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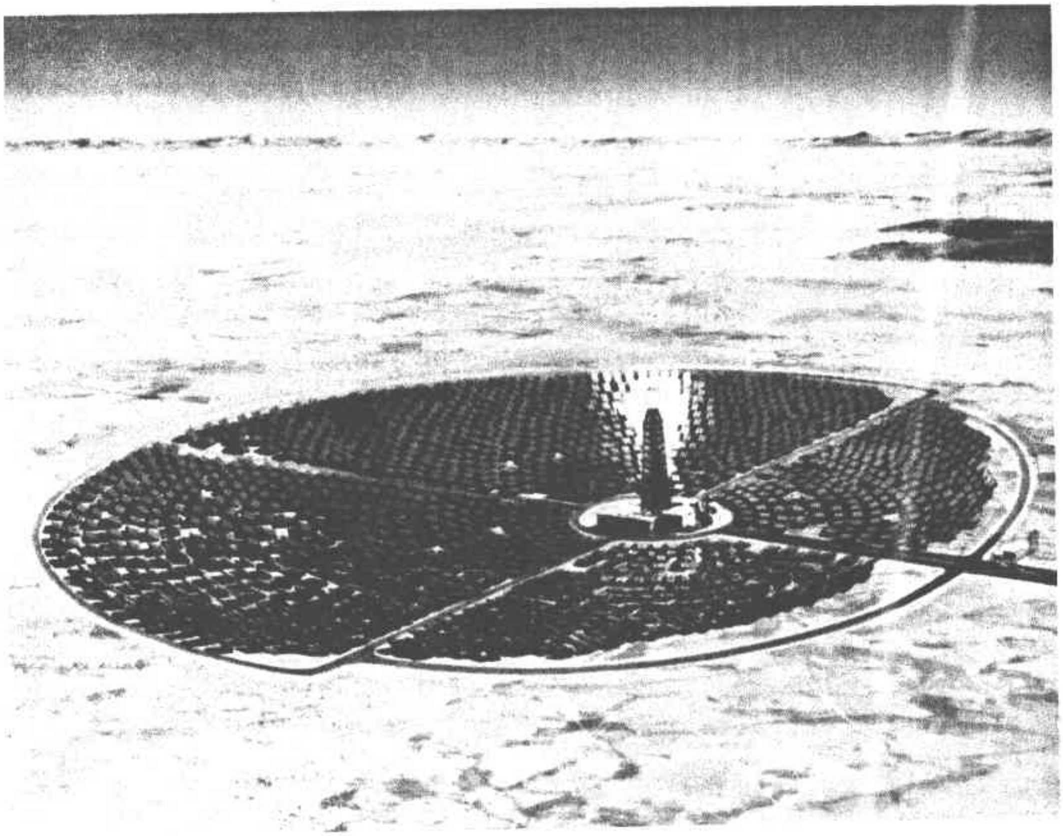
FINAL
ENVIRONMENTAL IMPACT ASSESSMENT/ENVIRONMENTAL IMPACT REPORT

10 MEGAWATT SOLAR POWER PILOT PLANT



June, 1978

Participants:
United States Department of Energy
Southern California Edison Company
Los Angeles Department of Water and Power
California Energy Resources Conservation and Development Commission

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LIST OF TERMS AND ABBREVIATIONS

ALBEDO	- Ratio of the radiation reflected by a surface to that incident on it
AT&SF	- Atchison, Topeka & Santa Fe
BLM	- Bureau of Land Management
BTU/SEC	- British Thermal Units per second
CEQA	- California Environmental Quality Act
CO	- Carbon Monoxide
Commission	- California Energy Resources Conservation and Development Commission
County	- San Bernardino County
DOD	- Department of Defense
DOE	- United States Department of Energy
DSE	- DOE's Division of Solar Energy
DWP	- Los Angeles Department of Water and Power
EIA	- Environmental Impact Assessment
EIR	- Environmental Impact Report
EIS	- Environmental Impact Statement
EPGS	- Electric Power Generating System
ERDA	- Energy Research and Development Administration
g	- acceleration of gravity
gpd/ft^2	- gallons per day per square foot
gpm	- gallons per minute
insolation	- Downward-directed solar radiation
kWh	- kilowatt hour
kW/m^2	- kilowatts per square meter
$kWh/m^2/day$	- kilowatt hour per square meter per day

LISTS OF TERMS AND ABBREVIATIONS

mm	-	modified mercali
mph	-	miles per hour
MW_e	-	Megawatt Electric
MW_t	-	Megawatts Thermal
NEPA	-	National Environmental Policy Act
NO_2	-	Nitrogen Dioxide
NO_x	-	Oxides of Nitrogen
NSF	-	National Science Foundation
OSHA	-	Occupational Safety and Health Administration
Pilot Plant	-	10 MW_e Central Receiver Solar Pilot Plant
PON	-	Program Opportunity Notice
ppb	-	parts per billion
ppm	-	parts per million
psf	-	pounds per square foot
SBCM	-	San Bernardino County Museum
SCAQMD	-	South Coast Air Quality Management District
SCE	-	Southern California Edison Company
SO_2	-	Sulfur Dioxide
SRE	-	Subsystem Research Experiment
STE	-	Solar Thermal Electric
STTF	-	Solar Thermal Test Facility
UP	-	Union Pacific
USFS	-	United States Forest Service
Utility Consortium	-	SCE, DWP & Commission

I. REPORT SUMMARY

A. Project

The project is the construction of a 10 Megawatt, Solar Thermal Electric, (STE) Pilot Plant in the Mojave Desert of California. It's purpose is to research, over a 5 year period, the technologic, economic and environmental feasibility of future STE utility application. The Pilot Plant will consist of a field of 2300 collector mirrors (heliostats) that will focus solar radiation on a boiler at the top of a 325' tower for the purpose of producing steam to drive a conventional turbine generator. The plant will require approximately 100 acres of a 130 acre site owned by Southern California Edison (SCE). It will be located 1 mile east of SCE's existing Coolwater Generating Station, 10 miles east of Barstow (120 air miles northeast of Los Angeles).

Project participants are the U.S. Department of Energy (formerly the Energy Research and Development Administration), SCE, the Los Angeles Department of Water and Power and the California Energy Resources, Conservation and Development Commission. This combined Environmental Impact Assessment/Environmental Impact Report was prepared by San Bernardino County with assistance from the project participants as requested for the purpose of fulfilling DOE's and the County's environmental review responsibilities.

B. Environmental Setting

The site is located on a flat alluvial plain adjacent to the normally dry Mojave River bed. Alfalfa was previously raised on the parcel, therefore vegetation primarily consists of pioneering native and exotic species. Surrounding wildlife habitat has been altered due to farming, rural and industrial development, and utility and transportation rights-of-way. The area's groundwater basin is in an overdraft condition. The region's low annual precipitation and high intensity solar radiation offer distinct advantages to Pilot Plant siting.

C. Land-Use Issues

The Pilot Plant's location adjacent to SCE's existing power plant eliminates most of the land-use impacts normally associated with utility siting. The proposed zone change from DL to M2 could facilitate longer term utility development on the parcel after the Pilot Plant is dismantled.

D. Energy Benefit

The Pilot Plant will primarily be used to research STE technology, therefore it will not generate significant amounts of electrical power for the regional utility grid system. Its major contribution will be data for use in future solar-related commercial power plant designs and operation.

