MASTER

**NORTHERN CALIFORNIA POWER AGENCY
NCPA NO. 2
GEOTHERMAL POWER PLANT
SONOMA COUNTY**

**DRAFT
JOINT ENVIRONMENTAL STUDY**

CALIFORNIA ENERGY COMMISSION

IN COOPERATION WITH

U.S. DEPARTMENT OF INTERIOR

**•BUREAU OF LAND MANAGEMENT
•GEOLOGICAL SURVEY**

U.S. DEPARTMENT OF ENERGY

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JOINT ENVIRONMENTAL STUDY

For The

NORTHERN CALIFORNIA POWER AGENCY GEOTHERMAL PROJECT NO. 2

APPLICATION NO. 79-AFC-2

APPROVED FOR CIRCULATION:

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PROPOSED PLANT SITE

LOOKING NORTH TOWARDS THE PROPOSED NCPA NO. 2
POWER PLANT SITE & "D" WELL PAD

Figure i-1

Figure i-2

GEYSERS AREA REGIONAL MAP

SUMMARY OF THE JES

The Northern California Power Agency proposes to construct a 110 megawatt geothermal power plant in The Geysers KGRA. The power plant, NCPA No. 2, would be located on federal land in Sonoma County, near the Lake County line on the Mayacmas Mountains ridgecrest. Geothermal steam wells which will supply the project are located in both Sonoma and Lake Counties.

Construction and operation of the power plant are subject to review by three federal agencies and the California Energy Commission. The federal actions addressed by this environmental analysis are: 1) funding by the Department of Energy, through the Geothermal Loan Guarantee Program; 2) approval of the Plan of Utilization by the United States Geological Survey; and 3) approval of the use of the site for the power plant by the United States Bureau of Land Management. The actions of the Energy Commission addressed by this analysis are the suitability of the site and certification of power plant for operation on the site.

PROJECT FEATURES

Preparation of a level site for the proposed power plant and related facilities would require alteration of existing topographic features. Approximately 245,000 cubic yards of earth would be moved during cut and fill activities.

In appearance and operation, the NCPA No. 2 Geothermal Project would be essentially the same as the geothermal units currently operated in The Geysers KGRA by the Pacific Gas and Electric Company. The power plant would consist of two 55-megawatt steam turbine units, each capable of operating separately, if necessary, during scheduled or unscheduled shutdowns.

The spent geothermal steam would be cooled by two, five or six-cell cooling towers. Prior to power plant start-up, approximately 400,000 gallons of water would be required to initially charge the cooling tower basin. During operation, additional cooling water would be provided by condensate from the spent steam. Excess condensate would be injected into the geothermal reservoir.

A number of potentially toxic substances are contained in the incoming geothermal steam supply. Of these, hydrogen sulfide (H_2S) presents the greatest potential for adverse impact from emissions from the spent steam. As proposed, the hydrogen sulfide emissions will be controlled by one or more abatement systems.

The primary H_2S abatement system proposed would use a surface condenser to "partition" the spent steam into condensate and noncondensable gases and solids. The noncondensables would be treated by the Stretford process, in which the hydrogen sulfide is catalytically oxidized into elemental sulfur. This sulfur would then be trucked from the site and sold or disposed of in an approved Class II-1 disposal site.

If the partitioning efficiency of the surface condenser does not equal or exceed 80 percent for the NCPA No. 2 project, some type of secondary H_2S abatement system would be necessary to meet required emission levels. With a secondary H_2S abatement system, the condensate would be treated before it reaches the

cooling towers. The secondary abatement system which looks most promising for geothermal application uses hydrogen peroxide (H_2O_2) to remove H_2S from the condensate.

Power produced by the project will be stepped up to 230 kV by an on-site transformer. From the site the power would be sent over a 2.1 mile long transmission line and tap into an existing 230 kV line which runs between the northern portion of the KGRA and Castle Rock Junction. The transmission facilities would initially consist of a single 230 kV circuit (three conductors per circuit) and, as the amount of power produced in this portion of the KGRA increases, eventually two, 230 kV circuits (six conductors), carried by nine towers of lattice steel design. The proposed route runs slightly below the ridgelines, across a deep drainage channel, and is hidden from the view of the populated areas by intervening ridges. Approximately one mile of additional new roads would be required to provide access to this transmission tapline.

Although not part of the proposed project nor subject to the jurisdictional actions previously described, this document also includes a description and discussion of the geothermal steam supply wells, the project-related steam gathering pipelines and reinjection facilities. Approximately five miles of pipeline would be constructed to gather steam from five supply well pads located less than the mile from the proposed project site. No additional access roads would be needed for the pipelines.

PROJECT IMPACTS AND MITIGATION

Disturbance of topographic features, soils and vegetation could cause significant erosion problems. These impacts would be mitigated by appropriate slope design and preparation during development of the proposed project site. Adequate drainage facilities should be provided under the fill areas and on slopes. Topsoil should be stockpiled to enhance revegetation efforts and exposed soil surfaces should be revegetated prior to the rainy season following soil disturbance and exposure.

Removal of vegetative cover could seriously affect the food and cover for a number of wildlife species, particularly those dependent upon chaparral habitat. Proposed revegetation and habitat management should mitigate this impact and may enhance remaining habitat.

There is a possibility that all or a portion of the geothermal fluids in the cooling system could accidentally spill. The possibility that such spills could enter ground or surface waters will be mitigated by covering the proposed project site with an impervious surface. In addition, the project site and those project facilities capable of a toxic spill will be surrounded with a berm sufficient to contain a maximum probable spill, or the rainfall from a six-hour, 100-year storm.

Transport of potentially toxic or harmful substances related to the H_2S abatement system(s) creates the possibility that these materials could be spilled and enter ground or surface waters. The probability for major accidental spills during transport is relatively low and can be mitigated by improved safety precautions and training.

Unabated emissions of H_2S would produce an increasing number of localized complaints about odor and the potential for disagreeable physical reactions in sensitive populations of the public. Application of various H_2S abatement systems is currently being tested on geothermal operations in The Geysers KGRA. Based upon the projected performance of these abatement systems and analysis of the H_2S emission impacts, the proposed project will not cause the state standard for ambient H_2S levels to be violated in the nearest population areas.

Emissions of potentially deleterious substances which are present in geothermal steam and/or the cooling tower plume may be carried in the air and deposited on soils, vegetation, wildlife and populated areas. The effects of small concentrations and cumulative deposition of substances such as mercury, arsenic, boron or radon, are not sufficiently understood and the significance of the impacts is unknown. Rates and amounts of emissions will be reduced by appropriate design of the cooling towers and other facilities.

Increasing development of geothermal resources and construction of large, visible structures would eventually alter the character of the landscape. The proposed project site and facilities are not visible either from the populated areas or the nearby highways in Lake and Sonoma Counties. No operating geothermal facilities are visible from the proposed site but steam gathering lines for PGandE's Geysers Unit 13 are visible along the ridge road northwest of the site. Visual effects will be reduced by appropriate design and by replanting areas where soils and vegetation have been disturbed.

Cumulative loss of wildlife habitat due to existing and projected geothermal development may significantly fragment and reduce remaining habitat, creating a corresponding decline in species numbers and diversity in The Geysers KGRA. Consistent, coordinated programs for erosion control, revegetation and habitat enhancement within the KGRA can reduce the cumulative effects of development on habitat and wildlife.

Development of geothermal resources and increased access to previously inaccessible areas may increase the potential for damage to uncommon, threatened or endangered (UTE) plant species found in the serpentine barrens of the KGRA. These effects can be reduced by avoiding development in the barrens and by controlling access in potentially sensitive areas.

Consumptive use of geothermal steam for power generation may eventually cause a loss of pressure in the geothermal reservoir. Although a portion of the spent steam will be reinjected into the steam reservoir, this may not be sufficient to recharge the reservoir and pressures may gradually decline.

Recent studies seem to indicate that pressures in the reservoir are dropping. The rate of reservoir recharge, if any occurs, is still unknown. Insufficient information is available to determine whether recharge will be successful.

If all mitigation measures proposed by the NCPA and recommended by regulatory agency staff are implemented, the proposed NCPA No. 2 Project is not expected to have a significant impact upon the environment.

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I INTRODUCTION

I. INTRODUCTION

THE PROJECT

The Northern California Power Agency (NCPA) proposes to construct a 110 megawatt (MW) geothermal power plant in the Geysers-Calistoga Known Geothermal Resource area, more commonly referred to as "The Geysers KGRA." (See Figure I-1) The proposed generating facility, NCPA Geothermal Project No. 2, lies on federally administered lands in Sonoma County.

The NCPA No. 2 facility would be situated on a ridge of the Mayacmas Mountains, near the Pacific Gas and Electric Company's (PGandE) Geysers Unit 16 (proposed) and Unit 13 (currently under construction) geothermal power plants (See Figure I-2). The proposed NCPA No. 2 project would be similar to the PGandE facilities in appearance and operating characteristics.

Project construction is proposed to occur in two phases, with the first 55 MW unit in operation in late 1981 and the full 110 MW available in early 1982. Power produced by the project would be transmitted to an existing 230 kV transmission line in the KGRA.

Geothermal steam for the project will be supplied by Shell Oil Company of Texas and California, the lessee of the federal lands. Although the steam supply wells, steam gathering pipelines and reinjection facilities are not part of the proposed project, this document includes a general discussion of these facilities because of their relationship to the proposed power plant.

THE AGENCIES INVOLVED IN APPROVAL OF THE PROJECT

The proposed NCPA No. 2 project is the first commercial geothermal power plant in the United States, planned for development on public lands. The location and size of the project requires review and authorization by the U.S. Geological Survey (USGS) and the U.S. Bureau of Land Management (BLM), plus the California Energy Commission (CEC). In addition, the NCPA has requested federal funding for a portion of the project, which requires project review by the U.S. Department of Energy (DOE).

Due to the interrelated roles and responsibilities of these agencies in evaluating and permitting this project, they entered into an agreement to consolidate proceedings related to the NCPA No. 2 geothermal project. The three federal agencies are actively participating in the Energy Commission's project review process and public hearings. They also agreed to jointly prepare a single, multi-agency environmental document, the Joint Environmental Study (JES).

AGENCY ROLES

On November 16, 1978, representatives for the four participating agencies signed a Memorandum of Understanding (MOU) which formalized their agreement to participate jointly in proceedings and environmental documentation related to the evaluation and authorization of the proposed project. A copy of this MOU is included in the JES as Appendix C.

Figure I-1: THE GEYSERS—CALISTOGA KGRA

SOURCE: USGS 1:250,000 Santa Rosa and Ukiah Quads.

Appendix C also contains a description of the roles and responsibilities of each of the four participating agencies. Briefly, agency actions are as follows:

- o US, BLM--will decide whether to issue license for use of public land for the proposed project.
- o USGS--will decide whether to issue a permit to construct and operate the proposed project on public land.
- o US, DOE--will decide whether to grant a loan for the project under the Federal Geothermal Loan Guarantee Program.
- o CEC--will decide whether there is a need for the project in California, whether the site and facilities are suitable and whether the proposed project would comply with applicable standards.

THE JOINT ENVIRONMENTAL STUDY (JES)

The four agencies recognized that the NCPA No. 2 proposal presented a unique opportunity to combine state and federal review efforts, to prepare a single document to evaluate environmental effects, and to provide information necessary for each of the agency's decision makers. The JES was prepared by the staff of the California Energy Commission, the U.S. Bureau of Land Management, the U.S. Geological Survey, and the U.S. Department of Energy, with assistance from Lawrence Livermore Laboratory (Refer to list of preparers on page I-8).

The Energy Commission accepted the lead for coordinating the preparation of the multi-agency Joint Environmental Study (JES). In an effort to meet the requirements of both state and federal environmental processes, the JES has been prepared in accordance with the following laws and guidelines:

- o California Environmental Quality Act (CEQA) [CPRC 21000 et seq]
- o State of California EIR Guidelines [14 CAC 15000 et seq]
- o California Energy Commission Regulations to Implement CEQA [20 CAC 23000 et seq]
- o National Environmental Policy Act of 1969 (NEPA) [42 USC 4321-4347]
- o Council on Environmental Quality (CEQ) Regulations for Implementation of NEPA (adopted 11/78) [40 CFR 1500 et seq]
- o U.S. Bureau of Land Management Guidelines for Preparation of an ES [BLM Manual, Part 1790]
- o U.S. Geothermal Steam Act of 1970 [30 USC 1000-1025]
- o U.S. Regulations the Leasing of Geothermal Resources, for USGS [30 CFR 270-271]

- o U.S. Regulations the Leasing of Geothermal Resources, for BLM [43 CFR 3000]
- o U.S. Department of Energy Guidelines for Environmental Review [10 CFR 711]

The purpose of the JES is to provide the general public and those making decisions about the proposed project with information concerning: (1) the environmental consequences of the project; (2) the manner in which significant effects of the project may be mitigated; and (3) any feasible alternatives to the project.

The data used in the preparation of the JES were compiled from a number of published and unpublished sources, and through staff contacts with knowledgeable persons familiar with the project area and its resources. Primary documents used were the Plan of Utilization (POU) submitted to the USGS by NCPA and the Notice of Intention (NOI) and the Application for Certification (AFC) submitted to the California Energy Commission by NCPA. Additional information was collected from supplements to the POU, NOI and AFC, from the transcripts of the NOI proceedings before the Energy Commission, and from comments received from other federal, state and local agencies, members of interest groups and the public.

Additional environmental information related to the steam supply wells for the proposed power plant was gleaned from a number of prior documents related to the geothermal leasing program for federal lands, the drilling of exploratory wells, development of production wells, and development of the necessary steam supply. Refer to Table I-1 for a listing of these prior documents, their subject matter, date of circulation and authors. As specified in Section 15149 of the California EIR Guidelines and in Section 1502 of the CEQ Regulations for EIS's, information from these sources has been identified, incorporated by reference or briefly summarized in the JES. Other sources are referenced as noted in the text and in the bibliography.

JES ORGANIZATION

This document discusses the proposed NCPA project, and the natural and social environment of the project and the surrounding area. The adverse and beneficial consequences of the project and any potential mitigation measures to reduce its significant adverse effects are also presented. The JES examines the following environmental areas: earth resources, water resources, biological resources, air resources, health and safety concerns, cultural resources, socioeconomic concerns, aesthetic considerations, and energy and material resources. Additional sections discuss feasible alternatives to the project, a comparison of its long-term and short-term effects, potential cumulative impacts, growth-inducing effects and irreversible changes associated with the proposed project.

TABLE I-1

LIST OF PRIOR ENVIRONMENTAL DOCUMENTS PERTINENT TO THE STEAM SUPPLY
FOR THE NCPA GEOTHERMAL PROJECT NO. 2

U.S. Department of Interior, Final Environmental Statement (ES)
the Geothermal Leasing Program, 1973

- Vol. I.: Promulgation of Leasing and Operating Regulations
Vol. II.: Leasing of Geothermal Resources in Three California Areas
Vol. III.: Proposed Geothermal Leasing and Operating Regulations
Vol. IV.: Comments on Draft Impact Statement and Proposed Regulations

U.S. Geological Survey, Environmental Assessments (EA's)

Number	Date	Subject	Lease Number
EA #1-4	8-26-74	One deep well, each lease	CA-949, CA-950
EA #13-5	7-28-75	Deep exploratory drilling, Site B	CA-949
EA #22-5	10-08-75	Deep exploratory drilling, Site C	CA-950
EA #37-6	7-19-76	Deep exploratory drilling, Site D	CA-949
EA #40-6	5-20-76	Deep exploratory drilling, Site B	CA-949
EA #48-6	9-13-76	Deep exploratory drilling, Sites A & C	CA-950
EA #66-7	5-04-77	Deep exploratory drilling, Sites F & G	CA-950
EA #68-7	5-20-77	Deep exploratory drilling, Site E	CA-949
EA #80-8	4-11-78	Deep exploratory drilling, Sites H & I and Site J	CA-950 CA-949
EA #95-8	8-24-78	Deep exploratory drilling, Sites K, L, M, P and Q	CA-949

Ecoview Environmental Consultants, Environmental Impacts Reports (EIR'S)

Date	Subject	Location
9-01-74	Well Pad A	Sonoma County
12-19-74	Well Pad B	Lake County
10-01-75	Well Pad C and Well Pad D	Sonoma County Lake County
11-29-76	Well Pad E	Lake County
12-15-76	Well Pad G	Sonoma County
9-01-78	Well Pads M, P, & Q	Lake County

As used in this document, the term, "project area," refers to all land and facilities located within the boundaries of the Shell Oil Company's combined leasehold, lease #CA-949 and CA-950. (See Figure II-2.) The term "study area," wherever used in this document refers to some portion of the project area. The limits of a particular study area are defined in the text associated with the environmental section in which the term is used. The term, "local area," as used in this document refers to any area in and around The Geysers KGRA which is within one-hour's driving distance of the project area.

The JES focuses on potentially significant impacts. A summary of the Impact Identification Matrix used by staff to determine significance of various impacts is included as Appendix A to this document. Where possible, technical environmental data are depicted in graphic form. A glossary of technical terms is included at the end of the JES in Chapter VII.

JES PUBLIC REVIEW PERIOD

A 45-day public review period will follow distribution of the Draft JES. During the review period one or more public hearings will be held in which the contents of the JES will be presented and explained by participating agency staff. Interested persons and/or agencies are encouraged to ask questions and provide comments during these public hearings.

The Final JES will reflect comments received at the hearing and during the review period. The proposed schedule for public review and distribution of the JES is:

November 19, 1979:	Draft JES approved for circulation
December 19-30, 1979:	Tentative period for public hearings on JES
January 3, 1980:	End of public review period
January 15, 1980	Final JES approved for circulation
January 30, 1980	Final JES certified and decision on project

Comments on the Draft JES may be submitted at the public hearings or may be submitted in writing before January 3, 1979 to:

Kathryn M. Matthews
California Energy Commission
1111 Howe Avenue, MS#32
Sacramento, CA 95825
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JES PREPARATION STAFF

Each of the participating agencies accepted lead responsibility for preparation of specific portions of the JES. These individual portions were then reviewed by counterpart staff in the other agencies and jointly revised prior to incorporation into the JES. In the list below, the name of the person having lead responsibility for each section is given first and the name(s) of their co-preparer(s) follow.

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II
**PROJECT
DESCRIPTION**

Figure II-1 Artist's Conception of Proposed NCPA No. 2 Geothermal Power Plant¹

Figure II-1

II. PROJECT DESCRIPTION

PROJECT OVERVIEW

The Northern California Power Agency (NCPA) proposes to construct and operate the NCPA Geothermal Project No. 2 power plant and related facilities on federally administered lands in The Geysers Known Geothermal Resource Area (KGRA). Geothermal steam will provide 110 MW of gross generating capacity which will be used to meet baseload requirements of the NCPA members. Plant construction is expected to begin in early 1980 and the first 55 MW unit is scheduled to begin operation in late 1981. The second 55 MW unit would begin operation six months later, in early 1982.

PROJECT PROPONENT

The NCPA was established pursuant to the State of California Joint Exercise of Powers Act. Each member of the NCPA is a public agency and has the power to purchase, generate, transmit, distribute, sell and interchange electrical energy, in addition to other powers which are common to each of them.

All members of the NCPA own and operate their own electric utility systems; however, they do not currently have their own generating facilities. The NCPA members now purchase power from the Pacific Gas and Electric Company (PG&E) and/or the Western Area Power Administration (WAPA), formerly the U.S. Bureau of Reclamation Central Valley Project (CVP).

Members of the NCPA include eleven cities and one Rural Electric Cooperative. Table II-1 lists the members and sources of electricity currently provided through purchase agreements.

Table II-1

NCPA Members and Suppliers of Purchased Power

City of Alameda	(PG&E)	City of Palo Alto	(WAPA)
City of Biggs	(WAPA)	City of Redding	(WAPA)
City of Gridley	(WAPA)	City of Roseville	(WAPA)
City of Healdsburg	(PG&E)	City of Santa Clara	(PG&E) & (WAPA)
City of Lodi	(PG&E)	City of Ukiah	(PG&E)
City of Lompoc	(PG&E)	Plumas-Sierra REC	(WAPA)

PROJECT LOCATION

The KGRA is a mountainous, rugged, and sparsely settled area located in the north central portion of the California Coast Range. (See Figure I-1) The KGRA is located approximately 70 miles north of San Francisco and 60 miles northwest of Sacramento. The site proposed for the NCPA No. 2 geothermal power plant is located on the Sonoma County side of the Mayacmas Mountain ridge line, just west of the Sonoma/Lake County line.

The site lies on a northwest/southeast trending ridge of the Mayacmas which rises above the Big Sulphur Creek and Bear Canyon Creek drainages, in the northwest quarter of Section 2, Township 10N, Range 8W of the Mt. Diablo-based meridian. Approximately 2-1/2 miles to the northeast of the proposed plant

LEGEND:

- Shell Leasehold Boundary
- Unit Area Boundary
- === Transmission Tapline Corridor
- A-M Shell Well Pads
- Producing Steam Wells
- Nonproducing Wells
- Steam Gathering System
- Condensate Reinjection Line

NCPA NO. 2 PROJECT AREA
FIGURE II-2

site is the Lake County community of Anderson Springs, estimated 1975 population, 200 (PGandE, 1975b); and about 6 miles to the east is the community of Middletown; estimated 1978 population, 1,400 (Clearlake Observer article, November 16, 1978).

In addition to the geothermal generating plant, the NCPA proposes to construct, operate and maintain a 230 kilovolt (kV) transmission tapline that would extend approximately 2.1 miles westward from the proposed plant site to an existing PGandE 230 kV transmission line. The proposed route lies within Sonoma County in Sections 2, 3 and 4, Township 10N, Range 8W, of the Mt. Diablo-based meridian. (See Figures II-3 and II-4).

PROJECT ACCESS

Access to the proposed project site is primarily from the Lake County side of The Geysers KGRA, via State Highway 175 and the Socrates Mine Road. From the Socrates Mine Road, a ridge road leads generally south and eastward into the project area, past the location of PGandE Geysers Unit 13 and the proposed location of PGandE Geysers Unit 16, onto the Mayacmas ridge crest to the proposed NCPA No. 2 site. Both the Socrates Mine Road and the ridge road are maintained by the various steam developers active in the area.

Access to the proposed site area is possible from the Sonoma County side of the KGRA via State Highway 128 and The Geysers Road to the entrance of the PGandE Geysers facilities. The route from The Geysers entrance to the NCPA No. 2 site involves traveling on a series of interconnecting, service roads associated with the PGandE Geysers facilities and maintained by the various steam developers (See Figures i-2 and I-1).

PROJECT HISTORY

The proposed NCPA Geothermal Project No. 2 will be the first electric generation facility owned and operated by the NCPA. PGandE currently owns and operates 13 geothermal power plants in The Geysers KGRA, equalling a total installed electric capacity of 663 MW. Additional geothermal power plants, Geysers Units 13 and 14 are currently under construction by PGandE, and will provide another 245 MW of electric capacity during 1979. Proposed Geysers Units 16 and 17 are expected to add an additional 220 MW of electric capacity by 1981. The NCPA No. 2 project would add an additional 110 MW of capacity by 1982. (See Table II-2 and Figure I-2).

The proposed NCPA No. 2 project is the first commercial geothermal power plant planned for development on public lands in the United States. The location of the plant site requires review and authorization by the United States Geological Survey, the United States Bureau of Land Management, and the California Energy Commission. In addition, the NCPA has applied for a federally guaranteed loan for a portion of project financing and this necessitates project review by the United States Department of Energy. A more specific discussion of the role and responsibility of these four agencies for this project is presented in Appendix C.

In December 1970, Public Law-91-581, The Geothermal Steam Act of 1970, was approved. The Act and subsequent regulations provide for the leasing and development of geothermal resources on public lands under continuing regulation and environmental controls.

■ EXISTING OR PROPOSED PG&E UNITS
 SOURCE: PG&E ENVIRONMENTAL DATA STATEMENT
 GEYSERS UNIT 17 July, 1977

GEYSERS AREA TRANSMISSION LINES

Figure II-3

STATION DATA		
STATION	BEARING (Deg. - Min. - Sec.)	DISTANCE (Feet)
1	86°11'33"W	1,195.00
2	86°10'42"W	1,195.00
3	86°10'10"W	1,027.00
4	86°10'10"W	1,027.00
5	86°10'10"W	1,027.00
6	86°10'10"W	1,027.00
7	86°10'10"W	1,027.00
8	86°10'10"W	1,027.00
9	86°10'10"W	1,027.00
10	86°10'10"W	1,027.00
Total Distance: 10,270.00 Feet

Figure II-4: Proposed NCPA No.2 Transmission Route

LEGEND:

- T.T. TRANSMISSION TOWER
- PROPOSED TRANSMISSION TOWER
- EXISTING POLE CO. TOWER
- EXISTING 10'-0" DIRT ROAD
- PROPOSED 10'-0" DIRT ACCESS ROAD
- PROPOSED TRANSMISSION LINE
- R/W RIGHT-OF-WAY
- ROCK ROCK CONTROL POINT

GRAPHIC SCALE: 1"=300'

SAI ENGINEERS, INC.				NORTHERN CALIFORNIA POWER AGENCY			
770 HILLY BLVD.				SANTA CLARA, CA 95051			
NCPA GEOTHERMAL PROJECT NO. 2				GENERAL LAYOUT			
230KV TRANSMISSION TAPLINE				78188			
AFC-6				12-19-88			

TABLE II-2

DETAILS OF GEOTHERMAL GENERATION¹

Year of Commercial Operation	Unit No. Designa- tion	Owner- ship	Capacity (MW)	Voltage of Trans- mission (kV)	Cumula- tive Geothermal Generation (MW)
On or Before Dec. 31, 1977	1,2 3,4,7,8 5,6,9,10,11	PG&E PG&E PG&E	24 160 318	60 115 230	502
1978	12 15	PG&E PG&E	106 55	230 115	663
1979	14 13	PG&E PG&E	110 135	230 230	908
1980	-	-	-	-	908
1981	17 16 18 19	PG&E PG&E NCPA-1S ² NCPA-2S ²	110 110 55 55	230 230 230 230	1,238
1983	20 21 22 23 24 25	PG&E-18 PG&E-19 CDWR-Site 1 CDWR-Site 2 NCPA-1N ² NCPA-2N ²	110 110 55 55 33 33	230 230 230 230 230 230	1,634
1984	26 27	PG&E-20 PG&E-21	110 110	230 230	1,854
1985	28	PG&E-22 ³	110	230	1,964
1986	29	PG&E-23 ³	110	230	2,074
1987	30 31 32 33 34 35 36	PG&E-24 ³ PG&E-25 ³ CDWR-Site 3 CDWR-Site 3 NCPA-3S ² NCPA-4S ² NCPA-3N ²	110 110 55 55 55 55 100	230 230 230 230 230 230 230	2,614 ⁴

Notes:

¹ PG&E Geothermal generation details, except for Unit No. 31 (PG&E-25), are obtained from Western Systems Coordinating Council Reply to United States Department of Energy order 383-5, Docket R-362 "Reliability and Adequacy of Electric Service" dated April 1, 1978. Unit No. 31 (PG&E-25) is to be in service by December 1987 as per telephone discussion of March 27, 1978, of the Consultant with Mr. H.R. Perry, Chief Planning Engineer of PG&E. CDWR and NCPA Geothermal generation details are based on the Consultant's understanding of CDWR and NCPA plans for such type of generation.

² Designation given by the Consultant-First figure signifies unit number.

N Signifies North Site

S Signifies South Site

³ Unit numbers are designated as per the Consultant's understanding with Mr. H.R. Perry, Chief Planning Engineer of PG&E.

⁴ PG&E (H.R. Perry letter July 6, 1978) totals 110 MW less installed by 1987 on 230 kV system.

Prepared by: R.W. Beck and Associates
Denver, Colorado

Date: 10/10/78
Revised 2/20/79

In order to determine whether or not leases were to be issued in The Geysers KGRA, the United States Department of Interior (USDI) needed to identify, evaluate, and describe the environment and the anticipated environmental impacts from geothermal leasing operations there. An Environmental Impact Statement (EIS) for the Geothermal Leasing Program was prepared by USDI to address these issues and also to discuss the alternative uses for KGRA lands and their ramifications. The EIS was published in October 1973 and contains information indicating that geothermal resources can be developed in environmentally non-sensitive area of The Geysers KGRA under careful regulation and environmental controls.

BLM used the recommendations presented in the 1973 EIS document to determine the suitable lease areas in The Geysers KGRA. Once these lease areas were determined, BLM performed a site specific Environmental Analysis Record (EAR) (see Appendix B) for each lease area to ensure environmental protection. The EAR document containing the analysis of the lease area that includes the Shell Oil lease tracts #CA-949 and #CA-950 was published in September 1974. In addition to recommended environmental protection stipulations taken from the EIS, the lease agreement also contains the site specific stipulations identified by BLM in the EAR (see Appendix B).

After the lease area was determined and the EAR was completed by BLM, the USGS became responsible for dividing the lease area into lease tracts. The lease tract information was returned to BLM, which then administered the competitive bidding procedure.

In January 1974, Shell Oil Company became the successful bidder for lease tracts #CA-949 and #CA-950 (of lease area T. 10N. R8W, MDM; Sections 1,2,3,4,11,12) in The Geysers KGRA and then entered into a geothermal resources lease with BLM.

Prior to construction activities and subsequent development of the geothermal resource on the leasehold, Shell was required to submit a Plan of Operation to USGS. After USGS reviewed Shell's Plan of Operation, it scheduled field trips to the drill sites described in the Plan of Operation.

On these field trips, the expected environmental impacts and their mitigation measures were determined in a coordinated effort between USGS and BLM experts and Shell representatives. From these field trips, USGS prepared Environmental Analyses (EA's) that contain special stipulations and permit conditions to protect the environment at these sites. No construction or development activity was approved by USGS until Shell agreed to comply with the stipulations in the EA for the development activities. Furthermore, once construction and operation begins, USGS and BLM make periodic inspection visits to the sites to ensure Shell is complying with all general and special stipulations, and the Geothermal Resource Operation (GRO) Orders* designed to protect the environment, and minimize or avoid adverse impacts.

*The Geothermal Resource Operational Orders are on file and available at the Office of the Area Geothermal Supervisor, United States Department of the Interior Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

On September 5, 1978, the NCPA submitted a loan application to the DOE. Action on this funding request is pending the outcome of environmental and regulatory review of the proposed project.

To date five production wells have been drilled and completed within the 3,000 acre Shell leasehold. On June 27, 1977, the NCPA entered into a contract with Shell for the purchase of geothermal steam from a designated 1,000 acre production area within the leasehold.

In March 1978, the NCPA filed a Plan of Utilization (POU) for their proposed Geothermal Project No. 2, with the USGS Area Geothermal Supervisor. On August 11, 1978, the NCPA submitted their Notice of Intention (NOI) to apply for certification of this project, to the California Energy Commission. After public review and evaluation, the NOI was approved on March 14, 1979 and on April 4, 1979 the NCPA submitted their Application for Certification (AFC) to the Energy Commission. Following completion of environmental and regulatory review of the proposed project, action will be taken on the POU by the U.S. Geological Survey and on the AFC by the Energy Commission.

On March 28, 1978, the NCPA made application to the BLM for use of the proposed sites for the construction of an electric generating plant and related facilities and transmission route. Action on the BLM license to use the proposed site is pending the outcome of environmental and regulatory review of the proposed project.

On September 5, 1978, the NCPA submitted a loan application to the DOE. Action on this funding request is pending the outcome of environmental and regulatory review of the proposed project.

PROJECT FEATURES

The Power Plant

The NCPA would own and operate the power plant and the associated facilities which are not operated by the steam supplier. The proposed NCPA facilities would include the power plant, cooling tower, hydrogen sulfide abatement equipment, and switchyard. The power plant and other related plant facilities would be situated on a paved, level pad, about seven acres in size. This pad would be created by moving an estimated 245,000 cubic yards of earth in a series of balanced cuts and fills. Refer to Figure II-1, for an artist's conception of the proposed power plant, and to Figure II-5, for a proposed layout of the power plant site.

The following are the principal features of the proposed power plant. For more specific information, refer to Section V, Volume I of the NOI, and Section III of the AFC. Refer to Figure II-6 for schematic diagram of plant systems. Principal features include:

- o Two, 55 MW turbine/generators mounted on concrete foundations and housed in a two-story, 12,500 square foot, steel frame building measuring approximately 200 feet long by 85 feet wide by 70 feet high.

Figure II-5

- o Each turbine/generator unit would have a surface condenser which will condense spent steam from the turbine exhaust and effect an increase in the partitioning of noncondensibles from the condensate and pumps to move condensate to the cooling towers.
- o After condensation spent steam from each turbine/generator unit would be cooled by a five or six cell, mechanically induced draft type cooling towers measuring approximately 220 feet long by 70 feet wide at the top and 65 feet high, supported by a reinforced concrete cooling water basin.
- o A concrete-lined condensate storage pond for holding wastes to be injected into the reservoir.
- o The primary set of hydrogen sulfide (H_2S) abatement equipment, (Stretford Process) in which the H_2S is scrubbed from the stream of noncondensable exhaust gases and catalytically oxidized into elemental sulfur (See Figure II-7). If needed to meet required emission levels, a secondary set of H_2S abatement equipment would be installed between the surface condenser and the cooling towers (See Chapter V for further discussion).
- o A transmission switchyard, located adjacent to the turbine/generator building and containing two main transformers.

The NCPA plans to install duplicate equipment, interconnected piping and circuitry to provide full redundancy of most generating plant equipment. Only one set of auxiliary plant equipment will be employed during normal operations and duplicate equipment will start automatically if the operating equipment fails. Each turbine/generator unit will have the capability to operate independently from the other unit and will have separate equipment and circuitry capable of handling all station requirements.

The entire power plant site, including the components described, will be constructed on an impervious, paved surface and surrounded by a berm of sufficient height to contain and control storm runoff and/or potential spills.

Proposed Hydrogen Sulfide (H_2S) Abatement System

The primary H_2S abatement system proposed for the NCPA No. 2 power plant is comprised of a Stretford process unit, conventional turbine exhaust-gas ejector equipment and turbine exhaust surface condensers (see Figure II-7). Spent steam from each 55 MW turbine/generator unit will contact the surface condenser. Condensation of the spent steam occurs on the surface of the metal tubes which make up the surface condenser. The noncondensable portion of the turbine exhaust steam is then evacuated from the surface condenser housing by the gas ejector system.

The surface condenser which condenses the spent steam from the turbine exhaust units is a critical component of the H_2S abatement system. As it cools and condenses the spent steam, the surface condenser will "partition" the steam into two components: 1) liquid condensate, which will contain varying amounts of dissolved H_2S , and 2) noncondensable solids and gases including H_2S . The partitioning effect of the surface condenser is highly dependent upon the chemical composition of the steam. Ideally, use of a surface condenser is

STRETFORD HYDROGEN SULFIDE ABATEMENT PROCESS

FIGURE II-7

expected to increase the amount of H_2S in the flow of noncondensable gases undergoing the Stretford process, and thereby reduce the amount of H_2S available to enter the atmosphere through evaporation and drift emissions from the cooling towers. However, use of a surface condenser to effect an increase in partitioning is a new technology and not totally proven.

The Stretford process was originally developed to remove H_2S from coal gas and has been successfully applied for treatment of natural gas, refinery gas, and tail-gas from Claus sulfur plants. In these applications, the Stretford process has removed in excess of 99 percent of the H_2S passing through the processing unit. Although the Stretford process had not previously been applied to geothermal operations, it is believed* to have the capability to be successfully adaptable and to present the most effective and only means of complying with the air quality standards.

Basically, the Stretford process involves the "scrubbing" of H_2S from the stream of noncondensable gases from the turbine units, by oxidizing the H_2S in the presence of catalysts to produce free sulfur. The overall reaction may be written as follows:

In addition to the sulfur, other byproducts of the Stretford process include the remaining noncondensable gases, water-saturated air from the oxidizer and a Stretford solution purge stream.

More specifically, the chemical reactions taking place in the Stretford process can be described as follows:

- a. Noncondensable gases will be washed in an absorber with a solution containing alkali (sodium carbonate or sodium hydroxide), sodium polyvanadate (Vanasol), and anthraquinone disulfonic acid (ADA).
- b. The hydrogen sulfide in the gas will be absorbed in the solution, where it will react with the sodium carbonate to form sodium bisulfide.
- c. The sodium bisulfide, in turn, will be oxidized by the five-valent state vanadate to form sulfur; this reaction reduces the vanadate to its four-valent state.
- d. Next, the solution is oxidized with air and the reduced vanadate will be restored to its five-valent state through oxygen transfer via the ADA.
- e. Finally, the solution will be recirculated and a sulfur-bearing froth, which will rise to the surface of the solution, will be removed for sale or disposal.

*This opinion is shared by the California Air Resources Board, Lake County APCD, Northern Sonoma County APCD, Energy Commission staff and the utilities making application for certification of geothermal power plants.

The combination of a surface condenser to increase the H_2S concentration in the gas stream and the Stretford process to remove the H_2S has been installed on PGandE's Geysers Unit 15 which began operation in 1979. The Stretford process is currently being tested for efficiency of H_2S abatement on Unit 15. This abatement system will also be used on PGandE's Geysers Units 13 and 14 which are currently under construction and Units 16 and 18, which are in the preconstruction permitting phase, and Unit 17 which was recently certified for construction.

As proposed by NCPA, the Stretford process is expected to remove at least 90 percent of all the H_2S in the turbine exhaust steam. Based upon the quality of the steam being supplied to the power plant, NCPA expects the rate of H_2S emissions to meet applicable regulatory standards.

However, additional H_2S abatement may become necessary if the amount of H_2S dissolved in the condensate formed at the surface condenser produces cooling tower emissions in excess of applicable standards. Secondary H_2S abatement would then be applied to the condensate flow, between the surface condenser and the cooling tower. NCPA proposes to use an iron catalyst/hydrogen peroxide system for secondary H_2S abatement.

Transmission Facilities

The NCPA proposes to design, construct, own, operate, and maintain the transmission facilities between the power plant site and the junction with an existing 230 kV transmission line which runs between the northern portion of The Geysers KGRA and Castle Rock Junction. NCPA is negotiating with PGandE to wheel electricity from this project over PGandE-owned transmission lines, to the NCPA members. Refer to Figures II-3 and Figure II-4 for location of the proposed route for the transmission tapline. Location of tower pads and routing detail are shown in Figure II-4.

Power will be generated at 13.8 kV and then will be stepped up by on-site transformers to 230 kV for transmission over the tapline. Proposed transmission facilities will consist of approximately 2.1 miles of double-circuit, 230 kV lines on nine towers of steel lattice design. Conductors will be 1,113 KCM and towers will average 110 feet in height. A minimum of 30 feet of vertical clearance will be maintained between electrical conductors and the ground.

Construction of the transmission tower pads would require the permanent clearing of approximately one-half acre of vegetation and the temporary disturbance of an additional two acres of vegetation. Existing access roads can be used for construction of approximately two-thirds of the transmission tapline. Additional spur roads will be required to construct and maintain three of the nine tower pads. Approximately one mile of additional access roads are proposed for construction of the transmission tapline, requiring permanent clearing of approximately five acres of vegetation.

Project-Related Facilities

Although the steam supply wells, steam gathering pipelines and reinjection facilities are not part of the project proposed by NCPA, they are project-related. A brief discussion of the principal features of development and operation of the geothermal steam supply are provided here.

Development of the Steam Supply

As is typical in The Geysers KGRA, exploration for and development of geothermal resources is conducted by a number of steam suppliers, many of which have been involved in development of petroleum resources. The NCPA has contracted with the Shell Oil Company for the purchase of geothermal steam from a designated production area within the Shell leasehold on public lands. Shell will drill, operate and maintain the geothermal wells, construct and maintain the steam gathering system, and reinject excess condensate and wastes from the power plant operation into the steam reservoir.

In developing the geothermal resource within their leasehold for the NCPA project, Shell has received drilling and associated permits for several well sites. Additional information on individual well sites and drilling programs may be found in a series of Environmental Analyses (EAs) prepared by the USGS. A corresponding series of Environmental Impact Reports (EIRs) were prepared by Ecoview Environmental Consultants for Lake and Sonoma Counties. Refer to Table I-1 for a complete listing of pertinent environmental documents.

A simplified conceptual drawing of a geothermal steam reservoir is shown in Figure II-8. In preparation for drilling steam supply wells, the drilling site or well pad, is stripped of vegetation and leveled. The required surface area of the well pad varies in size from less than an acre to approximately three acres, and it must be large enough to accommodate the drill rig, temporary structures, and crew parking. Due to the rugged terrain of The Geysers KGRA and to minimize environmental disturbance, most drill sites are situated on a ridge or a saddle. Sites are kept as small as possible. As many as four separate wells may be directionally drilled from a single well pad.

The principal features of the well pad area during the drilling phase are: the well head drill rig (which may extend over 100 feet in height), water storage tanks, drilling mud storage tanks, mud pit and sump, mud pumps, pipe racks, air compressors, diesel-powered generators, and emission and noise control equipment.

Once the drilling phase is completed, much of the equipment is removed and, to the extent possible, the well pad is restored to its predrilling state. In addition, after completion of the drilling, the contents of the mud pit and sump are analyzed. If the contents are deemed to be nontoxic by state and local regulatory agencies, the sump will be sealed with earth to serve as permanent disposal site for the drilling wastes. If the contents are deemed to be toxic, they will be removed to an approved Class II-1 disposal site located outside the JES project area, in Middletown or in Kelseyville, Lake County.

Underproductive or marginal wells may be used as condensate reinjection wells. Since the average cooling tower evaporation rate is less than the steam flow rate through the turbine/generator, excess condensate (estimated at 30 percent of the original steam flow) is accumulated in the cooling tower basin. From the cooling tower basin the excess condensate flows into a concrete collection pond where it is stored until it is piped to an injection well for reinjection into the steam reservoir.

SIMPLIFIED GEOTHERMAL FIELD

FIGURE II-8

Steam wells no longer in use are required to be filled and capped in accordance with the provisions of USGS Geothermal Resources Operational (GRO) Order No. 3. All surface equipment must be removed; the site must be regraded, contoured, seeded and replanted in order to return it, as much as possible, to its original condition. The dismantling of dry or abandoned wells and other surface equipment is regulated by the California Division of Oil and Gas and the U.S. Geological Survey. Site restoration is regulated by the USGS in consultation with the U.S. Bureau of Land Management and fluid waste disposal is regulated by the states's Regional Water Quality Control Boards.

Project Steam Supply

The steam supply field for the NCPA No. 2 project is situated on both sides of the Sonoma/Lake County line, about four miles south of Cobb Mountain, near the southeastern margin of The Geysers KGRA. The steam production area designated for the NCPA No. 2 power plant encompasses about one-third of Shell's leasehold in Sections 1, 2, 3 and 4 of Township 10 N, Range 8 W of the Mt. Diablo-based meridian. This area is shown on the "Whispering Pines" and "Mount St. Helena" topographic quadrangle maps (USGS, 7.5 minute series). Refer to Figure II-2 for leasehold and steam production unit boundaries.

Shell has drilled and completed five steam production wells within its leasehold. The NCPA No. 2 project is expected to use steam from wells located at Shell drilling sites B, C, D, F, and Q. A well at drilling site A will be used for reinjection. Refer to Figure II-2 for the location of these well pads and their relation to the proposed power plant site. Shell has estimated that, depending upon productivity, as many as 15 additional wells will be developed to provide the required volume of steam. Over the lifetime of the plant (approximately 30 years), Shell estimates that an additional ten wells will be required to make up for the decline in steam flow from the producing wells. This make-up steam may be obtained either by the cleanout and deepening of existing wells or by developing new wells at existing well pads. (NCPA, 1978a) Any future well development within the Shell leasehold will be under the jurisdiction of the USGS and BLM.

Steam Gathering Systems

In order to transmit the geothermal steam from the well sites to the proposed power plant, approximately five miles of insulated steam pipeline will be constructed. The pipelines are mounted upon steel support structures. During construction, a 30-foot wide corridor is initially cleared along the pipeline route. Vegetation is cut back to ground level and regrows from the remaining root structure. Following pipeline construction, vegetation growth within several feet on either side of the pipeline is maintained to near ground level for fire control purposes.

Pipelines are constructed along existing access roads whenever possible to minimize environmental disruption. (Refer to Figure II-2 for expected pipeline routes.)

NEED FOR THE PROJECT

Geothermal steam from The Geysers KGRA is currently providing an economic alternative for fossil fuels in the generation of baseload electric power. The capital costs for other generation alternatives such as nuclear, oil, or coal are escalating more rapidly than the general rate of inflation.

All NCPA members have been experiencing increasing power requirements and considerable increases in the cost of purchased wholesale power from PGandE and the Western Area Power Administration (WAPA). The areas served by NCPA lie within the PGandE service area boundaries. PGandE's current generation capacity is heavily dependent on oil (1979--45 percent). Fuel cost adjustments have resulted in price increases for PGandE power several times this year and more price increases are expected in the future. PGandE has applied for a license to operate its Diablo Canyon Nuclear Power Plant Units, 1 and 2, but there is some question as to when and whether that license will be granted.

Between 1980-1990, without power supplied by the Diablo Canyon units, PGandE could experience a drop in its reserve margin below the 15 percent traditionally accepted by the utility industry (see Table II-3). The availability of the power produced by the proposed NCPA No. 2 project for NCPA members will reduce the need for PGandE to provide this power and help maintain a reserve margin acceptable within the industry.

Beyond 1986 WAPA will not be able to meet the load growth of its customers and still meet their pumping energy requirements without new purchases of expensive thermal power or additional federal hydroelectric development. WAPA is losing 400 MW of coal-fired capacity in 1982 and any replacement of this capacity will result in increased power cost to WAPA customers.

The Energy Commission staff believes that the addition of this new geothermal baseload generation capacity to the PGandE service area represents the best supply option for NCPA because of:

- a. The effects the uncertainty in the planned operating date of either Diablo Canyon No. 1 or No. 2 (PGandE nuclear plant) will have on PGandE's reserve margin and reliability of supply. NCPA Project No. 2 could supply a 10 percent capacity of either Diablo Canyon No. 1 or No. 2.
- b. NCPA's proposed project could save approximately one million barrels of oil a year by displacing less efficient existing oil units in PGandE's system.
- c. Consistency with the Federal Power Plant and Industrial Fuel Use Act of 1978 (PPIFUA), which prohibits new thermal power plants from using petroleum or natural gas as their primary energy.
- d. Finally, the relatively short construction lead time of this project could allow the NCPA to plan and adjust for changes in forecasted peak demand with more flexibility.

The proposed NCPA No. 2 project is also consistent with Commission-adopted policy regarding geothermal resource development. On March 22, 1978, the Commission adopted its Geothermal Policy Report which recognizes geothermal energy as a preferred technology for meeting electrical power needs because: 1) it is indigenous to California; 2) its development offers a stimulus to the state's economy; 3) for dry steam resources, the environmental impacts and power plant technology are well understood; 4) geothermal power plants are relatively small (50-110 MW) and thus enable greater system reliability and flexibility; and 5) geothermal power plants may be planned and constructed in a time frame shorter than many power plants using other fuels.

The proposed project is the first geothermal baseload project planned by NCPA to develop its own generation capacity and to minimize increasing costs of power for its members. To further offset the need for purchased power from PGandE and WAPA, the NCPA proposed to construct an additional geothermal power plant known as NCPA No. 1 which will have a capacity of 66 MW and should be on-line in late 1983 or early 1984. This power plant is presently in the NOI phase of the Commission's regulatory process.

TABLE II-3

RESERVE MARGIN ANALYSIS

YEAR	PLANNING LOAD FORECAST MW 1/	SYSTEM CAPACITY MW 2/	CASE 1 WITH DRY YEAR LOAD ADDER NCPA/2 (MW) (%) 3/		CASE 2 W/O DRY YEAR LOAD ADDER WITH NCPA/2 (MW) (%) 4/		CASE 3 W/O DRY YEAR LOAD ADDER W/O NCPA/2 (MW) (%) 5/		CASE 4 W/O DIADLO CANYON 1 112 (%) (%)		REQUIRED RESERVE BASED ON ONE DAY IN TEN YEARS CRITERION (%)
1980	16346	18656	2310	14.1	2500	15.5	2394	14.8	7.5	0.73	13.9
1981	16893	20063	3170	18.8	2360	20.1	3254	19.5	12.3	5.80	13.9
1982	17513	19841	2328	13.3	2518	14.5	2412	13.9	7.1	0.79	14.3
1983	18017	21297	3280	18.2	3470	19.5	3364	18.9	12.2	6.0	14.5
1984	18599	22298	3699	19.9	3889	21.1	3783	20.5	14.1	8.1	14.7
1985	19200	23033	3833	20.0	4023	21.2	3917	20.6	14.3	8.6	14.7
1986	19778	24178	4400	22.2	4590	23.4	4484	22.9	16.8	11.2	15.6
1987	20399	25263	4864	23.8	5054	25.0	4948	24.5	18.5	13.1	15.7
1988	20871	26153	5282	25.3	5472	26.5	5366	25.9	20.1	14.8	16.1
1989	21476	27033	5557	25.9	5747	27.0	5641	26.5	20.8	15.7	16.6
1990	22149	27503	5354	24.2	5544	25.2	5438	24.8	19.3	14.3	16.0

1/ Commission adopted basic peak load forecast (1977). Plus load adjustments including 190 MW of dry year load adder, CFM-11 peak forecast adjustments, 4/4/78.

2/ PGandE's most recent resource plant including NCPA No. 2, CFM-II update of June 1979.

3/ Capacity reserve include NCPA Project No. 2 106 MW.

4/ Capacity reserve without 190 MW dry year load adder.

5/ Capacity reserve without 190 MW dry year load adder and NCPA No. 2.

III
ENVIRONMENTAL
SETTING

EARTH RESOURCES

GEOLOGYPhysiographic and Topographic Characteristics

The proposed project and the entire Geysers KGRA are located in the Coast Range's Physiographic Province. This province is characterized by a series of longitudinal folds and faults which have resulted in a group of nearly parallel mountains and intervening valleys, extending approximately 400 miles (640 kilometers) in a northwest/southeast direction (Thornbury, 1965). The site for the proposed project is located in the Mayacmas Mountain Zone of the Coast Range Province.

The physiography and topography in the immediate vicinity of the site are dominated by the main ridge crest of the Mayacmas Mountains (Figure III-1). Ridges in the area range in elevation from about 2,500 feet (760 meters) to 4,700 feet (1,430); valley floors lie as low as 1,200 feet (379 meters). The topography along the ridge crest is moderately gentle, with some narrow and steep spur ridges and intervening canyons.

Geologic Characteristics

Geologic characteristics of a project area must be evaluated to adequately design the proposed facilities to withstand potential seismic activity and to assure the stability of the underlying foundation materials. Particular associations of rock types have been deposited or formed at specific periods of geologic history. Knowledge of these associations allows an experienced geologist to anticipate the type, depth and interrelationship of the rock units underlying a particular area and their suitability as foundation material for proposed construction.

Stratigraphy and Lithology

Rock units in The Geysers KGRA range in age from Upper Jurassic to Quaternary, and include the Upper Jurassic and Cretaceous Franciscan Assemblage and Great Valley Sequence. Figure III-2 is a generalized geologic map of The Geysers KGRA.

The Franciscan Assemblage in the KGRA consists primarily of graywacke of varying composition, conglomerate and shale. Altered, intrusive and extrusive igneous rocks (greenstone) are second in abundance in the assemblage. Other rock types included in the Franciscan Assemblage include: radiolarian chert, metamorphic blueschist, and serpentinite.

The Great Valley Sequence consists mainly of well-bedded sandstone and shale, mudstones and siltstones, and conglomerate lenses and beds. About 35,000 feet (10,660 meters) of sedimentary strata in the Clear Lake area have been described as belonging to this sequence (Swe and Dickinson, 1970; in Bacon, et al., 1976). Localized occurrences of ultramafic rocks are present at the base of the Great Valley Sequence and are in fault contact with the Franciscan Assemblages.

The Coast Range ophiolite occurs below the base of the Great Valley Sequence, primarily in the southeast and southwest portions of Figure III-2 and also crops out along the north side of the Cobb and Collayomi Valleys. The ophiolite

FIGURE III-2 Generalized geologic map of Geysers Area showing the site, major faults and structural units (modified from McLaughlin, 1978).

GEOLOGIC SYMBOLS AND LEGEND TO ACCOMPANY

FIGURE III-3

LANDSLIDE
<p>APPROXIMATE LANDSLIDE BOUNDARY SCARP SLUMP BLOCK EARTH FLOW</p>	
SLUMP BLOCK	<p>PRIMARY - FLAT SURFACE ADJACENT TO BASE OF SCARP</p> <p>SECONDARY - SMALLER, LATER, AND SHALLOWER SLUMPING LOWER ON SLIDE SURFACE</p>
SCARP	<p>SOLID LINES = DEFINITE BOUNDARIES</p> <p>? = QUESTIONABLE LOCATION AND/OR EXISTENCE</p>
CONCEALED SLIDE BOUNDARIES	OLDER SLIDES WITH OVERLAPPING SLIDES
DIRECTION OF MOVEMENT	<p>SLUMP / EARTH FLOW / COMBINATION</p>
	DASHED ARROWS = OLDER SLIDES WITH OVERLAPPING SLIDES
	MULTIPLE ARROWS = MULTIPLE LANDSLIDES
	SMALL LANDSLIDES (75' OR LESS) ARE SHOWN BY ARROWS ONLY

————	RELATIVELY WELL LOCATED CONTACT
-----	LESS WELL LOCATED CONTACT
-?-?-	CONTACT EXISTENCE OR LOCATION UNCERTAIN
.....	CONTACT OBSCURED BY LANDSLIDE DEPOSITS

Qal STREAM DEPOSITES
sp SERPENTINITE
mum METAMORPHASED ULTRAMAFIC ROCKS
fs2 GRAYWACKE, SHALE, MINOR CONGLOMERATE
fg GREENSTONE, LARGELY BASALTIC PILLOW FLOWS, PILLOW BRECCIA, TUFF, AND DIABASE
fsr MELANGE, UNDIFFERENTIATED
fm HIGHGRADE BLUESCHIST ROCKS PRESENT AS TECTONIC INCLUSIONS
fms REGIONALLY METAMORPHASED METAGRAYWACKE
fc CHERT

IDENTIFICATION RELIABILITY AND LANDSLIDE ACTIVITY CLASSES:					
INCREASING IN AGE →					
BY ESTIMATED LEVEL OF RELIABILITY OF IDENTIFICATION	ACTIVE AND RAPID APPEARING	ACTIVE TO RECENTLY ACTIVE	DORMANT APPEARING	STATIC APPEARING	
DEFINITE (D) LANDSLIDES	DR	DA	DD	DS	
PROBABLE (P) LANDSLIDES	P (PROBABLY DORMANT)				
QUESTIONABLE (?) LANDSLIDES	? (PROBABLY DORMANT TO STATIC)				

Source: NCPA, 1978a.

TABLE III

Source: NCPA, 1978a.

GEOLOGIC MAP OF DEVELOPMENT AREA SHOWING LANDSLIDE
FEATURES AND EXISTING NEARBY DRILL PAD SITES

Note:
See Table III-1
for legend

FIGURE III-3

consists of varying proportions of peridotite, microgabbro and diabase, basalt and tuff. Radiolarian chert is found interlayered with basaltic rocks at Black Mountain. At Mount Saint Helena, located six miles (9.6 km) south of the proposed site, the ophiolite has a thickness of 4,659 feet (1,420 meters). (Bezore, 1969; in McLaughlin and Stanley, 1975).

As shown in Figures III-3 and III-4 and Table III-1, the proposed project area is located on a large block of graywacke of the Franciscan Assemblage. The graywacke, as addressed in this section, is composed of sandstone with interbedded shale and minor conglomerate and chert (NCPA, 1978a). Radiolarian chert is prominent at and in the vicinity of the proposed plant site and is often associated with paleontological resources. See additional discussion of radiolarian chert beginning on page III-60.

The graywacke sandstone occurs in two lithologies. The first type contains considerable interbedded shale and underlies the extreme northern and western parts of the site. It is medium- to coarse-grained, hard, and exhibits a moderate to close pattern of short, discontinuous and interlocking fractures at right angles to bedding. Individual beds range from one-half inch (one centimeter) to six inches (15 centimeters) in thickness. The interbedded shale is silty, fissile, and severely sheared. It ranges in thickness from less than one-quarter inch (one centimeter) to four inches (10 centimeters).

The second type of graywacke underlies most of the site and is massively bedded, with little or no interbedded shale. The sandstone is similar to that described above, except that the fractures tend to be more random and vary from about one-half inch (one centimeter) to 12 inches (30 centimeters) in spacing.

Recent stream deposits occur in the southwest, south, and southeast portions of the site. These deposits consist of unsorted and unconsolidated mixtures of clays, silts, sands and gravels. Their thickness is estimated to range up to ten feet (three meters). Artificial fill associated with the development of Well Pad D is present in the northern portion of the proposed plant site. The maximum thickness of this material is estimated to be less than 30 or 40 feet (several meters).

Structural Geology and Tectonic Setting

Present distribution of rock units and their structural relationships indicate the Great Valley Sequence overlies the Franciscan Assemblage along a zone of so called "regional thrust faulting." This subduction of the Franciscan Assemblage under the Great Valley Sequence is thought to have ceased about 34 million years before the present (Atwater, 1970; in McLaughlin and Stanley, 1975). At that time, the convergent motion between the plates changed to transform motion and initiated the San Andreas strike-slip system. Strike-slip movement continues today along the San Andreas fault system.

Seismicity -

The western coast of the United States, including northwestern California, is an area of significant seismic activity. Most of the activity is along specific active zones which can be correlated with known geologic structures.

EXPLANATION

Geologic Units

Artificial Fill	Qaf	- Artificial Fill
Stream Channel Deposits	Qal	- Stream Channel Deposits
Graywacke Sandstone with Minor Shale	fs2	- Graywacke Sandstone with Minor Shale
Conglomerate	fc	- Conglomerate
Chert	fc	- Chert
Serpentinite	sp	- Serpentinite

Map Symbols

- Geologic Contact, Approximately Located
- Shear Zone (Ancient Fault) Separating the Serpentinite and Graywacke Sandstone. Approximately Located; Dotted Where Concealed by Artificial Fill.
- Discontinuous Shear
- Strike and Dip of Bedding
- Seep or spring

Source: NCPA, 1978a.

RECONNAISSANCE GEOLOGIC MAP OF SITE
SHOWING STRUCTURAL FEATURES

FIGURE III-4

Although the first earthquake occurring in the region north of San Francisco was reported in 1853, good records of events with a magnitude greater than 2.5 have been available for this region for only about fifteen years. All data considered, two areas in northern California appear to exhibit the most frequent seismicity (Dames & Moore, 1978). One of these areas is offshore from Cape Mendocino and the other is around the City of Santa Rosa, 22 miles (36 kilometers) south of the project area. Selected seismic events occurring in northern California prior to 1930 are listed in Table III-2. Historical macroseismicity for the northern California region for the period 1906-1976 is shown in Figure III-5.

TABLE III-2
Partial Earthquake History, 1769-1928

Date ¹	Lat.	Long.	Maximum Intensity ²	Comments
08/19/1858	38.25	122.67	VI	Sonoma County
01/03/1865	39.33	123.25	VI	Ukiah, 2 shocks
09/26/1868	39.33	123.25	VII	Ukiah
08/07/1870	39.33	123.25	IV	Ukiah
08/01/1885	38.83	123.00	VI	Cloverdale
12/12/1893	39.33	123.25	V	Lakeport and Ukiah

Source: Townley and Allen, 1939; in Dames & Moore, 1978.

1. Only those earthquakes which might be associated with the Maacama fault zone and which have intensities judged sufficiently high to be magnitude 5 have been shown. All are apparently in the range of magnitude 5 to 6.

2. Intensities shown are on the Modified Mercalli Scale.

The Geysers KGRA and surrounding region are dominated seismically by the San Andreas fault and the associated faults which make up the San Andreas system. These faults include (among others): the San Andreas, Healdsburg-Rodgers Creek and Maacama faults. The Maacama fault, located adjacent to Alexander Valley, is the closest known active fault to The Geysers KGRA. The Healdsburg fault, located approximately 12 miles (19 km) to the southwest, is believed to be the focus of the Santa Rosa earthquakes of magnitude 5.6 and 5.7 in 1969. These earthquakes were accompanied by an intervening shock of 3.5 and on the following day, two aftershocks of 3.4 and 4.3 (NCPA, 1978b).

Other faults which have a potential for activity include the Collayomi, Konocti Bay/Childers Peak, Porter Creek, Mt. Jackson and Big Sulphur Creek faults (NCPA,

1978b). Figure III-6 shows the locations of these faults with respect to the proposed project area.

Although none of the numerous local faults within The Geysers KGRA are known to be or to have recently been seismically active, the potential exists for seismic activity in this region. Earthquake epicenters for events of magnitude 4.0 and greater on these faults are shown in Figure III-7. Table III-3 presents a summary of the characteristics of selected Quaternary faults in this region. At this time, the NPCA believes the Maacama fault would be the controlling fault for seismic design of the proposed project facilities.

Table III-4, below, summarizes potential seismic effects which may occur at the project site as a result of activity along those faults shown in Figure III-7. It must be emphasized that these values are based upon site-specific geotechnical design studies related to the proposed project. Further information concerning seismic design of the proposed facilities can be found in the AFC, Section III and Appendix A (NCPA 1979a).

Faulting in Project Area -

No major faults are known for the immediate project area nor has evidence of active faulting been observed in any of the geologic studies performed for steam well drill sites (NCPA, 1978b). The plant site is underlain by randomly fractured graywacke sandstone and shale which are in contact with serpentinite immediately to the north, near Well Site D (See Figure III-4). It is this area of contact between the two rock types which forms the shear zone encountered during geotechnical reconnaissance for Well Site D. At that time a zone of "...very dense bluegray, clay-like sand with gravel..." was observed in one of four test borings penetrating the well pad site (Moore & Taber, 1975).

