednesday morning, November 2, 1977 on the GRIPS project prior to the Lake County Workshop. The purpose of this program was to explain the GRIPS project and announce the public workshops to the radio audience. The guests of the program were Donald Johnson, (Planning Director for Lake County), Larry Vollintine (Planner for Lake County), and Connie Wade (Public Involvement Coordinator for SSI).

The following list represents a subject area tabulation of the concerns and suggestions expressed by the public at the workshop:

SUBJECT AREA:	TOTAL	NO.	OF	COMMENTS:
			_	
Air			5	
Water			6	
Noise			2	
Ecosystem			2	
Agriculture			2	
Silvaculture			2	
Socio-economics			14	
Public Involvement			15	
Legal and Regulatory			19	
Geothermal Development Technology			16	
Alternative Non-Electric Uses of Geothermal				
Energy			2	
Land Use			5	
Park and Recreation			1	
Visual			2	
Geologic/Soils			6	
Circulation			1	
Data/Information Center			19	
Resource Definition			11	
GRIPS, Organization/Procedures			23	
Study/EIR Process			13	
Regional Impacts of Geothermal Development			4	
Other KGRA's			i	
Ownership and Leasing of Geothermal Lands			5	

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CHAPTER III: PRIORITIES FOR DATA ACQUISITION

This chapter presents an initial summary of the high priority data acquisition and related needs for information in the GRIPS region and an evaluation of the procedures for setting priorities for subsequent GRIPS data collection programs. It should be emphasized that this initial summary is not a GRIPS research policy statement. It is only an initial listing of the priority issues (high, medium, and low) identified through the aforementioned GRIPS/LLL workshops. Development of a single list of priority items for adoption by the GRIPS Commission is one of the initial projects of the GRIPS Data Acquisition Program described in Chapter IV.

A. PRELIMINARY ASSESSMENT OF DATA AND MITIGATION PRIORITIES

A number of environmental concerns identified at The Geysers-Calistoga KGRA which are currently impeding development or are expected to become significant in the future. These concerns were combined to form the following issues discussed below by relative priority (high, medium and low).

1. High Priority Issues

The most critical issue identified at The Geysers-Calistoga KGRA is related to the release of hydrogen sulfide from power plants, geothermal wells and steam by-pass systems. The two high priority issues are therefore:

Hydrogen Sulfide Abatement: can hydrogen sulfide emissions be reduced so that the air quality standard is not exceeded?

Hydrogen Sulfide Pollution Prediction: can the transport and dispersion of hydrogen sulfide in the atmosphere be predicted and used to assess the air quality impacts of geothermal power plants?

2. Medium Priority Issues

The following issues have been identified as being of medium priority:

Landslides: What can be done to reduce the damage to the environment due to landslides induced by geothermal development?

Noise Control, specifically: Can practical, effective silencing systems be developed that can be used to reduce the noise from the free venting of steam wells and the drilling of wells?

What are the appropriate noise criteria for communities within The Geysers-Calistoga KGRA?

What are the characteristics (sound pressure levels, frequency spectra, and duration) of geothermal noise sources and how accurately can sound pressure level and frequency spectrum be predicted at different distances from a given geothermal noise source?

Rare and Endangered Species: What rare and endangered plant and animal species exist within The Geysers-Calistoga geothermal region and what are the locations of their habitats?

Groundwater and Hot Springs: What is the potential for significantly degrading or depleting of potable groundwater supplies and hot springs as a result of geothermal development in the hot-water geothermal resource region?

<u>Water Management</u>: What water management problems are expected to occur with the development of the hot water dominated geothermal resource and how can these problems be mitigated?

Cooling Tower Drift, specifically:

What are the emission rates of boron, ammonia, mercury, arsenic, and sulfates from geothermal power plant cooling towers?

What are the atmospheric dispersive characteristics of cooling tower drift in The Geysers-Calistoga region and what is the size of the area affected by cooling tower drift?

What are the rates of deposition of these substances onto the ground and what are the rates of accumulation in the soils?

What are the effects of the deposition of these substances on terrestrial species, aquatic systems and agriculture?

Hydrogen Sulfide Effects on Agriculture: What are the effects of hydrogen sulfide on crops when exposed for long time intervals at very low levels?

Location of Future Development: Where will future geothermal development occur within the resource region and at what rate?

3. Lower Priority Issues

The following issues, each of lower priority than the previously listed issues have been identified:

Baseline Ecosystem Data: What baseline data are available concerning the terrestrial and aquatic ecosystems of the geothermal region?

Ecosystem Impacts of Accidental Spills: In the event of accidents such as spills of condensate and drilling sump contents, well casing failure, or well blowouts, what are the impacts on the affected ecosystems?

Centralized Data Base: Can and should a centralized information source for geothermal and environmental data about The Geysers-Calistoga region be created?

Hydrogen Sulfide Odor Threshold: What is the human threshold for the detection of the odor of hydrogen sulfide?

Particulate Emissions: What are the physical characteristics (particle size distribution, element content, emission rate) of particulate emissions from geothermal activity at The Geysers?

Weather Modification: To what degree can emissions of water and aerosols modify existing weather conditions?

Subsidence and Seismicity, specifically:

What is the potential for increasing subsidence and seismic activity as a result of geothermal activities such as the drilling of wells, producing geothermal steam and water, and injection of geothermal waste fluids?

How can one distinguish between naturally-occurring geologic activity and that which is induced by geothermal production?

Noise Effects on Wildlife: What is the effect of increased noise levels on the distribution, abundance, and behavior of wildlife species?

Long-Term Ecosystem Effects: What are the cumulative long-term effects on terrestrial ecosystems of the many environmental changes that accompany geothermal development?

Water Pollution: Geothermal vs. Natural: What can be done to differentiate between naturally-occurring water pollution and that induced by geothermal development?

B. METHODOLOGY FOR ESTABLISHING A MASTER LISTING OF GRIPS ENVIRONMENTAL RESEARCH PRIORITIES

Chapter II provides a review of environmental research needs in various technical areas. LLL staff have already constructed such a list which is available in the Executive Summary of LLL's "An Overview of Environmental Issues: The Geysers-Calistoga KGRA." LLL's list provided the basis for the GRIPS Preliminary Assessment of Priorities as noted in the previous section of this chapter. The next major step required by the GRIPS Commission is to construct a master priority listing of research projects including all technical areas.

After completion of the final Water Quality, Geology, and Health Effects element reports of the LLL/GRIPS Workshops, the GRIPS Commission will independently construct a final master priority listing of environmental research priorities utilizing a methodology to be chosen later. GRIPS staff recommends an adaptation of the methodology developed by LLL and summarized in the following paragraphs.

All relevant environmental research projects will be prioritized according to their potential for resolving issues or problems that will impede geothermal development if not properly controlled or mitigated. Priorities will be set in a quantitative manner by subjecting each recommended study to the following set of questions:

Does the study bear on an impact which is currently affecting the region and/or is expected to occur in the future?

Does the study bear on an impact which is restricted to the primary area of geothermal development, or does it extend beyond these boundaries?

Does the study bear on an impact that regulatory agencies consider serious enough to provide legal means of control?