E. Summary of Major and Moderate Adverse Impacts

1. Misdirected solar radiation beams could present significant on and off-site hazards.
2. The region is subject to potentially damaging seismic activity.

3. Disturbed soils will be subject to wind erosion, resulting in fugitive dust. Existing ambient air pollutants could absorb and diffuse incoming radiation, thereby affecting plant efficiency. Climatological factors will affect plant operation.
4. Chemical additives in heliostat wash water could effect soil, vegetation and wildlife in the collector field.
5. The Pilot Plant will require approximately 220 acre-feet of water per year for cooling and other in-plant uses, but will not require a net increase in SCE's historic pumping rates at the Coolwater site.
6. The Pilot Plant's contribution to the long-range utilization of STE generation could induce both beneficial and adverse impacts in the southwest relative to plant siting, land use and water consumption.
7. 100 acres of semi-productive vegetation and wildlife habitat will be removed, but the site may be revegetated. Weed growth in the collector field might hinder operation and maintenance. The receiver tower and radiation beam may present hazards to bird life.
8. The Daggett community could experience some economic advantages and disadvantages.
9. Traffic impacts will generally be minor except during peak periods. The 325' tower may be a potential hazard to off-course private aircraft.
10. Pilot Plant visibility will alter the area's aesthetic values over the short-term.

11. Surface archeological remains will be removed from the site prior to construction. Undiscovered subsurface artifacts, (if any) could be damaged.

F. Alternatives

1. Other sites in the nation and in California have been thoroughly considered by the project participants and DOE.
2. Various design concepts have been reviewed in detail.
3. Funds could be used to develop other types of solar technology.
4. No project.

G. Agency Coordination, Correspondence and Hearing Input

Unresolved environmental issues, various governmental findings, certification results and public comments will be described in the final EIA/EIR.

II. PROJECT CHARACTERISTICS

A. Introduction

On January 6, 1977, the United States Department of Energy (DOE), formerly the Energy Research and Development Administration (ERDA), selected an offer by Southern California Edison (SCE), the Los Angeles Department of Water and Power (DWP), and the California Energy Resources Conservation and Development Commission (Commission) - hereinafter referred to collectively as the "utility consortium," - to participate in the design, construction and operation of a 10 Megawatt Electric (MWe) Solar Power-Steam Generating Pilot Plant (Pilot Plant) for research and development purposes. The Pilot Plant will be constructed on a site near SCE's existing Coolwater Generating Station near Daggett, approximately 12 miles southeast of Barstow in San Bernardino County.

The Environmental Improvement Agency of San Bernardino County (the County) prepared this Environmental Impact Report (EIR) as "lead agent" pursuant to the requirements of the California Environmental Quality Act. Much of the content was supplied by SCE, DOE and the Commission. DOE will utilize this document as part of its requirements under the National Environmental Policy Act (NEPA).

This report contains project and environmental data that are relevant to the needs of reviewers and decision makers for the determination of environmental effects. Detailed project information from which this EIR is written is on file with the County and all participants and is available to the public. Most of the specific material referenced in this report is not included in the Appendix in order to reduce copying and paper costs.

B. Participants

Following is a summarized description of the project participants:

- DOE is a federal agency created by the Department of Energy Organization Act of 1977 and charged with the responsibility of implementing programs for research, development and demonstration of new energy sources and technologies. DOE became the successor to ERDA on October 1, 1977.
- SCE is Program Director for the utility consortium and is an investor-owned utility serving over 7.5 million people in a large portion of Southern California.
- DWP is a municipal utility serving a population of 2.7 million in the City of Los Angeles.
- The Commission is a state agency charged with developing state energy conservation regulations and with helping to accelerate the development of alternative electrical energy sources. The Commission is also the lead state agency in approving sites for thermal electric power plants above 50 MWe.

C. Coordination

The members of the utility consortium have entered into an agreement whereby SCE will be the Program Director. SCE will act as primary agent for:

- Performance of environmental and planning work
- Provision of plant site
- Providing the steam turbine generator facilities (non-solar portion of the Pilot Plant)
- Acquiring all required licenses and permits for the turbine generation facilities and operation of the entire plant.
- Operation and maintenance of the entire Pilot Plant
- Capital improvements and integration of the electrical generation into SCE's distribution system which is interconnected with DWP and others.

DWP will provide:

- Participation in the preparation of environmental documents and planning work as required by the Program Director
- Completion of a study of the potential use of this technology in conjunction with hydroelectric pumped storage
- An evaluation of the technology as a potential generation resource

The Commission will provide:

- Information dissemination/technology transfer services
- Funding of some small environmentally related research activities to be identified during the course of the project
- Development of expertise for evaluating future sites

DOE will provide:

- Solar Plant design
- Design, material, equipment and services to install and start the solar portion of the Pilot Plant
- Complete heliostat field (collector system)
- Complete receiver system (tower and boiler)
- Complete thermal storage system
- Complete master control system to integrate the solar and non-solar plant portions
- Obtain all necessary permits and licenses to construct the solar facilities.

D. Cost Summary

The solar portion of the plant is estimated to cost approximately $100 million, to be funded by DOE.

The turbine generator costs will be paid by the utility consortium as follows:

	Costs	Ownership[1]
SCE	$15,330,000	80%
DWP	3,490,000	20%
Commission	800,000	None

The Commission's total contribution of $800,000 over the life of the project will be utilized for services rather than a capital commitment. The total non-solar costs are $19,620,000

E. <u>Procedural Requirements</u>

The California Environmental Quality Act (CEQA) requires environmental evaluation of projects and preparation and certification of necessary documents before state and local permits can be issued. Preparation of the necessary CEQA documents requires designation of a Lead Agency. The Commission's siting authority for thermal electrical power plants is limited to facilities of 50 MW_e capacity or more. Thus, the commission has no permit responsibility for the 10 MW_e Pilot Plant.

Section 15065(d) of the California EIR Guidelines allows a group of public agencies involved in one project to agree among themselves which of them will be the Lead Agency for EIR preparation. On August 4, 1976, a meeting was held in Sacramento to resolve the Lead Agency issue. Attending the meeting were representatives from: the Energy Commission, the California Public Utilities

Commission, the Governor's Office of Planning and Research, the Los Angeles Department of Water and Power, the Department of Water Resources and the County of San Bernardino. At this meeting, it was agreed that the County would be the Lead Agency for this Project because it has responsibility for issuing the principal permits.

Under the provisions of NEPA, the use and administration of federal funds by DOE in connection with the proposed Pilot Plant requires the preparation of an environmental assessment. During discussions among the project participants, San Bernardino County and DOE, it was agreed that DOE would participate in the preparation of the County's EIR and use it as an Environmental Impact Assessment (EIA) for the purpose of determining the need for a full Environmental Impact Statement (EIS) under NEPA. Therefore this document is a joint EIA/EIR pursuant to DOE's and the County's respective NEPA and CEQA guidelines.

County permits include the following:

- Zone change from DL (Desert Living) to M2 (Manufacturing) which is compatible with power plant siting (Board of Supervisors).
- "Site Approval" - (Planning Commission)[2]
- Grading and building permits - (Building and Safety Department)
- Sanitation - (Environmental Health Services)
- Fire protection review - (County Fire Warden)

Because the Pilot Plant size will be less than 50 MW_e, a site certification from the State Energy Commission and a California Public Utility Commission Certificate of Convenience and Necessity will not be required.