This clay-like material has been interpreted as fault gouge associated with an east/west trending shear zone (NCPA, 1978b; USGS, 1976). This fault gouge or shear zone is not considered to be an active feature. It has been postulated to have formed as a result of emplacement of a serpentinite body along an earlier-formed structural feature (NCPA, 1978b; USGS, 1976; Taggart, personal communication 1978). Bore hole information suggests that the plane of the shear zone or gouge dips steeply away to the south. Where the zone is or has been exposed; it appears to be about ten feet (three meters) wide, with most of the shearing within the serpentinite (NCPA, 1978b). Recent investigations have not revealed the presence of any such fault gouge or shear zone traversing the proposed power plant site (NCPA, 1978b).

Geothermal Resources -

The geologic characteristics of the geothermal reservoir are discussed in the Energy and Material Resources Section, beginning on III-70.

Project-Related Facilities

In addition to the power generation plant and related facilities located within the plant site boundaries, there are a number of associated off-site facilities such as transmission tapline, steam supply field, access roads, and steam

FIGURE III-6

MAP OF
REGIONAL QUATERNARY FAULTS

SCALE 1:750,000

10 0 10 20 km

----- Fault with known historic activity

- - - - - ? Fault with Quaternary activity

Faults are indicated by solid lines where well located, dashed lines where approximately located and dotted lines where concealed. Queried where continuation or existence is uncertain.

Source: NCPA, 1978a.

REF: Modified after Jennings, C.W., 1975, Fault Map of California, Calif. Div. of Mines & Geol., Calif. Geologic Data Map Series, Map No. 1.

REGIONAL MAP SHOWING FAULTS AND EARTHQUAKE EPICENTERS OF MAGNITUDE 4.0 AND GREATER

FIGURE III-7

TABLE III-3
SUMMARY OF SELECTED REGIONAL QUATERNARY FAULTS

CHARACTERISTICS	SAN ANDREAS	HEALDSBURG/ RODGERS CREEK	MAACAMA AND ASSOCIATED FAULTS	COLLAYOMI
DISTANCE FROM SITE (km)	53	20	13	2
MAPPED LENGTH (km)	1,200	72	150 (230) ⁶	About 40
TYPE OF FAULT	Right-lateral strike-slip	Right-lateral strike-slip, probably some small vertical component	Right-lateral strike-slip	Right-lateral strike-slip possibly some vertical component
ACTIVITY STATUS:				
1) Features indicating historic activity	Yes	None known, but small earthquakes have occurred	Yes	None known
2) Features indicating Holocene activity	Yes	Yes	Yes	None observed
3) Features indicating Quaternary activity	Yes	Yes	Geomorphic features suggestive of faulting	Yes
Estimated recurrence ¹ interval for maximum earthquake (years)	100-1,000	120+	—	—
Estimated maximum ² magnitude earthquake	8½	7.0	7.5 (8.1) ⁶	6.1
Estimated peak bedrock acceleration ^{3,4} at the site due to maximum earthquake	0.23g	0.33g	0.47g (0.52g)	0.59g
Estimated duration (seconds) of strong (0.05g) ground shaking ⁵ at the site	28	25	30 (33)	15
Remarks	Maximum displacement of 6m in 1906	Magnitude 5.7 earthquake in October 1969	Magnitude 3 to 4.5 earthquakes in 1969, 1971 and 1977	Offset terrace gravels with clasts dated as 0.4 million years old ⁷

CHARACTERISTICS	KONOCTI BAY/ CHILDERS PEAK	PORTER CREEK	MOUNT JACKSON	BIG SULPHUR CREEK
DISTANCE FROM SITE (km)	10	26	34	5
MAPPED LENGTH (km)	About 30	48	58	6.4
TYPE OF FAULT	Normal, high-angle	Right-lateral strike-slip	Right-lateral strike-slip	Normal with possibly some right-lateral strike-slip ⁷
ACTIVITY STATUS:				
1) Features indicating historic activity	None known, but small earthquakes	None known	None known	None known, possibly small earthquakes
2) Features indicating Holocene activity	Geomorphic features suggestive of faulting	Photo lineation	Photo lineation	Yes. Also geomorphic features
3) Features indicating Quaternary activity	Yes	None observed	None observed	Yes
Estimated recurrence ¹ interval for maximum earthquake (years)	—	—	—	—
Estimated maximum ² magnitude earthquake	5.8	6.2	6.6	4.4
Estimated peak bedrock acceleration ^{3,4} at the site due to maximum earthquake	0.31g	0.19g	0.17g	0.10g
Estimated duration (seconds) of strong (0.05g) ground shaking ⁵ at the site	10	9	12	—
Remarks	Offset Quaternary volcanics of the Clear Lake sequence ⁷	Based on aerial photographic interpretation	Based on aerial photographic interpretation	Possibly tilted Quaternary terrace deposits ⁷

NOTES:

- (1) Wallace, R.E., 1970, "Estimated Recurrence Intervals on the San Andreas Fault," *Geological Society of America Bulletin*, Vol. 81, pp. 2875-2890.
 - (2) Bonilla, M.G. and J.M. Buchanan, 1970, Interim Report on Worldwide Historic Surface Faulting, U.S.G.S. Open-File Report.
 - (3) Greensfelder, R.W., 1974, *Maximum Credible Rock Accelerations From Earthquakes in California*, California Division of Mines & Geology Map Sheet 23.
 - (4) Peak acceleration is generally not considered to be a reasonable figure for design since it occurs only once during a given earthquake and has a duration of a fraction of a second. Studies of accelerograms (Pioessal, M.R. and J.E. Slosson, 1974, "Repeatable High Ground Accelerations From Earthquakes," *California Geology*, Vol. 27, No. 9, pp. 195-199) have shown that below the peak acceleration there are several high peaks which are repeated a number of times. The average of these secondary peaks is defined as the Repeatable High Ground (or Bedrock) Acceleration (RHGA). The RHGA typically averages 65% of the peak acceleration for sites within 32 km of the epicenter and 100% beyond 32 km.
 - (5) Bolt, B.A., 1973, Duration of Strong Ground Motion, Proceedings of Fifth World Conference on Earthquake Engineering, Rome.
 - (6) Heard (Memorandum Report, U.S.G.S., 1976) has suggested that the Maacama Fault may continue northward to Willits (150km length) and possibly to Cape Mendocino (230km length). If true, the fault could have a maximum magnitude earthquake of M-7.3 to M-8.1 depending on the actual length. However, until more conclusive data is available, we suggest using the lower figures noted on the table above.
 - (7) McLaughlin, R.M., U.S.G.S., Oral Communication, 1976.
- REFERENCE: Modified after Borchardt, R.D., Editor, 1975, Studies for Seismic Zonation of the San Francisco Bay Region, U.S. Geological Survey Professional Paper 941-A.

Source: NCPA, 1978a.

gathering system. From a regional perspective, these facilities traverse the same varied terrain and geologic features as those discussed for the proposed plant site. Localized characteristics are discussed below.

Transmission Tapline -

The proposed transmission tapline route passes along hillsides near ridge crests in moderately undulating terrain above the Big Sulphur Creek drainage basin. The proposed right-of-way would cross high above Big Sulphur Creek, near the transmission line's junction with the existing line. No new rock types crop out along the route, and the route is under the same seismic and tectonic influence as the plant site. No identified active faults are known to intersect the right-of-way. The proposed right-of-way traverses a landslide approximately one mile (1.6 kilometers) west of the site. No mining or quarrying areas exist anywhere along the proposed route.

Steam Supply Field -

The location, limits and features of the steam supply field associated with the NCPA No. 2 project are discussed on pages II-15 through II-18. The geologic characteristics of the steam supply field have also been discussed in a series of environmental assessments prepared by the USGS (refer to Table I-1). Only a summary of this information about the wells is included here.

Regionally, the sites lie on rocks of the Franciscan Assemblage. Well Pads A, D, F, and J lie on graywacke, sites C and Q are situated on serpentinite. No known active faults traverse any of the sites. Those faults which do occur on or near the sites are thought to have developed early in the area's tectonic history and represent lithologic boundaries between various units comprising the Franciscan Assemblage. Each site is essentially subject to the same seismic and tectonic influences as is the proposed power plant site. None of the sites contain active landslides. Mining or quarrying is not known to presently occur on any of the sites.

Access Roads and Steam Gathering System -

All access roads leading from existing roadways to the drill pad sites and transmission tower pad sites are or would be constructed on the same varied terrain and geologic conditions as the proposed power plant site. Existing and proposed rights-of-way can be seen in Figure II-2. The steam gathering system is typically constructed alongside access roads to facilitate construction, operation and maintenance, and would be subject to conditions similar to the access roads.

Topographically, the access road and pipeline rights-of-way traverse the typical, moderately undulating terrain of The Geysers KGRA. No new rock types crop out along any right-of-way, and the seismic and tectonic influence is generally the same for all segments. No active faults are traversed but various inactive faults which make up formation contacts are traversed. Active landsliding is not known along any portions of the existing or proposed rights-of-way.

SOILS

Soils development is controlled by basic soil-forming factors such as parent material, topographic relief, climate, biological activity within and upon the soil, and the time span involved in soil formation. Soils underlying a proposed project site must be evaluated for depth and stability to identify erosion potential, to adequately design erosion control facilities and to assess the potential for successful revegetation.

Parent materials in The Geysers KGRA are rocks of the Franciscan Assemblage and younger volcanic formations. The topography in The Geysers area and the characteristically heavy precipitation contribute to rapid run-off and high erosion potential. Soils in the KGRA are considered relatively young due to rapid erosion.

North-facing slopes are usually more heavily vegetated and have deeper layers of soil than the sparsely vegetated slopes which face south. Moderate weathering has occurred on the proposed site and the soils cover is thin and patchy. Soil depth is variable, but is generally less than 12 inches (30 centimeters). With depth, the soils grade into bedrock.

Soils of the project area are typically shallow, stoney variants of eight upland soil series: Henneke, Hugo, Kidd, Josephine, Laughlin, Los Gatos, Maymen, and Stonyford. Figure III-8 shows the distribution of these soil series in the project area. Table III-5 summarizes physical characteristics and engineering properties of the soils series in the project area.

The brief descriptions of the soil series provided in Table III-5 are based on studies by Miller (1972) and Neilson, et al. (1975). The soil properties and interpretations described are estimates based on standardized examples of each soil series.

Power Plant Site

The proposed site is underlain primarily by soils of the Los Gatos series which consists of well-drained loams covered with a thin layer of manzanita leaves and twigs about one inch thick. The soils are underlain, at a depth of 24 to 48 inches (60 to 120 cm), by weathered sandstone and shale.

The eastern and western portions of the proposed site are underlain by soils of the Henneke series which consist of excessively drained gravelly loams having a very gravelly clay subsoil. These soils are underlain at an average depth of 20 inches (50 cm) by serpentine bedrock.

Both the Los Gatos and Henneke soils series have moderately slow permeability and a high to very high potential for erosion. Both series are subject to rapid or very rapid run-off.

Transmission Tapline

The proposed route for the transmission tapline is underlain by soils of the Henneke, Maymen, Los Gatos, Laughlin, Josephine and Stonyford series. The Henneke and Los Gatos series have been described above.

<i>symbol</i>	<i>soil type</i>
Hg	HENNEKE
Hk	HUGO
Hy	HUSE
Jog	JOSEPHINE
Kkg....	KIDD
Lk	LAUGHLIN
Lm	LOS GATOS
Mc	MAYMEN
Mo	MONTERA
Rog	ROCKLAND
So	STONYFORD

SCALE

- Power Plant Site

Source: NCPA, 1978a.

FIGURE III-8 DISTRIBUTION OF SOIL SERIES IN THE PROJECT AREA

TABLE III-5: SELECTED PHYSICAL and ENGINEERING PROPERTIES OF SOILS IN PROJECT AREA

Soil Series	Depth to Bedrock (cm)	Dominant Texture	Permeability	Runoff	Erosion Hazard	pH Value	Shrink-Swell Potential	Suitability as Source of road fill	Soil features affecting:	
									Road location	Embankments
Henneke	30-45	Gravelly loam and very gravelly clay	Moderately slow	Rapid	High-very high	6.6 - 8.4	Low	Good	30-45 cm to rock 5-75% slopes	Fair strength; low compressibility
Hugo	75-150	Gravelly loam and gravelly sandy clay loam	Moderate	Very rapid	Very high	5.1 - 7.3	Moderate	Fair to poor	75-150 cm to rock 9-75% slopes	Fair strength; medium compressibility
Huse	30-60	Gravelly to stoney clay loam	Moderate	Rapid-very rapid	High-very high	5.1 - 5.5	Moderate	Poor	30-60 cm to rock 30-75% slopes	Fair to poor strength; medium compressibility
Josephine	60-150	Loam	Moderate	Very rapid	Very high	5.6 - 6.5	Moderate	Fair to poor	60-150 cm to rock 9-75% slopes	Fair to poor strength; medium compressibility
Kidd	30-45	Gravelly loam	Rapid	Rapid-very rapid	High-very high	5.6 - 6.5	Low	Fair to poor	30-45 cm to rock 2-75% slopes	Fair strength; medium compressibility
Laughlin	30-90	Loam and sandy clay loam	Moderate	Very rapid	Very high	5.1 - 6.0	Moderate	Poor	30-90 cm to rock 2-75% slopes	Fair strength; medium compressibility
Los Gatos	60-120	Loam or gravelly loam	Moderately slow	Rapid-very rapid	High-very high	6.1 - 7.3	Low to moderate	Fair to poor	60-80 cm to rock 30-75% slopes	Fair strength; medium to high compressibility
Maymen	30-45	Gravelly sandy loam and gravelly loam	Moderate	Rapid	High	5.1 - 6.0	Low	Good	30-45 cm to rock 30-75% slopes	Fair strength; medium compressibility
Montera	15-45	Cobbly clay loam	Moderately slow	Slow to rapid	Slight to high	6.6 - 8.4	Low	Fair to poor	15-45 cm to rock 2-75% slopes; cobbly	Fair strength; medium compressibility
Rockland	0	Stoney	Low	Very rapid	High					
Stonyford	30-60	Gravelly or very gravelly day loam	Moderate	Very rapid	Very high	6.1 - 6.5	Low	Fair to poor	30-60 cm to rock 30-70% slopes	Fair strength medium compressibility
Yorkville	60-150	Clay loam	Slow	Moderate	High	5.6 - 8.4	Moderate to high	Poor	60-150 cm to rock 5-75% slopes; high shrink-swell potential	Fair to poor strength; medium to high compressibility

The Maymen series consists of well-drained gravelly sandy loams, underlain at a depth of 10 to 20 inches (25 to 50 cm) by sandstone and shale bedrock.

The Laughlin series consists of well-drained loams that have a sandy clay loam subsoil. At a depth of 24 inches (60 cm) to over 60 inches (150 cm) they are underlain by weathered, fine-grained sandstone and shale.

The Josephine series consists of well-drained loams that have a clay loam subsoil covered with a thin organic litter from madrone and Douglas-fir trees. At a depth of 24 inches (60 cm) to over 60 inches (150 cm) they are underlain by weathered, fine-grained sandstone and shale.

The Stonyford series consists of somewhat excessively drained gravelly loams that have a very gravelly clay loam subsoil, underlain at a depth of 12 to 22 inches (30 to 55 cm) by weathered greenstone and basic igneous rock.

These four soils series have moderate permeability. For the Laughlin, Josephine and Stonyford series, this level of permeability produces very rapid runoff and a very high potential for erosion. For the Maymen series, the runoff and erosion potential are described as high.

Steam Supply Field

The steam supply wells associated with the proposed NCPA No. 2 project are underlain by soils of the Henneke, Los Gatos, and Kidd series. The Henneke and Los Gatos series have been described above.

The Kidd series consists of somewhat excessively drained gravelly loams, underlain at a depth of 5 to 20 inches (10 to 50 cm) by rhyolite rock and rhyolite tuff. Although the rate of permeability for the Kidd soil series is rapid, they are still subject to rapid to very rapid runoff and a high to very high erosion potential.

Access Roads and Steam Gathering System

Existing and proposed access roads associated with the project are underlain by soils of the Henneke, Los Gatos, Laughlin, Maymen and Hugo series. All but the Hugo series have been described above.

The Hugo series consists of well-drained very gravelly loams that have a gravelly sandy clay loam subsoil, covered by a layer of loose litter comprised by fir needles and twigs. At a depth of 30 to 60 inches (75 to 150 cm) the soils are underlain by weathered, fine-grained sandstone and shale. The permeability rate for the Hugo series is moderate, runoff is very rapid and the erosion potential very high.

The steam gathering system is expected to parallel access roads and is expected to encounter these same soils series.

WATER RESOURCES

HYDROLOGY

The ridge of the Mayacmas Mountains near which the proposed geothermal power plant will be located constitutes the principal water drainage divide for the project area (see Figure III-9). The project area west of the Mayacmas ridge is drained by Big Sulphur Creek, the primary watercourse in The Geysers. With a total watershed of 82.3 square miles, Big Sulphur Creek drains to the Russian River near the communities of Preston and Cloverdale.

The project area east of the Mayacmas ridge is drained by Bear Canyon Creek and Dry Creek. Bear Canyon Creek drains approximately three square miles before it joins Anderson Creek near the community of Anderson Springs, and flows to Putah Creek. Dry Creek drains an area about 8.2 square miles and flows to Putah Creek near the community of Middletown. Eventually, Putah Creek flows into Lake Berryessa.

Proposed facilities for the NCPA No. 2 project will be located in both of the principal drainage basins. The proposed power plant site is located on a knoll (el. 3,275 ft.) slightly west of the Mayacmas ridge and at the headwaters of an unnamed tributary of Big Sulphur Creek. This tributary originates east of the proposed site and provides drainage for approximately 90 acres. The proposed transmission corridor runs almost directly west from the plant site and lies entirely within the Big Sulphur Creek drainage basin.

The steam field associated with the project lies on both sides of the Mayacmas ridge. That portion of the field located west of the ridge (including well pads A, D, C, and F) is drained by Big Sulphur Creek. The portion located east of the ridge (including well pads B and Q) is drained by Bear Canyon Creek and, to a lesser extent, Dry Creek. The northeast portion flows into Bear Canyon Creek, while the southeast portions flow into Dry Creek.

Precipitation

Average annual precipitation in the area west of the Mayacmas ridge is about 44 inches, but part of this area, between Cobb Mountain (el. 4722 ft.) and Mount St. Helena (el. 4343 ft.), may receive as much as 80 inches. The proposed power plant site, which lies between these two peaks (roughly 4 miles southeast of Cobb Mountain and 7 miles northwest of Mount St. Helena), receives an annual rainfall of between 50 and 60 inches.

The rainy season extends from October through May, with about 90 percent of the annual rainfall occurring between November and April. The wettest months are December and January. The high levels of precipitation in the winter months in

the project area are illustrated by Table III-6, which represents normal monthly mean flows for Big Sulphur Creek, recorded at a USGS gauging station(11-4632) near Cloverdale during 1958-1972.

TABLE III-6

Normal Monthly Mean Flows (cubic feet per second)
Big Sulphur Creek, Cloverdale Gauging Station, 1958-1972

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
37	100	386	607	562	286	176	60	26	11	6	8

Source: USGS; in NCPA (1978a)

Individual rainstorms in the project area can produce heavy rains in a relatively short period. According to NCPA, "Thunderstorms average five to ten per year and may occur in any month. A 100-year storm may deposit a maximum of 1 1/2 inches of precipitation per hour or fourteen inches within a twenty-four hour period," (NCPA, 1979b, page IV-8).

These figures are consistent with the numbers developed by staff. Using an assumed average annual precipitation of 76 inches and methods developed by Rantz for USGS, staff calculated the probable storm precipitation for a range of recurrence intervals and storm durations (See Table III-7). The estimates presented in the table suggest, for example, that a 25-year storm having a 12-hour duration could be expected to bring 8.5 inches of precipitation to the proposed site.

Nevertheless, because the plant site will be located near the top of a ridge line which serves as a major drainage divide, the possibility of surface floods from even the most severe storms is virtually nonexistent.

TABLE III-7

Storm Precipitation Values (inches)*

Duration	Recurrence Interval (years)					
	2	5	10	25	50	100
1 hour	.93	1.20	1.37	1.59	1.71	1.84
2 hours	1.54	1.94	2.15	2.35	2.54	2.70
3 hours	2.15	2.63	2.96	3.21	3.38	3.56
6 hours	3.62	4.70	5.26	5.82	6.22	6.55
12 hours	5.79	6.98	7.64	8.50	9.08	9.61
1 day	7.86	10.38	11.80	13.80	15.10	16.38
2 days	10.23	14.55	17.48	20.90	23.18	25.84

*Data adapted from Rantz (1971) and calculated for a mean annual precipitation value of 76 inches.

Figure III-9: HYDROLOGIC FEATURES AND SAMPLING LOCATIONS

Source: NCPA, 1978a

The USGS has maintained three gauging stations to monitor the creeks surrounding the plant site (See Figure III-9). Data from stations 11-4632 (on Big Sulphur Creek near Cloverdale), 11-4532 (on Dry Creek where it enters the Collayami Valley), and 11-4535 (on Putah Creek) are presented in the Notice of Intention (NCPA, 1978b) and the Plan of Utilization (NCPA, 1978a), pages IV-26 to IV-33. Using this data, USGS (Rantz and Thompson, 1967) estimated that slightly over half of the mean annual precipitation for Big Sulphur Creek basin reached station 11-4632 as runoff. Since there is virtually no consumptive use along the Creek upstream from the gauging station, the balance of the annual precipitation was retained within the basin.

Stream Flows in the Project Area

The pattern of runoff closely follows seasonal precipitation, as groundwater contributes only a small amount of runoff. As a result, the streams which drain the basins around the proposed plant site tend to be highly seasonal.

The proposed plant site is on a ridge above the headwaters of an unnamed tributary of Big Sulphur Creek which is ephemeral (dry in the summer months). However, a spring, or seep, occurs in the tributary channel east of the site. During a visit to the project area in September 1978, regulatory agency staff observed a small flow in the seep, perhaps equal to one gallon per minute. Established vegetation surrounding the seep indicates that some amount of flow has been present, even during previous drought years. The location of this seep is indicated on Figure II-5 and Figure III-4. Further discussion of the seep begins on page III-32.

Flows in the drainage basins east of the plant site are also seasonal. Except for the lower reaches of the main branch, Bear Canyon Creek in the vicinity of the project is dry during the summer months. Dry Creek is classified as an intermittent stream, with prolonged but not continuous flow.

Both Bear Canyon Creek and Dry Creek lie within the Putah Creek watershed. The major flows in this watershed occur between November and March. These major flows are responsive to seasonal rainfall and generally have sharp, high peaks for a short duration and have comparatively small volume. The Applicant's NOI contains additional information on historic peak flows and monthly mean flows for each of these creeks as measured at the USGS gauging stations. (NCPA, 1978a, pages IV-23 to IV-26).

WATER QUALITY

Water Quality Characteristics

A significant amount of information about the quality of water in the project area is available from past and ongoing sampling studies (Parametrix, 1975; Atlantis Scientific, 1976; Enviros, 1973; PGandE, ongoing; RFL, ongoing). These were conducted at several locations within or adjacent to the proposed project area. Figure III-9 shows these sampling locations in relation to the proposed project site.

Table III-8 presents typical water quality characteristics for three locations in the Big Sulphur Creek drainage. Samples taken at these locations indicate that limited traces of mercury, copper, ammonia, sulfates, and hydrogen sulfide

TABLE III-8: WATER QUALITY OF BIG SULPHUR AND LITTLE SULPHUR CREEKS, BEFORE FLOWING THROUGH THE GEYSERS FIELD

Parameter	Units	Big Sulphur Creek						Little Sulphur Creek		
		BS 17.8			BS 18.7			LS 13.3		
		May	June	July	May	June	July	May	June	July
Date	---	5-12	6-8	7-12	5-13	6-8	7-12	5-12	6-10	7-12
Time	---	---	1805	1150	---	1705	1025	---	1620	1545
Air Temperature	°C	11.7	26.5	18.8	28.3	31.2	19.5	24.4	25.8	26.0
Water Temperature	°C	14.6	22.5	20.5	20.3	25.5	18.2	15.2	11.8	20.5
Stream Flow	c.f.s. ²	---	6.9	6.8	---	---	---	7.5	2.0	1.7
Total Coliforms	MPN/100 ml	93	460	64	---	---	---	3.6	43	460
Turbidity	JTU	1	1	1	1	1	1	1	1	1
Color	APHA	5	---	---	5	---	---	5	---	---
Dissolved Oxygen	mg/liter	9.3	7.27	9.58	9.5	7.40	9.57	9.2	---	8.63
pH	---	7.95	7.96	8.03	8.15	8.65	8.22	8.09	8.04	8.19
Alkalinity	mg/liter	124.2	151.0	156.4	128.2	160.6	127.0	127.0	131.0	126.5
H ₂ S	mg/liter	0.02	---	---	0.02	---	---	0.02	---	---
Sulfates	mg/liter	31	20.5	27	17	21	27	8	10.5	8
Nitrite Nitrogen	mg/liter	0.009*	---	0.13	0.0025*	---	0.009*	u	---	0.008*
Nitrate Nitrogen	mg/liter	0.3	---	0.45	0.3	---	0.35	0.35	---	0.20
Ammonium Nitrogen ¹	mg/liter	0.10	0.10	0.14	0.01	0.10	0.08	0.01	0.18	0.08
Ammonia, unionized ¹	mg/liter	10	---	---	10	---	---	10	---	---
Oil	mg/liter	10	---	---	10	---	---	10	---	---
Cyanide	mg/liter	0.05	---	---	0.05	---	---	0.5	---	---
Settleable solids	mg/liter	u	---	---	u	---	---	u	---	---
Residue, filtrable	mg/liter	0.2	---	---	0.1	---	---	0.1	---	---
Residue, non-filtrable	mg/liter	0.0	---	---	0.0	---	---	0.2	---	---
Residue, Total	mg/liter	0.2	---	---	0.1	---	---	0.3	---	---
Chromium	ug/liter	0.2	---	---	0.2	---	---	0.65	---	---
Copper	ug/liter	0.50	0.05	---	0.10	2.0	---	0.20	0.05	---
Silver	ug/liter	0.02	---	---	0.02	---	---	0.02	---	---
Zinc	ug/liter	1	---	---	1	---	---	3	---	---
Cadmium	ug/liter	0.35	---	---	0.25	---	---	0.10	---	---
Mercury	ug/liter	1.02	0.55	1.9	1.13	5.45	116	5.64	0.30	0.02
Boron	mg/liter	6	---	16	12	---	17	4	---	14
Carbon, total organic	mg/liter	21	---	---	51	---	---	31	---	---
Lead	mg/liter	4.5	---	---	3.0	---	---	1.5	---	---
Nitrogen, Total	mg/liter	0.1	---	---	0.1	---	---	0.1	---	---
Arsenic	ug/liter	2.5	5.3	0.5	3.5	3.0	0.9	2.5	2.0	0.9
Selenium	ug/liter	1	---	---	1	---	---	1	---	---
Bromine	mg/liter	1.1	---	---	0.5	---	---	1.0	---	---
Chlorine, free	mg/liter	---	---	0.15	---	---	0.1	---	---	0.1
Chlorine, Total	mg/liter	---	---	0.15	---	---	0.1	---	---	0.1

* values not reliable below 0.01 mg/liter.

** values not reliable below 0.02 ug/liter.

¹ computed as per Spotte, 1973

u undetectable

Source: A Biological and Water Characteristic Study of Big Sulphur Creek and Adjacent Waters, Phase 1 Summary, Parametrics, Inc., 1975.

are present, and are natural to this drainage. (CEC-SRI, May 1977) Staff analyzed these results against EPA guidelines (EPA, 1976) and has determined that they are within limits for domestic and aquatic protection.

Water quality of the Putah Creek drainage to Lake Berryessa was sampled and analyzed by Parametrix (1975), Atlantis Scientific (1976) and Enviros (1973). Anderson, Bear, and Dry Creeks were analyzed along with their studies on Putah Creek. Table III-9 presents typical water quality characteristics of Dry Creek, representative of the Putah Creek drainage near the project.

These reports reveal generally good quality water within the proposed project area, adequate to protect the beneficial uses such as water supply, fisheries resources, and recreation.

Groundwater in Project Area-

The principal rock unit of the Mayacmas Mountains is the Franciscan Formation of the Jurassic-Cretaceous age. The Franciscan rock is generally classified as nonwaterbearing, except along fracture zones where yields of a few gallons per minute may be found. During geotechnical investigations of the site, NCPA detected groundwater at approximately the 3,160 to 3,170 foot elevations, 30 to 40 feet below the proposed project grade. No regional groundwater aquifers of significant yield have been identified to date.

Significant groundwater basins do exist in the alluvium of the valleys at the base of either side of the Mayacmas Mountain Range. The State Department of Water Resources is currently monitoring four wells located in the Collayomi Valley on a biannual basis. Data have been gathered from 1965 to present but are currently unpublished. Well locations, records of water levels and groundwater contour maps for these valley areas can be found in USGS Water Supply Papers and State of California Survey Water Supply Papers and State of California Department of Water Resources Bulletins (California Department of Water Resources, 1962; USGS, Water Supply Paper 1955, 1968; USGS 1972; USGS, 1955).

Sedimentation Studies in The Geysers-

Studies are currently being conducted in Bear Canyon Creek in the vicinity of the site for the proposed PGandE Unit 16. These studies are being conducted by PGandE to determine effects of geothermal development on the deposition of sediments on aquatic habitats. These studies will be conducted in three phases to evaluate effects before, during, and after construction. Preproject baseline studies were initiated in mid-1976 and will continue for a period of a year. A discussion and initial results of this study are included in "Geysers Unit 16 Site Specific Study, Fishery Resources and Stream Sedimentation" (PGandE, April 1977).

Beneficial Uses of Water in Project Area

The ridgeline of the Mayacmas Mountains provides a jurisdictional boundary for the state's Regional Water Quality Control Boards (RWQCB). The drainage west of the Mayacmas lies within the jurisdiction of the North Coast RWQCB. East of the ridge, the drainage area is within the jurisdiction of the Central Valley RWQCB.

TABLE III-9. DRY CREEK WATER QUALITY SURVEY

Water quality of Dry Creek at indicated locations:
Herman Creek, Black Rock Creek, and Kroll Creek

Constituents Analyzed	Sample Locations					
	Dry Creek			Herman Creek	Bl. Rock Creek	Kroll Creek
	1	2	3	4	5	6
	(mg/l except where units given)					
Sulfate (SO ₄)	18.	18.	16.	11.	3.7	6.7
Chloride (Cl)	2.3	1.9	2.2	2.0	3.2	1.8
Bicarbonate (HCO ₃)	200.	210.	220.	96.	320.	210.
Carbonate (CO ₃)	0.	0.	0.	0.	0.	0.
Nitrate (NO ₃)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ammonia (NH ₄)	0.18	0.10	0.17	0.10	0.12	0.17
Calcium (Ca)	21.	17.	26.	20.	27.	32.
Magnesium (Mg)	32.	34.	32.	8.5	53.	27.
Sodium (Na)	3.2	3.2	3.3	5.5	2.0	4.2
Potassium (K)	0.4	0.4	0.5	0.6	0.4	0.7
Fluoride (F)	0.28	0.23	0.22	0.26	0.21	0.30
Boron (B)	0.22	0.24	0.20	0.12	0.13	0.25
Aluminum (Al)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese (Mn)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron (Fe)	0.10	0.05	0.02	0.02	0.05	0.02
Mercury (Hg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids (TDS)	170.	170.	190.	27.	170.	201.
Total Suspended Solids (TSS)	<1.	<1.	6.	<1.	<1.	<1.
Total Hardness (CaCO ₃)	180.	180.	200.	86.	290.	190.
Turbidity-FTU Units	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hydrogen Ion Concentration-pH	7.8	7.9	7.7	7.4	7.9	7.7
Specific Conductance - micromhos at 25°C	360.	340.	350.	180.	480.	330.
Grease & Oil (Freon soluble)	2.0	<1.	7.0	2.8	5.4	<0.1
Total Coliform - MPN/100 ml	4.	4.	43.	9.	<3.	23.
Alkalinity - Total	160.	170.	180.	79.	260.	170.

Source: Enviros, March 1, 1976

Both regional boards have promulgated policies which prohibit degradation of existing water quality within the drainages under their jurisdiction. Each Board's Water Quality Control Plan ("Basin Plan"), defines "degradation" as, "...the potential for adverse effects upon the beneficial downstream uses of water." Beneficial uses identified by the RWQCB Basin Plans generally include irrigation, domestic water supply, recreation, aesthetic enjoyment, and the preservation and enhancement of fish and aquatic life.

Neither Board has adopted specific quantitative limits or other objective criteria for determining whether degradation is likely to occur from a proposed activity. Instead, each Board evaluates the potential effects of projects on a case-by-case basis, relying on the studies of impacts performed or prepared by Board staff, the project developer and interested parties.

Actual beneficial uses of waterways in the vicinity of the proposed project have been specifically identified only for the Russian River, of which Big Sulphur Creek is a tributary, and for Putah Creek, of which Dry and Bear Canyon Creeks are tributaries. The principal beneficial uses of the three lesser creeks are generally aquatic and wildlife habitat and, to a lesser degree, recreation.

There is no evidence of fisheries in the unnamed tributaries which drain the immediate project area and flow into these creeks. The California Department of Fish and Game has reported trout in that portion of Big Sulphur Creek immediately upstream from the confluence with the tributary that drains the plant site. (Letter from CDF&G to CEC Executive Director, April 30, 1979.) However, as noted in NCPA's responses to CEC Staff Interrogatories (NCPA, 1979d) substantial fisheries near the plant site are unlikely:

Depending on what is meant by "near" the plant site, NCPA disagrees that "upper Big Sulphur Creek near the plant site supports a substantial rainbow trout population." A migration barrier across Big Sulphur Creek just above the PG&E Units 1 and 2 will prevent access of anadromous fish to upper regions of Big Sulphur Creek. Rainbow trout (*Salmo gairdneri*) are reported to occur above the geothermal development (PG&E Unit 18, AFC page 5-81). However, the USGS water sampling station approximately 1/4 mile above the bridge near PG&E Unit 18 reported that in 1978 Big Sulphur Creek was just about dry with pools but no flowing water although seepage is presumed to occur between pools. Shell has conducted water sampling from Big Sulphur Creek approximately 1/2 mile above the USGS station, where the creek leaves the Shell leasehold, since 1976. Shell has during the dry months experienced difficulty in finding sufficient water for analysis. (See attached letters from Shell, July 20, 1979 and Multi-Tech. Labs, July 18, 1979.)

As for other beneficial uses along the three project-related creeks, CEC staff checked with both the North Coast RWQCB and the State Water Resources Control Board (WRCB) and ascertained that there are no known additional beneficial uses, beyond those described above, in the project area. A call to the State WRCB established that there are no recorded water rights applications, diversions, or riparian uses of Big Sulphur Creek--the principal drainage for the proposed plant site.

WASTE MANAGEMENTPotential Waste Materials

A number of liquid and solid wastes are produced during construction and operation of a geothermal power plant. These wastes include: excess soil and vegetation produced during preparation of the proposed site for construction; a wide variety of construction wastes; condensate from the spent geothermal steam blow-down from cooling towers and power plant systems; by-products from the H_2S abatement system(s); contents of steam well drilling sumps; and sanitary wastes.

The California Department of Health Services, Hazardous Waste Management Section, has informed the Energy Commission that cooling tower sludge, the Stretford solution purge stream and elemental sulfur produced by the H_2S abatement system(s) are potentially toxic substances (Collins, 1978). These substances are therefore presumed to be toxic unless they are shown not to be.

Contents of the well drilling sumps and sanitary wastes may be hazardous. Materials such as excess soil and vegetation produced during site preparation and excess or unusable construction debris are not considered potentially toxic.

Potential Disposal Sites

Wastes produced by geothermal power plant operations must be disposed of either at a Class I or Class II-1 site approved by the responsible regulatory agencies.

Geothermal Incorporated operates a Class II-1 disposal site near Middletown in Lake County, about six miles from the proposed project area. This operator has a permit to accept all wastes produced by the PGandE geothermal power plants in The Geysers KGRA. (Kritikos, 1979; Central Valley RWQCB, 1979). Approximately 2,000 cubic yards of sludge (waste from water processing systems at Geysers Units 3, 4, 5, 6, 11 and 12 and waste from cooling tower basins at Units 1-12) are produced each month by these 12 geothermal power plants. Based upon this rate of waste production, the operator of the Middletown site estimates there is capacity to accommodate these wastes for 50 years. (Kritikos, 1979).

IT Corporation operates Class II-1 disposal sites near Kelseyville in Lake County, about 17 miles from the proposed project area. The site operator is fully licensed for disposal of all wastes produced by the existing PGandE power plants in the KGRA. Based upon the current rate of waste production from Geysers Units 1-12, the current site has a design life of seven years. If the operation proves financially feasible for IT Corporation, there is disposal capacity for 50 years. (Bauer, 1979).

IT Corporation also operates a Class I disposal site near the city of Martinez in Contra Costa County, about 75 miles from the proposed project area. This site is licensed to accept wastes of the type produced in geothermal power plant operations.

BIOLOGICAL RESOURCES

Development of new facilities on sites not previously disturbed by construction requires clearing of existing vegetation and rearrangement of existing soils and water sources. This preconstruction clearing causes a corresponding disruption of wildlife habitat and existing ecological relationships and balances.

Several studies conducted in The Geysers KGRA provide data which is applicable to the NCPA No. 2 project area. Particularly relevant is The Geysers Wildlife Study (PGandE, et al, 1977) conducted on vegetation community types and wildlife use in habitats characteristic of the geothermal area for both developed and undeveloped locations. The community types studied included Oak Savannah, Oak Woodland, Chamise Chaparral, Mixed Chaparral, Mixed Evergreen Forest, and Riparian. Regional fishery resources studies show that the two drainages within the project area, Big Sulphur Creek and Putah Creek, contain trout spawning areas (Price et al., 1975; 1979). A summary of the cooling tower drift effects for the operating power plants documents that there has been damage and losses to vegetation (Malloch, 1979).

Within the project area, development of biological data and site reconnaissance information has been provided in the Environmental Impact Reports for each well pad prepared by Ecoview (see Table I-3). The information in the EIR for Well Pad D is particularly applicable to the power plant location. Applicability of these informational sources to the project site has been verified during site visits by biologists from Ecoview, California Department of Fish and Game, Bureau of Land Management, United States Geological Survey, and California Energy Commission. Additional biological information for the power plant site has been provided in the Notice of Intention to the California Energy Commission for the proposed project (NCPA, 1978b, Section 5), in the Application for Certification (NCPA, 1979b, p. IV-6-9), in answers to Energy Commission staff interrogatories, (NCPA, 1978c; 1979c; 1979d; 1979e; 1979f) and during public workshops.

In addition to the existing data available from earlier studies in the KGRA, the United States Geological Survey's regulations [30 CFR 270.34(k)] require that a geothermal developer on federal land prepare an environmental Baseline Study. The baseline information should be gathered at least one year prior to operation of the proposed project. The developer must submit a plan for the baseline study to the USGS Area Geothermal Supervisor's Office at least six months prior to the start of the study. The USGS reviews the proposed plan for adequacy and makes any necessary revisions before the developer or its contractor(s) begin the study.

The required Baseline Study should address the environmental parameters identified in the Guidelines for Acquiring Environmental Baseline Data, published by the Geothermal Environmental Advisory Panel (GEAP, 1977). Baseline studies to

be conducted prior to operation of the power plant will include data in support of the cooling tower drift monitoring program, a site specific botanical survey as required by USGS for plants indicated by the United States Fish and Wildlife Service (USFWS) and BLM, as Uncommon, Threatened and Endangered (UTE) plant species and those proposed and candidate species; and plans for monitoring the upper portion of Big Sulphur Creek for potential impacts to aquatic resources, such as fish and invertebrate populations, and sedimentation. In addition, a continuing monitoring program may be required by responsible regulatory agencies as a result of the Baseline Study findings.

REGIONAL INFORMATION

Vegetation Resources

The vegetation in The Geysers KGRA is typical of the Mayacmas Mountain Range and contains a number of varieties of plant communities. These communities include: Barrens, Mixed Chaparral, Serpentine Chaparral, Knobcone Pine, Mixed Evergreen, Douglas-fir and Riparian. Chaparral is the most abundant vegetation type in The Geysers KGRA and at the proposed project site. (Munz and Keck, 1973; Cheatum and Holler, 1975; Barbour and Major, 1977; and Neilson, 1975).

The plant communities in the KGRA have adapted to successive wildland fires and extreme seasonal weather variations typical of the Mediterranean climate. None of the plant communities in the project area have commercial significance. Douglas-fir (*Pseudotsuga menziesii*) is the only species of potential commercial significance but the small, scattered populations in the project area are not in demand. The Douglas-fir and other tree species are often used for firewood, but no such sales are anticipated in the project area.

Wildlife Resources

Baseline data on wildlife resources prior to extensive geothermal development in The Geysers KGRA are not available. Wildlife species associated with the various vegetation types occurring in The Geysers KGRA are documented in The Geysers Wildlife Study (PGandE, et al, 1977). Additional discussion of some of the species found in the project area is included in the NOI (NCPA, 1978b) submitted to the Energy Commission.

VEGETATION IN THE PROJECT SITING AREAS

Power Plant Site

Vegetation at the proposed power plant site is primarily of the Mixed Chaparral community. This community consists of three dominant genera: chamise (*Adenostoma* spp.), wild lilac (*Ceanothus* spp.) and manzanita (*Arctostaphylos* spp.). Oaks (*Quercus* spp.), toyon berry (*Heteromeles* spp.) and silk tassel (*Garrya* spp.) are common in specific areas where environmental conditions are favorable. The growth form and species composition are directly related to slope, exposure, available moisture, soil type and frequency of fire.

Typical growth forms of this community may vary from sites having shrubs 10 feet (3 meters) or more in height forming impenetrable stands, to sites having low prostrate shrubs less than 3 feet (1 meter) in height forming open stands of vegetation. This plant community is usually located in south to west exposures with dry, shallow rocky soils.

TABLE III-10
DESCRIPTION OF VEGETATION COMMUNITIES
IN FIGURE III-10

Barren

Nearly devoid of vegetation, barren pockets on serpentine outcrops; jewel flower (Streptanthus morrisonii complex), onion (Allium falcifolium), birds foot cliff brake (Pellaea mucronata).

Mixed Chaparral

Usually on south to west exposures with dry, shallow rocky soils; low prostrate shrubs less than one meter to stands three meters or more in height, vary from dense impenetrable stands to sites of sparse open stands; chamise (Adenostoma spp.), wild lilac (Ceanothus spp.), manzanita (Arctostaphylos spp.); scattered oaks (Quercus spp.), toyon berry (Heteromeles spp.), silk tassel (Garrya spp.).

Serpentine Chaparral

Serpentine soils where sufficient topsoil and moisture are available; Jepson's ceanothus (Ceanothus jepsonii), chamise (Adenostoma fasciculatum), leather oak (Quercus durata), Sargent cypress (Cupressus sargentii).

Mixed Evergreen

Usually dry, east-facing slopes or lower canyon bottoms near riparian areas; canyon live oak (Quercus chrysolepis), madrone (Arbutus menziesii), California bay (Umbellularia californica), black oak (Quercus kelloggii), big leaf maple (Acer macrophyllum), Douglas-fir (Pseudotsuga menziesii).

Knobcone Pine

Serpentine soils with more available moisture than serpentine chaparral, a fire climax community, generally found on easterly ridges; knobcone pine (Pinus attenuata) with a closed canopy, understory of manzanita (Arctostaphylos spp.) and wild lilac (Ceanothus spp.).

Douglas-fir

Normally occurs on moist sites, such as canyon bottoms or steep slopes with northern aspects, soils usually well developed with an acid pH; Douglas-fir (Pseudotsuga menziesii), black oak (Quercus kelloggii), madrone (Arbutus menziesii), big leaf maple (Acer macrophyllum), California bay (Umbellularia californica), canyon live oak (Quercus chrysolepis).

Riparian

Occurs along perennial creeks, mesic sites in deep canyons; understory of herbaceous vegetation and a complete canopy of trees; common trees identical to ones listed for Douglas-fir community.

The northern portion of the proposed power plant site, adjacent to steam well pad D, is covered by the Serpentine Chaparral community. The plant species that characterize this community are: Jepson's ceanothus (Ceanothus jepsonii), chamise (Adenostoma fasciculatum), leather oak (Quercus durata) and Sargent cypress (Cupressus sargentii). These species generally occur in clumps in areas of sufficient top soil and moisture. The understory is commonly a scattered population of flame buttercup (Senecio greenii), onion (Allium falcifolium), soap weed (Chlorogalum pomeridianum), Indian warrior (Pedicularis densiflora) and squirrel tail (Sitanion hystrix). The intershrub spaces between clumps of the dominant shrub species are characterized by rock outcrops or sparse stands of the understory species.

Within the unnamed drainage channel which runs along the eastern and southern boundaries of the proposed power plant site is the small seep shown in Figures II-5 and III-4. Surrounding this seep, and for a distance of approximately 150 feet (50m) downstream, is a narrow band of riparian vegetation.

The Riparian community occurs primarily along watercourses on mesic sites in deep canyons. The vegetation in this community consists of an herbaceous understory and a complete canopy of trees. The common trees in the Riparian community include: big-leaf maple (Acer macrophyllum), California bay (Umbellularia californica), and canyon live oak (Quercus chrysolepis). Other common tree species include: Douglas-fir (Pseudotsuga menziesii), black oak (Quercus kelloggii) and madrone (Arbutus menziesii). Elements of these Riparian communities are found in the drainages bordering the power plant site.

Transmission Tapline Corridor

The proposed transmission tapline will have nine towers and the corridor will cross several vegetation types (See Figure III-10). Tower pad and access road development will occur primarily in chaparral vegetation. The corridor between Tower No. 4 and Tower No. 5 spans a Riparian community and pockets of Douglas-fir which lie considerably below it, in the Big Sulphur Creek drainage.

Transmission Towers No. 1, 3, 4, 5 and 8 are located within the Mixed Chaparral community. Transmission Tower No. 2 is located in the Serpentine Chaparral community.

Transmission Towers No. 7 and 9 are located within the Knobcone Pine community. This type of vegetation normally indicates serpentine soils which have more moisture than is available in the Serpentine Chaparral community. The dominant species of this community is the Knobcone Pine (Pinus attenuata) which has a closed canopy and a dense understory of entangled dead branches. The presence of stands of knobcone pine indicates that this is a fire climax community since the cones of this species do not release their seeds until they are opened by a fire. Associated plant species within the understory are manzanita and wild lilac.

Transmission Tower No. 6 is located within the Mixed Evergreen community. The dominant tree species of the Mixed Evergreen community are: canyon live oak, madrone, and California bay. Associated tree species are black oak, big-leaf maple, and young Douglas-fir. This mixture of broad-leaf evergreen trees and associated species is a transitional vegetative community which may develop into a Douglas-fir climax forest, depending upon site potential. The usual site characteristics for this community are dry, east-facing slopes or lower canyon bottoms, near the Riparian community.

The transmission corridor between Towers No. 4 and 5 and between Towers No. 6 and 7 crosses Douglas-fir communities. This community normally occurs on moist slopes such as canyon bottoms or steep slopes with northern aspects. The soils associated with this community are usually well developed and have an acid pH. The common tree species of this community are Douglas-fir, black oak, and madrone. Also associated with this community are small numbers of other tree species which are scattered throughout the community on sites favorable for their reestablishment. These associated species include big-leaf maple, California bay, and canyon live oak.

AFFECTED VEGETATION OUTSIDE PROJECT SITING AREAS

Steam Gathering Routes

Steam for the NCPA No. 2 project would be supplied from Shell well pads B, C, D, F, and Q; well pad A would be used for reinjection. The steam gathering system is expected to parallel existing access roads between the wells supplying steam or providing for reinjection, and the proposed power plant. The primary vegetation along the routes is chaparral which is well-adapted to regrowth from the roots after being cut back for placement of the pipelines.

Depending upon the final route alignment selected, the pipelines from well pads F, Q, and B also traverse portions of the Knobcone Pine communities. In addition, pipelines from well sites C, Q, and B may cross vegetation associated with the Barren community. This community, which includes small, barren pockets within the Serpentine Chaparral community, is the only one which has unique features. In the study area it is the only community in which significant numbers and kinds of Uncommon, Threatened or Endangered plants have been found.

The Barren community is nearly devoid of any vegetation. The soils in the community are usually a serpentine type that provide a very harsh environment for any plants to establish in. Three of the most noticeable plants that have adapted to this environment are jewel flowers (Streptanthus morrissonii complex), onion (Allium falcifolium) and bird's foot cliff brake (Pellaea mucronata).

UNCOMMON, THREATENED, AND ENDANGERED (UTE) PLANTS

Uncommon plants are defined as those that are endemic to an area but with substantial populations within their limited habitats; that require special habitats which are widespread in distribution; and that are listed in Appendix I of the Inventory of Rare and Endangered Vascular Plants of California (Powell, 1974). The terms "threatened" or "endangered" conform with the use and definition as provided for in Public Law 93-205, "Endangered Species Act of 1973."

Seventeen UTE plants have been identified as potentially having populations within the NCPA study area. The habitats of these plants have been identified with the assistance of and in consultation with members of California Native Plant Society and through review of their publication, Inventory of Rare and Endangered Vascular Plants of California (Powell, 1974). In addition, field investigation and/or inventories have been partially completed by Bureau of Land Management personnel and a private consultant (Neilson, 1977; 1978). Appendix D lists the 17 UTE plants on the BLM list having the potential for occurring within the NCPA study area. The USFWS also has a list which identifies 27 proposed and candidate plants which may be present within the area.

Of the plant species on the BLM and USFWS lists, only members of the Streptanthus morrisonii complex have been observed in the study area. They occur throughout the Barrens identified on the vegetation map, Figure III-10. These barren areas are known to be critical habitat for these plants. None of the other species on these lists have been found during on-site surveys made in the late fall. Since most plant species are best identified when they are in flower, additional field surveys are needed in the spring and early summer.

WILDLIFE RESOURCES IN PROJECT AREA

Mature chaparral brush dominates the proposed plant site. Although relatively few species of animals appear to be adapted to extensive stands of mature chaparral, stands less than 10 years old support a variety of wildlife species. (Longhurst, 1978)

The most important wildlife habitats in the project area are the aquatic and riparian habitats found in the Big Sulphur Creek and Bear Canyon Creek drainages. Less well developed riparian habitat occurs along the drainages near the power plant site. The riparian vegetation around and downstream from the seep in the drainage southeast of the proposed plant site provides cover and water for local wildlife and may serve as a fawning area for deer. The well-developed Riparian community along Big Sulfur Creek and the pockets of Douglas-fir adjacent to the west side of the creek have increased importance as wildlife habitat because they remain relatively undisturbed by human activities.

A variety of wildlife species occurs within the project area. The proposed development sites include the entire habitat of certain of the smaller, less mobile species, such as mice and lizards, and various portions of the habitat used by larger and highly mobile species such as deer and birds. A list of the wildlife species found in the project area is included in Appendix D.

Mammals

Available data indicates that approximately 23 species of mammals occur in or periodically use NCPA development areas. The most common species include the Sonoma chipmunk, brush mouse, pinyon mouse, deer mouse, black-tailed jack rabbit, dusky-footed wood rat, coyote and black-tailed deer. These species are primarily associated with chaparral vegetation.

Two mammals, the black-tailed deer and the gray squirrel, have recreational value, although little recreational activity has occurred in the project area because of limited access. The black-tailed deer is quite common in all vegetation types throughout the area. Chaparral areas in the region, similar to those at the power plant site, have densities of 0.2 to 0.7 deer per acre (PGandE, et al, 1977). Based upon available data, the types and amount of habitat affected by project-related activities could support from 9 to 32 deer. This number of deer would not be found in this area at any given time but the area could be used in conjunction with adjacent areas to support this number of deer.

Gray squirrels prefer Mixed Evergreen and Oak vegetation types. Little to no gray squirrel habitat is included in sites proposed for development.

Birds

Approximately 39 species of birds are expected to occur at least periodically on or adjacent to NCPA development sites. Several other species of owls, humming-

birds, swallows, woodpeckers and sparrows may occasionally use the area. Birds are highly mobile and use of the NCPA development sites by these birds varies. More commonly occurring birds include mountain and California valley quail, mourning dove, poor-will, Western kingbird, scrub jay, common bushtit, wrentit, Bewick's wren, California thrasher, American robin, blue-grey gnatcatcher, Brewer's blackbird, house finch, lesser goldfinch, rufous-sided towhee, brown towhee, rufous-crowned and sage sparrows.

Three of these species, California valley quail, mountain quail and mourning dove, are classified as game birds. The two quail species prefer Mixed Evergreen and Chaparral vegetation communities. Doves prefer more open areas in chaparral and the other vegetation types as well.

Reptiles and Amphibians

Of the 11 species of reptiles present, the western fence lizard and sagebrush lizard appear to be most common. The Western pond turtle and the Western aquatic snake, along with a variety of amphibians, are primarily associated with aquatic habitats downstream from the plant site. Several of the most highly aquatic forms, particularly the newts, appear to be sensitive to changes in their habitat. Red-bellied and rough-skinned newts were found in much lower numbers in "developed" geothermal areas than in "undeveloped areas." (PGandE, et al, 1977)

Fish

Four species of fish occur in the upper portions of two drainages adjacent to the proposed project area. Sport fishing occurs in the Big Sulphur and Bear Canyon Creek drainages downstream from the project area. Big Sulphur Creek is an important spawning and rearing area for young steelhead trout in the Russian River system.

About 3,000 ft. downstream from the power plant site the natural intermittent drainage channel enters Big Sulfur Creek. This point of confluence is within the upper fish limit of the creek, as determined during studies conducted from June 1 through September 9, 1976 (Price, et al. 1979: Figure 1, page 6). The California Department of Fish and Game (CDFG letter to CEC, April 30, 1979) has stated that the trout populations in the creek during normal water years are probably greater than those indicated during the summer of 1976, following the 1975-76 drought. (See also comments by NCPA, page III-26).

Staff believes that during the normally high flows in the late winter/early spring season it is likely this upper reach of the creek is used as a spawning area for resident trout. In October 1978, trout or steel-head fry were present in Big Sulphur Creek, approximately 250 yards downstream from the cross-over point of the proposed 230 kV transmission tapline. According to the California Department of Fish and Game, Bear Canyon Creek provides the same desirable spawning and rearing habitat for trout which reside in Lake Berryessa.

Endangered Species

The Geysers KGRA occurs within a general area of preferred peregrine falcon habitat (GRIPS, 1978; Herman, et al, 1970). Recent recorded observations indicate only sporadic use of the KGRA area by these birds (Colson, 1977). There are no known, suitable nesting sites for the peregrine within the NCPA

development area. Current observations appear to indicate use associated with migration and, possibly, foraging flights from established aeries located 6.5 miles southwest of the proposed NCPA development. Similar use by the peregrine is expected to occur in the proposed project area.

Fully Protected Species, State of California

Golden eagles have been recorded in the KGRA area in relatively low numbers (PGandE, et al, 1977; Stager 1976 and 1975). One observation of the golden eagle has been recorded in the NCPA project area (NCPA, 1978b) but there are no known nesting sites. Current use of the proposed development area appears to be for low intensity foraging.

Although the ringtail, a fully protected mammal, is expected to occur in the project area, no observations have been recorded (NCPA, 1978b) during daylight surveys. Within the area proposed for development, the ringtail would most likely occur in the small drainage within the proposed power plant site. It is estimated that this area would provide only a portion of the habitat required by a pair of ringtails.

Ecological Relationships

There are no known unique wildlife ecological relationships occurring in the immediate project area. Present relationships are typical of those found primarily in partially altered chaparral vegetation throughout The Geysers KGRA.

Basic relationships exist whereby native vegetation provides food for various plant-eating insects and animals, including a variety of rodents, rabbits, deer and songbirds. These in turn serve as food for various predators such as the coyote, fox, ring tail and several species of raptors.

Off-site stream habitats support aquatic food chains. Plant and animal micro-organisms, including various algae and invertebrates, provide food for a variety of larger life forms including insects, fish, amphibians, reptiles, birds and mammals. Riparian plant communities found in these areas provide necessary habitat for large numbers and a wide variety of wildlife. The presence of aquatic and riparian habitat make these areas the highest value wildlife habitat per unit area in the potential influence zone of the NCPA project.

AIR RESOURCES

The most difficult environmental effects to analyze and evaluate are the impacts of power plant emissions on ambient air quality and the effects that deterioration in air quality have on surrounding plant, animal and human populations. Several factors account for this difficulty:

- a. Reliable up-to-date information on the existing ambient air quality is seldom available for the specific plant site;
- b. Emissions from the plant cannot be accurately predicted prior to actual operations because the exact composition and concentration of chemicals in the incoming steam are not known;
- c. The effectiveness of pollution control equipment has not been determined over a period of time long enough to assure the assumed figures are reliable; and
- d. There is little scientific certainty regarding the nature and extent of harmful effects of geothermal plant emissions, even after abatement to meet governmental standards, upon plants, animals and humans.

The air resources section examines available information on the ambient air quality at the proposed site, and the meteorological and climatic conditions that affect air quality. It also examines available information on steam content and ambient air conditions. The purpose of the discussion is to provide baseline information against which the proposed project's emissions and the changes in ambient air quality which result from those emissions, can be measured and their effects evaluated.

METEOROLOGICAL CHARACTERISTICS

Preproject Meteorological Conditions-

Weather conditions in the general vicinity of the site have been monitored at various times for several years. Two air quality and meteorological monitoring stations established by the Stanford Research Institute (SRI) are located near enough to the proposed NCPA site so that data collected there in 1976-77 can be used to determine ambient and meteorological conditions at the plant site.*

The nearest SRI station, SRI-2, is located on Anderson Ridge, (on the same general ridgeline of the Mayacmas Mountains as the plant site), about two miles (3.2 kilometers) north of the plant site. Station SRI-6 is located about 3 miles (4.5 km) to the northeast, near the eastern end of Anderson Springs, the Lake County community nearest the proposed project area. Between 1976-77, these stations monitored ambient concentrations of hydrogen sulfide (H_2S) and meteorological conditions such as temperature, wind speed and direction.

*The data and results from all eight of SRI's meteorological stations are contained in a report prepared for PG&E in June 1978; see Ronald E. Ruff, Leonard A. Cavanaugh, Janet D. Carr, "1977 Executive Summary Specialized Monitoring Services," (SRI International 1978). Hereafter, cited as Ruff, Cavanaugh, and Carr.

Figure III-11

A third source of data is a station located at PGandE's Geysers Unit 13, some one and one-half miles northwest of the proposed site for NCPA's Unit 2. In addition, in April 1978, Shell Oil Company placed a meteorological monitoring tower on the peak of the existing knoll on which the proposed NCPA power plant would be located. This tower does not measure H_2S ambient concentrations. The locations of these and other monitoring stations is shown in Figure III-11.

Meteorological conditions at the proposed plant site are typical of the general climate in The Geysers region, which is characterized by wet winters and dry summers. This general climate is affected by the Pacific High, a semipermanent high pressure system off the Pacific Coast which influences air flow and precipitation over the entire state. The clockwise flow of air around this high pressure area results in northwest winds over California and is also responsible for the persistent subsidence inversion which extends over much of the state during the summer months.

Ambient Air and Dew Point Temperatures--The complex terrain of The Geysers region is a major factor which affects local climate. The Mayacmas ridge deflects incoming marine air, moderating temperatures within The Geysers region. Even so, monthly temperatures at the site can range from 20°F (-6.6°C) in January to over 100°F (37.8°C) in August. Monthly average ambient temperatures measured at SRI-2 and at the Shell station on the proposed plant site are shown in Table III-11.

TABLE III-11

MONTHLY AVERAGE AMBIENT TEMPERATURES IN PROJECT AREA (°C)

Location	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Anderson Ridge; SRI-2 ¹	7°	7°	5.5°	10°	8°	20°	21°	22°	16°	14°	10°	7°
Proposed Plant Site ²	-1°	-1.6°	2.6°	4.3°	11.7°	13°	19.3°	18.4°	14.9°	13.6°	3.4°	1°

1. Ruff, Cavanaugh and Carr, 1977. Data shown were measured from February 1976 through September 1977.

2. Environmental Systems and Service (contractor for Shell's met station). Data shown were measured from April 1978 through March 1979.

The cold winter temperatures indicated by the Shell station data included in Table III-11 are important for several reasons. First, the H_2S abatement system proposed by NCPA must be maintained at temperatures at or above 60°F (15.6°C). Second, low winter temperatures associated with high wind speeds may result in a "down-wash" condition, in which pollutants from the project

site could be driven down the Mayacmas Ridge towards Anderson Springs. Such temperatures also appear to be associated with "drainage" conditions at Anderson Springs during which cold air containing pollutants can be pulled down the ridge towards the community. An analysis of the SRI data conducted by Environmental Research and Technology, Inc. (ERT) indicates that the highest concentrations of H_2S measured at Anderson Springs (SRI-6) occur during drainage flow conditions.*

The hot summer temperatures indicated by the Shell data contributed to inversion conditions which trap pollutants below hot air layers, preventing dispersion. A condition called "fumigation" can also occur in hot weather, causing pollutants to be transported downward from vigorous vertical mixing of air flows beneath a low inversion. In this condition high concentrations of pollutants can accumulate in relatively small areas.

Air quality is also affected by the relationships between dew point temperatures and cooling tower plume rise. In general, if the dew point temperature is higher, water vapor or steam emitted from a cooling tower condenses less rapidly. This allows the hot vapor or steam to rise higher, be carried aloft by wind streams, and be dispersed over wider areas. Conversely, when dew point temperature is lower, the water vapor or steam tends to condense more rapidly. Heat energy is lost, the resulting plume rise is lower, and dispersion is less extensive.