Does the study bear on an impact that is currently an impediment to geothermal development, and is expected to be an impediment in the future? and

Would the study itself be an impediment to geothermal development?

Each recommended study will be assigned a numerical score from 1 to 3

(1=low priority; 2=medium priority; 3=high priority) for each of the four questions above. The overall priority for each recommended study will then be established by summing the total number of points assigned for those four questions. This methodology for setting priorities is direct and simple, and will establish a firm basis to seek funding for the GRIPS research effort for the first year. A sophisticated methodology for establishing research priorities was developed for the GRIPS Commission by SRI*. The adoption of this method, or one similar thereto, for use by the GRIPS Commission is not recommended now, but there are certain elements in SRI's methodology which might be incorporated later into the permanent evaluation system for use by the GRIPS Commission.

It is important here to mention that the GRIPS Commission has already begun to implement some of highest priority research studies noted in the previous section of this chapter; that is:

The GRIPS Commission working primarily through Lake County and Sonoma County APCD's respectively, have continued to collect meteorological and air pollution data essential to expedite permit decisions, and have already initiated work to spur the development of more effective H₂S abatement technology by industry; and

The GRIPS Commission has already received its first grant from DOE as an autonomous agency for a study of peregrine falcons in The Geysers-Calistoga KGRA. (The lack of sufficient data regarding the habits of peregrines in this region led to a prohibition of geothermal development in a portion of the KGRA, and was the sole reason for delays in exploratory drilling.)

^{*}SRI Draft Report, March 1978: Methodology For Establishing R. & D. Priorities.

Part three:

PLANNED PROGRAMS

A. OVERALL PROGRAM DESCRIPTION

The overall GRIPS data acquisition and data management program consists of five elements. These elements, which are described in more detail in the following sections, are:

Data Acquisition Projects: GRIPS will use or refine the list of priority projects in Chapter III to support or participate in reserch activities to fill identified environmental and technologic needs;

Region-Wide Environmental Assessment Projects: GRIPS will establish appropriate procedures for, and will develop the capacity to produce, a Master Environmental Assessment for The Geysers-Calistoga KGRA. GRIPS also will develop the capability to produce EIRs and EISs needed for permitting decisions on geothermal development in the four counties;

Mitigation and Technologic Projects: GRIPS will suggest a series of recommended projects needed for filling the existing data gaps related to those geothermal development problems which have adverse environmental consequences:

Research and Data-Gathering Coordination: GRIPS will develop cooperative programs with Federal, State and other local government agencies as well as private industry, the general public, and academic to coordinate research efforts; will establish formal contracting procedures; will serve as a Committee for quality control of research in the region; and will serve as the regional program integration body; and

<u>Data Base Management</u>: GRIPS will use existing library facilities to handle the initial data base management and will explore the suitability and feasibility of the development of a specific GRIPS data base management system.

The overall data acquisitions and management objective of GRIPS is to gather and make available site specific and region wide environmental data so that the potential impacts of development can be understood and the decision making process improved and expedited. It is recognized that a local-state-federal cooperative venture is not necessarily a new concept. Yet in the case of GRIPS, a unique feature has been the local

mitigation of the program and will continue to be local directions and management. These efforts will, of course, utilize the support and collaboration of the other participating agencies and entities.

The emphasis upon local control stems from the fact that traditionally local government is responsible for land use decisions. Geothermal steam well development is the necessary initial phase of the productions of geothermal energy. Steam field development is a local land use decision and its permitting by local government constitutes a land use commitment. In addition, it is the local citizens and their local officials who must live with the eventual development. Their primary concern is that the development, if it is to be permitted, be done in the best manner. The extent that other agencies also have regulatory possible control over additional aspects of the development forms the central basis of cooperation in the GRIPS Program.

A locally directed GRIPS effort is, therefore, the best mechanism for insuring that:

The proposed research projects and planned programs will answer specific problems, and

The data produced will be used in the decision making process.

B. DATA ACQUISITION PROJECTS

GRIPS will:

develop and adopt a specific priority list of recommended study areas and operational progreams for implementation in The Geysers area taking into consideration the needs of CEC, BLM, DOE, and other local, state and federal regulatory agencies;

initiate and contract for specific research projects following priorities established by the Commission;

act as a clearinghouse for research projects of mutual concern as may be required and authorized.

report, hear and adopt the above as may be required;

develop operational procedures for obtaining funds, screening proposals, managing contracts, monitoring progress, and utilizing the data for research projects into The Geysers region.

GRIPS will emphasize those research needs identified by the member counties acting through the Commission. In addition, the needs of DOE, CEC and other regulating agencies will be included to reflect the needs of prime permit decision which must be made by agencies other than the counties.

C. REGION-WIDE ENVIRONMENTAL ASSESSMENT PROJECTS

GRIPS will establish capabilities to accomplish three forms of region-wide environmental assessments. As described in the following paragraphs, they are:

Master Environmental Assessment,
Suitability Analyses, and
Environmental Impact Reports/Statements.

1. Master Environmental Assessment

The staff of the GRIPS Commission will prepare to compile Master

Environmental Assessment (MEA) for The Geysers region consistant with the

Guidelines Section 15069.6 of the California Administrative Code

(recently promulgated by the Secretary for Resources on January 24, 1978)

that can be certified according to usual EIR certification procedures.

The new guidelines specifically permit MEAs to be prepared through a

joint exercise of powers agreement by neighboring local agencies. The

MEA can serve as an organizational framework for impact assessment data,

and can include an integrated assessment of the cumulative impacts

associated with various levels of development in different portions of

The Geysers region. The MEA should be periodically revised and expanded

to incorporate new information as it becomes available.

The major function of The Geysers area MEA will be to provide a common base of information that can be used either cooperatively or individually by the county governments, BLM, USGS, State Lands Commission, California Energy Commission and other state and federal agencies: (1) to evaluate long term plans for geothermal development and associated impacts (positive as well as negative) at the regional level,

(2) to allow the respective regulatory agencies to plan for appropriate levels of geothermal development consistent with the goals, objectives and requirements of those agencies, and (3) to assist in resolving policy conflicts and inconsistencies among jurisdictions regarding choices of resources to be developed in the same area.

a. MEA Contents

The MEA will be consistent with information requirements of EIRs as stated in Article 9 of the California Administrative Code, and will be sufficiently comprehensive to cover the geographic region contained within The Geysers-Calistoga KGRA. The level of detail usually provided for the site specific EIRs is not available for the entire region, but sufficient detail will be provided to permit governmental agencies to identify subregions potentially suitable for geothermal development and to define appropriate levels of development for those subregions. Site-specific data will be incorporated as it becomes available in the EIRs/EISs prepared to support proposed development projects.

The most significant component of the MEA for planning purposes can be an integrated assessment of the cumulative environmental impacts (as identified individually in Chapter II) associated with alternative scenarios of geothermal development for The Geysers-Calistoga KGRA as recommended in the socio-economic section. The use of scenarios is a very helpful tool for projecting potential levels of geothermal development. Such a scenario*, in general form, is already available for

^{*}JPL Publications, 77-63, "Analysis of Requirements for Accelerating the Development of Geothermal Energy Resources in California." 11/15/77.

