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INVESTIGATIONS AND ACTIVITIES OF
IMPERIAL COUNTY GEOTHERMAL STAFF: 1982-83

SUMMARY REPORT

DOE COOPERATIVE AGREEMENT DE-FC03-79ET27196

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SECTION 1: INTRODUCTION

The objective of the Imperial County Geothermal Program is to stimulate and support the development of geothermal resources in the County. Staff investigations and activities to accomplish this objective are directed in four general areas:

1. Staff develops and disseminates information on the progress of development and development-related impacts and needs.
2. Staff prepares information and recommendations on County policy regarding geothermal development and undertakes special research projects as needed.
3. Staff designs and implements environmental monitoring programs in order to assure that detrimental impacts on the environment can be identified and mitigated before impacts become serious.
4. Staff provides for comprehensive review of geothermal permit applications, coordinates environmental review of proposed projects, and develops recommendations on standards for geothermal projects.

This report will describe research projects initiated, in progress, or completed; County/Industry cooperative efforts; and reports related to geothermal development issued by the County between October 1982 and December 1983. Sections of this report have been excerpted or modified from other reports and documents prepared by County staff.

SECTION 2: GEOTHERMAL RESEARCH PROJECTS

Projects underway during the period covered by this report include projects involving environmental monitoring, advanced geothermal planning, needs of the geothermal industry, status of development, and promotion of development.

ENVIRONMENTAL MONITORING

Imperial County policy supports the development of geothermal resources and directs that development be planned to maximize benefits and minimize negative impacts on the environment. County efforts to prepare for geothermal development included studies to identify the potential impacts of development and collection of baseline environmental data. These efforts were largely funded by the federal government; agencies involved were the National Science Foundation, the Energy Resources and Development Administration, and the Department of Energy.

The availability of independent unbiased information regarding the effects of geothermal development has helped to assure widespread public support of development in Imperial County. Environmental issues are a concern to County decision-makers and the public; baseline data supplies a factual basis for decision-making and reduces public fear of detrimental impacts.

A variety of environmental monitoring programs are necessary during the course of geothermal development. Necessary monitoring programs include

monitoring of air and water quality, of seismic activity for the detection of induced seismicity, of subsidence, and of ecosystem quality. In order to remain useful, baseline environmental data must be kept current.

Monitoring must be performed both on-site and county-wide. The chart in Appendix 1 shows the current status of monitoring programs and the organizations funding and/or conducting these programs. Imperial County is directly involved in seismic, subsidence, and air quality monitoring. These programs are discussed below.

Air Quality Monitoring

Development of Imperial County's geothermal resources could adversely affect local ambient air quality. In 1977, Lawrence Livermore Laboratory (LLL) conducted baseline air quality studies as part of a DOE Project. These studies provided pre-development data on air quality. Subsequent computer analysis of data by LLL resulted in prediction of significant violations of hydrogen sulfide air quality standards as the geothermal resource is developed to its full potential.

Monitoring of air contaminants will be necessary to determine the impact to air quality as the industry develops. The extent of air contaminant mitigation required by the Air Pollution Control District (APCD) will depend on the magnitude of air quality deterioration.

The APCD will require monitoring and mitigation programs of geothermal developers as necessary to protect air quality. Since development of mitigation strategies should be based on actual air quality impacts, the APCD is planning to establish several air quality monitoring stations in geothermal resource areas. Monitoring will provide up-to-date data for determination of impacts caused by the development of geothermal resources.

Area stations will monitor emissions of hydrogen sulfide, sulfur dioxide, total suspended particulates, and wind speed and direction. In addition, site-specific monitoring of hydrogen sulfide and total suspended particulates is required by the APCD upon the issuance of an "Authority to Construct" permit for a geothermal facility. Monitoring stations will monitor pollutant levels in the areas of greatest possible impact and serve as a backup to required site-specific monitoring.

The APCD has received a grant from the California Energy Commission to fund the establishment and operation of the first area station for monitoring air quality. This first station will be located in the Brawley KGRA, southeast of the Union/Edison Power Plant. APCD staff is currently proceeding with station setup and acquisition of necessary equipment and supplies.

The APCD hopes to establish additional stations in the near future, as funding allows. The next station is to be located in Heber to monitor the Heber development projects (discussed elsewhere in this report), and a third station is to be located in the Salton Sea area.

Seismic Monitoring

Induced seismicity was identified as a potential impact of geothermal development in Imperial County by both the University of California at

Riverside and Lawrence Livermore Laboratory. County geothermal policy, as adopted by the Board of Supervisors in the Geothermal Element, requires seismic monitoring as a condition of production project permits. The County Department of Public Works is responsible for the development and implementation of the Seismic Monitoring Program.