Additional permits required from other agencies include:

- Federal Aviation Administration height variance for the receiver tower
- California Occupational Safety and Health Administration Permit for certain construction activities
- State Department of Industrial Relations - Division of Industrial Safety permit for the pressure vessels.

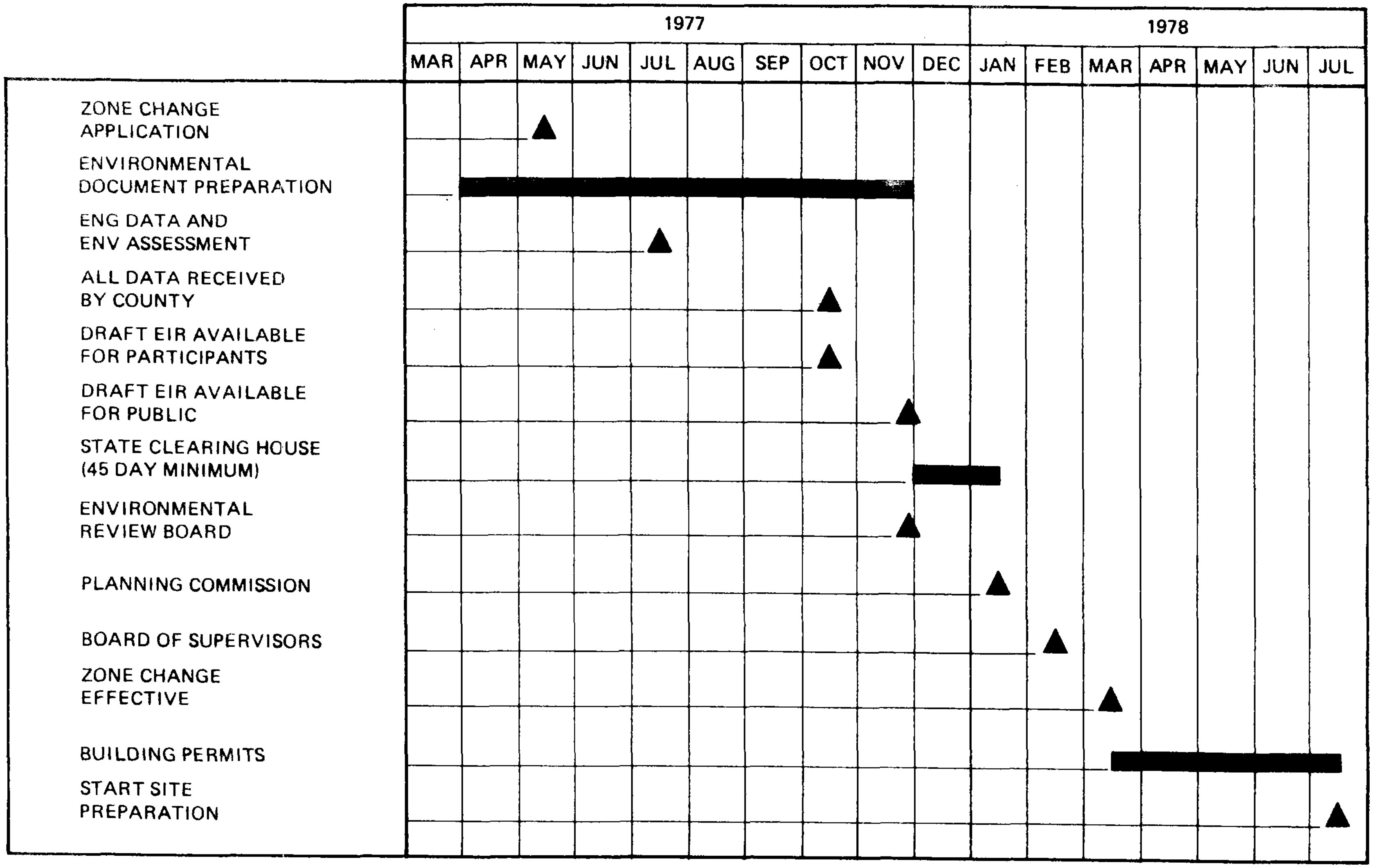
Exhibit II-1 is a project review and permit schedule.

F. Project Need, Objectives and Benefits

1. Need

Constraints on the supply, distribution and use of conventional energy sources have prompted the need for research and development of alternate energy sources including solar powered energy systems.

While fossil fuel based generation will continue to play an important role in meeting future energy needs, utilities cannot indefinitely continue to depend on fossil fuel supplies as the primary fuel feedstock for generating facilities. New technologies must be developed and implemented which will satisfy energy demands in an economically viable manner while producing the least



10 MWe SOLAR PILOT PLANT

PROPOSED PERMIT PROCESS SCHEDULE
EXHIBIT II-1

abrasive effects upon the environment. The construction of the Pilot Plant represents a combined industry/government effort to achieve this goal through research and development.

2. Objectives and Benefits

Through its Division of Solar Energy (DSE) DOE is engaged in an effort to develop the technology for the practical and economic collection and conversion of sunlight into electricity. An objective of the DSE Solar Thermal Energy Conversion Program is to demonstrate engineering understanding and identify economic and environmental factors, which may lead to subsequent purchase of Solar Thermal Electric (STE) plants by the utility industry. As a first step to verify the technical feasibility and collect the data to evaluate the economic feasibility of the solar central receiver concept, the Pilot Plant is planned for construction and operation by late 1980. Since it is a pilot project of relatively small size, it may not generate sufficiently economical amounts of electricity into the grid system to warrant its long-term use. If the full potential for research of the plant's technology is complete within 5 years of construction, it may be dismantled.

The objectives of the Pilot Plant are:

Principal

- To establish the technical feasibility of a solar thermal power plant of the central receiver type.

- To obtain sufficient development, production, and operating data to indicate the potential economic operation of commercial power plants of similar designs.
- To determine the environmental impact of solar thermal receiver plants.

Additional

- To gather operational data that can be analyzed to determine system stability and safety characteristics.
- To develop both utility and commercial acceptance of solar thermal central receiver systems.
- To stimulate industry to develop and manufacture solar energy systems.
- To enhance public acceptance and familiarity with solar energy systems.

It is not anticipated that this plant will be economically competitive with present power generation systems on either a capital or energy cost basis, nor is it anticipated that the system will be optimized for performance at the 10 MW_e level. This Plant is considered to be the first step towards development of commercial plants that will produce power economically competitive with other types of intermediate capacity power plants. The Pilot Plant's benefits would be the demonstration of technical feasibility and the hard data needed for assessment of the potential for economic competitiveness of such plants at commercial power production levels (100-300 MW_e), for peaking and intermediate-load applications.

G. Relationship to Other Solar Related Federal Projects and Programs

DOE is engaged in an effort to develop the technology for the practical and economic conversion of sunlight into electricity. As part of this effort, DOE has started construction of a 5 MW_e Solar Thermal Test Facility (STTF) located at Sandia Laboratories, Albuquerque, New Mexico. The test facility will allow component and system testing of receiver concepts, characterization of materials, and materials processing studies. The facility is planned to be operational at a reduced capability in late 1977. The 10 MW_e Pilot Plant will represent the first integration of solar system hardware on an engineering scale into a functional power generating plant whose performance and reliability will be assessed in a utility operational context.