The Geysers region, and refinements to the general scenario have been initiated recently by Science Applications, Inc. under funding by the Department of Energy. These scenario projections will be used as a basis for preparing detailed alternate scenario projections (i.e., low, medium, high) for The Geysers-Calistoga KGRA. Once these scenarios are complete, the cumulative environmental impacts from all sources (air quality, water quality, aesthetic, socio-economic, etc.) will be tabulated. A detailed inventory of mitigation measures and their effectiveness will be maintained as a part of MEA in order to make the determinations of expected impacts after the most effective mitigations have been applied.

The end product should be a detailed assessment of the combined impacts, after mitigation, over the long-term for each of the alternative development scenarios chosen.

b. MEA Uses

The MEA can be used by The Geysers counties and by State and Federal regulatory bodies in a three phased process for planning and decision making regarding geothermal energy development:

Phase I: although a portion of The Geysers-Calistoga KGRA has been intensely developed for geothermal power production, a much larger portion remains undeveloped. According to present concensus, this undeveloped portion has tremendous potential for generating electric power from hot water as well as dry steam resources, and for a number of direct heat uses. The first phase will consist of identifying the major environmental constraints to expanding geothermal development into undeveloped areas, and determining the compatibility of geothermal development with existing land uses (i.e., an analysis of land use suitability for geothermal energy development);

Phase II: for those portions of the KGRA which appear to be compatible with expanded geothermal development (as identified in Phase I), the second phase will consist of performing integrated assessments to determine the long range, area wide, and cumulative impacts of alternate levels of development for electricity production and for direct heat uses. These assessments can provide the basis

for making planning decisions by appropriate bodies regarding permissible levels of development in certain areas, the conditions and standards which must be observed during development and operation phases, and the mitigation measures which must be applied (and the efficiency levels expected) to insure minimal or acceptable levels of impact. In short, the second phase effort will establish "guidelines for development". These guidelines may, at the discretion of the county governments, take the form of a geothermal element to the county plan or geothermal ordinance, or use-permit conditions, or may be included as lease arrangements in any subsequent decisions to lease State or Federal lands; and

Phase III: the third phase will consist of evaluating individual projects for their compatibility and compliance with the guidelines established under Phase II. The MEA will provide a central source of current information and a common base of data and standards with which to conduct environmental assessments. All entities should be required to refer to the MEA prior to preparing individual EIRs, EISs or Negative Declarations, and will be expected to summarize and reference relevant portions appropriate to the individual project under consideration. In addition, the MEA will contain methodological requirements for collecting new data and expressing that data as required by the form and operation of the information system. This will insure that when new data is collected during the preparation of individual EIRs/EISs, that data is consistent with the already existing data base and can be easily incorporated into it. Finally, for all projects approved under Phase III, monitoring systems and enforcement capabilities should be required to verify the efficiency of mitigation strategies, and the compliance with all conditions and standards which apply; the monitoring data will also be incorporated into the MEA data base.

The environmental assessment procedures described will substantially reduce the duplicative assessments that have occurred in the past thus reducing the associated regulatory costs and times. But more importantly, it will provide for a more orderly and consistent environmental review process than has heretofor operated at The Geysers.

^{*}Using the techniques contained in the following reference as well as others: Lewis D. Hopkins: "Methods for Generating Land Suitability Maps: a Comprehensive Evaluation," AIP Journal, October, 1977.

2. Suitability Analyses

In addition to, but as part of the MEA process, GRIPS will explore a variety of methods for the preparation of "suitability analyses"* and select one or more for use in their program.

The objective of land suitability analysis will be to prepare a map (or maps) of the region which shows land areas classified, or ranked, in terms of suitability for a particular use. The methodology used to rank areas can vary, but generally involves a combination of land characteristics (geology, soils, vegetation, flood hazard, etc.) into a single matrix of suitability following a set of combination rules.

For GRIPS purposes, a land suitability map might be developed to rank areas in terms of suitability for geothermal development. Areas of low suitability might be excluded from consideration, or might have specific associated environmental standards which could be used to mitigate against development problems. Patterns of suitability could also be used to guide power plant siting and field layout.

3. Environmental Impact Reports/Statements

Pursuant to existing Federal and State procedures, it is possible for GRIPS to serve as staff for, or to manage, the production of EIRs or EISs or combined documents. GRIPS will develop the capacity to meet requests for the preparation of such documents or to manage their preparation under contract by qualified organizations. A specific outline for the development of this capacity will be prepared by GRIPS staff after the selection of an Executive Director.

D. MITIGATION AND TECHNOLOGIC PROJECTS

In addition to the environmental data acquisition projects outlined above (Section B), GRIPS will develop a set of recommended projects for development of information and/or techniques for the mitigation of technologically introduced impacts. This information will then be made available to participating agencies for attachment to development projects that they wish to permit. No specific program has been defined to date; the development of a prioritized list including, but not necessarily limited to, those technologic aspects summarized in Chapter III, will be one of the next GRIPS Commission efforts.

The following observations will serve as guides for development of the mitigation and technologic projects list:

the invention or development of new products or the adaptation of existing products, necessary to secure the data to be interpreted (the problems of the inadequacies of H₂S sensors and airborne sampling equipment are examples of this category). In general, this effort includes the building of hardware or scientific tools and equipment, using existing industrial and commercial technological processes;

in some instances the ability or the means to secure data, or to use it, to minimize unwanted effects of large scale commercial geothermal energy production does not exist. This situation is not unique and it has been characteristic of the development of new energy resources in the past. Until the methods and the necessary mechanisms or tools are available to measure and mitigate adverse effects, there is a point beyond which the collection of iterative data becomes, at best, a contribution to basic science rather than a mean to expedite geothermal energy development in an acceptable manner in acceptable locations; and

it is clear that the objectives of the GRIPS agency can best be attained by direct and continuous interest and involvement in the formulation, structure, and funding of R & D programs which suit the needs of the region.

E. RESEARCH AND DATA-GATHERING COORDINATION

This section presents recommendations for managing the needed coordination of research and data gathering. The two basic forms of coordination which are necessary for the success of the GRIPS effort are cooperative programs and contract research. These forms are discussed in the paragraphs which follow together with some initial recommendations regarding quality control and an overall regional program integration effort.

1. Cooperative Programs

Research and data gathering efforts have been undertaken by various Federal, State and local government, industry, and academic organizations. Past experience has shown that a less than satisfactory communicative and cooperative relationship has existed between all parties. GRIPS proposes to help remedy this problem. GRIPS need not have formal contract management responsibility for all efforts to influence their utility for GRIPS purposes. Program design, timing, and product management can be affected for GRIPS through a cooperative program in which GRIPS' concerns and product needs are regularly and systematically brought into the other programs.

The GRIPS staff will be available and responsible to participate with other entities in the design and operation of their research programs to facilitate the cooperative spirit. While the overall goals of such participation are essentially the same for each organization (e.g.: to ensure that each agencies concerns and research needs are made known to all others, and that GRIPS-related products are developed from each effort and made available to the GRIPS members) the specific cooperative

form may be different for each type of organization. Some preliminary suggestions are described below; final organizational arrangements will be made by GRIPS staff.

a. Federal

At the present time the federal government has several levels of cooperative programs. Within DOE there is the "Geothermal Environmental Coordinating Committee" which meets once a month. This committee provides overview appraisals and funding recommendations related to DOE's responsibility to facilitate the development of geothermal resources nationally. At the federal interagency level there is the "Intergovernmental Geothermal Coordinating Committee" which provides a forum for discussion of possible mutual federal agency interests in various geothermal projects. The chairman of this committee is the head of the Division of Geothermal Energy (DGE) of DOE.

