

From HNEI-SOH Program  
 Harry Olson  
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 Location Map

Figure 1b. Location of SOHs on the Big Island

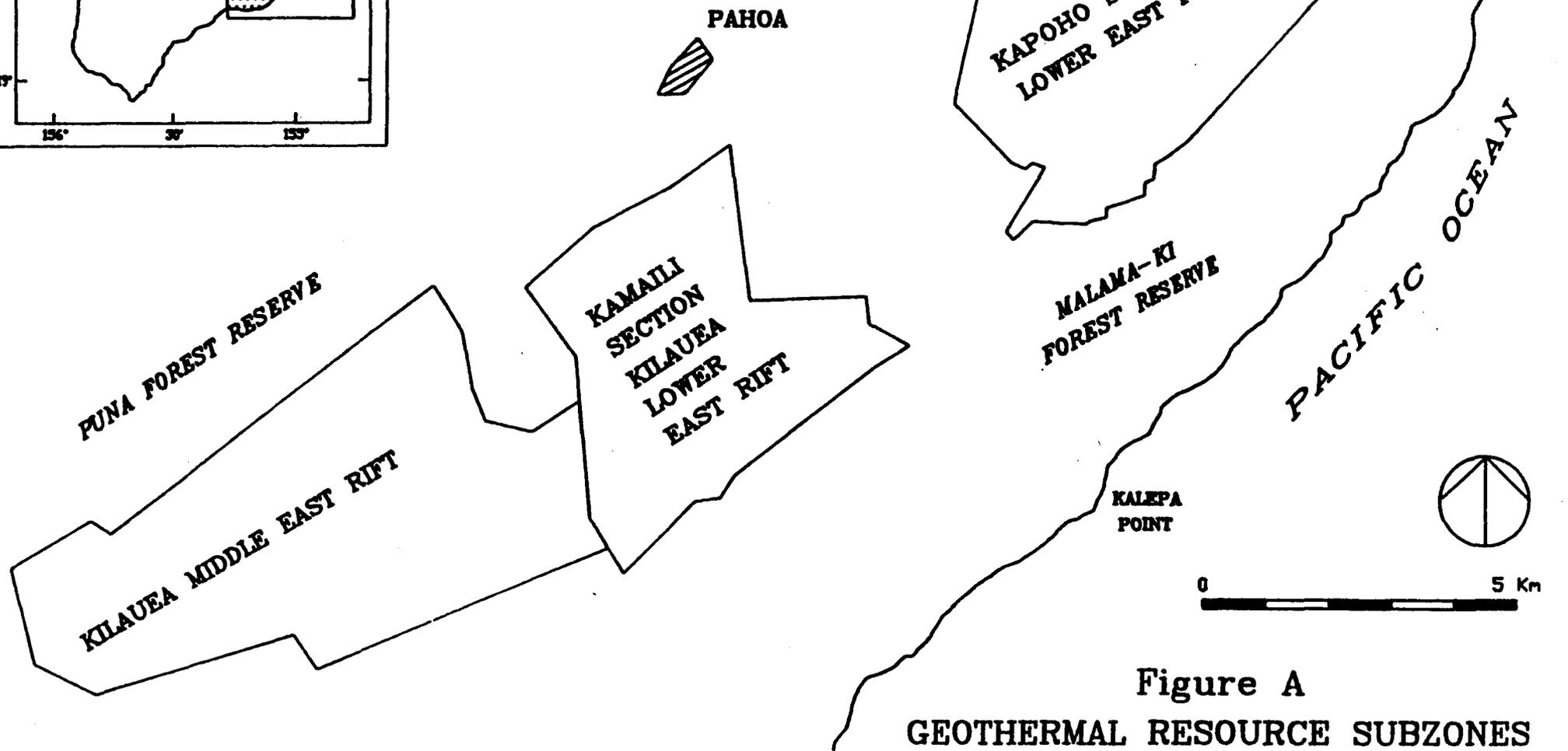
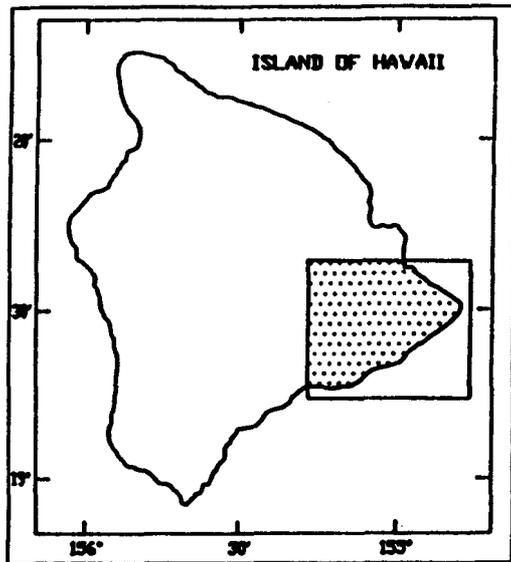


