SAN/RA 50239-SDG&E-0009

HEBER GEOTHERMAL BINARY DEMONSTRATION PROJECT

QUARTERLY TECHNICAL PROGRESS REPORT FOR THE PERIOD OCTOBER 1, 1981 - DECEMBER 31, 1981

San Diego Gas & Electric
Post Office Box 1831
San Diego, California 92112

Prepared for
The Department of Energy
Under Cooperative Agreement No. DE-FC03-80RA50239

DISCLAIMER

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This report was prepared as an account of work performed by San Diego Gas & Electric; sponsored by the Electric Power Research Insititute, the Imperial Irrigation District, the California Department of Water Resources, and the Southern California Edison Company, hereinafter called Sponsors; and supported by the U. S. Department of Energy, an agency of the United States Government. Neither San Diego Gas & Electric, nor the Sponsors, nor the United States Goverment nor any agency thereof, nor any of their employees or subcontractors, makes any warranty, express or implied,. or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacture, or otherwise, does not necessarily constitute or imply its endorsement or recommendation by San Diego Gas & Electric, or the Sponsors, or the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of San Diego Gas & Electric, or the Sponsors, or the United States Government or any agency thereof.

ABSTRACT

The purpose of this quarterly technical progress report is to document work completed on the nominal 65 Megawatt (Mwe gross) Heber Geothermal Binary Demonstration Project, located at Heber, California, during the period of October 1, 1981, through December 31, 1981. The work was performed by San Diego Gas & Electric Company under the support and cooperation of the U.S. Department of Energy, the Electric Power Research Institute, the Imperial Irrigation District, the California Department of Water Resources, and the Southern California Edison Company. Topics covered in this quarterly report include progress made in the areas of Wells and Fluid Production and Injection Systems, Power Plant Design and Construction, Power Plant Demonstration, and Data Acquisition and Dissemination.

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SUMMARY

Recognizing the desirability of demonstrating the operation of the binary cycle process for commercial-scale electric production, San Diego Gas & Electric (SDG&E), the United States Department of Energy (DOE), the Electric Power Research Institute (EPRI), the California Department of Water Resources (DWR), the Imperial Irrigation District (IID), and the Southern California Edison Company (SCE) joined together to carry out the Heber Geothermal Binary Demonstration Project.

The purpose of the Heber Binary Project is to design, construct, and operate a nominal 65 MWe (gross) commercial-scale, binary cycle power plant to demonstrate the technical and economic feasibility of geothermal power generation. The Project will be the first commercial-scale hydrothermal generating facility in the United States utilizing liquid-dominated resources and the binary energy conversion process. It is expected that information developed by this demonstration project will be applicable to a wide range of moderate-temperature, low-salinity hydrothermal reservoirs. Geothermal generation from the Project offers the possibility of displacing 525,000 barrels of oil per year that would otherwise have to be burned in Southern California. Figure 1 shows an artist's rendering of the Project and Figure 2 shows the location.

This report describes the Project's progress for the period of October 1, 1981, through December 31, 1981.

On December 30, 1981 the California Public Utilities Commission (CPUC) issued Decision 93892 in response to the SDG&E 1982 General Rate Case. That decision provided $6,631,000 in rates for SDG&E's share of Project expenses in 1982, which was the requested amount.

The agreement between the State of California and SDG&E to assign approximately 1.7 percent ($2 million) of the Project's cost to the State was signed by the State in November. However, approval of the agreement by the State Finance Agency has been withheld, pending appropriation of the funds by the State Legislature. It is expected the agreement will be in effect by July 1982.

Negotiations with Union Oil on the heat sales contract continued throughout the quarter. A price formula was agreed upon on November 25, 1981, which allowed SDG&E to demand brine for the plant over its design operating range.

In order to meet the requirements of the Imperial County Conditional Use Permit, emergency back-up strobe lights were installed on the Heber meteorological tower. Environmental monitoring continued at the plant site.

In the area of plant design, system process descriptions and P&IDs were reviewed for completeness of process features and mechanical details. Also, detailed engineering was performed on the electrical one-line metering and relaying diagram at Fluor. With regard to availability/reliability engineering, Pickard, Lowe & Garrick issued a revision to

their study on the reliability and maintainability of the heat exchangers and condensers. In January, PL&G is expected to issue the first draft of its instrumentation and control system study.