The effects of dew temperature on plume rise are not as strong as the effects of wind speed. In fact, mean dew point temperatures recorded at PGandE Geysers Unit 13 (PGandE, 1979d) during 1977-1978 show a fairly narrow range of 34°F (November) to 43°F (August). Although a wider range could be expected at NCPA's ridge-top site (Geysers 13 is at a lower, more sheltered location), CEC staff do not believe this difference would make dew point the predominant factor in determining plume rise or would have a major effect on determining "worst case" meteorological conditions for air quality analysis purposes.

Precipitation--In general, the amount of precipitation can affect the ambient air concentrations of total suspended particulates (TSP). Heavy rains and snow "scrub" or "wash" these particles from the air. Precipitation also helps dissolve certain water soluble gases that can be emitted from geothermal plants, such as hydrogen sulfide (a major concern in The Geysers), ammonia, boron, and others.

Average annual precipitation at the proposed plant site is approximately 76 inches. (See page 111-20 for additional discussion) Winter precipitation often occurs as snow above 2,000 feet (600m) and averages about 20 inches annually. Average relative humidity near The Geysers ranges from about 30 percent during the driest months to near 80 percent in the winter.

The high levels of precipitation during winter months are responsible for the fact that the ambient air concentrations of H_2S measured at the SRI stations were generally lower in the winter than in the summer.

*D. Steffan, L. Wang, G. Hidy, The Geysers Geothermal Area Emissions and Aerometric Data Set (1976-1977), (ERT, August 1978) prepared for The Geysers Geothermal Environmental Committee, hereinafter referred to as "ERT Report."

Wind Speed and Direction--Wind speed in the project area generally increases with elevation. The proposed project site is at about 3,200 feet elevation. Measurements taken at the Shell meteorological station at the site indicate average wind speeds of approximately 10 mph. SRI data indicate that the frequency of calms (winds less than 1 or 2 mph) is less than 0.3 percent at exposed, elevated peaks.

The directional frequency distribution of local wind flow is more complex. At elevations above 3,000 feet (900m), the average annual wind is either from the NE + 45° or the SW + 45°. This distribution pattern is observed during all seasons, although the NE direction is more prevalent in winter, and the SW predominant in summer. The likelihood of southwestern winds is particularly important since emissions from the plant can be carried toward Anderson Springs (2 miles to the NE) or down into the Collayomi Valley toward Middletown.

Directional frequency of wind flows at the SRI-2 meteorological station located on the ridge north of the proposed project site exhibits the typical NE/SW high elevation pattern. Figure III-12 presents "wind rose" patterns for the SRI-2 site for the years of 1976 and 1977. Figure III-12 also presents wind rose patterns for the SRI-6 site, located below the SRI-2 ridge site. Comparison of these sets of wind roses illustrates the effect of lower elevation and local terrain upon wind direction distribution and frequency.

At lower elevations, directional patterns bear little similarity to patterns found at high elevations, as local terrain becomes increasingly important in determining directional distribution. As indicated by the wind rose pattern for SRI-6, there is no dominant wind direction, and this lower area exhibits a high frequency of relative calms. Topographic features may cause channeling of moderate or strong flows within valleys and around obstacles. Heating and cooling of slopes tends to create upslope flows over sunheated surfaces and downslope flows at night. Downslope drainage flows are most developed in winter and upslope flows are strongest and most frequent in summer.

Worst Case Meteorological Conditions

In order to determine the maximum extent of adverse impacts from power plant air emissions on air quality, one must first determine what meteorological condition would create the "worst case" conditions for transport and concentration of pollutants. Several studies have been conducted by PGandE and NCPA consultants to determine the worst case conditions.

SRI's 1976-77 study established the data base for determining the dominant meteorological conditions at various points in the KGRA, including two points, SRI-2 (ridgetop) and SRI-6 (Anderson Springs), relevant to the NCPA project. SRI also sought to determine whether there are any strong correlations between specific meteorological conditions (temperature, windspeed and direction) and high concentrations of H₂S. Essentially, SRI found a strong correlation between wind speeds in excess of 5 miles per hour coming from the southwest and high H₂S concentrations at the ridgetop. The ERT Report then took the SRI data, confirmed the SRI conclusions, and additionally determined that H₂S concentrations peaked at the ridgetop during the cool night or early morning hours.

FIGURE III-12
WIND ROSE PATTERNS FOR SITES SRI-2 & SRI-6

Subsequently, a tracer study and analyses conducted by Meteorology Research, Inc. (MRI)* evaluated the SRI and ERT data in order to determine which meteorological condition would have the worst case impacts at the NCPA site and, more importantly, at the nearest communities, including Anderson Springs. Essentially MRI determined that the conditions which maximized H_2S concentrations at the ridgetop (plant site) were not necessarily the same conditions that produced maximum H_2S concentrations at Anderson Springs. MRI's conclusion is as follows:

In conclusion then, it can be stated that the worst case NCPA/Shell impact occurs when late afternoon, strong cross-ridge winds suppress plume rise through limited down-wash conditions toward the northeast. This effect may be accentuated by a capping inversion that also limits mixing and plume rise by capping valley airflow. If the plume, with limited plume rise, is mixed downward by the remnants of convective activity and then trapped by cool drainage flow on the shadowy side of the ridge, conditions are perfect for maximum impact. Although the tracer tests from the NCPA/Shell site carried out under various flow conditions seek to independently isolate each of the three conditions, it is when they occur in conjunction with each other that maximum impact may occur. Any of the three MRI conditions may of themselves create a high impact situation, but the synergism of all three conditions seems to create the major air quality concern of geothermal development on the southern flank of Cobb Mountain and the ridges to the south.**

In the tracer studies conducted by MRI, sulfur hexafluoride (SF_6) was released under certain defined meteorological conditions. The releases were made at NCPA's proposed plant site, at various locations in the Shell leasehold, and at PGandE's Geysers 13 and 16 plant sites; the conditions included nocturnal drainage, downwash, and limited vertical mixing (the three conditions found to contribute most to downwind impacts). The releases were carried out during periods when wind speeds and direction would be most likely to transport the tracer gases to populated areas. The results of MRI's tracer studies are contained in the MRI study cited above and are included in the NCPA Supplement to the AFC (NCPA, 1979c).

In determining the hypothetical worst case conditions for H_2S impacts, MRI's study does not conclusively establish what the worst case would be. Although the tracer gases were released during periods when each of the hypothesized worst case conditions occurred, no release has ever been conducted when all three occurred in conjunction. During the period of the study (June 1978 to January 1979) there is no indication that these three condition occurred in conjunction. If these conditions do not naturally occur, then the hypothetical worst case condition may be an overly conservative reference from which to estimate the potential impacts of plant emissions.

*Knuth, W.R. and H.D. Giroux, NCPA/Shell H_2S Impact Study (MRI, June 1979), hereinafter referred to as "MRI."

**MRI, pages I-27, I-30.

AIR QUALITY

Ambient air quality in The Geysers region is influenced predominantly by geothermal steam emissions. Seventy-one billion pounds of steam were used in 1976 by the 11 operating units of PGandE's Geysers Power Plant. Water vapor constituted about 98 percent of these emissions; the remaining two percent was comprised of noncondensable gases and solids.

Characteristics of Steam Content as They Relate to Air Quality

Composition of the steam varies according to the location of the source within the KGRA. A comparison of the composition of geothermal steam produced from wells supplying earlier PGandE units and those which will supply the NCPA No. 2 power plant are presented in Table III-12. The figures in this table are averages based upon the range of values measured for a number of steam wells. The table also indicates the amount of each steam component going through a 55 MW power plant each hour (NCPA's project will consist of two such 55 MW units), based on information from earlier PGandE units.

As the table demonstrates, the concentration of regulated pollutants in the steam from Shell's three wells is generally much lower than the average concentrations from other geothermal projects. Less than half of the Shell wells have been drilled and measured, and a total of 15 or more wells will be required for initial operation of the plant. Thus, no firm conclusion about ultimate concentrations of these pollutants can be made. However, information from wells drilled for nearby units (Geysers 13, 16, 18) suggests that the concentrations of pollutants in the southern part of the KGRA will be less than the concentration experienced in most other developed areas of the KGRA. These facts imply a greater likelihood of ability to meet air quality standards as well as a greater likelihood of avoiding adverse environmental impacts.

Table III-12 also shows a slightly increased level of mercury from the Shell wells over the concentrations found in earlier wells. However, even this increased level is relatively low. The potential health impacts from mercury and other pollutants is discussed in the Chapter entitled "Public Health."

Characteristics of Existing Ambient Air Quality

As geothermal development in The Geysers region has increased, ambient air quality has been monitored, along with meteorological conditions, at the locations shown in Figure III-11. In addition, a number of studies have been conducted to determine the presence of pollutants in the ambient air.

In 1975, the California Air Resources Board measured seven major air quality contaminants at two sites in southern Lake County. The two sites are Kelseyville, about 10 miles northwest of the site, and Middletown, about 6 miles to the west. The ARB monitored ozone, carbon dioxide, sulfates, total hydrocarbons, methane, nonmethane hydrocarbons, and coefficient of haze (reduced visibility). According to the ARB, the California ambient air quality standard for each of these parameters was not exceeded during the monitoring period, April 14 through May 12, 1975. No similar or more recent monitoring for these parameters has been undertaken despite the fact geothermal development has increased since 1975.

TABLE III-12

NONCONDENSIBLE GASES AND SOLIDS IN STEAM (AVERAGED)
FROM WELLS SUPPLYING GEOTHERMAL POWER PLANTS

Noncondensable Gases	Flow Into 55 MW Unit (lbs/hr)	Percent By Weight The Geysers*	NCPA/Shell**
Carbon Dioxide	2960	0.326	0.43
Hydrogen Sulfide	222	0.0222	0.0092
Methane	176	0.0194	0.018
Ammonia	176	0.0194	0.018
Nitrogen	47.1	0.0052	0.005
Hydrogen	50.8	0.0056	0.009
Ethane	-	Neg1	0.015
Total Noncondensibles	-	0.398	0.23
SOLIDS (parts per million, by weight)			
Arsenic	0.0171	0.019	<0.02
Boron	14.6	16.0	0.04
Mercury	0.00459	0.005	0.007

*Overall average from 61 producing wells supplying The Geysers Power Plant, measured in 1972-74. (NSCAPCD, 1974)

**Average from three producing wells proposed to supply NCPA No. 2, measured in latest Shell data (July 1979).

Pollutants associated with development of geothermal resources which are of concern in maintaining ambient air quality include suspended particulate matter, hydrogen sulfide, sulfur dioxide and sulphate, and radon. The ambient air conditions for each of these pollutants is described below.

Suspended Particulate Matter--Lake and Northern Sonoma County Air Pollution Control Districts recently completed a six-month program to monitor suspended particulate matter in The Geysers region. Data from four sample sites are presented in Table III-13. During the period of February through August 1977, 24-hour average suspended particulate matter concentrations ranged from 1.74 $\mu\text{g}/\text{m}^3$ on Socrates Mine Road 2 miles to the north (3/14/77), to 76.05 $\mu\text{g}/\text{m}^3$ in Middletown (8/11/77). The higher values observed in Middletown probably reflect the contributions from nongeothermal sources in Middletown such as vehicular traffic, construction activities, and agricultural activities. All reported concentrations are below the California ambient air quality standard of 100 $\mu\text{g}/\text{m}^3$ averaged over 24 hours.

Hydrogen Sulfide (H_2S)--Hydrogen sulfide is present in the geothermal steam in The Geysers KGRA and is one of the most noticeable pollutants associated with geothermal development. H_2S emissions from natural sources, such as geothermal springs, fumaroles (a natural surface crack emitting steam), or

TABLE III-13
HIGH VOLUME AIR SAMPLER DATA
Particulate Weight in Micrograms per Cubic Meter

Date	Socrates Mine Road	Anderson Springs	Wall Street Mine	Middletown
2/ 6/77	5.33	—	—	—
2/12/77	12.95	—	—	—
2/18/77	14.00	47.60	—	21.62
2/24/77	3.54	12.34	—	11.16
3/ 2/77	8.20	9.61	—	7.26
3/ 8/77	4.92	16.69	—	13.64
3/14/77	1.74	10.59	—	12.90
3/20/77	7.79	27.87	—	32.50
3/26/77	15.01	21.14	—	12.26
4/ 1/77	12.21	17.04	—	18.97
4/ 7/77	24.40	30.48	—	22.43
4/13/77	17.39	28.15	—	37.61
4/19/77	—	43.93	—	57.31
4/25/77	—	14.66	—	21.56
5/ 1/77	11.88	12.32	—	19.64
5/ 7/77	6.89	12.17	—	11.32
5/13/77	11.19	22.82	—	16.72
5/19/77	20.85	14.96	—	18.58
5/25/77	6.14	13.70	—	10.66
5/31/77	10.85	21.95	15.94	43.84
6/ 6/77	35.90	35.03	33.17	46.87
6/12/77	51.60	24.49	22.36	41.91
6/18/77	39.59	—	31.42	66.71
6/24/77	38.87	46.39	—	47.79
6/30/77	40.27	37.62	—	—
7/ 6/77	27.02	32.20	—	50.41
7/12/77	9.25	39.19	—	53.25
7/18/77	20.00	31.29	—	40.10
7/24/77	32.40	37.87	—	62.80
7/30/77	25.62	34.62	—	60.56
8/ 5/77	57.20	41.46	—	49.31
8/11/77	40.38	67.72	—	76.05
8/17/77	26.50	45.19	—	61.90
Sample Mean	20	28	24	35

Source: Environmental Systems and Service (1977).

streams carrying H_2S from other sources have been measured and reported by several investigators, including Environmental Systems and Services (ES&S) (1978), Frazier (1978), and Tolmasoff (1975).*

Generally, these studies indicate that individual natural sources can contribute as much as 75 to 250 lbs/day H_2S to the ambient air. However, there is no evidence of such natural sources at the proposed plant site, and only limited evidence of such sources near the project area. Two natural sources of undefined extent have been noted in a recent study by Environmental Systems and Services (ES&S). According to ES&S, the first source is located about 1 mile west of Anderson Springs and consists of small cemented pools of mildly sulphurated water. The second source is about 3 miles northwest of the NCPA site, and consists of a clear, apparently odorless water seep along Yellow Creek.**

Thus, H_2S concentrations in the vicinity of the site are not likely to result from these natural causes. Moreover, the ERT Report (Steffan, et al, 1978) found that cooling tower emissions could only be predicted within a range of +50 percent. This range of possible error is substantially greater than any likely contribution to H_2S concentrations that could be attributable to natural sources. Although certain wind patterns might result in detectable levels of H_2S from natural sources, the areawide emission of 30,000 to 40,000 lbs/day of H_2S (Steffan et al, 1978) from all sources make the small levels of H_2S from natural source relatively insignificant. Additional information on average annual H_2S emissions from geothermal operations at The Geysers Power Plant are presented in Appendix E.

As part of its study, SRI measured ambient concentrations of H_2S at eight locations in The Geysers region during 1976 and 1977. SRI then derived hourly averaged concentrations of H_2S . Tables III-14a and 14b present the distribution and frequency of times when the concentration equaled or exceeded the state ambient air quality standard of 0.03 parts per million (ppm) of H_2S , at each monitoring point.

*Characterizations of background hydrogen sulfide concentrations in and around The Geysers area have been the subject of several studies, including:

- o Swanson and Mooney H_2S survey of 1972 (PGandE);
- o Althsuler H_2S Air Quality Study, starting 1970 (PGandE);
- o Unit #11 monitoring, starting 1974 (PGandE);
- o Lake County Air Pollution Control District H_2S monitoring, starting 1975;
- o SRI, Inc., H_2S Study, starting 1976 through 1978;
- o Environmental Systems and Service H_2S monitoring at Klau Mines No. 1 Well Site, May 17 to June 19, 1977

** ES&S, 1978 Natural Emission Study, page 16.

TABLE III-14a
DISTRIBUTION OF H₂S HOURLY AVERAGES (30 ppb): 1976

Station		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Percent
1 Geyser Rock	≥30 ^a	8	45	22	24	49	99	57	103	45	9	27	488	7
	Days ^b	5	17	12	13	17	27	18	26	12	4	9	160	49
	Counts ^c	447	714	699	662	708	696	602	684	727	695	691	7325	91
2 Anderson Ridge	≥30 ^a	53	82	22	41	79	112	91	68	56	26	10	640	10
	Days ^b	12	19	10	14	16	20	20	19	14	11	5	160	49
	Counts ^c	399	718	691	330	675	715	646	663	729	598	496	6660	83
3 Kehn Ranch	≥30 ^a	1	5	0	1	4	7	0	13	7	1	1	40	.5
	Days ^b	1	4	0	1	2	3	0	4	2	1	1	19	6
	Counts ^c	474	713	672	644	712	725	715	661	732	599	691	7338	91
4 Pine Summit	≥30 ^a	5	4	0	1	2	6	0	7	10	3	1	39	.5
	Days ^b	2	4	0	1	2	4	0	4	5	2	1	25	8
	Counts ^c	347	710	707	651	702	713	720	594	721	641	662	7168	89
5 Whispering Pine	≥30 ^a	0	0	0	1	0	14	3	4	9	0	2	33	.5
	Days ^b	0	0	0	1	0	5	3	3	5	0	2	19	6
	Counts ^c	411	734	676	668	627	633	722	644	715	588	647	7065	88
6 Anderson Springs	≥30 ^a	0	0	0	0	2	1	0	0	0	0	0	3	.04
	Days ^b	0	0	0	0	2	1	0	0	0	0	0	3	.9
	Counts ^c	437	724	705	655	651	697	717	594	700	628	647	7155	89
7 Sawmill Flats	≥30 ^a	0	0	1	4	9	8	4	7	0	0	0	33	.5
	Days ^b	0	0	1	3	5	3	3	2	0	0	0	17	5
	Counts ^c	594	726	690	667	492	676	710	642	730	579	102	6608	82
8 Aidlin Ranch	≥30 ^a	25	0	0	3	5	1	12	2	17	37	84	186	3
	Days ^b	8	0	0	2	2	1	2	2	4	8	17	46	14
	Counts ^c	295	171	699	648	688	624	714	678	622	536	658	6333	79
Monthly Totals:	≥30	92	136	45	75	150	248	167	204	144	76	125	(All stations)	
	≥30	31	9	1	10	22	37	19	33	43	41	88	(Stations 3-8)	

a ≥30 ppb = number of H₂S hourly averages at or above 30 ppb.

b Days = number of days with at least one hour reading at or above 30 ppb.

c Counts = number of valid hourly averages (percent counts correspond to valid data capture for 1 February through 31 December)

TABLE III-14b

DISTRIBUTION OF H₂S HOURLY AVERAGES (30 ppb): 1977

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Percent
1 Geyser Rock	≥30 ^a	11	17	10	12	8	22	39	33	28	45	10	10	245	3
	Days ^b	5	7	3	6	4	11	16	14	13	17	5	5	106	29
	Counts ^c	673	587	713	685	737	719	713	705	694	718	679	648	8271	94
2 Anderson Ridge	≥30 ^a	11	31	5	11	25	65	80	70	10	51	17	20	396	5
	Days ^b	4	11	4	9	8	20	17	15	5	8	3	7	111	30
	Counts ^c	696	617	706	708	721	718	712	721	693	747	665	668	8372	96
3 Kahm Ranch	≥30 ^a	0	0	0	1	0	1	0	0	2	0	0	0	4	.05
	Days ^b	0	0	0	1	0	1	0	0	1	0	0	0	3	.8
	Counts ^c	700	583	713	697	740	718	712	716	660	709	677	672	8297	95
4 Pine Summit	≥30 ^a	0	0	1	2	1	12	13	17	4	5	5	4	64	.7
	Days ^b	0	0	1	2	1	6	5	6	1	3	3	2	30	8
	Counts ^c	664	654	672	685	738	717	666	731	705	731	690	700	8353	95
5 Whispering Pine	≥30 ^a	0	0	0	4	0	0	0	0	10	2	1	0	17	.2
	Days ^b	0	0	0	3	0	0	0	0	6	2	1	0	12	3
	Counts ^c	700	633	698	713	681	715	705	703	662	721	656	782	7869	90
6 Anderson Springs	≥30 ^a	0	0	0	0	2	6	1	8	0	8	0	0	25	.3
	Days ^b	0	0	0	0	1	2	1	4	0	2	0	0	10	3
	Counts ^c	664	633	670	679	622	717	703	708	703	734	689	679	8201	94
7 Sawmill Flats	≥30 ^a	0	1	0	2	1	3	8	4	1	1	0	0	21	.3
	Days ^b	0	1	0	1	1	3	7	3	1	1	0	0	18	5
	Counts ^c	671	636	662	694	712	713	715	711	698	734	677	677	8300	95
8 Aidlin Ranch	≥30 ^a	15	2	3	0	12	12	5	12	26	122	56	19	284	4
	Days ^b	9	2	2	0	3	6	3	4	7	23	20	8	87	24
	Counts ^c	478	601	682	513	688	689	518	678	660	708	585	542	7342	84
Monthly Totals:	≥30	37	51	19	32	49	121	146	144	81	234	89	53	(All stations)	
	≥30	15	3	4	9	16	34	27	41	43	138	62	23	(Stations 3-8)	

a ≥30 ppb = number of H₂S hourly averages at or above 30 ppb. (The actual measurement per hour must have averaged 29.5 or more.)

b Days = number of days with at least one hour reading at or above 30 ppb.

c Counts = number of valid hourly averages (percent counts correspond to valid data capture for 1 January through 31 December)

The SRI data indicate that H_2S levels in The Geysers Rock area (SRI-1) and on the ridgecrest above Anderson Springs (SRI-2) are somewhat higher than those of other areas monitored. Both sites are near producing geothermal fields. SRI-2 is the monitoring station nearest the proposed project site (2 miles to the north). The data indicate that 1976 H_2S levels at this site exceeded the state standard approximately 10 percent of the time (640 hours from a total of 7325 hours monitored). During 1977 the 30 ppb standard was exceeded approximately 5 percent of the time (360 hours from a total of 8372 hours monitored). Data for 1978 and 1979 are not available.

SRI-2, the ridge site, generally records high H_2S levels when the winds are from the southwest. The distribution of H_2S concentrations versus time-of-day also peak during the night or early morning hours. According to the ERT study, it is probable that natural fumarole activity coupled with emissions from geothermal development activities (operating PG&E Units and Union Oil Company wells) to the southwest of Cobb Mountain are the primary contributors to H_2S concentrations recorded at SRI-2 during west or southwest winds.

Data from SRI-6 (Anderson Springs) for 1977, located below the ridge in Anderson Springs, indicates that the state standard of 30 ppb H_2S was exceeded about .3 percent of the time (25 out of 8201 hours monitored).² Figures III-13a and b indicate the frequency and time-of-day patterns for these standards violations. Most of the violations in 1977 occurred during evening hours with low, southwesterly winds. Tables III-15 and III-16 provide data for each major wind direction, indicating the percentage of time various wind speeds occur and the percent of time various levels of H_2S occur.

It is impossible to determine the exact sources of H_2S during periods when state standards are violated. The existing Geysers development could well be contributing to these violations since it is possible that wind west of the Mayacmas ridge from the developed areas can be diverted southward by Cobb Mountain. Drainage flow downslope could subsequently dominate this wind flow and cause pollutants to flow around the mountain toward Anderson Springs.

For purposes of determining compliance with the state H_2S ambient standard, the air quality agency measures the H_2S ambient concentration at public areas (e.g., Anderson Springs, and Middletown) since the H_2S standard is designed to prevent a "public nuisance." On the other hand, CAL-OSHA standards apply at the plant site for protection of plant employees. (Refer to additional discussion in Chapter IV, Health and Safety section.)

Sulfur Dioxide (SO_2)

As part of its study, SRI measured SO_2 concentrations at Anderson Springs (SRI-6) and Pine Summit (SRI-4). Over 7,000 measurements were taken at each station between February and December 1976. At no time did SO_2 concentrations ever exceed the state standards for SO_2 (0.5 ppm hourly average or 0.05 ppm daily average). In fact only rarely (1.1 percent of the time) did the hourly average concentrations of SO_2 at Anderson Springs exceed .005 ppm.* Thus, no one expects SO_2 concentrations to approach or exceed ambient air quality standards.

*See Ruff, Cavanaugh, and Carr, page 6, Table 3 Distribution of SO_2 Hourly Averages: 1976.

FIGURE III-13a
1976 FREQUENCY OF H₂S STANDARDS VIOLATIONS, SRI-6

FIGURE III-13b
1977 FREQUENCY OF H₂S STANDARDS VIOLATIONS, SRI-6

WIND AND H₂S DATA FOR ANDERSON SPRINGS (SRI-6)

TABLE III-15

Relative Wind Speed and Direction
(as a percent of time)

Wind Direction	Wind Speed (miles per second)					
	1-2	3-4	5-6	7-8	9-10	11+
N	1.9	0.1	0.0	0.0	0.0	0.0
NNE	2.5	0.1	0.0	0.0	0.0	0.0
NE	2.9	0.0	0.0	0.0	0.0	0.0
ENE	1.5	0.0	0.0	0.0	0.0	0.0
E	0.7	0.0	0.0	0.0	0.0	0.0
ESE	0.3	0.0	0.0	0.0	0.0	0.0
SE	0.0	0.0	0.0	0.0	0.0	0.0
SSE	0.0	0.0	0.0	0.0	0.0	0.0
S	0.0	0.0	0.0	0.0	0.0	0.0
SSW	0.1	0.0	0.0	0.0	0.0	0.0
SW	2.1	0.0	0.0	0.0	0.0	0.0
WSW	1.6	0.0	0.0	0.0	0.0	0.0
W	1.8	0.1	0.0	0.0	0.0	0.0
WNW	2.9	0.2	0.0	0.0	0.0	0.0
NW	3.9	0.4	0.0	0.0	0.0	0.0
NNW	3.0	0.1	0.0	0.0	0.0	0.0
CALM	73.5					

TABLE III-16

Relative Wind Direction and H₂S Levels
(as a percent of time)

Wind Direction	H ₂ S Levels (parts per billion)			
	10	10-30	30	Total
N	2.0	0.0	0.0	2.0
NNE	2.5	0.0	0.0	2.5
NE	3.0	0.0	0.0	3.0
ENE	1.6	0.0	0.0	1.6
E	0.7	0.0	0.0	0.7
ESE	0.3	0.0	0.0	0.3
SE	0.0	0.0	0.0	0.0
SSE	0.0	0.0	0.0	0.0
S	0.0	0.0	0.0	0.0
SSW	0.1	0.0	0.0	0.1
SW	1.9	0.2	0.0	2.1
WSW	1.4	0.2	0.0	1.6
W	1.7	0.1	0.0	1.9
NNW	3.1	0.1	0.0	3.2
NW	4.1	0.2	0.0	4.2
NNW	3.0	0.1	0.0	3.1
CALM	65.8	7.6	0.3	73.7

Radon (Rn)

General findings regarding emission and presence of radon-222, radium-226, and lead-210 from The Geysers and surrounding environs have been issued in a report by LFE, Environmental Analysis Laboratories (LFE, 1977). The findings are summarized below:

- o Emission sources at The Geysers contain concentrations of radon-222 above average ambient air concentration. Most of the radon-222 passes through steam pipelines into power plants, and out off-gas ejectors. Free venting wells and particle separators constitute other sources of emissions.
- o Some occupiable areas at The Geysers show concentrations of radon-222 above average environmental levels, but not outside the range of permissible environmental levels. All measured values, except in infrequently encountered off-gas ejector plumes, were below 3 pCi/liter, the California Department of Health Services ambient air standard for radon-222 in uncontrolled areas.
- o Population areas around The Geysers were found to have no more than average ambient environmental concentrations of radon-222.
- o Near-site environment and population areas near The Geysers did not show any sign of accumulating radium-226 and/or lead-210 in soil, vegetation, or water.

HEALTH AND SAFETYPUBLIC HEALTHPollutants with Potential Health Effects

Geothermal power plants release to the atmosphere many pollutants which, when inhaled or ingested in sufficient quantities, can adversely impact human health. These pollutants include: (1) regulated pollutants, such as hydrogen sulfide, particulate matter, sulfur dioxide, sulfates, and radon-222; (2) unregulated pollutants, such as ammonia, mercury, arsenic, and boron. Additional pollutants are produced by the hydrogen sulfide abatement system(s), including vanadium, anthraquinone disulfonic acid (ADA), and particulate matter.

Atmospheric transport of power plant emissions can result in increased pollutant concentrations in ambient air in nearby populated areas. The potential for adverse impacts to public health is dependent upon the following factors: (1) pollutant emission rates and atmospheric transport, (2) background pollutant concentrations at the time the proposed plant is in operation, and (3) the potential population at risk and the health implications of exposure to the pollutants.

One of the areas of greatest uncertainty regarding the potential for public health impacts from geothermal development concerns background concentrations of pollutants, particularly the unregulated pollutants, in populated areas near The Geysers. With the exception of hydrogen sulfide and a few other regulated pollutants, there has been very little monitoring of existing air pollutant levels in the vicinity of The Geysers. Available monitoring results are often based on limited duration sampling which was conducted several years before major geothermal development occurred.

In the absence of more recent and complete data, the descriptions below provide an estimate of the potential for adverse impacts.

Radon-222: Concentrations of radon-222 in the atmosphere at The Geysers were measured by Lawrence Livermore Laboratory for PG&E during 1975-1977 when 11 geothermal power plant units were in operation. The highest recorded radon-222 concentrations in air were 0.5 pico Curies* per liter (pCi/l) at Geysers Units 1-2 and 1.4 pCi/l at Sawmill Flat (SRI-7) (See Figure III-11). These values are below the California Department of Health Services ambient air standard of 3 pCi/l for radon-222 in uncontrolled areas.

Mercury: Two studies of ambient concentrations in air within The Geysers KGRA report levels from less than 0.001 $\mu\text{g}/\text{m}^3$ to 0.018 $\mu\text{g}/\text{m}^3$ (Robertson, 1977), and up to 0.400 $\mu\text{g}/\text{m}^3$ (Jepson, 1973).

Arsenic: PG&E reports that arsenic concentrations in ambient air at Geysers Unit 11 ranged from less than 0.01 $\mu\text{g}/\text{m}^3$ to 0.044 $\mu\text{g}/\text{m}^3$ (PG&E, 1979a).

Boron: There is no information available regarding ambient boron concentrations in air in the vicinity of The Geysers KGRA.

Ammonia: Periodic ammonia monitoring during 1976 and 1977 at a number of locations in The Geysers KGRA reported one-hour average ammonia concentrations ranging from 0 to 0.263 ppm (CDWR, 1978).

Background concentrations of pollutants that are regulated under air quality standards are discussed in the section on Air Quality. The impact of the proposed project on ambient pollutant concentrations and the resultant potential for public health impacts are discussed in Chapter IV. Appendix F contains descriptions of health effects from exposure to pollutants of concern.

Potentially Sensitive Human Populations

PG&E reports that in January 1977, there were 3,737 residents within 10 miles of Cobb Mountain (PG&E, 1978). This includes residents of communities near the proposed site (see Figure III-11). The five human receptor sites nearest the proposed plant site are shown in Figure III-14.

*pico Curie - 10^{-12} Curie. A Curie is a unit of radioactivity.

Different segments of the human population are affected to varying degrees by exposure to air pollutants. Individuals who are generally most sensitive include the elderly, the very young and individuals already stressed by other health problems. From age distribution data provided by PGandE (PGandE, 1978b) it can be inferred that approximately 22 percent of the population residing within 10 miles of Cobb Mountain could be classified as "pollutant-sensitive" due to age.

Other individuals who may be more sensitive than the general population to hydrogen sulfide and other air pollutants are often concentrated in particular types of facilities like schools. A number of such facilities are located within six miles of the proposed project site: two convalescent homes, a hospital, a school and a children's camp.

At this time there have been no reported studies which describe existing public health in the vicinity of The Geysers. Some residents of Lake County have reported health effects attributed to the emissions from geothermal operations (Grew, 1978).

SAFETY CONSIDERATIONS

Two groups of people would be concerned about safety features of the proposed project. Workers involved in the construction and operation of the power plant and related facilities may potentially be affected by toxic gases and other toxic and/or carcinogenic substances from normal and accidental releases of pollutants.

In addition, people living along roads providing access to the proposed project area could potentially be affected by an accidental release of toxic and/or carcinogenic substances being transported to or from the project site.

NOISE

Potentially Sensitive Receptors

The proposed project site is located about 2 1/2 miles from the community of Anderson Springs and there are four other potentially sensitive noise receptors located within a three-mile radius from the plant site. These five receptor sites are shown in Figure III-14 and are briefly described here. Also included are the distance and the direction of these receptors from the proposed site.

- o Verdant Vales Camp (6500 feet, 007° North)--This receptor consists of a number of residential structures which are occupied year-round. It is used as a children's camp during the summer and a private school from September through June.
- o Anderson Springs (9000 feet, 031° North-Northeast)--A small residential community of approximately 200 residences. About 25 percent are permanently occupied homes and the remainder are occupied primarily on week-ends and during vacation periods.

LOCATIONS OF NOISE RECEPTOR SITES IN VICINITY
OF PROPOSED NCPA NO. 2 GEOTHERMAL POWER PLANT

Figure III-14

- o Peterson Ranch (14,000 feet, 113° East-Southeast)--This ranch includes the closest, permanently occupied dwelling in the Dry Creek watershed, about 2.7 miles from the proposed plant site.
- o Pine Flat (11,400 feet, 240° Southwest)--There are a number of scattered residences in this area. Some are used primarily as vacation and weekend retreats, but others are occupied year-round.
- o Contact Mine (14,000 feet, 281° West-Northwest)--A residence at the location of the old Contact Mine is apparently occupied on a regular basis.

Current Ambient Noise Levels

Since 1973, ambient noise levels have been measured at a number of locations in Lake County adjacent to the project area. These locations are shown on Figure III-15. Data from many of these studies of ambient noise levels have been previously published in environmental documents prepared for geothermal facilities already in operation, under construction or proposed by PGandE (PGandE, 1975a, 1975b, 1977a, 1977b).

Noise measurements are taken with a sensitive sound level meter and are generally recorded in decibel (dB) units. Noise measurements are most often shown as "A-weighted" or expressed as dBA. This indicates that the readings have been made from an A-scale of the meter which most approximates the response of the human ear. An average person's hearing ability ranges from just barely audible (10-15 dBA) through 140-150+dBA, when sounds become painfully loud. A soft whisper at 15 feet registers about 30 dBA, and freeway traffic at 50 feet registers between 70 and 75 dBA.

The A-weighted sound levels shown in Table III-17 indicate the ambient sound pressure levels measured at the locations shown in Figure III-15. These A-weighted sound levels range from 20 to 55 dBA. Where recorded sound levels are 45 dBA and above, there were either creek noises or audible geothermal steam releases included in ambient sounds.

Measurements at sites more remote from residential areas and geothermal developments sometimes yielded sound levels between 25 and 35 dBA. It is important to note that these data represent ambient noise conditions in periods of relative quiet when natural sounds such as wind, running water, and wildlife are dominant. Noise from human activities and machines intrudes at random times and would raise these measured levels somewhat.

Ambient noise level measurements have been made within and adjacent to the community of Anderson Springs because it is a populated area close to the proposed plant site. The measurement locations were selected randomly so that the sound levels obtained would be representative of existing ambient sounds. Sound levels measured in Anderson Springs (Table III-17; locations 1, 2, 3 and 5) varied from 37 to 55 dBA. The high of 55 dBA was caused by water flowing in the nearby creek. On several occasions distant stream noises were observed; however, these sounds are low in amplitude and not easily discernible. The character of geothermal steam well noise was audible as a low frequency rumble of varying amplitude.

The one sound level sample available from the vicinity of the Verdant Vales Camp registered 33 dBA (Leq) which is slightly lower than that at Anderson Springs. No samples of ambient sound are available for the proposed site or the immediate steam supply field. Current standards for noise are presented and discussed in Chapter IV.

AMBIENT NOISE MEASUREMENT LOCATIONS IN VICINITY OF
PROPOSED NCPA NO. 2 GEOTHERMAL POWER PLANT

Figure III-15

CULTURAL RESOURCES

As used in this document, the term "cultural resources" encompasses four major categories of resources:

- a. Paleontological Resources - fossilized evidence of prehistoric plants and animals.
- b. Archaeological Resources - relics, sites, artifacts, trails, and other evidence of prehistoric peoples and cultures.
- c. Historic Resources - sites, structures, artifacts, routes and other evidence of peoples and cultures, dating forward from the time of written history which, in the Western hemisphere, is considered to coincide with European arrival in individual locales.
- d. Other resources of educational, scientific, religious or cultural significance which have been identified through ethnographic research.

To provide a historical context for the cultural resources discussion, staff has summarized ethnographic and historical information from a number of environmental documents, studies and references prepared for geothermal developments in and around the proposed project area. Documents cited are listed in the Bibliography.

ETHNOGRAPHIC CONTEXT

Prior to European contact, the project area was inhabited and politically controlled by speakers of the Wappo language. These people are also referred to as the "Russian River," "Geyserville" or "Alexander Valley Wappo" (Sawyer, 1978; Patterson, 1978). The Wappo were a culturally distinct group which controlled the Mayacmas Mountains as far north as The Geysers and Cobb Mountain and the Napa Valley as far south as the northern limits of the present day city of Napa. They lived in the Geyserville area of the Russian River and may have had as many as seven villages, with a combined population of 1500. (Kroeber, 1925; Sawyer, 1978)

Generally, the Wappo family consisted of a small extended kinship group. These extended family households constituted the village which was the main socio-political unit. (Peri, et al; 1978) Wappo settlements were of two types: permanent winter towns and summer camp sites. The largest of the settlements were the winter towns, generally located near large creeks or near the Russian River, above the flood plain.

During dry weather the winter villages were temporarily abandoned as the Wappo dispersed into smaller family-units and scattered over a large area to gather localized resources. (Driver, 1936) Between late spring and the fall acorn harvest, small groups may have moved through the project area, establishing temporary camps for hunting deer and small mammals and for collecting various food plants. (Peri, et al; 1978)

HISTORICAL CONTEXT

The historical period for the North Coast Ranges began quite late following the arrival of European explorers and settlers. The Mission San Francisco de Solano, located in the City of Sonoma, was established in 1823. After 1840, the fertile lands at lower elevations were quickly settled. Lower lands near the project area were not inhabited until the 1870s by families engaged in farming. (Atlantis Scientific, 1976)

Cinnabar (mercury ore) was first discovered in the eastern portion of the Mayacmas Mountains in the early 1860s. A number of mines were developed and extensively worked during the late 1800s. Mining continued intermittently up through the 1930s (Ecoview, 1974i). Development of the geothermal resources for power generation began in the late 1950s and continues to increase.

The hot springs in several locations in The Geysers area were attractive to area settlers and many were developed into resorts during the latter part of the 1800s. The hot mineral springs at Anderson Springs were developed in 1873 and the resort remained popular up through the 1930s when there was a decline of interest in mineral waters. The area remained attractive to urban area residents for second, recreation homes and for retirement homes. Many of the resort areas are experiencing a resurgence of attraction and use and the resident population, especially of Lake County, is growing very rapidly (Ecoview, 1974).

CULTURAL RESOURCE INVESTIGATIONS

As the manager of public lands, the United States Bureau of Land Management (BLM) is required by the National Historic Preservation Act (NHPA) to identify all historical and archeological resources of cultural importance on lands under its jurisdiction. Sites with resources identified as "important to man's knowledge of himself and appreciation of life on earth" are nominated for inclusion in the National Register of Historic Places. To comply with NHPA regulations, BLM directed that a series of field surveys be conducted for the proposed project area.

Studies of literature and records concerning the project area, interviews, and extensive field surveys were conducted by members of the Anthropology Laboratory at Sonoma State University under the direction of Dr. David A. Frederickson, an acknowledged authority on cultural resources in The Geysers KGRA. The archeological survey and analysis met the requirements established by the National Historic Preservation Act of 1966 and regulations found in 36 CFR Parts 60, 63 and 800. The investigation also met the standards set by the Society for California Archeology, 1976.

Paleontological Resources

The rock units within the project study area which are most likely to contain recoverable and identifiable fossil materials are:

- o Chert, which may contain radiolarian micro-fossil remains.

- o Massive and bedded graywacke, which often includes lenses of radiolarian chert-bearing conglomerate (designated fs2 by McLaughlin on geologic maps; refer to Figure III-3).
- o Undifferentiated melange units likely to contain any of the above (designated fsr by McLaughlin).

The predominant rock type in the study area is medium-grained lithic graywacke and there is a distinctively low ratio of rock outcrops to total surface area. Each potentially fossiliferous rock unit or outcrop in the study area was intensively studied in the field.

During the field survey, a single microfossil (radiolarian) locality was discovered within the proposed transmission route. Its general location is approximately 100 feet to the east of Well Pad F and 50 feet north of proposed Transmission Tower #4. Based upon categories of significance established during previous paleontological studies in The Geysers KGRA, Dr. Frederickson rated the location of this microfossil as "B--new localities containing identifiable fossils, but which otherwise duplicate information already discovered in other localities having greater significance." (Frederickson, 1978c) No other paleontological resources were found during these investigations.

Archaeological Resources

Following the records and literature search, the investigators conducted an intensive, on-foot survey of the study area. Due to the dense chaparral cover, the rugged terrain, and the presence of slopes in excess of a 60 percent gradient, the investigators were unable to survey some portions of the study area. However, the proposed project is located in a portion of The Geysers KGRA in which few archeological resources have been found and the investigators found a general lack of archeological resources even in the more accessible areas.

The field investigators found no archaeological sites within the sites proposed for the NCPA No. 2 development. However, they did find occasional scattered archaeological specimens (e.g., obsidian artifacts and chippage) which lacked archaeological context and which attest to the use of this region by the Native American population.

The investigators also found a single archeological site within Shell's Leasehold #CA-950, several hundred yards west-northwest of the proposed power plant site. This resource site is approximately 40 meters square and contains evidence of decomposing organic material, hand-worked stones, and quartz crystals which are believed to have had religious significance to the Wappo. A copy of the site record form was filed with the State Historic Preservation Office in Sacramento and with the United States Bureau of Land Management in Ukiah. The site has since been designated as CA-SON-843 by the State Historic Preservation Office.

According to Dr. Frederickson, site CA-SON-843 "...is of particular interest for two reasons. First, the crystals (Lake County diamonds) occur on the surface, and it is unknown at this time as to whether they occur naturally or are part of a cultural deposit. Second, the site is in a hinter-land location where site density is as low as one site per every two thousand acres. Determination of

the function of the site in such a context would be particularly useful in understanding the prehistoric land use patterns. At the present time we have no data regarding the probable dating of the site." (Frederickson, personal communication to CEC, June 28, 1979).

Historical Resources

The investigators who reviewed field notes from earlier archaeological surveys and interviewed persons knowledgeable about historic uses of the area believe that no significant historic sites were likely to be present within the study area. During subsequent field surveys no historic properties were found within the project area.

Other Cultural Resources

On one of the field visits Wappo tribal scholar Laura Somersal joined the study team to help identify sacred or culturally significant sites in the study area. Mrs. Somersal stated that this general area, especially the bed of Big Sulphur Creek, would have provided good summer camp sites for gathering a variety of plant and animal resources. However, no specific campsite was found during the survey and no sites of religious, ceremonial, or other significance to contemporary Native Americans were found in the study area.

SOCIOECONOMICS

Socioeconomics includes a broad range of concerns related to the people, communities, services, land uses and governmental jurisdictions which could be affected by the construction, operation and/or maintenance of the proposed project.

SOCIAL AND ECONOMIC CHARACTERISTICS

The project area lies in a relatively isolated, mountainous portion of Sonoma and Lake Counties. The ridge of Mayacmas Mountains forms the boundary between the two counties.

Sonoma County

The population of Sonoma County has been growing rapidly at an average annual rate of 3.7 percent during the years 1960-75 and is expected, during the next 25 years to continue to grow at a 2.8 percent annual rate (Ecoview, 1976i). Growth has occurred principally through migration to urban areas and the fastest

growing urban center is Santa Rosa, located 22 miles southwest of the proposed site (Ecoview, 1976i). The population of Sonoma County in 1975 was 245,320 (special census, California Department of Finance) and is now estimated at 274,300 (California Department of Finance, Population Research Unit, personal communication, 1979).

Sonoma County's economy is relatively evenly diversified with major activity in services, agricultural and agricultural processing, trade, and forestry products (Ecoview, 1976i). Development of geothermal resources for electrical power generation has primarily occurred in the Sonoma County portion of The Geysers KGRA and has become an increasingly important component of the county's economic base.

Lake County

Based upon estimates of the current number of residents, Lake County population has nearly tripled in the last 30 years. As summarized in Table III-18, the average annual growth rate has risen sharply since 1950. The estimated 1978 population was 30,000 and the growth rate was estimated to be 4.5 percent annually.

TABLE III-18
Population Growth in Lake County

<u>Year</u>	<u>Population</u>	<u>% Increase</u>	<u>Average Annual Increase</u>
1950	11,480 ¹	--	--
1960	13,786 ¹	20.1%	2.0%
1970	19,700 ²	42.9%	4.3%
1976	26,500 ³	34.5%	6.9%
1978	30,000 ⁴	13.2%	6.6%
1979 (est.)	33,000 ⁴	10.0%	--

1. PGandE, Environmental Data Statement, Geysers Unit 13, 1975b.
2. PGandE, Environmental Data Statement, Geysers Unit 14 & 15, 1975a.
3. Ecoview, EIR for Shell Lease #CA-949, Well Sites M, P&Q, 1978.
4. California Department of Finance, Population Research Unit, 1977.
5. California Department of Finance, PRU, 1979, personal communication.

The proportion of Lake County residents over 65 years of age has been steadily increasing. In 1940 only 12 percent of the inhabitants were 65 or over (Ecoview, 1976h); by the 1970 U.S. Census, 24.3 percent were 65 or over. The recent, rapid rate of growth in the county may tend to reduce this percentage.

The population of Lake County is also subject to dramatic seasonal fluctuations during the summer months, when there may be as many as 100,000 additional people in residence (Ecoview, 1978a). This seasonal influx is due to recreational visitors, use of second or summer homes, and opportunity for employment in agricultural harvesting or processing.

Lake County remains quite rural in atmosphere and the economy is based essentially upon three sectors: agricultural; recreation and tourism; and

governmental transfer payments, such as Social Security, Unemployment Compensation, and Aid to Families with Dependent Children. Tourism associated with general outdoor recreation and transfer payments are presently the most important economic sectors (Gennis, 1978a).

Development of geothermal resources has greatly intensified in recent years and Lake County has now begun to experience an increase in industrial development as the exploration of the KGRA and proof of the geothermal resource have moved eastward. Continued geothermal development may grow to become a significant component of Lake County's economic base.

Employment Data

The resident construction labor force in Sonoma and Lake Counties will have reached approximately 6,000 when construction on the proposed project is scheduled to begin in early 1980 (EDD, 1979). Worker skills needed for construction of a geothermal power plant and electrical transmission facilities include: pipefitters, welders, electricians, iron workers, carpenters, equipment operators, concrete workers and finishers, teamsters and laborers, other manual labor skills and supervisory and quality control inspection personnel. The total labor force in Sonoma and Lake Counties will be in excess of 100,000 in 1980. (NCPA, 1978b)

The majority of EIR's previously prepared for various geothermal developments in The Geysers KGRA have consistently stated that there is a relatively constant pool of geothermal workers, most of whom reside in Sonoma County. Specific data on the workers' skills, number, and location and duration of residence are nearly impossible to confirm since United States Census data are very much out of date, employment records are generally keyed to the home office of the employer, and much of the information is considered proprietary by geothermal developers.

LAND USE

Except for Shell's exploratory drilling facilities, the project area is essentially undeveloped woodland and chaparral, with multiple land use values. These uses include watershed, open space, wildlife habitat, outdoor recreation and development of geothermal resources. With the increase in geothermal resource development, lands in The Geysers area are undergoing a transition from woodland/chaparral to scattered industrial development. Lands bordering the Shell leasehold project area are also under lease for geothermal development.

Little recreational activity has occurred in the project area. Easy access for the general public was lacking prior to the recent construction of steamfield development roads. As the lands have been leased and developed, public access in some areas has been restricted and recreational uses such as hunting, sight-seeing, or rock hounding have been curtailed. The area has also been intermittently logged and grazed, but the preponderance of mature brush and chaparral presently make the area unsuitable for intensive logging or grazing. There are no residences or other occupied structures within the project area (Ecoview, 1978a).

Land use designations for the project area have been established by local and federal agencies. After analysis of geologic features and evaluation of the resource potential, the U.S. Geological Survey has classified the lands

in The Geysers-Calistoga area as a "Known Geothermal Resource Area" (see Figure I-1). Surface management of public lands in the KGRA is administered by the U.S. BLM. Although a portion of the project area lies within the Pine Mountain Recreation Area, the BLM has issued leases and specified that geothermal development is the primary use of the project area.

The Sonoma County portion of the project area has been designated by the county as Primary Geothermal Resource Area. The Sonoma County General Plan Map (1975) indicates that the project area is zoned for "Agriculture" which also allows for geothermal development through issuance of a permit.

The Lake County portion of the project area has been designated as suitable for geothermal development on the Resources Conservation map of the county's Open Space and Conservation Element of the General Plan (1968). The Land Use Map of the Lake County General Plan indicates the project area is designated as "Extensive Agriculture" (which includes geothermal development) but is zoned "Unclassified". This is also true of most other geothermal development in Lake County.

Proposed development of unclassified lands is subject to review and permitting by the county on a case-by-case basis. According to the Lake County Zoning Ordinance No. 645, §4.1.2, geothermal development is permitted in any zone with a use permit issued by the County.

In May, 1979, Lake County was notified by the State Attorney General's Office and the Governor's Office of Planning and Research that its General Plan is legally deficient and must be updated. Portions of the Plan specifically identified as deficient were the Land Use, Housing, Open Space, and Conservation Elements. There is also concern about the large portions of the county remaining in the "unclassified" zoning designation. A citizens' advisory committee was appointed by the county to assist in preparing policies for updating the General Plan, but no date has been set for the adoption of a revised General Plan. In addition, Lake County is currently revising its Geothermal Regulations which are expected to be adopted sometime in 1979.

PUBLIC SERVICES

Current, and relatively thorough, discussions of existing Lake County public services are presented in the EIR for Shell Well Pads M, P, and Q, prepared for Lake County by Ecoview Environmental Consultants and in the EIR for Aminoil USA, Incorporated's "East Ford Flat Geothermal Exploration Project", prepared for Lake County by Gennis & Associates, Engineers. Below is a summary of the information contained in these documents.

Education

The Middletown Unified School District serves the project area and in recent years has shown a disproportionately higher increase in annual enrollments than other districts in the county. Due to a number of state legislative actions, there has been a simultaneous decrease in revenues during this same time period (Gennis, 1978a).

Protective and Emergency Services

Police protection for the project area is provided by the County Sheriff's Offices. Mobile units from Lake County would be dispatched either from the Lower Lake Substation or from Lakeport. Mobile units from Sonoma County would be redirected from the nearest field unit in that beat (Ecoview, 1978c).

Fire protection for the project area is provided by the California Division of Forestry from stations in Mt. Saint Helena, Kelseyville, Boggs Mountain/Hobergs and Middletown. Additional fire fighting support is provided by local fire protection districts maintained by volunteer members at Middletown and Cobb.

Should the need for emergency medical services arise, the nearest hospitals are Redbud Hospital in Clear Lake Highlands and Lakeview Hospital in Lakeport. A helicopter unit is available from the Boggs Mountain Heliport in Lake County during the summer fire season and year-round from the Sonoma County Airport in Santa Rosa. Helicopter response time to the project area is about 15 minutes to a maximum of one-half hour (Sonoma County Sheriff's Office, personal communication, October 1979). Rescue and first aid services are also provided by the County Sheriff's Departments and local fire districts (Ecoview, 1975k).

Utility Services

The project area is located within the PGandE service area for electricity. No natural gas is available, but bottled gas is available to individual consumers. There is no public or private water distribution system in the project area. Due to the ridge-top location and underlying rock structure, little or no groundwater is available at the plant site. Water is available from local wells, springs and/or creeks and may be trucked to the site to meet project needs.

Waste Disposal Facilities

No public sewage facilities exist within the project area or within nearby communities. Due to low population density, no community sewage disposal facilities are anticipated or planned. Two commercial solid waste disposal sites are located in southern Lake County, one near Kelseyville (17 miles northeast), and the other near Middletown (6 miles east). Both sites are rated as Class II-1 and are approved for disposal of geothermal wastes.

TRANSPORTATION

Access

Primary access to the project area from Lake County is by way of State Highway 175 northward to the Socrates Mine Road (see Figures I-2 and I-1). The initial portion of the Socrates Mine Road is paved, but the major portion remains unpaved. Most of the roads within the KGRA are developed and maintained by the various geothermal lessees and are used primarily by geothermal operators, employees, related contractors and visitors. A ridge road which intersects the Socrates Mine Road near the PGandE Geysers Unit 13 in the Castle Rock Springs area provides access to the project area. Additional spur roads connect the ridge road with steam supply well pads and the proposed transmission tower pads.

From Sonoma County, access to the project area is provided by State Highway 128 and The Geysers Road. A series of unpaved, privately maintained roads intersect with the ridge road to the project area. Additional spur roads provide connections with proposed transmission tower pads.

Traffic Levels

CalTrans traffic data (1978) indicate that the annual average daily traffic on Highway 175, between Middletown and Cobb is between 1,000 and 1,600. During the peak month the average daily traffic ranged between 2,000 and 3,000. Current peak hour volume ranges between 150 and 240 (CalTrans, 1979a). CalTrans has no plans to increase capacity or level of service on this section of Route 175 (Ecoview, 1978a; CalTrans, 1979b).

Project-related traffic will include construction and operation personnel, water trucks, construction equipment, over-sized load transports and materials transporters. The number and frequency of trips to and from the project site will depend upon the stage of project development, the size of the workforce needed, and the number of persons per vehicle per trip.

During the three-month site clearance and preparation period there could be as many as 30 round trips per day for personnel and about 10 round trips per day for water delivery. During the 3-month peak construction period, as many as 85 two-way trips could occur if each worker travelled separately. Throughout the construction period there will be occasional movement of heavy earthmoving equipment and an average of 3 or 4 loads of construction materials per day (NCPA, 1979d). During operation of the proposed project, personnel traffic would drop to about 8 to 10 round trips per day plus an average of 3 or 4 trips per week for removal of wastes (NCPA, 1978b; 1979d).

AESTHETICS

General Area Description

Visual characteristics and quality of the proposed project area were evaluated by staff of the BLM, Ukiah Office. The topography in the project area is characterized by steep, rugged hills with sharply defined drainage patterns. Although the topography is broken, the landform patterns are repetitive throughout the area and the overall scene is not one of high visual variety or interest.

The vegetative cover of chaparral, with interspersed patches of hardwoods and hardwood/conifer mixtures on lower slopes, is comparatively uniform throughout the area. The existing roads, well pads, jeep trails and past mining activities have created a network of disturbances on the surrounding terrain. There is evidence that past wildfires have also helped to alter the natural landscape.

The proposed power plant would be situated adjacent to an existing well pad, on a road where a small spur ridge joins the main divide of the Mayacmas Mountains. Refer to Figures III-16 & i-1 for photographic views of the proposed plant site. The plant site lies below the the main ridge of the Mayacmas, away from the settled areas of Lake County. Refer to Figure III-17 for a photographic view of the ridge from the Middletown area and from the Collayomi Valley in Lake County.

PROBABLE TRANSMISSION LINE RIGHT OF WAY
LOOKING NORTHWEST TOWARDS THE PROPOSED PLANT SITE
AND DOWN THE BIG SULPHUR CREEK VALLEY

MIDDLETOWN AREA

LOOKING WEST ACROSS THE COLLAYOMI VALLEY AND MIDDLETOWN
TOWARDS COBB MOUNTAIN AND THE MAYACMAS CREST BY THE
PROPOSED PLANT SITE (TAKEN AT 1300' ELEVATION)

Figure III-17

The topography and vegetative cover along the proposed transmission route are also similar to that at the proposed plant site; however, vegetation near Tower Site #5 includes tall trees rather than low-growing chaparral, and there is a serpentine barren area near the site of Tower #2.

The proposed route runs along the side of the spur ridges and crosses the upper reaches of the Big Sulphur Creek drainage before tapping into the existing 230 kV line. Refer to Figures III-16 & i-1 for views of the topography in the vicinity of the proposed plant site and the initial portion of the transmission route.

The proposed transmission route would parallel existing well access roads, up to Well Pad F. Between Towers #4 and #5, the transmission line would span Big Sulphur Creek and then run up along the side of the ridge toward Well Pad I. The route then would run along the side of the ridges between Well Pads I and G, relatively parallel to existing access roads.

ENERGY AND MATERIAL RESOURCES

Energy Resources

The heat source for The Geysers area occurs as a body of at least partially molten magma at a depth of 10 kilometers (6 miles) or more below the Clear Lake region. Fractured, relatively permeable, graywacke sandstone forms the subsurface reservoir for the geothermal water and steam. This reservoir rock is overlain by a relatively impermeable shaly melange, and serpentinite which caps the reservoir and inhibits both rapid circulation of cold water descending from the ground surface and rising hot geothermal fluids (McLaughlin, 1977).

Figure III-18 shows a cross-section through The Geysers-Clear Lake Region depicting structural elements of that geothermal system. As shown in this figure, the underlying body of magma provides the heat source to super-heat water and create a steam reservoir beneath the earth's surface. In effect, a boiler situation is created and maintained. It is not known whether the many steam reservoirs are independent or interconnected, and if so, to what extent. However, if the water recharge rate is less than the steam depletion rate, the "boiler" will lose pressure and eventually drop below that required to drive the turbines in the power plants.

Fig. III-18: **CROSS SECTION THROUGH THE GEYSERS—CLEAR LAKE REGION**

	Impermeable cap rocks
(Serpentine, greenstone,
melange, metagraywacke)		Partially crystallized magma body
inferred to be at depth with
center below 6 miles
	Fracture networks in graywacke
reservoir rocks		Water vapor in steam reservoir
above boiling water table
	Clear Lake Volcanics and associated
vents providing recharge
to geothermal system		Hot water

Structural model for the Geysers geothermal system. Cross-section through The Geysers-Clear Lake region, from the Maacama fault zone on the southwest, to Mount Knociti on the northeast, depicting structural elements of The Geysers-Clear Lake geothermal system.

Source: "Field-trip Guidebook Castle Steam Field, Great Valley Sequence," April 29, 1978, 53rd Annual Meeting, Pacific Sections AAPG, SEPM, SEG. Modified by the California Energy Commission, February, 1979.

The water recharge rate in The Geysers KGRA is not known. It is apparent that water recharge of the steam reservoirs occurs when steam is withdrawn because vast amounts of steam have already been withdrawn and steam is still being produced. However, reports of pressure readings indicate that there has been a marked pressure loss at shallow zones, and a recognizable pressure loss in the deep zones. Verification of these reports has been hampered because the information is considered proprietary.

Projections of geothermal generating capacity for The Geysers KGRA indicate that an estimated 2,000 MW of dry steam capacity is obtainable by 1990. The 13 geothermal power plants currently operating in The Geysers can produce a total electric capacity of 663 MW. The PGandE Geysers Power Plant Units 13 and 14 (currently under construction) are planned for operation in 1979 or early 1980 and will provide an additional 245 MW of electrical capacity. The proposed PGandE Geysers Units 16 & 17 and the NCPA No. 2 power plants would provide an additional 330 MW of power by 1981, bringing the total installed electric capacity at The Geysers KGRA to 1,128 MW (Hill, et al, 1978).

In addition to the dry steam resource, there is a hot water resource. The hot water sources are generally situated north of the dry steam sources. The technology exists to operate a hot water fueled power plant, but it has not been proven to be commercially feasible at this time. If developed commercially, it is estimated that an additional 2,000-3,000 MW of generating capacity may be attainable. Figure III-19 shows approximate inferred limits of steam or vapor-dominated and hot water-dominated areas.

Material Resources

Materials consumed in the construction and operation of the proposed power plant and related facilities; transmission towers and conductors and related access roads; steam-gathering system and related access roads; and all other facilities associated with this project, include concrete, steel, aluminum, expensive metal alloys and catalysts, wood, and paint. Energy consumed for construction and operation would also include fuels such as gasoline and diesel and electrical energy for lighting and other purposes.

IV IMPACTS & MITIGATION

IV. ENVIRONMENTAL IMPACTS AND MITIGATIONS MEASURES

This chapter identifies and analyzes potential environmental impacts caused by the construction and operation of the proposed NCPA No. 2 Geothermal Project. The discussions in this chapter are considered to apply generally to all components or aspects of the proposed project. Discussions which pertain only to a specific component or aspect of the project will be noted in the text.

The discussion will also include significant avoidable and unavoidable impacts and measures to mitigate or lessen the adverse impacts. Cumulative impacts of the NCPA No. 2 project and other projects in the area are also discussed in general.

As used in this chapter, the verb forms related to discussion of mitigation measures need some definition.

- o Must is used when the NCPA must take an action to comply with applicable federal laws and regulations as a condition of their lease or permit approval presentations.
- o Will is used when NCPA has stated in its NOI or AFC documents or in regulatory proceedings before the California Energy Commission, that they will take an action to reduce or eliminate particular impacts.
- o Should is used when an action is suggested and/or recommended by regulatory agency staff to mitigate particular impacts.
- o Could is used when an action is an optional means of mitigating particular impacts.

EARTH RESOURCES

GEOLOGYRegional Geologic Hazards to Proposed ProjectPotential Seismic Hazards -

The proposed project area is in a seismically active zone, dominated by the San Andreas and associated faults which comprise the San Andreas system. Potential seismic hazards include ground shaking and rupture, differential settlement, and liquefaction.

