G.R.I.P.S. COMMISSION

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MASTER

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GEOTHERMAL POLICY DEVELOPMENT PROGRAM

GEOTHERMAL ISSUES THAT CROSS COUNTY LINES

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Geothermal Research, Information and Planning Services / A California Joint Powers Agency

Lake County
Mendocino County

Napa County
Sonoma County

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ABSTRACT

This report identifies and briefly describes the principal issues that cross county lines or, at least, are of common concern to the counties in the Geysers-Calistoga KGRA, California. It is the objective of this report to identify and set forth in one place all the geothermal issues of mutual concern and to briefly describe the nature of each issue. To facilitate analysis and the establishment of priorities for action, the issues have been grouped according to whether they are Environmental, Administrative or Planning in nature.

Environmental problems discussed include air quality, (hydrogen sulfide emissions, cooling tower drift and acid rain), water quality (soil erosion and sedimentation, hazardous materials hauling, and groundwater depletion) wildlife habitat protection, and noise. The Administrative issues described include jurisdictional fragmentation, monitoring programs, 1916 Stock-Raising Homestead Act land jurisdictional problems, payments in lieu of taxes for publically-owned power plants, fiscal effects of power plant siting and local revenues from geothermal development on federal land. Finally, the Planning issues identified include resource assessment, road planning, cumulative impact assessment and transmission line routing and pipelines.

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EXECUTIVE SUMMARY

This report identifies and briefly describes the principal issues related to geothermal resources for the production of electricity, which cross county lines, as well as issues which may not cross county lines but which are of common concern to the four counties in The Geysers-Calistoga KGRA. As this compilation makes clear, the generation of electricity at The Geysers does not occur in a trouble-free environment -- rather, it occurs under difficult circumstances compounded by jurisdictional fragmentation. These factors are recognized by grouping the issues according to whether they are Environmental, Administrative, or Planning in nature.

While the issues identified herein are not of equal significance or current relevance in each county, with only three exceptions, they are either currently existing or can be projected to occur in each of the counties. Figure 1, Existing and Potential Issues of Common Concern by County, is based on a review of various environmental reports, discussions with county and other public agency staffs and a review of other documents. Certain issues which are classified as "Existing" may have a much more significant impact on one county than on another (for example, hydrogen sulfide emissions in Sonoma County which are carried into Lake County by prevailing winds). Other issues are not currently problems in some counties because power plant development has not yet occurred; but when such development occurs they will become issues unless the problems identified in this report are resolved beforehand.

Completion of this report and submission to the G.R.I.P.S. Commission and four county Boards of Supervisors will provide the opportunity for the counties to come together to develop a consensus on what can be done individually or collectively to address the issues identified herein. The impact of jurisdictional fragmentation in addressing these issues will be compounded by the varying interests, concerns, financial capabilities, staff capabilities and political circumstances brought to this process by the individual counties. The problems encountered as a result of these differing perspectives are further compounded by the fact that resolution of a number of the issues will require direct action or cooperation by a variety of state and federal agencies.

It should be recognized that there already exists a clear consensus regarding the relevance of certain of the issues identified herein. Beyond that there is the potential for development of a consensus on other issues, as well as a clear possibility that there never will be a consensus or agreement on some of the issues. In certain cases it is possible that the problems will be sufficiently mitigated by actions of those individual counties who consider issues of sufficient significance to take action on them.

On a final note, the technology involved in producing electricity using the dry steam geothermal resource, as well as the technologies involved in mitigating the various impacts of geothermal development, are evolving rapidly. Statements made in this report, or for that matter in any report, regarding the current capabilities of technology may in a short period of time become outdated. The efforts of many public and private organizations are leading to continuous technological improvements. Therefore, we can only try to reflect as accurately as possible what we understand the existing situation to be while recognizing that changes are being and will continue to be made in the way the resource is developed.

Figure 1

EXISTING AND POTENTIAL GEOTHERMAL ISSUES OF COMMON CONCERN

I S S U E S	C O U N T I E S A F F E C T E D			
	LAKE	MENDOCINO	NAPA	SONOMA
<u>Environmental</u>				
H ₂ S Emissions	Existing	Potential	Potential	Existing
Cooling Tower Drift	Existing	Potential	Potential	Existing
Acid Rain	Perceived	---	Perceived	---
Erosion and Sedimentation	Existing	Existing	Potential	Existing
Hazardous Materials	Existing	Existing	Potential	Existing
Ground Water Depletion	Potential	Potential	Potential	Potential
Wildlife Habitat Protection	Existing	Existing	Existing	Existing
Noise	Existing	Potential	Potential	Existing
<u>Administrative</u>				
Jurisdictional Complexities	Existing	Existing	Existing	Existing
Monitoring	Existing	Existing	Potential	Existing
1916 Stock-Raising Homestead Act	Existing	Potential	---	Existing
Governmentally-Owned Power Plants	Existing	Potential	Potential	Existing
Economic Impacts of Power Plants	Existing	Potential	Potential	Existing
Local Revenues from Federal Land	Existing	Potential	Potential	Existing
<u>Planning</u>				
Cumulative Impact	Existing	Potential	Potential	Existing
Road Construction and Maintenance	Existing	Potential	Potential	Existing
Power Transmission Line Routes	Existing	Potential	Existing	Existing
Resource Assessment	Existing	Existing	Existing	Existing

A. ENVIRONMENTAL ISSUES

Air Quality

Hydrogen Sulfide Emissions

The most important issue at The Geysers-Calistoga K.G.R.A. is the control of hydrogen sulfide emissions. The H_2S problem is one of the major obstacles to the growth of geothermal energy utilization. In the past, H_2S emissions have caused an odor nuisance, especially to Lake County residents in the vicinity of the community of Cobb, and have resulted in violations of state air quality standards. However, in the past couple of years data from monitoring stations in Lake County communities have indicated a reduction in the number of hours in which the standard is exceeded.

Cooling Tower Drift

Besides hydrogen sulfide, a number of other substances are emitted from the cooling towers of geothermal power plants. One of these, boron, has damaged vegetation in the immediate vicinity of existing power units. Recently, cooling tower design has improved and it is expected that environmental damage from this source will be less extensive in new power plants.

Acid Rain

There is not much concern expressed amongst the scientific community working on air quality problems about potential impacts caused by acid rains. Nonetheless, the issue is raised by members of the public at meetings on specific geothermal development projects about the possible effects of acid rain on grape production in the area.

Water Quality

Soil Erosion and Sedimentation

Due to the character of the steep terrain and the easily erodible soils in The Geysers, there is a potential for soil erosion and sedimentation resulting from the development of access roads, well pad sites and other facilities for geothermal development. This in turn might affect the water quality in local streams which may impact aquatic organisms and domestic water supplies.

Hazardous Materials Hauling

Substantial quantities of hazardous substances are generated by or brought into the area as a result of geothermal development. Accidental spills of these materials may effect aquatic ecosystems, agriculture and water quality. The law is ambiguous as to which state agency has jurisdiction over hauling hazardous drilling wastes at The Geysers, and consequently the movement of these materials may not be adequately regulated.