INTRODUCTION

The scope of the Heber Binary Project is to design, construct, and operate a commercial-size, binary cycle geothermal power plant at the Heber reservoir for a two-year demonstration period. The goal of the Project is to demonstrate the technical and economic feasibility, as well as the environmental acceptability, of geothermal power generation using the binary process. Our work plan for the Project consists of four major tasks, or Work Breakdown Structure (WBS) elements (see Figure 3), that are described below:

WBS 1.1 - WELLS AND FLUID PRODUCTION AND INJECTION SYSTEMS

Primary responsibility for this task has been assigned to the heat supplier. The task consists of well drilling, the construction of surface facilities for geothermal fluid production and injection, including the brine return pipeline, and operation of the field facilities to support plant operation.

WBS 1.2 - POWER PLANT DESIGN AND CONSTRUCTION

This task consists of the work by SDG&E, the architect/engineer, and the construction manager to manage the design, procurement, construction, and start-up of the power plant systems and the associated switchyard and distribution system. The task includes obtaining necessary permits, associated monitoring, design, procurement, construction, start-up, and project management activities.

WBS 1.3 - POWER PLANT DEMONSTRATION

This task consists of the work by SDG&E to operate the power plant for a two-year period to achieve the basic objectives of the Project. The task includes services, repairs, facilities, overhaul, cleaning, consumables, testing, spare parts, and the tools necessary to operate the plant in a safe and reliable manner.

WBS 1.4 - DATA ACQUISITION AND DISSEMINATION

This task consists of the work by SDG&E in gathering, reducing, evaluating, and reporting on reservoir and plant performance data.

The WBS will serve several functions. It divides the work into discrete and manageable work packages which, taken in the aggregate, will constitute Project implementation. To some extent, it will dictate organizational lines, and will be an important management tool. It provides a method of accounting for all work that must be performed, and is the basis for manpower loading and scheduling. In addition, it will be used for cost and schedule control and progress audit.

The following describes each subtask objective and status to date.

WBS 1.1
WELLS AND FLUID PRODUCTION AND INJECTION SYSTEMS

WBS 1.1.1 - DESIGN AND CONSTRUCTION

OBJECTIVE:

This WBS element will be performed and funded entirely by the heat supplier. It will include work to design, build, and test production and injection systems necessary to deliver fluid from the reservoir to the power plant and, after use, return the fluid into the reservoir.

STATUS:

SDG&E met with Union Oil on October 22, 1981, in Los Angeles and on October 30 in San Diego to continue heat sales agreement negotiations. A revised draft contract was distributed on October 27. The primary issue that remained to be resolved was price.

A technical meeting was held among representatives of SDG&E, Fluor, and Union on October 8. As a result of this meeting, a follow-up meeting was set to explain the plant details and optimization to Union.

Two meetings were subsequently held with Union on November 6. The first meeting dealt primarily with technical matters and was attended by eight of Union's staff. Union advised the Project that reservoir temperatures could decline below 338°F to around 325°F. They asked SDG&E to explain the ability of the binary plant to respond to lower temperatures at a follow-up meeting. Following the technical meeting, discussion was again held on contract language.

Another meeting was held on November 23 in Los Angeles among representatives from Union, SDG&E, and Fluor. Fluor described what could be done with the plant to continue operation below 338°F. Union's representatives seemed to find Fluor's response satisfactory. Again, contract language was worked on after the technical session. Union was advised their price was too high; they were asked to seriously consider reducing the price and paying 50% of the field O&M costs.

Contract negotiations resumed in San Diego on November 25. SDG&E agreed upon a price formula which allowed the plant to demand brine over its design operating range. The formula provided a mechanism for operating below 338°F, but imposed no obligation unless agreed to by the parties at that time. Union offered a small reduction in price, which did not even fully reflect the initial decrease in their supply obligation. They refused to share any of field O&M costs during the demonstration period.

A revised draft of the heat sales contract was completed December 3. This draft was circulated within SDG&E for review. Initial review is expected to be completed by January 15, 1982.