The occurrence of a major earthquake of magnitude 8.0 (Richter scale) or greater on the San Andreas Fault could produce significant rock accelerations within The Geysers KGRA. A number of other active faults capable of producing strong ground shaking at the proposed site occur within a 50-mile radius. These include the Healdsburg-Rodgers Creek, the Collayomi and Maacama faults. Of these, the Maacama fault, because of its length and proximity to the proposed site, would be the controlling fault for seismic design of the proposed facilities. (NCPA, 1979b)

According to Greenfelder (1974, in NCPA, 1978b), the site lies within a zone of maximum credible bedrock acceleration of 0.3 - 0.6g. Based upon preliminary work by the USGS, there is a 90 percent probability that the horizontal rock acceleration at the site, during a 50-year period, will not exceed 0.2g - 0.6g (NCPA, 1978b).

No active faults traverse the site proposed for the NCPA No. 2 facilities and the potential for ground rupture at the site is considered negligible. Regulatory agency staff considers the potential for differential settlement of site materials as a result of foundation loading negligible, even in the event of seismic activity. However, slight differential settlement of engineered fill may occur.

The potential for liquefaction at the site is low because the soil at and beneath the site is granular in nature and because there is no high water table at the ridge top site.

MITIGATION MEASURES

- o Careful inspection of the foundation areas will be conducted during site grading operations to detect possible soft areas. The foundations for major structures of the proposed project will be placed on dense bedrock.

Geotechnical consultants to NCPA conducted detailed statistical analyses of seismic data for each fault capable of affecting the proposed site to estimate recurrence intervals, Maximum Credible Earthquakes (MCE) and Maximum Probable Earthquakes (MPE). Based upon these analyses and other parameters, they selected four design earthquakes. In addition, the Maximum Probable Bedrock Acceleration (MPBA) and Maximum Credible Bedrock Acceleration (MCBA), both horizontal and vertical, which these earthquakes can be expected to

produce at a level rock outcrop at the project site were determined. They also studied in detail the amplifying effects of the softer materials over the hard rock, using the computer programs SHAKE II and FLUSH which were developed at the University of California, Berkeley.

Using the Maacama fault to determine seismic design values for project facilities, the MPBA peak acceleration for the turbine generator building is 0.35g horizontal and 0.23g vertical, if the structure is founded on hard rock. Seismic design values for the MPBA peak acceleration increase to 0.47g horizontal and 0.26g vertical if this structure is founded on weathered rock overlying hard rock (NCPA, 1979a Appendix A).

- o The proposed facilities will be designed to adequately withstand seismic shaking, particularly such critical structures as the power generation plant and its associated facilities. Additional information related to seismic design of the proposed project can be found in the AFC, Appendix A (NCPA, 1979a) and Responses to CEC Staff Data Requests (NCPA, 1979c).
- o No specific measures are proposed to mitigate effects to the proposed site from ground rupture, differential settlement or liquefaction. The potential for these phenomena affecting the site is considered low or negligible. Mitigation for differential settlement in areas of engineered fill consists of either avoidance of the fill areas during construction, or the use of shear walls anchored to bedrock.

Potential Hazards from Land Subsidence -

Recent work by the USGS indicates significant crustal deformation in The Geysers/Clear Lake Region. Analysis of data from geodetic surveys conducted since 1972-73 indicates both horizontal and vertical ground movement. Movement is abrupt in areas of new production and tends to stabilize within a few months after the beginning of steam production. Changes continue to occur in the area of fluid withdrawal (Lofgren, 1978).

Preliminary evidence suggests right lateral, horizontal movement along northwest-trending fault systems and vertical and horizontal compression of the deep reservoir system. This suggests a direct correlation between ground surface deformation and subsurface pressure changes in the reservoir rock.

USGS analysis of the 1973-77 survey data indicates that both regional and local vertical subsidence occurs, with a maximum of about 5 inches (13 centimeters) in 4-1/2 years, occurring in the area of most concentrated steam withdrawals and where fluid-pressure declines were near maximum. Around the perimeter of the steam production area, horizontal ground movement of as great as 0.8 inches (2.0 centimeters) per year inward, toward the center of production, was measured (Lofgren, 1978).

Microearthquakes may be caused in part by steam withdrawal. Regulatory agency staff anticipates that any impact from steam productions on seismic activity would be minimal. Impacts from microearthquake activity on soil stability in the site area also would be minimal or nonexistent.

MITIGATION MEASURES

Although subsidence is occurring in The Geysers region and is in part correlative with resource withdrawal, localized impacts from such subsidence are not considered environmentally significant. The potential for operational difficulties related to subsidence at the proposed plant site is low because of the varied terrain and underlying rock structure.

- o The presence of continuing subsidence is a significant indicator of hydrodynamic changes in the geothermal steam reservoir. In order to develop mitigation measures to counteract any subsidence induced by steam withdrawal, knowledge of changes in ground surface features is required. A survey network has been established at The Geysers by USGS and monitoring should be continued in order to more fully analyze the geologic consequences of steam withdrawal. Most of the information to date is from relatively short periods of time and longer data periods are needed to fully assess the problem in detail and to project future, long-term effects on the geothermal reservoir.
- o Should monitoring indicate that subsidence poses a hazard to continued operation of the proposed facilities, specific mitigation measures, including shut-down of the plant, will be evaluated. The monitoring will also help to indicate if any corrective action is necessary at all geothermal plants throughout The Geysers KGRA.

Potential Hazards Related to Site DevelopmentSlope Stability -

Although landslides have been mapped in the vicinity of the project site, none are known to exist at the proposed site. Landslides should pose no hazard to site stability. Due to its ridge-top location, landslides triggered by possible earthquake activity are not expected to affect the proposed site.

Construction of the power plant and attendant facilities would require grading and modification of the existing topography at the proposed site. Site development will involve redistribution of about 200,000 cubic yards (153,000 cubic meters) of earth in a series of cuts and fills within an approximate 25 acre (101,000 square meters) area.

Improperly constructed cuts and fills could cause slope failure or landsliding.

MITIGATION MEASURES

- o Construction of cuts and fills to assure slope and foundation stability will be achieved by detailed, preconstruction geotechnical investigations, proper engineering design, and careful inspection to insure stability. Failure of earth materials in areas of cuts and fills is not anticipated to pose a hazard to site stability since most cuts will be made into competent bedrock which exhibits only minor and random fracturing.
- o Cut slopes and keys for fill slopes which encounter seepage and springs during construction should be provided with subsurface drainage for

stability. The subsurface drainage systems should be connected to natural drainage channels and sedimentation basins should be employed to minimize sedimentation in these drainages. Refer to page IV-27 for additional discussion of mitigation measures related to the seep.

- o Where advisable, the top portion of cut slopes should be rounded to eliminate a sharp break between the cut face and the existing vegetation.
- o Fill materials should be placed only in areas deemed to have a satisfactory capacity to support the fill materials without inducing landsliding. If the soils stability analysis indicates that the land cannot accept the bulk of the cut material, alternate disposal areas should be used and only a minimum necessary amount of fill placed adjacent to the unit site.
- o All fill areas should be benched and keyed into undisturbed ground. Embankments should be placed in layers not to exceed eight inches (20 centimeters) in depth, moistened as required, and compacted to a probable minimum 95 percent of maximum density.
- o Stabilization methods should be used, as appropriate, to insure the sub-grade integrity of cuts and fills. Fill slope areas should probably have a maximum gradient of one and one-half to one (1-1/2:1).
- o Design and construction specifications for excavation, grading, drainage and erosion control, slope gradient and foundation stability should meet the requirements of Sonoma County ordinances and the requirements of the current, amended edition of the Uniform Building Code, Chapter 70.

Erosion -

Site development activities could cause increased erosion with subsequent siltation and sediment transport into the drainage basin of Big Sulphur Creek. Refer to page IV- 7 for discussion of erosion impacts.

MITIGATION MEASURES

- o Compacted slope areas should be vegetated immediately upon completion of final slope construction and grading to control or prevent erosion of the soil. Refer to page IV- 8 for full discussion of mitigation measures for erosion.

Expansive Soils -

The soils in the proposed siting area are thin and patchy and overlie bedrock which is only moderately weathered. Expansive soils at the site are limited to localized clay-like fillings in shear zones or minor faults.

MITIGATION MEASURES

- o Any deposits of expansive soils should be avoided or removed if they have any potential for causing damage.

Potential Hazards to Project-Related Facilities

The proposed transmission route, steam gathering line route and related access roads are essentially subject to the same kinds of potential hazards described for the proposed power plant site.

MITIGATION MEASURES

- o No transmission line towers should be located on active, or potentially active, landslide deposits. In any case where these deposits cannot be avoided, NCPA or its contractor(s) will present sufficient data to the USGS Area Geothermal Supervisor, to determine the safety of such transmission tower foundation design.
- o Preparation of road beds for new access roads needed for the proposed project should incorporate stringent design specifications to minimize erosion and siltation in downslope drainage channels.
- o The mitigation measures outlined above for the electrical transmission line shall also apply to construction of the steam gathering system. The steam developer will comply with the measures set forth in the leases and permits issued by federal, state and local governments.

Volcanism -

The Clear Lake area has a slight potential for renewed volcanism (Chesterman, 1971; Alfors, et al in NCPA, 1978b). In the event of renewed volcanic activity, ash could fall at the site, but the potential for volcanic flows at the site is remote.

Since the potential for renewed volcanism is so low, no specific measures are needed to mitigate potential hazards to the project related to deposition of volcanic ash.

Potential Impacts to Other Geologic or Mineral Resources

Cavities -

There are no known cavities or underground mine workings near any of the sites for the proposed facilities.

MITIGATION MEASURES

- o No mitigation measures are proposed.

Mineral Resources -

The Geysers KGRA lies within the Mayacmas mineral district, which is known for its mercury deposits. Several old mercury mines and prospects are scattered throughout the KGRA and in the vicinity of the project site. Although the area has had a long history of production, only minor activity has occurred since the early 1930s. There is no indication of remaining significant mercury or other mineral deposits at the site (NCPA 1978b).

MITIGATION MEASURES

- o Because of the total absence of mine workings in the immediate development area, it is logical to conclude there are no commercial mining, quarrying, or gem resources to be affected. In addition, there are no known fossil collecting localities, geysers, hot springs, fumaroles, caves or other geologic resources in the project area.

Geothermal Reservoir -

Discussion of impacts to the geothermal reservoir begins on page IV-85.

SOILS

Soil Erosion

Whenever the vegetation cover is removed and the soil mantle disturbed, the potential for soil loss increases. The combination of heavy and often intense rainfall, steep slopes, exposure of fragile soil types and phases, with the removal of vegetative cover presents a severe potential for soil erosion in most parts of the project area.

The proposed plant site is comprised of moderately steep slopes which will require cutting and filling to prepare an acceptable construction area. Grading would be done with conventional heavy earth moving equipment that would remove brush, shrubs, trees and all other ground cover in about a 10 acre area. This would increase the potential for soil erosion and possible siltation in the Sulphur Creek Drainage Basin.

The Universal Soil Loss Equation is used to determine acceptable rates of soil loss from erosion. Based upon generally accepted agricultural standards, an acceptable loss is 5 tons or less per acre. Calculations for the proposed Geysers Unit 17 site indicate that soil losses there will increase from a preconstruction rate of 1 ton per acre per year to 20 tons per acre per year during construction (PGandE, 1978a). Since the soils series at the proposed NCPA No. 2 site are similar to those at the Unit 17 site, the potential for erosion at and adjacent to the proposed project site ranges from high to very high.

While the erosion potential of the soils series in the project area is high to very high, the soils are thin (generally less than 30 cm) and overlie bedrock which is only moderately weathered. Therefore, the materials exposed during grading will primarily be hard, moderately weathered rock, which is only slightly susceptible to erosion.

During field inspections of the proposed site, Energy Commission staff observed good establishment of grasses on the road adjacent to the project site. Staff also noted the clay and iron content of the local soils. The B horizon of these soils contained relatively high iron content, as indicated by the soil's brown and red colors.

Bulldozer activity during construction of the proposed plant would tend to have the greatest short-term erosion impacts. Although the greatest amount of

erosion occurs when the soil is exposed, significant erosion at roadside cuts, fills, and culverts may continue indefinitely. Fill areas are much more susceptible to erosion than are cuts on the upslope of the development area.

MITIGATION MEASURES

- o NCPA or its contractor(s) should provide a specific plan prepared by a registered engineer or engineering geologist, to implement erosion control measures during or before preparation of the site begins.

The plan should include a specific schedule for field inspection of work in progress to ensure that mitigation measures are being properly applied throughout construction and operation of the proposed project.

- o Surface grading operations and methods of surface restoration and revegetation will be developed and conducted after consultation with the Ukiah District Office of the U.S. Bureau of Land Management and in accordance with the Geothermal Resources Operations orders of the USGS.
- o Construction grading should be conducted during the dry season to reduce erosion related to seasonal storm run-off. Any existing topsoil removed should be stockpiled and replaced after construction.
- o Existing roads should be used whenever possible for transmission and steam-gathering line construction. Any additional access roads will be constructed to meet minimum standards.
- o Roads and cut and fill areas should be lightly sprinkled during construction operations to keep soil transportation by wind movement to a minimum.
- o Temporary spur roads should be returned to their natural state by removing outside berms and installing water checks at appropriate intervals to disperse and distribute runoff water to the outside of the roadway. Discharge points should be designed to include adequate erosion control and energy dissipation features.
- o Temporary erosion control measures should be used during construction of cut and fill slopes, excavation for foundations and grading operations at the site. These measures will comply with the standard specifications of the State of California and any requirements of the Regional Water Quality Control Board.
- o Temporary erosion control measures should include necessary facilities and appropriate measures to prevent erosion and resulting transport of sediment of silt from disturbed areas into natural or man-made facilities beyond the project limits.
- o Control measures which should be used to reduce erosion of cut and fill slopes of the proposed site include:

Hydroseeding--a popular and effective method of applying seed, mulch and fertilizer in one operation. Each component of the mix is added to a slurry tank containing water. Following a brief mixing period, the slurry is sprayed over the designated area to the desired thickness.

Punched Straw--cereal grain or rice straw is evenly applied over the designated areas at a rate of approximately two tons (1,800 kilograms) per surface acre. The straw is incorporated into the soil of the slope with a studded roller, to a depth of six inches (15 cm). Following incorporation, the area appears tufted and each tuft provides an effective erosion barrier. The area would then be seeded.

Revegetation--done on cut and fill slopes following completion of slopesteppping or punched straw. Both native and nonnative species should be used, based upon adaptability and past experience with revegetation at The Geysers. Refer to page IV-21, for additional discussion of revegetation.

Slope Stepping--Cut slope excavations would provide a stairstep effect on slopes. Each step or bench would provide a nearly level microsite for vegetation to reestablish. In addition, the slope steps would dissipate the velocity of run off water on the benches, thereby reducing the erosion potential.

- o Drainage control facilities should be provided to minimize creation of gullies during seasonal run-off. These facilities may include:
 - 1) A collector ditch located a few yards back from the top of any cut slope;
 - 2) A ditch running parallel to the top-of-the-cut line to intercept the surface water flowing down from higher ground before it reaches cut slope;
 - 3) A surface ditch located at the base of cut slope to intercept runoff; and
 - 4) Berms and gutters constructed at plant grade to intercept surface water and prevent it from spilling down any fill slopes causing surface erosion.
- o All ditches should be connected to an engineered, buried drainage system within the site. Any open drainage systems should be lined to prevent erosion, and if necessary, energy dissipators should be provided. Outfalls should be directed toward natural water courses.
- o Natural drainage crossings should be fitted either with culverts or fordings. Following use, natural drainage ways should be cleared of temporary construction materials.

Soil Compaction

Heavy equipment passing back and forth over the soil surface compacts and physically alters the natural soil profile. Compaction decreases soil porosity and interferes with root penetration and root oxygen supply. Compacted soils do not absorb water as rapidly as noncompacted soils, so run-off is greater and soil moisture is not adequately replenished. Reduced soil moisture favors vegetation which requires drier conditions and vegetation becomes sparse. Decreased permeability and sparser vegetation may lead to increased run-off and erosion. Soils of the Huse, Los Gatos and Josephine series are especially susceptible to soil compaction.

MITIGATION MEASURES

- o Operation of heavy equipment should be controlled to avoid unnecessary compaction of the soils. The periphery of the construction sites should be clearly marked. No equipment should be allowed to go beyond these boundaries unless approved by the project engineer for safety purposes.

Cooling Tower Drift

Emissions from the cooling towers for the geothermal generating plant contain various chemical compounds which may settle out on vegetation and soils in the vicinity of the project site. Continuous operation of the cooling towers may result in a build-up of these compounds on the soil surface.

Deposits from cooling tower drift which may have settled out on vegetation and soil may enter seasonal storm run-off, producing only a miniscule increase in sedimentation in the Big Sulphur Creek drainage.

MITIGATION MEASURES

- o Cooling towers should be designed to minimize the composition and quantity of chemical compounds entering the plume emitted from the towers during power plant operation.

Soils in test plots located in the direction(s) of the prevailing winds in the project area and located at variable distances from the cooling towers should be monitored periodically to determine type and quantity of compounds being deposited. Refer to page IV-19 for additional discussion related to biological effects.

WATER RESOURCES

The potential sources of adverse impacts on water resources stemming from the construction and operation of the proposed plant are: (1) erosion from excavation and fill activities during construction, and potential erosion from sloped surfaces after construction is complete; (2) spills from the hydrogen sulfide (H_2S) abatement process area; (3) spills from the cooling water and condensate systems; (4) storm runoff; (5) plume drift deposition; and (6) disposal of liquid and other wastes. Each of these potential sources is explained below along with proposed mitigation measures. All of the potential adverse impacts on water resources from these sources can be mitigated.

HYDROLOGY

Control of Storm Runoff

During review of the NCPA proposal, CEC and RWQCB staff expressed a concern that hazardous or toxic materials could accumulate on the plant site through the dry season and be washed from the plant site into the retention basin by the first rainfall of the season. From there, the polluted runoff could be discharged (through the rainfall discharge valve) into the tributary that flows to Big Sulphur Creek.

Storm runoff on a typical plant site can be significantly contaminated by plant operations. During normal operations, cooling tower drift (containing boron, mercury, and ammonia), oil drips from machinery and vehicles, residuals from condensate and other chemical spills, particulates settled from the air, and other pollutants are likely to accumulate on the impermeable surface of the plant site. Storm runoff could wash these pollutants from the plant site in sufficient quantities to affect water quality adversely.

NCPA has stated that storm runoff will not be directed to the reinjection surge tank and that its contract with Shell Oil Company does not allow for reinjection of storm runoff. According to NCPA "...it is very unlikely that early rainfall runoff will adversely impact water quality," (NCPA, 1979e, page II-3), because amounts of pollutants in the runoff will be highly diluted and they will be collected in the sedimentation pond where they will settle out and be disposed of.

The absence of a contractual arrangement for reinjection of storm runoff does not make this potential mitigation measure infeasible. Reinjection of storm runoff is a design feature of other recent Geysers plants, including PGandE's Unit 18. The post-release monitoring proposed by NCPA, while useful in itself, is essentially a reporting system and would not allow actual pollution releases to be mitigated.

MITIGATION MEASURES

Staff recommends the following mitigation measures:

- o Early season runoff should be diverted to the reinjection surge tank for eventual reinjection. If necessary, the capacity of the tank and pumps should be increased to handle the additional fluids. NCPA should obtain a contract amendment from Shell to allow injection of storm runoff.

- o Any storm runoff following a prolonged dry period (one month or more) and any storm runoff following any significant spill of contaminants should be diverted to the reinjection surge tank for reinjection.
- o NCPA should notify the North Coast RWQCB of any significant spill of condensate or other contaminants within 24 hours of its occurrence. Within 30 days after such a spill NCPA or its contractor(s) should prepare and file with the RWQCB, the CEC, and USGS a report describing the nature and extent of the spill, its causes, clean up procedures undertaken, and measures to prevent a reoccurrence.

Erosion and Sedimentation From Construction Activities

Existing vegetation on the slopes on each side of the drainage basin breaks the force of falling rain, reducing soil erosion and sediment load in the nearby unnamed tributary and, eventually, in Big Sulphur Creek.

Clearance of vegetation cover and exposure of cut and fill areas during site preparation and development will result in increased soil erosion in newly exposed areas and on the newly created slopes and fills. This potential would be substantially increased if these activities were conducted during the rainy season. Soil erosion will in turn increase the potential for siltation or sedimentation in the tributary and possibly Big Sulphur Creek. During rain runoff, the increase in suspended solids and turbidity and the decrease in dissolved oxygen could adversely affect aquatic plant and animal life along the tributary and creek.

MITIGATION MEASURES

To minimize the possibility of siltation and sedimentation in the surface waters, the following mitigation measures will be taken:

- o NCPA or its contractor(s) will not commence site clearance and earth moving activities until after the 1979-80 rainy season ends. NCPA or its contractor(s) will not schedule earthmoving activities in subsequent rainy seasons or in other rainy periods.
- o The NCPA's proposed construction schedule requires that a sedimentation basin be constructed before any other earth moving activity. The sedimentation barrier and basin will be constructed at the bottom of the drainage channel approximately 200 feet downstream from the toe of the fill-slope. The barrier will consist of an engineered dam not to exceed eight feet in height. The resulting basin will be a permanent structure covering 0.2 to 0.3 acres.
- o The basin will reduce the hydrologic energy of runoff from the plant site and allow suspended solids to settle out. The accumulated sediments in the basin will be removed and disposed of as the basin becomes two-thirds full. The sediment will be evaluated for the presence of toxic or hazardous substances, prior to removal, to determine the necessity for disposal at regulated sites.

- o The ammount of sediment accumulating annually in the sedimentation pond will be reported to both CEC and the North Coast RWQCB. This data will be used to evaluate the effectiveness of NCPA's erosion control plan.
- o The basin will be inspected for sediment levels following each rainstorm. NCPA or its contractor(s) will also monitor the quality of water released from the sedimentation basin into the tributary of Big Sulphur Creek.
- o NCPA or its contractor(s) will lay perforated metal pipe in trenches along the original drainage channel to collect water from the natural seep and other sources. Water from the seep will be redirected to a wildlife watering facility. The outfall of the drainage system will be the sedimentation basin.
- o All disturbed slopes, cuts and fills will be revegetated in order to stabilize soils and minimize siltation. Details of NCPA's revegetation measures are set forth on pages XII-5 to XII-7 of NCPA's Responses to CEC Staff Interrogatories (July 27, 1979). Additional revegetation measures are suggested, beginning on page IV-21.

WATER QUALITY

Containment of Steam Condensate and Cooling Tower Spills

Steam from the wells passes through the turbines and then on to a series of primary and secondary condensers. As the steam cools and condenses, the liquid is circulated through the cooling tower, cooled through evaporation, and then pumped back to the condensers to be used for cooling purposes. Excess condensate is piped to a well for injection into the steam reservoir.

Spills of steam condensate are a water quality concern because the condensate contains harmful chemicals, including, but not limited to, ammonia, boron, arsenic, and mercury. Large spills allowed to reach surface or ground waters can thus have toxic effects on aquatic organisms, change the water's chemical composition, as well as result in erosion and turbidity in receiving waters.

Since 1974, the North Coast Regional Water Quality Control Board has required any actual or potential discharger of wastes or hazardous materials to prepare and file a spill prevention and contingency plan with the Board. The Board has informed NCPA that it will require NCPA to file such a plan in lieu of the imposition of waste discharge requirements. Under the Board's general Order No. 74-151, the spill contingency plan must contain the following:

- a. The kinds of spills that could occur at the site;
- b. The chemical composition, temperature, volume, duration, and any other characteristics of the potential spill material;
- c. A description of potential harmful effects of the spill material;
- d. A description of safeguards which will be used to prevent and deal with spilled material;

- e. Immediate diligent cleanup action; and
- f. A detailed contingency plan containing names of persons to be contacted and procedures to be followed in case a spill occurs;
- g. Procedures should also include a discussion of containment, disposal and possible restoration of impacted areas.

In approving the Notice of Intention for the NCPA Geothermal Project No. 2, the California Energy Commission directed NCPA to submit a proposed spill contingency plan as part of its Application for Certification (AFC), however no such plan has yet been filed. The North Coast RWQCB has recommended that an acceptable plan be submitted as a condition of certification. To ensure that the potential for toxic or hazardous spills is adequately considered in the design, construction, and operation of the project, the Applicant should comply with the following:

- o NCPA or its contractor(s) shall prepare and file with the North Coast RWQCB, the California Energy Commission and USGS its proposed spill contingencies plan in compliance with Order No. 74-151. The plan shall be filed by the commencement of hearings on the JES.

Spills as large as 250,000 gallons (estimated for a 1977 condensate spill at PGandE's Unit 8) have occurred at existing Geysers operations from both cooling water and condensate reinjection systems and from construction activities, well discharge and leaks. Most of these spills were minor and produced no known long-term adverse effects on local waters. However, there is a potential for large spills.

At the NCPA power plant, the condensate flow rate through the cooling towers will be approximately 3.6 million gallons per hour, or 60,000 gallons per minute. The amount of condensate in the system at any one time, however, is probably less than 400,000 gallons, since condensate is recycled through the cooling system several times. Based upon its assumptions regarding spill alarm systems and operator response times, NCPA has indicated that the maximum potential spill that could be expected at its site is 170,000 gallons.

Experience from earlier spills at existing Geysers units indicates that the ability to prevent spill contaminates from reaching surface or ground waters depends on the adequacy of the containment measures around the cooling tower basin and plant site in general.

MITIGATION MEASURES

In the NCPA proposal, the following measures will be taken to prevent accidental spills from reaching surface or ground waters:

- o Spills from the turbine/generator building will be collected in a 2,000 gallon capacity drainage sump and pumped by one of two 120 gpm pumps to a reinjection surge tank and pump pit, from which the condensate will be reinjected into the steam reservoir by Shell.
- o Spills or overflow from the secondary condensate pump pit will be pumped back into the condensate cooling system.

- o Normal overflow from the cooling tower basins (250-700 gpm from each of two basins) will flow directly into the reinjection surge tank for reinjection. The reinjection pump pit will be drained by two 1,400 gpm pumps (one primary, one back-up).

According to drawing AFC-15 (NCPA, 1979b, page III-71) potential spills of up to 170,000 gallons could occur from either cooling tower basin. A spill of that magnitude would exceed the active capacity of the reinjection surge tank (81,000 gallons). To handle this contingency, the following measures will be employed:

- o A spill retention basin (shown as "Diked-Spill Retention Pond" in drawing AFC-15) with a maximum capacity of 451,000 gallons will be constructed around the cooling towers. The basin will be paved with asphalt concrete and have a permeability of 1×10^{-6} cm/sec or less. Retention dikes will be formed principally by raised roads.
- o Because storm runoff will also be collected in the spill retention basin, the diversion valve box will have a rainfall discharge valve which could allow runoff to flow off the site to the sedimentation basin at the toe of the fill. A contaminate discharge valve on the box will allow spilled condensate to flow into the reinjection surge tank for reinjection to the steam reservoir.
- o Within the cooling towers, NCPA or its contractor(s) will install water level indicators with an alarm system which will warn plant operators whenever there is a significant change in the water levels in the basin. Unlike some Geysers units which are controlled from remote central stations, NCPA's plant will always have operating personnel at the site, which will reduce the time needed to locate and correct spill sources.

Spills From H₂S Abatement Processes

NCPA plans on-site storage of the following chemicals for the Stretford process H₂S abatement equipment: (1) alkali (sodium carbonate or sodium hydroxide); (2) sodium ammonium polyvanadate (Vanasol); and (3) anthraquinone disulfonic acid (ADA). NCPA also plans to store hydrogen peroxide and ferric sulfate in the H₂S abatement area if a secondary abatement system is necessary to supplement the Stretford system. All of these chemicals are hazardous or toxic and, if spilled into surface waters, would result in lethal or near lethal effects on aquatic organisms.

MITIGATION MEASURES

To minimize the possibility, the following mitigation measures will be taken:

- o To prevent spills of Stretford process material from reaching the drainage basin, NCPA or its contractor(s) will surround the H₂S abatement process area with an impermeable concrete barrier. (Design details are presented in the AFC Supplement, page III-1.) Spilled chemicals and solutions will drain to a sump where they will be pumped to a chemical storage tank for reuse in the Stretford process, pumped to the reinjection sump, or disposed of off-site at an approved Class II-1 solid waste disposal site.

- o Rainwater entering the Stretford process area will be retained on the plant site then pumped to the cooling tower basin. No waters which accumulate in the abatement area will be allowed to enter surface or ground waters.

Deposition of Cooling Tower Drift

The likely effects of cooling tower drift on water quality in Big Sulphur, Dry and Bear Canyon Creeks is not known at this time. The plume will probably contain trace emissions of ammonia, boron, sulfates, arsenic, mercury and other pollutants, but their likely concentrations cannot be determined at this time because (1) the concentrations in incoming steam cannot be predicted before additional wells are drilled and steam content analyzed, and (2) the chemical composition of steam condensate after it goes through the new surface condensers (part of the cooling and primary H₂S abatement process) cannot be predicted. Additional operating experience at PG&E's Unit 15--the first and only unit using a surface condenser--will provide evidence of pollutant concentrations in cooling tower emissions but, because of differing steam contents, the results may not be readily applicable to the NCPA plant.

Few studies on this question are available. A study conducted for PG&E's Unit 17 (Enriquez, 1978) predicted that drift impacts from Unit 17 on Squaw Creek would be negligible. In Big Sulphur Creek, natural concentration of the same pollutants found in cooling tower plumes may be higher than the plume concentrations from the proposed NCPA No. 2 project. In 1978, Lawrence Livermore Laboratory analyzed the problem in its Geysers - Calistoga KGRA Environmental Overview. The study concluded that cooling tower drift is not presently a significant water quality concern, but that soils and water monitoring should be an ongoing program. These measures are already included as mitigation in this and other sections.

MITIGATION MEASURES

- o NCPA will orient the cooling tower structure parallel to the direction of the prevailing winds at the project site to reduce the amount of emission from the cooling towers.

WASTE MANAGEMENT

Disposal of Construction Wastes

Construction wastes may include excess soil and rock materials, cleared vegetation, miscellaneous debris, oily discharge and residues, and sanitary wastes. The exact quantities and description of each are unknown at this time.

MITIGATION MEASURES

- o Excess earth materials will be incorporated into the series of balanced cuts and fills used to prepare a level site for project development. Cleared vegetation and miscellaneous debris may be disposed of on-site or at an approved disposal site. Wastes which are not hazardous can be transported by unregistered haulers and disposed of in any site which has

been approved by the regional water quality control board and responsible local agencies.

Disposal of Sanitary Wastes

Sanitary wastes at the NCPA site will be of limited volume, but they cannot be disposed of on-site because the slope and soils of the proposed site do not allow for construction of an adequate leachfield disposal system. Therefore, NCPA proposes either to inject this waste into the geothermal reservoir, along with the other operating wastes from the cooling tower basin and air pollution control equipment. If not reinjected, these wastes will be disposed of at an approved disposal site appropriate for sanitary wastes.

Disposal by Underground Injection

Potentially toxic wastes from the geothermal power generation process include: the excess condensate, fluid wastes from air pollution control equipment and water from the cooling tower basin. These wastes have historically been disposed of by reinjection into the steam reservoir through nearby dry or underproductive wells. Tests of the hydrogen sulfide abatement system(s) currently in progress at PGandE's Unit 15 (refer also to discussion on pages IV-41 and V-6) also include an investigation into the toxicity of the wastes produced by the abatement system(s).

Although there have been no studies made to determine the effects of reinjection of any of these geothermal wastes, no adverse effects are anticipated by either RWQCB or CEC staff because the reservoir lies far beneath any groundwater aquifers and is separated from these aquifers by natural barriers (tight and clayey soils) and deep well casings (CEC--SRI study 1977).

The responsible regulatory agencies (Regional Water Quality Control Boards and Department of Health Services) have indicated that reinjection of sanitary liquid wastes back into the steam reservoir is an acceptable practice (Central Valley RWQCB, 1978; Ed Crawford, CVRWQCB, 1979). If reinjected into the steam reservoir, any pathogens in this waste would be killed by the intense heat and pressure of the steam reservoir.

Disposal of Hazardous Wastes

A hazardous waste is one which, because of its quantity, concentration or particular characteristics, may cause severe illness or pose a threat to human health, safety or the environment when improperly stored, disposed of or otherwise managed (Health and Safety Code, Division 20, Chapter 6.5).

The California Department of Health Services considers the solid wastes produced during drilling to develop the geothermal resource, cooling tower sludge and the elemental sulfur produced as a by-product from the Stretford process, as hazardous wastes (DOHS, Batham, 1979). Other hazardous wastes include oils, thinners, and solvents. All such wastes must and will be disposed of at a Class I or Class II-1 disposal site approved for geothermal wastes.

Based upon data provided for Geysers Unit 17 (PG&E, 1979b), the operation of a 110 MW geothermal power plant using a surface condenser and Stretford system for

H₂S abatement can be expected to produce approximately 250 cubic yards of sludge (20 percent solids/80 percent water) every two years. The proposed Stretford system would also produce an undetermined quantity of sulfur and used process solution.

If a secondary H₂S abatement system is required to meet emission standards, an undetermined quantity of sludge would be produced. Wastes from secondary abatement could amount to as much as 80 cubic yards per week of sludge (40 percent solids/60 percent water). (PG&E, 1979b)

MITIGATION MEASURES

- o Limited quantities of potentially toxic or hazardous wastes may be stored on-site for a limited period of time. Storage facilities must be maintained in conformance with regulations of the California Department of Health Services and the regional water quality control boards.
- o Transportation of these wastes is also under regulation by the Department of Health Services, Hazardous Materials Management Section. Hazardous wastes being removed from the site for disposal must be carried by registered haulers who must comply with applicable sections of the California Health and Safety Code and pursuant to DOHS regulations.

The producer of hazardous wastes is responsible for their disposal even after they have been delivered to the hauler. In the event of a spill during handling or transporting of these wastes, protective service agencies, such as the county sheriff, highway patrol, highway department and fire department, generally respond to assist in needed abatement, clean-up or other protective measures. The Department of Health Services and regional water quality control boards may provide consulting services if requested.

- o Hazardous wastes must be disposed of at approved Class II-1 sites, such as Martinez, Middletown or Kelseyville. NCPA or its contractor(s), should determine whether the proposed disposal site(s) has adequate capacity for estimated wastes produced during the lifetime of the proposed project.
- o Elemental sulfur produced as a by-product of the Stretford process is considered hazardous. As such it is subject to the regulations shown above. However, as nearly pure sulfur cake this by-product is also saleable. NCPA or its contractor(s) should explore the feasibility of marketing this "waste", either individually or in conjunction with other geothermal operators.

BIOLOGICAL RESOURCES

PROJECT ACTIVITIES AFFECTING BIOLOGICAL RESOURCES

Construction Impacts

Construction of a geothermal power plant requires clearing and preparation of a pad 5 to 10 acres or more in size for the power plant. These facilities include a turbine building, cooling towers, an area for H_2S abatement equipment and storage of chemicals, and an electrical transmission switchyard. In The Geysers KGRA, because of the hilly terrain, siting pads are frequently cleared on top of a hill, with the cut material being placed on the hillside. The fill slopes result in the burial and disturbance of additional acreage of natural vegetation. Related power plant construction includes development of pads for the transmission tower foundations, clearing of lay-down areas for the lines and pulling equipment, and construction of access roads.

Prior to power plant construction the steam well pads, each occupying between one half acre and five acres, and access roads to the pads have been constructed. Additional vegetation clearing is required for construction of the steam gathering lines and their access roads. Construction of access roads and well pads results in loss of natural vegetation and wildlife habitat and, in addition, the access roads and steam gathering lines cut the remaining habitat into small patches. The increase in access roads has also resulted in erosion, with a corresponding increase in sedimentation and opportunities for increased public access to the area.

The total impacts of an individual project after implementation of feasible mitigation measures are not substantial, but the cumulative impacts of geothermal development in the KGRA are significant and increasing. These cumulative impacts are made no less significant by the fact that substantial portions of the KGRA have, in effect, been dedicated to geothermal development. The proliferation of well pads, access roads, steam gathering lines, transmission lines and power plants is gradually altering the character of The Geysers KGRA from near-wilderness to industrial. No amount of mitigation at individual project sites can alter this basic cumulative impact.

Operation Impacts

Drift from the cooling towers of the existing power plants has been documented as causing damage to and loss of vegetation. The studies of this impact indicate that boron contained in the drift is causing the problem. New towers are being designed to reduce the drift rate. However, there has been an increase in boron levels in the cooling tower water at the existing units which may tend to offset the decrease in drift leaving the towers. There has also been some indication that the moisture from the towers and other chemical emissions, such as H_2S , may have potential to cause adverse effects on the vegetation of the area. Spills of the cooling tower blow-down caused by breaks in the pipelines and overflows from the cooling tower basins and reinjection basins, have entered the creeks and have been reported to cause loss of fish.

Side casting during road and pad maintenance and unsuccessful revegetation attempts on fill slopes have continued to cause erosion and sedimentation

problems during the operational stages of the development. Operating noise and maintenance activities may have some effect on wildlife, but studies have not indicated that these impacts by themselves are significant (Leitner, 1978, p. 14). The new air quality emission control methods being used will cause an increase in truck traffic to supply necessary chemicals and to haul waste materials away from the power plants for disposal. This activity has a potential for increasing the number of accidental spills.

PROJECT IMPACTS AND MITIGATION

NCPA has proposed a number of mitigation measures related to biological resources in the project application documents filed with regulatory agencies responsible for certification or authorization of the proposed project. In addition, staff of these regulatory agencies and other agencies concerned with biological resources have jointly supported recommendations for additional mitigation, compensating measures, baseline studies and monitoring studies.

VEGETATION IMPACTS

Losses Related to Construction of:

The Power Plant Site-

Preconstruction preparation of the proposed power plant site by cutting down the existing knoll and filling portions of the existing drainage channels near the ridge top would temporarily disturb approximately 11 acres of vegetation. However, because of the steep terrain the actual acreage of wildlife habitat covered over or disturbed may be much greater. Construction of power plant facilities and an impervious surface on the project site would permanently remove approximately 7 acres of vegetation.

The major portion (about 7 1/4 acres) of the vegetation affected is Mixed Chaparral. Nearly one-quarter of an acre of riparian vegetation associated with the seep in the drainage channel in the southeastern portion of the project site would be completely covered by fill material during site development. Additional losses include about 1/2 acre of Knobcone Pine woodland and 3 acres of grassy and open, rocky areas.

The Transmission Facilities-

Development of pads for transmission tower foundations and related lay-down areas will disturb approximately one acre of vegetation. An estimated 0.52 acres of vegetation will be permanently removed by placement of tower footings.

Pad sites for Transmission Towers 1, 3, 4, and 8 are located in Mixed Chaparral vegetation. The pad sites for Towers 5 and 6 are in a Mixed Evergreen vegetation community and placement of the transmission lines may require the topping of some of the taller Douglas-fir trees. The pad sites for Towers 7 and 9 are in Knobcone Pine communities.

The pad site for Transmission Tower 2 is located about 100 feet above a serpentine barren which contains the Streptanthus morrisonii complex. This species is included in the list of Uncommon, Threatened, and Endangered (UTE) Plants (see

Appendix D) and is particularly vulnerable to disturbance related to site preparation and construction. Impacts and mitigation measures related to this complex are discussed in greater detail on page IV-24.

The New Access Roads-

Construction of approximately one mile of new roads needed for access to Transmission Towers 5 and 8 will disturb approximately 5 acres of vegetation during road bed preparation and would permanently remove about 2 1/2 acres of vegetation.

Construction of the new access roads will affect primarily vegetation of the Mixed Chaparral community. The access road to Tower 5 will also affect vegetation of the Mixed Evergreen community.

The Steam Gathering Lines-

Construction of the steam gathering system is expected to parallel existing access roads. The total area of vegetation affected would be about four acres. The pipelines run several feet above the ground and are suspended between regularly spaced support structures. Only the vegetation under the supports would be lost; the remainder should be cut back to ground level prior to construction and kept trimmed immediately under and near the pipelines during operation.

Construction of steam gathering lines from Well Pads D and F and the reinjection pipeline to Well Pad A will affect primarily the Mixed Chaparral community; the pipeline from Well Pad F may also cross through Knobcone Pine, Serpentine Chaparral and Barren communities.

Construction of steam gathering lines from Well Pads C and Q will affect primarily the sensitive Serpentine Chaparral and Barren communities. The pipelines from Well Pad C and Q may also cross Knobcone Pine and Mixed Chaparral communities. If steam from Well Pad B is required for the proposed project, the principal type of vegetation crossed is Mixed Chaparral but the route may also affect areas of Serpentine Chaparral.

MITIGATION MEASURES

- o Revegetation of disturbed areas is necessary to reduce erosion impacts. Most disturbed soils provide a reasonable seed bed for vegetative growth. Vegetation must be re-established on all disturbed areas, except those occupied by buildings or project-related facilities and roadbeds of necessary access roads.
- o Revegetation procedures will take place during the period of July through October of the same year in which the disturbance occurred (i.e., seeding attempts will be made as soon as possible after clearing and before each winter season).
- o Disturbed areas to be revegetated should be prepared in accordance with the slope preparation and erosion control measures discussed on page IV-8.

- o Upon completion of plant construction, final landscape plantings consisting of ground cover, shrubs and trees should be selected on the basis of adaptability, vigor, growth habit, wildlife use, and the desired aesthetic effect. (Refer to page IV-83 for additional discussion of aesthetics).
- o All disturbed areas will be revegetated with grasses, herbs, shrubs and trees of both native and approved nonnative plant species in order to replace, to the extent possible, the vegetation types permanently lost during project development. Nonnative plant species must be compatible with the conditions and native species in the project area in order to reduce the likelihood of introducing aggressive species which would invade and overrun existing native plant communities. Plant species native to the project area listed in Appendix D.
- o Exposed cuts and fills should be revegetated by hydroseeding using an application of seed and fertilizer at the rates shown below. Straw should be placed on all possible slopes by blowing or hand application. Gypsum will be required on all serpentine soils to supply calcium.
- o The following seed mixture should be applied at the rate-per-acre described below:

<u>Common Name</u>	<u>Scientific Name</u>	<u>Pounds/Acre</u>
Blando Brome	Bromus mollis	15
Pubescent Wheatgrass	Agropyron tricophorum	10
Perennial Ryegrass	Lolium perenne	8
Palestine Orchardgrass	Dactylis glomerata	8
Sweet Clover	Melilotus indicus	2
		<u>43</u>

In addition the following substances should be applied at the rate-per-acre shown below:

a. Fertilizer (16-20-0)	480
b. Gypsum (on serpentine soils only)	1000
c. Grain straw (excluding rice straw), free of noxious weeds	3000
d. Soil Tackifier-	
Examples are: Terratack II	90
Ecology Controls M-Binder	100

- o Additional notes on revegetation procedures.

Gypsum, seed and fertilizer can be applied together, or in any combination, with a spraying device if so desired, prior to applying straw. A tackifier to help hold the straw in place should be applied either simultaneously with the straw blowing or after blowing.

Legumes must be inoculated in a manner equivalent to the Prill Coat or Ramsey Seed methods. The same inoculant as is use on alfalfa, such as Inoculant A sold by Nitragin Company, or the equivalent. (No endorsements are implied herein).

Because of varying availability of seed and differing site needs, changes in species composition can be made with the consent of the Bureau of Land Management. All slopes must be hydromulched unless otherwise specified by the BLM.

- o Based upon previous revegetation attempts in The Geysers KGRA, the seeded areas should receive periodic irrigation as needed during the dry season until the vegetation is successfully established.
- o Prior to revegetation efforts, the NCPA or its contractor(s) should contact knowledgeable persons with the California Department of Fish and Game (CDFG) and various agricultural extension agents to determine whether the site rehabilitation procedures they propose should be implemented or whether others are more appropriate based upon the most recent knowledge.
- o Site rehabilitation efforts by the NCPA or its contractor(s) should continue until representatives designated by the regulatory agencies responsible for project approval, have determined either that acceptable success has been achieved or that reasonable effort has been expended.

Physiological Stress Related to Geothermal Resources

The susceptibility of native species to habitat modifications specifically associated with geothermal development has not been determined. Although some of the potential impacts listed below have been observed in the more intensely developed parts of The Geysers KGRA, a causal connection to geothermal operations has not yet been scientifically established.

Regulatory agency staff have observed leaf burn, leaf drop and plant death within one-quarter mile of an operating geothermal power plant. These symptoms have also been observed near cooling towers and venting geothermal wells (Neilson, 1975; Ecoview, 1975a; and CDWR, 1978). Studies have not yet identified which species are most susceptible to contaminants in geothermal steam.

Substances toxic to vegetation such as boron, hydrogen sulfide (H_2S), and salts are contained in geothermal steam. Boron contained in cooling tower drift has been shown to cause vegetation stress and damage around the existing geothermal power plants in The Geysers KGRA (Malloch, et al, 1979). This damage has resulted from uptake through the roots and the leaves. Most of the damage has been the result of uptake through leaves rather than from boron accumulation in the soil. It is not certain to what extent this will be an impact at the NCPA No. 2. project area. Staff does not believe that this impact could preclude development of the project; however, it is not possible to say at this time that the impact is insignificant.

On a cumulative basis, vegetation stress and damage from geothermal development is considered to be significant. As of 1977, approximately 250 acres of vegetation were damaged in the vicinity of existing power plants (Malloch, et al, 1979). This number will continue to increase as geothermal development continues.

The signs of physiological stress observed at more distant locations from the power plants could have been caused by direct impact of increasing development of geothermal resources, operation of geothermal power plants and associated

facilities, or they could be a result of indirect environmental changes such as climatic fluctuations produced by the development.

Plant species may be affected by gaseous compounds and/or chemical contaminants such as boron and sulfates which precipitate from venting geothermal wells or cooling tower emissions.

The increase in humidity as a result of cooling tower emissions may alter the micro-climate conditions and the moisture regime of plant communities with potentially negative effects on component species.

Plant communities may be adversely affected by deposition of dust on their leaves or by the modification of the moisture regime as a result of the diversion of surface or subsurface water during construction activities.

MITIGATION MEASURES

- o Emissions from power plant cooling towers can be controlled to some degree by appropriate design features. Cooling towers for the proposed project should incorporate current design in order to minimize the amount, the direction, and the potentially deleterious composition of the cooling tower emissions and drift.
- o The scientific studies should be continued in The Geysers KGRA by geothermal developers and operators and the scientific community to determine the degree to which cooling tower emissions and drift are detrimental to surrounding vegetation, particularly the UTE plants. Refer to page IV-24 for additional discussion the of Streptanthus morrisonii complex.
- o The NCPA or its contractor(s) must prepare and implement a vegetation monitoring program to assist in data collection for such a study. Sample plots located at varying distances from the cooling towers should be identified, both within and outside the projected drift precipitation pattern. Existing vegetation quantity and diversity should be described as part of the baseline study required by the USGS Geothermal Resources Order No. 4 and 30 CFR 270.34 (k).
- o The sequence and frequency of periodic monitoring of sample plots during project operation should be determined jointly by the NCPA or its contractor(s) and knowledgeable representatives of the regulatory agencies responsible for project approval.

Impacts Related to Increased Access

Uncontrolled wildfires may become more frequent in areas which become more accessible to man.

The Mixed Evergreen, Douglas-fir and Riparian communities could be severely impacted by wildfire through the loss of dominant tree species and temporary replacement by secondary, successional shrub species. Since existing communities provide more stable watershed than shrub communities, this loss and replacement could significantly affect any further soil development and could also lower water quality by increasing the sediment load in affected watercourses.

Chaparral communities would be severely affected only if fires occur more often than once every five years. Frequent fires can encourage development of homogeneous stand of the single chaparral species, chamise (A. fasciculatum), which provides a less stable watershed than a stand of mixed species.

The increasing number of access roads associated with development of the KGRA also provides increased opportunity for access to potentially sensitive habitat. The availability and increasing use of off road vehicles (ORV's) also increase the potential for uncontrolled intrusion into environmentally sensitive areas.

MITIGATION MEASURES

- o As required by the BLM, NCPA or its contractor(s) must prepare a fire management plan which would reduce the likelihood and frequency of catastrophic fire. This management plan should be designed to create a multiple-aged stand of chaparral which is conducive to improvement of wildlife habitat. Refer to page IV-27 for additional discussion of habitat improvement through prescribed burning of chaparral.
- o Since the proposed project is located on public lands, the land must remain reasonably accessible for use by the public. However, protective measures such as fencing or posting can be required to reduce access to environmentally sensitive or potentially hazardous areas.

Impacts on Uncommon, Threatened and Endangered Plants

Plant species identified by the California Native Plant Society as uncommon, threatened, and endangered (UTE) and the USFWS list of proposed and candidate species are listed in Appendix D. Individuals of the Streptanthus morrisonii complex have been found in the project area, particularly near the sites proposed for the power plant and for Transmission Tower 2, and along the proposed steam supply pipelines from Well Pads B, C, and Q. (Nielsen 1974a; Ecoview 1978i).

Species on the UTE list may be more sensitive than others to the potential impacts described in preceding sections.

The Barren communities provide favorable habitat for UTE species and little else. As its name implies, a Barren area is potentially more attractive to ORV users because of easy accessibility and lack of obstacles.

Surface disturbance related to geothermal development activities or increased accessibility could seriously reduce the population of UTE species.

Introduction of aggressive, nonnative plant species could lead to competition with and displacement from the niche presently occupied by UTE species.

The causes of physiological stress from cooling tower drift observed in other plant communities in the vicinity of operating geothermal power plants could produce a critically intensified response in UTE species.

MITIGATION MEASURES

- o The NCPA or its contractor(s) must conduct an intensive vegetative inventory, during the appropriate flowering period, of all areas which have

been identified as potential habitat for UTE plants in any area which would be disturbed during the site development and construction phases of the proposed project. The extent and timing of the vegetative inventory must be coordinated with the Ukiah Office of the BLM.

- o If any UTE plants are found in areas subject to construction disturbance, the activity likely to disturb the plants must be adjusted or relocated.
- o All project-related surface disturbances must be located and designed so that a change in environmental conditions (e.g., soil erosion, change in moisture requirements or cooling tower discharge components) will not affect known populations of UTE plants, or their potential habitat. NCPA or its contractor(s) should conduct monitoring studies to determine the extent of actual vegetation effects caused by cooling tower drift from this power plant and particularly the effects on the Streptanthus complex.
- o During installation of Transmission Tower 2 and the steam pipeline route from well pad Q, a knowledgeable representative of the BLM must be present at the sites to ensure that there are no intrusions onto the adjacent areas identified as habitat for the Streptanthus morrisonii complex and that there is no unauthorized removal of this plant.
- o Any increase in man's activity, such as ORV use, should also be prohibited in areas where UTE species have been identified. Protective measures such as fencing, site relocation and surface paving may be required.
- o Native plants or approved, nonaggressive species must be used to minimize the possibility of introducing species which could compete with UTE species in their existing and potential habitats.

IMPACTS TO WILDLIFE RESOURCES

Impacts Associated with Habitat Loss and Alteration

Disturbance or removal of vegetation has two major impacts upon wildlife resources, it temporarily or permanently eliminates 1) wildlife cover and 2) food sources.

Areas of compacted soils, such as roadbeds, and areas occupied by buildings and other project-related facilities, would be permanently lost to wildlife use for food and cover due to removal of vegetation. Developed areas such as roads and transmission corridors would remain available for use as travel-ways to surrounding vegetated areas.

Most of the vegetation removal and alteration associated with the project would occur in the brushy, chaparral communities which support diverse types of wildlife. Lesser impacts are expected for several species which are less dependent upon the chaparral habitat.

Impacts to recreational species from this project alone are not considered to be significant. At a population density of 0.2 to 0.7 deer per acre for chaparral habitat, the loss of approximately 46 acres for the combined steamfield and power plant could theoretically displace 9 to 32 black-tailed deer. Cumulative impacts from other geothermal developments could increase these losses to a significant level for the entire Geysers KGRA.

Most of the larger, wider-ranging wildlife species would be relatively unaffected. If the proposed project development areas comprise a portion of the hunting territory of a gray fox, bobcat or mountain lion, these animals would have to modify their patterns of use and movement.

Smaller, more sedentary mammals (e.g., rodents) with small home ranges would be most directly affected by project development. An unknown number of these animals would be killed during construction.

The smaller mammals, along with other small birds and animals, provide a preybase for larger predators and birds-of-prey. Based upon preliminary data from The Geysers Wildlife Study (PGandE, et al, 1977), the proportion of species comprising the prey-base may change but the total numbers available would remain roughly equal in "undeveloped" areas and in habitat adjacent to "developed" areas.

Birds most affected by the proposed development would include resident and nesting species associated with chaparral vegetation. Based upon preliminary data from The Geysers Wildlife Study, estimated overall densities of various types of birds observed were greater per 100 acres in "developed" than in "undeveloped", mixed chaparral. Species composition also appeared to be altered by development; a greater variety of birds were observed in developed areas.

Project development would result in the reduction of habitat for a variety of reptiles. Unknown numbers of reptiles would be killed during construction but overall effects to reptile populations resulting from construction are anticipated to be light.

MITIGATION MEASURES

- o An attempt to revegetate all areas disturbed during development of the proposed project will be made by NCPA or its contractor(s). Revegetation measures described on page IV-21 will accomplish three primary goals: 1) to rapidly establish vegetation which may reduce the movement of silt into aquatic habitats and 2) to provide some food for wildlife, and 3) to stabilize the terrain. However, revegetation using plant species associated with the chaparral will be a long process over the better part of 50 years, so loss of this habitat for food and cover will be evident over the expected life of the project.
- o Seeded cut and fill areas would provide a diversity of habitat which would be used quite heavily for feeding by deer and a variety of granivorous birds.
- o To achieve partial mitigation for habitat permanently lost, the overall carrying capacity of small areas of existing, mature chaparral should be improved for wildlife use by a program of prescribed burning. Fire in mature (over ten years old) stands of chaparral is beneficial to most wildlife species adapted to chaparral brushlands (Longhurst, 1978).
- o The NCPA or its contractor(s), with the cooperation of California Department of Fish and Game officials, will determine appropriate size,

area and frequency of burning. Regulatory agency staff recommends that a minimum of 60 total acres should be burned within 10-year periods throughout the lifetime of the proposed project. With prescribed burning of mature chaparral, the carrying capacity for deer would be reduced little, if at all, and could be increased.

- o Preconstruction site preparation and construction, operation and site-restoration activities will be monitored by designated representatives of the regulatory agencies responsible for project approval. Habitat disturbance and loss due to number of roads and size of project-related roadbeds and facility pads will be kept to a minimum.
- o If the proposed project receives authorization to proceed, workers involved in preconstruction site preparation, construction, operation and maintenance of the proposed project will be given detailed instructions for work to be done. These instructions will be described in the various documents authorizing the proposed project and granted by the responsible regulatory agencies.
- o Any deviations from authorized project development will require written permission from responsible regulatory agencies. Impacts created by authorized or unauthorized deviations from the proposed project will also require necessary mitigation.

Impacts to Seep and Associated Riparian Vegetation

Approximately 850 feet of the drainage channel at the headwaters of a small, unnamed tributary to Big Sulphur Creek will be covered by fill material during development of the site for the proposed power plant. Within this drainage, in the southeast portion of the proposed project site, there is a small spring, or seep. Presently rainfall, runoff, and the natural seep combine to provide a year-round water resource which supports willows and other riparian species, aquatic vegetation, and a small grove of Douglas-fir in a narrow band on either side of the channel. Such seeps are rare in this type of terrain. Refer to Figures II-2 and III-3 for the location of the seep.

This seep, near the ridgecrest, provides water for diverse kinds of localized wildlife. These smaller wildlife species comprise a portion of the prey-base for wider-ranging predators and raptors. The water source and overhead canopy of riparian vegetation appear to be used by larger species such as deer, to provide a relatively protected spot for fawning.

Bird species associated with riparian vegetation, such as warblers, orioles and the brown towhee, would also be impacted by this loss of habitat. Raptors, particularly the red-tailed hawk, would have to make adjustments in their foraging patterns.

The habitat of mountain quail, California valley quail, and mourning dove would be temporarily reduced but the doves and a variety of songbirds would feed in the revegetated cuts and other disturbed areas.

The riparian vegetation in the Big Sulphur Creek channel below the proposed plant site would be relatively unaffected by project development. Transmission Towers 4 and 5, and the associated access roads will be located at least 550

feet horizontally and 340 feet vertically, away from the edge of the creek. Except for minimum tower pad clearing and road maintenance, no other alteration of vegetation would be authorized.

MITIGATION MEASURES

- o As discussed on pages IV-5 and IV-9, a drainage system will be installed in the seep area and in the existing tributary channel, under the fill materials to ensure slope and site stability and necessary erosion control.
- o Water quantity and quality in the unnamed tributary channel should not be diminished nor degraded by development of the proposed project. Water produced at the seep and/or in this channel should remain available to wildlife in an uncontaminated condition.
- o Depending upon quantity and quality of the water, a concrete water storage basin (500 gallon maximum capacity) and a wildlife drinking facility consisting of small rock and concrete ramps must be constructed. It must be located below the plant site in undisturbed vegetation adjacent to the drainage. The preferred location for the wildlife drinking facility would be in the natural drainage channel about 150 feet south of the existing seep and across the proposed road located along the toe of the fill slope. If water from the seep is lost during construction, water may have to be piped to the facility from the power plant. The facility must be designed to provide water throughout the year.
- o Special plantings to provide food and cover to wildlife species should be made around the watering area. Special plantings of willows and other plants to provide food and cover to wildlife species should be made around the watering area and in wet depressions along the channel where these plants do not now occur.
- o Facilities for collecting and diverting this water for wildlife use should be constructed in a manner that will not entrap wildlife.
- o Barriers to contain silt should be constructed below the area disturbed by development of the proposed power plant site to prevent excessive silt loads from entering aquatic habitats. This silt barrier should be periodically cleaned out, prior to the rainy season, to maintain its effectiveness.
- o Plantings to provide food and cover to wildlife species should be placed around the edge of the sediment basin.
- o In the event that additional development occurs in the future, a 300-foot wide undisturbed buffer zone should be maintained on either side of the remainder of this drainage channel.

Impacts Associated with Siltation

Due to removal of existing vegetative cover and the disturbance of soils, the greatest potential for production of silt occurs during preconstruction site development and during construction of road networks, steam well pads, etc.

Watershed alteration resulting in increased erosion and siltation is considered a most serious potential development impact (Leitner, 1978). If adequate precautions are not taken, silt would degrade aquatic habitats downstream from the proposed development. Because of the location of the proposed project and the extent of fill being used, habitat in Big Sulphur Creek would be most vulnerable.

Any additional silt entering the streams will contribute to the degradation of fish spawning habitat. It also would contribute to the reduction and change in aquatic organisms which provide food for higher life forms.

MITIGATION MEASURES

- o Silt movement is expected to subside with time, as cut and fill areas become more stable with the re-establishment of vegetative cover.
- o A monitoring study should be conducted to verify the effectiveness of the erosion control programs. These studies should include monitoring of siltation in Big Sulphur Creek near the point where the intermittent drainage empties into the creek and monitoring of the success and density of vegetation on the revegetated fill slopes.
- o Design of all project-related facilities, site development, and preparation of roadbeds should incorporate stringent specifications to minimize erosion and resultant siltation in all drainages affected by proposed project activities.
- o Refer to discussions beginning on pages IV-4, IV-8 and IV-11, for additional description of measures to control erosion and minimize the potential for siltation impacts.

Impacts Associated with Toxic Substances

Cooling Tower Drift--Several potentially harmful materials such as boron, mercury and hydrogen sulfide are known to occur in cooling tower drift (GRIPS, 1978a). Impacts associated with cooling tower drift in the KGRA are not well understood. Emissions vary with location.

Recent observations in the vicinity of operating towers indicate some damage to and loss of habitat components, including herbaceous vegetation, shrubs and trees (Leitner, 1978; Malloch, et al, 1979). See additional discussion, page IV-10.

The effects of accumulation of various toxic substances in animal tissues is unknown. Effects of accumulation would likely be greater in long-lived animals, and particularly in the carnivores at the end of the various food chains.

Toxic Spills--Major spills of condensate from cooling systems and condensate storage facilities located within the proposed project site could occur during the lifetime of the project. As much as 170,000 gallons of potentially toxic fluids could be released at one time.

Potentially toxic materials generated by or used in the hydrogen sulfide abatement system(s) would be transported by truck to and from the proposed project

site. Varying amounts of these materials could be accidentally spilled due to unexpected road impairment, faulty equipment, driver error, mishandling and other such causes.

The accidental spillage of various toxicants represents a serious potential threat to downstream habitats, vegetation, and wildlife species. Vulnerable species would include the rainbow trout and three other fish species, six to eight species of amphibians; the western garter snake; birds such as the belted kingfisher and the dipper; and a variety of aquatic invertebrates.

Depending upon its magnitude, composition, and toxicity, an accidental spill could affect species as far downstream as the Russian River or Putah Creek. Impacts could range from immediate elimination of one or more species, to an accumulation of toxic substances in the food chain, to subtle alteration of species composition.

Mishandling of various toxic materials within the proposed project site or steam supply system could cause more localized, minor impacts.

MITIGATION MEASURES

- o Discussion of cooling tower drift reduction begins on page IV-23.
- o As required by the North Coast Regional Water Quality Control Board, NCPA or its contractor(s) must prepare a "Spill Prevention Contingency and Containment Plan", (NCRWQCB, order 74-151). Discussion of the contents and requirements of this plan begins on page IV-13.
- o All potential toxic materials generated by or used during construction and operation of the proposed project and associated facilities will be regularly monitored to prevent habitat degradation and harm to vegetation and wildlife.

