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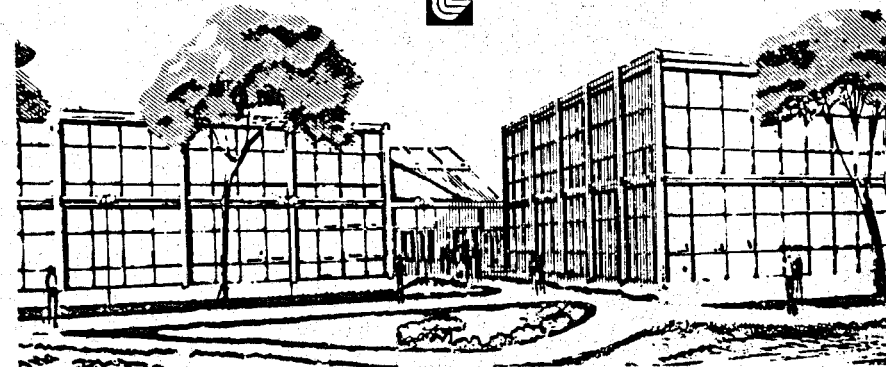
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GEOHERMAL RESOURCE AREAS IN THE UNITED STATES

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SUMMARY

Utilization of geothermal resources in the United States is on the threshold of undergoing rapid expansion. The Department of Energy (DOE) is sponsoring a number of programs in support of developing the technology and resources related to achieving such an expansion. These include electrical power plant demonstration projects, resource development, environmental research and loan guarantees. In order to assure that any development of geothermal resources takes place in an environmentally acceptable fashion, the Office of Assistant Secretary for Environment, DOE, has recently implemented a program that focuses on the early identification of environmental assessment needs. This program is called the Geothermal Overview Project. It is now in place at several Known Geothermal Resource Areas (KGRAs). These include The Geysers-Calistoga, Mono-Long Valley, Roosevelt Hot Springs, Raft River and regions of the Texas-Louisiana gulf coast. In the future, programs at other high priority KGRAs will be implemented. These will include Hawaii, Coso Hot Springs, Northern Nevada and Oregon.

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The basic purpose of the Geothermal Overview Project is to identify, summarize, and assess the environmental issues of the top priority KGRAs from among the approximately 40 KGRAs currently identified by the Division of Geothermal Energy, DOE, as having high possibilities for commercial development. The Geothermal Overview Project addresses issues pertaining to air quality, ecosystems quality, noise effects, geological effects, water quality, socioeconomic effects and health effects. For each KGRA the following functions are accomplished: (1) identification of key issues, (2) inventory of all available data, (3) analysis and assessment of available data, and (4) identification of what additional information is required for adequate assessments.

Vital to the Overview approach is the free and open flow of information and the early involvement of all interested parties which include local, state, and federal agencies, electrical utilities, resource developers, universities, private and public groups. By involving all interested parties from the very outset, the Overview report will reflect a consensus of these groups. Another aspect is to avoid redundancy of efforts by clearly establishing the status of current and planned research, including environmental baseline measurements and effects studies. It is also clear that time and money do not permit environmental studies to be conducted simultaneously at a large number of KGRAs. The Overview Project does, however, permit selecting on a priority basis those areas having the most critical need for environmental assessments.

Implementation of the Overview Project has been done through subcontracts to a number of groups, with overall management responsibilities at the Lawrence Livermore Laboratory. Criteria for selection of a particular subcontractor mandated that they be located reasonably close to the KGRA;

working relationships could be established with the various participants within the geothermal industry developing the resource; and appropriate involvement could be developed with the various government agencies responsible for the planning and regulating aspects. The various lead subcontractors currently in place are:

Lawrence Livermore Laboratory: The Geysers-Calistoga, California
(in cooperation with Sonoma, Lake, Mendocino, Napa Counties: (GRIPS)

University of California, Los Angeles: Mono-Long Valley, California

University of Utah Research Institute: Roosevelt Hot Springs, Utah

Idaho National Engineering Laboratory: Raft River, Idaho

University of Texas-Austin, Louisiana State University, Gulf Region

Advisory committees were established for each KGRA. Membership was drawn from experts associated with the development or management of the various geothermal resources. The advisory committees were charged with identifying all appropriate participants, planning workshops and reviewing reports.

Participation was typically represented by the following groups:

Federal Government: Geological Survey, Bureau of Land Management, Environmental Protection Agency, Fish and Wildlife Service, Forest Service, Department of Agriculture, Department of Energy

State Government: Air Resources Board, Energy Commission, Water Resources Board, Fish and Game Commission, Division of Oil and Gas, Land Commission, Railroad Commission, Department of Health, Public Utility Commission

Local Government: Planning Department, Public Works Department, Air Pollution Control District, Multi-county regional groups, Agriculture Commissioner

Developers: Electrical utilities, resource developers (steam, hot water, suppliers, etc.)

Others: Universities, private environmental laboratories, national laboratories, environmental groups

A workshop approach has been used, since a goal of the Overview Project was to have input from all participants in the process of identifying key issues and priorities. These participants represent, in most cases, the best possible expertise available for each KGRA.

The workshops were designed to review current knowledge and ongoing or proposed environmental programs. Usually one day was required for such a review, with a second day spent in small groups to address specific issues and requirements. This approach has been very successful in surfacing information that could not be conveniently obtained by other methods. The specific subcontractor is responsible for evaluating all data and developing a comprehensive report. These reports have been made available to local, state, or federal agencies, utilities, developers, or public groups.