SDG&E's Fuel Planning and Forecasting & Analysis Sections completed their economic analysis of the contract on December 9. Their economic analysis was presented to SDG&E's Geothermal Advisory Group on December 14. This analysis has identified a price which will give SDG&E a reasonable chance of operating the Plant at SDG&E's avoided cost following the demonstration period.

WBS 1.2
POWER PLANT DESIGN AND CONSTRUCTION

WBS 1.2.1 - ENVIRONMENTAL STUDIES AND PERMITS

OBJECTIVE:

The objective of this WBS element is to obtain the necessary permits and provide enviromental studies and monitoring to facilitate plant design and ensure compliance with government regulations for plant construction and operation.

STATUS:

Groundwater level monitoring continued at the Heber site over the entire quarter. A letter detailing well locations and previous measurements was sent to Fluor.

Also, temperature monitoring continued at the New River. Temperature monitors containing data for part of August and all of September, October, and November were removed and sent to the consultant for data reduction. New monitors were installed each month to replace those that were removed.

A proposal for installing the emergency back-up strobe lights on the Heber meteorological tower was approved. The lights were subsequently installed, thus fulfilling the requirement in the Imperial County Conditional Use Permit.

WBS 1.2.2 - POWER PLANT ENGINEERING, DESIGN, AND PROCUREMENT

OBJECTIVE:

The objective of this WBS element is to prepare engineering and design specifications and procure major equipment to build a nominal 65 Mw (gross) electrical geothermal power plant. Special studies also will be accomplished whenever required.

PROCESS/MECHANICAL ENGINEERING

System process descriptions, P&ID's, and equipment specifications were reviewed for completeness of process features and mechanical details. Letters were prepared and issued to Fluor which contained SDG&E's findings and recommendations as coordinated with other disciplines. Significant recommendations included:

Hydrocarbon System

a. Install turbine exhaust piping that will permit part-load operation of plant with one condenser out of service.

b. Make provisions to: (1) bypass booster pumps to allow warm-up of heat exchanger trains with condensate pumps; (2) bypass knockout drum during start-up; (3) allow turbine warm-up; (4) isolate condensers, turbine, and major pumps; (5) have drains and vents for proper filling, draining, and collection.

c. Provide control of condensate and booster pump recirculation for minimum flow protection.

d. Provide condenser hotwell level control and operability.

e. Provide hydrocarbon filtering.

Hydrocarbon Unloading and Recovery System

a. Install modified piping and pumping to accomplish liquid hydrocarbon recovery.

b. Determine purge gas requirements for safety of personnel on entering vessels.

Cooling Water and Service Water Systems

a. Install two 100 percent service water heat exchangers with the provisions for isolating a fouled heat exchanger and placing the standby in service.

Brine Collection System

a. One brine collection/separator vessel should be used rather than two on the basis of reduced maximum brine flow.

b. The brine vapor should be discharged to a small stack rather than the large flare stack to minimize flare stack diamater.

c. The brine collection/separator tank should be reduced in size from that initially specified on the basis of reviewed rinse flow, liquid de-entrainment, and pressure of the system.

Water Treatment and Distribution System

a. Specific recommendations related to process design were to provide capability to alternate ponds for silt collection for operational flexibility, pump control and protection, chemical concentration, and dosage demand. In addition, several recommendations were made to provide valving for isolation of equipment.

Plant and Instrument Air System

a. Provide for cross-connecting the plant and instrument air compressors for effective backup of air supply from one system to the other.

Following this, SDG&E engineers met with Fluor process and mechanical engineers to discuss their resolution/action on these recommendations. In general, all critical and major recommendations were accepted and are being incorporated in the P&ID's.

ELECTRICAL AND I&C ENGINEERING

Fluor detailed engineering was in progress on the electrical one-line metering and relaying diagram. Technical specifications for the main transformer and induction motors were reviewed and comments sent to Fluor. Also, technical specifications for the generator breaker and segregated phase bus were issued for SDG&E review.

SDG&E's Transmission Planning group continued work on IID system technical studies based on the revised electrical one-line. Additional stability studies were performed to determine the effect on IID's system of maintaining brine production well and return pump loads following a full-load trip.

