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AGRIBUSINESS AND SPACE CONDITIONING APPLICATIONS  
FOR THE CITY OF DESERT HOT SPRINGS ◊

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ABSTRACT

This paper presents a status report of a study to evaluate potential nonelectric applications of an identifiable geothermal energy resource underlying the City of Desert Hot Springs, California. Promising Applications identified to date include greenhouse culturing of European cucumber and aquaculture operations of Malaysian freshwater prawn. Other applications being investigated involve space conditioning, refrigeration, water heating, and energy cascading systems.

I. Introduction

Under the sponsorship of the Department of Energy Geothermal Energy Division and the California Energy Resources Conservation and Development Commission, a study was initiated to evaluate potential applications of an identifiable geothermal energy resource in terms of engineering, economic, and institutional considerations and to formulate the preliminary design and implementation plan of the most promising demonstration or industrial development project.

The study will focus upon a reservoir specific, multi-use application of hydrothermal resources underlying the City of Desert Hot Springs, California. Potential applications to be considered include space conditioning of commercial and residential buildings and an agricultural and aquacultural installation in individual as well as energy cascading systems. To extend the utility of the study findings, the assessment of potential applications will be conducted within the wider context of satisfying broad regional needs.

The project is administered and managed by the City of Desert Hot Springs and supported programmatically by Rogers Engineering Co., Inc. and the Jet Propulsion Laboratory.

II. Background

The City of Desert Hot Springs (DHS) is a small desert community encompassing approximately nine square miles on a gently sloping alluvial fan at the northern end of the Coachella Valley in Riverside County. As its name implies, the City of Desert Hot Springs is richly endowed with low-and moderate-temperature resources (Figure 1). These resources are attributable to major faults that subtend the City. The major fault, Mission Creek Fault, consists of a near vertical fault zone trending southeastly with several splinter breaks that extend toward the Little San Bernardino Mountains on the northeast.

The present population is ~ 3600 full-time residents, but a peak weekend may draw over 14,000 people. City growth, has in large part, been a product of the indigenous hot mineral springs and spas which offer both therapy and relaxation. Over the last decade, the mineral waters and dry desert climate have made the City a haven for many retired and semi-retired persons.

The City is further characterized by lacking a major industry, limited employment opportunities (which impede growth), major requirement for space conditioning, and high energy costs.

Further exploitation of the indigenous geothermal resources offers a unique opportunity to develop this resource as a viable alternate

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energy source for providing economic incentives for expansion of health resort activities and initiation of new enterprises compatible with a health resort community's needs and development goals.

### III. Project Status

#### Resource Characterization

In order to assess the nature and extent of the geothermal resource, the types of projects the resource can support, and how the resource must be managed to sustain these operations, an effort was initiated to determine (1) the areal extent of the geothermal aquifer system, (2) a safe yield for the hydrothermal resource, and (3) potential areas of recharge and reinjection.

A temperature isotherm map for the DHS project site was constructed utilizing temperature graduations representative of agribusiness and space conditioning thresholds (Figure 2). The surface extent determined by the 90° F isotherm is 5.45 square miles.

Two hot spots predominate in this region; a southeastern pocket within Desert Hot Springs and the Dillion Road area (outside the city limits). This indicates that these two systems may be isolated somewhat from each other, most likely by the source of their water supply and heat.

The safest safe yields determined for potential project sites are as follows:

<u>Temperature</u>	<u>DHS</u>	<u>Dillion Road Area</u>
90° F	2,100 acre ft/yr	
120-150° F	2,800 acre ft/yr	2,400 acre ft/yr
150-180° F	2,700	2,400
> 180° F		2,300

Recharge is preferred over reinjection as a means of managing the reservoir and the most likely locale for siting a recharge basin is along the northern extremity of the City, near the Blind Canyon Fault.

#### Requirements Analysis

The results of work conducted to date indicate that commercialization of hydrothermal resources in Desert Hot Springs is primarily a local impact which may have beneficial effects on a more regional basis, such as the creation of a center of employment activity in the northern Coachella Valley not dependent upon tourist trade.

Introduction of this technology is not expected to significantly alter the socio-political structure of the community. Although the commercial development of geothermal resources within DHS can provide significant impetus to a

wider and more diversified economic base within the City, job opportunities appear to be aimed at the younger permanent employees, and not at significant opportunities for senior citizens employment on a part time basis.

The results of public attitude surveys have not been analyzed; however, from the overwhelming number of people who believe that the geothermal resource of their city should be developed to its fullest potential, endorsement of geothermal development is expected to follow.

Screening criteria developed for candidate applications include (1) technological/economic viability (2) community needs/goals, (3) resort motif compatibility, (4) broad regional needs, (5) market potential, (6) public service impact, (7) environmental assessment, and (8) ongoing operations compatibility considerations.