Groundwater Depletion

If a flash or binary system which consumes large volumes of water for cooling purposes was used to generate electricity from geothermal hot water in the vicinity of The Geysers,

it would consume large volumes of water and could present a threat of depletion to the limited groundwater supplies in the area. Groundwater is used by existing residents for domestic water supplies and for crop irrigation.

Wildlife Habitat

Due to the nature of geothermal development at The Geysers, there may be impacts on the environment from such activities as roadbuilding and drilling, as well as from the facilities themselves such as extensive runs of pipelines. These activities and facilities may have a disruptive effect on wildlife species.

Noise

In the past during the process of developing and utilizing the dry steam resource for electrical production, noise has occasionally been a significant problem to nearby residents and communities. Recent progress in noise abatement techniques has substantially reduced this impact so that on new projects where appropriate mitigation measures are applied, noise levels are within generally accepted levels.

B. ADMINISTRATIVE ISSUES

Jurisdictional Complexity

The development of the dry steam resource at The Geysers, and the protection of the environment, occur in a fragmented and complex jurisdictional maze. The permitting procedures for development vary depending upon factors such as the land and mineral rights ownership, and the stage of development represented by a particular project. Moreover, the conditions and standards imposed, as well as the monitoring procedures, vary by jurisdiction. Communications between agencies is also a problem, as are the legal ambiguities surrounding certain allocations of responsibilities.

Monitoring

In order to insure compliance with development conditions imposed as part of the permitting process, it is necessary to monitor development. At the present time, each permitting agency establishes its own monitoring program, and these vary considerably in their effectiveness. Moreover, under the existing uncoordinated monitoring system, there are substantial inefficiencies such as overlapping monitoring programs. Several efforts have been made to establish a more coordinated monitoring system; however, there has been only limited success to date.

1916 Stock-Raising Homestead Act Lands

There are thousands of acres of 1916 Act lands in the four Geysers' counties in which the federal government owns the geothermal rights while the surface rights are owned privately. This bifurcation of rights has led to questions of whether the counties can continue to exercise jurisdiction over geothermal development. For the moment it appears that the U.S. Geological Survey and the counties have established mutually agreeable procedures in which they will jointly process development applications. However, a problem could arise if a county denied a development application on a project that the federal agency was willing to approve.

Payments in Lieu of Taxes for Governmentally-Owned Power Plants

A number of public agencies have recently initiated development of power plants in The Geysers. This could create economic difficulties for the KGRA counties, since public agencies are not liable for paying local property taxes.

Fiscal Effects of Power Plant Siting

At The Geysers the dry steam reservoir is bisected by county boundaries. The selection of a power plant site immediately on one side of the county boundary can confer substantial economic benefits on one county and not its neighbor, while both counties may incur significant financial and environmental costs related to that power plant.

Local Revenues from Geothermal Development on Federal Land

Prior to the passage of AB 1905 in May, 1980, local governments in the vicinity of The Geysers were concerned about not receiving revenues from geothermal development on federal land. AB 1905 assured that the local counties in which federal lease sales were occurring would receive at least a share of the revenues that were returned by the federal government to the state.

C. PLANNING ISSUES

Cumulative Impact

The incremental nature of geothermal development at The Geysers presents special difficulties in evaluating

the cumulative effects on the environment of continuing development. The importance of this issue has generally been recognized by governmental agencies at all levels; however, funding to address this problem has not been available until recently. In the last few months the staff of the California Energy Commission has begun a project to assess the cumulative effects of further development.

Roads

There are four county roads leading into The Geysers that were not intended when they were built to handle numbers of large vehicles on a daily basis. These roads all present continual problems of maintenance, particularly during the wet winter months. In addition, there is a vast network of private roads owned and maintained by the developers serving each of the well sites and power plants in the area. These roads also present problems of maintenance, and, as development expands, new roads must be built at substantial cost both in dollars and in terms of environmental effects. Solutions need to be found for financing public road maintenance problems in The Geysers and for planning new roads so as to minimize their cost as well as their environmental and growth-inducing impacts.

Power Transmission Lines and Pipelines

With the construction of PG&E's proposed 230kV transmission line from Castle Rock Junction to Lakeville, there will be sufficient outlet capacity to serve up to 2600 MW of generating capacity at The Geysers. While there are no proven geothermal reserves for units beyond those already planned, if reserves should become available, the development of additional generating capacity would require that one or more additional transmission routes be established. These new corridors will raise a substantial number of environmental questions that should be addressed well in advance of any pressures for construction. Moreover, pipelines that cross county lines in The Geysers can present problems of equitable taxation, joint planning and liability in the event of environmental damage.

Resource Assessment

There are indications that the dry steam reservoir is subject to depletion over time. The California Division of Oil and Gas is undertaking a study which will attempt to determine the field boundaries of the dry steam reservoir as well as the nature of the reservoir, including the steam reserves. This type

of information clearly has important implications for the counties in terms of land use decisions they must make, environmental impact consequences that must be dealt with, and economic projections that will be utilized.

I. INTRODUCTION

This report, prepared under contract to the U.S. Department of Energy, identifies and briefly describes the principal geothermal issues that cross county lines or, at least, are of common concern to the counties in the Geysers-Calistoga KGRA. The issues that were selected to be discussed in this report were those issues determined to be of importance prior to November, 1980.

It is the objective of this report to identify and set forth in one place all the geothermal issues of mutual concern; to briefly describe the nature of each issue; and, ultimately, to stimulate the counties -- both individually and collectively -- to address the issues. To facilitate analysis of the report, and the establishment of priorities for action, the issues have been grouped according to whether they are Environmental, Administrative or Planning in nature.

Due to its geographic location in an area where four counties either join or are in close proximity to one another, geothermal development occurring in one county can, and very often does, have serious environmental consequences for one or more nearby counties. Since physical development related activities are taking place in all four counties which may affect one or more of the other three counties, there is a common interest in seeking satisfactory solutions to such Environmental problems as air quality, water quality, hazardous materials hauling, wildlife habitat protection, and noise.

Moreover, because the geothermal resources overlap the four counties, they share concerns regarding nonphysical issues relating to the process of development. One set of these issues is basically Administrative in nature. These include jurisdictional fragmentation, monitoring programs, 1916 Stock-Raising Homestead Act land jurisdictional problems, payments in lieu of taxes for publicly-owned power plants and fiscal effects of power plant siting.

Another set of these nonphysical issues is essentially planning in nature. These Planning issues include resource assessment, road planning, cumulative impact assessment and transmission line routing.

For the moment, the emphasis has been placed on issues related to development of the dry steam resource because that is where by far the most activity is occurring and where there is the greatest experience. However, as work under our extended contract with D.O.E. on direct heat commercialization progresses, and as the hot water resource begins to be developed, new issues may be identified that are peculiar to that resource or to the uses to which it is put.