Impacts Associated With Project Operation

Noise--Various noises produced at the plant site would contribute to the displacement of some wildlife in the immediate area. It is anticipated that certain larger and more wary animals, including the wide-ranging carnivores and birds-of-prey, would be most adversely affected. Loud, periodic noises such as well venting would temporarily displace local wildlife for the duration of the sound. These displacements are not considered significant.

Powerline Collisions--Bird collisions with electrical transmission facilities should not be a significant problem in the project area. The proposed transmission route does not cross any known pathway for concentrated bird migration. Chance collisions can be expected to increase as additional transmission facilities are constructed in The Geysers KGRA.

Impacts Associated with Human Disturbance

Disturbance in the proposed project area would vary according to the amount of human use. As a matter of federal land and resource management policy, existing public access to public lands must be maintained but offroad access, particu-

larly in sensitive resource areas, can be controlled (USDI, BLM Interim Management Plan, 1975).

Considerable temporary disturbance would occur during construction phases when a large workforce would be present in the project area. It is anticipated that most wildlife would reoccupy remaining suitable habitat upon completion of construction activity and related disturbances.

Larger and more wary animals would be frightened away from human use areas. More permanent disturbance would occur adjacent to permanently manned facilities, particularly during daylight hours. Displacement due to human presence would result in changes in species composition in areas of disturbance. Species more adaptable to human presence would remain and perhaps increase; less adaptable species would decline (Geysers Wildlife Study, PGandE, et al, 1977).

Displaced wildlife which cannot return to the project site because of disturbance and/or habitat modifications would be forced to compete with other wildlife on adjacent undeveloped lands for food, water and cover. The end result will be the death of some individual animals. These losses should be minimal with respect to project area. Cumulatively, however, wildlife losses for development in The Geysers KGRA could be significant.

A total of about one mile of new access roads would be constructed in conjunction with the 2.1 mile transmission line. The major portion of construction activity related to the transmission line would occur along previously disturbed areas. A minor amount of wildlife disturbance would occur along these new roads, particularly if they remain open to the general public. An unknown number of various wildlife species would be killed on active roadways.

Wildfire may become more frequent in the areas which are more accessible to man. The most vulnerable vegetation communities also support a greater number and variety of wildlife species than the chaparral habitats. Vegetative changes after an uncontrolled burn would tend to reduce the wildlife diversity by making a more homogeneous habitat than now exists.

After an uncontrolled burn, heavy siltation could occur in affected drainages with a corresponding adverse impact on aquatic habitat and wildlife.

An unknown number of smaller, more sedentary animals would be killed when fire occurs.

MITIGATION MEASURES

- o The degree to which the project area will be accessible and open for general public use is unknown at this time. Access to environmentally sensitive and potentially hazardous areas will be restricted and travel on privately-owned and maintained roadways may be limited by leaseholders.
- o Refer to previous discussions for additional mitigation.

Impacts to Endangered Species

Although sporadic use of the proposed project area by the peregrine falcon may occur, it is the consensus of regulatory agency staff that the proposed project

would have no adverse impact on this endangered species. (CEC, 1978: Proposed Findings and Conclusions for Biological Resources)

Impacts to Fully Protected Species

Based upon available recorded data, the proposed project would have little or no impact upon the golden eagle, Aquila chrysaetos, as long as transmission facilities are properly designed to minimize the potential for collision and electrocution. A small amount of habitat suitable for use by the ringtail, Bassariscus astutus, may be destroyed. If this occurs, the impact is not expected to be significant.

CUMULATIVE EFFECTS TO BIOLOGICAL RESOURCES

Increased development in the KGRA would reduce the total amount of habitat available to wildlife and, to an unknown degree, may fragment habitat into units, unuseable by some species.

Aquatic habitats would most likely reflect early and serious effects of cumulative impacts.

Increasing disturbance of vegetation and soils for development of power plants, well pads, roads, and transmission foundations will produce a corresponding increase in erosion and siltation.

Changes in density and/or species composition of songbirds, deer mice (Peromyscus spp.), spiny lizards (Sceloporus spp.), and newts are becoming apparent (Geysers Wildlife Study, PGandE, et al, 1977). Preliminary data suggest that species associated with climax conditions are more impacted by geothermal development than those associated with earlier successional stages (Leitner, 1978).

Cumulative impacts associated with long-term cooling tower drift are largely unknown. However, there are indications that the deposition of toxic materials is occurring (Leitner, 1978; Malloch, et al, 1979).

Disturbance to wildlife and vegetative species, associated with human use, will increase throughout the previously somewhat inaccessible KGRA. Increased human accessibility and use may also increase the probability of uncontrolled wildfires and disturbance or elimination of endangered, threatened or uncommon species.

Increasing geothermal development would increase the probability of accidental spills and the resulting adverse effects upon wildlife and vegetation.

MITIGATION MEASURES

Full implementation of all recommended mitigation measures will reduce the cumulative impacts to acceptable levels for this project. The CEC and CDFG staffs are currently working with the utilities and steam developers to establish regional monitoring programs and to develop monitoring studies of mitigation measures to further reduce cumulative impacts. Additional efforts are in the planning stage to quantify the wildlife resource impacts and losses of plant communities from proposed full development of The Geysers KGRA.

BLM plans large scale wildlife habitat improvement prescribed burning of chaparral in the Cow Mountain area. This area is located to the north of the proposed project site in the same mountain range (the Mayacmas) and in similar habitat. Burning projects will begin in the Fall of 1979 and continue for at least four years. A total of 20,000 acres of chaparral will be improved as a result of this project. BLM feels that public interest will be better served by habitat improvement in this area where public access is readily available.

AIR RESOURCES

METEOROLOGICAL CHARACTERISTICS

Impacts Associated with the Proposed Project

Several microclimate variables can be affected by persistent emission of heated water vapor. Addition of this vapor to the atmosphere slightly increases ambient temperature and humidity, and reduces insolation (incoming solar radiation). Due to the relatively low volume of emissions in relation to the absorption capacity of the overlying air mass, staff does not anticipate that emissions from the proposed project will have a significant effect on local humidity and temperature.

During calm winter nights when drainage or down slope wind flows predominate, emission of water vapor may slightly increase the frequency and duration of fog within one-half to one mile of the proposed project site.

Potential Cumulative Impacts

Water vapor plumes from a cooling tower generally disperse rapidly in the atmosphere due to their buoyancy and air entrainment, as well as to atmospheric turbulence. Beyond a radius of about one-third mile (about one-half kilometer) from a particular cooling tower structure, the combined contribution from all operating cooling towers must be considered in evaluating their effects on the environment.

In the absence of an intense inversion, the cumulative contribution of water vapor to the atmosphere from all power plants presently operating in The Geysers KGRA would result in only minor changes to the area's climate.

For the annual average wind speed of 11 miles per hour (5 meters per second), the contribution at downwind distances of 5 to 10 miles (8 to 15 kilometers) from the 11 operating units of The Geysers Power Plant is less than 0.1 gram of water vapor per cubic meter of air. At the coldest temperatures expected in the

area, saturated air would contain at least three grams of water vapor per cubic meter. This addition of water vapor corresponds to a change of less than 1°F in wet-bulb temperature readings.

During the dry season of April through October, the capacity of the air for water vapor ranges from 6 to 40 grams per cubic meter, so the addition of cooling tower water vapor from all units during this period will not change the wet-bulb temperature more than 0.5°F. During this dry season, the area is generally in or above the inversion so that the relative humidity is low and the addition of cooling tower water vapor causes an insignificant change. (CEC Staff analysis, 1979)

Some concern, however, has been expressed among members of the scientific community that even minor changes in temperature and humidity may impact sensitive plant species and their ability to survive (Neilson, 1975a; Ecoview 1975j; Leitner, 1978).

MITIGATION MEASURES

- o Reduction of emissions has been suggested to mitigate potential impacts to soils (page IV-10), vegetation (page IV-22), and wildlife resources (page IV-29).
- o The NCPA or its contractor(s) should participate in a cooling tower emission monitoring program which will provide data upon which a decision on the need for mitigation of potential impacts can be made.

AIR QUALITY

Ambient air quality in The Geysers KGRA is influenced by geothermal emissions. Water vapor constitutes about 98 percent of these emissions and the remaining 2 percent are comprised of noncondensable gases and dissolved mineral salts. As indicated in Chapter III, Table III-18, noncondensable gases in geothermal steam include: carbon dioxide, hydrogen sulfide, methane, ammonia, nitrogen, hydrogen and ethane. Salts may include mercury, boron, arsenic and other suspended particulate matter.

Of the gases present in the steam, all except hydrogen sulfide are expected to have no significant environmental impact. Hydrogen sulfide (H_2S) has a noticeable rotten egg odor and has occurred naturally in The Geysers KGRA prior to development of geothermal resources for power generation. The presence of H_2S is due both to natural sources, such as fumeroles, and to man-made sources such as well drilling or power plant operation. The portion of H_2S present from natural sources is only a fraction of that present from man-made causes (CEC, 1979c).

The Northern Sonoma County Air Pollution Control District (NSCAPCD) reports that complaints about H_2S odor from The Geysers began in 1972 and concludes that an emission threshold was reached at that time. Emission data shows an average annual H_2S emission rate of 482 lbs/hr in 1971 and an increase to 919 lbs/hr in 1972 (Tofmasoff, 1977).

Complaints about H_2S odor had already occurred in Lake County prior to 1972. Winds transport H_2S emitted in Sonoma County across the Mayacmas ridgecrest

into southern Lake County. Local air quality is now being affected by geothermal emissions to such a degree that the Lake County Air Pollution Control District (LCAPCD) has declared that significant levels of contaminants are present in the Cobb Valley and adjoining areas. These contaminants are deemed a public nuisance and may have possible health effects which are incompletely understood at this time (refer to discussion beginning on page IV-51).

Potential Sources of Pollutant Emissions

Air pollutants from a geothermal power project can be emitted from two principal sources: (1) the power plant itself, including cooling towers; and (2) steam wells and steam transmission lines. The first source produces emissions during routine operation of the steam turbine-generator, while the latter sources produce significant emissions only when the steam turbine-generator is shut down and steam from the transmission lines is vented (stacked) to the atmosphere.

In addition, small quantities of pollutants can be emitted from the steam transmission line from the well bleedlines, leaky gaskets, or the clean-out of particulate collectors. These emissions are continually released at numerous points throughout the leasehold, but their impacts are generally considered insignificant.

The two most important air pollutants that will be emitted from the NCPA project are hydrogen sulfide (H_2S) and particulates (total suspended particulates, or TSP). Both pollutants are present in the incoming steam and must be controlled by various abatement systems.

Particulate Sources and Quantities

The amount of particulates entering the plant is expected to be approximately 2.6 lbs./hr. Particulates can be emitted from several points in the steam cycle. Particulates that are not removed by the strainers in the steam transmission line will proceed through the turbine and during the condensation process become part of the condensate. The condensate will eventually pass into the cooling towers where part of the particulates will be released into the atmosphere in the form of drift. Additional particulates can be transported by noncondensed gases into the Stretford H_2S abatement system. The particulates will then be emitted with the gases from the Stretford system's cooling tower and also transported to the plant cooling tower where it is emitted to the atmosphere.

A third potential source of particulates is the secondary H_2S treatment process, if one is required. Typically, such condensate treatment systems use peroxide/iron sulfate catalyst to transform dissolved hydrogen sulfide (H_2S) into ammonium sulfate $[(NH_4)_2SO_4]$, which can be emitted as a solid, or particulate. Other solids may also be formed in the chemical reaction. Until the required extent, if any, of secondary H_2S treatment is determined, the amount of particulates that could be produced and emitted from this process cannot be determined.

Including an assumed contribution from secondary H₂S treatment, the plant's total particulate emissions will be approximately 5.9 lbs/hr*, which includes 3.3 lbs/hr from the main cooling towers and 2.6 lbs/hr from the Stretford cooling tower. The relatively low levels of particulates in the steam is partly attributable to the fact that centrifugal filters will be placed in steam gathering lines to collect particulates before they enter the plant.

*To arrive at particulate emission figures, CEC staff used the following assumptions:

- (1) Total concentration of all solids in the steam condensate is 60 ppm--the maximum of an estimated range;
- (2) Hydrogen sulfide content in the incoming steam is the maximum of the expected range--90 ppm;
- (3) Steam condensate flow is 2,000,000 lbs/hr;
- (4) The percentage of H₂S remaining in steam condensate after partitioning is 35 percent of the incoming H₂S;
- (5) All of the H₂S dissolved in the condensate is converted to ammonium sulfate (NH₄)₂SO₄;
- (6) Up to 10 ppm of catalysts are added to the condensate; and
- (7) The ratio of total circulating water solids is at the maximum of its range--approximately 6:1;
- (8) NCPA stated plant operating flow rates, including:
 - a cooling tower air flow of 650,000,000 ft³/min.;
 - a maximum cooling tower drift rate of 0.002 percent of the hot water flow rate;
 - a maximum hot water flow rate of 162,000 gallons per minute.

With these assumptions, the cooling tower particulate emissions due to the additional solids content of the condensate after secondary treatment would be approximately 3 lbs/hr. The estimated cooling tower emission without secondary treatments would be about 0.3 lbs/hr. Thus, the total particulate emissions from the cooling tower should be no more than 3.3 lbs/hr.

Hydrogen Sulfide Sources and Quantities

The greatest potential source of H_2S emissions from the proposed power plant is the amount of H_2S dissolved in the spent steam. Left untreated, the spent steam would violate applicable standards for H_2S emissions.

For the proposed project (as in others recently proposed) the primary H_2S abatement equipment will consist of a surface condenser and the Stretford process (Refer to Chapter II for a complete description of project features).

The success of the H_2S abatement system depends greatly on the efficiency of the partitioning which occurs in the surface condenser. That portion of the spent steam which is partitioned into noncondensable gases will be diverted to the Stretford process for treatment which will remove virtually all of the H_2S in the noncondensibles. Any remaining gases can then be exhausted to the atmosphere from the Stretford cooling towers or the plant cooling tower.

That portion of the spent steam which is condensed at the surface condenser eventually circulates through the main power plant cooling towers, becoming the most significant potential source of H_2S emissions. Unless the surface condenser is able to partition most of the H_2S in the spent steam into the noncondensable gases, NCPA will have to resort to some form of secondary H_2S removal from the condensate in the line between the surface condenser and the cooling towers. Thus, the critical task of the surface condenser is to provide plant cooling in such a way as to maximize the partitioning of H_2S and other noncondensable gases from the steam, so that the H_2S gas can be treated in the Stretford unit.

Based on the limited data from the initial Shell steam wells, NCPA has estimated the range of H_2S concentration in the steam entering the power plant will be 50 to 90 parts per million, by weight (ppmw) (NCPA, 1978b; page III-6). The total amount of H_2S entering the plant, based on an expected incoming steam flow of 1,966,000 lbs/hr (NCPA, 1979b; page III-55), could range from 98 to 177 lbs/hr.

Compliance With Emissions Limitations

Emissions from the proposed project are subject to New Source Review Rules and emission limitations of the Northern Sonoma County Air Pollution Control District (NSCAPCD). Under the federal Clean Air Act, the District must determine whether a proposed project's emissions will prevent the attainment, interfere with the maintenance, or cause a violation, of a national ambient air quality standard.

Under state law, the same determination must be made with respect to state ambient air quality standards which may be in addition to or more stringent than federal ambient standards. The California Air Quality Standard for H_2S is 30 ppb (parts per billion) for a one-hour average. The standard was set to reduce annoyance caused by H_2S odors. In addition, NSCAPCD rules impose certain emissions limitations for various pollutants which must be met before a permit can be granted.

Emissions Limitations-

The Northern Sonoma County APCD has adopted H₂S emission regulations which are intended to reduce the total emissions from existing as well as future sources. These regulations are intended to bring the KGRA into attainment with the California standard. Under NSCAPCD Rule 455(b), H₂S emissions from a geothermal plant cannot exceed 100 grams per gross megawatt hour (100g/GMW). For the total 110 megawatt power plant, 100g/GMW converts to approximately 24.2 lbs/hr. Since the proposed facility will consist of two independent turbine units, under NSCAPCD regulations, Rule 455(b) applies to each 55 megawatt unit and each unit will be allowed to emit no more than 12.1 pounds of H₂S per hour.

Commencing on January 1, 1985, all units will have to meet a doubly stringent standard of 50 grams per gross megawatt hour. Under this revision, the equivalent limits will be 12.1 lbs/hr for the entire plant and 6.05 lbs/hr for each unit. The more stringent 1985 revision is subject to NSCAPCD review prior to its implementation.

MITIGATION MEASURES

- o To reduce the H₂S emissions of the proposed power plant, NCPA plans to construct a Stretford process unit as part of the proposed project. The unit will be capable of processing 300 pounds of H₂S per hour. Although NCPA has not yet selected a manufacturer, it has specified in its bid requests that the unit must have an H₂S removal efficiency in excess of 99 percent.

Emissions Analysis of Primary H₂S Abatement System-

If one assumes that the H₂S content in incoming steam remains within the range expected by NCPA (70+20 ppmw, or 50 to 90 ppmw), then the total amount of H₂S entering the plant will range from about 98 to 177 lbs/hr.* To meet the 24.2 lbs/hr limitation will require an overall abatement efficiency of 75.3 percent to 86.3 percent, depending on the H₂S concentration in incoming steam.

The Ralph M. Parsons Corporation, the manufacturer of the Stretford units for PGandE's Geysers Units 15, 17, and 18, now offers guarantees that the treated gas stream leaving its Stretford unit contains no more than 10 ppm by volume H₂S. This constitutes an abatement level above 99 percent and an H₂S emission rate of less than 1 lb/hr for proposed Unit 18, which is expected to have approximately the same H₂S flow rate as the NCPA No. 2 project.

Thus, the feasibility of meeting the 75 percent to 86 percent total abatement efficiency without secondary treatment of the steam condensate depends upon the ability of the surface condenser to partition approximately the same percentage--75 to 86 percent--of H₂S from the steam as noncondensed gas.

*Based on the following calculations:

$$\frac{50 \text{ lbs. of H}_2\text{S}}{1 \times 10^6 \text{ lbs of steam}} \times \frac{1.966 \times 10^6 \text{ lbs. of steam}}{1 \text{ hour}} = 98.3 \text{ lbs H}_2\text{S/hr.}$$

(The same calculation for 90 ppmw gives a figure of 176.9 lbs H₂S/hr.)

When NCPA filed its AFC with the Energy Commission, it anticipated achieving a partitioning efficiency from its surface condenser of 90 percent or higher; that is, 90 percent of the H_2S present in the turbine exhaust steam would be separated from the steam condensate as noncondensed gas. An efficiency of 90 percent would clearly meet the present emissions limitation for H_2S .

However, preliminary test results from PG&E's Unit 15--the first Geysers Unit to employ a surface condenser--suggest that partitioning efficiencies of 90 percent may not be feasible. The following test results from the Unit 15 project are relevant to the proposed project:

- a. The partitioning efficiency so far achieved by Unit 15's surface condenser is about 67 percent. A comparable efficiency at NCPA's plant, given H_2S concentrations of 98 to 177 lbs/hr, would result in H_2S emissions of 32 to 58 lbs/hr in the absence of secondary treatment.
- b. The test results suggest that partitioning efficiency decreases as the concentration of H_2S in incoming steam decreases. For Unit 15 the concentration of H_2S is 180+10 ppm. For NCPA it is expected to be 70+20ppm. NCPA's partitioning efficiency may therefore be less than 67 percent.
- c. Measurements at Unit 15 slightly overstate the partitioning efficiency. The results compare H_2S concentrations of steam entering the turbine and of condensate leaving the condenser. The latter measurement includes H_2S from the condensate generated at the two condensers used in the gas ejection system. In the NCPA design, this condensate is carried directly to the cooling tower. If similar tests were conducted at the NCPA plant, and the turbine condenser and gas ejector were of equal efficiency to those used at Unit 15, the partitioning efficiency would be lower for the NCPA unit.
- d. Unit 15 results indicate that the relative acidity, or pH, of the steam condensate is an important factor in maintaining partitioning efficiency. H_2S tends to remain in the condensate if the condensate is basic (pH greater than 7.0). The presence of ammonia in incoming steam tends to make the condensate basic in the absence of compensating acidic chemicals. The pH level of steam entering NCPA's plant cannot be determined until additional steam wells are drilled. PG&E has attempted to determine the probable pH of steam condensate from a surface condenser by sampling steam from Unit 3. The results from Unit 3 indicate a pH of 7.1.

The foregoing discussion indicates that the probable level of H_2S emissions following primary condensate treatment could range from 32 to 58 lbs/hr, which is considerably in excess of the 24.2 lbs/hr limits of Rule 455(b).

MITIGATION MEASURES

- o The PGandE Geysers Unit 15 power plant was the first time the proposed Stretford process and surface condenser system for H_2S abatement have been applied to geothermal operations. If tests and analyses of the Unit 15 system indicated that H_2S emissions would not meet required limitations, NCPA agreed to install a secondary abatement system to treat the condensed steam before it reached the cooling towers.

Emissions Analysis of Secondary H_2S Abatement System-

Whether it is feasible to provide sufficient secondary treatment to meet Rule 455(b) has been addressed by the CEC in its certification proceedings for PGandE's Unit 17. The incoming H_2S concentration for PGandE Unit 17 is 350+100 ppm. This corresponds to a H_2S flow rate of 516 to 957 lbs/hr.

If one applies the 67 percent partitioning efficiency data from PGandE Unit 15 to the highest expected H_2S content of the steam supplies to the Unit 17 and NCPA plants, then the H_2S removal requirement by secondary treatment would be approximately 315 lbs/hr of H_2S for Unit 17 and 34 lbs/hr for NCPA. This indicates that the required capacity of storage tanks and size of other system components, as well as the reduction of side effects such as sludge creation, makes the problems of a secondary H_2S treatment system substantially smaller for the proposed project than those expected for Unit 17. The Commission found that the PGandE proposals for secondary treatment were feasible (CEC, 1979d) and therefore staff expects they are also feasible for the NCPA No. 2 project.

NCPA has agreed to install a secondary condensate treatment system (NCPA, 1979b; page III-69) if the necessary degree of partitioning is not obtained in tests to be conducted at PGandE Unit 15. At this time, NCPA's choice for condensate treatment is a hydrogen peroxide/iron sulfate catalyst system (NCPA, 1979d). Tests of a modified system of this type on PGandE's Geysers Units 3, 4, 5, 6, and 11 have resulted in average abatement levels of 92 to 95 percent (PGandE 1979b; Appendix C, Table 1). If one assumes that at least 90 percent of the H_2S dissolved in the condensate can be removed by secondary treatment, that a 67 percent partitioning efficiency is obtained, and that the Stretford units removes 99+ percent of the H_2S entering it, the overall H_2S emission rate would be on the order of 6 lbs/hr. This would satisfy the NSCAPCD requirements by a good margin. In fact, a secondary system would have to remove no more than about 60 percent of the H_2S in the condensate in order to meet Rule 455(b) under comparable assumptions.

NCPA has indicated that if a secondary H_2S abatement system is required, it will use a 50 percent hydrogen peroxide (H_2O_2) solution in the condensate, at 1:1 peroxide to sulfide ratio to remove the H_2S from the condensate. Information on the degree of secondary treatment necessary under varying assumptions was supplied by NCPA and is presented in Table IV-1.

RECOMMENDED POST-CERTIFICATION PROCEDURES-

There are great areas of uncertainty concerning (1) H_2S concentrations and pH levels in incoming steam; (2) achievable partitioning efficiencies for the

TABLE IV-1

ANALYSIS OF SECONDARY H₂S ABATEMENT SYSTEM

Input to the peroxide system assuming 90%, 70% and 50% partitioning and 90 ppm H₂S steam are summarized below:

<u>Partitioning</u>	<u>H₂S to Peroxide System</u>	<u>H₂S Converted</u>
90%	23 #/hr	22 #/hr
70%	54 #/hr	48 #/hr
50%	90 #/hr	85 #/hr

The third column shows the amount of H₂S that will be converted to sulfur by the 95% effective system.

The peroxide system will be working on a condensate stream with pH less than or equal to 7 so that only one part hydrogen peroxide will be consumed per part H₂S. The hydrogen peroxide used is found by the following:

$$(\text{\#}/\text{hr H}_2\text{S}) \times \frac{(\text{Molecular Wt. H}_2\text{O}_2)}{(\text{Molecular Wt. H}_2\text{S})} = \text{\#}/\text{hr H}_2\text{S} \times \frac{(34)}{(34)} = \text{\#}/\text{hr H}_2\text{S}$$

Therefore the amount of hydrogen peroxide used will be the same as the amount of H₂S to be converted as shown in the above table. Also iron catalyst, ferrous sulfate, will be used. Vendor data indicates that only one ppm catalyst is needed. For the NCPA No. 2 condensate flow two pounds of catalyst per hour will be used and reinjected into the wells.

<u>H₂S Converted</u>	<u>H₂O₂ Annual Consumption</u>	<u>Ferrous Sulfate Annual Consumption</u>
22 #/hr	176,000 #	16,000 #
48 #/hr	384,000 #	16,000 #
86 #/hr	687,000 #	16,000 #

Source: NCPA, 1979d

surface condenser; (3) extent of necessary secondary treatment systems; (4) reliability of and amounts of solid wastes produced by the secondary treatment system. Because of these uncertainties, CEC staff recommends the post-certification procedures described below to ensure compliance with Rule 455(b). Due dates for responses expected from post-certification procedures will be developed during the Energy Commission's post-certification proceedings on compliance and monitoring requirements.

- o NCPA should file with the Commission and NSCAPCD an analysis of available information on the H₂S abatement performance testing at Unit 15 and its applicability to the proposed NCPA plant. Such a report should include test data on the Stretford process, condenser partitioning and steam characteristics.
- o In the event the primary H₂S abatement system (Stretford surface condenser combination) at Unit 15 does not provide adequate abatement performance, NCPA should augment its proposed H₂S abatement system with the necessary secondary treatment and provide to the Commission and the NSCAPCD design and test information on the secondary system prior to its procurement and fabrication.
- o Upon NCPA plant operation, NCPA shall monitor H₂S abatement system performance. If compliance with Rule 455(b) is not achieved, NCPA should prepare a plan for additional treatment of gases to achieve H₂S discharge requirements. The plan should be submitted to the Commission and the NSCAPCD, for their review and approval.
- o If a solids removal system (for the secondary treatment process) proves necessary at the NCPA plant, NCPA should provide design criteria and specifications to the NSCAPCD and Commission for review and approval prior to the system's procurement and fabrication. The system shall be installed and operating according to the approved design criteria prior to commercial operation.
- o Prior to NCPA plant operation, NCPA will submit to the Commission and the NSCAPCD a specific H₂S monitoring plan of the abatement system performance of the facility. NSCAPCD will advise the Commission as to the acceptability of the monitoring plan.
- o Results of the monitoring program are to be submitted to the Commission and the NSCAPCD, as follows:
 - a. NCPA shall provide a report on the results of the monitoring program within 90 days after the facility commences commercial operation. The monitoring activity to obtain data for the report is to cover a minimum period of 75 operating days. The data used for the report shall be based on the highest levels of emissions and electrical power generation achieved for a cumulative period of 30 operating days.
 - b. If, during the first 90 days of monitoring described in item (a), 100 percent rated power has not been achieved for a cumulative

period equal to 30 days, a second report shall be issued. This report shall be based on data obtained at 100 percent rated power for a cumulative period equal to 30 days.

- c. Upon review of information in the preceding items the Air Pollution Control Officer of the NSCAPCD shall present to the Commission, findings of conformity to air quality and/or acceptability of proposals to achieve those standards.

Compliance With Ambient Air Quality Standards

The California standard of 30 ppb H_2S for a one-hour average has consistently been exceeded throughout The Geysers and the surrounding areas. As shown in Chapter III, Tables III-21a and III-21b, measured levels of H_2S exceeded the standard 10 percent of the time in 1976 and 5 percent in 1977 at the SRI-2 site on the ridge near the proposed plant site. At the SRI-6 site in Anderson Springs, the standard was exceeded 0.04 percent of the time in 1976 and .013 percent in 1977. With further development of geothermal resources in The Geysers, even greater and more frequent violations would be anticipated if H_2S emissions from power plants continued, unabated.

The location of a particular emission source influences the direction, distance, and degree of dispersion of emissions. Topographic features influence meteorological conditions and can create a wind flow field which would tend to direct the flow in a specific direction. The presence of a strong atmospheric inversion will tend to contain emissions within and beneath the inversion layer. Since wind is the transport mechanism for emissions, misplacement of an emission source may cause localized increases in pollutant levels and violations of standards.

During certain wind and/or atmospheric inversion conditions, emissions may be blown or drawn downslope into low-lying valley areas. If the area is populated, there may be an increase in complaints about odor and the unknown potential for long-range impacts to the population and/or the environment.

The NCPA has stated in the NOI (NCPA, 1978b) that emissions during downwash conditions would be carried into the Dry Creek watershed and drainage area and would be dissipated before affecting populated areas. MRI, under contract to NCPA has conducted additional tracer studies to determine the direction and destination of emissions from the project during a variety of meteorological and atmospheric conditions.

The MRI Study-

In order to calculate the projected impacts of the NCPA No. 2 power plant emissions on nearby sensitive receptors (i.e., Anderson Springs, Middletown and Collayomi Valley), MRI first conducted a study (Knuth and Giroux, 1979) to determine the anticipated ambient H_2S background concentrations in potential receptor areas.

The MRI study was based on a "rollback" analysis. Rollback assumes that baseline air quality, as affected by a diffuse source configuration such as the numerous geothermal power generating units in The Geysers, is approximately

proportionate to the upwind source strength. Rollback analysis was performed to determine what H_2S background concentrations would be in future years when the emissions from existing plants are reduced through retrofit control technology.

MRI tabulated estimated H_2S background concentrations (see Table IV-2) in various areas of The Geysers (see Figure IV-1 and reviewed historical measurements of air quality and meteorological data, such as the ERT report (Steffan, et al, 1978). MRI indicated that different Geysers Units create maximum impacts in different downwind areas.

Figure IV-1 (Knuth and Giroux, 1979) shows a somewhat idealized profile of cross-ridge transport around Cobb Mountain to populated communities in Lake County. Emissions from sources (power plants, steam wells, natural emissions) near the bottom of Big Sulfur Creek (source Area #1) are channeled eastward past SRI-2, into the Putah Creek watershed. Emissions from other sources (Source Area #3) outside of Big Sulfur Creek generally flow in a northeasterly path around the community of Cobb, across Cobb Valley, and into the Kelsey Creek drainage.

The area around Units 9 and 10, located four miles northeast of the proposed NCPA No. 2 site, because of its high elevation (approximately 3,000 ft) and intermediate location between the two assumed distant source areas, comprises a small region designated as Source Area #2. Due to the outstanding topographic feature of Cobb Mountain, there may be some cross-over between the two air-streams on the lee side of Cobb Mountain near Whispering Pines. The topography of the KGRA thus represents an effective barrier that allowed MRI to distinguish between the probable sources that impact each given area.

The area of maximum probable NCPA No. 2 impact, as designated by MRI and confirmed by NSCAPCD and CEC staff, includes the Putah Creek watershed and the Bear Canyon Creek and Anderson Creek drainages. In this impact area, MRI estimated that future maximum baseline H_2S levels for the community of Anderson Springs would be about 20 ppb, for Collayomi Valley about 20 ppb, for Middletown about 15 ppb and for Whispering Pines about 10-30 ppb. The uncertainty at Whispering Pines reflects the unique location of that community in the lee of Cobb Mountain that receives airflow from the other Geysers source areas (see Figure IV-1).

Having established the probable future baseline concentrations of H_2S at various sensitive receptors, NCPA next determined the potential incremental impacts that the proposed NCPA No. 2 project would contribute to the future baseline. A series of tracer tests were conducted during November 1978 and January 1979 from the proposed power plant site to simulate transport and dispersion from the proposed site. The tests were conducted with tracer releases at heights simulating those anticipated for a cooling tower plume under the following estimated worst case meteorological conditions:

- a. "Limited Vertical Mixing", in which a layer of neutral stability extends above the ridgeline and is capped by a stable layer (subsidence inversion);
- b. "Downwash", in which high velocity (greater than 8 meter/second) air movement across a ridge top is deflected downward into an adjacent valley or lee side of the ridge by mechanical fluid motion;

Figure IV-1

Idealized source/receptor relationship for predicting future Geysers area H_2S concentrations

TABLE IV-2

Projected Background H₂S Levels at Various Lake/Sonoma County Sites, As Predicted by "Rollback" Model

Receptor Area (SRI-#)	Current Annual Max. H ₂ S (ppb)	Dispersion Factor (ppb/lb/hr)	Future Max. Annual H ₂ S Conc. (ppb)
2	250	.23	60*
5	60	.06-.55	10 - 30
6	80	.07	20
8	80	.05	20

* only a portion of new units will impact Anderson Ridge site
Source: Knuth and Giroux, MRI 1979.

TABLE IV-3

Maximum Predicted 1982 H₂S Concentrations for Sensitive Receptor Locations

Location	NCPA No. Contribution (24 lb/hr emission rate)			"Ambient" Sources Contribution	Maximum Combined Impact
	Limited Mix	Downwash	Drainage		
Anderson Ridge	—	—	—	60	60
Whispering Pines	0.2	0.7	0.0	20	20.7
Anderson Springs	1.2	1.2	0.7	20	21.2
Hartin Springs	1.0	1.8	0.0	18	19.8
Collayomi Valley	2.4	2.4	1.2	20	22.4
Middletown	1.2	1.5	0.9	15	16.5
Cloverdale	0.7*	0.5*	0.2*	10	10.7
Alexander Valley	1.2*	1.4*	0.5*	15	16.4
Healdsburg	0.5*	0.2*	0.2*	10	10.5

* Based on the assumption that the greater distance from the source (2 to 3 times) will create dispersion of that same magnitude as compared to Collayomi Valley.
Source: Knuth and Giroux, MRI, 1979.

- c. "Nocturnal Drainage", in which low velocity (less than 3 m/sec) air flows occur near the ground surface on hillsides and in valleys, trapping pollutants, and confining them near the ground.

Although no tracer releases were conducted at the proposed site under nocturnal drainage conditions, tracer releases in the immediate area (Unit 13, Unit 16, and elsewhere in the Shell leasehold) were analyzed. Sufficient data and information existed to allow the NSCAPCD to conclude that an analysis using a tracer release at a ridgeline site (such as the proposed NCPA No. 2 site) would not be necessary to evaluate drainage condition impacts (NCPA, 1979d).

Projected Impacts-

Utilizing the previously described project pollutant emission rates (Table III-10), results from tracer releases from the proposed project site, and a review of MRI's impact analyses, MRI projected impacts on various sensitive receptors. These impacts are shown in the AFC. (NCPA, 1979b; Appendix B). The results are summarized below:

- a. On November 2 and 8, 1978, tracer releases were conducted from the proposed NCPA/Shell site during Limited Vertical Mixing meteorological conditions. Based on an assumed plant emission rate of 24 lbs/hr of H_2S , estimated ambient concentrations of H_2S at sensitive receptors (Anderson Springs, Collayomi Valley, and Middletown) would reach levels of approximately 3 ppb maximum (NCPA, 1979d).
- b. Downwash meteorological conditions were evaluated on January 17, 1978, and predicted maximum impacts at the same sensitive receptors could reach 3 ppb maximum.
- c. Analysis of tracer releases conducted off the site but within the Shell leasehold and a specific release from the site into Sonoma County under drainage conditions predicted a maximum impact of less than 2 ppb at the same sensitive receptor locations.

Compliance Determination-

Given the maximum future baseline H_2S concentrations at sensitive receptor locations and the additional impacts that could be expected from the NCPA No. 2 project, the final step is to superimpose the results of these analyses and determine if the attainment and maintenance of the California H_2S ambient air quality standard is likely to occur. To make this determination, the combined impacts of all geothermal units in operation when the NCPA No. 2 plant becomes operational has been correlated to the state ambient H_2S standard in Table IV-3.

The table indicates that it is likely that, under the assumptions previously stated (calculated background concentrations, PGandE Geysers units operating in compliance with NSCAPCD and LCAPCD regulations, and a 24 lb/hr emission rate from the NCPA No. 2 plant), the H_2S ambient air quality standard will not be violated in areas of sensitive receptors nor will there be interference with

achievement of the standard. However, violation of the H_2S ambient standard may occur in other areas. In fact, as indicated in Table IV-3, a violation is predicted to occur on Anderson Ridge with or without the proposed NCPA No. 2 project.

Evaluation of data gathered on ambient total suspended particulate matter (TSP) indicates that no violations of this standard have occurred at sensitive receptor locations. The NCPA No. 2 plant, as proposed, is not a major source (6 lbs/hr maximum) of TSP and therefore is not likely to cause a violation nor interfere with the maintenance of the standard. Assuming the TSP were transported to the same sensitive receptor locations evaluated for H_2S impacts and assuming the TSP impacts to also be proportioned to their emission rate, a simplified calculation of projected ambient concentration has been performed below.

$$\begin{aligned} 24 \text{ lbs/hr } H_2S &= 3 \text{ ppb ambient concentration} \\ &= 4.2 \mu\text{g/m}^3 \text{ ambient concentration} \end{aligned}$$

$$\begin{aligned} 6 \text{ lbs/hr TSP} &= \text{one-quarter } H_2S \text{ ambient concentration} \\ &= 1.05 \mu\text{g/m}^3 \text{ ambient concentration} \end{aligned}$$

Compared to the $100 \mu\text{g/m}^3$ (24 hr average) ambient air quality standard for TSP, the impacts from the proposed NCPA No. 2 plant appear insignificant.

Compliance During Abnormal Conditions

Analysis of project impacts must not only consider anticipated normal operating conditions (a 24 lbs/hr H_2S emission rate) but also abnormal conditions. Periodically a geothermal power plant may cease operation, either because of scheduled, routine maintenance or because of unscheduled, forced shutdown. When this occurs the steam supply is vented to the atmosphere or "stacked". During "stacking" as much as 177 lbs/hr of H_2S may be emitted at the proposed project site. The 177 lb/hr emission rate is based on data in the AFC document concerning steam quality and steam flow rates. ($90 \text{ ppm } H_2S \times 1,966,000 \text{ lbs steam/hr} = 177 \text{ lbs/hr } H_2S$).

Using the MRI tracer study findings, the estimated ambient H_2S levels resulting from maximum H_2S emissions during stacking (177 lbs/hr H_2S) show no violation of the ambient air quality standard at the sensitive receptor locations. This conclusion assumes that the maximum potential impact of 177 lbs/hr will be 7.5 times the potential impact of the normal plant emission rate of 24 lbs/hr H_2S ($177/24 = 7.5$). (For example, 7.5 times the expected level of 2.4ppb = 18ppb of Collayomi Valley.)

However, if these impacts are added to the assumed 1982 background, MRI's results would predict violations to occur in three sensitive receptor locations: Anderson Springs, Harbin Springs and Collayomi Valley. A similar analysis of the impact of steam stacking during the outage of a single plant turbine unit (resulting in 88.5 lb/hr of H_2S emissions) predicts a violation of the standard only in Collayomi Valley.

Under NSCAPCD Rule 230 (New Source Review) a new source cannot be permitted if the source's contribution to ambient background concentrations of a pollutant will result in a violation of the ambient air quality standard for that pollutant. Since steam stacking episodes are predicted to result in violations, neither NCPA nor Shell will be permitted to stack steam during single or dual unit outages (the conditions under which the 88.5 or 177 lbs/hr H₂S emission maximum is possible) without additional abatement.

MITIGATION MEASURES

During abnormal operating situations the following abatement measures will be implemented by NCPA and Shell:

- o The proposed plant will employ 100 percent backup systems for many critical components, including condensate pumps. In addition, the plant is designed to operate as two independent 55 MW units. During outages at one unit, steam will continue to flow to the operating unit and crossover piping will allow rereouting of steam from one unit to the other.
- o Shell will use automated control valves which will throttle back supply wells during plant outages.
- o Shell's control valves will be capable of reducing steam flow by 50 percent within 30 minutes of an unscheduled outage at one unit and within 15 minutes of an outage at both units (Shell, in NCPA, 1979e). CEC staff believes this response time is adequate to keep stacking emissions in compliance with the H₂S ambient standard. The staff conclusion has not yet been verified by the NSCAPCD.

Prevention of Significant Deterioration (PSD)

The federal Clean Air Act Amendments of 1977 contain comprehensive regulations intended to prevent significant deterioration of the existing air quality in those places where the air quality is presently better than the national ambient air quality standards. This law required EPA to categorize these areas into one of three classes: Class I applies to areas where practically no deterioration is permitted and the siting of new sources is greatly limited; Class II applies to areas where a moderate amount of deterioration would be allowed; and Class III applies to areas where greater, but defined, amounts of deterioration would be acceptable. In any event, Class I, II, or III areas are not allowed to be impacted by new sources to such a degree as to exceed the National Ambient Air Quality Standards.

The proposed project is located in an area presently designated as Class II. All assessed impact areas are also classified as Class II. The nearest Class I area is approximately 50 miles north of the proposed project site. At the present time, the only emissions from the proposed project which are directly regulated by PSD are particulate emissions.

Under PSD regulations, the maximum permissible deterioration in ambient particulate levels in a Class II area is 37 $\mu\text{g}/\text{m}^3$ (24 hour averaging time). Assuming the estimated maximum particulate emission rate of approximately 6 lbs/hr, the maximum impacts from the project on ambient TSP will be on the order

of $1 \mu\text{g}/\text{m}^3$ (averaged over one hour) at the sensitive receptors described earlier. This $1 \mu\text{g}/\text{m}^3$ impact would be even less if averaged over 24 hours, as specified by the PSD Class II allowable deterioration increment. Consequently, the impact of the proposed NCPA No. 2 facility would be far below the allowable Class II increment, and the facility would be too far from the nearest Class I area to cause any significant air quality deterioration.

PSD regulations also require best available control technology (BACT) to be applied to sources of any regulated pollutants. Although H_2S is not directly regulated by PSD regulations, H_2S is a federally regulated pollutant in some circumstances. Consequently, if EPA required that BACT for H_2S be employed on this facility, compliance is likely. The federal definition of BACT is similar to "reasonably available (state of the art) control technology." The use of Stretford abatement supplemented by secondary condensate treatment is expected to satisfy the federal BACT requirement.

HEALTH AND SAFETY

PUBLIC HEALTH

NCPA No. 2 geothermal power plant will emit steam contaminants and H_2S abatement chemicals, resulting in an increase in ambient air concentrations of pollutants in nearby populated areas. When pollutant levels are sufficiently high, adverse health effects can result. Appendix F contains discussions of health effects from geothermal pollutants.

The potential for public health impacts is determined by comparing ambient pollutant concentrations to ambient air quality standards for regulated pollutants, or guidelines for suggested safe levels of unregulated pollutants.

Standards

Table IV-4 lists ambient air quality standards for regulated pollutants, and Table IV-5 lists values for assessing potential public health impacts from unregulated pollutants in ambient air.

For certain geothermal contaminants, there are both occupational exposure and ambient air quality standards. Occupational standards are intended to protect generally healthy workers exposed to certain pollutants for limited times (e.g., work hours), often under controlled conditions. Ambient air quality standards are generally intended to protect a more diverse population containing potentially sensitive individuals (e.g., the very young and old, the acutely or

TABLE IV-4
Ambient Air Quality Standards

<u>Pollutant</u>	<u>Averaging Time</u>	<u>California Standard</u>	<u>Primary Federal Standard</u>
Carbon Monoxide	12 hour	10 ppm ₃ (11 mg/m ³)	—
	8 hour	—	9 ppm (10 mg/m ³)
	1 hour	40 ppm ₃ (46 mg/m ³)	35 ppm (40 mg/m ³)
Hydrogen Sulfide	1 hour	0.03 ppm (42 µg/m ³)	—
Non-Methane Hydrocarbons	3 hour (6-9 a.m.)	—	160 µg/m ³ (0.24 ppm)
Lead	30 day	1.5 µg/m ³	1.5 µg/m ³ (quarterly average)
Nitrogen Dioxide	Annual Average	—	0.05 ppm (100 µg/m ³)
	1 hour	0.25 ppm (470 µg/m ³)	—
Oxidant (Ozone)	1 hour	0.10 ppm (200 µg/m ³)	0.12 ppm (240 µg/m ³)
Sulfur Dioxide	Annual Average	—	0.03 ppm (80 µg/m ³)
	24 hour	0.05 ppm (131 µg/m ³)*	0.14 ppm (365 µg/m ³)
	1 hour	0.5 ppm (1310 µg/m ³)	—
Suspended Particulate Matter	Annual Geometric Mean	60 µg/m ³	75 µg/m ³
	24 hour	100 µg/m ³	260 µg/m ³
Sulfates	24 hour	25 µg/m ³	—
Radon-222	Annual Average	3 pCi/l**	—

*When standards for total suspended particulates or oxidant are being exceeded.
**Above natural background, at point of release to the environment.

TABLE IV-5

Values for Assessing Potential Public Health Impacts
From Non-Regulated Pollutants in Ambient Air

Pollutant	Type of Value	Source	Concentration	Averaging Time
Ammonia	California Occupational Standard	Cal/OSHA	25 ppm	8 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	0.06 ppm (43 $\mu\text{g}/\text{m}^3$)	annual average*
	Foreign Ambient Air Quality Standards	Russia & East European Countries	0.14 - 0.71 ppm	24 hours
Arsenic	Suggested Occupational Standard	NIOSH	2.0 $\mu\text{g}/\text{m}^3$	15 minutes
	Suggested Threshold Limit Value	ACGIH	50 $\mu\text{g}/\text{m}^3$	8 hours
	Presumed Safe Level	MTR - 6401	5.9 $\mu\text{g}/\text{m}^3$	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	0.005 $\mu\text{g}/\text{m}^3$	annual average*
Boron	Presumed Safe Level	MTR - 6401	50 $\mu\text{g}/\text{m}^3$	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	7.4 $\mu\text{g}/\text{m}^3$	annual average*
	California Occupational Standard	Cal/OSHA	10 mg/m^3 boron oxide	8 hours
Mercury	Presumed Safe Level	MTR - 6401	0.8 $\mu\text{g}/\text{m}^3$	24 hours
	Suggested Ambient Level Goal (based on toxicity)	EPA-600/7-77-136	0.1 $\mu\text{g}/\text{m}^3$	annual average*
	Suggested Ambient Level Goal (based on carcinogenic potential)	EPA-600/7-77-136	0.01 $\mu\text{g}/\text{m}^3$	annual average*
	California Occupational Standard	Cal/OSHA	50 $\mu\text{g}/\text{m}^3$	8 hours
Vanadium	Presumed Safe Level	MTR - 6401	6.8 $\mu\text{g}/\text{m}^3$	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	1.2 $\mu\text{g}/\text{m}^3$	annual average*
	Suggested Threshold Limit Value	ACGIH	0.5 mg/m^3 (dust) 0.05 mg/m^3 (fume)	8 hours
	Calif. Occupational Standard	Cal/OSHA	0.5 mg/m^3 (dust) 0.1 mg/m^3 (mist)	8 hours
ADA (anthraquinone disulfonic acid)	Suggested Ambient Level Goal	To be published by Oct 1979**	260 $\mu\text{g}/\text{m}^3$	annual average*
Hydrogen Peroxide	Suggested Threshold Limit Value	ACGIH	1 ppm	8 hours
	Calif. Occupational Standard		1 ppm	8 hours
Iron	Suggested Threshold Limit Value	ACGIH	10.0 mg/m^3 (iron oxide fumes) 1.0 mg/m^3 (iron salts) 0.08 mg/m^3 (iron pentacarbonyl)	8 hours
	Calif. Occupational Standard	Cal/OSHA	10.0 mg/m^3	8 hours

*Although an averaging time for Suggested Ambient Level Goals is not stated within the document, EPA-600/7-77-136 the authors have indicated that these goals are most applicable to annual average concentrations.

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Abbreviations: Cal/OSHA California Occupational Safety and Health Administration
NIOSH National Institute for Occupational Safety and Health
ACGIH American Conference of Governmental and Industrial Hygienists

EPA-600/7-77-136 Multimedia Environmental Goals for Environmental Assessment, J. L. Cleveland and G. L. Kingsbury, U.S. EPA, Nov. 1977.

MTR-6401 Presumed Safe Ambient Air Quality Levels for Selected Potentially Hazardous Pollutants, S. L. Wilcox, The MTR Corporation, May 1978.

chronically ill, etc.) from longer term continual exposure. Both types of standards are based on concern for human health, but they often provide different levels of protection. Typically, ambient air quality standards are more stringent than necessary for application in working environments, while occupational exposure standards may only provide a rough guide for evaluating the significance of ambient air quality impacts for the general public. An appropriate ambient air quality standard for a given pollutant may be several orders of magnitude lower (more restrictive) than an occupational exposure standard for the same pollutant.

Conversely, the absence of an ambient air standard to protect public health from a given pollutant does not necessarily mean that the pollutant poses no threat to human health. Rather, such absence may reflect more a lack of sufficiently reliable data upon which to base a legal standard, or the considerable time required by the rulemaking procedures to establish standards, than a lack of need or concern. For example, there is no adopted ambient air quality standard for arsenic. Yet, arsenic and certain arsenic compounds are known toxicants and carcinogens.

The 1977 Amendments to the Clean Air Act direct the Federal EPA to determine the health risk posed by certain unregulated pollutants, including arsenic, and if a potential danger to public health exists, establish criteria and regulations for their control. To date, the EPA has not adopted regulations or standards for many potentially harmful power plant emissions. In the interim, the Commission should be concerned about emissions from thermal power plants such as arsenic and other unregulated pollutants, which are generally known to be or suspected of being harmful to human health.

For those pollutants which are not subject to adopted ambient air quality standards, several agencies and research groups have suggested what they consider to be safe levels or maximum permissible ambient air concentrations of certain pollutants. Methodologies and criteria for determining these levels vary, often resulting in quite different values. Neither CEC nor other state or federal agencies have adopted any of these suggested levels as standards. Staff analysis therefore presents the range of those values suggested by agencies and research groups as a guide for assessing the potential for public health impacts.

Most available air quality data for The Geysers area are expressed in terms of maximum hourly average pollutant concentrations. In order to make comparisons with suggested safe annual average concentrations, CEC staff has assumed, as a worst case, that annual average pollutant concentrations are one-tenth the maximum hourly averages. This assumption is based on historical H_2S data for The Geysers area (SRI, 1978). The data showed that, depending upon the location, maximum hourly average H_2S concentrations ranged from 11, to greater than 48 times the annual average H_2S concentrations in 1976 and 1977. It is assumed that the relationship between maximum hourly average and annual average concentrations are similar for other geothermal pollutants.

Ambient Pollutant Concentrations

Ambient pollutant concentrations to which the public will be exposed are the sum of background pollutant concentrations and the contribution of project emissions

to ambient concentrations. Obviously, an air quality analysis is necessary for any public health analysis. Such a study is being prepared by the Commission Staff and the Northern Sonoma County Air Pollution Control Officer (APCO), based on the data submitted by NCPA and their own independent studies. The public health analysis presented here is based on a worst case air quality assumption and uses much of the public health impact data provided by NCPA in the NOI and AFC.

Table IV-6 lists NCPA's estimated rates of steam contaminants from the NCPA No. 2 cooling tower. The values in Table IV-6 are maximum possible emission rates based on available data.

TABLE IV-6

Estimated Emission Rates of Pollutants in Geothermal Steam

Hydrogen Sulfide	24 lb/hr
Ammonia	388 lb/hr
Mercury	0.04 lb/hr
Arsenic	0.038 lb/hr
Boron*	32 lb/hr
Radon-222	0.0122 lb/hr
Total Suspended Particulates	3.3 lb/hr

SOURCE: NCPA, 1979 b, pages VII-1 to VII-7.

*Based on average boron concentration in steam from 61 producing wells at The Geysers (Altschuler, 1978, in PGandE Report 420-78.104).

The emission rate for hydrogen sulfide assumes abatement to comply with the Northern Sonoma County Air Pollution Control District emission limitation of 100 grams H_2S per gross megawatt hour. The emission rates of ammonia, arsenic, and boron are based on average steam composition from 61 producing wells measured at The Geysers in 1972-1974 (PGandE, 1978). Available data indicates that four wells drilled for NCPA No. 2 contain less than average concentrations of steam contaminants measured at The Geysers (NCPA, 1979d). In addition, the emission rates for ammonia, mercury, arsenic, boron and radon-222 assume that the total quantity of these steam constituents entering the plant are emitted to the atmosphere from the cooling tower. Studies of pollutant flow through geothermal power plants at The Geysers, however, indicate that a portion of the incoming steam contaminants are rejected with excess condensate or deposited in cooling tower sludge (Pimental, 1978).

Hydrogen Sulfide

NCPA has concluded that the proposed power plant H_2S emissions of 24 pounds per hour would contribute a maximum of 2.4 parts per billion (ppb) H_2S to background levels. The maximum impact on ambient H_2S levels at the nearby

sensitive receptors, Anderson Springs and Middletown, is estimated by NCPA to be 1.2 ppb or less (NCPA, 1979b, IV-6). This contribution from the proposed project by itself is well below the state ambient air quality standard of 0.03 parts per million (ppm) H_2S .

The acceptability of NCPA's air quality analysis has not been acknowledged by the Northern Sonoma County Air Pollution Control Officer.

Radon-222

CEC staff believes that because of steam source similarities, radon-222 emissions from the proposed project probably will not differ substantially from those monitored at PGandE's Geysers Units 1 through 11 (see Table IV-5). Results of monitoring programs for Units 1-11 indicate that radon-222 emissions meet applicable standards, therefore NCPA No. 2 radon-222 emissions from the proposed project probably will not exceed applicable standards.

Ammonia

If the steam supply for the NCPA No. 2 project contains 194 parts per million (ppm) ammonia, (the average concentration measures in steam from 61 wells at The Geysers) the maximum contribution to ambient air ammonia concentrations in populated areas would be 0.08 ppm (one-hour average) based on tracer study results (NCPA, 1979f). However, concentrations of ammonia in steam from exploratory wells for the proposed project are reported to be less than 194 ppm (NCPA, 1979b). This analysis assumes all ammonia entering the plant would be emitted to the atmosphere through the cooling tower and dispersed as a gas.

Based on analysis of available data, staff concludes that ammonia emissions from the NCPA No. 2 project would not increase background ammonia concentrations above suggested safe levels, and public health will not be adversely impacted.

Arsenic

NCPA estimates that if the steam supply for NCPA No. 2 contains 0.019 ppm arsenic, the average concentration measured in steam from 61 wells at The Geysers, the maximum contribution to ambient air₃ arsenic concentrations in populated areas would be approximately 0.005 g/m^3 (one-hour average) (NCPA, 1979 b, VII-3). Concentrations of arsenic in steam from exploratory wells for the proposed project are reported to be less than 0.02 ppm (NCPA, 1978b). This analysis assumes that all arsenic entering the plant is emitted to the atmosphere through the cooling tower and disperses as a gas according to results of the tracer study (NCPA, 1979 b; 1979 f). The incremental increase in emissions from the proposed project, over the maximum background arsenic concentrations defined by limited historical data (see Chapter III, public health) would result in a maximum hourly average concentration of approximately 0.049 g/m^3 .

Assuming as a worst case, that the annual average concentration is one-tenth the maximum hourly average concentration, the corresponding maximum annual average arsenic concentration would be 0.0049 $\mu g/m^3$. This estimated maximum concentration is approximately equal to most stringent suggested safe level, the Multimedia Environmental Goal of 0.005 $\mu g/m^3$ arsenic in air.

Based on analysis of available data, staff concludes that arsenic emissions from the NCPA No. 2 project would not increase background arsenic concentrations above suggested safe levels, and public health will not be adversely impacted.

Mercury

Concentrations of mercury in steam from exploratory wells for NCPA No. 2 are reported to be as high as 0.02 ppm (NCPA, 1979 b). NCPA estimates, based on this concentration of mercury in incoming steam and tracer study results, that the maximum contribution to ambient air mercury concentrations in populated areas would be $0.005 \mu\text{g}/\text{m}^3$ (one-hour average) (NCPA, 1979 b).

Assuming as a worst case, that the annual average concentration is one-tenth the maximum hourly average concentration of $0.405 \mu\text{g}/\text{m}^3$, the corresponding maximum annual average mercury concentration based on NCPA No. 2 contribution and limited historical data (see Chapter III, public health) would be $0.0405 \mu\text{g}/\text{m}^3$. This estimated maximum concentration is less than the most stringent safe level of $0.1 \mu\text{g}/\text{m}^3$ based on toxic effects of mercury suggested by EPA-600/7-77-136.

One suggested safe level, the Multimedia Environmental Goal for organic mercury compounds in ambient air is $0.01 \mu\text{g}/\text{m}^3$, based on carcinogenic potential. Analysis of mercury in cooling tower exhaust indicates that mercury at The Geysers is primarily inorganic mercury (Robertson, 1977). CEC staff believes that the suggested level for mercury based on toxicity is probably more applicable than the suggested level based on carcinogenic potential when comparing project emissions to ambient mercury concentrations at The Geysers.

Based on analysis of available data, staff concludes that mercury emissions from the NCPA No. 2 project would not increase background mercury concentrations above appropriate suggested safe levels, and public health will not be adversely impacted.

Boron

If the steam supply for NCPA No. 2 contains 16 ppm boron, (the average concentration measured in steam from 61 wells at The Geysers), the maximum contribution to ambient air boron concentrations in populated areas would be approximately $4.5 \mu\text{g}/\text{m}^3$ (one-hour average). This analysis assumes that all boron entering the plant is emitted to the atmosphere through the cooling tower and disperses as a gas according to results of the tracer study.

This maximum one-hour average concentration is less than the most stringent suggested safe level, $7.4 \mu\text{g}/\text{m}^3$ (annual average). Therefore, based on available data, it appears that NCPA No. 2 boron emissions would not adversely impact public health.

Emissions from Hydrogen Sulfide Abatement System

NCPA has proposed to abate hydrogen sulfide emissions from the proposed project with a surface condenser and a Stretford System. If necessary, NCPA will also

use a secondary condensate treatment system of hydrogen peroxide and iron catalyst. In the Stretford System the noncondensable gases are passed through a chemical solution; the hydrogen peroxide/iron catalyst system injects chemicals into the steam condensate. A portion of these introduced chemicals will be released to the atmosphere at the Stretford System cooling tower and at the power plant cooling towers. Furthermore, H_2S abatement processes may result in the formation of other compounds, such as sulfates, which can be emitted.

Hydrogen sulfide abatement systems are not expected to reduce emission rates of any pollutant besides H_2S .

Table IV-7 lists estimated Stretford system cooling tower emissions. These values were estimated by the R.M. Parsons Company for the Unit 16 Stretford System; NCPA presumes they are also applicable to the proposed project (NCPA, 1979 d).

TABLE IV-7

STRETTFORD SYSTEM COOLING TOWER EMISSIONS

ADA	0.011 lb/hr
V	0.021 lb/hr
$NaHCO_3$	0.127 lb/hr
Na_2SO_4	0.493 lb/hr
$Na_2S_2O_3$	0.097 lb/hr

SOURCE: NCPA, 1979 d.

Table IV-7 presents maximum resultant ambient concentrations if these emissions disperse in air according to results of the tracer study. Since these emissions will be from the Stretford System cooling tower, instead of the power plant cooling tower, application of the tracer study to these emissions does not produce accurate estimates. However, in light of the very small resultant ambient concentrations, as compared to standards and suggested safe levels (see Tables IV-5 and IV-7), it appears that public health will not be adversely impacted by NCPA No. 2 Stretford System air emissions.

TABLE IV-8

Estimated Maximum Ambient Air Concentrations
Of Stretford System Emissions

Anthraquinone Disulfonic Acid	0.0015 $\mu g/m^3$
Vanadium	0.0029 $\mu g/m^3$
Sodium Bicarbonate	0.0178 $\mu g/m^3$
Sodium Sulfate	0.0690 $\mu g/m^3$
Sodium Thiosulfate	0.1540 $\mu g/m^3$

SOURCE: CEC Staff Analysis.

MITIGATION MEASURES FOR PROJECT-RELATED EMISSIONS

- o Mitigation of health effects or the potential for adverse health effects from inhalation of geothermal pollutants could be achieved by reducing emissions of those pollutants wherever possible. Methods for abatement of H_2S emissions are discussed in Chapter II, project features, Chapter IV, air quality and Chapter V, alternative H_2S abatement.
- o Monitoring emissions and concentrations of H_2S should be conducted to ensure continued compliance with applicable regulations and standards to assist in the protection of public health.
- o The NCPA or its contractor(s) will evaluate existing baseline concentrations of mercury, arsenic and ammonia in ambient air in the vicinity of the proposed NCPA No. 2 project.
- o The NCPA or its contractor(s) will monitor concentrations of radon-222 in incoming steam quarterly to ensure continued compliance with state standards.
- o The NCPA or its contractor(s) will monitor concentrations of ammonia, mercury, arsenic and boron in incoming steam quarterly. If concentrations are sufficient to result in significant ambient concentrations of these pollutants, the NCPA or its contractor(s) will conduct an ambient monitoring program.

These programs are described in detail in Appendix F.

Occupational Health and Safety

Geothermal power plants can pose risks to workers' health and safety. These risks are primarily related to toxic and potentially carcinogenic chemical compounds associated with geothermal steam and hydrogen sulfide abatement systems to which workers may be exposed. Such exposures may occur during routine operation, accident or upset conditions, repair and maintenance activities, and process or system modification activities.

Workers may come into contact with many of the potentially toxic and potentially carcinogenic substances (e.g., hydrogen sulfide, ammonia, radon-222, trace elements, and chemicals associated with hydrogen sulfide abatement systems) in geothermal steam, waste streams and during handling of chemicals used in abatement systems or as a result of leaking equipment. Adverse effects of such exposures could include dermatitis, acute chemical poisoning, chronic illnesses and, potentially, cancers after some induction latency period.