Present DOE planning provides for a second generation of 10 MWe pilot plants of an improved design. Demonstration plants (50 to 100 MWe) may be built as an intermediate step between the pilot plants and 100 to 300 MWe commercial plants. Projects between the first Pilot Plant and the commercial scale plant may be dropped or accelerated, depending on the rapidity with which improved technologies can be developed. This Plant Plant will be constructed in order to demonstrate the concept's economic, technological and environmental feasibility. Other solar-related research and development projects are also federally and locally funded, but limited to STE application for utility usage.

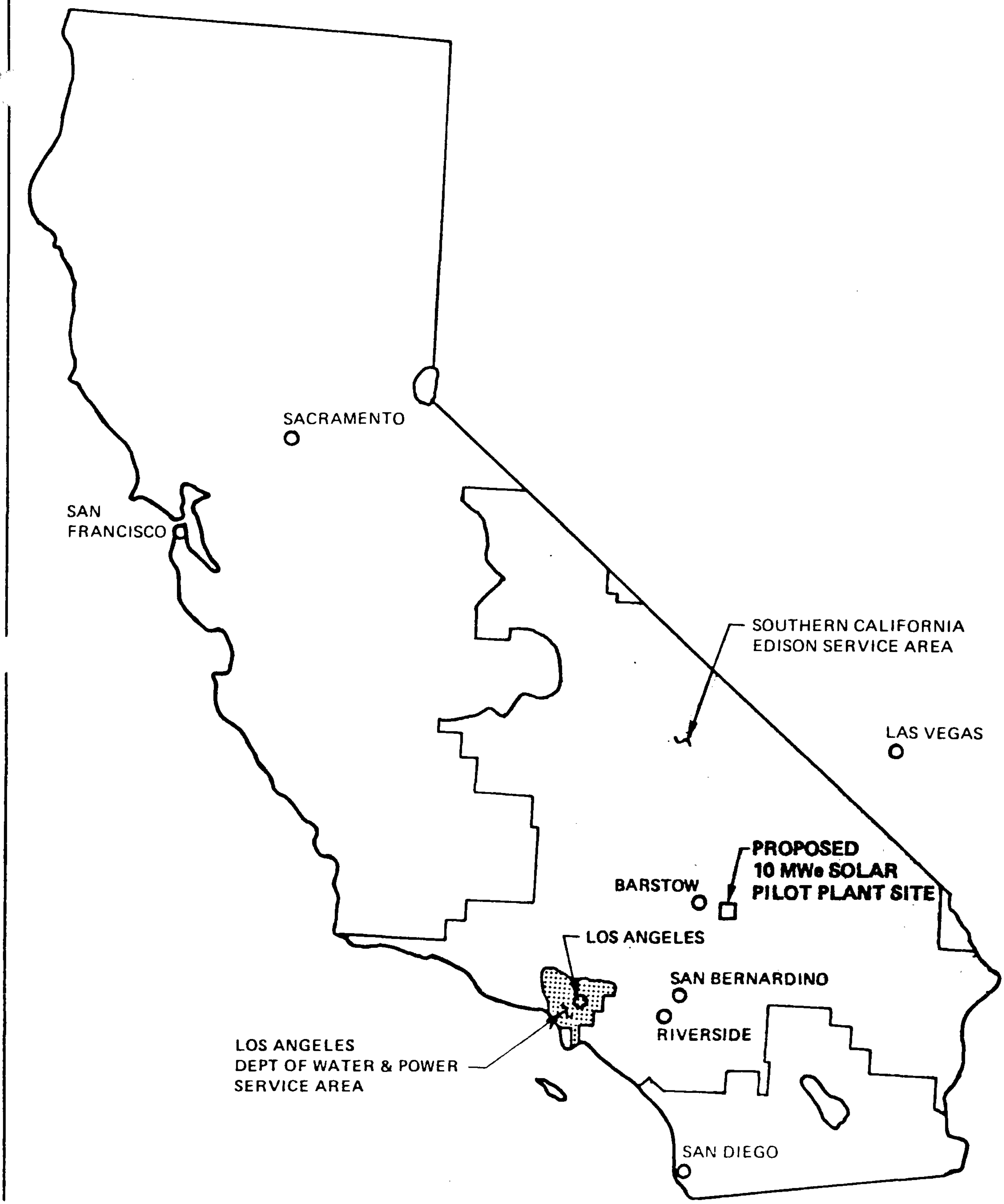
The intent of researching a mix of solar powered systems is to determine the most efficient use of solar radiation as an alternate energy source. The viability of solar powered centralized power stations that produce the electricity for indirect space cooling and water and space heating must be quantitatively compared with the efficiency of localized solar collection devices that directly convert insolation into useful heat or air cooling. Therefore, in these beginning stages of study, all solar research programs will have to be coordinated in order to determine the net benefit of certain devices or mix of devices relative to environmental factors, land-use requirements, net energy benefits and cost (See Chapter VIII - "Alternatives" - for an analysis of various options.)

H. Location

The proposed Pilot Plant will be located on SCE property near the existing Coolwater Generating Station, which is situated in the Mojave Desert in northwestern San Bernardino County, approximately 12 miles southeast of the City of Barstow and 120 miles northeast of Los Angeles (Exhibit II-2 and II-3). The facility itself will occupy approximately 130 acres of the west half of Section 13, Township 9 North, Range 1 East, San Bernardino Base and Meridian. SCE presently owns a 2337 acre site at Coolwater (as shown in Exhibit II-4 and II-4a). Exhibit II-5 is an aerial photograph depicting the proposed Pilot Plant site in relation to the existing Coolwater plant.

I. Siting Criteria

A study of nine sites was carried out by the utility consortium in selecting the proposed location near the Coolwater Generating