#### Greenhouse Cucumber Operations

A promising agricultural application identified involved the greenhouse culturing of European cucumber that makes it a distinctly different and superior product to conventional field cucumbers. Some of the key selling features of the European cucumber are the longer shelf life, uniform high quality, superior taste, burpless, seedless, and no peeling needed. Additionally, the produce lends itself to each of the chief requirements for effective market penetration (i.e., high quality fruit, high volume production, year round production).

Since its introduction into the domestic market, both demand and wholesale prices have grown steadily to the point where profit margins can be achieved year round and the market is nowhere near saturation.

Preliminary design of a 2 acre greenhouse complex, complete with packing, cold storage, and office facilities has been formulated (Figure 3). The design has been narrowed to a linked metal frame greenhouse construction with fiberglass panels, utilizing a recirculating heating and single-pass evaporative cooling system. Estimates of capital and operating costs are being developed to assess the economic viability of a DHS installation.

#### Aquaculture Operations

The giant Malaysian prawn (*Macrobrachium rosenbergii*) has been selected as the target shellfish for an aquaculture operation at Desert Hot Springs. This particular species of freshwater prawn appears well-suited to culturing for numerous reasons: it grows rapidly at elevated temperatures, has an omnivorous diet, reproduces easily in captivity, produces large numbers of larvae per female, has relatively short larval phases, is hardy and disease resistant, has good food conversion ratios, has good taste, and has relatively high market value.

The per capita consumption of shrimp and lobster tails, which the Macrobrachium is targeted to displace, has risen over the period from 1957 to 1975.<sup>1</sup> The shrimp market is volatile and sensitive to the economic conditions in the country while lobster prices have exhibited a continual upward trend from year to year. Recent marketing programs of freshwater prawns on the east coast have enjoyed success in displacing both lobsters and shrimp by the introduction in a size and form comparable to the shellfish the prawn displaced.<sup>2</sup>

Conceptual design studies of pond and raceway culturing of prawns have been conducted. A representative design of a raceway system of equivalent yield to a one acre pond is presented in Figure 4. The schematic is complete from geothermal well to recirculation and mixing circuit, substrate culture, overflow, settling pond, and reinjection well.

Studies are continuing to also assess automated temperature control and feeding, fluoride tolerance and uptake, NH<sub>3</sub> tolerance levels, biomass buildup, effluent requirements, and potential beneficiation effects.

Work has not progressed to the point where conclusions regarding the preferred mode of operation can be drawn at the present time.

#### Space Conditioning Applications

In order to assess the local market potential for geothermal space conditioning, a load survey for Desert Hot Springs was conducted along with cycle analyses to identify the various heating and cooling options. A comparison of the load to known resource characteristics indicated that the safe yield of the DHS hydrothermal resource could not accommodate a centralized space conditioning network for the entire community, but is of sufficient capacity to sustain commercial and industrial uses of space conditioning, cold storage, and refrigeration.

#### Social-Legal-Institutional-Environmental Analysis

In order to define the framework in which geothermal projects can be implemented, an effort is underway to assess socio-economic changes, legal-institutional issues and requirements, project management systems, and surface and subsurface effects resulting from project implementation.

The results of this work are expected to yield a permitting flow diagram, well spacing and field development recommendations, fluid handling and disposal recommendations, ranking of follow-on project, management plan, environmental analysis, and project financing recommendations.

#### Deliverables

The study will culminate in the preliminary design and implementation plans of

the most promising demonstration or industrial development project as well as a self-start manual. The latter document should provide interested communities and users having similar geothermal resources with a mechanism by which they may readily evaluate appropriate nonelectric applications to meet their specific needs and gain added insight into how best to implement these applications.

#### IV. Tentative Findings

Work conducted to date has yielded the following findings:

- Hydrological data substantiate the feasibility of indigenous resources to support typical low temperature industrial development.
- The nature and extent of emerging operations are not likely to significantly alter the socio-political structure of the community and are expected to be supported by the community at large.
- Greenhouse culturing of European cucumbers appears to be a viable industrial undertaking that can add to the economic base of the community.
- Aquaculture of Malaysian freshwater prawns is also surfacing as a candidate pilot project with significant market potential.
- The hydrothermal resource, as presently understood, is not of sufficient yield to totally space condition the entire community, but is of sufficient magnitude to sustain typical industrial projects.