To date, the most complex study has been carried out for The Geysers-Calistoga KGRA in Northern California and will be used as an example for this paper. This was done in conjunction with the Geothermal Resources Impact Projection Study (GRIPS), a regional body consisting of the counties of Lake, Mendocino, Napa, and Sonoma. Other participants were the California State Energy Commission and the Department of Energy. Jointly sponsored workshops (Lawrence Livermore Laboratory and GRIPS) were held for issues relating to air quality, ecosystems quality, noise effects, and water quality. Yet to be held are workshops on socioeconomic effects and health effects.

A number of environmental concerns were identified at The Geysers-Calistoga KGRA which either are currently impeding development or are expected to become significant in the future.⁽¹⁾ These concerns have been combined to form twenty-one issues, each dealing with a measurable impact on the environment.

The issues were prioritized according to their potential for impeding geothermal development if not properly controlled or mitigated. Priorities were set in a qualitative manner by subjecting them to the following questions:

Does this issue involve an impact which is currently affecting the region, and is it expected to occur in the future?

Is the impact restricted to the geothermal development area or does it extend beyond these boundaries?

Do regulating agencies consider this issue to be sufficiently serious to provide legal means for control?

Is this issue currently an impediment to geothermal development, and is it expected to be an impediment in the future?

The most critical issue identified at The Geysers-Calistoga KGRA is related to the release of hydrogen sulfide from power plants, geothermal wells, and steam by-pass systems. Currently, the California air quality standard of 30 ppb is being exceeded a significant number of days each year. The Northern Sonoma County Air Pollution Control District Office (APCD) has formally requested cancelling hydrogen sulfide variance permits for five power plants which will result in long-term shutdowns. Also, the Lake County APCD has requested the State Air Resources Board to require shutdown of old power plants as new ones come on-line.

The continued development of these resources requires the effective control of hydrogen sulfide emissions. Assuming that sufficient control is achieved to allow additional geothermal development, there is a need for methods of predicting the transport of hydrogen sulfide throughout the

region. This capability has the potential for determining the source when a hydrogen sulfide episode occurs, for predicting the impacts of a specific power plant site, and for assessing the regional impacts of large-scale development.

The remaining issues, which potentially will have less impact, were ranked into three categories. The issues included in the first two categories are described below.

Category 1

A comprehensive regional baseline study of rare and endangered species is needed to identify the species inhabiting the region and to locate their habitats. This issue has already led to an intensive delay in at least one geothermal project and to inadvertent destruction of some rare plant populations.

Much of The Geysers region is characterized by steep slopes which are covered with an unstable mantle of badly decomposed rock. These mantles often move downslope as large sheets forming landslides. Within key development regions, the surficial geology should be mapped and potential hazards identified.

As development approaches more populated areas, there will be an increasing need for practical, effective silencing systems to reduce the noise from the free venting and drilling of steam wells.

Recent data suggests that an extensive hot-water dominated reservoir exists in the region northwest of the current development area. The potential for the development of this resource to degrade or deplete potable groundwater supplies and hot springs in the region needs to be evaluated.

Nearly all of the environmental impacts are highly dependent upon the location of the geothermal facilities due to the complex terrain of the region. A description of the future development is needed which identifies the air basins, water sheds, and counties where geothermal growth will occur.

Category 2

Under current operating practices essentially all pollutant emissions to the atmosphere occur through the cooling tower. After hydrogen sulfide, boron emissions are of primary concern. Of secondary importance are emissions of ammonia, mercury, arsenic, and sulfates, although none of these substances has been identified as causes of detrimental effects at The Geysers. Further studies need to be conducted to determine the dispersion of these substances in the atmosphere, their possible accumulation in soils and on vegetation, and their potential effects on the local ecosystems.

Baseline data concerning the terrestrial and aquatic ecosystems of the region are needed to facilitate planning and siting of geothermal facilities, to conduct impact assessments and monitoring, and to effectively manage these renewable resources. The specific information sought is species composition, abundance, habitat location, and relationships between species.

The construction of geothermal facilities has a direct impact on the local ecosystems resulting in habitat loss for terrestrial species and stream alteration for aquatic species. An assessment of the magnitude of these effects from future development needs to be undertaken.

Development of the hot water resource may result in higher use of existing freshwater supplies by geothermal industries and waste disposal problems of spent geothermal water and cooling water blowdown. An assessment of these water management problems will be needed prior to development.

With geothermal development approaching more populated areas, there is the need to establish noise criteria for communities within The Geysers-Calistoga region. Impact studies for future geothermal sites should be made using existing noise propagation models to ensure these standards are met.

In the development of The Geysers there have been a number of accidental releases of steam condensate and drilling wastes. These areas should be monitored to determine the long-term effects of such accidents.

There are a variety of groups conducting environmental research and assessment activities in The Geysers region, and the data resulting from these efforts is often very difficult to locate. Consequently, a centralized information source is needed from which environmental data pertaining to the region can be obtained.

This has been a summary of the major environmental issues and information requirements needed to promote the development of geothermal energy at The Geysers-Calistoga KGRA. A more detailed description of the situation at The Geysers, the environmental issues, and the proposed research and assessment studies is presented in the Overview Report.⁽¹⁾

(1) D. Ermak and P. Phelps, Eds., An Environmental Overview of Geothermal Development: The Geysers-Calistoga KGRA, Lawrence Livermore Laboratory, in preparation (1978). Currently available in draft form. UCRL #52496.

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