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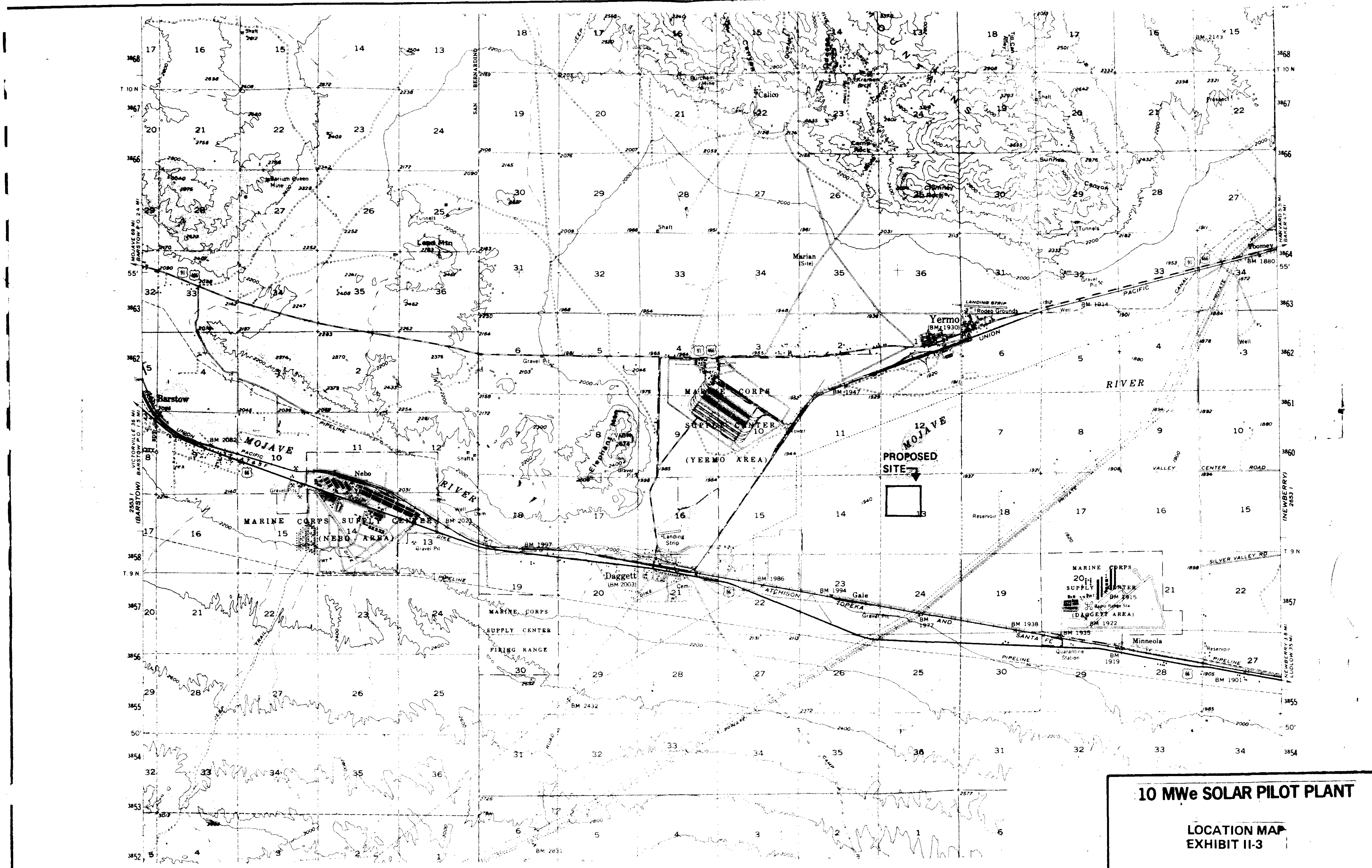
REGIONAL LOCATION OF SITE
EXHIBIT II-2



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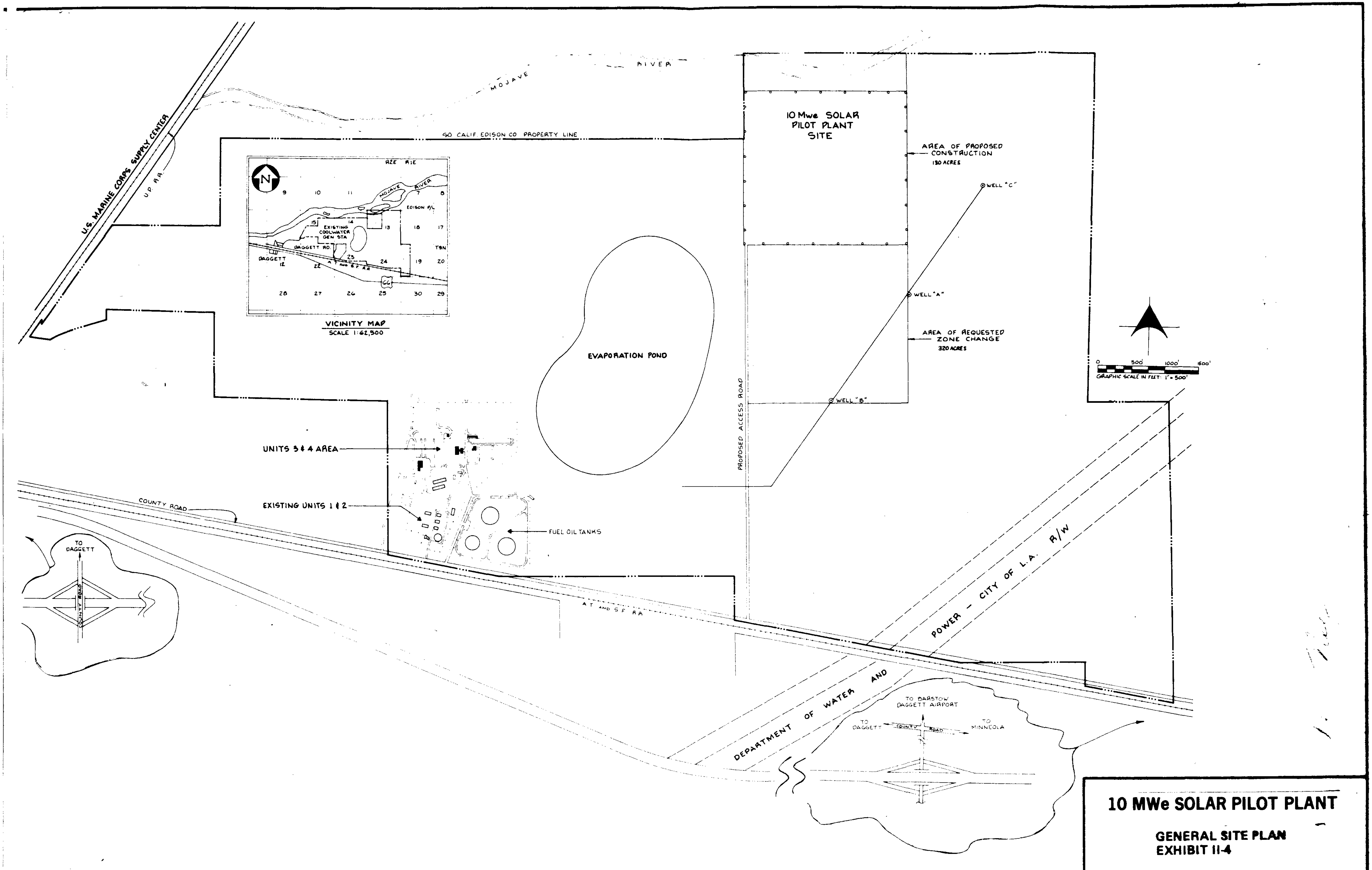
LOCATION MAP
EXHIBIT II-3



