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SAN BERNARDINO
GEOHERMAL DISTRICT HEATING PROJECT

Joe Stejskal

and

Roy A. Cunniff

Director, Engineering-Construction-Maintenance
San Bernardino Water Department
P.O. Box 710
San Bernardino, CA 92403

Physical Science Laboratory
New Mexico State University
Las Cruces, NM 88003

ABSTRACT

This summary provides the highlights of a successful project to use low-temperature geothermal water for a Geothermal District Heating Project. Initial use is as a heating source for a two-million gallon anaerobic sludge digester. Expanded usage includes adding two such digesters, in addition to domestic hot water and space heating for a planned total of more than 52 buildings. Construction has started on the expanded system, and testing results to date indicate the geothermal resource will be fully adequate for intended uses.

contracts before all the construction funds are released. Initially, however, funds are released incrementally to provide well field expansion and pipelines to connect user segments. The grant will convert to a loan repayable within 10 years. Project location is depicted below.

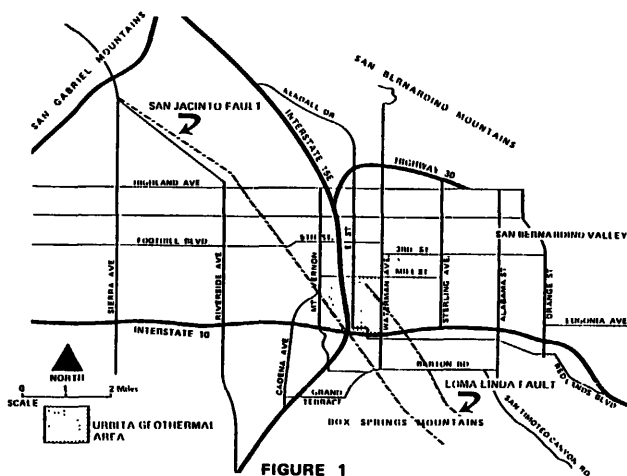


FIGURE 1
LOCATION MAP
SAN BERNARDINO VICINITY

INTRODUCTION

Using a grant from the California Energy Commission, the City of San Bernardino has completed the initial project leading to a Geothermal District Heating System. This grant also financed a geothermal gradient well drilling program which proved the wide-spread existence of a usable resource. The action agency for the City of San Bernardino is the Board of Water Commissioners, who have taken the lead in the development of geothermal energy. The city has purchased an existing well, which is free-flowing under artesian pressure at a rate between 2,000 and 3,500 gpm, and at a temperature which varies between 130 and 138°F. The City of San Bernardino is using this well for the digester project, and as one of the primary production wells for the larger District Heating Project.

The California Energy Commission is financing the District Heating Project under an innovative grant-loan program. The contractual terms require certification that at least 60 percent of the planned users will sign user

DIGESTER PROJECT

Initially only 175 gpm of the artesian geothermal resource is being used. The San Bernardino Sewage Treatment Plant contains two sludge digesters, each of two-million gallon capacity. Anaerobic bacteria require a temperature of 90 to 98°F to function efficiently. The 130 to 138°F geothermal water is piped 4,400 feet to the digester, where it warms the sludge from 75°F to optimum 98°F, using an installed heat exchanger. The geothermal water provides up to 1.5 million Btu per hour to the sludge. This system was dedicated on April 5, 1983.

The sewage treatment plant is being expanded, and two new digesters will be added. Of the total of four digesters, at any time three will be heated with geothermal water. Concurrently, five administration buildings at the plant will be heated geothermally. For three of these buildings, the geothermal water also will be used to heat domestic water for showers and lavatories.

From work performed by the California Division of Mines and Geology, and Republic Geothermal as part of the digester project, a clearer understanding of the San Bernardino geothermal resource is emerging. The resource appears to be fault-controlled, with hotter water (up to 185°F) near the San Andreas fault. Within the city, the Loma Linda and San Jacinto faults probably are the controlling mechanism, with the warmest water on the eastern side of the Loma Linda fault. Much of the Bunker Hill water basin serving San Bernardino and other nearby cities has artesian water wells, but currently only those near the Loma Linda fault are warm.

The existing Digester Project well has been tested extensively, and four temperature gradient wells drilled by Republic Geothermal in 1982 also have been measured repeatedly. At the peak of winter artesian head, the wells have a temperature of 138°F, originating at a depth roughly coincident with the top of the San Timoteo formation (700 to 850 feet). The lowest temperature was recorded with the well free-flowing at 2,500-3,000 gpm in January, 1983, at a value of 131°F. At least three more gradient wells will be completed in late summer, 1983, to map the geothermal resource.