It should be noted that the technology involved in producing electricity using the dry steam geothermal resource, as well as the technologies involved in mitigating the various impacts of geothermal development, are evolving rapidly. Statements made in this report, or for that matter in any report, regarding the current capabilities of technology may in a short period of time become outdated. The efforts of many public and private organizations are leading to continuous technological improvements. Therefore, we can only try to reflect as accurately as possible what we understand the existing situation to be while recognizing that changes are being and will continue to be made in the way the resource is developed.

II. ENVIRONMENTAL ISSUES

A. Air Quality

There are a number of sub-issues relating to the effects of geothermal development on air quality including hydrogen sulfide emissions, cooling tower drift and concerns about the potential for acid rains.

1. Hydrogen Sulfide Emissions

The most critical issue at The Geysers-Calistoga KGRA is the control of hydrogen sulfide emissions. Hydrogen sulfide is a component of the geothermal fluid and is released to the atmosphere at several points in the development process, particularly through power plant cooling towers. Historically there have been small quantities of emissions stemming from natural sources such as fumaroles.

Once in the atmosphere H_2S is often transported across county lines to surrounding regions and can result in an odor nuisance if the concentration is sufficiently high. The California air quality standard for hydrogen sulfide is 0.03 ppm for a one-hour average. This standard is approximately at the geometric mean of the odor detection threshold (0.029 ppm), and was imposed to minimize the annoyance of odor.

The emissions from geothermal development at
The Geysers

"...have led to occasional high concentrations of H_2S in the region, with substantial differences in air quality occurring between the ridges near the steamfield and the nearest populated areas.... At ridgetop locations near operating units, hourly H_2S concentrations have exceeded the 30 ppb ambient air standard as much as 10 percent of the time. In the populated valleys, measured concentrations have been much lower, and the 30 ppb limit has been exceeded less than one percent of the time.

SRI International monitored ambient H_2S from February 1976 to December 1978. SRI monitors were located at Anderson Springs, Whispering Pines, Hobergs, Sawmill Flat, and Kahm Ranch in Lake County; at Anderson Ridge and Geyser Rock on the Lake-Sonoma County line; and at Aidlin Ranch (located at a low elevation in the Big Sulphur Creek Valley) in Sonoma County....

Violations of the state standard were observed during every year at each of the SRI stations. In general...for most stations, the high concentrations occurred most frequently in the summer and early autumn months. The exception was station 8 (Aidlin Ranch), where the meteorological condition leading to high concentrations, drainage down Big Sulfur Creek, occurred more frequently in the late autumn and early winter.

The SRI data clearly show higher concentrations at the ridgetop locations (Geyser Rock and Anderson Springs) than in the populated valleys. Ambient concentrations of H_2S measured at Whispering Pines and Anderson Springs equalled or exceeded the ambient air standard less than one-half of one percent of the hours, but never exceeded 80 ppb.

"SMUD and DWR collected meteorological and air quality data in 1979 and 1980. ...As seen in the SRI data, the SMUD-DWR network showed that the highest concentrations and the greatest number of hours exceeding the standard were observed at the ridgeline (Geyser Rock) and Big Sulphur Creek sites.

Recent H₂S monitoring in populated areas of Lake County has shown a decrease in the frequency of exceedences of the H₂S standard. Four monitoring sites in the SRI and the SMUD-DWR networks are in identical locations (Anderson Springs, Geyser Rock, Pine Summit, and Aidlin Ranch - Big Sulphur Creek). A detailed study of the data from these sites was performed by SAI (Teschke, et al, 1980). Assuming that the recovered data from each of the sites are representative of the entire monitoring period, the average number of exceeds per year of the hourly 30 ppb limit can be compared between the SRI (1976-78) and SMUD-DWR (1979-80) monitoring periods. At Geysers Rock the average number of exceeds per year decreased from 211.3 to 71.3, a decrease of 66.3 percent; at Pine Summit the average number of exceeds per year decreased from 42.7 to 2.3, a decrease of 94.6 percent; and at Aidlin Ranch-Big Sulfur Creek the average number of exceeds per year decreased from 237.5 to 118.5, a decrease of 50.1 percent.

The available H₂S monitoring data confirm that air quality in the Anderson Springs-Whispering Pines area has also been improving in recent years....The average number of exceeds per year of the hourly H₂S standard at the Anderson Springs station was 6.2 during 1976 to 1978; no exceeds occurred during the 284-day monitoring period of 1979 and 1980 at the SMUD Anderson Springs Station. The LCAPCD Anderson Springs H₂S monitor measured one exceedence during the five-month period of July through November 1980 (Saderlund, 1981). An H₂S monitor sponsored by PG&E and the Air Resources Board was recently installed

at Whispering Pines. Data from August through September 1980 indicate that no exceeds occurred at this station. The OXY aerometric station at Starview on Boggs Mountain above Whispering Pines recorded no H₂S concentrations above 5 ppb from August 1980 through January 1981 (Trainor, 1981).

The reduction in the number of hours which exceeded the standard in populated areas of Lake County coincides with the efforts over the past four years to reduce H₂S emissions from the existing geothermal development. Further reduction of H₂S emissions from existing older units are expected by 1984. This improvement in air quality will be partially offset by the new geothermal projects being proposed and constructed in the general vicinity of these two communities."¹

There are at present three types of H₂S control systems being used at The Geysers: the iron/caustic/peroxide system, the Stretford process and a system developed by the EIC Corporation. The California Energy Commission staff finished a recent analysis of the state of H₂S abatement efforts by concluding that, "The use of these technologies can permit additional development of the geothermal resources in The Geysers region without frequent air quality violations."² In addition, the staff went on to note, "The Commission is funding studies on the cumulative air quality effects

¹Occidental Geothermal, Inc. "Application for Certification, OXY Geothermal Plant No. 1", Jan. 1981, pp. 5-1 to 5-3.

²California Energy Commission, "Electricity Tomorrow, 1980 Preliminary Report", October, 1980, pp. 165-66.

of geothermal development at The Geysers to identify the best sites for additional units."¹

2. Cooling Tower Drift

The effects of drift from power plant cooling towers has long been a topic of interest and a subject for research at The Geysers.

"Under normal operating conditions, essentially all pollutants from power units at The Geysers are emitted through the cooling towers, only a few of these substances pose potential problems to the environment. Besides hydrogen sulfide gas, boron carried in liquid drift droplets from the towers is of current concern. Boron emissions have damaged vegetation in the vicinity of existing power units at The Geysers. Of secondary importance are emissions of ammonia, mercury, arsenic, and sulfates, although none of these substances have been identified as causing detrimental effects at The Geysers."²

The Bottle Rock Geothermal Power Plant Revised Draft EIR points out that,

"Lawrence Livermore Laboratory analyzed the problems of cooling tower drift in their 1978 Geysers-Calistoga KGRA Environmental Overview and concluded that cooling tower drift is not presently a water quality concern, but soil and water monitoring should be an ongoing program."³

¹ California Energy Commission, "Electricity Tomorrow, 1980 Preliminary Report", October, 1980, p. 166.