Under leadership provided primarily by the U.S. Geological Survey, a number of Federal agencies are represented on the Geothermal Energy Advisory Panel (GEAP) which serves to provide general technical counsel on geothermal development on Federal lands. Additionally, the Federal government has organized Federal Research Councils (FRCs) operating in different regions of the United States. The purpose of these councils is to provide interagency coordination between Federal agencies.

It is planned that GRIPS will make the necessary arrangements to become an ex-officio member of GEAP and California FRC and that it regularly participate in the DOE committees through the DOE appointee to GRIPS and selected additional participation by GRIPS commissioners and/or staff.

b. State

As a result of the recommendations of the State Geothermal Task

Force, (Kapiloff Committee) the concerns of the Resources Agency, and the
concerns of the California Energy Commission, the State's Geothermal
Resources Council will be taking a more active role in the interagency
coordination of the State's interests in geothermal development.

It is recommended that GRIPS regularly represent The Geysers area regional data interests before both the Council and the California Energy Commission. Additionally the State's appointee to the GRIPS Commission can represent GRIPS at regular general meetings and alert the staff or other commissioners when specific GRIPS matters might be scheduled to come before either party, or the Legislature. As during the previous phases of the GRIPS effort, it is expected that the Energy Commission will be represented at the staff level through their continued participation in the Staff Advisory Committee.

It is also recommended that GRIPS encourage and facilitate the establishment of formal cooperative relationships between each member, county and the California Energy Commission, or other state agencies, for their mutual compliance with the California Environmental Quality Act. Lake County has recently submitted a proposal to CEC to provide for preparation of unified full-field/power plant EIR's for projects where both county and state have lead agency authority. The exchange of environmental data, staff expertise, and combining of public hearings are also suggested as possibilities. The purpose of this venture is to improve the overall geothermal environmental review and decision making process while shortening the processing time and reducing overall regulatory costs.

c. Local

The most critical communication link for GRIPS is its continued cooperation with the counties and their respective staffs. The key to this cooperation will be the continued participation of members of the Counties staffs in the GRIPS Staff Advisory Committee and Board members of the GRIPS Commission. The GRIPS staff will schedule meetings with county members at least two times per month. These meetings are particularly important since the county staffs will be integral components to the successful implementation of the Public Participation Program. Further, GRIPS staff will copy each of the GRIPS commissioners and one (1) designated county staff member on all GRIPS:

contracts,

cooperative agreements,

project reports (progress and final), and related technical and policy matters.

"lead-people" for specific technical areas. A specific list of personnel and subject areas will be developed annually and be expanded/reduced as each country adds/deletes pertinent disciplines to their staff or as technical areas are identified. Staff time contributions can represent the counties continued "in-kind" committment to the GRIPS program.

d. Industry

In 1977 the industrial organizations operating in The Geysers region established a "Geysers Geothermal Environmental Committee" (GGEC) as a subcommittee of the G.O.C. The initial effort of that Committee was to fund a study "to gather, assess, and analyze information on all past and

ongoing efforts at studying hydrogen sulfide emission and receptor data related to geothermal development in (a portion of) The Geysers area, California." GRIPS has been represented in their initial project design through participation by the Lake- and Sonoma-County Air Pollution Control Officers. Data from this study will be inputed into the GRIPS central data system.

It is planned that GRIPS will develop procedures for it to attend the GGEC (and other industry councils as needed) on a regular basis in order to provide a direct, industry-wide cooperation link. A GRIPS staff member or commissioner should be the regular attendee with other commissioners, staff, or SAC members being called in for participation on specific technical matters.

e. Academia

An approach to the coordination of academic research will be developed by the GRIPS Commission.

2. Contract Research

One of GRIPS' major efforts will be to serve as a focal point for contract research programs. To function in such capacity GRIPS will develop specific proposals for obtaining master grants or contracts from funding agencies and specific forms for research contracts. The details of the programs will be drafted by the Executive Director for adoption by the GRIPS Commission using the following set of basic considerations.

a. Statements of Qualifications

It is recommended that GRIPS adopt a procedure for securing

Statements of Qualifications (SOQs) from prospective contractors to

conduct research for GRIPS. As a minimum, such statements should include:

the organization's experience in the technical areas and geographic areas in question;

the personnel available for research and their specific related experience;

examples of previous work;

basic charge rates;

compliance with equal rights procedures and requirements;

ability to handle work load; and

available facilities and special equipment, if any, required for the work time for the project.

Procedures will be developed so that the organizations can update their SOQs' annually and so that the information can be summarized systematically for rapid dissemination to all GRIPS Commissioners, staff, and others as needed.

b. Requests for Proposals

GRIPS requests for proposals (RFPs) will be written with sufficient specificity to provide a basis for preparation of creative equivalent proposals by organizations responding thereto, but should not be so specific that they restrict creative responses. Each RFP should provide a concise statement of:

the problem to be addressed;

scope of work;

the time schedule and work level;

the expected products;

the basic program budget;

any specific personnel or experience requirements; and evaluation criteria.

Furthermore, each RFP should clearly indicate the necessity for the respondents to provide a specific, detailed statement of work, delivery schedule, and list of deliverables as the focal point of their management proposal. It should not be the purpose of each request for proposals to require respondents to document all experience and detailed background. Furthermore, it is recommended that the adopted SOQ-RFP procedure include a pre-qualifications screening procedure so that lengthy documents or an unnecessary number of proposals would not be expected or requested.

c. Contract Management

It is recommended that all contracts be managed by a GRIPS staff member designated as "contract administrator" (specific personnel recommendations are presented in Chapter VI). As noted previously, copies of all contracts should be sent to each commissioner and designated county staff member and made available to all SAC members.

Contract management should include periodic reporting. However, such periodic reports should be of a technical nature so that they will "build" toward the final technical reports. To meet this end, it is recommended that each contract (or as many as possible) contain the requirement that the contractor prepare a recommended outline of their final report for submittal to GRIPS within thirty (30) days of execution of the contract and that the outline specify the "partial" products to be used as the periodic reports (interim deliverables). It should be the contract administrator's responsibility to bring these outlines and reporting plans to the attention of the full GRIPS Commission, with copies to the responsible funding sources, within thirty (30) days of receipt from the contractor, and to have the materials reviewed and

"adopted-in-principle" before the project is underway more than two (2) months, or to suspend the work until such materials are satisfactory to a majority vote of the commission pursuant to the voting procedures specified in the Joint Powers Agreement.

It is also recommended that as often as feasible, contracts be' awarded on a "Task Order" basis. That is: as often as possible, contractors' projects will be divided into distinct tasks under a master project plan. Subsequent Task Orders would be executed in sequence as interim deliverables are completed. It is felt this procedure will provide GRIPS a maximum of contract control and accountability.

It is recommended that additional contract management procedures be adapted from those currently in use by the California Energy Commission and adopted for use by GRIPS.