Preliminary switchyard plan drawings were developed by Fluor. Work continued on physical arrangements for the switchgear room and building electrical designs. An interface meeting was scheduled for January 13, 1982, to primarily address switchyard design. The technical studies related to motor starting transient voltage dips continued, but were not completed in time for discussion at this meeting.

The central control system specification was issued by Fluor for SDG&E review. A draft of SDG&E comments was prepared for discussion with Fluor I&C engineers at a meeting scheduled for January 7.

CIVIL/STRUCTURAL ENGINEERING

A review was completed of the architectural design criteria and building arrangement drawings. Comments were transmitted to Fluor for incorporation. Also, a meeting was held with Fluor on November 12 to discuss SDG&E comments on building arrangements. All comments were resolved in the meeting.

EQUIPMENT SPECIFICATIONS

A meeting was held between SDG&E and Fluor to discuss Fluor's resolution on SDG&E's recommendations for the plant and instrument air compressors and brine return pump specifications. The air compressors will be single stage rather than two stage, with refrigerant dryers, not dessicant dryers.

The brine return pump variable-speed operational requirements were better defined; however, protection of the pumps on loss of production well pumps is being evaluated by Fluor. Tandem, double seals with purge water will be used on the pumps.

A review was completed on the pressure filter specification. A revised piping and control valve scheme was devised which will provide the capability to backwash each filter unit (two total) independently without interrupting the operation of the filter that is in service.

A review of the heating, ventilating, and air conditioning (HVAC) design criteria was completed.

In addition, SDG&E reviewed the following equipment specifications and issued letters containing multi-discipline findings, comments, and recommendations to Fluor:

1. Hydrocarbon Booster Pumps
2. Water Treatment and Distribution Pumps
3. Service Water Pumps
4. Sump Pumps
5. Chemical Injection Packaged Systems
6. Main Circulating Water Pumps
7. Cooling Tower

SDG&E engineers attended individual meetings with each turbine generator vendor to obtain clarification of specific proposal items. Following these series of meetings, two additional meetings were held with Fluor to give them specific recommendations on their approach in evaluating the turbine generator proposals. This level of support was required to meet the December 21 deadline for SDG&E concurrence with the Fluor turbine generator vendor selection.

AVAILABILITY/RELIABILITY ENGINEERING

Pickard, Lowe & Garrick (PL&G)

Amendment No. 1 to the Availability Enhancement Contract between SDG&E and PL&G was forwarded to PL&G for signature in October. This amendment provides for a change in compensation and tasks.

Amendment No. 2 to the same was submitted to SDG&E's Legal Department for approval as to form. This amendment provides for a transfer of Task E from the first milestone to the second milestone. This task, which originally involved the development of a prototypical equipment test program, has been redirected toward confirmation of equipment reliability, using vendor data. Since the first fee milestone was predicted on completion of this task in October and the required vendor data will be tied to a procurement schedule which will extend into 1982, the modification was made to allow PL&G to continue on track with their collection of fee. This amendment has no effect on cost.

The "consent package" on the PL&G contract required by the DOE Cooperative Agreement was submitted informally to DOE. The premise that the selection was made by competition was not demonstrated in DOE's opinion. A meeting was requested for the first week in January.

PL&G issued a report on failure rate probability distributions and mean time to repair estimates for the brine/hydrocarbon heat exchangers and hydrocarbon condensers. This report is the first in a series of reports concerning uncertainty analysis relative to the unavailability of critical equipment.

PL&G also issued a revision to their study on the reliability and maintainability of the heat exchangers and condensers. They also completed a review of the initial availability data submitted by the potential turbine generator vendors. The information will be analyzed and incorporated into future availability assessment studies. In January, PL&G is expected to issue: (1) the preliminary report on the assessed availability of the definitive design based on the initial P&ID's and (2) the first draft of the instrument and control system study.

PROCUREMENT

SDG&E's equipment purchase agreement was revised to develop a standard equipment contract for the Heber Project. This has been reviewed in-house, and has been forwarded to Fluor for inclusion in the standard bid package.