² Ernak, Donald D. and Paul L. Phelps, "An Environmental Overview of Geothermal Development: The Geysers Calistoga KGRA, Vol. 1 Issues and Recommendations". Lawrence Livermore Laboratory. October 4, 1978, page 7.

³ California Energy Commission, Bottle Rock Geothermal Power Plant, Revised Draft EIR, August, 1980, pp. 98-9.

This same Revised Draft EIR goes on to discuss the damage that can occur to vegetation from cooling tower drift,

"Cumulative stress and vegetation damage due to cooling tower drift has been documented by PGandE as part of a six year aerial photography study. The extent and severity of stress differs at each unit; however, the total extent of stressed vegetation in this area as of 1979 covers 247 acres (six percent) of the total leasehold area of PGandE Units 1-11..."¹

While acknowledging improvements in cooling tower drift limiting technology, the report concludes that in order to identify and mitigate impacts that occur from cooling tower drift a monitoring program should be undertaken which at a minimum would consist of visual observation and aerial infrared photography.² Although the effects of drift seem to be limited to an area generally within 1,000 feet of the cooling towers, nevertheless, in situations where a power plant is located near a county line there is a potential that the drift could cause environmental damage in counties other than where it originates.

¹California Energy Commission, "Bottle Rock Geothermal Power Plant, Revised Draft EIR". August, 1980, p. 10.

²Ibid, p. 108

3. Acid Rain

The topic of acid rain is one that has occupied the public's attention for several years in the Midwest and Eastern United States as well as in parts of Europe. Only in the last few years has this subject arisen on the West Coast.

"Over the decades .. in many areas of the nation and the world, simple rainfall has taken on a new and threatening complexity. In these locales the rain is no longer benign, for here the rain must pass through an atmosphere polluted with sulfur oxides and nitrogen oxides. Such atmospheric oxides do occur naturally and have, in past partnership with the rain, become part of nature's balance to help nourish plants and aquatic life. But it is the oxides from the unnatural sources -- man-made industries, power plants, auto exhausts and other fossil fuel combustion process -- that have disrupted that partnership and upset the balance. The falling rain and snow now react with the oxide pollutants to produce precipitation of new chemical properties, often a mixture of sulfuric acid, nitric acid and water, a far cry from "pure rain" or "clean snow". It has become acid precipitation -- acid rain."¹

Depending on factors such as climate, topography, geology, biota and human activity,

¹United States Environmental Protection Agency. Acid Rain. July, 1980, page 2.

acid rain can have a deleterious effect on aquatic ecosystems, soil systems, vegetation man-made objects. "The direct biological effects of acid rain on humans have yet to be established" however, it has been noted that, "the heavy metals released by acid rain ... do present a potential threat to human health."¹

It is conceivable under certain circumstances that hydrogen sulfide releases in geothermal steam may increase atmospheric sulfur compound levels (predominantly sulfate) associated with acid rains. However, in The Geysers, "The ambient air quality standards ... for H₂S have been shown to be sufficiently low that no appreciable acidity effects will occur, unless these standards are grossly exceeded.... Measurement of rainwater acidity conducted by SRI in The Geysers area concluded that acid rains were not and would not be a problem...."² Moreover, a recent study of acid rain conducted in Northern California by Dr. John McColl of the Department of Soils and Plant

¹United States Environmental Protection Agency. Acid Rain. July, 1980, page 23.

²Gennis and Associates, Engineers, Draft EIR, "Union Oil Co., Northeast Geysers Unit Geothermal Exploratory Project, Lake County, California", March, 1980, p. 4-3

Nutrition at U.C. Berkeley, has concluded that nitrogen oxide emissions such as those stemming from auto exhaust emissions dominate the makeup of acid rains in this area. Sulfates, such as those produced in industrial and power plant emissions also contribute, although unlike the situation in the Midwest and Eastern U.S., they are a relatively minor component of the problem.¹

In reviewing the literature on air quality problems at The Geysers, there does not, at the present seem to be much concern about potential impacts caused by acid rains amongst the scientific community working on these problems, and there is no documented evidence of damage to crops or wildlife in California.² Nonetheless, the issue is often raised by members of the public at meetings on geothermal development projects. Most often concern is expressed about the possible effects of acid rains on grape production which is such an important element of the local economies and the local visual atmosphere. It would take additional study to determine definitively if these perceptions of a potential problem have any basis in fact.

¹Discussion with Bill Sessa, California Air Resources Board, February 23, 1981.

²Discussion with Bill Sessa, California Air Resources Board, February 23, 1981.

B. Water Quality

There are actually three types of issues relating to water quality. The first of these issues is the sedimentation of streams resulting from landslides and soil erosion. The second issue is water pollution resulting from accidental spills of toxic geothermal and waste fluids. And the third issue relates to the potential for depleting the limited groundwater supplies in order to serve new power plants utilizing the hot water resources.

1. Soil Erosion and Sedimentation

Much of The Geysers region is characterized by steep terrain with easily eroded soils, having many landslides. Causes of the unusually rapid erosion and numerous landslides lie in high precipitation rates and in the character of the rocks underlying the slopes; much of it is physically incompetent because of severe fracturing and chemical weathering.

Development of well pad sites, other facilities for geothermal development and, particularly, access roads has increased the natural rate of erosion and has led to problems of stream siltation.

"Erosion can destroy fish habitat and thereby eliminate or seriously deplete the fish population of a stream. A silt coating of nests containing eggs of young fish will restrict the movement of oxygen-bearing water through the gravel and result in the smothering of eggs and young. Erosion and siltation causes the degradation of an aquatic environment, including salmon and steelhead streams. Salmon and steelhead cannot successfully spawn in heavily silted areas, and silt also spills in the nursery pools needed for rearing fish fingerlings. Additionally, silt reduces or eliminates aquatic organisms that fish need for food."¹

Recent experience, particularly in the Anderson Springs area of Lake County, has demonstrated the deleterious effects geothermal development can

¹Hussey, Elaine T., "Impediments to Geothermal Development in Lake County, California", Working Paper V, Jet Propulsion Laboratory, December 1, 1976, p. 11-12.

have on stream turbidity. Moreover, in certain cases, as at Anderson Springs, this problem can raise residents' concerns regarding the effects of sedimentation on domestic water supplies.

Yet not all of The Geysers counties incorporate the basic provisions that are essential to control erosion and sedimentation in the use permits they issue for geothermal projects. As Figure 2 shows, Napa and Mendocino counties impose almost no conditions that might reduce erosion and sedimentation. Sonoma County exercises somewhat more control, and, through their requirement for engineering design, may in fact provide as much protection as Lake County.