3. Quality Control

Quality control is one of the key responsibilities of GRIPS. Toward that end the GRIPS Commissioners, or a subcommittee thereof, will serve as a controlling body to establish and enforce quality control procedures. This will include but not be limited to:

review data requirements (annually);

review research priorities (annually);

write (or coordinate the writing of) research problem statements;

establish contractor quality control check list;

review and comment on all qualifications statements;

participate in the screening of all proposals;

monitor technical performance (periodic reports);

establish technical reporting format (including map scales, related graphics; and

establish and review procedures for systematic evaluation of work being "followed" by GRIPS through the coordination programs monitored in the preceeding section.

Composition of this Committee (which as noted could indeed be a "Committee of the Whole") should be subject to careful consideration by the Commission. The membership should include the Executive Director, at least one GRIPS Commissioner, and 2 or 3 SAC members bringing the total to a minimum of five on the committee. It is recommended that the Committee report at least quarterly to the full commission on the progress of all research work, including both contract research and coordination programs.

4. Regional Program Integration

The strongest coordination effort that can be developed to benefit

The Geysers Region would be a single forum comprised of interagency,

intergovernmental, industry and the public and private sector to:

recommend priorities for research programs;

develop cooperative work programs;

organize research effort-finding and geographic coverage; provide common data for individual as well as common needs; and advise generally on research and data gathering and methodologic needs.

GRIPS will be developed as such a regional environmental data forum. It would appear that the government codes which were followed to establish the GRIPS Joint Powers entity provide for such a vehicle through the possible establishment of a "GRIPS Advisory Committee" which could be composed of Federal, State, or local members or members from the general public or private sector as well:

6508: Government Code: "The governing body (commissioners) so created shall be empowered to delegate its functions to an advisory body or administrative entity for the purpose of program development, policy formulation, or program implementation, provided, however, that an annual budget of the agency to which the delegation is made must be approved by the governing body of the Joint Powers Agency."

F. DATA BASE MANAGEMENT

A comprehensive data base management (DBM) capability is required for the extensive GRIPS data base; however, it has been concluded that, at the present time, the DBM requirements have not been adequately specified and a specific program should be developed only after GRIPS has a permanent staff. This section, therefore, presents:

- a brief summary of the available facilities, and
- a review of the characteristics of possible facilities.

1. Existing Library Facilities

Existing libraries can be used by GRIPS until the final desirability and design of a GRIPS data base system is established. The Pacific Union College, at Angwin in Napa County (a GRIPS participant) has a biological data base that is unique in the United States. All of the public libraries of the four GRIPS counties are organized as a Joint Powers Agency which also includes Sonoma State College (Pacific Union College is an associated member of the agency). Membership in the Library Joint Powers Agency includes Marin County and Colusa County. The library agency has a data processing center in Santa Rosa and provides or participates in the services of information programs for other agencies. The library system in fact is a long-standing example of the same regional integration of functions for specific purposes that is proposed by GRIPS.

2. Possible Facilities Development

Towards the ultimate development of a DBM system, two major immediate steps have been identified. The first is the specifications for data

base management (DBM) needs capability; the second is a postulated methodology for the development of a prototype capability. A discussion of each of these approaches follows; both will be subject to further review and analysis by GRIPS prior to adoption and funding.

a. Data Base Management Criteria

In order to determine the data base management capability required for a particular application it will be necessary for GRIPS to perform a number of tasks. The work of these tasks can be extensive or limited, but the quality of the final product depends upon the care and detail of the work of each of the tasks. A set of possible tasks for this area are as follows:

determine scope and objectives;

determine data requirements/needs;

survey a range of existing, available, and realistic capabilities; postulate an approach (including viable alternatives);

prepare a feasibility/cost analysis;

review task work to date and make decisions as to which alternative to select;

prepare requirements specifications;

prepare evaluation requirements; and

determine acceptance/performance criteria.

The work of these tasks can be followed by the procurement of a DBM capability, its testing, and finally the actual operation of the capability in its intended environment if a separate system is desired.

b. Methodology for a Prototype Initiation

For a more limited approach to the implementation of a data base management capability, the following methodology can be used to establish a prototype capability based upon a selection of a subset of the total required capabilities. This approach runs the danger of not being sufficiently flexible ultimately to encompass the total required capabilities, but it can be useful in implementing a capability that will handle a substantial portion of the total activity level. Further, at a somewhat lower level of cost, users can gain increased familiarity with existing technology and capabilities, and use this knowledge to select a capability that will meet most existing needs. A set of possible tasks for this effort are as follows:

select or appoint an individual for the development of a responsible prototype (real end user);

select one or two data-types;

make a comprehensive determination of the analysis needs and goals; determine volumes and characteristics of the data;

define explicitly the procedures and outputs;

determine the location and number of users (and level of expertise); establish definitive requirements and specifications;

survey existing available services and equipment;

postulate a solution (in terms of the facility, configuration, and approach);

determine and consider alternatives;

write the specifications and the evaluation and acceptable criteria; and

prepare and "Go" for Bid to execute the system.

Many of the above tasks (or parts thereof) have been undertaken already for the GRIPS air quality and meteorological data base. As a result, this data base is an excellent candidate for development of a prototype DBM. Not only are the types and volumes of data known to a large extent, but over 70% already exist in computer form. Also many of the user requirements have been defined. Thus, the air quality and meteorological data base could be adapted to a DBM facility in the shortest time frame.

CHAPTER V: PUBLIC PARTICIPATION PROGRAM

The ultimate success of GRIPS will be measured in how well it provides information for decision makers and properly informs the general public. For this reason a continuing effort of GRIPS shall be devoted to developing, expanding and maintaining a comprehensive public information program. The following material presents a summary of the background and need for such a program, the program for future public involvement in GRIPS, and a suggested schedule.

A. BACKGROUND: A FOUNDATION FOR CITIZEN PARTICIPATION

The primary purpose of the public involvement process for GRIPS is to involve affected and interested individuals, special interest groups, institutions, the geothermal industry, and the "silent majority" in the planning process for geothermal development in the Geysers-Calistoga KGRA. The GRIPS public involvement process is, therefore, a joint public involvement process for the Counties of Sonoma, Lake, Mendocino, and Napa, and others which may enter the joint powers agreement in the future.

This public involvement process for GRIPS is intended to (1) provide those members of the public which are already actively interested the opportunity for personal involvement in the geothermal planning process, and (2) help those members of the public which are currently unaware and uninvolved to understand the issues and to become involved.

It is planned that the public be involved in GRIPS at all major points throughout the GRIPS effort. Public involvement from the beginning to the end of the program will provide both continuity and visibility, thereby maintaining interest on the part of the publics and accountability on the part of the decision-makers.

The public involvement process is included in the GRIPS project for the following reasons:

Consent of the governed (the democratic principle of public participation in the decision making process);

California Environmental Quality Act of 1970 (CEQA) mandates provision of adequate opportunities for the public to participate in decision making;

Establishment of open lines of communication between all participants;

Implementation of GRIPS projects will require public commitment to the results of decision-maker actions, and

Trust and confidence can be built through real communication means.