A more detailed description of the work performed in this study may be found in the quarterly reports generated to date.<sup>3,4</sup>

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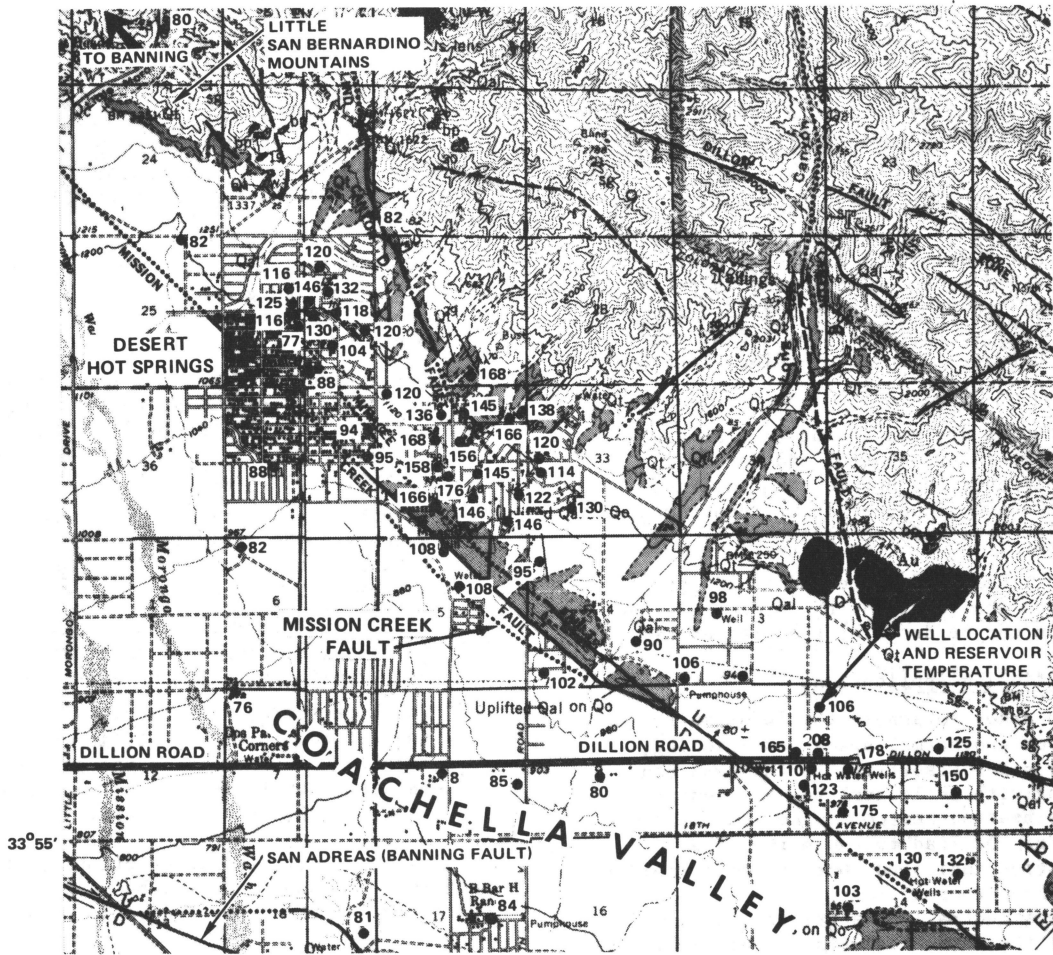