Figure 2
EROSION AND SEDIMENTATION CONTROLS
BY COUNTY

<u>Mitigation Measures</u>	<u>Lake</u>	<u>Mendo.</u>	<u>Napa</u>	<u>Sonoma</u>
Compaction of fills	X			
Replanting	X			X
Control over the steepness of cuts	X			
Stream and spring buffers	X	X	X	X
Subdrains	X			
Construction prohibited during rainy season	X		X	X
Construction prohibited on landslides	X			
Designed by registered civil engineer	X			X

As can be seen from the following map, large portions of southern Lake County, southeastern Mendocino County, and portions of northwestern Napa County drain into adjacent counties. Therefore, erosion can have an effect on stream siltation in adjacent counties, although it should be noted much of the sediment carried by erosion will often settle in pools within a mile or so downstream of the source point.

2. Hazardous Materials Hauling

In the course of geothermal development at The Geysers, substantial quantities of hazardous wastes are produced. These materials are generated primarily in the course of drilling for the dry steam resource, as well as in the course of abating hydrogen sulfide emissions. Hazardous materials occur naturally in the region and are also trucked into the area in large quantities. At the present time, irrespective of which county hazardous waste materials are generated in, they are generally disposed of in either of two Class II-1 disposal sites in Lake County.

Map 1
AREAS THAT DRAIN INTO AN ADJACENT KGRA COUNTY
Scale 1" = 6 Miles

With the continuous presence of quantities of hazardous substances, there is a potential for water pollution incidents stemming mainly from accidental spills which can occur either at the drilling or power plant sites, in transit to or from the drilling or power plant sites, or at the disposal sites. This ever-present danger raises concerns over the effects of spills on aquatic ecosystems, agriculture and domestic water supplies.

Due to an ambiguity in the law, we are concerned here primarily with which state agency has responsibility for regulating the hauling of drilling sump wastes. There are, of course, a significant number of truck loads carrying wastes from drilling pad sumps. With large volumes of these materials being transported over narrow winding roads through mountainous terrain, there is a constant danger of spills.

One of the problems in dealing with hazardous wastes at The Geysers is the difficulty of ascertaining precisely which wastes are in fact hazardous. This is particularly true in the case of sump contents which do not always contain sufficient concentrations of toxic materials to be considered

hazardous. Sump contents vary from site to site and over time depending on such variables as the type and quantity of additives used with the drilling muds, the amount of naturally occurring materials encountered in the course of drilling, and whether or not spills or petroleum products have occurred.

The complexity of the situation is compounded by jurisdictional ambiguities fostered by the state law governing Hazardous Waste Control (Chapter 6.5, Section 25100 et seq, Health and Safety Code). This chapter assigns responsibility over hazardous wastes on a state-wide basis to the State Department of Health Services. For example, the Department is required to prepare and adopt listings of wastes which are determined to be hazardous (Section 25140); it is required to register haulers of hazardous wastes (Section 25163); and, it is required to issue permits to use and operate hazardous waste facilities (Section 25200).

While the above assignments are reasonably clear, the ambiguity arises over Section 25143 which states in part, "...Any drilling for geothermal resources shall be exempt from the requirements of this chapter because the disposal of geothermal wastes is regulated by the Regional Water Quality Control Boards." It would seem from a reading of this section of the code that the Regional Water Quality Control Boards have been given jurisdiction over wastes generated in the course of drilling for geothermal resources. And in fact the two Regional Boards covering The Geysers Area -- The North Coast Regional Water Quality Control Board and The Central Valley Regional Water Quality Control Board -- are exercising authority over the construction of sumps and the disposal of drilling waste at the drill site.

However, it is not entirely clear in reading the law whether the intent was to also give the Regional Boards control over power plant wastes and hazardous materials being hauled away to the disposal sites. On the one hand the Regional Boards have worked with the utilities building power plants and have succeeded in getting basins built around the plants to catch any spills that may occur before they can cause any problems to the surrounding natural environment. On the other hand the Regional Boards have not taken any steps to control the hauling of hazardous materials.

With regard to the transport of most hazardous materials, it is required by State Law that businesses engaged in hauling liquid wastes be registered as a liquid waste hauler by the State Water Resources Control Board (Section 14020, State Water Code), and, in addition, persons who haul hazardous waste must be registered by the Department of Health Services. Current regulations require that haulers carry hazardous waste manifests on their trucks indicating the types of wastes being hauled and the hazardous properties of those wastes (e.g. toxic, flammable, corrosive, etc.).

However, the hauling of hazardous materials seems to be one aspect of the problem that has fallen between the regulatory cracks. Because of the

broad interpretation given to Section 25143 by the Department of Health Services, they have assumed that the Regional Water Quality Control Boards are controlling hauling at The Geysers. Whereas the Regional Boards, having taken a narrower view of Section 25143, assume that the Department of Health Services is regulating geothermal haulers just as they do for all other hazardous materials haulers in the State.

As a consequence, neither agency is regulating the haulers. Situations like the accident in Lake County last November can occur in which hazardous wastes including arsenic and lead were being hauled by an unlicensed hauler without a manifest in the truck which would inform people at the scene of an accident about the hazardous nature of the materials involved. In the Lake County incident approximately 3,000 gallons of waste materials were spilled close enough to domestic wells that the County Health Department authorized testing of those wells. Without the type of information contained in a manifest, emergency crews have difficulty in knowing how to respond properly. Moreover, the truck drivers of unlicensed haulers may not have had proper training regarding emergency procedures in case of an accident.

In should not be inferred that this regulatory vacuum at the state level has led to a situation in which all wastes at The Geysers are being hauled indiscriminately. In fact, a number of developers and producers such as Union Oil, MCR Geothermal and PG&E do use licensed haulers, and manifests are carried on those trucks. Moreover, the Federal Department of Transportation's regulations do place some requirements on haulers of hazardous materials regarding such things as placards on the outside of the trucks, labels on containers, shipping papers, and compatibility of chemicals.

Ultimately, it appears that the issues surrounding the management of hazardous wastes at The Geysers is primarily an administrative one. And it will be necessary for the various interested agencies to get together to develop a program for resolving these administrative problems.

3. Groundwater Depletion

In an area where there is very little groundwater such as The Geysers, any potential for diversion of this valuable resource will be viewed with concern by the local population. The existing limited supplies are being used for vital functions such as drinking water and irrigation of croplands. Naturally persons dependent on this source of water have a high stake in its protection, and would be unhappy to see it diverted to power production as is conceivable if generating technologies different than those currently employed at The Geysers are instituted. For example, generating technologies associated with hot water resources which may ultimately be utilized, such as flash or binary systems, consume large quantities of water for cooling purposes, and it is also sometimes used for injection to replenish the resource and to control subsidence.

C. Wildlife Habitat

The areas in which geothermal development is currently occurring tend to be fairly remote, and contain a wide variety of habitat types with a corresponding variety of wildlife species. "The primary impacts on the area's wildlife will occur as a result of vegetative loss, disturbance from construction activities, or the release of toxic substances."¹ In this context there is a special need to deal with the problems of endangered and fully protected species, and the disruptive effect that large scale geothermal development can have on their continued use of the area.