Informed decisions are the best decisions. The concerns of the affected and interested public are an integral part of the decision-making process, and must therefore be included if that process is to be complete and successful.

B. GRIPS PUBLIC PARTICIPATION PROGRAM

The GRIPS Public Participation Program consists of five key elements: identification and recognition of the public on a continuing basis; balanced use of general approaches for communication with the publics; involvement of citizens' groups; specific use of communication means; and continuous evaluation and replanning of communication-effectiveness.

1. Identification of the Public

The affected and interested publics may be identified in two ways.

First, the publics' participation in the initial public involvement process identified many of the interested groups and individuals. The publics' attendance at the GRIPS Commission public meetings and GRIPS/LLL workshops, and their response through the open channels for written and telephoned communication served and will continue to serve as the primary sources for the identification of the publics.

Second, active research will be conducted to reach the "silent majority", those potentially affected publics which may be currently unaware and uninvolved in GRIPS. The purpose of this search will be to inform these publics about the public involvement process for GRIPS and to invite them to participate. Categories of such publics include civic organizations, land-owners, leaseholders, tax-payers, recreators, resort owners and operators, students, and the retired. Sources of information to identify the public include public libraries, schools, Chambers of Commerce, County Assessors' Offices, and City and County Departments of Planning, Social Services, and Parks and Recreation. The primary goal of the GRIPS Public Involvement Program is to identify and recognize all of the "publics" and involve them in the GRIPS effort.

2. Approaches To Public Communication

There are two basic approaches to public communication: "mass" and "focused". The GRIPS program will use both approaches to ensure all segments of the public are contacted.

a. "Mass" Approach

This public involvement procedure is designed to reach large numbers of people at one time. The GRIPS public involvement process will employ both public meetings and public workshops. The public meetings will be intended for public briefings and presentations to provide the planners and decision-makers of GRIPS and the Counties the opportunity to inform and educate the publics.

The public workshops will be intended for informal discussions between all participants. This format provides the opportunity for all publics, including the decision-makers, to discuss informally and debate publicly any conflicting values and positions which might exist, thereby contributing to the identification of acceptable solutions and unnoticed mutual interests and concerns. Depending upon the attendance, the workshops will be organized into large or small group formats. All attendants will gather at the beginning of the workshops as a "large group." This provides the format for opening the workshops and providing information and instructions regarding the agenda. The participants will then break into three or four smaller groups. If the attendance is large, this "small group" format will provide for more informal discussion of the issues at hand, giving everyone a better chance to contribute to the discussion. Graphic aids, such as maps, photographs, films, and slides, may be employed during the public meetings and

workshops to provide participants with an informational base for discussion.

b. "Key-Group": Focused Approach

The public involvement procedure is designed for two way communication between GRIPS and participating key individuals and groups. Because of their past and current activities and/or their participation at the previous GRIPS public workshops, the following have been identified at this early stage as "key groups":

Sonoma County Tomorrow Madrone Audubon Society Nature Plant Society Redwood Regional Crinthalogical Society Lake County Energy Council Geothermal Association for Lake County Friends of Cobb Capital of The Age of Enlightenment for Northern California Vision Mound Sanctuary Tax Payers Association of Lake County Clearlake Water Quality Council, Inc. Anderson Springs Homeowners Association Redbud Audubon Society Navarro Watershed Study Rural Institute Tax Payers Land Use Committee, Mendocino County Napa County Citizens Geothermal Task Force Sierra Club Friends of the Earth American Association of University Women League of Women Voters Chambers of Commerce School, College, and Universities Geothermal Operators Council P. G. & E. Northern California Power Association

3. Citizens' Involvement Groups

GRIPS plans to create two specific mechanisms for formal citizen participation: a "Citizens' Advisory Council" and "Citizens' Study Committees." Each of these groups is described below.

a. Citizens' Advisory Council (CAC)

A GRIPS Citizens' Advisory Council (CAC) will be established from selected designates chosen from each of the four or more GRIPS counties to provide broad representation of all interested publics. It would thus be a KGRA-wide representative body from the publics. The recommended functions of the CAC will be threefold:

through continual evaluation and feedback of the public involvement process, the CAC would assist GRIPS and the decision-makers in developing and implementing meaningful analysis process;

the CAC or specific designates attend all Commission meetings. The key individuals and groups will be given the opportunity and responsibility to document and express the official positions of their organizations on the issues surrounding geothermal development in the KGRA before the GRIPS Commission; and

the CAC would be given the opportunity and responsibility for formal review of and contribution to the GRIPS project as it progresses.

b. Citizens' Study Committees (CSCs)

Members of the public who wish to review incoming data and the status of projects in specific technical subject areas (e.g.: air quality or water quality) or specific geographical areas (e.g.: Cobb Valley or Napa Valley) would be constituted as temporary "Citizens' Study Committees" (CSCs).

The purpose of the CSCs will be to comment on the relevancy of incoming data for GRIPS to answer the concerns and expectations of the public. Projects would be summarized by professionals to answer technical questions of the CSCs. The CSCs would also receive a copy of the specific topical information as it becomes available and have the opportunity to meet with the professional researchers during public workshops. The comments and suggestions of the CSCs from the workshop can be documented by the members and submitted to GRIPS and the various professionals involved.

All CSCs will be established by the CAC with a finite period for their operation; none will be permanent communittees.

4. Public Information and Communication Means

All reasonable communication means will be employed to reach the GRIPS public and to provide information. Actual specific efforts will be the responsibility of the GRIPS management.

a. Public Education, Libraries and Schools

In order for interested and affected public groups to participate actively in any planning process, they must understand both the process itself and the subject of that process. Therefore, a public involvement process is, in part, an informational and educational process. GRIPS staff, with the advice and assistance of county staffs will develop informational materials designed for the public utilizing many of the means suggested below. The purpose of providing this information is to inform citizens about geothermal energy, its problems and benefits, the status of research and data availability, how the regulatory process works, and how GRIPS operates. GRIPS may be able to coordinate with local educational institutions to arrange formal and in-depth educational programs for those who wish to participate. Sonoma State College has prepared a proposal for a Regional Geothermal Resource Center to be established "to facilitate, through education, public understanding of geothermal energy production and potential in Northern California." This proposal could provide a vehicle for coordinated public education about general aspects of geothermal development.

b. Media Contacts

GRIPS will establish rapport with Newspaper managing editors and radio and television station managers in the GRIPS region so that newsworthy items can be quickly and regularly published. It is important that the media understand GRIPS and its significance; such understanding will help to assure that GRIPS receives helpful and continual media coverage.

c. Open Telephone Channels

Telephone numbers and addresses of principal GRIPS leaders will be made available to the public so that the GRIPS organization remains "visible" at all times. This will provide the opportunity for the public to initiate involvement in, to submit evaluations of, and make suggestions for GRIPS projects and programs. These open channels will provide the opportunity for those who wish not to or can not attend public meetings and workshops to submit their values and concerns regarding geothermal development.

d. Mailing List

A mailing list will be compiled, listing all participants in the public involvement process who request receiving a Newsletter. The proposed sublistings of the mailing list are as follows:

Individual citizens,
Groups and institutions,
CSCs (key individuals and groups),
CAC,
Geothermal industry and utilities,
Internal public (GRIPS Commission; GRIPS Advisory Staff, local,
regional, state and federal government officials and representatives;
project consultants), and
Media contacts (newspapers, television and radio stations).

e. Newsletter and Questionnaires

GRIPS will prepare a periodic newsletter to serve as the official "information publication" for the GRIPS project and related matters and the public involvement process. Mail-back questionnaires will be sent out periodically as inserts in the newsletter, requesting public feedback and evaluation of the GRIPS project and the public involvement process.

f. Public Announcements

The dates, times, locations and agenda for all public meetings and workshops will be publicized in accordance with the Agreement. While the Agreement calls for a minimum notice of five days, meetings should be announced two weeks in advance whenever possible to facilitate public involvement.