Figure A  
GEOTHERMAL RESOURCE SUBZONES

## Evaluation of Proposals

A committee may be formed by DBED to evaluate proposals received. If deemed necessary, discussions may be held with respondents. Fee negotiations will be conducted and the contract awarded by the Director of DBED or his designated representative.

Unless all responses are rejected, the contract shall be awarded to the respondent whose proposal, conforming to the RFP, is determined to be the 'best overall response', defined as the best response substantively after taking into consideration cost and other factors.

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### Disclosure of Any Conflicts of Interest

Respondents are required to disclose any real or potential conflicts of interest, including any work in progress or recently completed and any contracts entered into, with any private firms involved in geothermal exploration or development in Hawaii. Any affiliations with such firms on the part of consultant, its owners, officers, and employees, such as board or committee memberships, should be disclosed.

### Contract Term

Consulting services will commence on or about July 1, 1991, subject to final execution of an agreement. Duration of the contract will be one year. The contract may be extended for a second year, but any such extension is subject to the availability of funds and to determination by DBED of consultant's satisfactory performance.

### Firm Price and Payment

Payment for work will be made as it is completed upon DBED's receipt of consultant's invoice, with supporting evidence, submitted at the end of each month. Ten percent (10%) of the contract amount may be retained by DBED until final completion and acceptance of all services to be performed under the contract.

### Consideration of Proposals

Only proposals received on or before the submittal deadline will be considered.

Final consultant selection will be made by the Director of the Department of Business, Economic Development & Tourism. DBED reserves the right to reject any or all proposals.

Proposal shall constitute a firm offer to DBED and cannot be withdrawn for a period of 60 days after the due date for submission of proposals.

The requirements, scope of work, and terms set forth in this RFP will be used as the basis for a cost-reimbursable contract. Respondents should submit proposed hourly costs for labor and provide a separate estimate for expenses, including any subcontractors to be used on the project. If subcontractors are to be used, respondents should provide information on their qualifications and anticipated responsibilities.

private sources; (3) a summary of reasonable judgments and objective conclusions which the consultant is able to make from the available data and information about the extent and nature of geothermal resources; (4) a discussion of the accomplishments of the consultant in assisting the program during the contract term; and (5) recommendations with regard to future needs, priorities, and plans. DBED will work cooperatively with the consultant during the early part of the contract term to develop an outline for this report in order to make it as meaningful as possible. The report should address each of the elements covered by the foregoing scope of work.

\* submission, at least 5 days prior to the end of the one-year contract term, of a final resource assessment report, incorporating any changes suggested or required by DBED.

### Information Requested to be Included in the Response

DBED wishes to give respondents considerable latitude in describing how they would work toward accomplishing the defined objectives as well as any other objectives they believe to be important. In the interest of providing general guidelines, DBED suggests that respondents provide the following kinds of information:

\* Qualifications in the scientific and technical disciplines relevant to geothermal resource assessment, including but not limited to: geology, geophysics, geochemistry, hydrology, reservoir and well-field engineering, power plant design, and drilling operations.

\* Relevant work experience including any specific experience in regionally-oriented, as distinguished from site-oriented, geothermal resource assessment

\* Accessibility and responsiveness, including ability to respond in a timely manner to requests to provide reports and attend key meetings.

\* Information on hourly billing rates by individual or job category, overhead multipliers, if any, and other pertinent information regarding normal fees and charges. (Evidence of cost-effectiveness and cost reasonableness is an important criteria for the State). The State does not wish to prescribe a fixed price for the services requested in this RFP but will establish a maximum cost ceiling in the contract.

equipment, methods and procedures, personnel, and budgets.