As with other possible impacts, the County's goal is to assure that sufficient data is collected to identify impacts so that mitigation measures can be implemented if needed. County staff is currently reviewing the seismic monitoring program, with information and assistance from the U.S. Geological Survey, the California Division of Mines and Geology, and the geothermal industry.

Geothermal industry participation is obtained through the Geothermal Industrial Committee (discussed elsewhere in this report). The seismic review project has been discussed at several committee meetings, a special workshop has been held, and a subcommittee has been formed to develop recommendations on the Seismic Monitoring Program.

Subsidence Monitoring

Regular subsidence monitoring is essential in Imperial County because of the high level of natural seismic activity and the possibility that geothermal development could induce subsidence. Since the agricultural industry depends on gravity flow irrigation and drainage systems, Imperial County has placed a high priority on subsidence monitoring.

The County Geothermal Subsidence Detection Committee (with representatives of State and Federal agencies, Imperial County departments, other public agencies, and geothermal developers) designed the Geothermal Subsidence Detection Network and worked with the County in accomplishing the necessary surveys of the Network. A limited existing network, originally established by the United States Coast and Geodetic Survey in 1927-28, was the initial foundation of the Network. The old network has last been surveyed in 1941 following a major earthquake. In order to cover all areas of geothermal potential, that network was substantially augmented, and the Network now consists of over 400 miles of benchmarks. Appendix 2 shows the Geothermal Subsidence Detection Network and its relation to Imperial County Known Geothermal Resource Areas (KGRA's).

The intent of subsidence monitoring is to detect subsidence before impacts become serious so that any necessary mitigation programs can be developed and implemented. Past surveys of the Network have shown that natural subsidence occurs throughout the Valley. Tectonic subsidence is resulting in a downward tilt of the Valley surface from the Mexican border to the Salton Sea and a deepening of the Salton Trough. The National Geodetic Survey has not completed the analysis of the 1980 resurvey data, but preliminary comparisons of the 1980-81 data with data from earlier levelings indicate that some changes may have occurred in the pattern of natural subsidence. Further data is needed to substantiate changes and identify any emerging pattern.

Although the possibility of subsidence induced by geothermal development has been of concern since geothermal development first began, the actual potential for geothermally-induced subsidence in the Imperial Valley

remains unknown. Research funded by the U.S. Department of Energy has considered the development of direct monitoring and measurement techniques, reservoir compaction and prediction models, and assessment of impacts. Understanding of the dynamics of geothermal reservoirs has improved, however experts agree that surface monitoring remains essential to detection of induced subsidence.

The County requires geothermal developers to set benchmarks at well sites and tie into the major Network. Operators monitor regularly according to the County's requirements, which are based on the frequency and volume of brine extraction. Monitoring by developers supplies survey data on Specific project sites, and site-specific survey systems connect to the major Network.

The Network survey data is the stable base from which all determinations of movement are made. If significant subsidence should be detected, the developer, the County, and the California Division of Oil and Gas would cooperate in developing a specific program to mitigate impacts.

Since the major Network is the reference for adjustment of the site specific data collected by geothermal developers, Network survey data must be periodically updated to avoid biasing the results of surveys by developers. Surveys have been conducted regularly since 1971: in winter 1971-72; winter 1973-74; winter 1975-76; and winter 1980-81. The cost of the survey work has always required Imperial County to seek assistance from other agencies to support part of the program.

Imperial County is currently resurveying portions of the subsidence monitoring network with grant assistance from the California Energy Commission. Due to the high cost of completing a total resurvey in one winter, the County is utilizing a phased approach, wherein the total resurvey is accomplished in four phases. Following completion of the phased resurvey, the County hopes to perform a complete resurvey in one winter season.

The first phase of the current project, the main north/south segment of the network, was surveyed in winter 1982. Phase 2, currently in progress, will survey a major portion of the main east/west segment of the line. The final two phases would survey the remaining second order lines throughout the network to complete the project. Appendix 3 shows survey routes for Phases 1 and 2.

As additional geothermal facilities begin operation in Imperial County, the need for regular subsidence monitoring will continue. Based on the findings of monitoring in the early years of development, requirements for long term monitoring will be established. The magnitude of any impacts will help to determine the desirable frequency of resurveys, and the type of mitigation measures that should be implemented as development continues.

GEOHERMAL WASTE DISPOSAL

Recognizing that adequate geothermal waste disposal services are indispensable to geothermal development in Imperial County, the County Board of Supervisors initiated a program to develop a geothermal waste disposal site. During the course of the project a number of potential sites were identified and geotechnical testing of the proposed sites was performed.