5. Evaluation Criteria

GRIPS Communication efforts will be evaluated by the staff and Commission annually. The specific criteria to be used by the Commission for such evaluation will be finalized when the permanent staff is employed. It is expected that the criteria will include answers to the following questions (methods of evaluating are shown in parentheses):

Have all affected and interested public groups been informed of the planning and decision-making process for geothermal development in the Geysers-Calistoga KGRA? (Direct Survey);

Have all affected and interested public groups been informed of opportunities and mechanisms to participate in that planning and decision-making process and the GRIPS public involvement process? (Direct Survey);

Do channels exist through which the public groups can initiate involvement? (Review of GRIPS operating procedures and actual experience);

Have decision-makers presented adequate information which aids the publics in (1) defining the problems, solutions, and priorities, and (2) understanding the nature of the decision-making process itself and their roles as participants? (Review of Minutes);

Have the concerns of participants been addressed, with the rationale behind adoption or rejection of the suggestions made? (Review by CAC);

Have decisions been subject to independent appraisal and review? (Review by CAC); and

Is the public involvement process continuous, objective, and totally visible? (Review by CAC).

C. PUBLIC INVOLVEMENT SCHEDULE

It is recommended that a series of public workshops be held during the next phase for the purpose of presenting the GRIPS plan to the public for comment prior to its final adoption by the Commission. The following sequence of public meetings will be arranged for GRIPS. It is expected that specific meeting details will be finalized by the GRIPS staff after the Executive Director has been selected (see also Chapter VI: Administrative Program):

FIRST MEETINGS: REVIEW OF GRIPS PLAN

Format:

Public Workshops

Timing:

Within 60 days after the GRIPS plan has been submitted to the GRIPS Commission and copies placed in public libraries, schools, and the four County Planning Department offices for public access, but before final adoption by the Commission.

Locations:

Kelseyville (Lake County) Ukiah (Mendocino County) Calistoga (Napa County) Santa Rosa (Sonoma County)

Agenda:

- Presentation of the GRIPS plan (slides, maps, graphs); and
- Request for the publics' comments and approval.

SECOND MEETINGS: GRIPS OPERATIONS REVIEW

Format:

Public Meetings

Timing:

Within 60 days after adoption of GRIPS by the

Commission

Locations:

Kelseyville (Lake County) Ukiah (Mendocino County) Calistoga (Napa County) Santa Rosa (Sonoma County)

Agenda:

- Explanation of geothermal energy generation and alternative uses of the resource (DOE Film);
- Explanation of GRIPS (slides);
- Explanation of who the decision-makers are, and the types of information which are used in arriving at decisions (slides and possibly DOE film);
- 4. Introduction of GRIPS staff;
- Explanation of the publics' role as participants in the decision-making process;
- Explanation of existing legislation regarding geothermal development (slides);
- 7. Explanation of existing sources of information regarding geothermal development (handout);
- 8. Follow-up procedures.

SUBSEQUENT MEETINGS: PROJECT REVIEWS

Format:

Public Workshops

Timing:

Major points throughout the GRIPS project

Locations:

Kelseyville (Lake County)
Ukiah (Mendocino County)
Calistoga (Napa County)
Santa Rosa (Sonoma County)

Agenda:

1. Technical information and reports presented, as they become available through GRIPS, in a form the general public can understand;

- 2. Discussion of the technical information and reports with the technical researchers, and the publics' response to this material: and
- Follow-up procedures.

CHAPTER VI: ADMINISTRATIVE PROGRAM

The preceeding recommendations relate to the overall functions, goals, and objectives of GRIPS; this chapter focuses on a recommended program for the administrative management of GRIPS. As specified in the GRIPS Joint Powers Agreement, "the day-to-day administration of the Agreement shall be by (an) Executive Director" and "located at a office within the GRIPS Region" (in one of the counties which is a party to the Agreement). The purpose of this chapter, therefore, is to describe the administrative program for the functions and office of the Executive Director. The program is presented in four parts:

Organization, Personnel, Location, and Facilities.

A. ORGANIZATION

The recommended GRIPS organization contains essentially the same elements as envisioned in the original GRIPS proposal to ERDA (now Department of Energy: DOE). The five major components are the GRIPS Joint Powers Commission, a GRIPS Citizens' Advisory Council, and the GRIPS Staff Advisory Committee, an "Overview Function" described as necessary by the Commission, and the Office of the GRIPS Executive Director. The functions of each of these offices is as outlined:

GRIPS JOINT POWERS COMMISSION (Commission); one member selected from and by each party to the Agreement and selected non-voting Federal and State governmental members as specified in the Agreement;

GRIPS CITIZENS' ADVISORY COUNCIL: representatives of identified citizens' groups in each county to serve as a forum for identification and discussion of issues and communication from local concerns to the overall GRIPS concerns and establishment of Citizens' Study Committees established as needed;

GRIPS STAFF ADVISORY COMMITTEE (Committee): one or more staff members designated by the parties to the Agreement, Federal and State energy organizations, and other cognizant agencies or institutions as nominated and accepted by the Commission;

GRIPS EXECUTIVE DIRECTOR (Director): a person appointed by the Commission to manage the day-to-day operations of the Commission with support as defined in the following section;

OVERVIEW FUNCTION: professionals and others called as needed by the Commission to provide it direct, independent evaluations of products, processes, or other areas of activity;

<u>LEGAL COUNSEL</u>: retained and supervised by the Commission to provide legal services as needed; and

ACCOUNTING COUNSEL: retained and supervised by the Commission toprovide financial management and auditing services as specified in the Agreement.

B. PERSONNEL

Three (3) initial positions will be developed for the day-to-day administration of GRIPS:

Executive Director, Secretary/Office Manager, and Clerk Typist.

The "Roles and Responsibilities" for the first two of these positions are described in the following paragraphs. It should be noted that funds to support these initial have been acquired and the positions will be filled immediately upon the establishment of the GRIPS Executive Office. Future personnel will be added on a phased basis as support becomes available (e.g., Contract Manager and Grantsperson, Technical Writer and Public Involvement Coordinator).

1. Executive Director

The chief administrative officer of the GRIPS Office of the Executive Director shall be the "Executive Director". The Executive Director will be responsible for the overall direction of GRIPS. Specifically, the Executive Director, under the general policy guidance of the Commission, will:

manage the personnel of the office, including all hiring and firing; manage, including both directly and through delegation, all functions of GRIPS;

be responsible for the development of all annual and special reports to the Commission;

be responsible for interagency, intergovernmental and public and private institutional coordination;

represent the Commissioners before such agencies or learned bodies as may request presentations of GRIPS programs or as may be requested by the Commissioners to make such presentation; manage the contractual research or operational services of and for GRIPS;

serve as contracts manager and grantsperson and public involvement coordinator as needed; and

conduct other business of Commission as the Commissioners may delegate to the Office of the Executive Director.