General Industry Safety Order 3203 (Subchapter 7 of Chapter 4, California Administrative Code, Title 8) requires employers to have an accident prevention program to reduce or prevent occupational injuries and illnesses, and to conduct periodic inspections to correct unsafe conditions. Employers must comply with California Administrative Code, Title 8, Chapter 4, Group 16 (Articles 107-112) which refers to control of hazardous substances. Construction Safety Order 1509 (Chapter 4, Subchapter 4, CAC Title 8) requires employers to have an accident prevention plan for construction activities.

The California Division of Occupational Safety and Health (DOSH) enforces compliance with state occupational safety and health standards. DOSH must inspect the plant if there is a complaint from an employee. If worker conditions are found to be in violation of an occupational standard, DOSH will determine what corrective actions must be taken. There is generally no means for ensuring that an employer has an adequate accident prevention program until DOSH receives a worker complaint regarding worker health or safety.

Mitigation Measures

- o NCPA should submit to the Energy Commission, not later than 150 days prior to commencement of operation of the proposed project, a letter from the Cal/OSHA Consultation Service indicating that NCPA's program is in conformance with the requirements of Title 8 CAC, General Safety Order 3203.
- o NCPA should also submit to the Commission a letter from the Cal/OSHA Consultation Service indicating that NCPA's accident prevention program is in conformance with the requirements of Chapter 4, Subchapter 4, Title 8 CAC, Construction Safety Order § 1509.

The Cal/OSHA Consultation Service has agreed to review the accident prevention program proposed for the NCPA No. 2 project. NCPA has agreed to have the Cal/OSHA Consultation Service make recommendations regarding the adequacy of its worker health and safety program (NCPA, 1979e).

NOISE

Geothermal energy development and utilization in The Geysers KGRA was for many years confined to remote, nearly uninhabited mountainous areas. Since the early 1970s, however, geothermal development projects have been moving closer to residential districts and citizens have expressed concern about potential increases in noise.

The sources and intensities of noise generated by the proposed project will vary according to the phase of the project. The effects of project-generated noise will vary according to distance, terrain and meteorological conditions. All project-generated noise will be in addition to existing ambient sound levels at a particular receptor site. For a more complete listing of sound data associated with geothermal development and operation refer to Figure IV-2.

Copies of the noise report prepared for the NCPA No. 2 project by staff at Lawrence Livermore Laboratories (Lamson, 1979) are on file at the following locations:

1. The California Energy Commission, Sacramento
2. Lawrence Livermore Laboratories, Berkeley
3. U.S. Department of Energy, Oakland

Noise Standards

Sonoma County has adopted a Noise Element to its General Plan which is intended to provide the basis for local programs to control environmental noise and to protect the community from excessive noise exposure. In the absence of

NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

SOURCE: EPA:PB#206-717, ENVIRONMENTAL PROTECTION AGENCY, 31 DEC 1971
NOISE FROM CONSTRUCTION EQUIPMENT AND OPERATIONS

CONSTRUCTION EQUIPMENT NOISE LEVELS

Figure IV-2

California Energy Commission permitting authority, Sonoma County would issue a conditional use permit which would most likely limit project noise emissions. Previous permits for production activities have set noise limits of 65 dBA for daytime and 55 dBA for night (10 pm - 7 am) as measured at the exterior of the nearest occupied residence. Noise limits for operations are set at 65 dBA daytime and 50 dBA, night.

Lake County has adopted a Noise Element to its General Plan and is currently in the process of adopting a noise ordinance. It is the intent of this element to limit noise levels at residential receptors to 55 Ldn. Under the proposed ordinance, maximum permissible sound levels received at a residential land use may not exceed 55 dBA during the day and 45 dBA during the night. Intermittent noises may exceed these limits by 3 dBA for a duration of 30 minutes per hour and by 15 dBA for less than 2 minutes per hour.

The applicable federal noise abatement regulations are contained in the Geothermal Resources Operation Order No. 4 published by the Conservation Division of the U.S. Geological Survey. The criteria for noise are:

"...the lessee shall not exceed a noise level of 65 dB(A) for all geothermal-related activity including but not limited to, exploration, development, or production operations as measured at the lease boundary line or 0.8 km (one-half mile) from the source, whichever is greater, using the A-weighted network of a standard Sound Level Meter. However, the permissible noise level of 65 dB(A) may be exceeded under emergency conditions or with the Geothermal Area Supervisor's approval if written permission is first obtained by the lessee from all residents within 0.8 km (one-half mile)."

The U.S. Environmental Protection Agency (EPA) has identified sound levels necessary to protect the public health and welfare. These EPA values are shown in Table IV-9. It should be noted that the exposure period which results in adverse health effects is 40 years.

TABLE IV-9

Standards for Occupational Noise Exposure

Duration Per Day, Hours	Sound Level, dBA (Slow Response)
8	90
6	92
4	95
3	97
2	100
1-1 1/2	102
1	105
1/2	110
1/4 or less	115

Source: Handbook of Noise Measurement, Table G-16; Title 8 CAC, Article 105

Noise Impacts

Each of the noise sources discussed below will intermittently produce an individual or a cumulative increase in local noise levels during the construction or operation of the proposed project. Using the simple model and the methodology described in Appendix G of this document, forecasts of project noise generation have been made and compared with existing, measured ambient noise levels and applicable standards.

Table IV-10 presents a summary of this analysis of project noise effects at the nearest sensitive receptor, Verdant Vales Camp, located 6,500 feet northeast of the project area (See Figure III-14). Based upon the data shown in this table, project-generated noise should be within daytime standards and will be lower than ambient levels, even during shutdown conditions requiring steam stacking. There is a possibility that unmuffled steam venting for more than a few minutes during the nighttime hours (10:00 p.m. to 7:00 a.m.) would exceed Lake County noise standards and anticipated Sonoma County requirements. However, unmuffled noise represents a worse case occurrence. In the situation most likely to occur, venting steam will be muffled and noise will meet applicable levels.

Table IV-11 presents projected noise levels reaching the next nearest receptor, Anderson Springs, located 9,000 feet east of the project area (See Figure III-14). Ambient noise levels in this community presently range between 37 and 55 dBA. Based upon the data in the table, the projected noise levels, even during steam stacking, should fall within measured ambient levels. Due to topographic deflection of any noise produced, actual sounds reaching the community should be lower than the projected sounds shown in Table IV-11.

If the proposed control measures are implemented, sounds produced by the proposed project should be within the levels identified by the EPA as requisite to protect the public health and welfare, with an adequate margin of safety.

Noise During Power Plant Construction

Construction noises are considered to have relatively short-term impact and are generally limited to the daylight hours, Monday through Friday. During site preparation and construction of the power plant facilities, the primary source of noise will be the motorized equipment used at the site. Sound levels from typical equipment used during this phase are shown in Figure IV-2. Based upon data presented in this figure, the highest levels of construction noise (70-95 dBA) will occur when earth moving equipment is in operation.

MITIGATION MEASURES

- o Construction workers and equipment operators on-site will be most directly affected by construction sounds. The NCPA should require its employees and contractors to abide by the current provisions of Cal/OSHA and meet the current standards for occupational noise exposure, as indicated in Table IV-9. All motorized equipment should be muffled. Where sound levels are in excess of exposure standards, hearing protectors should be provided for workers.

SUMMARY: PROJECT NOISE EFFECTS AT CLOSEST RECEPTOR COMPARED TO APPLICABLE STANDARDS

TABLE IV-10

E.P.A. EQUIVALENT SOUND LEVELS IDENTIFIED AS REQUISITE TO PROTECT THE PUBLIC HEALTH AND WELFARE, WITH ADEQUATE MARGIN OF SAFETY VS. PREDICTED NOISE LEVELS AT CLOSEST SENSITIVE RECEPTOR SITE (CAMP VERDANT VALES) DUE TO ACTIVITIES AT THE NCPA/SHELL POWER PLANT SITE.

NCPA/SHELL Noise Source	Predicted Outside ² Noise Level at Camp Verdant Vales (dBA)	E.P.A. Guidelines, ³ with adequate margin of safety. Residence with outdoor space and farm residences L _{dn}	Sonoma County Noise Standards	Lake County Noise Standards (Draft 1/79) (dBA)	Federal Standards (dBA)	Sample Ambient Noise Levels (dBA)
Site Construction	33	55	No set standards; uses land use compatibility criteria. Use permits usually specify 60 dBA day and 40 dBA night.	55 dBA day 45 dBA night Allows higher peaks 3-15 dBA for short durations, excursions.	65 dBA at lease boundary or 1/2 mi from source. Allows higher peaks of short duration.	38-55
Clearing steam pipelines ¹	58	55		Residential receptor	65	
Normal power plant operation	23	55		55	65	
Outage Condition (Steam venting)	38	55		55	65	

1. Infrequent, sporadic operation.

2. See Table 9 for details. These predicted levels are based on maximum levels at source as detailed in Table 9; normal levels are typically lower. See data in Tables 5, 6, and 7 and Figures 6 and 7 and discussion in Section IV Mitigating Measures, use of noise reducing mufflers, etc.

3. See Table 10 for details.

4. See Tables 1, 2 and 3 for details.

NOTE: For explanation of L_{dn} and dBA, see Table 10.

Source: Lawrence Livermore Laboratories, January, 1979

TABLE IV-11

SUMMARY OF - PROJECTED NOISE LEVELS AT THE WEST END OF ANDERSON SPRINGS

	Min	Max	L ₉₀	L ₅₀	L ₁₀	L _{eq}	L _{np}	L _{dn}
Typical Ambient Background Noise During Quiet Conditions, Sound Level dBA	28	53	38	40	45			
Projected Site Preparation Noise at a Distance of 10,000 feet, Sound Level dBA			22	27	32	30	45	37
Construction Noise Criteria - Noise Pollution Level (NPL) L _{np} from EDP 206 717- Clearly Acceptable							<62	
Activity Interference Criteria for Outdoor Space L _{dn} from EPA 500/9-74-004 Table 4 p 40, dBA-Residential with Outdoor Space and Farm Residences								≤55
Projected Noise or Main Steam Line Clean Out at a Distance of 10,000 Ft. Sound Level dBA			36	41	46	42	51	48

Source: NCPA, Notice of Intention, August 1978.

- o Off-site effects of construction noise would be mitigated by the natural noise barrier provided by the location of the plant site. The ridge crest to the east would deflect sounds up and over the nearest two receptors, Verdant Vales Camp and Anderson Springs. The plant site is also sufficiently distant from these and other known receptors so that construction sounds would not be discernible from typical ambient sounds during quiet conditions.
- o Construction activities shall occur during daylight hours only, unless unforeseen circumstances require construction during nondaylight hours.

Noise During Normal Power Plant Operations

Inside Power Plant Facilities-

Under normal circumstances the power plant will be in continuous operation and there will be three major sources of noise: The turbine/generator, the steam jet ejectors, and the cooling towers. The building containing the hydrogen sulfide abatement equipment is not expected to be a major source of noise.

The estimated noise levels associated with normal, full-load operation of a geothermal power plant are summarized in Table IV-13. Additional data recorded at operating geothermal facilities is presented in Table IV-14.

Noise propagation characteristics and their associated annoyance potential are dependent upon location, physical dimensions and the noise spectrum of the source. Sound levels from the turbine/generator and other in-plant equipment are estimated to be in excess of 90 dBA at a distance of 5 feet. The sound levels from the steam jet ejectors may reach 93 dBA at a distance of 5 feet. The sound levels from the steam jet ejectors may reach 93 dBA at a distance of 10 feet, but this diminishes rapidly with increased distance because of its high frequency and small radiating surface area.

MITIGATION MEASURES

- o In order to minimize the impacts of equipment noise on workers during operation and maintenance activities, the NCPA should encourage manufacturers to supply equipment which produces a sound level no greater than 80 dBA at 3 feet.
- o An enclosed control room will be built on the turbine/generator floor, inside the turbine building and this will minimize sounds reaching plant operators in the control room.
- o Additional mitigation occurs because this noise-producing equipment is located inside the turbine/generator building. The building walls and roof provide an effective noise barrier which will reduce transmission of noise to the outside. At a distance of 25 feet outside the building sound levels are estimated to range between 70-75 dBA.

Outside Power Plant Facilities-

Outside the turbine/generator building, the primary source of plant operation noise will be in the cooling towers. During normal operation the estimated

TABLE IV-13

ESTIMATED A-WEIGHTED NOISE LEVELS FOR
NORMAL FULL LOAD OPERATION OF THE POWER PLANT

<u>Noise Source Description</u>	<u>Distance Feet</u>	<u>Sound Level (dBA) re. 20 micropascal</u>
1. Cooling Tower	5/10	81/85
2. Outside Turbine/Generator Building	25	70/75
3. Steam Jet Ejector (SJE)	3/10	88/93
4. Around Turbine/Generator Unit Inside Building	3/5	92/94
5. Random Locations on Turbine/ Generator Floor	-	90/94
6. At Plant Fence Line, Distance from Noise Pro- ducing Surfaces	20/70	67/83
7. Total Unit Noise*	500	60 $\pm$ 5

* Total noise from unit at distances greater than 200 feet will be primarily from the cooling tower only.

Source: Ecoview in NCPA Notice of Intention, August 1978.

TABLE IV-14
A-WEIGHTED SOUND LEVELS FROM VARIOUS
NOISE SOURCES AT THE GEYSERS,
dBA, re 0.0002 MBAR OR MICROBAR

<u>Date</u>	<u>Noise Source</u>	<u>Dis- tance, ft.</u>	<u>Sound Level, dBA</u>	<u>Comment</u>
6/27/74	Steam well--Sulphur Bank No. 3	45 180	89/92 73/75	Main valve closed, bleed line exhausting freely.
6/27/74	Steam well--Sulphur Bank No. 13	45	59/62	Main valve closed, bleed equipped with silencer, exhausting freely.
6/27/74	Steam well--Happy Jack No. 8	90	84	Muffled steam well ex- hausting through silencer. Several small diameter bleed lines exhausting.
6/27/74	Steam well--name unknown.	450	105/110	Main valve open, unsilenced. Steam plume about 50 yards high.
6/27/74	Steam well--name unknown.	3000	71/83	Main valve open, unsilenced. Steam plume about 50 yards high.
6/ 1/73	Steam line vent from Unit 7 main line muffler.	40 300	92/94 70/75	Directly in front. 15/25 degrees off axis.
3/21/73	Steam line vents from both Unit 7 & 8 main line mufflers.	800	64	15/25 degrees off axis.
6/ 1/73	Steam jet gas ejec- tor--Unit 5	5	91	Microphone height 5 ft., Unit 5 load unknown.
6/27/74	Steam jet gas ejec- tor--Unit 8	10 20	88 86	Microphone height 5 ft., Unit 8 load 41 MW.
6/27/74	Cooling tower Units 5 & 6.	10	81	Microphone height, 5 ft.
6/27/74	Cooling tower Units 9 & 10	10 40 140	84 80 72	Microphone height, 5 ft.
11/28/73	Outside Unit 5 & 6 turbine generator building.	25	72	Unit 5 - 44 MW Unit 6 - 54 MW

Source: P.G.&E. Amended Environmental Data Statement, Geysers Unit 13, March 1975.

sound level from the cooling towers is 93 dBA at a distance of 10 feet. The cooling towers, because of their large size and wide frequency spectrum, will become the dominant noise source at distances greater than 200 feet from the fence line of the power plant facility.

MITIGATION MEASURES

- o Path treatment installed on the exterior surfaces of the steam jet ejectors will consist of mineral wool and an impervious membrane (an aluminum and/or lead jacket).
- o Thermal (high density) insulation on the exterior surfaces of the steam turbine will reduce the noise inside the turbine building.
- o Steam-heat lines will be routed back into the condenser so that steam will not be discharged into the atmosphere during unit start-ups.
- o Increasing distance from the source and barrier effects of the terrain are expected to produce additional reduction of sound levels. At a distance of 500 feet, overall plant noise is estimated to be 60 + 5 dBA. These noise levels, projected to the west end of Anderson Springs, will not be perceivable. Noise from the NCPA plant should not be a community annoyance in any of the inhabited or sensitive receptor areas. Normal operating noise levels generated by the power plant are expected to produce only temporary effects on wildlife adjacent to the fenced plant boundaries.

During Shutdowns-

Throughout the operational lifetime of the project, there may be occasional emergency or maintenance shutdowns in which a portion of the incoming steam is vented to the atmosphere. When only one of the two turbine/generator units is shut down, automatic control valves will reduce the flow of incoming steam in the pipelines by 50-60 percent. The diminished flow of steam will be directed into the remaining operational unit, reducing the need for steam stacking or venting and any associated increase in sound levels.

Should both units require simultaneous shutdown, the flow of incoming steam will be automatically reduced and the remainder stacked, or vented into the atmosphere. As indicated in Table IV-14, the noise level of unmuffled steam venting directly into the atmosphere has been recorded at 105-110 dBA at a distance of 450 feet.

MITIGATION MEASURES

- o Recently, large rock-filled pits have been constructed adjacent to several existing geothermal power generating units. During stacking situations, steam is vented through these rock mufflers and the noise levels have been reduced from over 100 dBA at a distance of 75 feet to 72 dBA at 25 feet.
- o The NCPA No. 2 project should use a rock muffler to reduce noise produced by steam stacking during periodic shutdowns. In addition, the presence of the ridge will tend to deflect this sound up and over Anderson Springs and the projected noise level reaching the west end of this community is 23 dBA, well below the existing ambient noise levels of 37-55 dBA.

Noise During Steam Supply Development

Sounds generated during site preparation and construction at the well sites and along pipeline routes and access roads will be similar to those produced during power plant construction.

Steam Well Drilling-

Sound levels associated with steam well drilling, stand-by venting and well testing are presented in Figure IV-3.

FIGURE IV-3:
NOISE LEVELS FROM GEOTHERMAL OPERATIONS
Noise Level (dBA) at 50 feet

Drilling of geothermal steam wells is a continuous, 24-hour a day operation lasting from a few weeks to several months for each well site. Wells are

typically mud-drilled in the upper portion and air-drilled to the well bottom. Drilling in a steambearing zone is accomplished with compressed air which is forced down the drill pipe. The air returns, carrying rock cuttings and any steam encountered. This return material is vented through a pipe known as a "blooie" line.

Two steam developers operating in The Geysers KGRA have conducted noise monitoring at a well site during the entire drilling process. Sound level measurements for both mud and compressed-air drilling operations have been published. Typical sound levels measured during drilling range from 75 dBA to 100 dBA, at 50 feet. Occasional, higher noise peaks occur when the drill string is being raised or lowered and complaints have sometimes been received from persons living within 1000 to 3000 feet of a drill site. There are no residences this close to the proposed project and supply wells.

MITIGATION MEASURES

- o Noise levels from air drilling can be reduced through use of a large cyclonic separator/muffler at the end of the "blooie" line. Noise control is particularly effective when water is injected into the "blooie" line upstream from the cyclonic muffler. Use of the cyclonic muffler can reduce air drilling sound levels to less than 90 dBA at 50 feet.

Well Venting-

Venting of large quantities of geothermal steam at the wellhead, along the pipelines and at the generating units is the loudest source of industrial noise at The Geysers KGRA. Measured sound levels for venting steam range from 125 to 100 dBA at distances of 25 to 100 feet. Unmuffled venting steam can be audible at a distance of three miles and can produce annoyance at two miles.

Although large-scale steam venting occurs intermittently and infrequently, it can occur throughout the life of the project. Early in the development of the steam supply, each well is tested for production capacity by venting. Prior to installation of wellhead equipment, each well is vented to clear it of rocks and other debris. Prior to start-up of the power plant, all supply wells and pipelines must be vented to clean debris which could damage the turbine. Venting is also necessary at various points along the pipelines to clear out condensate which accumulates as the steam cools slightly during its flow to the power plant.

MITIGATION MEASURES

- o In recent years, the geothermal industry has improved control over the noise generated by venting steam. Due to its frequency characteristics, the sound produced by venting can be attenuated by muffling, by distance and by topographic obstacles. In many cases the cyclonic muffler used during the air drilling phase of steam development can also control noise during the production testing and initial clean-out of newly completed well as long as the drill rig and related equipment are still on-site.
- o Steam venting also occurs during shutdown of power plant operations which may last from a few hours to several days, or even weeks during a serious

emergency. The effects of venting and mitigation measures have been discussed under power plant operations.

Closing and Capping-

If a drilled well is unsatisfactory for steam supply, it is capped and not used or it is used for reinjection. This type of well is not a source of noise since there is no steam flow. When the proposed project and associated steam supply are no longer usable for electrical generation, the wells must be closed in and capped in accordance with federal lease conditions and the land must be returned to its predevelopment state.

Other Noise Related to This Project

Secondary noise impacts may occur along project area access roads as materials, workers and equipment are transported to the project site. This traffic noise would produce intermittent effects on sensitive receptors along the route. Traffic noises produced on-site and on nearby connecting roads should have an insignificant effect on the nearest receptors. To minimize any potential secondary noise effects, deliveries of supplies and equipment should be made during daytime hours.

CULTURAL RESOURCES

The literature search and field surveys conducted by investigators from the Anthropology Laboratory at Sonoma State University did not find any resources of cultural value in the immediate project area. The two sites of cultural value which were found (one micro-fossil site and one archeological site) are both located outside the immediate site limits of the proposed project. The project should not have any direct, significant adverse impacts on cultural resources. However, these two resource sites may be indirectly affected by project development.

There is always the potential for increased access, disturbance or vandalism as a result of construction and site development activities such as placement of transmission towers or construction of the steam gathering system and new access roads.

PALEONTOLOGICAL RESOURCES

The micro-fossil site within the proposed transmission tapline route was rated by Dr. Frederickson as duplicating information already discovered in other localities having greater significance. The study of fossil radiolaria in chert is an area in which few people have expertise. The potential importance of this micro-fossil site lies in its possible significance to those scientists interested in tectonic plate movement or previous seismic activity.

MITIGATION MEASURES

Since the micro-fossil locality has been identified and since the resource has potential scientific value, every effort should be made to protect the site from direct or indirect impacts such as disturbance, destruction or vandalism, from the proposed project. In order to achieve protection of this resource the following steps should be taken:

- o Construction and grading near the fossil location should be avoided. Tower pads, equipment and tower laydown areas and/or access roads should not disturb the fossil site.
- o If disturbance of this location becomes unavoidable, samples of the resource material should be sent to Professor E.A. Pessagno, Jr., at the University of Texas in Dallas. Pessagno has been identified by Dr. Frederickson as the one person most capable of making positive identification of the fossil material and, therefore, the most qualified to evaluate the scientific and cultural significance of fossiliferous chert localities. Dr. Pessagno should be consulted prior to any disturbance of this locality.

Archaeological Resources

Archaeological site #CA-SON-843 is located along Big Sulphur Creek, some 1,000-1,500 feet northwest of the transmission route, between Towers #4 and 5. The potential for increased access to this resource site is minimized by the fact that the proposed new access roads to Towers #4 and 5 would be constructed on the ridges, more than 1,000 feet from the site. Although the proposed transmission route passes directly over that portion of Big Sulphur Creek upstream from the site, conductor cables will be strung by helicopter and there is no need for access roads connecting Towers #4 and 5 or crossing the creek bed in this area.

MITIGATION MEASURES

Although no direct impacts are expected, the following steps should be taken to limit access to archaeological site #CA-SON-843 and to minimize the potential for vandalism:

- o No access roads should be permitted into the main drainage channel of Big Sulphur Creek. If access roads must be allowed in this channel, the entrance should be controlled by fencing and a locked gate.
- o The Bureau of Land Management will make unscheduled inspections of the area to ensure that the site is not disturbed.

OTHER CULTURAL RESOURCES

To ensure preservation and protection of all cultural resources now or subsequently identified within the project area, the NCPA or its contractor(s) should prepare a mitigation contingency plan to ensure that a qualified cultural resource specialist familiar with the project area is available during grading and site development activities in potentially sensitive portions of the project

area. Such areas include those sections of the unnamed tributary of Big Sulphur Creek which would be covered by fill or cleared and leveled for construction of the sedimentation basin.

SOCIOECONOMICS

SOCIAL AND ECONOMIC CHARACTERISTICS

Impacts to Local Populations

During Development of Steam Supply-

Development of the geothermal resources necessary to supply each power generation plant or unit requires a drilling crew comprised of 18 to 25 employees working around the clock for a period of nearly 12 months.

In the past, as many as nine well-drilling companies have routinely worked in The Geysers KGRA and many of the crew members have become permanent or semi-permanent residents of Lake and Sonoma Counties. As of October 1978, four drilling companies were operating in The Geysers area. (Gennis, 1978a)

Completion of the requisite steam supply for the NCPA No. 2 power plant will occur during the power plant construction period. Drilling and pipeline construction activities will draw upon an existing pool of drilling contract workers, many of whom are permanent residents of Lake and Sonoma Counties. Specific data on the skills, number, location and duration of residence of this pool of workers have never been documented.

During Project Construction-

Construction of the proposed power plant and related on-site facilities will require an average work force of 46 employees, with a peak of 85 reached about midway through the 26-month construction period. Refer to Figure IV-4 for a graph of project employment.

The construction work force required for the proposed project is expected to be drawn from the existing pool of experienced geothermal workers in the local area. Although no specific residence data have been confirmed, it is believed that the major portion of the workers employed in The Geysers KGRA reside in Sonoma County (Vollintine, 1976). The increase of geothermal development on the east side of the Mayacmas Mountains may generate a corresponding desire for the existing geothermal work force to reside in Lake County, rather than commuting across more mountainous terrain, through The Geysers Power Plant area.

CONSTRUCTION WORKFORCE-NCPA NO. 2 POWER PLANT

Figure I-2

Based upon estimates of cumulative workforce required for construction of ongoing and future PGandE Geysers Units, total power plant construction workforce peaked at about 310 in late 1978. (PGandE, 1979d) The cumulative workforce for PGandE projects and the proposed NCPA No. 2 and DWR Bottle Rock projects would reach approximately 140 in early 1981. Refer to Figure IV-5 for a cumulative overlay of construction schedules for forthcoming geothermal projects.

During Operation and Maintenance-

Operation of the proposed project and related on-site facilities is designed to be fully automatic. The power plant will be attended by eight workers during a single, daily work shift.

MITIGATION MEASURES

- o With two geothermal power plants nearing completion in 1979, and two more scheduled for completion by 1980-81, the proposed project could provide opportunities for continued employment of geothermal construction workers as other geothermal projects are completed. Staff anticipates no significant influx of population for construction of the proposed NCPA No. 2 project. Operation and maintenance of the proposed power plant would offer employment opportunities for a relatively small number of workers and would have an insignificant effect on local unemployment levels.

Impacts to Local Communities

Both Sonoma and Lake Counties are experiencing a rate of growth greater than the statewide average. As a more populated urbanized area located near to the metropolitan Bay Area, staff believes Sonoma County is unlikely to experience any significant changes in community structure related to the NCPA No. 2 project.

As a small rural area, somewhat insulated from the metropolitan centers in the Bay Area, Lake County has fewer resources available to deal with the effects of its accelerated growth rate. Incoming new residents from more urbanized areas often bring with them greater expectations for local government and services. These expectations are often in conflict with the values and expectations of long-time residents and create difficult problems for local government decision-makers. Reactions of County residents to increasing geothermal development span the entire range from full support to adamant opposition.

MITIGATION MEASURES

- o Many of the difficult problems being experienced by the Lake County government are not directly related to the proposed project or even solely to geothermal development. The NCPA or its contractor(s) should be aware that these difficulties exist and should remain available to coordinate and participate in geothermal development planning with both Lake and Sonoma Counties, if requested by the counties to do so.

CUMULATIVE GEOTHERMAL PLANT CONSTRUCTION WORKFORCE, 1976-1983

Source: CEC, 1979

Figure IV-5

Impacts on Local Economy

Potential Revenues-

Both Lake and Sonoma Counties will experience some economic effects related to the proposed project. During construction, the direct employment income generated by the project is estimated to total \$6 million for the 26-month construction period. Project expenditures made locally include wages, some expendible supplies for construction, and general construction expenditures for local subcontractors for site and road preparation.

The project will also generate additional revenue to Lake and Sonoma Counties from taxes on the lessee's possessory interest in the land and the facilities and from royalties paid on the steam extracted from the geothermal reservoir. The proposed power plant site and associated steam supply field are located on federal lands leased by Shell Oil Company for geothermal development. Royalties paid by Shell for the steam extracted are evenly split between the federal and the state government. Although federal lands are tax exempt, the leaseholder is subject to local taxation on their possessory interest in their development of and upon the land.

The value of The steam wells, pipelines and related developments necessary to supply a 110 MW geothermal power plant would be computed annually by the local taxing entity to allow for depreciation of the steam resource. Subsequent additional steam wells needed to maintain steam production for the power plant would be evaluated and assessed in a similar manner. Of the potential royalties and revenues associated with the project steam supply, Lake County would receive about a 10-15 percent share annually and Sonoma County would receive the remaining 85-90 percent share.

The NCPA will become responsible for payment of taxes upon their interest in the power plant and transmission facilities located on their portion of the leasehold. However, all but one member of the NCPA are municipalities and, as such, are tax exempt.

After much discussion with local agencies, the California Board of Equalization and the tax law consulting firm of O'Melveny & Myers, NCPA has formed a non-profit corporation for operation of the power plant and, thereby, has become liable for property tax assessment by local governments.

Exact amounts of property taxes paid depend upon a number of factors:

- a. Whether facilities on federal land can be taxed by local governments.
- b. Current assessed value of the land;
- c. Current assessed value of the facilities;
- d. Current assessed value of the resource;
- e. Current rate of taxation per taxing entity;

- f. Current interpretation and resolution of the effects of the Jarvis-Gann Initiative approved by California voters in June 1978; and
- g. Portion of total taxable area included within the jurisdiction of the taxing entity.

The proposed power plant and related on-site facilities have been estimated to have a potential value of \$65,700,000. Based upon a maximum assessment at 1 percent of market value, potential annual tax revenues of \$657,000 would accrue to Sonoma County (California Board of Equalization personnel communication; October 30, 1978).

Potential Costs-

A comprehensive discussion and detailed breakdown of potential costs to a local jurisdiction involved in permitting and monitoring development of an exploratory geothermal well, are provided in the EIR for the Aminoil "East Ford Flat" Geothermal Exploration Project (Gennis, 1978). Maximum direct cost to Lake County, including cost of overhead, was estimated to be \$14,547 for this Aminoil proposal. This total also includes the cost of appealing an unfavorable decision by the Planning Commission or the Air Pollution Control District, to the Board of Supervisors.

Potential initial costs to Lake County associated with the two or three proposed supply wells for the NCPA No. 2 project could be roughly estimated as two or three times the maximum figure developed in the East Ford Flat EIR or \$29,000 and \$44,000. These costs, however, are related to steam supply rather than power plant development activities and as such are not direct project costs.

There may be longer term, direct project costs to local governments associated with monitoring of required impact mitigation during construction and operation of the power plant. These costs would be spread over a number of years and a number of similar geothermal developments and staff expects that the combined annual revenues would offset such costs.

MITIGATION MEASURES

- o NCPA has taken the steps necessary to become liable for taxation, and revenues from the proposed power plant facilities will accrue to Sonoma County. Lake County will receive royalties from a portion of the steam supply facilities associated with the proposed project.

LAND USE IMPACTS

Plant Site

Construction of the proposed power plant will permanently remove approximately seven acres of chaparral from production. Land in the plant site area will be restricted specifically to controlled-access, industrial use.

Cut and fill activities necessary to level the knoll to prepare a pad for the generating plant site will temporarily remove an additional 16 or 17 acres of

vegetation from use as watershed and habitat. Revegetation of this area should offset construction-caused losses and possibly enhance wildlife habitat values. See additional discussion beginning on page IV-21.

Electrical Transmission Route

Construction of tower pads for the proposed 2.1-mile transmission tapline will remove approximately one-half acre of chaparral and other mixed types of vegetation from production. Much of this vegetation will regenerate and regain its previous value and use as watershed and habitat. Construction of necessary roads will remove approximately 5 acres of vegetation from production.

Steam Supply System

Construction of the steam gathering pipelines and support pads will temporarily disturb about 5 acres of chaparral and other mixed types of vegetation, and reduce its use as habitat and watershed.

Steam wells and the access roads associated with the steam supply system have already been constructed; impacts and mitigation measures are summarized in Appendix B.

Cumulative Effects of Land Use Changes

Examining the proposed project in a broader context, the advent of geothermal resources development in the project area and vicinity has created a transition from woodland and chaparral to scattered industrial development. Lands surrounding the project area are also leased for geothermal development and the area is expected to continue to move toward a more industrial character.

The shift toward development of an industrial character is expected to produce some reduction in perceived desirability of this land as open space. The shift toward an industrial character should not significantly affect the potential for these lands to be used for watershed, wildlife habitat, logging or grazing. However, the potential for continuing these uses may be significantly affected by disturbance of vegetation and soils during geothermal resource development and use. See additional discussion beginning on page IV-21.

Recreational uses such as hunting, sightseeing and rock-hunting have been somewhat curtailed as lands in the KGRA have been leased and developed. These types of recreational uses will be confined to those areas which would not present a threat to the safety and operation of the proposed generation plant and related facilities.

As development and utilization of geothermal resources moves closer to settled communities there is an increasing potential for conflict between residential and industrial land uses. This potential conflict can be mitigated through thoughtful long-range planning by local jurisdictions to establish sufficient land use buffer zones.

Communities in Lake County are more likely than those of Sonoma County to experience this potential encroachment of industrial land use into residential use areas. The Lake County General Plan, as presently constituted, provides

little guidance to local decision-makers involved in authorizing increased geothermal development. In an effort to make the General Plan a more effective tool, Lake County has been required by the state to totally update and revise the General Plan. No date is available for estimated adoption of a revised plan.

MITIGATION MEASURES

- o Land use impacts are difficult to mitigate because they combine environmental, economic and perceptual concerns into one issue. If this project is approved, any mitigation effort should incorporate this document's recommendations for mitigation related to erosion control; wildlife habitat protection and enhancement, water quality control; air quality protection and improvement; and protection of public health and safety.
- o Mitigation of land use impacts related to geothermal development should also include active participation of local government in the regulatory proceedings related to this and any future geothermal proposals. Local participation in decisions affecting local areas should help cushion the project's effects upon the larger area's multiple uses and promote the multiple-use values of the project area after cessation of project operations.

PUBLIC SERVICES

Education Facilities

The proposed project is not expected to create a significant demand for educational facilities.

Construction of the power plant and completion of the steam supply field are anticipated to draw upon an existing labor force already resident within the local area. Operation and maintenance of the power plant and associated facilities is expected to require less than 20 full-time employees.

Protective and Emergency Services

Police, fire, ambulance or medical services may be required at some time during the projected 30-year lifetime of this project. Staff anticipates that the demand for these services will be minimal. Present services should be adequate to serve most needs generated by the proposed project, but response time for ground vehicles could be as much as one hour due to distance, equipment availability, weather conditions, and terrain difficulties.

The Redbud Hospital in Clear Lake Highlands and the medical center in Kelseyville are currently adding new equipment and medical services to meet the needs of present rapid growth in Lake County. Staff expects that these facilities are adequate to serve any medical demands associated with this project.

Utility Services

Electrical power for construction equipment will probably be provided by a 21 kV distribution line which will also supply the nearby PGandE Geysers' Units 13

and 16. No significant impact on local supplies of electricity is anticipated. After start-up, the proposed power plant will provide its own power for pumps, fans, control center, etc. There will be no need for natural or bottled gas.

About 9.2 acre-feet of water will be used during the 26-month construction period; this will be obtained locally by the construction contractor(s). About 1.2 acre-feet of water will be needed to initially fill the cooling tower basin; thereafter, use of the excess condensate will make the plant self-sustaining for cooling water. During the first two years after site preparation, about 300 gallons of water per day will be needed to establish landscaping and revegetation of the site. Staff considers these water requirements to be an insignificant portion of available supply.

Waste Disposal Facilities

Sanitary liquid wastes generated at the project site will be disposed of by injection to the geothermal reservoir, along with condensate and liquid residue from the hydrogen sulfide abatement equipment. Solid wastes collected in the drilling sumps may be disposed of at either of the two Class II-1 dump sites located between 6 and 17 miles from the project area. If these wastes prove to be nontoxic, they may be disposed of on-site, in accordance with requirements of the appropriate Regional Water Quality Control Board.

TRANSPORTATION

Traffic

During the peak construction period as many as 85 workers may be traveling to and from the proposed project site. This will be a short-term impact and is expected to diminish to less than 20 trips per day once the project is completed (NCPA, 1979d).

Delivery of materials, equipment, supplies and water to the proposed site will require an unknown number and frequency to trips over roads to the project area. Periodically the transport vehicles may be quite large, heavy and slow-moving in order to carry loads of unusual size and/or bulk (NCPA, 1979d).

CalTrans has indicated that transport of the large, heavy loads associated with geothermal development is expected to accelerate the aging and need for maintenance and repair of State Highway 175 (CalTrans personal communication; June, 1979).

MITIGATION MEASURES

- o Many of the workers involved in construction of the proposed project and completion of the steam supply field are expected to be drawn from an existing, resident labor pool. Since the primary access road to the proposed site also serves a number of other geothermal projects in the same vicinity, there should be no significant increase in traffic, but rather a change in destination.
- o Unpaved roads should be regularly sprinkled to minimize dust.

AESTHETICS

The construction of a geothermal power plant, with associated transmission lines, access roads and a steam-gathering system, would increase the intrusion of man-made structures on the mountainous terrain and open landscape within the project area. Engineered slopes and leveled pads will appear angular and/or denuded when compared to natural landforms. The importance of these visual changes can only be judged by comparing the quality of the existing landscape and the relative visibility of the changes by observers. Refer to Figure II-1 for an artist's conception of the proposed power plant set on to the landscape shown in Figure i-1.

The impact of the presence of the proposed facilities on the visual landscape within the immediate project vicinity would be considered great. The proposed development would be visible from roads located within The Geysers KGRA. However, relatively small numbers of people outside the geothermal industry would observe the changes in the visual landscape associated with the proposed project. To date, the majority of nonindustry visitors to The Geysers area have been sightseers and their use of the project area has been seasonal and relatively limited.

From a broader perspective, the impact of the visual changes associated with the project would be comparatively low because of existing landscape quality and the presence of other geothermal development in the vicinity. Since the majority of the structures related to the project development will be located below the main Mayacmas ridge, away from the view of nearby settled areas of Lake County, there should be minimal to no visibility of the project features.

At times, vapor plumes from the proposed project site may occasionally rise above the ridge line and become visible from the settled areas in Anderson Springs and the Collayomi Valley and from the more heavily traveled roads located in Lake County to the east of the project area. These plumes would be most noticeable during periods of cooler temperature and higher relative humidity. In areas located to the north and west of the project site (i.e., Whispering Pines and Cobb Valley), plume visibility would be reduced because a number of ridges and Cobb Mountain block the line of sight.

MITIGATION MEASURES

- o To minimize the potential for negative visual effects, a professional landscape architect should develop design elements for the final facility design using, in part, the mitigation guidelines listed below. In order to better evaluate impacts, the final design should be portrayed using photographic simulation techniques. The simulation should be submitted to responsible regulatory agencies for approval, prior to a decision on the Application for Certification filed with the California Energy Commission.
- o The following mitigation measures should be incorporated into those discussed for site development (beginning on page IV-4); for drainage control (beginning on page IV-9); for habitat protection (beginning on page IV-27); for revegetation (beginning on page IV-21); and for soil protection (beginning on page IV-8).

- a. Clearing of vegetation should be minimized.
- b. Any necessary clearing of vegetation should leave irregular edge patterns which repeat as nearly as possible natural edges of existing openings.
- c. All altered or created land slopes should be contoured and graded to approximate existing landform character.
- d. Where feasible, slopes should be revegetated with chaparral species to conform with the surrounding vegetation type; revegetation should be irregular and mixed to repeat natural patterns.
- e. All paints and surfaces should be nonreflective and of color schemes which blend with existing landscape colors.
- f. Road construction to transmission lines should be to the minimum design standards feasible.
- g. "Skylining" of transmission towers should be avoided wherever possible.
- h. Lattice-type towers should be used wherever feasible to help the transmission system to blend into the landscape.

ENERGY AND MATERIALS RESOURCES

ENERGY RESOURCES

Energy consumed for construction and operation would include fuels, such as gasoline and diesel, and electrical energy for lighting and other preoperation power needs. The quantity of this type of energy consumed will be minimal.

Impacts on the Geothermal Resource

The impact of the proposed NCPA No. 2 geothermal project upon the geothermal steam reservoir is potentially significant. The extraction of geothermal steam in The Geysers area is known to decrease subsurface fluid pressures in the vicinity of producing wells (Lofgren, 1978).

The reservoir recharge rate, if any, is unknown. However, the decline in reservoir pressures suggests that the water recharge of the reservoir by re-injection of spent geothermal fluids or natural water inflow is at a rate less than the rate of steam production.

If the reservoir is not being sufficiently recharged, the pressures within this natural steam "boiler" will eventually decrease below that needed to drive power plant turbines.

Gradual reservoir pressure decline will require the development of additional steam supply wells throughout the project lifetime in order to maintain the 2,000,000 lbs/hr steam pressure needed to produce 110 MW.

MITIGATION MEASURES

The steam developer believes there is sufficient steam for the lifetime of the project.

- o As outlined in applicable Geothermal Resources Operations orders (USGS, 1977), every effort must be exercised to maintain maximum productivity of the reservoir. These efforts should include analysis of well and reservoir production data, production monitoring and appropriate reservoir engineering.
- o Free venting of geothermal steam directly to the atmosphere during power plant shutdowns will be minimized by use of redundant turbine/generator design, automatic control valves on individual steam supply lines and/or cross-over interconnections between operating power plants or other geothermal facilities.
- o NCPA has designed the proposed power plant to consist of two 55-MW turbine units which can be operated separately if one unit is shut down for maintenance or forced outage. This should minimize the need for steam stacking since the incoming steam can be partially throttled back and the rest used to keep one unit in operation.
- o The NCPA or its contractor(s) should investigate the feasibility of cross-over interconnection between the proposed project and neighboring geothermal power plants.

Potential Transmission Losses

NCPA has proposed a transmission route which taps into an existing 230kV transmission route, near the western edge of the Shell leasehold, approximately one mile north of the proposed Castle Rock Junction Substation. Although this existing transmission route has adequate capacity to accommodate power from the proposed NCPA No. 2 project, the additional 110 MW will increase the load on this route to near capacity. As a transmission line nears its design capacity there is a corresponding reduction in efficiency and increasing transmission losses.

MITIGATION MEASURES

Generally, some amount of transmission losses are unavoidable. However, losses can be significantly reduced by:

- o Minimizing the electrical path by minimizing the distance between the point of generation and the point of consumption, and
- o Using the largest conductors which can be economically justified.

Refer to additional discussion in Chapter V, "Alternative Transmission Facilities."

MATERIAL RESOURCES

Materials consumed in the construction and operation of the proposed power plant and other facilities associated with this project include concrete, steel, aluminum, expensive metal alloys and catalysts, wood and paint.

The amounts of materials consumed by the proposed NCPA No. 2 project are considered minimal in proportion to the quantities available locally regionally, and nationally.

V
PROJECT
ALTERNATIVES

V. PROJECT ALTERNATIVES

There are a wide variety of potential alternatives to the proposed NCPA No. 2 power plant. These alternatives assume that the basic need and purpose of the project is to supply 110 MW of baseload generation capacity to the NCPA by late 1981. The alternatives are: no project; alternative location; alternative facilities; alternative magnitude or size; alternate designs; alternative means of accomplishing project objectives; alternative transmission facilities; alternative steam gathering facilities; and alternative uses of geothermal steam.

NO PROJECT

The construction and operation of the NCPA No. 2 power plant would generate 770 million kilowatt hours (kWh) of energy each year (based upon an 80 percent capacity factor). Without this project the NCPA would continue to purchase power from PGandE and the Western Area Power Administration (WAPA formerly the Central Valley Project) in increasing quantities and at an expected cost greater than the cost of power from the proposed project. About 31 percent of PGandE's generating capacity is hydroelectric; all of the WAPA capacity is hydroelectric. In 1975, NCPA purchased 57 percent of their power from PGandE and 43 percent from WAPA. According to NCPA these percentages would continue to be valid through the year 2000 (NCPA, 1978a).

PGandE is presently operating the most efficient oil-fired generating plants in their system at maximum output. Therefore, to increase their output in order to meet the needs of the NCPA it is expected that PGandE would have to make greater use of less efficient oil-fired facilities which are presently not being used to capacity because of oil prices or air quality regulations.

ALTERNATIVE LOCATIONS

The location of a geothermal power plant is limited to areas of proven geothermal resources within a designated leasehold, and to specific areas within that leasehold in regard to topographic and geologic features. In addition, the power plant must be located at a distance no greater than one mile from each geothermal steam supply well. Transport beyond this distance causes the steam to lose the temperature and pressure required to efficiently operate the steam turbine.

The NCPA initially considered three sites for the proposed project within the 3,000 acre Shell Oil Company leasehold. Site 2 was rejected because a greater amount of excavation would be required than for Site 1 and because the facilities and the site area would be readily visible from the north and east due to the site's location on a ridgecrest. Additionally, this site would have required the longest transmission line. Although Site No. 3 would require the shortest transmission line and the least amount of excavation, it was rejected because it would have the greatest visual impact, it would not be centrally located in consideration of the probable steam supply well locations, and it is in a poor geologic foundation area. The principal characteristics of the sites as identified by NCPA are listed in Table V-1. The locations of the three alternative sites are shown in Figure V-1.

TABLE V-1
SUMMARY COMPARISON OF PROPOSED PLANT SITES

Considerations	Site 1	Site 2	Site 3
Location Approximate Coordinates State Place Coordinate System Township and Range Accessibility	N 395,950 E 1,795,100 3200' S - 450' E NW Corner Section 2, RBW - T10N MDM South of Shell "D" Drill Pad along Ridge Road and "A" Pad Road	N 397,770 E 1,793,850 1400' S - 800' W NE Corner Section 3, RBW - T10N MDM Adjacent to Ridge Road	N 395,800 E 1,796,120 3380' S - 1500' E NW Corner Section 2, RBW - T10N MDM Adjacent to Ridge Road and "F" Pad Road
Topography Elevation, proposed site Surface Slope Vegetation	South & below crest of ridge 3200' 0 - 30% Mixed Chaparral, few pines	On crest of ridge 3250' 15 to 30% Mixed Chaparral	On crest of ridge 3150' 15 to 30% Digger pine and mixed chaparral
Geology Outcropping Soils Land Slides Land Sensitivity Foundation Competence	Graywacke Firm None (fills seated against opposite slopes) 1 (highest) and 2 (high) Excellent	Graywacke Small earth flows 2 (high) Good	Serpentine & Graywacke thrust fault contact None 2 (high) and 4 (low) Fair - poor
Environmental Impact Visual Impact	Slight Slight - can only be seen from development area.	Greatest amount of excavation required. Greater. Is located on ridge crest but has Spur Ridge to south to provide backdrop and soften impact. Excavation scar will be the greatest and will be on the skyline.	Slight - least amount of excavation required. Greatest of 3 sites. Site is on ridge crest and will be silhouetted against sky.
Steam Supply Transmission Line	Centrally located for steam supply wells. Low visual impact. Can use existing roads for most of construction.	Centrally located for steam supply wells. Longer transmission line.	Not centrally located. Steam must be piped further. Shortest transmission line.

Source: NCPA, 1978a

ALTERNATE POWER PLANT SITE LOCATIONS

Figure V-1

ALTERNATIVE FACILITIES

The primary determinate for consideration of alternative facilities at this stage in the Energy Commission licensing process is the time required for planning, design, licensing, and construction of an alternative facility in relation to the date when the electricity is required to be on-line. Due to the long lead times required to construct coal-fired, nuclear, and hydroelectric generating plants, these types of plants are not considered as feasible alternatives to the NCPA No. 2 facility.

New energy sources such as fuel cells, solar, tidal energy, magnetohydrodynamics, and wind power have limited applications, will not be commercially available within the necessary time frame, and would not provide sufficient baseload reliability comparable to this project. Oil-fired generating plants such as combined-cycle units, the repowering of existing generating plants, and cogeneration are all possible alternatives because the lead time required from planning to operation varies from slightly less to a little more than the time required for a geothermal project. However, using fuel oil for combustion purposes is contrary to the Federal Power Plant and Industrial Fuel Use Act which precludes the use of fuel oil for new generation facilities with only a few exceptions.

ALTERNATIVE SIZE

NCPA believes that a 110 MW plant is the optimal size based on the quality and quantity of the steam within the steam field. Geothermal power plants can be larger or smaller in size. In The Geysers KGRA, the PGandE Geysers Unit 13 power plant currently under construction will produce 135 MW, the largest in The Geysers. PGandE's Geysers Unit 17 (recently certified by the Commission) and their proposed Geysers Units 16 and 18 are all rated at 110 MW. Some geothermal plants, such as PGandE Unit 15 and the CDWR Bottle Rock project, are each 55 MW. The smallest power plant in The Geysers is PGandE Unit 1, which produces only 11 MW.

ALTERNATIVE DESIGNS

The components of a geothermal generating facility which allow some flexibility of design are the cooling systems and hydrogen sulfide secondary abatement systems.

Proposed Cooling System

The cooling system proposed for the NCPA No. 2 power plant is comprised of a surface condenser which condenses the steam exhausted from the turbines, and two five-to-six-cell, fan-assisted, wet-type cooling towers which cool the water heated during its passage through the surface condenser.

Prior to start-up of the power plant the cooling system will be charged with approximately 400,000 gallons (1.2 acre feet) of water. Once the power plant is in operation, the initial start-up water will be supplemented by condensate from the surface condenser. Excess condensate not needed to replace cooling water lost through evaporation and drift emissions will be reinjected into the steam reservoir.

Alternative Cooling Methods Considered

- o Direct Contact Condenser - This system has been used by PGandE in their Geysers Power Plant Units 1 through 12. In this cooling method, steam exhausted from the turbines is mixed directly with the cooling water and then pumped to the cooling tower. The initial cost of this system is less than a surface condenser but it does not give the degree of H_2S abatement that is expected to be achieved with the surface condenser in conjunction with the Stretford process for H_2S abatement.
- o Air-Cooled Condenser - With this system, the exhaust steam from the turbines is condensed in a tubular type of heat exchanger by air passing over the tubes. This system has three major disadvantages: large size, greatly increased cost and decreased operating efficiency. An air-cooled condenser requires an extremely large surface area in order to be effective and the chemical and physical properties of the steam in The Geysers require use of higher-cost materials, thereby increasing costs. The efficiency of the power plant would be reduced because use of an air-cooled condenser would increase turbine back-pressure much of the time.
- o Closed-Cycle Cooling - The cooling water, in a closed-cycle system, circulates within a closed system using surface condensers and indirect contact, water-to-air, "dry" cooling towers. All the condensate would be reinjected if such a system were used for the proposed plant site. The noncondensable gases in the steam would still have to be removed from the condenser and treated to comply with air quality standards. However, complete reinjection would eliminate H_2S emissions that occur in direct water to air contact type towers.

The use of a closed-cycle cooling system would approximately double the total cost of the proposed power plant. The capital cost of a closed-cycle system could be reduced by reducing the capacity of the plant during the summer peaking period but this would reduce the value of generating capacity.

- o No Cooling System - In this system, the turbine exhaust steam is discharged directly to the atmosphere from the turbine and requires no cooling. This system was considered in early geothermal power cycle studies but was found to be very inefficient due to the level of back pressure in the turbine units. In order to generate the same amount of power much more steam is required per unit of power generated. Direct discharge of the exhaust steam to the atmosphere also requires consideration of noise mitigation and would not comply with air quality standards.
- o Once-Through Cooling System - Use of this system would eliminate the need for a cooling tower but is not considered practical for the NCPA No. 2 project since the large water supply required is not available in The Geysers area nor within economically reasonable transport distance.
- o Natural-Draft Cooling Tower - A natural draft cooling tower is not practical for a power plant of this size since it would have to be very large to create the required air flow. The larger natural draft towers, in

addition to creating greater visual impact, would also compound the difficulty of locating satisfactory plant sites in the mountainous terrain of The Geysers KGRA. The cost of this type of tower is several times greater than the cost of the proposed mechanical draft cooling tower.

Alternative H₂S Secondary Abatement Systems

As proposed, NCPA expects the Stretford H₂S abatement system to remove most of the H₂S contained in the exhaust geothermal steam. Based upon the quality of the steam being supplied to the power plant, NCPA expects the rate of H₂S emissions to meet applicable regulatory standards.

Additional H₂S abatement may be necessary if the amount of H₂S dissolved in the water formed by the surface condenser produces cooling tower emissions in excess of applicable standards. Secondary H₂S abatement would be applied to the condensate flow, between the surface condenser and the cooling tower.

- o The Metal Catalyst System - Hydrogen sulfide dissolved in water, in the presence of air and at normal temperatures, is unstable and undergoes oxidation to form free sulfur. This reaction is ordinarily slow but can be accelerated by use of appropriate catalysts such as dissolved ferric ion. In the process the ferric ion is regenerated, so that more hydrogen sulfide is oxidized. The iron concentration in the cooling water is maintained at 30 ppm by weight or higher. The condenser off-gas is released in the cooling water, so that its hydrogen sulfide content is also oxidized. The major problems associated with the iron catalyst system are corrosion of metal parts in contact with the cooling water and rapid accumulation of sludge.

A metal catalyst, supplemented either with hydrogen peroxide or with caustic soda is being used continuously at PGandE Units 3 and 6 and Unit 11. This system will also be used at other PGandE Units only during H₂S episodic alert days.

PGandE reports that they have achieved 90 percent abatement in their existing direct condenser units by use of high concentrations of iron catalyst. However, systems using this form of abatement experienced serious operational problems which caused reduced reliability due to sludge formation and induced corrosion.

- o Hydrogen Peroxide Oxidation - The FMC Corporation of Philadelphia has found that hydrogen peroxide (H₂O₂) can remove essentially all the H₂S in the steam after it has been condensed. This process can occur in less than 15 seconds if 1 ppm (by weight) of iron is present to catalyze the reaction. This iron concentration is so low that it does not cause corrosion and sludging problems.

The amount of H₂O₂ required depends upon the products of the reaction and the pH. It may be economical to employ pH control to keep the H₂S out of the condensate in the first place and not use H₂O₂ at all. The amount of H₂O₂ required for the reaction may also prove to be several times the amount estimated. The exact procedures and chemistry of the hydrogen peroxide secondary abatement system will not be known until the results of full scale tests at PGandE's Unit 15 are available in late 1979 or early 1980.

This system is being considered as the preferred secondary abatement method, if necessary, for other proposed power plants that are presently at various stages of the Commission's regulatory process; they are: PGandE Units 16 and 18; CDWR Bottle Rock and NCPA No. 1.

- o Sulfur Dioxide pH Control - Injection of sulfur dioxide (SO_2) into the condensate to control the pH of the condensate and to displace the H_2S dissolved in the condensate is an attractive method for reducing the amount of H_2S in the condensate. Sulfur obtained from the Stretford process could be burned to provide a readily available source of SO_2 .

Significant development and prototype testing remain to be done on this system before it can be adapted for commercial use. However, if the Stretford process does not provide the necessary H_2S abatement, the use of sulfur dioxide pH control should be considered and evaluated as a secondary H_2S abatement method.

Other H_2S abatement systems which have been or could be used are discussed below. Most have proved ineffective or have been displaced by the Stretford and surface condenser/partitioning process.

- o Steam Converters - An old geothermal industry process, the steam converter was the only effective way of reducing the high gas content of the steam. However the process seriously degrades the quality of the steam and nearly double the mass of steam is required to produce the same amount of power as unconverted steam.
- o Preplant Oxidation - PGandE has briefly experimented with the injection of oxygen (O_2) into the incoming geothermal steam, upstream of the turbine units. The results were not encouraging since injection of twice the amount of O_2 theoretically required for full oxidation only caused an H_2S reduction of 5 percent. Upstream injection of H_2O_2 has also been tried but with poor results.
- o Upstream Absorption Scrubbers - Upstream absorption of H_2S with a copper sulfate solution has been investigated by the EIC Corporation. Although a field trial by PGandE at Geysers Unit 7 removed 90 percent of the H_2S , considerable development and testing remain to be completed before this process can be adopted for commercial use.
- o The Burner-Scrubber System - This system mixes the condenser off-gases with air and burns them. The system was used on PGandE's Unit 4 but was discontinued because it was unable to reduce H_2S emissions by more than one-half of that required and because the off-gases are only marginally flammable.
- o The Deuterium Process - The Deuterium Corporation has installed and tested a liquid absorption type of scrubber to remove H_2S from a portion of the incoming steam at PGandE's Unit 7. Details of the process are considered proprietary information but early test results indicated 90 percent or better H_2S abatement. There were problems associated with regeneration of scrubber solutions which have yet to be resolved.

The Deuterium process has been developed to produce "heavy" water (deuterium) and requires copious amounts of process steam, electrical power and hydrogen sulfide. Therefore, the process would be a secondary geothermal industry rather than an abatement system.

ALTERNATIVE MEANS OF ACCOMPLISHING PROJECT OBJECTIVES

Energy Conservation

The discussion of need in Chapter II, "Project Description," refers to the Energy Commission's adopted forecast for energy and peak demand. These figures incorporate some conservation measures and new and expanded measures will be implemented by the NCPA, thereby reducing electrical demand in the members' service areas.

NCPA's present baseload demand is approximately 700 MW and this is projected to increase at an annual rate of 3.8 percent. Even if conservation measures were implemented in the NCPA service area to effect a savings of 110 MW, the present demand for an additional 590 MW would remain and continue to increase as projected. It would be economically advantageous to NCPA to construct and operate its own geothermal power plant to supply a portion of its baseload demand rather than PGandE or WAPA (refer to additional discussion of purchased power, below, and to Chapter II).

Geothermal baseload electrical generation is specified by the Energy Commission as a "preferred" technology, (CEC, 1978a) and is relatively cost-effective compared to other alternative electrical generation technology. Conservation is an alternative technology that would be more applicable as an alternative to other, less-preferred and less cost-effective forms of electrical generation.

Purchased Power

The NCPA presently has no power generation facilities of its own and its members rely upon purchase agreements with PGandE and WAPA. In an effort to develop baseload capacity for its members and to supply electrical energy at a more economic rate, the NCPA is proposing to own and operate the NCPA No. 2 geothermal project. The possibility of an eventual freeze in the amount of power available for purchase from the Western Area Power Administration provides an additional incentive for the NCPA to develop its own generation facilities.

The output of this project is expected to meet only a portion of the NCPA service area demand for power. The NCPA will continue to purchase power from both PGandE and the WAPA. NCPA's increased demand would be primarily supplied by PGandE through increased operation of oil-fired plants. However, based on NCPA estimates of the cost of purchased power as reported in Section II of "Business Review of NCPA Application", the proposed geothermal generation is an economically preferable source of electricity for NCPA. (Capitol Research and Consulting, 1979)

ALTERNATIVE TRANSMISSION FACILITIES

Transmission Structures

Any number of designs for towers, insulators and conductors are presently available. NCPA proposes to use double-circuit, steel lattice towers and nonspecular conductors which will blend into the background landscape and minimize visual impacts. An alternative design consisting of large-diameter, steel pole-type towers would provide a substantial structure which is quite visible against the brush and tree-covered hillsides.

An underground, low pressure, oil-filled, self-contained cable could be utilized as an alternative for the overhead transmission line. Underground transmission would require excessive clearing, grading and trenching and would significantly increase the estimated cost of the project. Undergrounding the proposed transmission line would reduce the visual impact and physical obstruction but the greatly increased installation costs and the possible effects of erosion or slope failures on cable reliability make this an undesirable alternative.

Transmission Routes

The proposed NCPA No. 2 power plant is slightly more than two miles from the point of connection with the existing PGandE 230 kV transmission line between Castle Rock Junction and the north end of The Geysers KGRA. The proposed transmission route lies on federal land, entirely within Shell's leases #CA-950 and #CA-949.

Although the existing PGandE 230 kV transmission line is adequate to accommodate the power produced by the proposed project. The addition of this 110 MW output will bring that portion of the line between the point of connection and Castle Rock Junction close to its design capacity. As a transmission line approaches capacity, there is a decrease in efficiency and an increase in transmission losses. CEC staff estimates transmission losses from the proposed route will total 1,500,000 kWh per year, over the 30-year lifetime of the project. The amount of energy lost would be equivalent to that needed to supply 250 households.

NCPA has discussed three alternative routes to the proposed transmission route. Locations of these alternatives is shown in Figure V-2.

Alternative A: This route would run nearly directly from the proposed power plant site to the proposed Castle Rock Junction Substation. Compared to the proposed route, Alternative A has heavier vegetation, more rugged terrain and limited existing access roads. NCPA estimates the construction costs for Alternative A would exceed those for the proposed route by approximately \$60,000 (NCPA, 1979f). These costs do not include purchase or lease negotiations for right-of-way outside of the Shell leasehold #CA-950.

By transmitting the power from the proposed project directly to Castle Rock Junction the transmission losses associated with the proposed route would be avoided. CEC staff estimates that the dollar cost savings associated with these reduced transmission losses are approximately 15 times greater than the increased construction costs. Alternative A offers an opportunity for long-term cost savings and conservation of energy.

LOCATION OF ALTERNATIVE TRANSMISSION ROUTES

Figure V-2

In the absence of detailed route plans and tower locations for Alternative A, it is difficult to adequately assess potential environmental impacts for comparison with the proposed route. Staff conducted a preliminary evaluation of the route which indicated a greater potential for impacts related to the need to clear additional vegetation for new roads into currently inaccessible portions of this route. The number and location of potentially sensitive vegetation and wildlife species, soils and cultural resources are unknown and unsurveyed for Alternative Route A. Disturbance of existing vegetation would increase the erosion potential of exposed soils and further reduce and/or fragment wildlife habitat.

Alternative B: This route would run from the proposed NCPA No. 2 project site to the proposed Geysers Unit 16 site, approximately 1.2 miles to the north. The route traverses terrain somewhat less rugged than that of Alternative A and also has no existing access roads along its distance.