In The Geysers there are two species that are most often discussed in this regard. The ringtail, which is a small mammal, is a fully protected species; and the State Energy Commission staff is currently undertaking a study to gather field data on distribution, abundance, habitat, preference and behavior of the animal, and to assess the potential impact of present and future geothermal development on this species.

¹California Energy Commission, PG&E Geysers Unit 16 Geothermal Power Plant Draft EIR, May, 1980, p. I-49.

The second species about which considerable concern had been expressed is the American Peregrine Falcon which nests in parts of the KGRA in at least one site where their foraging flights take them across county lines. This species of falcon is on the Federal Endangered Species list; and the Secretary of the Interior has designated two of the areas within the KGRA as Critical Habitat Zones. A two-year study of the peregrine falcons was carried out under a Department of Energy grant to the G.R.I.P.S. Commission. In presentation of the final report of this study, while it was concluded that development could proceed, a series of management recommendations were also advanced that emphasized the following:

- Continued monitoring of falcon activities;
- Discouraging human presence in the habitat zone;
- Constraints on the location of new power transmission lines;
- Development by the state of a Nest Territory Plan for the eyrie.

D. Noise

Due to the remoteness of the majority of The Geysers developments, most of the noise that occurs in the process of developing and utilizing the dry steam resource does not impinge on local communities.

However, where development does take place there are points in the process when noise could be a problem to residents and communities which may be in the vicinity. During drilling, when compressed air is being used once a steam-bearing zone is reached, noise levels can be quite high.

"Compressed air is forced down the drill pipe and returns carrying rock cuttings and any geothermal steam produced. The steam, air, and cuttings are vented through a pipe known as a blooie line. All developers currently operating at The Geysers use a large cyclonic separator/muffler at the end of the blooie line to control particulate and noise emissions. Control is particularly effective when water is injected into the blooie line upstream from the cyclonic muffler. Noise levels from air drilling can be reduced from about 120 dBA at 50 feet with only a blooie line expander tube to below 90 dBA with the cyclonic muffler."¹

The relatively short-term nature of the drilling operations, combined with the reduction of noise achieved by the cyclonic muffler, has the effect of reducing the impact of noise on nearby residents and communities from this particular stage of development.

Under certain circumstances, individual wells may be vented to the atmosphere without muffling for 1-3 hours. Sound levels may reach a maximum of 125 dBA at 50 ft.

¹Leitner, P., "An Environmental Overview of Geothermal Development: The Geysers-Calistoga KGRA, Vol. 3, Noise", Lawrence Livermore Laboratory, August 16, 1978, pp. 6-7.

This procedure is used to clean out wells of accumulated rock and debris. It occurs infrequently and is primarily used on older wells. Cleanout and testing of newly drilled wells may be done unmuffled, but is usually through the cyclonic separator/muffler while the rig is still in place. Sound levels can be kept to no more than 90 dBA at 50 ft.¹

Since it is not practical to shut in wells in a steam supply field during a short-term outage at the generating unit, large quantities of steam have to be released to the atmosphere. However, widespread use of rock mufflers at power plants has effectively mitigated noise levels of stacked steam vented during short-term plant outages.

In the case of long-term power plant outages, as shut-in wells are brought back on line, steam is vented through a rock muffler at the power plant. When steam is vented at the power plant, noise levels are expected to be 90 dBA or less at 100 ft.² Venting is also necessary at several points along the pipelines, as they are heating, in order to clear accumulated condensate. Sound levels at these drain valves can reach 120 dBA at 50 ft. for 1-3 hours. If necessary, pipelines can be vented through individual rock mufflers to avoid noise impacts to nearby residents.

¹Ecoview, "Union Oil Geothermal Division L'Esperance Leasehold Draft EIR", August 18, 1980, page 134.

²SMUD, "AFC, SMUDGE #1", February, 1980, p. 5-100.

III. ADMINISTRATIVE ISSUES

A. Jurisdictional Complexity

The development of the dry steam resource at The Geysers, and the protection of the environment, occur in a fragmented and complex jurisdictional maze. Not only are all three levels of government involved -- local, state, and federal -- but numerous agencies within each level are involved. Moreover, at the local level, each county imposes a different set of requirements on developers.

This jurisdictional fragmentation is further complicated by the fact that the institutional responsibility between the various agencies and levels of government changes according to whether the project is for exploration, field development, or power plant construction. Moreover, the institutional path a developer must follow in seeking permits for a particular project will vary depending upon whether the project is located on private land, state-owned land, federally-owned land, or 1916 Stock-Raising Homestead Act land. And, finally, the kinds of conditions and standards that would be applied to a development project will differ depending upon the jurisdictions involved, and the monitoring of compliance with those standards and conditions will also vary.

The governmental agencies at all levels involved with development at The Geysers have made substantial efforts to integrate permitting procedures and to simplify, wherever possible, the systems for obtaining permits. Nevertheless, each agency at each level of government has a legitimate interest in insuring that the matters for which it is responsible are examined as part of the permitting process.

It is difficult for governmental agencies to give up their permit review prerogatives to another agency which may have similar interests but perhaps a somewhat different capability or perspective. Perhaps the greatest difficulty related to the jurisdictional fragmentation of The Geysers is in assuring that lines of communication between the interested agencies are open and that there is a constant referral between the agencies. This problem of communications becomes more pronounced when the different agencies seem to be in a continuous state of flux, both organizationally as well as in terms of the changing personnel.

In the past, there has been substantial ambiguity about the legal responsibilities of various agencies. For example, the counties' authority to issue use permits for power plants was unclear at one time. Fortunately, these kinds of ambiguities are gradually being resolved.

B. Monitoring

There are several agencies at each level of government issuing permits that control virtually every activity undertaken in conjunction with geothermal development. Each permit normally carries with it a set of conditions or stipulations governing the manner in which development is allowed to proceed. In order to ensure compliance with these development conditions, it is necessary to monitor the development process.

At the present time, each agency establishes its own monitoring program. These programs vary from quite frequent and regular on-the-spot checks to no field visits whatsoever. Consequently the effectiveness of the monitoring programs varies considerably. Ideally it would be desirable to monitor each permit condition or stipulation for each development project as frequently as is necessary to identify potential problems before they occur. Obviously, based on this criterion, certain conditions would have to be monitored more frequently than others.

Under the existing system at The Geysers, there is overlapping monitoring of similar development stipulations by different agencies, and time is lost by representatives of each agency traveling to and from the project

area.

This is particularly true where there are a number of different agencies such as County Planning Departments, Fish and Game, Department of Forestry and the Regional Water Quality Control Boards involved in related issues such as grading, erosion control, fire prevention, vegetation removal and water quality.