2. Secretary/Office Manager

Working under the direction of the Executive Director, the "Secretary/
Office Manager" of the Office of the Executive Director will:

provide secretarial support for the Executive Director, the Commission, GRIPS Advisory Committee, and Citizens Advisory Council;

provide or coordinate office and travel services for the Executive Director, other staff members, and GRIPS Commissioners when not otherwise provided by their agencies in accordance with the Agreement; and

undertake other duties as may be assigned by the Executive Director.

3. Possible Future Personnel

As noted above additional personnel may be added to GRIPS staff in the future. Two of the most important considerations are for a "contract administrator/grantsperson" and "public involvement" coordinator.

a. Contract Administrator/Grantsperson

It is expected that one of the key functions of the Office of the Executive Director will be contract management and grants/contracts development. Working under the general direction of the Executive Director, roles and responsibilities of this person would be to:

manage all GRIPS Commission contracts;

develop and manage information on possible grants or contracts to meet GRIPS objectives;

coordinate information on such funding or technical support for all parties interested in GRIPS operations; and

perform such support services as the Executive Director may designate.

b. Public Involvement Coordinator

Implicit in both the goals and the operational objectives of GRIPS is the development and continued maintenance of means to make technical information available to all parties. A key role of the Office of the Executive Director, therefore, would be to provide technical information in a meaningful manner to all interested parties. Under the general direction of the Executive Director, a Public Involvement Coordinator would:

provide writing services as needed to convert technical documents to general information documents and/or news items;

write or cause to be written special information items on the work and operations of the Commission;

coordinate the preparation of special reports, background documents for GRIPS contract or grant applications, and other reports, including EIRs or EISs if required or desired;

serve as a single point for information requested by and of the public go coordinate publuc input to GRIPS and make GRIPS information and documents available to the public; and

perform other tasks as may be delegated from the Executive Director.

C. LOCATION

Pursuant to the Agreement, the GRIPS Commission shall locate its executive office in the Geysers region. The final office location should be determined after it is determined where a library or computing service center might be located (see Chapter IV, Section F). Candidate locations which have been identified are:

Co-located with California State College at Sonoma,
Napa County office building, or
Other county offices.

D. FACILITIES

GRIPS needs a minimum of approximately 1,000 square feet for five areas of their operations (assuming the recommended four-person organization). These facilities will be approximately as follows:

Secretary-Receptionist Area		200
Executive Director's Office		200
Staff Office (2 persons)		250
Conference Room/Library		250
Storage Area		100
	Total	1,000

Office equipment needed for this GRIPS operation will include normal office equipment.

Part four:

BUDGET

CHAPTER VII: BUDGET

The following paragraphs present the initial budget for administrative management of GRIPS and a suggested schedule for the hiring of GRIPS personnel.

A. ADMINISTRATIVE BUDGET

The recommended budget for the GRIPS operation is shown on Table VII:1. The budget is presented in tabular form from March 1978 through 1983. By GRIPS fiscal year (Agreement Article IV: July 1 to June 30) the recommended operating budgets are:

March 1, 1978 - June 30, 1978	\$ 13,200
FY 1978-1979	\$111,100
FY 1979-1980	\$153,901
FY 1980-1981	\$154,140
FY 1991-1982	\$159,904
FY 1982-1983 (est. only)	\$155,000

The individual budget items are shown in the figure and explained by the footnotes thereto. The initial budget for the Public Involvement Program is assumed to be approximately 10% of the basic GRIPS effort.

Figure VII:1

PRELIMINARY ESTIMATED GRIPS ADMINISTRATIVE BUDGET MARCH, FY 1978-79 through FY 1981-82

		Fiscal Year			
LABOR (GRIPS STAFF PERSONNEL)	1978-79	1979-80	1980-81	1981-82	
Executive Director Sec./Office Manager Contract Mgr. Public Involvement Coordinator Sub-total Annual Increase (5%/year) Sub-total Fringe (22%) TOTAL LABOR AND FRINGE	\$ 36,000 12,000 12,000 9,000 69,000 n/a 69,000 15,180	\$ 36,000 12,000 24,000 18,000 90,000 4,500 94,500 20,790	\$ 36,000 12,000 24,000 18,000 90,000 9,000 99,000 21,780	\$ 36,000 12,000 24,000 18,000 90,000 13,500 103,500 22,770	
OFFICE COSTS (GRIPS' OFFICE):					
Rental (1000 sq.ft. @ \$0.50/sq.ft.) Telephone Utilities Equipment Miscellaneous Reproduction TOTAL OFFICE EXPENSES	3,000 2,000 (Included 220 800 400	6,000 3,600 in buildi 220 1,200 1,200	6,000 3,600 ng rental) 220 1,600 1,200	6,000 3,600 220 1,600 1,200	
OTHER EXPENSES (INCLUDING COMMISSIONERS:					
Travel Budget Newsletter (\$200/mo.) Legal Services Audit Costs TOTAL OTHER (3) EXPENSES	1,000 2,400 4,000 2,000	3,000 2,400 2,000 3,000	4,000 2,400 2,000 3,000	4,000 2,400 2,000 3,000	
TOTAL EXPENSES	\$101,000	\$139,910	\$146,800	\$152,290	
SUPPORT OF PUBLIC INVOLVEMENT PROGRAM	10,100	13,991		7,614	
TOTAL BUDGET Notes:	\$111,100	\$153,901	\$154,140	\$159,904	

⁽¹⁾ Assume an annual salary of \$36,000

(2) Cost of equipment allocated at cost of equipment spread over 10 years:

Executive Office \$ 500.00
Sec./Reception 400.00
Staff Office (2) 400.00
Conference Room 400.00
Storage & Misc. 500.00
TOTAL: \$2,200.00 (\$220/yr./10 yrs.)

(3) Estimates based on present, Phase I experience.

B. HIRING SCHEDULE

It is recommended that the GRIPS operation continue as at present until decision on staffing and location are made; that is, that contract management be through Sonoma County so that the Commission may select and staff its Executive Office and develop its facilities and equipment as smoothly as possible before establishing separate administrative supports and facilities. Such services by Sonoma County should be as in-kind credits for their recommended contributions to GRIPS operations pursuant to Article VI of the Agreement.

Further, it is recommended that the initial full-year GRIPS staff be confined to an Executive Director, Secretary/Office Manager and Clerk/Typist sharing the duties of the four previously defined positions, so that the actual roles and responsibilities and candidates for the positions can be more fully developed by the Executive Director and GRIPS Commisioners and hiring be done only after adequate funds are identified and developed. It is recommended, therefore, that the preceeding budgets be considered as operational objectives, not definitive budgets until funding is formalized.

C. PROGRAM BUDGETS

Specific budgets for the data acquisition program and public participation program will be developed by the Executive Director and submitted to the Commission during the first quarter of FY 1978-1979. Expenses to administer these programs have been included in the initial administrative budget estimates.