Following completion of site testing, the Board of Supervisors terminated County efforts to establish a disposal site. The decision was based, in part, on the interest private firms expressed in establishing any necessary geothermal waste disposal sites.

County interest in alternatives to landfill disposal of geothermal wastes has continued. Geothermal waste contains many valuable minerals and metals. Reclamation of these resources could lead to reduced volumes of wastes requiring land disposal, as well as increasing the economic benefit of geothermal development. The County is collecting data on matters related to metal and mineral reclamation.

DIRECT HEAT UTILIZATION

Imperial County hopes to stimulate economic development. County economic development efforts are focused predominately on industries that utilize resources found in Imperial County. Industries of particular interest would be labor-intensive and agriculture-related, such as food processing firms.

Imperial County geothermal resources have great potential for direct utilization by industry. Imperial County policy supports direct heat development and a project to promote resource development for direct heat purposes has been initiated. The first part of the promotional program was funded by DOE and involved the preparation of a geothermal direct heat study and a marketing brochure. These tasks were completed by a consultant. The project was planned to meet two major needs: the development of the necessary planning policies and procedures for handling permit applications from direct heat industries, and the development of information and materials to use in a program for attracting direct heat industries to the County.

During the development of the direct heat study, the consultant worked with the County Geothermal Direct Heat Committee, composed of the Agricultural Commissioner, the Administrative Officer, the Planning Director, and the Public Works Director. The Division of Community Economic Development worked with the Committee and the consultant during the development of the marketing tasks of the project. The Geothermal Coordinator acted as staff to the Committee and liaison with the consultant.

The objective of the planning policies task was to develop planning policies which would enable the County to encourage the utilization of geothermal resources for direct heat projects, while assuring that projects meet appropriate County standards. A County planning framework was designed to handle the diverse kinds of direct heat projects, within the context of current Imperial County zoning. Performance standards were proposed for control of environmental impacts of direct heat projects.

Implementation of recommendations on planning policies is underway. A "Comprehensive Geothermal Procedure Ordinance" has been drafted and distributed for comment by County staff and the Geothermal Industrial Committee. The procedure is intended to simplify the permitting process, while assuring that regulatory objectives are met. A major purpose of the draft ordinance is to facilitate permitting of direct heat projects. The ordinance will be presented to the Board of Supervisors for their consideration early in 1984.

The direct heat marketing work focused on preparing Imperial County to promote the use of geothermal energy for direct heat utilization projects. The consultant reviewed types of geothermal heat applications to determine those applications most compatible with the County's current agricultural economy. Potential cost and energy savings were calculated.

In consultation with County staff, a listing of individual firms in a number of industries was prepared. The listing includes data on individual firms for use by the County in promotional efforts.

The consultants prepared the layout for a geothermal marketing brochure. "Camera-Ready copy" of the eight page, full color brochure has been approved for printing by the Board of Supervisors. Printing will be completed in early 1984.

The County Division of Community Economic Development will include the distribution of the brochure and the promotion of geothermal development activities in the County's overall economic development and promotional program. The Division will coordinate with the Public Works and Planning Departments in geothermal-related matters.

Promotional efforts will be guided by a development plan prepared by the consultant. The plan identifies marketing actions which can be undertaken by the County, and indicates possible sources of funding for marketing efforts.

WATER FOR GEOTHERMAL DEVELOPMENT

Because of concerns expressed at various public meetings regarding the availability of water for geothermal development, County staff initiated research on water issues related to geothermal development. So far, the investigations indicate that information concerning water availability is adequate at the current stage of development.

In considering County-wide water use, the contribution of existing and proposed geothermal development projects to problems is minor. The Imperial Irrigation District has allocated 20,000 acre feet of water per year for geothermal projects and less than 8% is currently being used. If the various geothermal power plants currently operating, under construction, or proposed were in operation, the 20,000 acre feet per year currently allocated would be sufficient to meet total cooling water demand. This total is less than 1% of all water received by Imperial County from the Colorado River.

A literature search indicated that existing information on Imperial County hydrology and related issues is comprehensive. Many studies of the water issues related to geothermal development have been performed. Any future progress will require experience with operating geothermal facilities.

The County will continue to collect information on water issues as related to geothermal development in Imperial County. Topics will include water sources, quantity, and quality; water processing technologies; geothermal cooling water requirements; environmental impacts; and geothermal injection requirements, impacts, and environmental effects.