\* assist DBED and DLNR by providing technical guidance relative to the geothermal/cable project master plan and EIS being prepared by the consulting firm ERCE.

\* assist DBED and DLNR by providing technical guidance relative to planning and design of the geothermal/cable project by the consortium and HECO.

\* assist DBED and DLNR to make reasonable judgments and to reach objective, scientifically supported, conclusions about the extent and characteristics of geothermal resources, recognizing that such judgments and conclusions may serve as the basis for public policy and/or investment decisions.

\* advise DBED and DLNR on well-field design and management in order to assist them in adopting appropriate policies, standards, and design criteria to avoid over-production and premature depletion of geothermal resources.

#### Anticipated Work Efforts and Products

\* attendance upon request at key meetings of State interagency technical and policy committees involving DBED, DLNR, other State agency officials, and, on appropriate occasions, representatives of involved institutions such as the University of Hawaii and USGS.

\* preparation, as needed, of written reports addressing specific aspects of or problems concerning resource assessment work in progress and making specific recommendations.

\* submission, on or before December 1, 1991 (approximately one month prior to the start of the 1992 legislative session), of an interim draft written report on geothermal resource assessment, consisting of the following information: (1) a status report on the State's geothermal resource assessment program; (2) a description and brief analysis of available data and information from all public and accessible private sources; and (3) a summary of reasonable judgments and objective conclusions which the consultant is able to make from the available data and information about the extent and nature of geothermal resources.

\* submission, at least 45 days prior to the end of the one-year contract term, of a draft annual report on geothermal resource assessment including the following kinds of information: (1) a status report on the State's geothermal resource assessment program; (2) a comprehensive analysis of available data and information from all public and accessible

resource for commercial exploitation, as typically expressed in terms of megawatts of installed capacity, megawatt hours of energy production over time (project life), and pounds of steam and/or fluids available for direct use applications.

With regard to characterization of the geothermal resource(s), the Administration is vitally interested in its sustainable yield. The State is interested in seeing geothermal development planned and implemented in a manner which avoids premature resource depletion through excessive or improper exploitation.

The focus of State-sponsored research and exploration is regional rather than site-specific. It is not a primary objective of the program to directly assist active geothermal developers to prove the resource which they are developing (or hoping to develop) on lands which they currently own or lease. However, in the past a degree of synergism has been realized between the commercial developers and SOH in exploration. Opportunities for further cooperation will be evaluated objectively based on State criteria. Examples of possible mutually beneficial efforts might include use of an SOH to pressure monitor a commercial production well during a flow test and performance by SOH personnel of certain geophysical tests on commercial wells, which the developer would not otherwise perform as part of his program.

The focus of research and exploration has to date been on the KERZ, because it was originally identified by scientists as the area having the greatest potential based on subsurface heat and groundwater estimates and limited data from surface and aerial surveys. Whether future assessment continues to focus on the KERZ or elsewhere is a technical matter which will be evaluated objectively, taking into consideration land-use, environmental and socio-economic factors.

#### Contract Scope of Work

\* assist DBED and DLNR in establishing priorities among available resource assessment methods, including (as examples): exploratory drilling; core-sampling and well-testing; surface and aerial surveys; and regional mapping. Guidance in this regard must be sensitive to budget constraints.

\* assist DBED and DLNR in planning the direction of and managing the SOH program and in evaluating available exploratory drilling methods, with cost effectiveness being a major criterion.

\* assist DBED and DLNR in designing and planning appropriate well tests, surface and aerial surveys, and/or mapping projects. Provide advice on appropriate instrumentation and

Numerous electric and electromagnetic surveys have been conducted in the KERZ. These include dipole-dipole, electromagnetic, and VES soundings; and mise-a-la-masse, self-potential, and airborne electromagnetic surveys.

### State of Hawaii Management of Geothermal Resources and Geothermal Resource Assessment

By statute, the Department of Land and Natural Resources (DLNR) is the agency responsible for issuing mining leases and for managing geothermal resources, which are treated as a mineral owned by the State. DLNR is involved in issuing drilling permits for geothermal and other wells. It is also responsible for issuing permits for use of State land in Conservation Districts.