There would be an overall increase in transmission distance if this route were used since power transmitted from the NCPA No. 2 site would have to double back to the Castle Rock Junction on existing lines after it reached The Geysers 16 site. Proposed capacity for the Unit 16 transmission line is designed to accommodate an additional 220 MW from future PGandE units, but was not intended to also accommodate the 110 MW produced by NCPA No. 2. Thus, the transmission losses, wheeling distances and associated costs would be much greater for Alternative B than for the proposed route. Approximately one mile of right of way would have to be acquired.

Alternative C: This route would run north along the ridgeline and intertie with the PGandE system at The Geysers 13 plant site, approximately 1.5 miles away. Terrain and vegetation along the route are less rugged than those along alternative routes A and B. Approximately one mile of right of way would have to be acquired outside the federal leasehold.

Existing access roads could be used if the route were to run along the ridge-line. However, if the towers were placed below the ridge to avoid visual impacts associated with "skylining" of towers, there are no existing access roads available. Use of this alternative would also have greater transmission losses than the proposed route.

ALTERNATIVE STEAM GATHERING FACILITIES

Alternative Structures

In order to maintain the high temperature of the geothermal steam it must be transported in insulated pipes. Physical and chemical properties of the steam resources constrain the types of materials feasible for use in construction of the gathering system. Since the steam often carries solid debris and other foreign materials which settle out as the steam is transported, the steam gathering system must have vents and centrifugal filters at intervals along the pipeline. These vents and traps must be accessible for periodic cleaning and maintenance. For these reasons an above-ground construction of the steam gathering system is preferred.

Alternative Routes

In order to maintain the maximum usefulness of the natural steam resource, the distance between the steam supply and the power generating facilities must be minimized. The exact location of the steam supply pipelines and support towers associated with the NCPA No. 2 project are not yet available. The policy of the federal agencies which manage the lands within the proposed project area is to encourage the lessee of the lands to route the steam gathering system along the existing system of access roads constructed during the development of the geothermal resource. The steam developer also would prefer to route the gathering system along already existing roads since it provides easier access for maintenance of the system and reduces costs.

ALTERNATIVE USES OF GEOTHERMAL STEAM

In addition to its use for electrical generation geothermal steam can be used for a variety of domestic and industrial processes, typically these processes depend on a resource with a 100° to 150°C temperature range which is considered "moderate." Direct heating uses of geothermal energy include water heating, space heating and cooling, food processing, refrigeration, and process-heating applications. The most common of these uses are direct heating for buildings or for industrial dehydration processes. The most efficient uses of this heat requires that the user be not more than a mile away from the resource due to heat loss in transportation and there are no residences within this distance. Geothermal resources above 150°C are considered to be potential for commercial power production; these additional temperature resources could also provide process heat to favorably located industries. The steam resources at The Geysers is about 250°C.

VI
SUMMARY OF
ENVIRONMENTAL
CONSEQUENCES

VI. SUMMARY OF ENVIRONMENTAL CONSEQUENCES OF THE PROJECT

UNAVOIDABLE ADVERSE IMPACTS

Disturbance of topographic features, soils and vegetation could cause significant erosion problems. A series of cuts and fills will redistribute approximately 200,000 cubic yards of earth for site and road development. Sedimentation in downslope drainage channels could produce harmful effects on aquatic life and habitat. It could also degrade local, and occasionally regional, water quality and could potentially build up enough to hinder the flow of water in the channel. Proposed drainage and erosion control measures and recommended revegetation procedures should reduce the potential for significant adverse impact.

Removal of vegetative cover would increase the potential for serious erosion and would eliminate food and cover from a number of wildlife species, particularly those dependent upon mixed chaparral habitat. Approximately 30 acres of vegetation will be disturbed during construction of the power plant, transmission line and roads to serve the plant. Of these 30 acres approximately 9-1/2 acres will be permanently removed from production. Proposed and recommended revegetation procedures for the remaining 20.5 acres and the recommended program of prescribed burning of chaparral should reduce the potential for significant adverse impact.

Use of geothermal steam produces a number of toxic substances including boron, mercury, and arsenic which are present in the spent steam condensate. There is a possibility that all, or a portion of, the fluids in the cooling system could accidentally spill into drainage channels downslope from the proposed project site. A spill of this toxic material could have adverse effects on aquatic habitat and water quality. As the number of operating power plants in the KGRA increase, the probability of major, serious toxic spills would also increase. Proposed and recommended design features to prevent discharge of toxic substances into natural watercourses and/or groundwater should reduce the potential for significant impacts. Monitoring programs to test samples of deposited sediments in the sediment basin and samples of waters released into the unnamed tributary south of the proposed plant site will provide warning of any problems in the pollution control system used to maintain good water quality in the drainage below the project site.

Ground or surface waters could be impaired by accidents involving the transporting or improper on-site storage of potentially toxic or hazardous substances. These substances include oils, thinners, solvents, Stretford process chemicals, and elemental sulfur. On-site storage of these above substances in unpaved-unbermed areas increases the chance of groundwater pollution by percolation, or surface water contamination by off-site flow or spillage.

Transport by truck, over the unpaved and narrow Geysers area access roads increases the possibility of spillage, probably by an accident such as a wreck with another vehicle or the truck going off the road. As the number of power plants in The Geysers KGRA increases, so will the number of transport vehicles. This will increase the possibility of accidents on the roads and the chances for any type of off-site accidental spill. Proposed and recommended safety

precautions and procedures will reduce the potential for significant adverse impacts from the storage or transporting of toxic or hazardous materials.

Emission of hydrogen sulfide into localized and regional air sheds could produce an increasing number of complaints about odor and disagreeable physical reactions in sensitive populations of the general public. The potential for harmful physical effects related to long-term exposure to low levels of H_2S remains an unanswered question. Proposed and recommended hydrogen sulfide abatement system(s) are expected to reduce H_2S emissions to levels required to meet standards for ambient concentrations of H_2S . Recommended monitoring programs should provide a data base for study of long-term effects of exposure to low levels of H_2S .

Emissions of potentially deleterious substances including boron and mercury present in the geothermal steam and in the cooling tower plume may be carried in the air and deposited on soils, vegetation, wildlife, and populated areas. Although studies of potential effects have been initiated, there is insufficient information available to determine what, if any, are the effects of cooling tower emissions and drift deposition. Proposed and recommended design features for cooling towers should reduce the potential for significant adverse impacts related to deposition of cooling tower drift. Recommended monitoring programs should provide a data base for study of potential impacts of cumulative deposition.

Increasing development of geothermal resources with related soil and vegetation disturbance and removal, and the construction of large, visible structures will inevitably alter the character of the landscape and the potential uses and characteristics of the land. Proposed and recommended erosion control measures, revegetation procedures, landscape and design features and location below the ridgeline away from populated areas should reduce the potential for significant adverse impacts.

Although this individual geothermal power plant may only affect some 100 acres, the cumulative area affected by the projected, full dry-steam resource area totals about 1,400 acres. Loss of this acreage is a significant portion of the habitat available in the KGRA and it may become so disrupted and/or fragmented as to be undesirable and unusable for wildlife use. This could cause a corresponding decline in species numbers and diversity. Attempts to enhance remaining habitat through erosion control, revegetation programs and prescribed burning of chaparral may be narrowly successful, but could potentially be overcome by the cumulative effect of combined disturbances. Proposed and recommended erosion control measures, revegetation procedures and the prescribed burning program should reduce the potential for significant adverse impacts on habitat. Recommended monitoring programs should provide a data base for study of cumulative impacts of geothermal development on habitat.

Increased environmental disturbance related to geothermal development could increase the potential for disturbance and/or destruction of uncommon, threatened and endangered plant species found in the Barren communities within the project area. The increasing number of geothermal access roads provides increased accessibility to areas potentially sensitive to damage by off-road vehicles or man-caused wildfires. Recommended access control measures should reduce the potential for significant adverse impacts to sensitive species in the Barren plant communities.

IRREVERSIBLE, IRRETRIEVABLE COMMITMENTS OF RESOURCES

The geothermal steam delivered to the power plant for power generation is irretrievably committed to use and irreversibly discharged. An anticipated 5-10 percent of the spent steam may be condensed and reinjected into the steam reservoir. At the rate of 2,000,000 pounds per hour of steam needed to produce 110 MW of electrical power, the NCPA plant would use between 8 and 9 million tons per year for each of the projected 30 years of project operation. At the present time use of the steam to produce electrical power precludes it from being used for other purposes in The Geysers.

The 9.2 acre-feet of water needed during power plant construction and the 1.2 acre-feet of water needed to initially charge the cooling tower basin will be irretrievably committed to the project.

Of the estimated 30 acres of vegetation disturbed by development of the proposed siting areas approximately seven acres will remain irretrievably committed to use for geothermal generating facilities and operations. This loss is considered reversible and the NCPA is required as a condition of its permit to use federal land, to return the site to its natural, preproject condition when the proposed project is no longer in operation.

The commitment of materials to construction of the proposed facilities is generally considered irreversible although some portion of them, such as various systems components and equipment or structural steel or expensive metal alloys and catalysts, may ultimately be recycled and, therefore, be retrievable.

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Short Term Uses

The proposed NCPA geothermal project will provide short-term (approximately 30 years) benefits by providing electricity to the NCPA members, while allowing NCPA to develop its electrical generation resource base and decrease its dependence upon purchased power. The project also provides short-term tax, employment and other fiscal benefits to individuals and to Sonoma and Lake County jurisdictions.

Maintenance of Long Term Productivity

Development of geothermal power generation represents an increasingly attractive alternative to the continued use of fossil fuels. Potentially adverse environmental impacts appear to be feasibly mitigable and the cost per kilowatt hour of generated power appears to be reasonably competitive with standard methods of power generation.

Because use of geothermal resources for electrical generation is relatively new, some long-term concerns remain, e.g., renewability of the geothermal reservoir; the long-term production capacity of the KGRA; the potential effects of long-term exposure to varying concentrations of hydrogen sulfide and other potentially deleterious components of geothermal steam and emissions; and the long term effects of development of the estimated total capacity of The Geysers KGRA.

POTENTIAL CUMULATIVE IMPACTS

The environmental impacts associated with the proposed project are typical of those encountered with other geothermal projects with which the Commission is familiar. As with other projects, the total impacts of this project after consideration of feasible mitigation measures are not substantial, but the cumulative impacts of geothermal development in The Geysers KGRA are significant and increasing. These cumulative impacts are made no less significant by the fact that substantial portions of the KGRA have, in effect, become "industrialized" due to geothermal development. The proliferation of well pads, access roads, steam conveyance lines, transmission lines, and power plants is gradually altering the undisturbed natural environment of The Geysers KGRA, and no amount of mitigation at individual project sites can alter this basic fact.

There are currently eight operating power plants (13 units) totalling 663 MW of capacity in the KGRA. An additional nine power plants with a capacity of 861 MW are, as of November 1, 1979, either under construction, recently certified by the Commission, or at various stages in the Commission's regulatory process. It is estimated that an additional six plants would be necessary to achieve a total generation capacity of 2,000 MW in the KGRA. It is estimated that 2,000 MW of on-line capacity will not be reached until after 1986.

It is difficult to determine to what degree impacts associated with the NCPA No. 2 project will contribute to the cumulative impacts of the overall steam field development in the KGRA. Cumulative impacts are of concern in the areas of erosion and sedimentation, air quality, biological resources, public health, land use, recreational use, and aesthetics. Many individuals and agencies have expressed a concern that development may have already or soon will reach an impact saturation point which would preclude further development of geothermal resources for electrical generation or other uses.

Although there have been a number of specific, individual studies made of various environmental aspects of development of The Geysers potential, there is no single coordinated, compilation which identifies predevelopment conditions and compares those conditions to the overall effect of development to date and the effects of future plans for the full development of The Geysers resource or alternatives to those plans.

In February of 1978, the counties of Lake, Mendocino, Napa, and Sonoma, which were concerned about impacts of geothermal development in The Geysers, entered into a joint powers agreement and formed the Geothermal Resources Impact Projection Study Commission (GRIPS). The purpose of the commission was to develop a comprehensive environmental data base for The Geysers KGRA to better coordinate projected development and mitigation measures.

As discussed in the GRIPS Study Plan (GRIPS, 1978a), many of the problems associated with impact analysis of geothermal resource development involve the lack of various kinds of data. Many changes have undoubtedly already occurred as development has increased, yet these changes have been only incompletely monitored and recorded.

To date, few study results related to The Geysers KGRA have been published and no set of baseline data is available. There are no current estimates for completion of all or portions of the desired studies.

GROWTH-INDUCING IMPACTS

The proposed NCPA No. 2 Geothermal Project is not expected to have any growth inducing effects either in the area directly involved in the project development or in the service area to which the power will be provided.

During project development the phase with the greatest potential for inducing growth in the local area is the construction period. For the NCPA No. 2 project, there will be a maximum of 85 workers involved in the project for a period of two or three months. Most of these workers are expected to be drawn from the existing, resident geothermal workforce which has been involved in previous and current power plant development. Operation and maintenance of the proposed project will only require 8 to 10 workers. In either case the number of workers is not considered to represent a significant change from the existing fluctuation in local population.

Within the area served by the NCPA and/or its present suppliers of purchased power, the addition of 110 MW is a relatively insignificant increase in available electrical power. If the 110 MW were equally divided among the eleven municipal members and the one rural electric cooperative, each would receive less than 10 MW, which represents an insignificant part of their total electrical service demand.

VII

BIBLIOGRAPHY
ORGANIZATIONS &
PERSONS CONSULTED
GLOSSARY

BIBLIOGRAPHY

The bibliography has been separated into two sections. The initial section contains general reference materials related either to the proposed NCPA No. 2 project or to the project area and vicinity. The second section has been subdivided by technical area, following the pattern set in the text of the JES. The references contained in the second section are more specifically related to the individual subject areas.

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ORGANIZATIONS AND PERSONS CONSULTED

FEDERAL AGENCIES

Bureau of Land Management, Ukiah District
Department of Energy, Oakland Office
Department of Energy, Washington D.C. Office of NEPA Review
Environmental Protection Agency, San Francisco Office
Federal Aviation Agency
Federal Communications Commission
Fish and Wildlife Services, Division of Ecological Services
Geological Survey, Office of Area Geothermal Supervisor
Geological Survey, Conservation Division Manager's Office
Soil Conservation Service, Davis Field Office

STATE AGENCIES

Air Resources Board
Attorney General's Office, Public Resources Section
Department of Finance
Department of Fish and Game, Sacramento
Department of Fish and Game, Region III
Department of Health Services, Hazardous Materials Management Section
Department of Health, Office of Noise Control
Department of Industrial Relations, Division of Industrial Safety
Department of Parks and Recreation
Department of Transportation, District 04 Maintenance
Department of Transportation, Permits Office
Department of Transportation, Office of Planning and Design
Department of Transportation, Division of Aeronautics
Department of Water Resources
Division of Forestry
Division of Mines and Geology
Division of Oil and Gas
Employment Development Department
Historic Preservation Office
Native American Heritage Commission
Office of Planning and Research
Public Utilities Commission
Solid Waste Management Board
Water Quality Control Board, North Coast Region (1)
Water Quality Control Board, Central Valley Region (5)

LOCAL AGENCIES

Lake County -

Air Pollution Control District
Office of County Administrator
Office of County Counsel
Planning Department
Roads Department

Sonoma County -

Air Pollution Control District, Northern Sonoma County
Department of Public Works, Roads
Office of Community and Environmental Services, Environmental
Administration
Office of Community and Environmental Services, Planning Department
Office of County Administrator
Office of County Counsel

OTHERS CONSULTED

Anthropology Laboratory, Sonoma State University

Cooper-Clark & Associates
Ecoview Environmental Consultants
Gennis & Associates
The GRIPS Commission

Lawrence Berkeley Laboratories
Lawrence Livermore Laboratories
Meteorology Research, Incorporated
McCulloch Geothermal Corporation
SAI Engineers, Incorporated
Shell Oil Company
Union Oil Company

The Clear Lake Observer

The Lake County Record-Bee

GLOSSARY

A-WEIGHTING--Weighting system that approximates the auditory response of the human ear, which discriminates against low and high frequencies.

AEROSOL--A colloid system of solid or liquid particles dispersed in a gas.

ALPHA ENERGY--Energy from the positively charged alpha particle emitted by certain radioactive materials. It is unable to penetrate the epidermis of skin, but when inhaled or ingested is considered dangerous.

AMBIENT TEMPERATURE--Natural temperature of the environment at a given time.

AQUIFER--Any geological formation containing water, especially one that supplies water for wells, springs, etc.

ARCHAEOLOGY--That branch of anthropology concerned with the identification, description and classification of sites, artifacts or other evidence of pre-historic peoples or cultures. With respect to the Western Hemisphere, this includes the Native American era.

BACT--Best Available Control Technology; often used with reference to mitigation measures for maintaining air and water quality.

BERM--A ledge or shelf, typically one that contains or guides drainage at the top or bottom of a slope.

BLEED--Small amount of steam vented to atmosphere when well is shut in.

BLOOIE LINE--A pipe used to carry fluids and cuttings from the well to a muffler/separator during air drilling operations.

BLOWOUT--An uncontrolled eruption of a geothermal steam well.

CAPACITY--The ability of a power plant or generating unit to produce a certain level of power, usually expressed in kilowatts or megawatts.

CARCINOGENIC--Those agents which can cause cancer.

CHRONIC--Of long duration; continuing.

Ci/ML (CURIES PER MILLILITER)--A measure of concentration of radioactivity in a substance.

CLASS I DISPOSAL SITE--A site which lies over a usable groundwater source but which has a natural, geologic barrier which prevents the vertical or lateral transfer of leachate from the disposal site to the ground water.

CLASS II-1 DISPOSAL SITE--A site which lies over a usable groundwater source but which has been modified to prevent the vertical or lateral transfer of leachate from the site to the ground water.

CONDENSATE--The liquid which results from the condensation of geothermal steam.

CONSTITUENTS--As used in referring to water quality, the chemical components of a waste on a body of water.

COOLING TOWER--Structure in which heat is removed from hot condensate taken from the condenser.

CULTURAL RESOURCES--As used in this document, this term encompasses four major categories of resources important to man's knowledge of himself and his appreciation of life on earth. These categories include: paleontological resources, archaeological resources, historic resources, and other resources of educational, scientific, religious or cultural significance which have been identified through ethnographic research.

CUT AND FILL--Construction term referring to earth removal at a site (cut) and disposition of the excess dirt (fill).

DECIBEL--One tenth of a Bel--a measure of sound pressure.

DECIBELS A-WEIGHTED (dBA)--Sound pressure levels weighted in accordance with "A" scale. A-weighted scale expresses the relative intensity of sounds, similar to the response of the human ear. 2 represents the faintest audible sound; 130-140 represents the average pain level.

DECIDUOUS--Vegetation that loses its leaves annually, generally in fall or winter.

DEW POINT--The temperature to which a given parcel of air must be cooled at constant pressure and constant water vapor content in order for saturation to occur.

DIELECTRIC--Nonconducting.

DRIFT--The gaseous and aqueous plume which comes out of the cooling tower and is dispersed by meteorological conditions or deposits on the surrounding environment.

DRY STEAM--Hot steam which contains no condensate.

EDGE--The division between two adjoining habitats.

EFFLUENT--Water or waste stream which flows out of a treatment facility.

ENTRAINMENT--The mixing of environmental air into a pre-existing organized air current so that the environment air becomes part of the current.

EMISSION--Material passed into the atmosphere in a gas stream; may contain an air contaminant.

ETHNOGRAPHIC--Related to the branch of anthropology concerned with the classification and description of regionally different human cultures.

FAULT--A fracture or fracture zone in the earth's crust along which parallel slippage of adjacent earth material has occurred.

FAUNA--Animals of a specified region.

FEN--An area of low, flat, marshy land.

FLORA--Plants of a specified region.

FRANCISCAN ASSEMBLAGE or FORMATION--A geologic rock formation comprised primarily of graywacke conglomerate and shale with overlying volcanic deposits. This formation is thought to represent a deep ocean trench deposit which has gradually converged with and been carried under the Great Valley Sequence.

FUMARoles--A naturally occurring hole in geothermal areas from which hot steam and gases arise.

GEOHERMAL STEAM--Steam created by the heat of the earth.

GEYSER--Spring that throws forth continuous or intermittent jets of heated water and steam.

GRAYWACKE--In geology, a type of sandstone rock which is comprised of varying percentages of quartz, eldspar, and framents of other types of rock such as slate or schist. This is the predominant type of rock in the Franciscan Assemblage.

GREAT VALLEY SEQUENCE--A geologic rock formation consisting mainly of sandstone and shale, mudstones and siltstones, and conglomerate lenses and beds. This pedimentary formation is thought to represent rocks originally deposited along the continental margin, considerably to the east of the Franciscan depositional site. During a long period of tectonic movement this formation gradually converged with and over-rode the Franciscan Assemblage.

GROUNDWATER--Water found underground in porous rock strata and soils.

HABITAT--The environment where a plant or animal lives.

HAZARDOUS WASTES--A hazardous waste is one which, because of its quantity, concentration, or particular characteristics, may cause severe illness or pose a threat to human health, safety or the environment when improperly stored, disposed of or otherwise managed (Health and Safety Code, Division 20, Chapter 6.5).

HISTORIC RESOURCES--Sites, structures, artifacts, routes, and other evidence of peoples and cultures, dating forward from the time of written history, which in the Western Hemisphere, is considered to coincide with European arrival in individual locales.

IGNEOUS--Rock material formed by cooling and solidification of molten magma, either at the surface, such as volcanic rock, or at depth.

INSOLATION--Solar irradiation.

INVERSION--An atmospheric condition where a layer of cool air is trapped by a layer of warm air so that it cannot rise. Inversions spread polluted air horizontally rather than vertically so that contaminating substances cannot be widely dispersed.

JURASSIC-CRETACEOUS--Relating to periods of the Mesozoic Era (75-180 million years ago). Also the system of strata deposited during those periods.

KILOWATT (KW)--1000 watts.

KILOWATT-HOUR (kWh)--The basic unit of electric energy equal to one kilowatt (1,000 watts) or power supplied to or taken from an electric circuit steadily for one hour.

Lx--The statistical level of noise which is exceeded x percent of the time during the observation interval, dB. Three common statistical parameters are L_{10} (high level), L_{50} (median level) and L_{90} (low level).

Leq--Energy equivalent level or equivalent sound level is the steady noise level which is a stated period of time would contain the same noise energy as the time-varying noise during the same time period.

Lmax--Maximum A-weighted sound level for a given time or event.

Lmin--Minimum A-weighted sound level for a given time or event.

LEACHATE--Drainage from a waste or fluid resulting from the percolation of liquid through a waste substance.

LEASEHOLD--An area leased by a steam supplier for geothermal development.

MAGMA--Molten rock material within the earth, from which an igneous rock is formed by cooling.

MAXIMUM CREDIBLE...--A design value which represents the expected maximum event (e.g., earthquake, rainfall) which a structure will have to withstand.

MAXIMUM PROBABLE...--A value for a natural event (e.g., earthquake, rainfall) which is derived from statistical analysis of historic occurrences and magnitudes and the probability that they will be equalled or exceeded within the lifetime of the structure being designed.

MEGAWATT (MW)--1,000 kilowatts or 1 million watts.

MELANGE--Mixture of incongruous elements of soil and rock; in the Franciscan Formation this refers to the presence of variable blocks of stable rock in a matrix of sheared and pulverized rock.

MESIC--A habitat characterized by a moderate amount of water.

METAMORPHIC ROCK--Rock changes by combinations of pressure, heat and water solutions.

MICROGRAMS PER CUBIC METER (g/M^3)--A measure of concentration of a pollutant in air. A microgram is one millionth (10^{-6}) of a gram.

MILLIGRAMS PER CUBIC METER (mg/M^3)--A measure of concentration of a pollutant in air. A milligram is one thousandth (10^{-3}) of a gram.

MICROCLIMATE--The conditions of temperature, humidity, wind, etc., immediately surrounding an organism or in a particular habitat.

MORPHOLOGY--The form and structure of plants and animals.

MUFFLER--Device for sound attenuation through which steam is directed during periods of release, such as stacking, to the atmosphere.

NATIVE SPECIES--Flora or fauna which would normally or naturally occur in an area unaffected by human entry or use.

NATURAL BACKGROUND RADIATION--That radiation which is not man-made and originates from terrestrial (pertaining to the earth's crust) and cosmic (pertaining to outer space) sources.

NATURAL RECHARGE--An area of very permeable soil through which rainwater percolates to replenish groundwater aquifers.

PALEONTOLOGY--The branch of anthropology concerned with the study of fossilized evidence of prehistoric plants and animals.

PARTICULATES--Any material, except uncombined water, which exists in a finely divided form as a liquid or solid at standard conditions.

PATH TREATMENT--A reduction of noise at the receiver's position due to a physical change in the path of sound between source and receiver.

PICO CURIES--(pCi) - 10^{-12} Curie. A curie is a unit of radioactivity.

POLLUTION ROSE--A graphic representation of the effect of wind direction on average air pollutant concentrations.

PROJECT AREA--For this project, this area is the entire 3,000 or so acres which comprise the federal lands leased by Shell Oil Company for geothermal development. Lease #CA-949 lies primarily within Lake County and Lease #CA-950 lies primarily within Sonoma County.

RAPTOR--Bird of prey such as a hawk, owl, or eagle.

REINJECTION--Process of removing excess condensate from the cooling tower basin and injecting it into the steam reservoir through nonproducing wells.

RESERVE CAPACITY--Backup generating capacity used in the event other generating units are unavailable for service because of forced or scheduled outages or in the event of unforeseen conditions that can effect either the magnitude of the load or system capacity or both.

RIPARIAN--Associated with or adjacent to a permanent or seasonal water source.

RUNOFF--That portion of precipitation on the land that ultimately reaches streams; water from rain or melted snow that flows over the surface.

SCRUBBERS--Devices used to remove contaminants from a gas stream.

SEDIMENTATION--The settled earthen solids in a liquid.

SEISMICITY--State of being caused by or subject to an earthquake or earth vibrations.

SERPENTINE--A rock or mineral consisting essentially of a hydrous magnesium silicate, usually having a dull green color and often found along fault zones and landslide areas.

SHEAR ZONE--A zone of crushed rock caused by tectonic forces, often in relation to faulting.

SILVICULTURE--The art or procedures of producing and tending a forest and forest trees.

STEAM PRODUCTION AREA--For this project, this is defined as that portion of their leaseholds which Shell has identified in their steam sales agreement with the NCPA, as the production area providing the steam needed for the project.

STEAM RESERVOIR--A porous and permeable geological structure, underlain by a heat source and overlain by an impermeable caprock, containing steam.

STEAM STACKING--The condition where incoming steam is released to the atmosphere instead of entering the power plant. This condition occurs when a geothermal power plant is not in operation.

STEAM SUPPLIER--Geothermal development firm with which the utility has contracted for the sale and purchase of geothermal steam.

STEAM SUPPLY AREA--Land area necessary to provide an adequate source of geothermal steam for a particular power plant unit.

STEAM RESERVOIR--A porous and permeable geological structure, underlain by a heat source and overlain by an impermeable caprock, containing steam.

STEAM SUPPLY FIELD--A geographical area overlying one or more steam reservoirs accessible by conventional drilling technology.

STUDY AREA--Area of variable size which has been individually defined and described for each subject area in which it is used.

SUBSIDENCE--Settling or sinking of land, usually due to withdrawal of natural underground fluids by man.

SUMP--A pit or reservoir serving as a drain or receptacle for liquids.

TAPLINE--The connection of a short electrical transmission line to a main transmission line with no switching facilities at the point of connection.

TECTONIC--Relating to the folding or faulting of the earth's crust.

TERATOGENIC--Those agents which can cause development of abnormal structures in an embryo; development of a severely deformed fetus.

THOUSAND CIRCULAR MILLS (mcm)--A circular mill (cm) is a term used to define cross sectional areas, being a unit of area equal to the area of a circle 1 mil in diameter. A mil equals one-thousandth of an inch.

TOPOGRAPHY--Physical features of a district or region such as are represented on maps; the relief and contour of the land.

TRANSMISSION LINE--Structures and conductors that carry bulk supplies of electrical energy from power generating units for system needs. By definition, transmission voltage is 50 kV or above.

TROPHIC LEVELS--A means of categorizing organisms by their position in the food chain. Higher trophic levels are those animals which consume other animals.

TROPOPAUSE--Upper portion of the atmosphere, which extends outward about 7 to 10 miles from the earth's surface.

TURBINE--Rotating engine activated by the reaction or impulse or both of a current of fluid or gas.

VENTING--Releasing steam from a pipeline section through valves to the atmosphere.

WATERSHED--A topographically defined area drained by a river/stream or system of connecting river/streams such that all outflow is discharged through a single outlet.

WATER VAPOR--Water substance in vapor form; one of the most important constituents of the atmosphere.

WATT (W)--The amount of work available from an electric current of 1 ampere at a potential of 1 volt. 1,000 watts (1 kilowatt) is roughly the amount of energy required to raise the temperature of one pound of water one degree Fahrenheit per second.

WHEEL ELECTRICITY - Use of the transmission facilities of one utility system to transport power of and for another utility.

WIND ROSE--A graphic depiction of the predominant wind direction and force and relative occurrence of calms.

VIII
APPENDICES

APPENDIX A

SUMMARY OF IMPACT

IDENTIFICATION MATRICES

The purpose of an environmental matrix is to focus the JES onto only the potentially significant environmental impacts resulting from the project. All impacts found to be significant or unresolved are discussed under the appropriate section of this Draft JES. What follows is a listing of various possible environmental impacts that the staff identified as clearly insignificant.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>EARTH RESOURCES</u>		
<u>Well Field</u>		
Potential subsidence or seismicity from extraction or reinjection of geothermal fluids.	No subsidence anticipated from dry stream extraction.	NOI, Vo. 1, pg. VII-1.
Potential damage to well from geological hazards (i.e., landslides, seismic activity, mass soil movement).	Potential considered negligible.	Staff determination.
Interference with the extraction of other mineral resources in the area.	No mining present in well field.	NOI, Vol. 2, pg. 3-3.
<u>Power Plant</u>		
Potential damage or destruction to power plant and ancillary facilities due to geological hazards (earthquake shaking, landsliding, erosion activity, expansive soils, fault displacement, volcanic activity, or subsidence), either natural or intensified by man's activities (grading, ground water withdrawal, etc.).	Potential considered negligible.	Staff determination.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
EARTH RESOURCES (continued)		
<u>Power Plant</u>		
Interference with or prevention of on-site mineral resource extraction.	No indication of significant mineral resources at the proposed site.	NOI, Vol. 1, pg. IV-20. NOI, Vol. 2, pg. 3-3.
<u>Transmission Lines</u>		
Loss of mineral deposits under facilities.	No mineral deposits occur under proposed transmission facilities.	NOI, Vol. 2, pg. 3-3.
<u>AIR RESOURCES</u>		
<u>Well Field</u>		
Change in local meteorological conditions due to heat emissions.	Discharge from individual wells minor.	ECOVUEW-EIR, Shell Oil site G, pg. 14.
Changes in local meteorological conditions due to site preparation and construction.	Small area occupied by wells.	ECOVUEW-EIR, Shell Oil site G, pg. 14.
Release of primary and secondary pollutants	Evaluation of Shell well analysis results.	NOI, Vol. 2, Addendum 2-B of Section 2.0.
<u>Power Plant.</u>		
Change in local meteorological conditions due to site preparation and construction.	No perceptible effects expected.	NOI, Vol. 1, pg. VI-1,2.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>AIR RESOURCES</u> (continued)		
<u>Power Plant</u> (continued)		
Meteorological effects of stack emission products.	Some fogging for about 1-mile radius, then dissipation.	NOI, Vol. 1, pg. VII-1.
Creation of aerial dust during construction.	Roadways and site to be wetted during construction.	NOI, Vol. 1, pg. VI-2.
Emission of air pollutants from construction equipment and vehicles.	Sources operated on a temporary schedule for a limited time.	NOI, Vol. 1, pg. VI-2.
Emissions from facilities manufacturing construction materials such as concrete batch processing and rock and aggregate crushing, and from storage of materials.		
A-3 Possible emission of particulates and other air pollutants if slash (vegetation removed from site) is burned or if solid waste from construction is incinerated.	Burning to be conducted under control situations and maximum dispersion days.	Staff determination.
Addition of water droplets containing cooling system chemicals to the air from wet cooling towers and ponds (i.e., the entrainment of small water droplets into the air stream).	Cooling tower design will minimize effects.	NOI, Vol. 2, pg. 2-8.
Effects of stack emission production on visibility and light scattering.	Hidden from populated areas by ridges.	NOI, Vol. 1, pg. VII-6 and 7.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
AIR RESOURCES (continued)		
<u>Transmission Lines</u>		
Production of oxidants, ozone, and NO _x by energized line.	Background levels well below ambient standards.	Staff determination.
Contamination of insulators by particulates and sulfur dioxide in the air.	Plant emission of particulates and sulfur dioxide minimal.	Staff determination.
<u>WATER RESOURCES</u>		
<u>Well Field</u>		
Increased water pollution due to damage caused by environmental hazards.	Sumps and drainage will be adequately controlled by RWQCB's waste discharge requirements.	Staff determination.
Potential damage to well or pipeline facilities from flooding.	Field sits above surface water drainage courses.	Staff determination.
Change in the temperature of receiving waters from thermal effluents.	No discharge of thermal effluents expected.	NOI, Vol. 1, pg. III-8.
Modification of existing stream flows and infiltration patterns due to the location and construction of reservoirs, lakes, ditches, pipelines, towers, cooling ponds, etc. Includes stream channel ponds, etc. Includes stream channel relocation or diversions and altered site drainage characteristics.	Wells and sumps are above and removed from stream channels. Pipelines and roads follow hill crest.	Staff determination.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<p><u>WATER RESOURCES</u> (continued)</p> <p><u>Power Plant</u></p> <p>Potential degradation of water quality related to:</p> <ul style="list-style-type: none"> - Discarded or discharged construction materials, fuels, fluids - Herbicides used to retard vegetative growth, pesticides -Wastewater (construction, sanitary) -Dredging and spoil disposal -Nutrient loading from fertilizers -Increased water temperatures due to increased turbidity -Soil additives (such as lime, fly ash, asphalt, phosphoric acid, sodium and calcium, chlorides -Temperature increase due to removal of vegetation. -Disturbance of stream bed for road, pipeline, and cable crossing. <p>Potential destruction from flooding, either natural or intensified by construction activities.</p> <p>Impacts from consumptive use of water in generating plant operations.</p>	<p>None to be discharged.</p> <p>None to be used.</p> <p>Wastewater to be reinjected.</p> <p>Spoils taken to solid waste disposal site.</p> <p>Minimal amounts of fertilizer used.</p> <p>Turbidity will be retained.</p> <p>None to be utilized</p> <p>Minimal vegetation removed, prompt revegetation will occur.</p> <p>Culverts will be used on currently existing roadways.</p> <p>Site is on a hill, above the surface water drainage course.</p> <p>Water will come from condensed steam flow.</p> <p>Drinking water will be bottled.</p>	<p>Staff determination.</p> <p>Staff determination.</p> <p>AFC, pg. III-60.</p> <p>Interrogatories, Soils, 7-27-79.</p> <p>Staff determination.</p> <p>NOI, Vol. 2, pg. 5-14.</p> <p>Staff determination</p> <p>NOI, Vol. 2, pg. 5-14.</p> <p>NOI, Vol. 1, pg. III-7.</p> <p>NOI, Vol. 1, pg. IV-19.</p> <p>AFC, pgs. III-57, III-63.</p>

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>WATER RESOURCES</u> (continued)		
<u>Transmission Lines</u>		
Alter existing flow patterns (water courses, overland flow, ground water recharge) by placement of tower pads and substation and switchyard facilities.	Minimal area affected; proposed site location near ridge tops, below crests.	Staff determination.
Potential loss of tower, transmission lines, or other facilities due to flooding.	Lines located above surface water flows.	Staff determination.
<u>BIOLOGICAL RESOURCES</u>		
<u>Well Field</u>		
Disturbance of wildlife by human activity and noise.	Post construction operational activity not substantial	NOI, Vol. 2, pg. 5-13. AFC, pg. IV-6, Section A.2. AFC, pg. IV-11, Section A.7.C.
<u>Power Plant</u>		
Potential loss of flora and fauna related to the increased fire hazard caused by operation and maintenance of the facility.	Operation and maintenance of geothermal power plant is not based upon combustion of flammable fuels. Some potential for fire hazard related to increased access to KGRA.	AFC, pg. IV-6, Section A.2. Staff determination.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>BIOLOGICAL RESOURCES</u> (continued)		
<u>Transmission Lines</u>		
Restriction of wildlife migration routes and daily movement corridors.	No impacts identified due to type of wildlife in area and short distance of line.	AFC, pg. IX-1.
Collision mortalities, especially in waterfowl migration routes, between birds and towers, cables or other facilities.	Route is not within normal migratory route of waterfowl. Collision by other species minimal.	NOI, Vol. 2, pg. 5-1; Section 5. AFC, pg. IV-6, Section 2.
Electrocution of large birds on towers and cables.	Design factors will minimize impacts.	AFC, pg. IX-8, Fig. IX-1.
Permanent loss of habitat under tower footings, paved access roads, switchyard and substation facilities. Loss of rare and endangered and unique or unusual species or habitat. Loss of wildlife species supported by habitat permanently lost (if adjacent areas unable to support displaced wildlife).	Minimal clearing of vegetation will be required. Construction of new access roads will be limited. Construction not allowed where sensitive plant and/or animal species have been identified.	AFC, pg. IX-7, Section D.
Change in species composition and in food and cover value of transmission right-of-way.	No significant alteration within right-of-way.	AFC, pg. IX-1, Section A.2.
Loss of vegetation and supported wildlife by selective thinning of vegetation during maintenance activities.	No thinning required.	AFC, pg. IX-1, Section A.2.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>BIOLOGICAL RESOURCES</u> (continued)		
<u>Transmission Lines</u>		
Probable detrimental effects to flora and fauna from exposure to electric and magnetic fields in the vicinity of power lines.	No known effects caused by power levels to be used on proposed lines.	Staff determination.
Potential fire hazard to lands (vegetation, wildlife) from fires started by downed lines.	While potential exists, it is not significant since chaparral is a fire controlled community.	AFC, pg. IV-6, Section A.2. Staff determination.
<u>HEALTH AND SAFETY</u>		
<u>Well Field</u>		
8-1 Emissions may be caused by accident hazard during well operations.	Potential emission would be minimal. Steam is vented to the air during normal outages.	NOI, Vol. 1, pg. III-6.
<u>Power Plant</u>		
Possibility of accidents associated with transportation systems constructed as a direct adjunct to the power plant (examples: new supply road).	Good design practice proposed for all-weather roads.	NOI, Vol. 1, pg. III-7, V-15, VI-3. AFC III-1.
Possibility of accidents associated with use of explosives, heavy equipment operation.	Compliance with CAL/OSHA, UBC; experienced local work force; work suspended during inclement weather.	NOI, Vol. 1, pg. V-17.
Possibility of security problems associated with general operations and maintenance of the plant.	Security problems minimal at site.	Staff determination.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>HEALTH AND SAFETY</u> (continued)		
<u>Transmission Lines</u>		
Potential health hazard from exposure to electric fields and magnetic fields.	Transmission route will cross unpopulated area.	NOI, Vol. 1, pg. VIII-1.
Possibility of accidents associated with the electric transmission system.	Low possibility expected.	Staff determination.
Exposure to noise in excess of 90 dB(A) for 8 hours for workers, or in excess of 55 dB (L _{dn}) to sensitive receptors.	Construction subject to CAL/OSHA regulations.	NOI, Vol. 1, pg. VI-4.
<u>CULTURAL RESOURCES</u>		
<u>Well Field</u>		
Disturbance or destruction of cultural resources due to exploration, drilling and construction related to development of geothermal resource.	No known sites in area of wells.	NOI, Vol. 1, pg. IV-49.
Disturbance or destruction of paleontological resources resulting from construction.	Single site identified near well Pad F; pad and roads relocated to avoid disturbance. No other known paleontological site near wells.	NOI, Vol. 2, pg. 11-A-3.
Disturbance or destruction of archaeological or historical resources.	No known historic resources.	NOI, Vol. 1, pg. IV-49.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>CULTURAL RESOURCES</u> (continued)		
<u>Well Field</u>		
Destruction of valuable resources by ongoing maintenance, operation and visitors.	Only known resource site near well pad F not readily apparent or attractive to operators or visitors.	NOI, Vol. 1, pg. IV-49.
<u>Power Plant</u>		
Possible disturbance or destruction of archaeological resources resulting from construction.	No resources have been located in plant siting area.	NOI, Vol. 1, pg. IV-49.
Disturbance or destruction of paleontological resources resulting from construction.	No resources have been located in area.	NOI, Vol. 1, pg. IV-49.
Disturbance or destruction of historical resources.	No resources have been located in area.	NOI, Vol. 1, pg. IV-49.
Disturbance or destruction of educational, religious, scientific or other cultural resources.	No resources have been located in area.	NOI, Vol. 1, pg. IV-49.
Destruction of valuable resources by ongoing power plant maintenance and operation and visitors.	No resources have been located in area.	NOI, Vol. 1, pg. IV-49.
<u>SOCIOECONOMICS</u>		
<u>Well Field</u>		
Potential change in economic activity in primarily rural/agricultural/recreational areas.	Not applicable - well field already developed.	NOI, pg III-1 - 8. AFC, pg. III-1.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>SOCIOECONOMICS</u> (continued)		
<u>Well Field</u>		
Potential impacts on local/regional employment by workers employed within power plant project area for development of geothermal resource.	Not applicable - well field already developed.	NOI, pg. III- 1 - 8. AFC, pg. III-1.
Secondary impacts of population increase service (indirect) employment, population increase, and demand for housing.	Not applicable - well field already developed.	NOI, pg. III- 1 - 8. AFC, pg. III-1.
<u>Power Plant</u>		
A-11 Possible changes in community structure, lifestyle.	Cumulative effects of increasing geothermal development could effect such changes in the rural communities.	Staff determination.
Impact of constructing project on national capital supplies.	Capital cost = \$57 million to be provided through the federal geothermal loan guaranty program, through the DOE.	NOI, pg. II- 1-6; VII-6. AFC, pg. II - 1-15.
Conformity with the CERCDC biennial forecast of electrical demand.	NCPA No. 2 project included in PGandE service area and planning forecast.	CFM II, 1979. NOI, pg. II 1-6. AFC, Pg. II - 1-5. CEC, Staff Position Paper (draft)
Impact of proposed project on "average" residential, commercial and industrial rate schedule.	Busbar cost per kilowatthour is less than for other, fossil-fuel generated power or purchased power.	AFC, pg. II - 1-5. CEC, Staff Position Paper (draft)

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>SOCIOECONOMICS</u> (continued)		
<u>Power Plant</u>		
Change in basic economic activities of affected region.	Cumulative effect of increasing geothermal development and use will expand and diversify economic base of region.	Staff determination.
Impact of additional population on adequacy of commercial services.	Project is expected to draw upon existing work-force already active in geothermal development in The Geysers KGRA.	NOI, pg IV-50; V-18.
Change in land use due to transportation needs.	Project will use existing transportation routes and services.	NOI, pg. IV-50, V-15.
Change in land use due to fuel and waste disposal.	Project will use existing disposal sites or under-productive wells for reinjection of wastes.	NOI, pg. VII- 2 and 3. AFC, Pg. VII-9. NCPA, Responses to Interrogatories 7/29/79.
Consumption of land for generating plant and related facilities.	Plant site will require 7 acres of land transmission tower pads will require less than one acre; access roads, less than 5 acres.	NOI, pg. V-1,12,15. AFC, pg. III-2. NCPA, Response to Interrogatories, 7-29-79.
Project area will experience increased employment and income directly attributable to construction of power plant and related facilities (Primary employment)	Project is expected to draw upon existing work-force already active in geothermal development in The Geysers KGRA.	NOI, pg. IV-50, pg. V-18.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>SOCIOECONOMICS</u> (continued)		
<u>Power Plant</u>		
Project area will experience increased employment and income directly attributable to operation and maintenance of power plant.	Operation of power plant will require 8-10 employees which represents an insignificant portion of available workforce.	NOI, pg. VII-6.
Project area population will increase due to increases in direct and indirect employment.	Small size of operation workforce would produce little or no indirect employment and project impacts would be insignificant.	NOI, pg. VII-6.
Power plant construction will compete with other projects or existing sources of employment for workers.	Timing of construction coincides with a reduced need for other Geysers projects.	PGandE, Responses to NOI Interrogatories for Geysers Unit 18. JES: Figure IV-3.
Housing units will be required to accommodate construction worker households.	Peak construction period workforce for this project does not exceed previous cumulative peak experienced during late 1978 for construction of PGandE Geysers Units.	PGandE, Responses to NOI Interrogatories for Geysers Unit 18.
Operation and maintenance of power plant may result in new households in project area.	Immediate project area not zoned for residential and existing housing supply adequate to accommodate 8-10 families.	Lake County General Plan and zoning map Sonoma County General Plan and zoning map. NOI, VII; page VII-6.
Absence of power plant may diminish employment in other sectors.	Number of operation and workforce is considered an insignificant fraction of available workforce in area.	NOI, pg. IV-50, V-18, VII-6. AFC, Pg. IV - 29.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>SOCIOECONOMICS</u> (continued)		
<u>Power Plant</u>		
Adequacy of community services/facilities due to plant requirements, e.g., waste water, solid waste, police, fire.	Available community services/facilities are adequate for plant requirements. Capacity of each of the local solid waste disposal sites is estimated to be adequate to accommodate geothermal wastes for 50 years.	NCPA, Response to AFC Interrogatories, July 23, 1979. Personal communications with CEC staff, June, 1979 and July, 1979.
Adequacy of community services/facilities due to increased population (construction and operation work force). Services/facilities demanded could include: Sewer Water Transportation Police protection Fire protection Solid waste General government Schools Medical care Electrical and gas utilities Parks and recreation Flood control and drainage Telephone and communications Housing	Peak construction workforce for project will not exceed prior peak and operation workforce is of insignificant size to adversely affect adequacy of community services.	NOI, pg. IV-50, V-19 & 80, VII-6. AFC, pg. IV-29
Potential depletion of municipal water supplies by heat dissipating system.	Consumption of approximately 1.3 acre feet of water during construction and initial start-up activities considered insignificant portion of available water supply. Once in operation water in excess of plant requirements will be produced by the generation process.	NOI, pg. VII-2&3, V-6, 8, 17, 18. AFC, pg. IV-8.

A-17

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<p><u>SOCIOECONOMICS</u> (continued)</p> <p><u>Transmission Lines</u></p> <p>Identify public utility lines requiring alteration.</p> <p>Population and housing effects due to construction of transmission lines.</p> <p><u>AESTHETICS</u></p> <p><u>Well Field</u></p> <p>Alteration or disruption of visual attributes of site by exploration and production of geothermal resource.</p> <p>Change in noise characteristics of site by exploration and production of geothermal resource.</p> <p>Effects resulting from smell of increased H₂S emissions.</p> <p><u>Power Plant</u></p> <p>Alteration or disruption of aesthetic attributes of viewscape and/or site due to construction of power plant and related facilities.</p>	<p>Project will tap into existing PGandE transmission system about 2 miles west of plant site. No alteration of lines required.</p> <p>Peak construction not expected to exceed previous peak in late 1978.</p> <p>Area has been disturbed by previous development.</p> <p>Steam is vented through rock mufflers to lessen noise impacts.</p> <p>No major increase expected; nearest sensitive receptor located more than a mile away.</p> <p>Plant site can be viewed only from the immediate vicinity, which is already developed.</p>	<p>NOI, V-1,9,12,15; VIII-1, X-11. AFC, IX - 1-9.</p> <p>NOI, pg. V-17; VII-6 PGandE, Responses to NOI Interrogatories for Geysers Unit 18.</p> <p>Staff determination.</p> <p>NOI, Vol.1, pg. III-6.</p> <p>Staff determination.</p> <p>NOI, Vol. 1, pg. VI-4.</p>

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>AESTHETICS</u> (continued)		
<u>Power Plant</u>		
Changes in noise characteristics resulting from power plant operation.	At full operation, noise levels are not expected to exceed 60 ± 5 dBA at 500 feet.	NOI, Vol. 1, pg. VII-7.
Effects of H ₂ S emission resulting in unpleasant odors.	Plant emission should not contact populated areas in significant quantities potential cumulative effects.	NOI, Vol. 1, pg. VII-5.
<u>Transmission Lines</u>		
Accessibility to new vantage points allowing people easier access to areas, thereby effecting aesthetic attributes.	Approximately one mile of new access road to be added to existing system. Access controlled by steam developers.	Staff determination.
Alteration or disruption of aesthetic attributes of viewscape of and/or route for transmission system.	Route will be located below ridge crest to minimize visual impacts.	NOI, Vol. 1, pg. VIII-1
<u>ENERGY AND MATERIAL RESOURCES</u>		
<u>Well Field</u>		
Use of resources and energy associated with construction of well field and waste fluid disposal facilities, and with well field abandonment.	Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	NOI, pg. III-4 through 8; V-1 through 7. Staff determination.
Energy use associated with operation of well field and waste fluid disposal facilities.	Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	NOI, pg. III - 4 through 8; V-1 through 7. Staff determination.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>ENERGY AND MATERIAL RESOURCES (Cont.)</u>		
<u>Power Plant</u>		
Use of resources and energy in the preparation of the site and construction of the various facilities including the generating plant.	Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	NOI, pg. III - 4 through 8; V-1 through 7. Staff determination.
Resource and energy uses associated with project facilities including the generating, service water, and waste heat dissipating systems (e.g., coolant pumps, cooling towers blowers) plus other internal uses.	Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	NOI, pg. III - 4 through 8; V-1 through 7. Staff determination.
Use of chemicals, materials, fuel and electricity for facilities operation and maintenance.	Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	NOI, pg. III - 4 through 8; V-1 through 7. Staff determination.
Energy and resources used in maintenance of turbines.	Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	NOI, pg. V-1 through 17. Staff determination.
<u>Transmission Lines</u>		
Use of resources and energy associated with construction of electrical transmission system, including transformer stations, etc.	Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	NOI, pg. V-12 through 15,17; IX-3 Appendix C, pg. 15-1 through 10. Staff determination.
Use of resources and energy associated with transmission facilities-transmission lines, transformer stations, switchyard, etc.	Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	NOI, pg. V-12 through 15,17; IX-3 Appendix C, pg. 15-1 through 10. Staff determination.

Insignificant Environmental Impacts

Potential Impact	Reason for Insignificance	Source
<u>ENERGY AND MATERIAL RESOURCES</u> (cont.) <u>Transmission Lines</u> Energy used in transmitting, transforming, switching and regulating electrical energy (transmission lines, terminal equipment (transformers, converters, switchgear) and control and metering systems). Fuel, chemicals, materials and electricity used for transmission facilities operation and maintenance.	 Amounts used are not considered significant in terms of construction throughout the state or in the energy industry. Amounts used are not considered significant in terms of construction throughout the state or in the energy industry.	 NOI, PG. V-12 through 15, 17, IX-3 Appendix C, pg. 15-1 through 10. Staff determination. NOI, pg. V-12 through 15, 17, IX-3 Appendix C, pg. 15-1 through 10. Staff determination.

APPENDIX B
HISTORY OF PRIOR FEDERAL ACTION
AND
NEPA DOCUMENTATION

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AND
NEPA DOCUMENTATION

The proposed project of the Northern California Power Agency (NCPA), to utilize geothermal steam from Shell Oil Company wells in a 110 MW power plant in The Geysers KGRA, was preceded by Federal actions which span almost a decade. These federal actions were designed to ensure environmental protection for the leasing, exploration, development, and utilization of geothermal resources on public lands.

GEOHERMAL STEAM ACT OF 1970 AND IMPLEMENTING REGULATIONS

The first major Federal action was the decision to lease federal lands for geothermal development under provisions of the Geothermal Steam Act of 1970. Leasing, operating, and unit plan regulations necessary to implement the Act have been published in the Federal Register since July 1971. The Act and its regulations define both the guidelines and the environmental impact evaluation process that must be followed for the leasing, exploration, development, and utilization of geothermal resources on public lands.

UNITED STATES DEPARTMENT OF THE INTERIOR (USDI)
ENVIRONMENTAL IMPACT STATEMENT (EIS) for the GEOHERMAL LEASING PROGRAM

In order to determine whether or not leases were to be issued in The Geysers KGRA, the United States Department of the Interior (USDI) needed to identify, evaluate, and describe the environment and the potential impacts on the environment, from geothermal leasing operations there. Furthermore, USDI needed to identify the alternatives to a geothermal leasing program on the Geysers KGRA lands. The Environmental Impact Statement (EIS) for the Geothermal Leasing Program published in October 1973 contains the results and conclusions of the USDI environmental impact assessment for the Geothermal Leasing Program in The Geysers KGRA.

The Environmental Impact Statement (EIS) for the Geothermal Leasing Program assessed the kinds of impacts that could be expected to occur with geothermal development in The Geysers KGRA. Alternatives that were addressed in the 1973 EIS included: (1) promulgation of leasing and operating regulations, (2) alternatives for leasing geothermal resources, (3) alternatives for exploration and development, and (4) alternative sources of electrical energy. Further, specific alternatives for The Geysers KGRA were discussed. These included: (1) no leasing, (2) lease in connection with the related development of geothermal resources on contiguous private lands, and (3) lease only selected areas where geothermal development is compatible with existing land uses in the area.

The 1973 EIS indicates that leasing and development should not take place unless it can be accomplished in an environmentally acceptable manner. From this investigation, USDI determined that geothermal leasing and resource development in The Geysers KGRA would be acceptable on lands of low environmental sensitivity, and with the implementation of continuous regulation and strict environmental controls.

BUREAU OF LAND MANAGEMENT
ENVIRONMENTAL ANALYSIS RECORD (EAR)

The Bureau of Land Management (BLM) used the information, recommendations, and conclusions presented in the 1973 EIS to determine the suitable lease areas of The Geysers KGRA.

After determining the suitable lease areas of The Geysers KGRA, BLM performed a site specific Environmental Analysis Record (EAR) for each of the lease areas. This preleasing EAR, published in 1974, identifies and describes the impacts that could accompany geothermal development and operation in The Geysers KGRA. Included in the EAR (BLM, 1974) are specific stipulations for protecting the environment in the lease area containing lease tracts #CA-949 and #CA-950. This lease area is identified in the EAR as T. 10N, R. 8W, MDM; Sections 1, 2, 3, 4, 11, 12. Each section of this lease area is defined by size, ownership, location, characteristic landmarks, significant contents, and special environmental protection stipulations as shown in the following excerpts from the EAR.

LEASING AREA

Section 1 - 760 acres NRL - Lake County. Northern portion Bear Canyon Creek drainage, southern portion Dry Creek drainage. Vegetation chaparral, chamise, knobcone pine and cypress. Mining activity in south part, balance of area undisturbed. Anderson Springs about one mile north. Stipulate to stay out of creeks. High, distant visibility from Highway 175.

Section 2 - 800 acres NRL - grandfather application - Lake and Sonoma Counties. Bear Canyon Creek and Big Sulphur Creek drainages. Chaparral, dense patches of knobcone pine, some scattered digger pine, fir and ponderosa pine. None commercial. Very rough, mountainous country. Some mining on north and south edges. Nearest habitation Anderson Springs 1-1/4 miles NE. Both watersheds support game fish. Stipulate to stay out of stream.

Section 3 - 620 acres NRL and 400 acres NRL grandfather application - Sonoma County. Sulphur Creek drainage. Area has public access. Good stand of ponderosa pine and Douglas-fir along Big Sulphur Creek. Balance of area predominantly Henneke soil and associated chaparral. Nearest home about 1/2 mile northwest, recreation cabin in Section 3 (SW1/4SW1/4). Stipulate buffer zone along Big Sulphur Creek.

Section 4 - 57 acres NRL and 320 acres grandfather application - Sonoma County. Sulphur Creek drainage. Public access. Chaparral, mostly chamise and scrub oak. Ponderosa pine and Douglas-fir along Sulphur Creek requires buffer zone stipulations. Nearest home 1/4 mile.

Section 11 - 300 acres NRL - Sonoma County. Headwaters of Ingalls Creek. Chaparral brush, Henneke soil, south slope, cabin very near NRL, Locke mining claim.

Section 12 - 60 acres NRL - Sonoma and Lake Counties. Ingalls and Dry Creek watersheds. Pine mountain in section. Jeep trail. No public access. Chaparral, surface disturbance from mining activity.

These special environmental protection stipulations are incorporated into the geothermal lease agreement, Section 31. More general stipulations of Section 14 ("Protection of the Environment (Land, Air, and Water) and Improvements") and Section 15 ("Waste") of the lease agreement.

LEASE TRACT DETERMINATION BY USGS

Following completion of the EAR by BLM, the United States Geologic Survey (USGS) was assigned the task of dividing the lease areas into lease tracts for competitive bidding. USGS does this on the basis of geologic considerations, maximum allowable acreage limitations, and lease tract manageability. The lease tract documentation is then returned to BLM which is the agency responsible for the administration of the competitive bidding procedure.

LEASE SALE AND ENVIRONMENTAL PROTECTION

In January 1974, Shell Oil Company became the successful bidder for both lease tracts #CA-949 and #CA-950. Shell then entered into a geothermal lease agreement with BLM. By signing the lease Shell Oil Company agreed to comply with the environmental protection stipulations in Sections 14, 15, and 31 of the Geothermal Resource Lease. The information contained in these sections is as follows:

Sec. 14. PROTECTION OF THE ENVIRONMENT (LAND AIR AND WATER) AND IMPROVEMENTS - The Lessee shall take all mitigating actions required by the Lessor to prevent: (a) soil erosion or damage to crops or other vegetative cover on Federal or non-Federal lands in the vicinity; (b) the pollution of land, air, or water; (c) land subsidence, seismic activity, or noise emissions (d) damage to aesthetic and recreational values; (e) damage to fish or wildlife or their habitats; (f) damage to or removal of improvements owned by the United States or other parties; or (g) damage to or destruction or loss of fossils, historic or prehistoric ruins, or artifacts. Prior to the termination of bond liability or at any other time when required and to the extent deemed necessary by the Lessor, the Lessee shall reclaim all surface disturbances as required, remove or cover all debris or solid waste, and, so far as possible, repair the offsite and onsite damage caused by his activity or activities incidental thereto, and return access roads or trails and the leased lands to an acceptable condition including the removal of structures, if required. The Supervisor or the Authorized Officer shall pre-

scribe the steps to be taken by Lessee to protect the surface and the environment and for the restoration of the leased lands and other lands affected by operations on the leased lands and improvements thereon, whether or not the improvements are owned by the United States. Timber or mineral materials may be obtained only on terms and conditions imposed by the Authorized Officer.

Sec. 15. WASTE - The Lessee shall use all reasonable precautions to prevent waste of natural resources and energy, including geothermal resources, or of any minerals, and to prevent the communication of water or brine zones with any oil, gas, fresh water, or other gas or water bearing formations or zones which would threaten destruction or damage to such deposits. The Lessee shall monitor noise, air, and water quality conditions in accordance with any orders of the Supervisor.

Sec. 31. SPECIAL STIPULATIONS-(stipulations, if any, are attached hereto and made a part hereof)

SPECIAL STIPULATIONS AND CONDITIONS

GEYSERS KGRA

LEASEHOLDS NOS. CA-949 AND CA-950

The lessee shall contact the Supervisor prior to the development of a plan of operation to be apprised of practices which shall be followed or avoided in field development, including but not limited to road standards, road crossings, gates, cattleguards, fencing, erosion controls, and surface rehabilitation.

The lessee shall comply with the following special conditions and stipulations unless they are modified by the Lessee, the Supervisor, and the authorized officer.

1. Upon notification by the authorized officer that archeological values exist or are believed to exist in the leased lands, the Lessee will engage a qualified archeologist, acceptable to the BLM, to survey and salvage items of archeological value in advance of any surface disturbance. The responsibility and cost of this survey and salvage will be that of the Lessee.
2. The Lessee shall participate in earthquake and land subsidence prevention and detection programs applicable to the leased area where determined to be necessary.
3. Mud pits and sumps containing any additives toxic to wildlife will be protected from entry by birds and other wildlife.
4. Noise levels shall at all times be kept to a minimum and will never exceed 65 decibels at a distance of 1,500 feet from its source.

5. No clearing of ground cover for power transmission lines, except for tower or pole pads, shall be allowed.
6. All power and transmission lines will be designed to minimize loss of raptors and other large birds by electrocution. Nonspecular conductors may be required.
7. The use of wide-tired or balloon-tired, vehicles and helicopters may be required in off-road areas where necessary, to protect the soil and other resources.
8. Disturbance of soils, within the leased lands which are susceptible to slides, slumps, excessive settlement, soil creep, and severe erosion shall be avoided wherever possible. If it is not possible for the Lessee to avoid these areas, the Lessee shall comply with special stabilization and prevention of soil movement practices required by the Supervisor.

All soil disturbances shall be stabilized by mulching and seeding.

a. No vegetation or soil shall be disturbed within 300 feet (horizontal measurement) of Bear Canyon Creek, Dry Creek, Gunning Creek, Anderson Creek, Big Sulphur Creek, Little Sulphur Creek, Hot Springs Creek, Squaw Creek, Hummingbird Creek, Cobb Creek, or Ana Blecher Creek except at approved crossings and other areas approved by the Supervisor.

b. No vegetation or soil shall be disturbed within 700 feet (horizontal measurement) of Kelsey Creek, High Valley Creek, Sweetwater Creek, and Adobe Creek except at approved crossings and other areas approved by the Supervisor.