A number of attempts have been made to reduce monitoring redundancy, to reduce the time and money spent on monitoring, and to improve the overall quality and effectiveness of monitoring. Examples of these initiatives include the G.R.I.P.S. Commission's "Comprehensive Air Monitoring Plan" which is awaiting action by the local Air Pollution Control Districts; the work of the KGRA Aquatic Resource Monitoring Task Force being coordinated by the staff at the State Energy Commission; the Energy Commission's efforts to coordinate monitoring of each power plant on a project-by-project basis; and, the recent directive by the Energy Commission to its staff to prepare a report and institute hearings "... for the purpose of establishing a monitoring system to assure that certified geothermal power plants in The Geysers are constructed and operated in compliance with applicable regulations, standards, guidelines, and conditions specified

in the Commission's decisions on the applications."¹

Two of the greatest problems inherent in the establishment of coordinated and more comprehensive monitoring programs are: 1) resolving jurisdictional conflicts involving overlapping responsibilities; and 2) reaching agreement on an equitable funding formula to finance the cost of monitoring. Due to the plethora of agencies, developers and utilities with an interest in geothermal development at The Geysers, solutions to these problems that everyone can support are difficult to devise.

C. 1916-Stock-Raising Homestead Act Lands

In a 1977 decision, the United States Court of Appeals, 9th Circuit ruled, in the case of the United States v. Union Oil Company of California, that the geothermal resource is a mineral right reserved to the United States on land homesteaded pursuant to the Stock-Raising Homestead Act of 1916. This decision affects thousands of acres of land in each of the four counties of The Geysers-Calistoga KGRA, and it raised the question of local jurisdiction over the privately owned surface rights to the land.

¹ California Energy Commission, Order Instituting Hearings, Docket No. 80-MON-1, June 6, 1980.

The Lake County Board of Supervisors last year passed a resolution maintaining that the County retains control over land use decisions made on the surface of these properties. Sonoma County has taken a similar position. The U.S. Geological Survey, on the other hand, states that they would "support, honor and abide by all County standards" for geothermal wells, although it is their belief that the federal government has the legal responsibility to decide whether drilling will take place on the 1916 Act lands.

Recent experience in both Lake and Sonoma counties has been that the developers have continued to apply to the counties for use permits on 1916 Act lands, and the Geological Survey has not objected to this practice. In fact, the Geological Survey has recently revised their procedures so that they do not issue a permit until after the county has held a hearing on issuance of a local permit, and, in addition, they have made an effort to incorporate provisions of CEQA into the Environmental Assessments they must prepare. For their part, Sonoma County has offered to express their use permit conditions in such a way that the Geological Survey would be responsible for their implementation rather than implementing them in normal ways.

So long as the counties continue to approve such applications, effective joint permitting procedures can probably be worked out. However, difficulties could arise in a situation in which the federal government is prepared to permit geothermal development and the county in question denies a use permit application. In this case, the only remedy might be to ask an appropriate Court to render a decision in the matter. However, given the legal ambiguities involved, it is clear that neither the local counties nor the U.S. Geological Survey wish to seek a judicial solution to the problem.

D. Payments in Lieu of Taxes for Governmentally-Owned Power Plants

Historically, the development of power plants in The Geysers has been by PG&E. PG&E, as a privately-owned company, has paid property taxes to the local counties on their power plants. This has provided substantial revenues to Sonoma County. Recently, however, a number of public agencies (i.e. Sacramento Municipal Utility District, California Department of Water Resources and the Northern California Power Agency) have initiated development of power plants in The Geysers, and several applications for power plant construction are currently being processed in Lake and Sonoma counties. This could create economic difficulties for the KGRA counties, since public agencies are not liable for local property taxes.

Consequently, because the counties would not be receiving annual property tax payments on governmentally-owned power plants, Lake and Sonoma counties have been pressing the governmental agencies who wish to construct power plants to make payments in lieu of taxes as compensation. While there seems to be some recognition by the public power plant developers of the appropriateness of these payments, the negotiations involved in each individual case require substantial time and effort by the county involved. Moreover, there is some feeling by the counties that this type of development runs counter to their economic self-interest.

E. Fiscal Effects of Power Plant Siting

As it happens, at The Geysers the county line between Lake and Sonoma counties runs through the heart of the dry steam reservoir. In addition, Mendocino County's boundary may also cut through the northern tip of the reservoir. A number of existing leaseholds straddle the county line between Lake and Sonoma counties, and PG&E's Unit 13 power plant has already been built very near the county line. Other power plants, for example, PG&E's Unit 17, SMUDGE #1, and NCPA #2, are all proposed to be located very near the county line. The selection of a power plant site immediately on one side of the county boundary can confer substantial economic benefits on one county and not its neighbor, while both counties may incur significant financial and environmental costs related to that power plant. Since each situation is unique, and the extent of the impacts will vary depending upon which side of the county line the development wells are located, access is provided, etc., a procedure is needed that allows the legitimate interests of both counties to be considered in negotiations regarding compensation with the utility.

F. Local Revenues from Geothermal Development on Federal Land

For some time as geothermal activity on federal land progressed at The Geysers, local governments have been concerned about not receiving revenues from this development to offset the costs of providing services and facilities. All the revenues obtained from federal lease sales were being split equally between the Federal Bureau of Land Management and the State.

In 1979 an effort was initiated to require the state to return the revenues they receive from geothermal lease sales on federal land to the counties. Assemblyman Bosco introduced a Bill, AB 1905, to allocate all federal geothermal lease funds that went into the state treasury to the local governments where the sites are located. This measure got the support of the four Geysers-Calistoga KGRA counties.

After much negotiation with various state agencies, who felt they too had a legitimate claim on a share of the federal geothermal lease funds, Governor Brown signed AB 1905 into law on May 30, 1980. In its final version, this law distributes the 50 percent of the lease revenues that are

returned to the state in the following manner:

- 30 percent of the funds are earmarked for the State's Parklands and Renewable Resources Investment Fund
- 40 percent of the funds are returned to the "counties of origin" where the geothermal leases are located
- 30 percent of the funds are given to the California Energy Commission for disbursement in the form of grants to local governments for geothermal planning and development activities

While this distribution formula is not all that the local counties desired, it does provide several hundred thousand dollars each year which both Lake and Sonoma counties can use to offset the costs they incur as a result of geothermal development at The Geysers. Moreover, all the local agencies in the vicinity of The Geysers are eligible to apply for grants from the funds the Energy Commission was given.

IV. PLANNING ISSUES

A. Cumulative Impact

The incremental nature of geothermal development at the Geysers presents special difficulties in evaluating environmental impact. As each project goes through the permitting process, and is subjected to environmental scrutiny, our capacity to evaluate the environmental consequences of individual projects has increased. However, the dilemma that arises is in coming to grips with the cumulative environmental effects of all of the existing projects taken together with projects that have not yet been built or even proposed. As the California Energy Commission staff has declared in a recent report, "Data are needed to assess and plan mitigation of the long range cumulative effects of geothermal development on the ecosystem."¹ To date no mechanism has been created at the Geysers for projecting these cumulative impacts.