HEBER GEOTHERMAL DEVELOPMENT PROJECTS

In 1983, construction began on two commercial scale geothermal power plants in the Heber anomaly. Construction and operation of these two plants - of the same size, in the same anomaly, in the same time span, and with geothermal resources supplied by the same company - offer the opportunity to compare the "Binary" and "Dual Flash" technologies. The projects also offer an opportunity to evaluate the overall impacts of large geothermal plants.

The comparative evaluation of project operations and impacts is of great interest and importance. The County is collecting and analyzing information on the local impacts of the Heber development projects. This information will assist County decision-makers in decisions regarding the permitting and regulation of future projects.

A review of information on initial impacts of the Heber development projects indicates that most impacts will be beneficial. Economic effects, including employment and tax revenues, will aid the local economy. Implementation of necessary monitoring programs is in progress. Public service requirements due to the projects are not expected to place a burden on local agencies. Overall, project development is expected to increase local support for development as the benefits become obvious and adverse impacts are controlled.

The County will continue to collect information on the projects and the impacts of the projects as development progresses. As appropriate, periodic reports on the status of development and local impacts will be issued.

SECTION 3: COUNTY/INDUSTRY COOPERATIVE EFFORTS

An important function of the County geothermal staff is to assist the County in preparing for and facilitating geothermal development. Staff coordinates the geothermal activities in the County, monitors the progress of geothermal projects, and attempts to anticipate and address important issues. Staff keeps County decision-makers informed on geothermal development, prepares special reports on particular issues of interest or concern, and works to assure that County needs are met. Staff also provides technical assistance and information to developers, other governmental agencies, and the public. These activities require staff to work closely with geothermal developers, and representatives of local, state, and federal agencies.

In addition to the special projects described in Section 2, cooperative efforts include the Annual Geothermal Development Meeting, the County Geothermal Industrial Committee, and various kinds of technical assistance.

ANNUAL GEOTHERMAL DEVELOPMENT MEETING

The geothermal staff organizes a Geothermal Development Meeting which is held in the spring each year. The meeting provides an opportunity for persons and organizations involved in geothermal development in Imperial County to review the problems encountered and the progress made, and to discuss the prospects for future development.

Speakers include representatives of resource developers, utilities, other users of geothermal resources, academics, consultants, the County, and state and federal agencies. The meeting fosters a cooperative relationship between industry and government by providing a forum for discussion of development issues.

Geothermal Development Meetings have been held annually since first initiated in 1976 (with the exception of 1979). As geothermal development progressed in Imperial County, the focus of meeting presentations shifted from discussion of exploration and resource assessment in the early years; to development issues, scenarios, and environmental impacts; to reports from operators on facilities efficiencies, availabilities, and operational challenges.

Currently, the political and economic challenge are of primary importance. The economic situation and its effect on geothermal development was a major topic of discussion at the 1983 meeting. Developers discussed their success in resolving technical problems and questions of environmental impact, but stated that economic problems faced by the industry remain serious. The decision of the California Public Utilities Commission on the Chevron/Southern California Edison Heber Flash Power Plant was noted to be of major concern to the industry. Participants agreed that state and federal policies encouraging development could be helpful in maintaining the momentum of development.

Project status reports for 1983 illustrated substantial progress on geothermal projects throughout the County. Three power plants were operating at full capacity, several projects were scheduled to begin construction in late 1983 or early 1984, and other projects were in some stage of design or permitting.

GEOHERMAL INDUSTRIAL COMMITTEE

The Geothermal Industrial Committee began meeting regularly in 1983. The purpose of the Industrial Committee is to serve as a forum for discussion of geothermal issues of interest to the County of Imperial, geothermal developers, and other agencies.

Committee members include representatives of resource developers, utilities, County agencies, the Imperial Irrigation District, and the California Division of Oil and Gas.

To date, major topics of discussion have included the Seismic Monitoring Project, the proposed update of the Geothermal Element, and geothermal-related legislation. The full Committee will meet semi-annually, with interim meetings and subcommittee meetings scheduled as necessary.

TECHNICAL ASSISTANCE

The geothermal staff receives many requests for information from representatives of other county and state governments. The staff supplies information on permitting policies and processes, local development plans and status, and other topics as requested.

The geothermal staff works with developers during the preparation of geothermal applications so that County information needs are met and

processing time can be minimized. The staff also assists prospective developers and resource users to locate other sources of information and assistance.

The Geothermal Development Quarterly Report, prepared by the Geothermal staff, has proven to be of interest and value to a wide variety of persons involved in geothermal development. The report discusses geothermal development and related activities in Imperial County. Topics include the status of geothermal development projects, activities related to geothermal development, such as monitoring programs; development of County policies and services, and public meetings and hearings.