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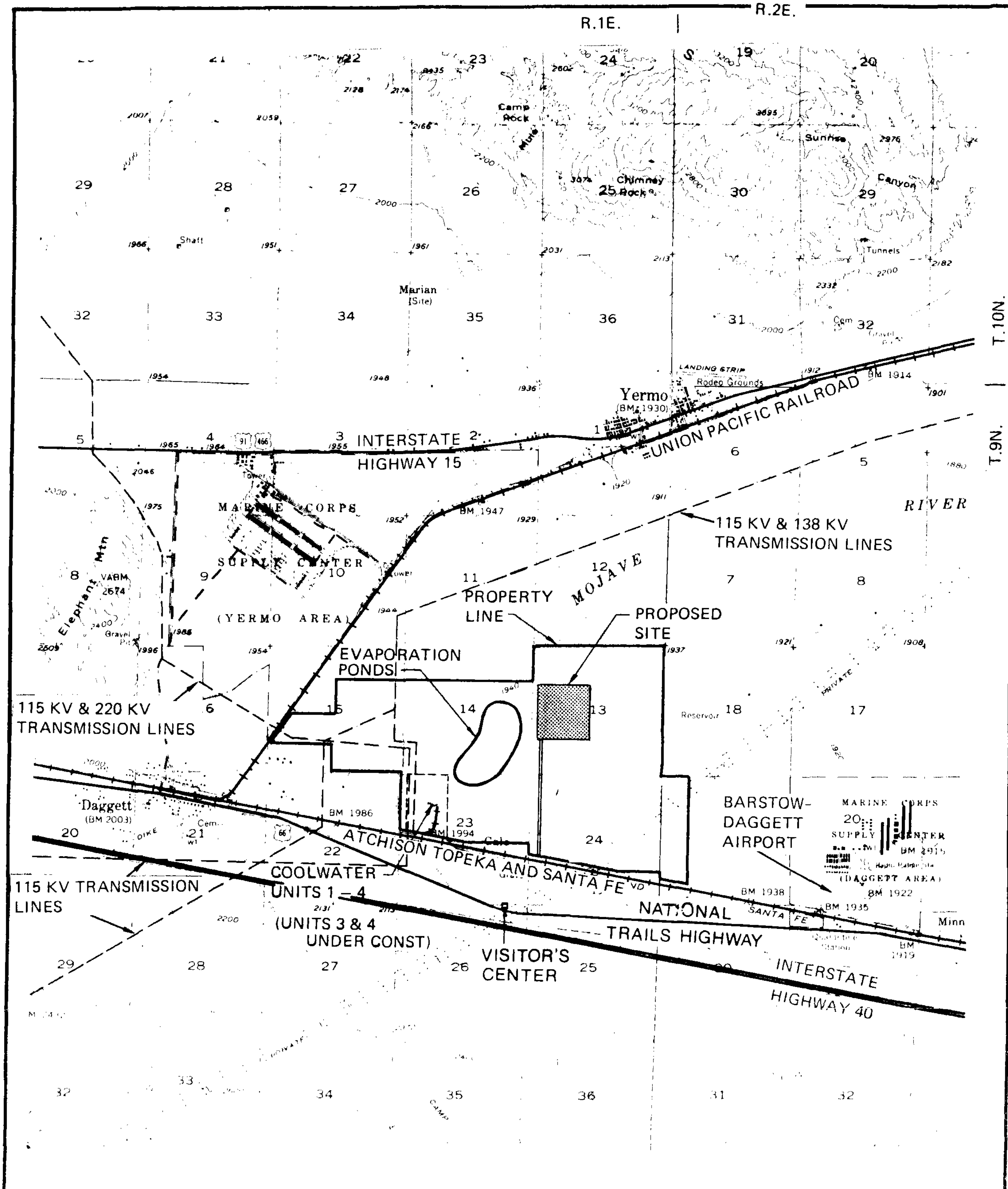
GENERAL SITE PLAN
EXHIBIT II-4



PORTION OF U.S.G.S. TOPOGRAPHIC MAP
DAGGETT, CALIFORNIA QUADRANGLE

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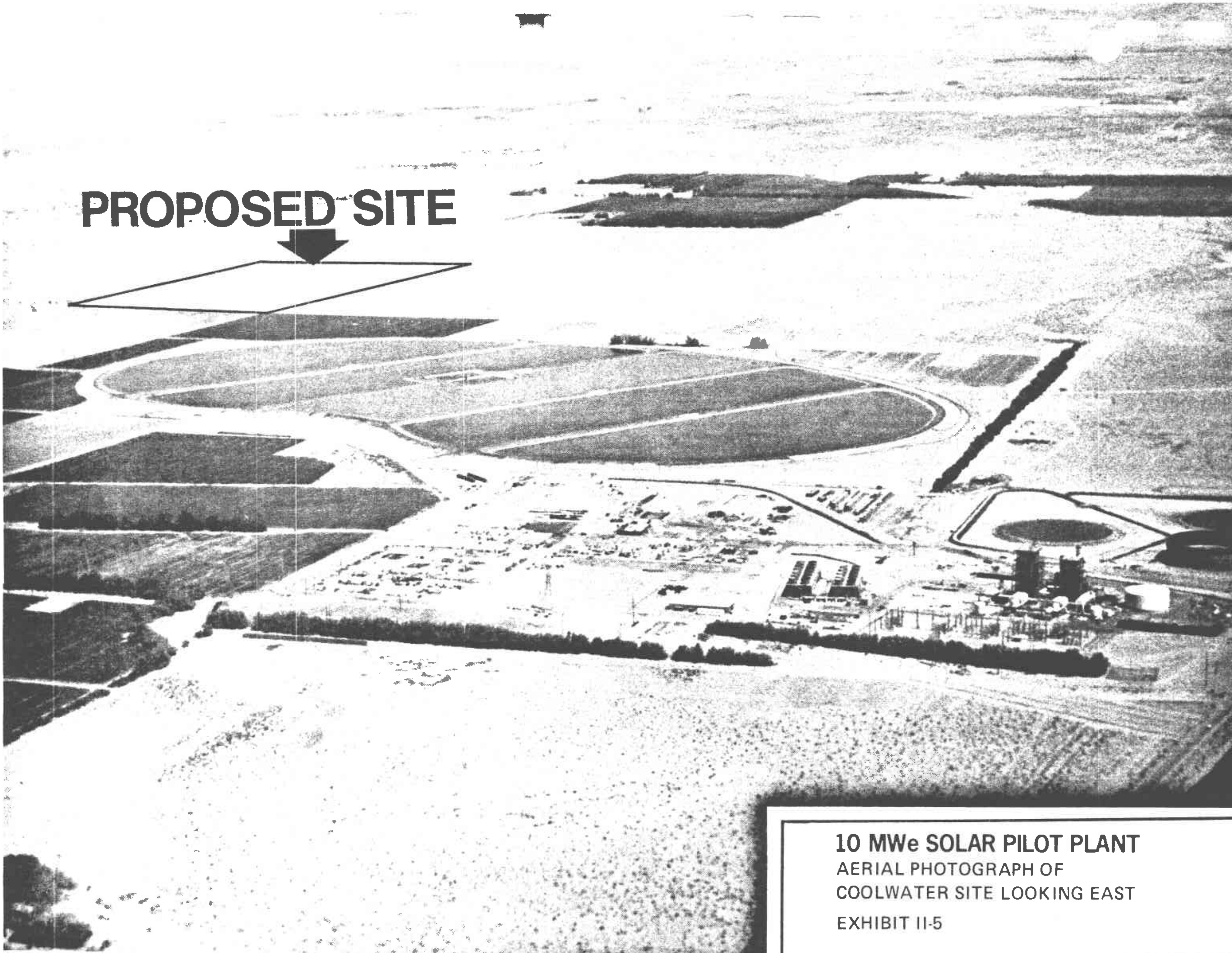
GENERAL SITE PLAN
EXHIBIT II-4a



10 MWe SOLAR PILOT PLANT
AERIAL PHOTOGRAPH OF
COOLWATER SITE LOOKING EAST

EXHIBIT II-5

Station. Criteria used in the siting study included the 13 site characteristics required in DOE's Program Opportunity Notice (PON)[3] plus five additional aspects including the effect of air quality on plant operation, utility system interface and impacts on biology, archaeology and aesthetics.

Based primarily on the criteria outlined in the PON, the Coolwater site was selected as the preferred in California. Particular attributes of the site include the following:

- The site receives high average annual total insolation at 5.8 kilowatt hours per square meter per day ($kWh/m^2/day$), which is well in excess of the 5 $kWh/m^2/day$ required in the PON.
- An adequate supply of good quality groundwater is available from currently developed resources.
- Access to the site is excellent with two Interstate highways within four miles and paved roads adjacent. There are also several railroads in the immediate vicinity, including a spur onto the site for equipment and material unloading. Additionally, a helistop will be provided to complete the means of access.
- The site is ideally located for public exposure and is 12 miles from the City of Barstow which has excellent visitor facilities.
- Site topography and seismicity are such that design and construction will require only normal considerations.