Figure 1. Geologic Map of the Desert Hot Springs Area<sup>5</sup>

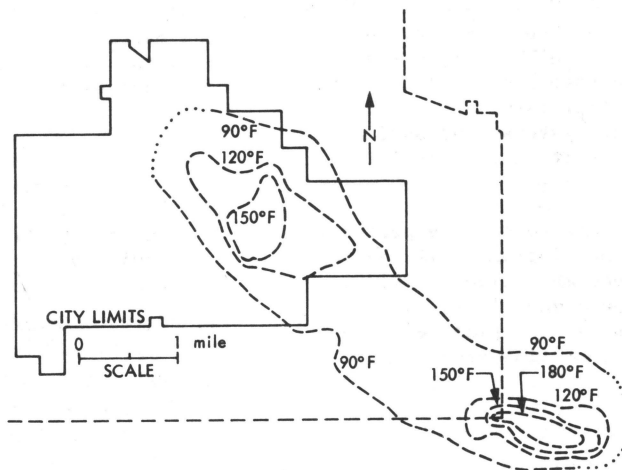


Figure 2. Temperature Isotherms in the Desert Hot Springs Area

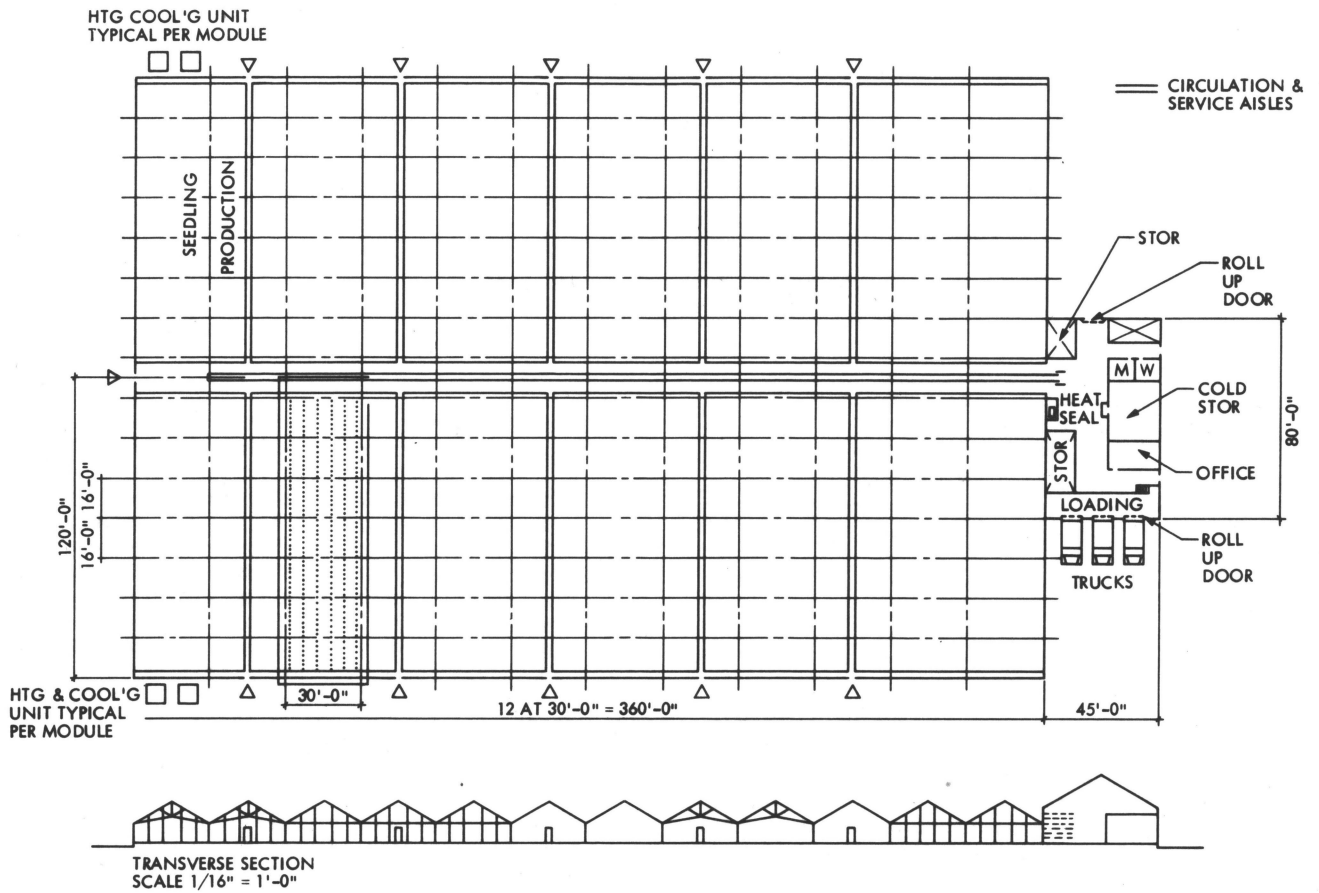


Figure 3. Proposed Greenhouse and Warehouse Development

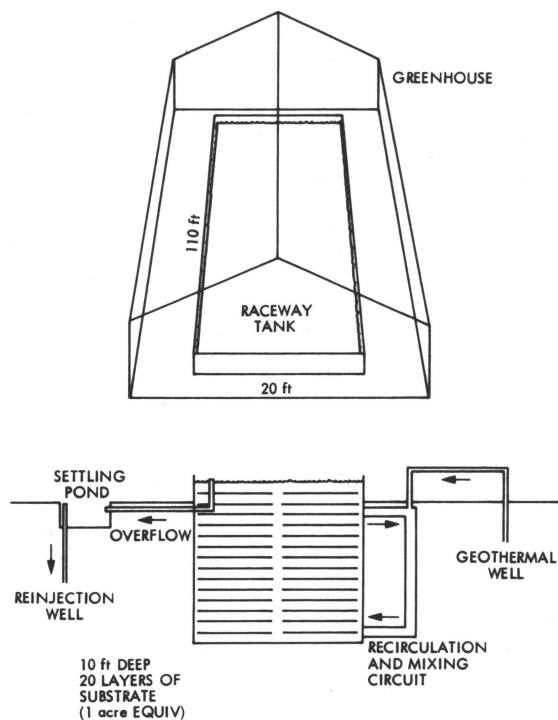


Figure 4. Raceway Culture System