A meeting was held with Fluor on October 30, 1981, to discuss issues relative to major commercial and technical quotations for turbine generators. A schedule was developed for evaluating bids. Also discussed were methods for obtaining DOE consent on the contract for the turbine generators, and procedures for processing additional procurements for the condensers, heat exchangers, pumps, etc.

WBS 1.2.3 - POWER PLANT CONSTRUCTION

OBJECTIVE:

The objective of this WBS element for Phase I is to provide construction input to the architect/engineer during the design of the power plant to allow construction in an orderly, cost-effective manner. In Phase II, efforts will focus on actual construction of the geothermal binary power plant.

STATUS:

A draft of the proposed construction manager contract was forwarded to Dravo Utility Constructors, Inc. (DUCI) in mid-October, and a contract negotiations meeting was held on October 28. Agreement was reached between the two parties and the contract became effective December 1, 1981.

A draft of the DOE consent package for the DUCI contract was generated, using the PL&G package as a model. This draft was reviewed by an outside consultant in early November. In addition, SDG&E requested that DOE/SAN perform a pre-award audit of DUCI.

A purchase order to allow DUCI to start work needed for the Definitive Estimate was issued in early December. A meeting was held on December 10 at Fluor in which DUCI revealed their proposed breakdown of the construction work packages, the scope of each work package, and the construction schedule based on a November 1982 construction start date. Fluor will now evaluate their ability to meet this proposed construction schedule in terms of engineering and procurement support and respond in a meeting to be held in mid-January. This meeting also revealed the necessity of DUCI to perform work outside the scope of the newly issued purchase order, and the decision was made to execute the construction manager contract before DOE consent is received. The contract was sent out for Sponsors' Management Committee approval and contract execution is expected in early January.

WBS 1.2.4 - POWER PLANT START-UP

OBJECTIVE:

The objective of this element is to start-up, check-out, and test the completed power plant. This effort shall include the necessary personnel training and the correction of equipment or system problem areas identified during plant start-up.

STATUS:

During this period, in-house work continued on the Start-up Planning and Procedures Manual.

WBS 1.2.5 - PROJECT MANAGEMENT

OBJECTIVE:

The objective of this WBS element is to provide Project management by establishing interfaces and control between SDG&E, the heat supplier, the architect/engineer, the construction manager, other subcontractors, and the Sponsors; defining schedules and reporting progress based on actual accomplishments; finalizing procedures for management, engineering, start-up and design, construction cost and scheduling, accounting, procurement, and reporting; providing cost control by combining estimating, recording, reporting, analyzing, forecasting, and trending of cost data; monitoring work package budget estimates and reporting progress; negotiating and administering Project agreements and contracts; coordinating legal, public information, geothermal heat supply, and procurement activities; and preparing, reviewing, and publishing information regarding the technical status, cost, and schedules of the Project.

STATUS:

COOPERATIVE AGREEMENT MODIFICATIONS

Two modifications to the Cooperative Agreement between DOE and SDG&E were executed in December. Modification A003 provided $150,000 for Radian, Lawrence Berkeley Laboratories, and Battelle Northwest Laboratories to continue technical support of the Project. Modification M004 was an extension of Phase 1 to August 31, 1982.

In addition, a modification proposal was submitted to the Department of Energy on December 29. The proposal increased the scope of Phase I by including construction management, procurement of major equipment, increasing committed amount for the PL&G contract, and allowing for SDG&E efforts on data acquisition, all through August 31, 1982. The proposal was packaged in two parts: Part I was the Proposal and Part II was the cost documentation to the Proposal. Presently, it is being analyzed by the DCAA auditors and DOE technical parties.

The effort on preparing the Definitive Estimate proposal is underway, as a "kick-off" meeting was held December 10, 1981, at Fluor. The meeting included Fluor, DUCI, and SDG&E personnel. In-house effort has also been initiated, and standarized estimating forms have been prepared. The Definitive Estimate proposal is scheduled to be submitted on or before April 30, 1982.