- Electrical system access will be available at the site through existing substation facilities.
- A more than adequate amount of land is available at the site.
- Environmental impacts are minimized by the fact that the site has limited vegetation and wildlife with no apparent rare and endangered species.
- The site is not within the control zone of any airport, though it is about 2-1/2 miles from the Barstow-Daggett Airport.
- Wind velocities are considered acceptable with 30 miles per hour (mph) exceeded only 2-3% of the time and 40 mph exceeded 1% or less of the time.

A detailed discussion of site characteristics and project impacts is provided in Section X.

J. Regional Setting

When viewed in a regional context, the proposed Pilot Plant site is located within a crescent of scattered urban and rural development (Exhibit II-6). From the Newberry area located ten miles east of the plant site, the band of development extends westerly along Interstate 40 to include Daggett, the plant site, and the community of Yermo located on Interstate 15 a few miles north of the plant site. Continuing to the west the band of development follows the course of the Mojave River and former U.S. Highway 66 through Barstow and Lenwood. It then tends to the south including the communities of Helendale, Oro Grande, Adelanto, Victorville, and Hesperia and then east to the communities of Apple Valley and Lucerne Valley. The interior of the crescent of development is mountainous or rough terrain. The major private land uses within the developed area are agricultural and residential, including both permanent residences and second homes (i.e., "rural retreats"). In addition, there are major government and public land holdings in the region under jurisdiction of the U.S. Forest Service (USFS), Bureau of Land Management (BLM) and Department of Defense (DOD). To the south of Apple Valley is the San Bernardino National Forest (USFS) and to the north of Barstow are the Calico Mountains with the Calico Mountains National Recreation area (BLM) and Calico Ghost Town (Country Regional Park). To the south of Daggett is the Rodman Mountains National Recreation Area (BLM). Active mining occurs in both the Rodman and Calico mountain regions. The entire eastern open end of the crescent is occupied by the Marine Corps Twentynine Palms Training Center (DOD).

The area immediately around the Pilot Plant site is sparsely populated except for the incorporated City of Barstow and the community of Daggett. This area contains mixed residential, commercial, and industrial land uses interspersed along the major highways and railroad lines. Agricultural plots, mainly alfalfa, are scattered throughout the Mojave River Valley. Employment in the study area is largely in the transportation (21.5%) and government (25.3%) sectors, primarily attributable to the Santa Fe Railroad freight classification yard and U.S. Marine Corps Supply Center. In addition, 21% of employment is in the retail trade sector of which a significant portion is tourism-related. Although agriculture is a major land use in the study area, it accounts for less than 3.0% of employment.

1. Major Cities and Towns

The population of the study area as estimated for April 1977 by the San Bernardino County Planning Department is approximately 27,900. Of this, less than 10% is located in rural areas and the remainder live in the communities discussed below. Population has been declining in the study area since 1970 and is projected to further decrease by 1980 (San Bernardino County estimates).

a. Barstow

The City of Barstow is located twelve miles west of the site at an elevation of 2,142 feet. It is the hub of three major highways: Interstate 15, Interstate 40, and Highway 58, and several major rail lines. Very few of its employed residents work outside the County (2.8%) and very few (5.8%) work in the City of San Bernardino.

The population of the city was estimated to be 16.9 thousand for 1977. Population growth to 1990 is expected to be modest, only about 1,900 persons, due in large part to the lack of employment opportunities and the distance separating the community from the highly urbanized San Bernardino Valley region.

The education facilities for Barstow consist of elementary, junior, high schools, and a junior college. Recreation facilities consist of: 1 golf course, 1 museum, 12 public parks, 3 campgrounds, 2 swimming pools, and 13 tennis courts.

b. Daggett

Daggett is located 2 miles west of the proposed site. The estimated population of the unincorporated town is 646 residents. Daggett has an elementary school, two churches, a general store, a garage, three gas stations, three trailer parks, a cafe, and motels.

c. Lenwood

Lenwood is located 14 miles west of the site, and has a population of approximately 3,900. Lenwood residents rely on the shopping and civic facilities of Barstow which is only three miles to the east. The area's agriculture potential has declined due to groundwater overdrafts.

d. Yermo

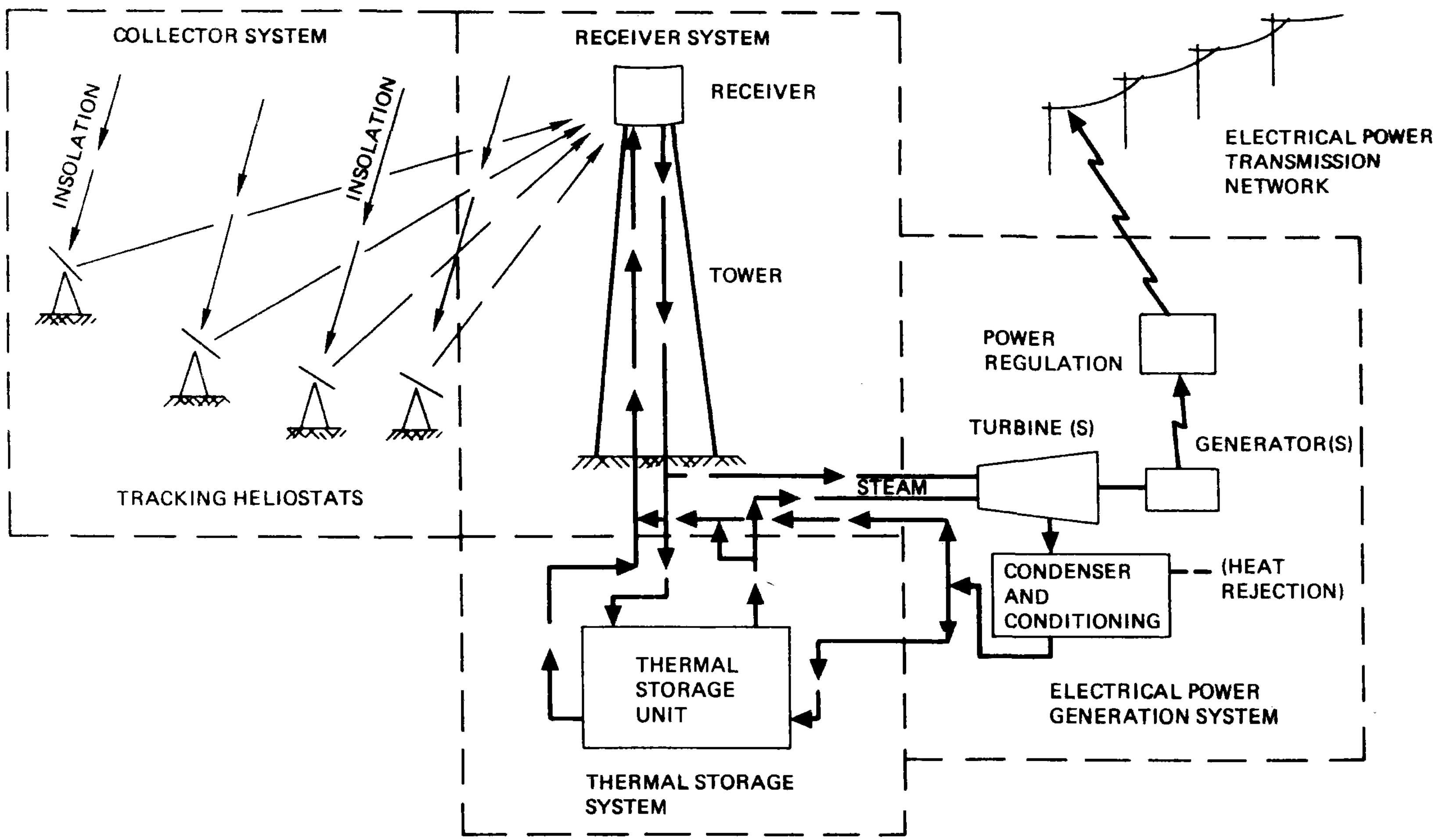
Yermo is located 16 miles east of Barstow and 4 miles due north of the proposed site. The unincorporated town has a population of 1,200 people with a hotel, motels, three markets, eight service stations, five garages, eight cafes, a general store, one elementary school, and two churches. An annex to the U.S. Marine Corps Supply Center tends to stabilize the recreation-tourist influenced economy.