PLAN OF OPERATION FILED BY SHELL OIL COMPANY

After signing the lease agreements for the tracts #CA-949 and #CA-950, Shell Oil Company proceeded to develop and submit to USGS a Plan of Operation for the drilling, testing, and operation of wells on leaseholds. One plan was submitted in July 1974 and contains the types of activities Shell proposed to perform during the construction, drilling, and operation of wells and related projects at the site.

USGS ENVIRONMENTAL ANALYSES (EA'S)

USGS then arranged field trips to the locations described in the submitted Plans of Operation. On these field trips USGS took professionals whose expertise and backgrounds would permit them to: (1) critically evaluate the environment; (2) predict the potential adverse environmental consequences from the proposed operating methods; and (3) communicate and cooperate with the lessee to modify the Plan of Operation to include the necessary mitigating measures for protecting the environment and avoiding adverse impacts. Using this procedure, USGS is able to guarantee that construction does not commence until the site specific environmental protection measures are taken.

From the information gathered during the field survey USGS prepares a site-specific Environmental Analysis (EA) which describes the existing environment, the proposed actions of the lessee, the anticipated problems, and reports the communications and cooperation between the lessee and USGS to identify the suitable stipulations to be agreed to and used by the lessee to ameliorate the anticipated problems. Each EA also discusses the alternatives to the proposed activities of the lessee and considers the need for their implementation. Table B-1 is a list of the EA's prepared for geothermal resource development on lease sites #CA-949 and #CA-950.

TABLE B-1. U.S. GEOLOGICAL SURVEY, ENVIRONMENTAL ASSESSMENTS (EA) FOR SHELL OIL LEASEHOLDS CA-949 AND CA-950.

Number	Subject	Lease Number
EA #1-4	08-26-74	One deep well, each lease
EA #13-5	07-28-75	Deep exploratory drilling, Site B
EA #22-5	10-08-75	Deep exploratory drilling, Site C
EA #37-6	07-19-76	Deep exploratory drilling, Site D
EA #40-6	05-20-76	Deep exploratory drilling, Site B
EA #48-6	09-13-76	Deep exploratory drilling, Sites A & C
EA #66-7	05-04-77	Deep exploratory drilling, Sites F & G
EA #68-7	05-20-77	Deep exploratory drilling, Site E
EA #80-8	04-11-78	Deep exploratory drilling, Sites H & I
		and Site J
EA #95-8	08-24-67	Deep exploratory drilling, Sites K, L, M, P and Q

In addition to the general and special stipulations contained in the lease and EA, the lessee must also consider pertinent state and local standards.

Following agreement on the modified Plan of Operation, USGS and BLM make frequent visits to the site of operation to monitor for adherence to the stipulations and conditions of the lease, the EA's, and the Geothermal Resource Operation Orders. These efforts are designed to make certain that adverse environmental consequences are avoided or minimized.

The procedures described above were adopted by the Department of Interior and its agencies to achieve compliance with the policies, purposes, and goals of the National Environmental Policy Act (NEPA, 1969). The documents prepared from the environmental assessments of BLM, USGS, and USDI, are designed to be used in the evaluation of projects by decision makers. Furthermore, these actions and reporting procedures have provided the framework for developing whatever special terms and conditions are needed to protect the environment, permit the use of the land for other purposes, and prevent significant deterioration of other natural resources during the leasing, exploration, development, construction, operation, and utilization of geothermal resources.

REFERENCES FOR APPENDIX B

NEPA, 1969. National Environmental Policy Act of 1969. 42 USC 4321-4347. U.S. Government Printing Office, Washington, D.C.

USDI, 1973. Final Environmental Statement for the Geothermal Leasing Program. 4 Vol. U.S. Department of the Interior, U.S. Government Printing Office, Washington, D.C.

BLM, 1974. Environmental Analysis Record of Geothermal Leasing in The Geysers KGRA, EAR #012. Bureau of Land Management Office, Ukiah, CA.

APPENDIX C

AGENCIES INVOLVED IN
APPROVAL OF THE PROJECT
AND
MEMORANDUM OF UNDERSTANDING

APPENDIX C

THE AGENCIES INVOLVED IN APPROVAL OF THE PROJECT

The proposed NCPA No. 2 project is the first commercial geothermal power plant planned for development on public lands. The location of the project requires review and authorization by the U.S. Geological Survey and the U.S. Bureau of Land Management, plus the California Energy Commission. In addition, the NCPA has requested federal funding for a portion of the project, which requires project review by the U.S. Department of Energy.

Due to the interrelated roles and responsibilities of these agencies in evaluating and permitting this project, they entered into an agreement to consolidate proceedings related to the NCPA No. 2 geothermal project. The three federal agencies are actively participating in the Energy Commission's project review process and public hearings. They also agreed to jointly prepare a single, multi-agency environmental document, the Joint Environmental Study (JES).

AGENCY ROLES

Below are brief descriptions of the jurisdictional interests of the four agencies involved in the joint review and processing of the proposed NCPA Geothermal Project No. 2.

The California Energy Commission (CEC)

All new thermal power plants greater than 50 MW output proposed in the State of California must be reviewed and certified by the CEC. On August 11, 1978, the NCPA submitted its Notice of Intention (NOI) to apply for the certification of its Geothermal Project No. 2. The NOI is the first stage of the Energy Commission's two-stage siting process for thermal power plants. As a precertification stage, the purpose of the NOI is to assess the general acceptability of the site and the need for a proposed new power plant or transmission line.

The NCPA submitted its Application for Certification (AFC) for this project on April 5, 1979. The AFC is the second stage of the Energy Commission's siting process and is the formal permitting process in which specific site plans and facility designs are reviewed against applicable standards. The purpose of the AFC is to ensure that the proposed power plant and related facilities will be constructed and operated in compliance with all applicable standards and in a manner which is environmentally and economically acceptable, safe and reliable.

For most geothermal power plant proposals, the NOI and AFC stages of the Commission's siting process are each nine months long. The NOI stage for the NCPA No. 2 project, however, has been completed in seven months. The Energy Commission expects to process the AFC in about nine months.

Preparation of the Commission's environmental document began when NCPA filed the NOI for their Geothermal No. 2 project. This JES, prepared jointly by the four agencies (CEC, BLM, DOE and USGS), plays an integral part in the Energy Commission's NOI/AFC process by documenting the environmental consequences, mitigation measures, and alternatives to the project for the decision makers and the general public.

The U.S. Bureau of Land Management (BLM)

The BLM acts as the surface land manager for the U.S. Department of Interior. The proposed project is located on public lands which BLM has determined through the environmental assessment process, are compatible for geothermal development. The steam supplier for the NCPA No. 2 project was the successful bidder on a portion of these lands and has entered into a geothermal resources lease with BLM.

The BLM, as the lead agency in leasing, consults with the U.S. Geological Survey (USGS) to determine the value of the resources present, and to evaluate geologic aspects of the project and to interpret expected environmental impacts associated with resource development. Following this consultation, BLM prepares the environmental assessments record necessary for a decision on leasing and any stipulations or conditions required for development of the resource.

Prior to offering the public lands in The Geysers KGRA and elsewhere for development of geothermal resources, the Department of Interior prepared and circulated for public review, a programmatic Environmental Impact Statement (EIS) in 1973. Following approval of the leasing action proposed in the EIS, the BLM issued 12 leases in The Geysers KGRA and cooperates with the USGS in overseeing resource development activities within the individual leases.

The BLM has responsibility to license an electrical generating plant larger than 20 MW and/or proposed for operation on federal lands longer than five years. Licensing the proposed power plant will require preparation of an environmental assessment specific to the NCPA proposal.

The U.S. Geological Survey (USGS)

The USGS acts as the mineral resource manager for the U.S. Department of Interior and is responsible for geologic, engineering, and economic value determinations, and supervision of lease operations. The USGS evaluates the type, value, and potential of the resources present on federal lands and may make recommendations to the land management agency (either BLM or the U.S. Forest Service) relative to stipulations on lease agreements to allow for multiple use.

Prior to leasing, the USGS assists the surface land management agency (in this case BLM) in the preparation of environmental assessments necessary for the lease. The USGS role in preparing these documents is to provide the surface manager with the geologic evaluation and interpretation of expected impacts on the environment resulting from the proposed geothermal development. The USGS may also assist the surface manager in supervising any pre-lease, preliminary exploration of resource potential.

Although the BLM is responsible for lease approval and issuance, BLM must obtain the advice and/or concurrence of the USGS on certain technical aspects. After issuance of the lease the USGS assumes the lead role for approval and supervision of all activities relating to operations conducted on the lease by the lessee or his operator. Under its regulatory responsibility, the USGS ensures that all lease operations comply with other federal agency regulations and all state and local standards.

In addition to the BLM license to use the site, the USGS issues a permit to construct and operate an electrical generating plant after a Plan of Utilization filed with the USGS Area Geothermal Supervisor has been approved. The NCPA filed a Plan of Utilization for their proposed Geothermal Project No. 2 in March 1978. This document is identical to Volume I of the NOI filed with the California Energy Commission.

The U.S. Department of Energy (DOE)

DOE administers the federal Geothermal Loan Guarantee Program (GLGP). The purpose of this program is to accelerate the commercial development of geothermal energy by the private sector by minimizing the financial risk to lenders, and encouraging the development of a normal lender/borrower relationship in the geothermal industry.

Under the Geothermal Loan Guarantee Program, the federal government provides a loan guarantee on private loans for geothermal projects. Before approving a loan guarantee, the DOE reviews the projects for environmental, technical and economic viability. The emphasis of the review is to determine if there is reasonable assurance that a guaranteed loan can be repaid.

Attorneys for DOE have determined that approval of loan guarantees is a significant federal action under the National Environmental Policy Act (NEPA). This determination requires the preparation of environmental documentation prior to decision on the loan guarantee. This Joint Environmental Study, in accordance with the Memorandum of Understanding dated November 16, 1978, and signed by the DOE Assistant Secretary for Environment is expected to provide this required documentation. The JES will be used as part of the decision process to determine whether to grant the loan guarantee. Completion and certification of this JES is expected to fulfill DOE's responsibilities under NEPA for environmental documentation for this action.

MEMORANDUM OF UNDERSTANDING

MEMORANDUM OF UNDERSTANDING

78-N01-5

REGARDING THE NORTHERN CALIFORNIA POWER AGENCY

ENERGY COMMISSION
RECEIVED

GEOTHERMAL UNIT #2 POWER PLANT AT THE

NOV 22 1978

GEYSERS, SONOMA COUNTY, CALIFORNIA

This agreement entered into this 16th day of November, 1978, by and between the United States Geological Survey, hereinafter referred to as USGS; the United States Bureau of Land Management, hereinafter referred to as BLM; the United States Department of Energy, hereinafter referred to as DOE; and the California State Energy Resources Conservation and Development Commission, hereinafter referred to as CEC;

W I T N E S S E T H

WHEREAS, the Northern California Power Agency, hereinafter referred to as NCPA, proposes to construct and operate a 110-Mw geothermal-powered thermal power plant on federally-owned and leased lands in the Geysers, Sonoma County; and.

WHEREAS, NCPA has filed, pursuant to 43 CFR 3250 et seq., with BLM a license application (LA) to construct the plant on federally-owned land; and

WHEREAS, NCPA has filed pursuant to 30 CFR 270 et seq. with USGS, a plan of utilization (POU) for the construction and operation of the plant; and

WHEREAS, NCPA has filed pursuant to 10 CFR 790 et seq., with DOE, an application for a Federal Geothermal Guaranteed Loan to provide guaranteed financing for the construction of the plant; and

WHEREAS, NCPA has filed with the CEC, pursuant to Public Resources Code section 25500 and implementing regulations a notice of intention to file an application for certification (NOI); and

WHEREAS, the NCPA project may in the view of the CEC have a "substantial adverse impact" (as such is defined by the California Environmental Quality Act, hereinafter CEQA) upon the environment, including, but not limited to, impacts on air and water quality, waste disposal, fish and wildlife, agricultural and growth effects which must be considered by the CEC when reviewing and acting on the project pursuant to CEQA and other applicable state laws; and

WHEREAS, the NCPA project may significantly affect the quality of human environment, within the meaning of the National Environmental Policy Act, hereinafter NEPA, thus the environmental impact must be considered by USGS, BLM and DOE when reviewing and acting on the project pursuant to NEPA, and other applicable federal laws; and

WHEREAS, the additional informational requirements of the respective permitting authorities relative to the approval of the construction of a power plant are similar; and

WHEREAS, it is in the mutual beneficial interest of the USGS, BLM, DOE, and CEC to share in the task of the preparation of the appropriate environmental document, the collection of other data pertinent to the plant construction and to conduct the necessary public hearings on the proposed power plant and environmental document on the proposed NCPA project, jointly

wherever practicable, so as to reduce the duplication of staff efforts, share respective staff expertise and information already generated and to promote intergovernmental coordination at the state and federal levels, thus serving the goal of producing more efficient environmental review and power plant permitting process, and the public interest;

NOW THEREFORE, in consideration of the mutual covenants, conditions and promises hereinafter set forth is agreed as follows:

I. ENVIRONMENTAL STUDY

1. USGS, BLM, DOE, and the CEC agree to combine their efforts to prepare a joint environmental study, hereinafter referred to as the study, as set forth in this agreement and in accordance with provisions of NEPA and CEQA.

2. The study shall address itself to the impacts on the environment of the proposed NCPA project as well as alternatives thereto, including, but not limited to, air, water quality, fish and wildlife, agriculture and land use impacts at the proposed location.

3. The general tasks to be performed are outlined immediately below. Specific implementation measures are stated in paragraph 4 following:

a. Each agency (USGS, BLM, DOE and CEC) shall appoint a project representative. An agency may change its designated representative upon notice to other parties. The CEC project representative shall be overall project

leader for the preparation of the study. All contacts, to the extent possible, with NCPA, shall be made through the CEC project leader.

b. The CEC project representative shall in conjunction with the other present representatives prepare or cause to be prepared a draft study, which shall be consistent with the project description, format, outline and the provisions of CEQA and NEPA.

c. The study shall be prepared with all information which USGS, BLM, DOE or CEC believe is necessary in order for the document to properly evaluate the project, provided that use and inclusion of such information is not in violation of applicable laws and regulations.

d. The draft study may be organized to include by reference or appendices technical information, environmental data assessments, and other documents provided that such appendices are separate from the study itself, and the source of such appendices or information is included.

e. The final study shall also address the concerns and comments of public agencies and the general public. To this end, public review of the draft study shall take place through appropriate state and federal procedures jointly wherever practicable. The USGS, BLM, DOE, and CEC shall address public comments before certifying/determining the study as final and complete.

4. The provisions of paragraph 3 shall be implemented as follows:

a. The names, addresses and business phones of the initial agency project representatives are:

Mr. Robert Kent
United States Geological Survey
345 Middlefield Road
Menlo Park, CA 94025
(415) 323-8111

Mr. Joel Verner
Bureau of Land Management
P. O. Box 940
555 Leslie Street
Ukiah, CA 95482
(707) 462-3873

Ms. Kathryn Matthews (Environmental Team Leader)
California Energy Commission
1111 Howe Avenue
Sacramento, CA 95825
(916) 445-8094

Mr. Raymond A. Brechbill
Department of Energy
1333 Broadway
Oakland, CA
(415) 273-7964

b. Within ten days of receipt of an NOI by the CEC, the project coordinators shall meet to establish a preparation plan which shall include but not be limited to the following:

- 1) outline a time schedule;
- 2) design study format;
- 3) determine the possible scope of the proposal, significant issues to be addressed and the alternatives to be considered;
- 4) identify and eliminate nonsignificant issues from detailed study;

5) agree on data requirements, inventory methodologies and the level of detail for each resource component;

6) agree on assignments for the participating agencies for the preparation of specific sections of the study;

7) prepare a mailing list of interested or affected entities or individuals; and

8) agree on a plan for public involvement in the preparation of the study.

c. Each agency shall thereafter prepare the direct section(s) assigned to it, if any, in accordance with the preparation plan. The completed draft section(s) from the participating agencies shall be forwarded to CEC for incorporation into a predraft study. The predraft study shall be submitted to USGS, BLM, and DOE for review. Within fifteen days of receipt of the predraft, each of the parties to the agreement shall approve or provide comments on the prestudy to the CEC. The draft study shall not be issued without the informed concurrence of all parties.

5. In order to obtain comments from public agencies and input from the general public on the impacts of the project, the approved draft study shall be submitted to the appropriate federal, state, and local agencies and interested persons for review and comment. If deemed necessary by any party, a public hearing or hearings, in addition to the public hearings required for the ultimate approval of the power plant construction, may be conducted

by one or more parties, regarding the draft study. Such public hearing shall be noticed in accordance with the agencies' usual procedures, and shall be conducted jointly whenever possible.

6. After completion of the public review of the draft, the comments received shall be analyzed by each party and environmental issues raised in the review process shall be addressed in the final study.

7. Upon completion of the final study, notification shall be made by the CEC to the State Resources Agency pursuant to CEQA.

8. In the event of disputes as to scientific issues relating to the study, the study shall contain the conflicting viewpoints. Disputes other than scientific shall after the project representatives have exhausted every means of resolution, shall be referred to the next higher level of authority in the respective agencies for resolution.

II. PROJECT REVIEW AND DECISION

It is recognized and understood by all parties to this agreement that each must issue its appropriate agency license, permit, approval or decision for the NCPA project in accordance with its individual procedures. It is also recognized that each of the parties' license, permit, approval or decision may affect the license, permit, approval or decision of the other parties if differing conditions are placed on the respective decisions. It

is therefore the desire of the parties to ensure consistency of decisions to the maximum extent possible.

In order to fulfill the above understandings, the staffs of each party shall cooperate with one another and may participate in the review proceedings of the other parties.

The parties further agree to take whatever further steps they deem necessary, including further agreements or amendments to this memorandum, in order to fulfill the purpose of this memorandum.

III. GENERAL

1. It is the intent of the parties to the agreement to make the appropriate final determination regarding the project within one year from the date of the receipt of the NOI by the CEC to the extent allowable by law.

2. Amendments to any section or term of this agreement shall be made on mutual agreement provided in writing by BLM, USGS, DOE and CEC.

3. BLM, USGS, DOE and CEC may terminate their participation in the agreement upon thirty days written notice served upon the other parties. The party electing to terminate the agreement shall state in writing its reason for desiring the termination and provide such to the other parties. During the ensuing thirty day period all parties shall actively attempt to resolve any disagreements so that the termination of this agreement may be avoided.

4. In the event of termination of this agreement, CEC shall prepare the appropriate document as required under CEQA and other statutory requirements, and BLM, USGS, and DOE jointly or separately shall prepare the appropriate document as required by NEPA and other statutory requirements. The parties shall continue, however, to share and exchange information during the preparation of the environmental documents and project review in order to avoid duplication and excess expense.

5. Unless terminated as set forth above, this agreement shall continue until a final decision has been made by all parties.

IN WITNESSETH THEREOF, the parties hereto have caused this Memorandum of Understanding to be duly executed on the respective date set forth opposite their signatures.

SIGNATURE PAGE

Attached to and made a part of the Memorandum of Understanding regarding the Northern California Power Agency Geothermal Unit #2 Power Plant at The Geysers, Sonoma County, California.

Dated: United States Geological Survey

By Wright Sheldon
Wright Sheldon
Acting Manager, Conservation Division

Dated: Bureau of Land Management

By Dean C. Stepanek
Dean Stepanek
District Manager

Dated: Department of Energy

By Ruth C. Clusen
Ruth C. Clusen
Assistant Secretary for Environment

Dated: Energy Resources Conservation
and Development Commission

By Richard L. Maullin
Richard L. Maullin
Chairman

APPENDIX D

WILDLIFE SPECIES KNOWN OR EXPECTED
TO OCCUR IN PROJECT DEVELOPMENT AREA

U.S. BLM AND F&WS LIST OF UNCOMMON, THREATENED AND
ENDANGERED (UTE) PLANTS

APPENDIX D

Wildlife Species Known or Expected to Occur in the NCPA Development Area

<u>Mammals</u>	<u>Scientific Name</u>
Towbridge shrew	<u>Sorex trowbridgii</u>
Broad-footed mole	<u>Scapanus latimanus</u>
Bats (several species)	<u>Myotis</u> spp.; <u>Eptesicus</u> spp.
Brush rabbit	<u>Sylvilagus backmani</u>
Black-tailed jack rabbit	<u>Lepus californicus</u>
Sonoma chipmunk	<u>Eutamias sonomae</u>
Western gray squirrel	<u>Sciurus griseus</u>
Heerman's Kangaroo rat	<u>Dipodomys heermanni</u>
Western harvest mouse	<u>Reithrodontomys megalotis</u>
Brush mouse	<u>Peromyscus boylii</u>
Pinyon mouse	<u>Peromyscus truei</u>
Deer mouse	<u>Peromyscus maniculatus</u>
Dusky-footed wood rat	<u>Neotoma fuscipes</u>
California vole	<u>Microtus californicus</u>
Coyote	<u>Canis latrans</u>
Gray fox	<u>Urocyon cinereoargenteus</u>
Ringtail	<u>Bassariscus astutus</u>
Mountain lion	<u>Felis concolor</u>
Bobcat	<u>Lynx rufus</u>
Black-tailed deer	<u>Odocoileus hemionus columbianus</u>

Birds

Turkey vulture

Cooper's hawk

Red-tailed hawk

Golden eagle

Peregrine falcon

Mountain quail

Mourning dove

Poor-will

Belted Kingfisher

Common flicker

Ash-throated flycatcher

Black phoebe

Western Kingbird

Western wood pewee

Scrub jay

Plain titmouse

Bushtit

White-breasted nuthatch

Wrentit

Dipper

Bewicks wren

California thrasher

American robin

Blue-gray gnatcatcher

Scientific NameCathartes auraAccipiter cooperiiButeo jamaicensisAquila chrysaetosFalco peregrinusOreortyx pictusZenaidura macrouraPhalaenoptilus nuttalliiMegasceryle alcyonColaptes auratusMyiarchus cinerascensSayornis nigricansTyrannus verticalisContopus sordidulusAphelocoma coerulescensParus inornatusPsaltiriparus minimusSitta carolinensisChamaea fasciataCinclus mexicanusThryomanes bewickiiToxostoma redivivumTurdus migratoriusPoliophtila caerulea

Birds continued

Hutton's vireo
Orange-crowned warbler
Yellow warbler
Wilson's warbler
Northern oriole
Brewer's blackbird
Black-headed grosbeak
Lazuli bunting
House finch
Lesser goldfinch
Rufous-sided towhee
Brown towhee
Rufous-crowned sparrow
Sage sparrow
Song sparrow

Scientific Name

Vireo huttoni
Vermivora celata
Dendroica petechis
Wilsonia pusilla
Icterus bullockii
Euphagus cyanocephalus
Pheucticus melanocephalus
Passerina amoena
Carpodacus mexicanus
Spinus psaltria
Pipilo erythrophthalmus
Pipilo fuscus
Aimophila ruficeps
Amphispiza belli
Melospiza melodia

Amphibians

Pacific giant salamander
Rough-skinned newt
Red-bellied newt
California slender salamander
Black salamander
Western toad
Pacific tree frog
Yellow-legged frog

Scientific Name

Dicamptodon ensatus
Taricha granulosa
Taricha rivularis
Batrachoseps attenuatus
Aneides flavipunctatus
Bufo boreas
Hyla regilla
Rana boylei

Reptiles

Western pond turtle
Western fence lizard
Sagebrush lizard
Western skink
Western whiptail
Southern alligator lizard
Striped racer
Common Kingsnake
Gopher snake
Western aquatic garter snake
Western rattlesnake

Scientific Name

Clemmys marmorata
Sceloporus occidentalis
Sceloporus graciosus
Eumeces skiltonianus
Cnemidophorus tigris
Gerrhonotus multicarinatus
Masticophis lateralis
Lampropeltis getulus
Pituophis melanoleucus
Thamnophis couchi
Crotalus viridis

Fish

Rainbow trout
California roach
Sacramento sucker
Riffle sculpin

Salmo gairdneri
Hesproleucus symmetricus
Catostomus occidentalis
Coffus gulosus

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Ukiah District

UNCOMMON - THREATENED - ENDANGERED ^{2/} PLANTS

Plant Code ^{3/}	Scientific Name/Common Name FAMILY	R-E-V-D Codes ^{1/}	County Code ^{2/}	Planning Unit Code ^{2/}	CNPS List ^{3/}	FEDERAL LISTS			Phenological Data ^{6/}	Habitat ^{6/}
						1975 ^{4/}	1976 ^{5/}			
ANLU	Amsinckia lunaris BORAGINACEAE	1- - -	U.N.	U.N.	X				April-May (flowering)	Dry S. facing slopes, clayey soil.
ANSU-1	Antirrhinum subcordatum Dimorphic snapdragon SCROPHULARIACEAE	2-2-1-3	11, 21	10, 06, 08	X	X			June-July (F.P.)	Chaparral. Rare apparently on serpentine.
ASSO	Asclepias solanoana ASCLEPIADACEAE	2-2-1-3	033 105	05 09	X				June (flowering)	Dry serpentine outcroppings 2000-5000 feet. Yellow pine forest.
COTLC	Cordylanthus brunneus (or tenuis) ssp. capillaris/Pennell birds beak SCROPHULARIACEAE	3-2-1-3	097	07 09 10	X			X	July-August (flowering)	Often on serpentine Chaparral Foothill Wd.
CECO-3	Ceanothus confusus RHAMNACEAE	3-2-1-3	097	09 10	X				Feb-Apr (flowering) May-Jun (fruiting)	Serpentine soil. Chaparral
CEDI-2	Ceanothus divergens RHAMNACEAE	2-1-1-3	55, 97	07, 10	X				Feb-Mar (flowering)	Chaparral & foothill wd.
CESO-2	Ceanothus sonomensis RHAMNACEAE	1- - -	097	09, 10	X				Feb-Apr (f. p.)	Below 2200 ft; Chaparral
ERHE-1	Erythronium helenae LILIACEAE	1- - -3	033 055 097	09	X				Mar-May (flowering)	Well watered volcanic soil & leaf mold, in brush & woods 1500-2000 ft. Chaparral foothill Wd.
ERNE-4	Eriogonum nervulosum POLYGONACEAE	2- - -3	033	08, 09	X				Aug-Sep (flowering)	Stony places and serpentine outcrops Red Fir F., serpentine chaparral. Snow Mt., Lake County & Colusa.

C-050-7170-1
(June 1978)

DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Utah District

UNCOMMON - THREATENED - ENDANGERED ^{2/} PLANTS

Plant Code ^{2/}	Scientific Name/Common Name FAMILY	R-E-V-D Codes ^{1/}	County Code ^{2/}	Planning Unit Code ^{2/}	CNPS List ^{3/}	FEDERAL LISTS			Phenological Data ^{6/}	Habitat ^{6/}
						1975 ^{4/}	1976 ^{5/}			
PRPU-3	<i>Fritillaria purdyi</i> LILIACEAE	1- - -	021 023 033 045 055 103 105	02 05 06 07 08 09 10	X				Mar-Jun (flowering)	Serpentine ridges 1400-6900 ft. chaparral, yellow pine/F. foothill wd.
HEAD	<i>Hesperolinon adenophyllum</i> / Glandular dwarf flax LINACEAE	2-1-1-3	023 033 045	02 06 07 08 09 10	X	X			Jun-Jul (flowering)	Dry brushy hills and woods at least on serpentine 1500-4500 feet. Chaparral, N. Oak wds.
HEBI-2	<i>Hesperolinon bicarpellatum</i> / Two carpel flax LINACEAE	2-1-1-3	033 055	08 09 10	X	X			May-Jun (flowering)	Clay and serpentine brushy slopes and open woods ca. 1200-1500 ft. chaparral, foothills wds.
LORE	<i>Lomatium repostum</i> UMBELLIFERAE	1- - -3	033 055 097	09	X				Apr-May (flowering)	Chaparral, closed-cone pine F., foothill wd.
LUSE-2	<i>Lupinus sericatus</i> /Cobb Mt. Lupine FABACEAE	2-1-1-3	033 055	09 10	X	X			Apr-Jun (flowering)	Open wooded slopes 2000-4000 ft. Yellow Pine F. Mixed evergreen F.
SIORH	<i>Sidalcea oregana</i> ssp. <i>hydrophila</i> MALVACEAE	2-1-1-3	33, 55	UN	X	X			Jul-Aug (F. P.)	Mixed evergreen f. Yellow pine f.
STBR-2	<i>Streptanthus brachiatus</i> / contact mine <i>streptanthus</i> BRASSICACEAE	3-1-1-3	097	09	X	X			June (flowering)	Serpentine outcrops east of Pine Flat.

C-050-7170-1
(June 1978)

DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Ukiah District

UNCOMMON - THREATENED - ENDANGERED ^{2/} PLANTS

Plant Code ^{3/}	Scientific Name/Common Name FAMILY	R-E-V-D Codes ^{1/}	County ^{2/} Code	Planning Unit Code ^{2/}	CNPS List ^{3/}	FEDERAL LISTS			Phenological Data ^{6/}	Habitat ^{6/}
						1975 ^{4/} T	E	1976 ^{5/}		
STMO Complex	Streptanthus morrisonii Complex (Newly discovered group that needs further taxonomic work)	- - -	33, 97	09					June (flowering) July (fruiting)	Barren serpentine ridge (head of Bear Creek)

C-050-7170-1
(June 1978)

- 1/ Rarity (R) 3/
1. Rare, of limited distribution, but distributed widely enough that potential for extinction or extirpation is apparently low at present.
 2. Occurrence confined to several populations or one extended population.
 3. Occurs in such small numbers that it is seldom reported; or occurs in one or very few highly restricted populations.

P.E. Possibly extinct or extirpated.

Endangerment (E)

1. Not endangered.
2. Endangered in part.
3. Totally endangered.

Vigor (V)

1. Stable or increasing.
2. Declining.
3. Approaching extinction or extirpation.

General Distribution (D)

1. Not rare outside California.
2. Rare outside California.
3. Endemic to California.

2/	Code	County	2/	Flowering Unit	Code	3/
	011	Colusa		King Range	01	
	015	Del Norte		Humboldt	02	
	021	Glenn		Red Mountain	03	
	023	Humboldt		East Mendocino	05	
	033	Lake		Cow Mountain	06	
	041	Marin		Russian River	07	
	045	Mendocino		East Lake	08	
	055	Napa		Putah Creek	09	
	095	Solano		Vallejo	10	
	097	Sonoma		Unknown	U.N.	
	103	Tehama				
	105	Trinity				
	113	Yolo				
	U.N.	Unknown				

3/ California Native Plant Society. 1974. Inventory of Rare and Endangered Vascular Plants of California and supplement list, December 9, 1976.

4/ U.S. Department of the Interior, Fish & Wildlife Service. Review of Status of Over 3000 Vascular Plants and Determination of "Critical Habitat," Federal Register, Vol. 40, No. 127, Tuesday, July 1, 1975, Part V.

5/ U.S. Department of the Interior, Fish & Wildlife Service. Proposed Endangered Status for Some 1700 U.S. Vascular Plant Taxa, Federal Register, Vol. 41, No. 117, Wednesday, June 16, 1976, Part IV.

6/ Munz, Phillip. 1968. A California Flora and Supplement. University of California Press.

7/ U.S. Department of the Interior, August 23, 1966. Bureau of Land Management Manual. 1265 - Automatic Data Processing Appendix 1, page 12-13.

8/ U.S. Department of the Interior, August 6, 1969. Bureau of Land Management Manual. 1265 - Automatic Data Processing Appendix 1, page 90-91.

9/ Uncommon - plants that are endemic but with substantial populations within their limited habitat; require special habitats that are widespread in distribution and are listed in Appendix I, CNPS 3/.

Threatened/Endangered - conform with definition in Public Law 93-205 "Endangered Species Act of 1973."

APPENDIX E

PRIMARY EMISSION SOURCE CATEGORIES
OF GEOTHERMAL POWER FACILITIES

ENVIRONMENTAL CATEGORIES

- Construction equipment operation and traffic. Dozers, graders, trucks, cranes, and other equipment are employed for road and pad construction and equipment installation. Additionally, a number of daily vehicle trips are needed to support construction activities. In almost all cases, the larger vehicles and equipment are diesel-powered. Equipment and vehicle operations produce engine exhaust emissions. These operations are relatively minor in nature and will not generate significant quantities of air pollutants.

Grubbing of construction sites will expose surface soils to wind erosion. In addition, dust will be produced by movement of vehicles and other construction activity. Roads and construction sites will be treated to minimize dust generation.

- Drilling operations. Geothermal wells are drilled with conventional drill rigs. Mud pumps and air compressors used in drilling are typically equipped with diesel engines. A total of about 1,800 gallons of fuel are consumed per day in the drilling of an average geothermal well. The drilling operation is short term, thus significant quantities of air pollutants will not be generated from drill rig exhaust emissions.

The drilling process is conducted in three stages:

- 1) The shallower portions of wells are typically drilled using a water-based mud slurry to remove drill cuttings. No pollutants are emitted.
- 2) Intermediate sections of the well may be drilled, using mud and air. When compressed air is used to bring air, steam (if encountered), particulates, and rock cuttings to the surface, they are collected in a flow diverting device (banjo box), and directed through a horizontal pipe (blooie line) into a cyclone dust arrestor and muffler before discharge to the atmosphere. Water is injected into the blooie line in the section between the banjo box and the cyclonic muffler. This provides a crude venturi scrubbing effect where particles are agglomerated through high turbulence and water contact. Heavier particles and condensate are removed by centrifugal action and fall to the bottom of the muffler. Lighter particulates and steam pass through the cyclone stack and escape to the atmosphere.
- 3) The steam producing section of the well is typically drilled with air. Air is used to cool the bit and to convey rock fragments to the surface. Up to 450 kg/hr of rock may be drilled in this manner, most of which ends up as drill chips in the waste retention sump. However, some is ground into dust and escapes into the air. In addition to particulates created by the drill bit, some particulate arises from erosion within the well bore and from within the steam fracture.

Drilling normally takes 45 to 60 days for each well, including 15 to 20 days for air drilling. Steam, noncondensable gases, and particulates are produced at increasing rates from zero at the start of the air drilling

phase to essentially full flow at the time of completion. Full flow emissions vary considerably from well to well, however the average for the steam field is about 150,000 lbs/hr steam. In 1974, well drilling contributed about 4.4 percent of the total prepower plant steam vented at The Geysers. Particulate emission rates varied from selected wells from 3 to 140 lbs/hr (Tolmasoff, 1976).

- Well testing and cleanout. When a productive geothermal zone is encountered, wells are tested to determine flow rates and physical properties of the steam. A flow test may be completed in as little as 4 to 6 hours, or may take as much as 4 days.

Shut-in wells, when brought back into production, are vented at full flow so that large rock particles and water are not directed into the steam pipeline. This operation usually requires only a few hours, but can take up to several days.

About 14 million pounds of steam are vented per well for each test. In 1974, steam vented by testing and clean-out amounted to 13 percent of the total prepower plant steam vented at The Geysers (Tolmasoff, 1976). Although both operations are short-term, they generate the highest emissions rate of steam and noncondensable gases encountered in normal well operations.

- Well bleeds. When a well is shut-in, the temperature of the well is maintained by constant bleed of steam through a vent. A single well bleed allows 300 to 1,200 pounds of steam to vent per hour. While emission rate is relatively low during bleeds, a well may remain on standby status for several months, or even a few years. The total emissions from a field are compounded by the summation of up to 15 wells being bled simultaneously prior to power plant completion. In 1974, 3.6 percent of the total prepower plant steam vented at The Geysers came from well bleeds (Tolmasoff, 1976).
- Uncontrolled wells. Uncontrolled wells discharge steam and associated pollutants at rates equivalent to full production levels with no abatement. Thus, a well blowout which is difficult to bring under control represents a "worst case" air pollution scenario for well operations. This is clearly shown by statistics for The Geysers operation in 1974. In that year, 34.8 percent of the total prepower plant steam vented originated from one uncontrolled well (Tolmasoff, 1976).
- Steam "stacked" or by-passed at the power plant. Upon power plant shutdowns, steam is stacked through a bank of mufflers located near the plant site. Steam is stacked at various rates, depending upon the duration of the plant shutdown. Steam from all field wells is stacked if the shutdown is 4 hours or less.

In 1974, about 3.3 percent of the total steam produced at The Geysers was stacked at the plant, accounting for 29 percent of the total prepower plant steam vents (Tolmasoff, 1976). While the duration of stacked steam emissions is usually short for an established operating field (downtime is

somewhat more frequent when a plant is first brought on line), the emission rate associated with the practice is the highest encountered in all normal geothermal operations.

- Steam pipeline vents. In order to protect the pipeline and turbine from particulate matter, centrifugal separators are installed in the pipeline near each well head at the plant yard. The entrapped particles are bled off through small steam vents, usually 0.6 cm (1/4 in) diameter. Steam condensate traps are installed to collect condensate which forms in the pipeline. This water is pushed out of the traps by steam pressure through small vents, or it may be diverted into a vent-gathering system. Other sources of pipeline vents are pressure relief valves and vents required for pipeline maintenance.

Up to September 30, 1977, steam pipeline vents accounted for 4 percent of prepower plant steam venting at The Geysers. Steam transmission line vents at the Unit #11 field (which is equipped with a vent-gathering system) averaged 1,600 lbs/hr steam in 1975 (Tolmasoff, 1976).

APPENDIX F

POTENTIAL HEALTH EFFECTS OF
GEOTHERMAL POLLUTANTS

HEALTH RELATED MONITORING PROGRAMS

APPENDIX F

POTENTIAL HEALTH EFFECTS OF GEOTHERMAL POLLUTANTS

Geothermal steam contains contaminants which when inhaled or ingested in sufficient quantities can adversely impact human health. These include hydrogen sulfide (H_2S), radon-222 (^{222}Rn), ammonia (NH_3), particulate matter, and trace elements, such as mercury (Hg), arsenic (As), and boron (B). Abatement systems can also emit varying amounts of pollutants such as vanadium (V), anthraquinone disulfonic acid (ADA), hydrogen peroxide, iron (Fe) (from catalysts), sodium carbonate ($NaHCO_3$), sodium sulfate (Na_2SO_4), and sodium thiosulfate ($Na_2S_2O_3$). Some of these pollutants can react in the ambient air to form secondary pollutants such as sulfur dioxide and sulfates.

The potential for adverse impacts to public health depends on: 1) the toxicity of the emitted contaminants, 2) the concentration or quantity to which the public is exposed, and 3) the duration of exposure. Exposure to these pollutants can occur from inhalation of air, or ingestion of contaminated drinking water or food. The following discussion addresses potential adverse human health impacts associated with these contaminants.

Hydrogen Sulfide

Hydrogen sulfide is a toxic gas which can be fatal to humans when inhaled in concentrations of 1000 parts per million (ppm) and above for several minutes (NIOSH 1977). Longer exposure to lower concentrations also can be fatal. In concentrations above the state occupational standard of 10 ppm (8 hour average) H_2S can cause irritation of the eyes and respiratory tract, damage to the lungs and loss of consciousness. Sulfide at levels below 10 ppm may induce decreased corneal reflex, nausea, insomnia, headaches, loss of sleep, and other symptoms (Table F₁) (Walton and Simmons 1978).

There have been relatively few studies of adverse health effects from exposure to H_2S at low concentrations (less than 0.1 ppm) such as those measured in populated areas around The Geysers. Because of the lack of studies and questions concerning the validity of results from some of those studies, there appears to be controversy as to the potential for adverse effects from H_2S at low concentrations.

Some experts do not believe that exposure to concentrations below 1 ppm adversely affects human health (Simmons, 1979). The State of Montana has proposed an H_2S standard based on reported health effects at 0.3 ppm (Montana 1979). The lowest concentrations accepted by other experts as inducing adverse health effects is 0.08 ppm (Illinois Institute for Environmental Quality, 1974), almost three times greater than the California ambient air quality standard for H_2S . Nausea, fatigue, loss of appetite, dizziness, blurred vision and increased incidence of mental depression have been reported to result from chronic exposure to this concentration (ibid).

There have been studies which report adverse health effects at levels below 0.08 ppm, the validity of these low level studies, however, has been questioned (LBL, 1977; Walton, 1978). Yet, the possibility that these low levels can induce adverse health effects cannot be dismissed without further investigation.

TABLE F₁

HUMAN HEALTH EFFECTS OF HYDROGEN SULFIDE

ppm*	Health Effects	Reference
0.00047- 0.0045	Odor threshold	Leonardos, 1969 Wilby, 1969
0.007- 0.03	Slight odor	Gurinov, 1952
0.03	California ambient air quality standard for one-hour average (concentration based on the odor threshold)	ARB, 1970
0.04- 0.13	Clear definite odor	Gurinov, 1952
0.08	Increased incidence of mental depression, dizziness and blurred vision	State of Illinois, 1974
0.30	Increased incidence of nausea, insomnia, shortness of breath and headaches with chronic exposure	Indiana APCD, 1964
0.7-7	Incidence of decreased corneal reflex with chronic exposure	State of Illinois, 1974 Rubin, 1975
4.6	Readily apparent, offensive odor	Simson, 1971 Yant, 1930
10	Threshold limit value for 8-hour exposure at the work place	American Conference of Governmental Industrial Hygienists, 1977
10- 50	Threshold for irritative action with prolonged exposure: eye irritation such as conjunctivitis and at the higher concentrations dry throat. Fatigue, loss of appetite and insomnia with chronic exposure	Ahlborg, 1951 Gurinov, 1952 NIH, 1941
20- 30	Very strong, but not intolerable odor	State of Illinois, 1971 Yant, 1930
70- 150	Eye irritation after several hours of exposure; conjunctivitis, keratitis and photophobia. Threshold for olfactory paralysis occurring within minutes	Devege, 1956 Evans, 1967 Mitchell, 1925 AIHA, 1963
200- 300	Serious local irritation to eyes and respiratory tract caused upon inhalation for one hour, with possible subsequent pulmonary edema. This is the maximum concentration which can be inhaled for one hour without serious consequences.	Mitchell, 1925 Haggard, 1925

Adapted from Walton, A.H. and W.S. Simmons, 1978

There is reason to believe exposure to H_2S may be more harmful to certain groups of individuals than to the general population. These H_2S sensitive group include infants, individuals with anemia, eye or respiratory problems, schizoid or paranoid tendencies and those who have recently consumed alcohol (Illinois Institute for Environmental Quality, 1974; Walton, 1978).

Hydrogen sulfide gas has a characteristic odor of rotten eggs which can be detected at low concentrations. The odor threshold varies with individual sensitivity; thresholds have been reported as high as 0.14 ppm and as low as 0.00047 (Walton and Simmons, 1978). Different experimental techniques and difficulties in accurately preparing very dilute hydrogen sulfide concentrations may contribute to the wide discrepancy between reported thresholds. At high concentrations (70-150 ppm) hydrogen sulfide causes olfactory paralysis - loss of sense of smell (Walton and Simmons, 1978).

The California ambient air quality standard for H_2S is 0.03 ppm (1 hour average). Although public health protection was considered, this value was based on the average H_2S odor threshold obtained in a study conducted by the California Department of Public Health. In that study H_2S odor thresholds for 16 individuals were reported to range from 0.012 to 0.069 ppm; the average was 0.029 ppm H_2S (California Air Resources Board, 1970). A report prepared by Lawrence Berkeley Laboratories states that if the standard is to be based on known odor threshold, "then the standard should be lowered by a factor of 3 to 5 to the more recently accepted value for the odor perception threshold" (Case, 1977).

Radon-222

The noncondensable gas fraction of steam originating from natural fumaroles and developed geothermal wells contains the noble radioactive gas, radon-222 (^{222}Rn). When the steam is used to produce electrical energy, ^{222}Rn and its daughter products are found in the cooling tower sludge, in the steam condensate released to the atmosphere from the cooling tower, and at various locations with the workings of the plant itself (i.e., the steam exhaust ducts and condensers).

The primary health hazard associated with ^{222}Rn and its short-lived daughter products is inhalation and possible deposition in the lung. ^{222}Rn itself is usually inhaled and exhaled without disposition on lung tissue. However, the short-lived daughter products of ^{222}Rn (especially those which emit alpha particles), have a high probability for deposition. Deposition of an alpha-emitting substance on the lungs provides a greater potential for temporary or permanent tissue damage through the natural destructive action of the alpha energy.

Standards for radon-222 set by the Department of Health Services (DOHS) (Section 30355 of Title 17 of the California Administrative Code), are 100 pCi/l in air for a controlled area and 3 pCi/l in air for an uncontrolled radiation area at the point of release to the environment. These standards are for concentrations in the air above natural background radiation. A controlled radiation area is interpreted as being an occupational area and an uncontrolled area in interpreted as being any area to which the general public would have access.

TABLE F₂
Ambient Air Quality Standards

<u>Pollutant</u>	<u>Averaging Time</u>	<u>California Standard</u>	<u>Primary Federal Standard</u>
Carbon Monoxide	12 hour	10 ppm ₃ (11 mg/m ³)	—
	8 hour	—	9 ppm (10 mg/m ³)
	1 hour	40 ppm ₃ (46 mg/m ³)	35 ppm (40 mg/m ³)
Hydrogen Sulfide	1 hour	0.03 ppm (42 µg/m ³)	—
Non-Methane Hydrocarbons	3 hour (6-9 a.m.)	—	160 µg/m ³ (0.24 ppm)
Lead	30 day	1.5 µg/m ³	1.5 µg/m ³ (quarterly average)
Nitrogen Dioxide	Annual Average	—	0.05 ppm (100 µg/m ³)
	1 hour	0.25 ppm (470 µg/m ³)	—
Oxidant (Ozone)	1 hour	0.10 ppm (200 µg/m ³)	0.12 ppm (240 µg/m ³)
Sulfur Dioxide	Annual Average	—	0.03 ppm ₃ (80 µg/m ³)
	24 hour	0.05 ppm (131 µg/m ³)*	0.14 ppm ₃ (365 µg/m ³)
	1 hour	0.5 ppm ₃ (1310 µg/m ³)	—
Suspended Particulate Matter	Annual Geometric Mean	60 µg/m ³	75 µg/m ³
	24 hour	100 µg/m ³	260 µg/m ³
Sulfates	24 hour	25 µg/m ³	—
Radon-222	Annual Average	3 pCi/l**	—

*When standards for total suspended particulates or oxidant are being exceeded.

**Above natural background, at point of release to the environment.

Ammonia

Ammonia is primarily an irritant to eyes, mucous membranes, and the upper respiratory tract. The lowest concentration reported to cause irritation in humans via inhalation of 20 parts per million (ppm) (EPA, 1977), and barely noticeable eye irritation has been reported at 5 ppm (NIOSH, 1974). Exposure to low levels of ammonia has not been observed to cause permanent adverse health effects (EPA 1977). The odor threshold for ammonia has been reported to range between approximately 0.7 ppm and 50 ppm (NAS, 1977). Standards and suggested safe levels for exposure to ammonia are listed in Tables F₂ and F₃.

Trace Elements and Chemical Emissions

Geothermal steam contains trace elements, including mercury, arsenic and boron. Abatement systems emit vanadium, iron, NaHCO_3 , Na_2SO_4 , and $\text{Na}_2\text{S}_2\text{O}_3$. These substances could cause adverse public health impacts if present in sufficient concentrations. Suggested standards and safe levels for these pollutants in air are listed in Tables F₂ and F₃.

Mercury

Inhalation of mercury compounds can induce cough, fever, bronchitis and pulmonary edema. Chronic poisoning results from the accumulation of mercury in the brain, kidney and hair, and causes symptoms such as headaches, dizziness and fever. Children are especially susceptible to mercury poisoning (Britt, 1976). Certain mercury compounds have been shown to have potential to cause cancer or birth defects (EPA, 1977).

Organisms, particularly those in aquatic environments, can absorb, concentrate and transform trace elements. Mercury may be transformed to more hazardous forms (such as methyl mercury), and accumulate in various links in food chains, particularly in higher trophic levels. Fish can contain high mercury levels since they take up mercury compounds both through consumption of food and through their gills (Britt, 1976). Ingestion of mercury in contaminated food or water can result in adverse health effects such as headaches, blurred vision, loss of muscular coordination and death (Waldbott, 1973). To protect public health from hazards of mercury ingestion, the Federal Food and Drug Administration recommends 1.0 ppm mercury in fish as a safe level for human consumption.

High concentrations of mercury have been measured in fish at Clear Lake, not far from The Geysers (Week, 1978). Although the mercury content in most fish tested was below the recommended safe level of 1.0 ppm in edible fish, a small number of the fish sampled exceeded this value. Such high levels are believed to be caused by sources other than mercury emissions from The Geysers power plant, yet it can be inferred that this area may carry a significant burden of background mercury already, and any addition to the environment would increase this burden.

Arsenic

Arsenic emitted from geothermal steam may be in varying forms such as suspended particulate, vapor or arsine. Acute exposure to arsenic (depending on concentration) may cause headaches, dizziness, numbness, chills and fever, nausea,

TABLE F₃

Values for Assessing Potential Public Health Impacts
From Non-Regulated Pollutants in Ambient Air

Pollutant	Type of Value	Source	Concentration	Averaging Time
Ammonia	California Occupational Standard	Cal/OSHA	25 ppm	8 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	0.06 ppm (43 ug/m ³)	annual average*
	Foreign Ambient Air Quality Standards	Russia & East European Countries	0.14 - 0.71 ppm	24 hours
Arsenic	Suggested Occupational Standard	NIOSH	2.0 ug/m ³	15 minutes
	Suggested Threshold Limit Value	ACGIH	50 ug/m ³	8 hours
	Presumed Safe Level	NTR - 6401	5.9 ug/m ³	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	0.005 ug/m ³	annual average*
Boron	Presumed Safe Level	NTR - 6401	50 ug/m ³	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	7.4 ug/m ³	annual average*
	California Occupational Standard	Cal/OSHA	10 mg/m ³ boron oxide	8 hours
Mercury	Presumed Safe Level	NTR - 6401	0.8 ug/m ³	24 hours
	Suggested Ambient Level Goal (based on toxicity)	EPA-600/7-77-136	0.1 ug/m ³	annual average*
	Suggested Ambient Level Goal (based on carcinogenic potential)	EPA-600/7-77-136	0.01 ug/m ³	annual average*
	California Occupational Standard	Cal/OSHA	50 ug/m ³	8 hours
Vanadium	Presumed Safe Level	NTR - 6401	6.8 ug/m ³	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	1.2 ug/m ³	annual average*
	Suggested Threshold Limit Value	ACGIH	0.5 mg/m ³ (dust) 0.05 mg/m ³ (fume)	8 hours
	Calif. Occupational Standard	Cal/OSHA	0.5 mg/m ³ (dust) 0.1 mg/m ³ (mist)	8 hours
ADA (anthraquinone disulfonic acid)	Suggested Ambient Level Goal	To be published by Oct 1979**	250 ug/m ³	annual average*
Hydrogen Peroxide	Suggested Threshold Limit Value	ACGIH	1 ppm	8 hours
	Calif. Occupational Standard		1 ppm	8 hours
Iron	Suggested Threshold Limit Value	ACGIH	10.0 mg/m ³ (iron oxide fumes) 1.0 mg/m ³ (iron salts) 0.08 mg/m ³ (iron pentacarbonyl)	8 hours
	Calif. Occupational Standard	Cal/OSHA	10.0 mg/m ³	8 hours

*Although an averaging time for Suggested Ambient Level Goals is not stated within the document, EPA-600/7-77-136 the authors have indicated that these goals are most applicable to annual average concentrations.

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Abbreviations: Cal/OSHA California Occupational Safety and Health Administration
NIOSH National Institute for Occupational Safety and Health
ACGIH American Conference of Governmental and Industrial Hygienists

EPA-600/7-77-136 Multimedia Environmental Goals for Environmental Assessment, J. L. Clend and G. L. Kingsbury, U.S. EPA, Nov. 1977.

NTR-6401 Presumed Safe Ambient Air Quality Levels for Selected Potentially Hazardous Pollutants, S. L. Wilcox, The Nitro Corporation, May 1978.

vomiting, abdominal pain, pulmonary edema, jaundice, and leukocytosis. Chronic exposure may cause irritation to nose and throat, hair loss, tremors, anemia and cancer of the skin, lung, or liver (Britt and Hushon, 1976).

Boron

Compared with other atmospheric pollutants, the medical literature on boron and its compounds is sparse (Waldbott, 1973). Boron and most boron compounds are not highly toxic (Waldbott, 1973; Durocher, 1969), although boron hydrides have been rated as highly toxic (Durocher, 1969).

Chronic exposure to boron and boron compounds can result in reduced appetite, nausea, weight loss, increased risk of lung infection, central nervous system depression and kidney injury (Britt and Hushon, 1976).

Inhalation of boric acid and boron oxide in the form of dust can cause respiratory irritation, but is not likely to induce permanent damage (Waldbott, 1973).

Inhalation of boron hydrides (boranes) can result in severe central nervous system damage with symptoms including headache, dizziness, drowsiness, convulsions, fever, cough and pneumonia (Wilcox, 1973; Waldbott, 1973). Death or permanent damage may result (Durocher, 1969).

Vanadium

Excessive concentrations of vanadium can become toxic and result in conjunctivitis, skin irritation, chest pain, cough, asthma, pneumonia, nausea and vomiting, headache and tremor. Long range effects include hypertension, cardiovascular disease, kidney damage, anemia, emphysema and pulmonary fibrosis (Britt and Hushon, 1976). There is no evidence of teratogenicity, carcinogenicity, or mutagenicity due to vanadium. In fact, studies suggest that vanadium may be an essential element for some animals (at certain concentrations).

Occupational standards and recommended safe levels of exposure to vanadium has been given in Table F₃.

Anthraquinone Disulfonic Acid (ADA)

Stretford solution contains Anthraquinone 2:7 Disulfonic Acid (PGandE, 1979b), an organic aromatic compound most commonly used in the dye industry (Stern, 1977). Very little information is available which describes health effects from exposure to ADA.

Anthraquinone is reported to be a naturally occurring mutagenic compound, although the contribution to human cancer remains to be evaluated (Ames, 1979). It has low systemic toxicity to humans, but may cause skin irritation sensitization (The Merck Index, 1968). Anthraquinone 1:5 Disulfonic Acid and Anthraquinone 1:8 Disulfonic Acid are suspected to have low toxicity (The Condensed Chemical Dictionary, 1972).

Hydrogen Peroxide

Exposure to hydrogen peroxide fumes has been traditionally an occupational worker concern rather than a public health concern. Hydrogen peroxide is nonflammable, but since it is an oxidizing agent, it helps to support combustion. Hydrogen peroxide, by itself, is not as toxic as it is when in combination with other pollutants such as ozone. Ozone (1 ppm) combined with hydrogen peroxide at concentrations above 1.5 ppm were lethal to some animals; whereas hydrogen peroxide by itself in a concentration of 200 ppm produced only a slightly toxic response (Svirbely, J.L. et al., 1961).

Iron

Exposure to iron oxide fine particulates results in conjunctivitis, chronic bronchitis, pulmonary fibrosis and emphysema. Iron oxide can penetrate the walls of the lung bronchi and alveoli without damage to the mucous or ciliary barrier. In this way it can transport the carcinogen benzo(a)pyrene into the lungs (Waldbott, 1973). Ingestion of ferric sulfate causes vomiting, tachycardia, liver insufficiency, and capillary damage.

Occupational standards and recommended safe levels of exposure to iron and its compounds are given in Table F₃.

Sulfates

High concentrations of sulfates are associated with increased attack frequency in asthmatics, worsened symptoms in cardio-pulmonary patients, decreased ventilatory function in school children and symptoms of acute and chronic diseases in children and adults (Bachman, 1975).

Ambient and occupational standards associated with sulfate are given in Table F.

APPENDIX F

HEALTH RELATED MONITORING PROGRAMS

Conclusions presented in this document regarding the potential for public health impacts from operation of NCPA No. 2 are based on estimated NCPA No. 2 steam composition, air quality impact analysis and tracer study results, and historical data regarding ambient pollutant concentrations in The Geysers area. If actual conditions vary substantially from the information used in the analyses, the conclusions reached could be incorrect, and there could be a greater potential for adverse public health impacts. Furthermore, ongoing and future geothermal development will increase pollutant emissions at The Geysers during the operating lifetime of NCPA No. 2. Although the increase in ambient pollutant concentrations resulting from one power plant unit may be small, the cumulative impact of future development at The Geysers may increase ambient pollutant concentrations above ambient air quality standards or suggested safe levels.

California Public Resources Code Section 25532 specifies the Energy Commission's responsibility to establish monitoring programs. NCPA will periodically measure concentrations of hydrogen sulfide, radon-222, ammonia, mercury, arsenic, and boron in NCPA No. 2 incoming steam. This information is necessary to verify estimated NCPA No. 2 steam composition, and to determine if concentrations of contaminants in NCPA No. 2 steam vary substantially with time.

Hydrogen Sulfide

The details of an emissions monitoring program for H₂S will be determined by the Northern Sonoma County Air Pollution Control Officer.

Ammonia, Mercury, Arsenic and Boron

NCPA has agreed to conduct quarterly monitoring of ammonia, mercury, arsenic and boron concentrations in incoming steam (NCPA's responses to CEC staff interrogatories received August 14, 1979). Monitoring will begin within 45 days of commencement of commercial operation, and reports will be provided to CEC within 30 days of sampling. The methods for sampling and analysis will be discussed with the Department of Health Services. At the end of one year of monitoring, NCPA, CEC, and DOHS staff will evaluate the results of the monitoring program to determine future monitoring requirements, if any. Continuation of the quarterly steam analysis depends on: a) the variation of the steam concentrations of each pollutant b) the rate of emission of each pollutant, and c) the development or status of ambient or emission regulations for each pollutant. If pollutant concentrations do not vary more than 20 percent, and rates of emission are low, monitoring will be terminated for specific pollutants unless new regulations have been adopted requiring monitoring. The Applicant and Staff shall agree upon significant rates of emissions for NCPA No. 2 emissions not later than 120 days prior to commencement of commercial operation.

If new wells are added to steam supply to NCPA No. 2 additional steam analyses may be required to guarantee that pollutant emissions do not change significantly (20 percent). NCPA has agreed to inform CEC staff if a new well which has not been tested is proposed to supply steam to NCPA No. 2.

Staff recommends that if NCPA No. 2 emissions are great enough to cause significant ambient pollutant concentrations, NCPA be required to conduct an ambient monitoring program. Significant ambient concentrations would be 33 percent of any standard, or 50 percent of any standard when plant contribution is added to the existing background.

Since there are currently no ambient air quality standards for ammonia, arsenic, or mercury, staff recommends that not later than 120 days prior to commencement of NCPA No. 2 commercial operation, NCPA and CEC staff will agree upon significant ambient concentrations for these pollutants. The Executive Director should inform the Commission as to the nature of these NCPA/staff agreements. If NCPA and staff are unable to reach agreement, the staff shall request the Commission to convene a hearing for the purpose of resolving disputes.

NCPA has agreed to evaluate existing baseline concentrations of mercury, arsenic, and ammonia in ambient air in the vicinity of the NCPA No. 2 project site (NCPA, 1979f). This evaluation of mercury and arsenic will include:

- a. Review of previous ambient monitoring results;
- b. Analysis of several of the most recent high volume samples collected in The Geysers KGRA; and
- c. Conducting vapor phase ambient monitoring at locations representative of population exposure.

Final details of this evaluation will be worked out by NCPA or its contractor(s) and CEC during the AFC process.

The evaluation for ammonia will include:

- a. Review of previous ambient monitoring results.
- b. Extrapolation of ambient ammonia concentrations using the emissions ratio of hydrogen sulfide and ammonia and ambient H₂S data.

Spot field measurements will be used to confirm the methodology for extrapolating ammonia concentrations prior to commencement of NCPA No. 2 operation.

Radon-222

The Department of Health Services (DOHS) Radiologic Health Section (RHS) requires periodic monitoring of radon-222 concentrations in incoming steam of geothermal power plants to verify compliance with applicable standards and to provide input into an RHS multiple source modeling study investigating the cumulative impacts of radon-222 in The Geysers area. This monitoring requirement is based on California Health and Safety Code 25607.

§§ 25607. Radiological monitoring. No person shall operate a nuclear reactor, nuclear fuel reprocessing plant, or other installation, as defined by the department, which could, as a result of routine operations, accident, or negligence, significantly contaminate the environment with radioactive material, without first instituting and maintaining an adequate program of radiological monitoring. The proposed program shall be submitted to the department for review and acceptance as to its adequacy.

California Administrative Code Title 17, Section 30355 specifies concentration limits for radioactive effluents released to uncontrolled areas. The concentration limit for radon-222 is 3 pCi/l above natural background radiation at the point of release to the environment.

The Radiological Health Section has proposed the following minimal requirements for monitoring and reporting on radon-222 at The Geysers.

1. Each power production unit must be sampled such that the instantaneous radon-222 emission rate (Ci/sec) to the environment can be accurately determined.
2. Each unit must be sampled at least quarterly.
3. The sampling and analysis methods must be shown to be accurate by comparison to known standards supplied by an acceptable source (NBS or EPA). This "standard comparison" or "calibration" shall be run with each set of samples counted unless it is shown that the counting system is sufficiently stable that calibration is unnecessary for each run, then calibration shall be required at least once per year.
4. Notification levels (as specific activity determined in the effluent) are: 3pCi/l of radon-222 warranting a written 30-day notice to RHS upon confirmation of that level in the original sample, and 6 pCi/l, radon-222 warranting a notification to RHS within 24 hours of detecting that level of activity in a sample.
5. Approximately 10 percent of samples taken will be duplicated, with the duplicate sample sent to the Sanitation and Radiation Lab for cross-check analysis as a quality control on the utility's lab analyses.
6. Annual report shall be sent to the Department of Health Services, Radiologic Health Section. It shall discuss each point above, present all data in the calculation for emission rate, and include and one sigma standard deviation associated with the counting error. The error in the sampling procedure and emission calculation shall be discussed.

The report will also indicate the maximum dose due to emissions, calculated at the site boundary, and to the nearest resident, and the resultant population dose. (These dose calculations may follow a simplified methodology to be established by RHS in the near future).