STATE FUNDING

The agreement between the State of California and SDG&E to assign approximately 4.3 percent of the ownership interest and approximately 1.7 percent of the cost responsibility of the Heber Binary Project was signed by the State in November and forwarded to the State control agencies for approval. Approval of the agreement, however, has been withheld by the

State Finance Agency until the State Legislature votes the funds to fulfull the agreement. An appropriation for such funds has been included in the Governor's budget submittal. It is expected the agreement will be in effect by July 1982.

The draft agreement between IID and SDG&E to assign 0.5 percent of the ownership interest and 0.2 percent of the cost responsibility of the Heber Binary Project from IID to SDG&E has been awaiting review by IID's legal counsel. There are no outstanding issues and an executable contract should be ready in January 1982. The agreement is not expected to be signed until the effective date of the State of California/SDG&E Assignment is more imminent.

GENERAL

On December 30, 1981, the CPUC issued Decision 93892 in the SDG&E 1982 General Rate Case. That decision provided $6,631,000 in rates for Project expenses in 1982--the amount requested by SDG&E. By February 26, 1983, SDG&E is required to file an Advice Letter showing the status of the Heber balancing account recorded expenditures, and provide justification for 1983 expenditure levels. The $6,631,000 authorized in rates for 1982 will be adjusted accordingly (after hearings if necessary) for 1983.

The Environmental Program Plan, Health and Safety Management Plan, and Availability Enhancement and Reliability Plan were delivered to DOE and other Project participants in early October. The Quality Assurance Management Plan draft was reviewed by the SDG&E Task Force members; the final draft was submitted to Project Managment.

The Project was visited by Mr. Ed Dickenson, DOE/SAN Audit Manager, on December 3. This was a meeting arranged by DOE to insure themselves that the DCAA audit staff is performing audits of the Project on a timely manner and in the DOE interest. Mr. Dickenson was introduced to all Heber Project Management staff who may have reason to be contacted by DOE auditors.

The Sponsors' Technical Committee and Sponsors' Management Committee meetings were held in San Diego on November 4 and 5, respectively.

Delays in completing the existing computer risk model are causing a delay in releasing the request for bids on the risk analysis. Schedule impact is being evaluated. Obvious coding errors have been corrected and a request for bid is expected to be released in January 1982.

WBS 1.3
POWER PLANT DEMONSTRATION

WBS 1.3.1 - DEMONSTRATION, OPERATION, AND MAINTENANCE

OBJECTIVE:

The objective of this WBS element is to demonstrate reliable and economic geothermal power generation.

STATUS:

On November 2-4, representatives of SDG&E visited the Raft River Geothermal Project located at Malta, Idaho. The purpose of the visit was to gain first hand knowledge in the areas of operation and maintenance that can be used in the systems design and operating procedures of the Heber plant. The trip proved to be very beneficial. Time was spent observing the plant operate in the turbine bypass mode, and also reviewing the plant's process, operating and maintenance procedures, and control systems. In addition, several of Raft River's problems were assessed and documented in the areas of design and maintenance. The Project will be very attentive to these problems as the Heber design progresses.

WBS 1.4
DATA ACQUISITION AND DISSEMINATION

WBS 1.4.2 - DATA ACQUISITION, ANALYSIS, AND DISSEMINATION

OBJECTIVE:

The overall objective of the data management effort is to acquire, store, evaluate, and report Project data to the energy generation industry and to other parties interested in liquid-dominated geothermal power plant performance. The intended result is to stimulate commercial development of hydrothermal resources in the United States.

STATUS:

A very fruitful Data Acquisition System (DAS) Committee meeting was held on October 1 resolving many of the unanswered questions concerning the DAS. Magnetic tape will be the output medium, and a steady-state five minute recording interval will be used. A bulk memory device, capable of storing several hours of data sampled once a second, will be used to record process transients. Fluor is currently involved in an economic analysis on the impact of data residence time on the bulk memory device. A list of DAS requirements and a finalized Point List will be forwarded to Fluor in November.

A draft of the Data Acquisition System requirements were reviewed by the DAS Committee members. Following the incorporation of members' comments, the finalized DAS requirements will be forwarded to Fluor.