The Department of Business, Economic Development, and Tourism (DBED) is the agency responsible for promoting and assisting energy conservation and alternative energy development in the State. The Director of DBED serves as the Energy Resources Coordinator. Within DBED, the Energy Division, headed by the Energy Program Administrator, supervises the Geothermal Program, which includes geothermal resource assessment and master planning of the geothermal/cable project.

DBED is the agency which will issue and administer the subject agreement for technical advisory services relating to geothermal resource assessment. However, the consultant selected will work closely with both DBED and DLNR as well as with ad-hoc inter-agency committees which may be convened to facilitate discussion of resource assessment and management matters. Respondents should be aware of the involvement of the State Department of Health (DOH), which administers regulations pertaining to water quality, underground injection, air quality, and noise. Also, the County of Hawaii issues use permits for development of land in agricultural, urban, and rural districts. The County is becoming increasingly active in monitoring and enforcing permit conditions for geothermal facilities.

### Geothermal Resource Assessment Objectives

The Administration's fundamental resource assessment goals are: (1) to determine the extent of geothermal resources within the State and (2) to learn as much as possible about the characteristics of those resources. (The program has been labeled by some as the "geothermal resource verification and characterization program" (GRVC) in an effort to highlight these dual objectives).

The orientation of the program is commercial rather than scientific. The objective is to determine the potential of the

True/Mid along the center of the axis of the rift. SOH-4 initially recorded a bottom hole temperature of 583 degrees F. Drilling of the second well, SOH-1, was started in June, 1990, and completed to a depth of 5,526' depth in 213 days. SOH-1 is located in the Kapoho GRS approximately 2,100' north of the PGV plant site, which is presently under construction. SOH-1 initially recorded a bottom hole temperature of 403 degrees F. The drilling procedure for SOH-2 was modified by HNEI after the completion of the SOH-4 and SOH-1 because of cost overruns. The method used at SOH-2 and planned for SOH-3 is to rotary drill to approximately 2,000' (or lower, depending on drilling conditions), set casing, and then core drill to the bottom. Drilling of SOH-2 was started in February, 1991. SOH-2 is located in the Kapoho GRS approximately two miles east and one mile north of SOH-1. SOH-2 is the first well in the eastern part of the KERZ which is being drilled into what is thought to be the northern part of the rift. A fourth SOH, SOH-3, is being permitted. It will be located in the Middle East Rift GRS approximately one half mile north of True/Mid. It will continue exploration aimed at establishing the northern extent of the KERZ.

An evaluation of the SOH Program, from both a technical and managerial standpoint, was made by R.A. Patterson & Associates (RPA) in the late Fall of 1990, and a Final Report was submitted to DBED. It recommended continuing the SOH program through the completion of the four planned holes for which permit applications have been secured or filed. It recommended a few program changes, including rotary drilling (instead of core drilling) the upper section of the well) as well as improvements in reporting costs, drilling progress, and problems.

#### History and Availability of Surface and Aerial Surveys and Regional Maps

Two gravimetric surveys have been made, one on a regional scale for the Island of Hawaii and one, more detailed, for the KERZ. ENEL concludes that the information is of limited value.

Two aeromagnetic surveys were conducted in 1966 and 1978, respectively. The first covered the entire Hawaiian archipelago and, according to ENEL, is of limited value in identifying a shallower structure such as dike complex. The second, conducted by USGS, covered only the Island of Hawaii and is more valuable. Magnetic mapping, utilizing 1978 survey data, was performed in 1986 by Flanigan and others.

A network of seismometers has been in operation on Kilauea since the 1950s. It has generated valuable information about seismicity in the KERZ. Limited microseismic and seismic refraction surveys have been conducted in the lower portion of the KERZ.

and Wells. The shallow wells range in depth from 41 to 802 feet; the deep wells extend to depths of approximately 5,000 to 8,300 feet. The eleven deep wells are the SOH-4, SOH-1, True/Mid, HGP-A, Kapoho State-1, Kapoho State-1A, Kapoho State-2, Lanipuna-1, Lanipuna-1ST, Lanipuna-6, Ashida-1, and Kapoho State-3. True-Mid consists of five legs directionally drilled from a single bore. Lanipuna-1ST is actually a sidetrack off Lanipuna-1.