The seriousness of this issue has been generally recognized by the four counties of The Geysers-Calistoga KGRA, as well as by various state and federal agencies involved in geothermal development. Since individual project EIRs and EISs are inadequate in their treatment of the subject, it has been felt that the preparation of a Master EIR or Master Environmental Assessment would provide the necessary perspective. Several attempts to do this have been initiated; however, none have come to a satisfactory conclusion.

¹ California Energy Commission, "Commercial Status: Electrical Generation and Nongeneration Technologies - Staff Report", April, 1980, p. 120.

In the fall of 1980 the Energy Commission Staff began to pull together organizationally several on-going studies as well as some newly initiated projects dealing with the effects of development at The Geysers. Apparently a common focus of the elements of this program will be an assessment of cumulative impact. The work during FY 80/81 will concentrate on the dry steam area, and it is anticipated that during FY 81/82 attention will shift to the surrounding areas where there are hot water resources. Topics to be covered in the current fiscal year include public health, biological resources, water quality, socioeconomics, seismic design, erosion/sedimentation, transmission capacity, air quality, and reservoir characteristics.

B. Roads

The four county roads leading into The Geysers -- Geyser Road and Pine Flat Road from the Sonoma County side, and Socrates Mine Road and Bottle Rock Road from the Lake County side -- at the time they were constructed were never intended to handle large numbers of heavy vehicles on a daily basis; in fact, Socrates Mine Road is still not even paved. All are relatively narrow two-lane roads that wind their way across extremely unstable areas that are subject to landslides and high rates of erosion. The combination of difficult and unstable terrain and heavy vehicles leads to continual problems of road maintenance, particularly during the wet winter months.

In addition to the public roads leading to The Geysers, there is a vast network of private roads owned by the developers serving each of the well sites and power plants in the dry steam field area. While many of these privately owned roads are not subject to the same high volumes of traffic as the roads leading into The Geysers, they are subject to problems of instability and they do have to support heavy vehicles on occasion so that maintenance (although not paid for by taxes) can be a problem here as well.

Naturally, as development expands, new roads must be built at substantial cost both in dollars and in terms of environmental effects. These possible environmental effects, particularly soil erosion and stream sedimentation, as well as growth, can extend across county lines, thereby creating problems in neighboring jurisdictions.

C. Power Transmission Lines and Pipelines

PG&E has installed 908 MW of geothermal power generation at The Geysers (Units 1-15) and is in the process of installing another 220 MW by 1983 (Units 17 and 18). With the addition of these latter two power plants, the capacity of the existing 60kV, 115kV, and 230kV transmission line outlets will be used up. Therefore, additional transmission capacity will be needed to serve additional future power plants.

At the present time, there is one other power plant under construction (NCPA #2), and several more going through the permitting process (PG&E #16, DWR/Bottle Rock, NCPA #1, DWR/South Geysers and SMUD #1). The combined total generating capacity of these plants is 341 MW. To meet the need for transmitting the power generated by these units out of The Geysers, PG&E is proposing to construct a 230kV transmission line from Castle Rock Junction (four miles south of The Geysers) to Lakeville Substation near Petaluma.

PG&E estimates that this proposed line, " ... together with the existing transmission, and additional system development to Sobrante will provide adequate transmission outlet capacity for a Geysers development of 2600 MW."¹ This figure jibes closely with a goal of 2700 MW by 1990 that was considered reasonable in a paper titled "Projected Geothermal Generating Capacity at The Geysers" prepared by David Hill of the California Energy Commission staff in November, 1978. Moreover, 2600 MW falls within the range of 2,000 to 3,000 MW that the California Energy Commission concluded should, for the purpose of transmission system planning, "... be assumed for total electric generating capacity at The Geysers using presently commercialized technology; i.e., exploitation of the dry steam resource."²

To the extent that additional generating capacity beyond 2600 MW can be developed in the dry steam reservoir, or using the hot water resource that may exist in other parts of the KGRA, then one or more additional transmission lines will have to be established. Should these lines involve the creation of new corridors,

¹PG&E, "Geysers Unit 16, AFC, Vol. II", December, 1979, p. 11-2.

²California Energy Commission, "Draft EIR, PG&E Geysers Unit 16 Geothermal Power Plant, Geysers 16 to Lakeville Transmission Line, Lakeville to Sobrante Transmission Line", May, 1980, p. II-1.

it can be anticipated that the same questions relating to the scenic environment and physical and mental health which have been raised in prior hearings will again be brought forth.

The staff of the California Energy Commission is currently undertaking a transmission system study which includes the following components: designing a transmission line master plan for The Geysers; determining the need for a 230 kV switching station in the system; and, assessing the impact of additional generating units on the local carrying capacity of existing transmission lines.

Another linear element associated with geothermal development is pipelines. At The Geysers where the steamfield is bisected by at least one county line, there are situations in which wellheads located in one county are connected by a pipeline across the county line to a power plant in an adjacent county. This can raise sensitive issues of equitably distributing taxes, joint planning to minimize environmental

disturbance in both counties, and assigning responsibility in the event of environmental damage. While there have not been significant problems in this regard in the past, as more and more development occurs, the potential for problems may increase.

D. Resource Assessment

Due to the complex subsurface geology of the Franciscan formation, it is extremely difficult, if not impossible, to assess with any degree of certainty the boundaries of the dry steam resource. The extent to which the dry steam resource is currently being depleted, or to determine whether in fact serious depletion is occurring at all.

The fact that replacement wells must be drilled to maintain the steam volume to supply existing power plants appears to indicate that resource depletion does occur. Moreover, the project now under construction by Union Oil in Sonoma County to divert excessive stream flows for injection into the underground reservoir is a further indication that the resource may be depleting.

In a gravity study conducted a few years ago, it was concluded that,

"Decreases in gravity measured at The Geysers between June 1974 and February 1977 indicate that water vapor being withdrawn for the field is not being replenished significantly by natural recharge... Extrapolation of this lack of recharge is premature for accurately predicting the useful lifetime of the fluid, clearly a matter of real concern."¹

On the other hand, tests have been run that seem to indicate that fluid re-injected after passing through the cooling towers is, in fact, finding its way into the underground reservoir. This seems to show promise for the benefits of

¹ Isherwood, Wm. F., "Reservoir Depletion at The Geysers, California", Geothermal Resources Council, Transactions, Vol. 1, May, 1977, p. 149.

re-injection. At the present time, the California Division of Oil and Gas, funded by D.O.E., is compiling and reviewing reservoir engineering, subsurface geology and geophysical data in order to determine the field boundaries of the dry steam reservoir as well as the nature of the reservoir, including the steam reserves.

An understanding of the areal extent of the resource is important to the local counties in making informed decisions regarding land use, and the potential environmental effects of future geothermal development. Similarly, information about the amount of resource remaining, and the rate of depletion, is vital in making economic projections. If the counties are going to do more than simply respond to development pressures as they occur, better information regarding the resource must be obtained.