A meeting was held on November 13 between SDG&E and DOE in which Battelle, Pacific Northwest Laboratories, made a presentation on its proposed corrosions monitoring plan. The plan combined manual analysis of fluid and material samples with on-line readouts of fluid leadage, corrosion rates, and corrosion condition in the brine and cooling water. The majority of the on-line data will be input to the DAS with the leakage detection information providing a control room alarm.

FIGURE 1

HEBER BINARY PROJECT
ARTIST'S RENDERING

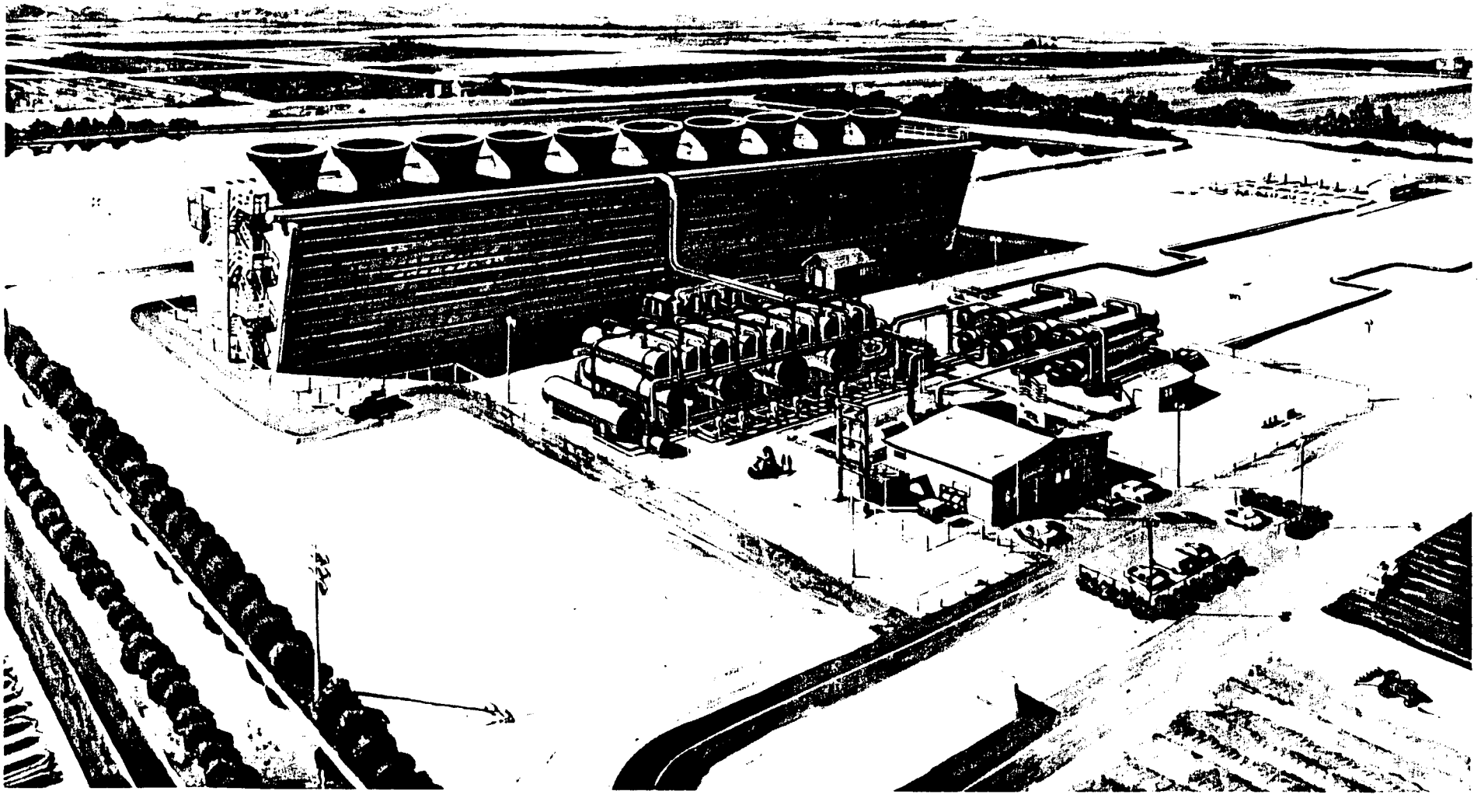

FIGURE 2
HEBER BINARY PROJECT
PLANT LOCATION

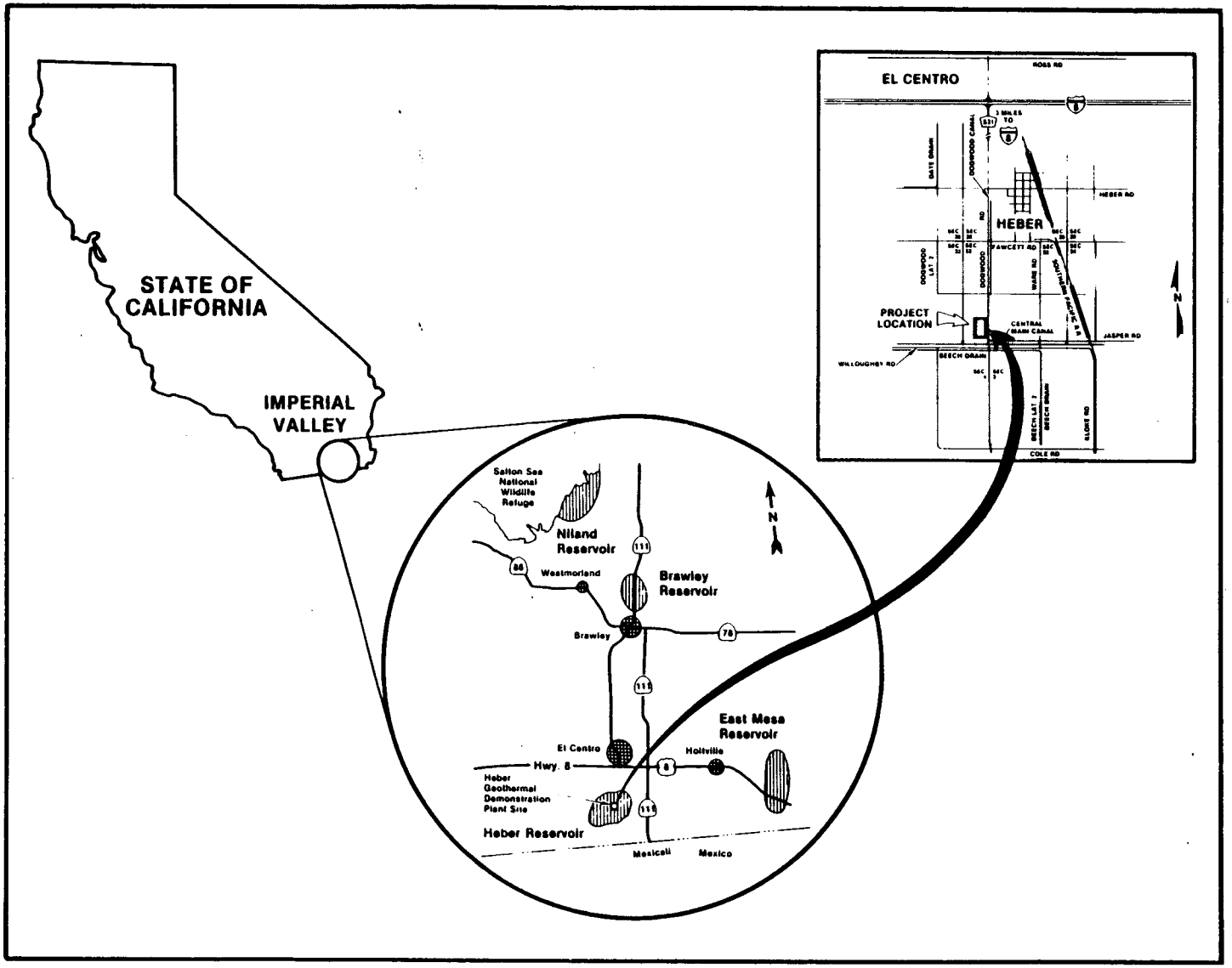

FIGURE 3
HEBER BINARY PROJECT
WORK BREAKDOWN STRUCTURE