Wellbore temperature and pressure data as well as fluid chemistry is available for these wells. Geophysical and flow test data is available for some of them. SOH permits, applicable to two recently completed wells, plus one well presently being drilled and one planned to be started in the Spring of 1991, do not presently permit flow testing, although it is hoped that this restriction might be lifted for future SOHs.

The deep productive wells (HGP-A, Kapoho State-1 and Kapoho State-2) display average temperatures of about 625 degrees F in the 4,000 to 8,000-foot depth interval. The deep, unproductive wells (Lanipunas -1, 1ST, 6 and Ashida-1) range in temperature from about 340 degrees F to over 680 degrees F. The upper 1,500 to 2,000 feet of the deep wells is generally isothermal. Fluid chemistry is quite variable and consists of varying mixture of fresh water and seawater and varying concentrations of H<sub>2</sub>S.

The HGP-A well supplied steam to a pilot power plant which supplied approximately 2.5 megawatts of electricity to the utility grid continuously from 1982 through 1989.

PGV recently completed its first new well, Kapoho State-3. It is presently constructing a 25 megawatt power plant which will be served initially by seven to nine production wells and two to three injection wells. It plans to rework Kapoho State 1-A and to drill new production and injection wells. In the course of drilling its first injection well, it encountered a steam pocket in the shallow aquifer (approximately 2,600 feet), resulting in an unplanned vertical venting and causing it to close in the well for safety reasons. This incident represents the first instance in KERZ exploration that steam has been tapped at a relatively shallow depth.

The Hawaii Natural Energy Institute (HNEI), under contract with DBED, is managing the SOH program, which involves the drilling and testing of slim holes. A map titled Location of SOHs on the Big Island, is attached herewith. The following is a brief summary of progress to date:

The first two SOHs were core drilled from top to bottom. Core analysis and well testing are underway but incomplete. Drilling of the first well, SOH-4, was started in December, 1989 and completed to a depth of 6,562' depth in 151 days. SOH-4 is located in the Kamaili GRS approximately three miles east of

5. active and passive seismic data
6. location of main geoelectrical data
7. main results of geoelectrical data
8. apparent resistivity map from VLF survey

Annex A of the ENEL report presents graphs of geochemistry data from existing wells. Annex B presents graphs of well data, including technical profile, lithology, depth, temperature, and pressure. Annex C lists all the references consulted. The narrative report, titled The Kilauea East Rift Zone; Geothermal Evaluation of the Existing Data, analyzes the available information and comments on its quality.

Basically, the ENEL report confirms the presence of a widespread geothermal anomaly but concludes that more data is needed to verify the presence of an industrially exploitable geothermal reservoir. Wells drilled to date, most of which are localized in one small area, have confirmed a high thermal anomaly but have shown discontinuous permeability due to fracture systems. The report recommends further exploratory drilling, well testing and additional surface and aerial surveys.

The technical advisory services being sought through this RFP are specifically required to assist the State's geothermal resource assessment program. The following section describes this program.

#### Status of the State's Geothermal Resource Assessment Program

The State's geothermal resource assessment program has to date focused on the KERZ. The program consists presently of two elements: (1) exploratory drilling utilizing "slim hole" technology; and (2) core analysis of slim holes and well testing of SOHs as well as other existing production and exploration wells. Other research methods utilized previously in resource assessment and being considered for future application are: regional mapping; and surface and aerial surveys.

In 1985 the State Legislature established within the KERZ three geothermal resource sub-zones (GRS), which are identified on the attached map titled Geothermal Resource Subzones. Geothermal development is restricted by State law to these zones. Exploration, including exploratory drilling, is permitted outside of the sub-zones but is subject to State and County permitting requirements, which are stringent.

#### History and Status of Exploratory and Production Drilling in the Kilauea East Rift Zone

To date a total of ten shallow wells and eleven deep wells have been drilled in the KERZ. The locations of these wells are identified on the attached map titled Geothermal Resource Subzones

the axis of the rift in the Wao Kele O Puna forest. They have applied for permits to drill more exploratory wells from a second pad to be located about a mile east of the first pad along the axis of the rift.