The Quarterly Report is submitted to the U.S. Department of Energy, and the Imperial County Board of Supervisors and Planning Commission, and services to provide information on the status of development and on any issues that arise in the course of development. Representatives of certain California and federal agencies, and other organizations also receive the report.

Special coordination and technical assistance efforts have been made by County staff in various departments in order to assist potential direct heat developers. The proposed "Comprehensive Geothermal Procedure Ordinance", discussed above, is one result of the effort to simplify the permitting process for geothermal-related projects.

The County has continued to expand the Imperial County Geothermal Research Library. Acquisitions include data, analyses, and reports on subjects related to geothermal development. Particular topics include geothermal development projects in Imperial County and elsewhere; impacts of geothermal development; geothermal waste composition and characteristics, and reclamation processes, technologies, and economics; geothermal waste disposal; and water for geothermal development.

SECTION 4: IMPERIAL COUNTY GEOTHERMAL REPORTS

As part of the County's Geothermal Program, the County sponsors and prepares reports to meet a variety of needs - from general information on geothermal development, to detailed analyses of particular geothermal-related subjects, to reports on grant-funded projects. Reports issued by staff in the period covered by this Report are listed below.

1. Geothermal Development Quarterly Report; issued by the Imperial County Public Works Department each calendar quarter.

These Reports give a brief summary of the status of geothermal development projects in the County, describe staff activities, and other geothermal-related topics.

2. Imperial County Geothermal Development Summary Report 1979-1982, Imperial County Public Works Department, October 1982.

This Report discusses the progress of geothermal development in Imperial County from 1979 to 1982, County activities in support of development, current challenges, and the future needs of the geothermal industry and the County.

3. Imperial County Geothermal Development Annual Meeting, May 5-6, 1983, Meeting Summary, Imperial County Department of Public Works.

Report summarizes presentations made at the Annual Geothermal Development Meeting.

4. Preliminary Assessment of the Impacts of the Heber Development Projects, Imperial County Department of Public Works, January 1984. (Report discussed above).
5. Geothermal Direct Heat Study, Imperial County California; VTN Consolidated, Inc.; May 1983. (Report discussed above).
6. Evaluation of Alternative Sites for Geothermal Waste Disposal, Imperial County, California; Brown and Caldwell Consulting Engineers, November 1982.

This document reports findings of the geotechnical testing of potential disposal site locations. Staff document only.

7. Seismicity and Induced Seismicity as Related to Geothermal Development in Imperial Valley; a Summarizing Report; Imperial County Planning Department, March 1983.

Report summarizes findings resulting from a review of reports and other materials on seismicity and induced seismicity in Imperial County.

8. Geothermal Subsidence Detection Network Monitoring and Rechecking, Quarterly Report, Imperial County Department of Public Works.

Report on grant-funded resurvey project. Reports describe progress made on the resurvey of the Geothermal Subsidence Detection Network.

9. Water for Geothermal Development in Imperial County: A Summarizing Report; Imperial County Department of Public Works, January 1984. (Report discussed above).

Appendix 1

Current Monitoring Programs for Geothermal Environmental Impacts

Monitoring Program:

Participants/Status of Environmental Monitoring Program

Air - Project Site
 County-wide

Geothermal Industry: On-going monitoring at operating facilities

County Air Pollution Control District:

Station 1 (Brawley KGRA) - under construction 1983

Station 2 (Heber KGRA) - Planned 1984 (Additional funding necessary)

Station 3 (Salton Sea KGRA) - Proposed 1985 or 1986

Ecosystem

Geothermal Industry, Electric Power Research Institute, and academic research programs.

Seismic - Project Site
 County-wide

Geothermal Industry/Continuous monitoring of production zones

USGS/Continuous monitoring of County-wide network

Subsidence - Project Site
 County-wide

Geothermal Industry: Periodic monitoring of project area networks

County with assistance from other agencies/organizations: Phased resurvey in progress; Phase 1 completed 1982-83 winter, Phase 2 in progress 1983-84 winter.

Water - Project Site
 County-wide

Geothermal Industry: On-going monitoring at geothermal project locations

Regional Water Quality Control Board (Region 9): Biannual sample collection and analysis.

Appendix 2

GEOTHERMAL RESOURCE AREAS & SUBSIDENCE MONITORING NETWORK

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Appendix 3

PHASES 1 AND 2 SURVEY ROUTES

LEGEND

- Phase 1 Survey Route
- Phase 2 Survey Route

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