Water quality is excellent. Total dissolved solids (TDS) of the existing well are less than 300 mg/liter. Fluoride levels exceed drinking quality standards, and boron levels are somewhat higher than irrigation standards. Because the dissolved minerals are in such low concentrations, the Environmental Assessment and NPDES Discharge Permits have been approved to discharge cooled geothermal water into the natural surface drainage channels. Locations of the primary well (Meeks and Daley #66) and the gradient wells are shown below.

MAXIMUM TEMPERATURE CONTOUR MAP

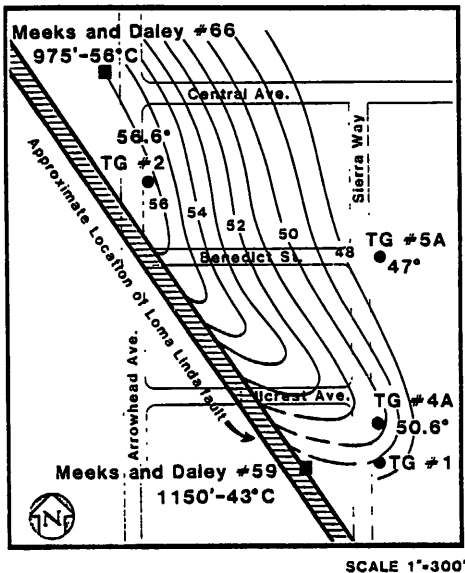


FIGURE 2

Based on the results of a market survey and a detailed preliminary feasibility study, the San Bernardino Heating District is technically and economically feasible. In concept, the District will encompass users in South and Central San Bernardino, including Norton Air Force Base. Identified potential users are arrayed in the following table.

SAN BERNARDINO POTENTIAL GEOHERMAL MARKET

Public Sector	Buildings
City of San Bernardino	4
County of San Bernardino	2
State of California Buildings	3
Norton AFB	29
Subtotal	38
Private Sector	Buildings
Motels	7
Restaurants	11
Retirement Centers	2
Other	4
Subtotal	24
TOTAL	52 Buildings

The potential users currently consume annually more than 1,276,000 therms of natural gas for space heating and domestic hot water, at a current cost of more than \$765,000. The City of San Bernardino Board of Water Commissioners will sell geothermal water at a price linked to January 1983 natural gas prices, but at approximately 50 percent cost based on heat consumed. For the first full year of loan repayment, which is considered to be 1985, the city is expected to have gross revenues of approximately \$670,000. Operating costs, including electricity, maintenance and management fees should be roughly \$125,000. The balance of revenues should be adequate to repay the loan principal and interest in ten equal annual payments.

Construction will proceed incrementally, with the first user cluster to be connected consisting of those users located near the Wastewater Treatment Plant. These will be connected in late summer, 1983. Depending on the results from the on-going resource assessment program, the next cluster to be connected will be the fast-growing commercial center known as Hospitality Lane. This cluster consists currently of four motels, seven restaurants, and three other users. Based on announced and planned construction permits, this area could have a three-fold increase in geothermal consumption within 3 to 5 years. Remaining clusters will be brought on line sequentially, with Norton AFB the last cluster, possibly not until 1986 or later. The following figure shows the general location of each of the clusters.

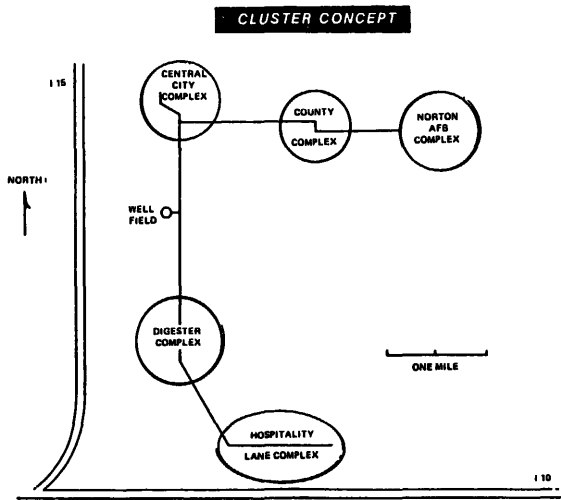


FIGURE 3

The completed project will have two or more wells, and more than five miles of city-owned insulated pipeline. User retrofit, to be financed by savings on energy costs, will include heat exchangers and user-installed interconnects, with Norton AFB having the largest amount.

ACKNOWLEDGEMENTS

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REFERENCES

- City of San Bernardino Board of Water Commissioners, 1983, Feasibility of Geothermal Direct Use Applications in San Bernardino, California, Final Report (A report prepared by the Water Department and its contractors).
- Republic Geothermal, 1982, Evaluation of a Thermal Gradient Drilling Program Related to the San Bernardino Municipal Water Department Wastewater Treatment Plant Geothermal Project.