For over ten years, the State of Hawaii has been interested in investigating the potential of geothermal to meet a significant portion of the Oahu's baseload energy needs. In 1981 the Hawaii Integrated Energy Assessment recommended that geothermal be developed on the Big Island on a large scale and transmitted to Oahu via undersea cable. Also in 1981 the State initiated the Hawaii Deep Water Cable (HDWC) program to demonstrate the feasibility of a 500 megawatt interisland electric transmission system. Research supported with Federal and State funds and involving the collaboration of Hawaiian Electric Company (HECO), Oahu's electric utility, was completed in 1990. Prototype cable was tested in Italy, and in 1989 a six mile section of smaller diameter surrogate cable was laid in the deep Alenuihaha Channel between the Big Island and Maui. Both tests were successful in demonstrating the technical and physical feasibility of interconnecting the Hawaiian islands with an undersea cable.

In 1989 the State entered into a contract with ERCE, an energy and environmental planning firm, to prepare a master development plan and environmental impact statement for the large-scale geothermal/cable project. This work is proceeding.

HECO is in the process of negotiating an agreement with Kilauea Energy Partners (KEP), an international consortium of large, private companies, to plan and develop the geothermal/cable project. KEP was selected through a competitive bid (RFP) process which began in 1989 and to which five international consortia responded. The lead partner of KEP is Mission Energy Company, a subsidiary of SCE Corporation. Once an agreement is in place, it is assumed that KEP will play a key role in planning and implementing geothermal exploration.

In 1990, the National Electric Board of Italy (ENEL) was contracted by DBED to compile and analyze all available data and reports relating to geothermal research and exploratory drilling in the KERZ. ENEL looked at more than 150 documents. They assembled and organized the data into a series of thematic plates (maps) and graphs, and they submitted a narrative report including conclusions about the geologic structure of the KERZ and several recommendations on appropriate resource assessment methods. The plates depicting compiled data are titled as follows:

1. main volcanic and structural features.
2. main hydrogeological features and sea level temperature distribution
3. gravity data
4. aeromagnetic data

**REQUEST FOR PROPOSAL FOR TECHNICAL ADVISORY SERVICES  
RELATING TO GEOTHERMAL RESOURCE ASSESSMENT**

The State of Hawaii, Department of Business, Economic Development, and Tourism (DBED), invites respondents to submit a proposal to provide technical advisory services for the State's geothermal resource assessment program.

Six copies of the proposal must be received on or before 4:30 P.M. on Friday, April 26, 1991, either by mail addressed to:

Mr. Murray E. Towill, Director  
Department of Business, Economic Development & Tourism  
Attention: Energy Division  
P.O. Box 2359  
Honolulu, HI 96804

or delivered to: 335 Merchant Street, Room 110, Honolulu

Introduction

The State of Hawaii as a whole is 90% reliant on imported oil for electricity; Oahu is 98% reliant on oil. This extreme dependence on a single, finite fuel source with a history of supply discontinuities, combined with steady annual growth in electrical demand, makes it necessary for the State to aggressively pursue other energy options, including conservation and development of alternative sources, to meet its future generation requirements. Among the potential replacement technologies, geothermal ranks at the top. The Energy Functional Plan of the Hawaii State Plan states: "Geothermal is the only indigenous resource...which can be converted to baseload electricity and is commercially mature."

The Island of Hawaii, the largest and youngest of the islands in the Hawaiian chain, is known to have substantial geothermal resources. It is the home of two active volcanoes: Mauna Loa and Kilauea. The Kilauea East Rift Zone (KERZ) has been identified as the most promising area for geothermal development and has been the focus of a substantial amount of research and exploration.

Two private companies, Puna Geothermal Venture (PGV) and True/Mid-Pacific Geothermal Venture (True/Mid) are actively exploring for geothermal resources in the KERZ at the present time. The near-term objective of these companies is to meet the Island of Hawaii's expanding needs for baseload supply. PGV has entered into a long-term agreement with Hawaii Electric Light Company (HELCO) to provide 25 megawatts of baseload energy before the end of 1991. PGV has started constructing a power plant near Pahoa in the Kamaili section of the KERZ and is actively drilling both production and injection wells. True/Mid has obtained permits granting it the right to explore for 100 megawatts of geothermal energy in the eastern portion of the KERZ. To date True/Mid has directionally drilled five legs from a single pad located along