K. Project Description

The following description of the proposed solar collection/steam driven Pilot Plant is generally confined to those characteristics that either influence or will be influenced by environmental factors.

DOE contracted with the firms of Boeing, Honeywell, Martin Marietta and McDonnell Douglas (MDAC) for conceptual studies of plant design. The MDAC conceptual design was chosen by DOE in August of 1977 as the reference engineering concept, therefore it forms the basis of this project description. The readers should note that final conceptual design of the plant is in preparation, and that preliminary and final design engineering is planned for calendar years 1978 and 1979. Therefore, the numerical solar plant/component specified parameters are conceptual estimates and may be expected to vary by ±20%. The alternative conceptual designs will be summarily described in Section VIII - Alternatives. DOE will soon select contractors to design and manufacture the various solar-related components based on the reference design. (See Cover Sheet Artist Rendering.)

1. <u>General Description of Solar Thermal Concept</u>
The proposed Pilot Plant will utilize a central receiver concept wherein a large field of heliostats (sun tracking mirrors) is employed to redirect and focus radiant energy from the sun toward a central receiver at the top of a tower. At that point the concentrated solar energy is utilized as a heat source to produce steam from water. This steam will be directed to either, or both of two places: 1) to a conventional steam turbine-generator which will then be utilized to produce electricity (Exhibit II-7), and 2) to a thermal storage unit.



10 MWe SOLAR PILOT PLANT

CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM

EXHIBIT II-7

The plant will be rated at approximately 10 Megawatts Net Electric output when receiving steam directly from the receiver, and approximately 7 Megawatts Net when receiving steam from the thermal storage unit. The Pilot Plant is expected to have a capacity factor of approximately 55% (45% downtime out of 24 hour day due to lack of radiation, research and development activity (DOE).

The main components of the Pilot Plant are illustrated in Exhibit II-8 and are as follows:

Collector System

- Heliostat field
- Sensors and control equipment

Receiver System

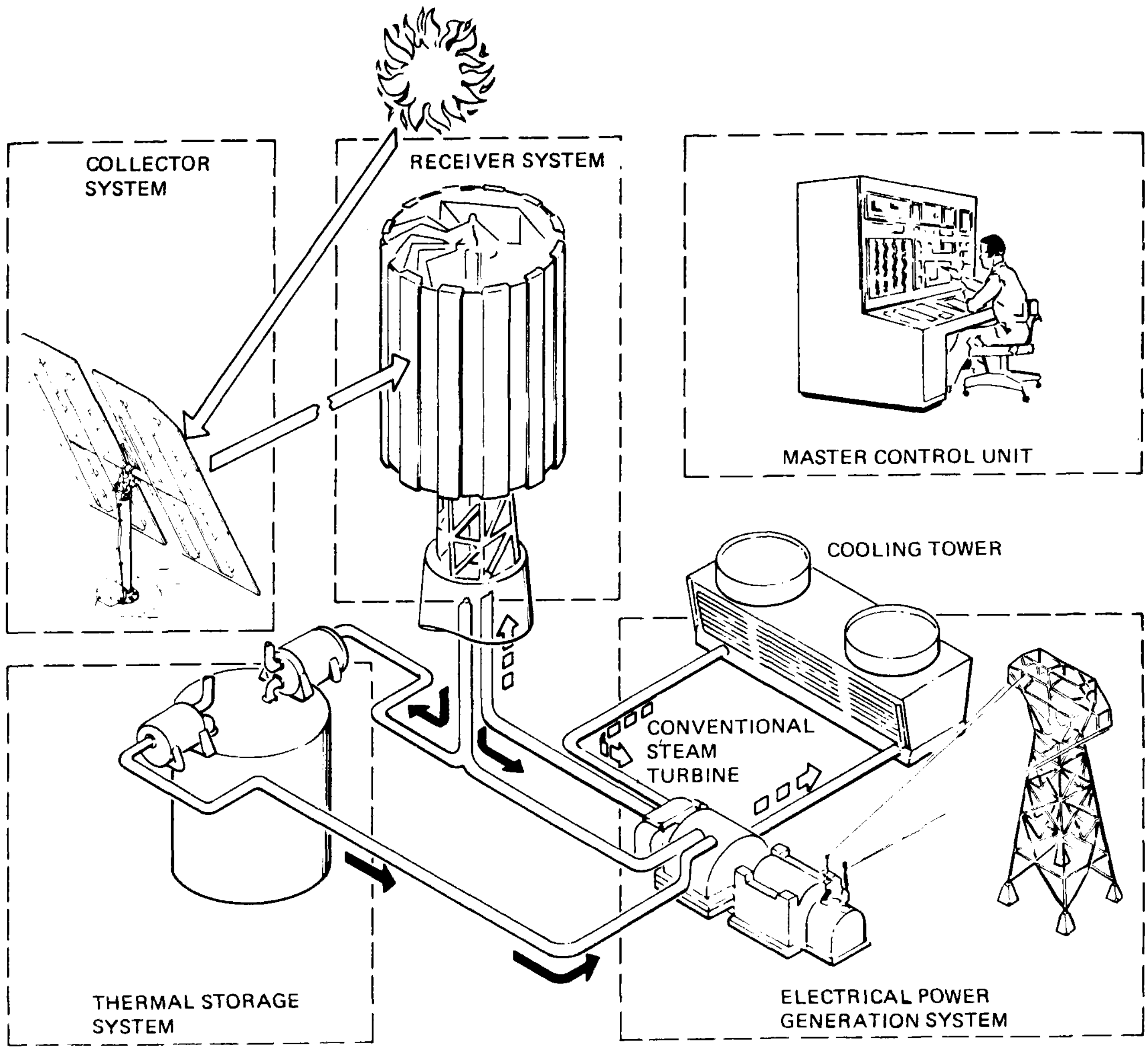
- Receiver support tower
- Receiver (or steam boiler)
- Steam and water piping within the tower
- Controls

Thermal Storage System

- Heat exchanger
- Heat storage tank filled with oil and rock

Electric Power Generating System (EPGS)

- Steam turbine
- Electric generator
- Associated piping and mechanical equipment
- Associated electrical equipment
- Controls
- Heat Rejection Components
- Water Treatment Facilities



10 MWe SOLAR PILOT PLANT

CENTRAL RECEIVER BASELINE CONCEPT
EXHIBIT II-8

Master Control System

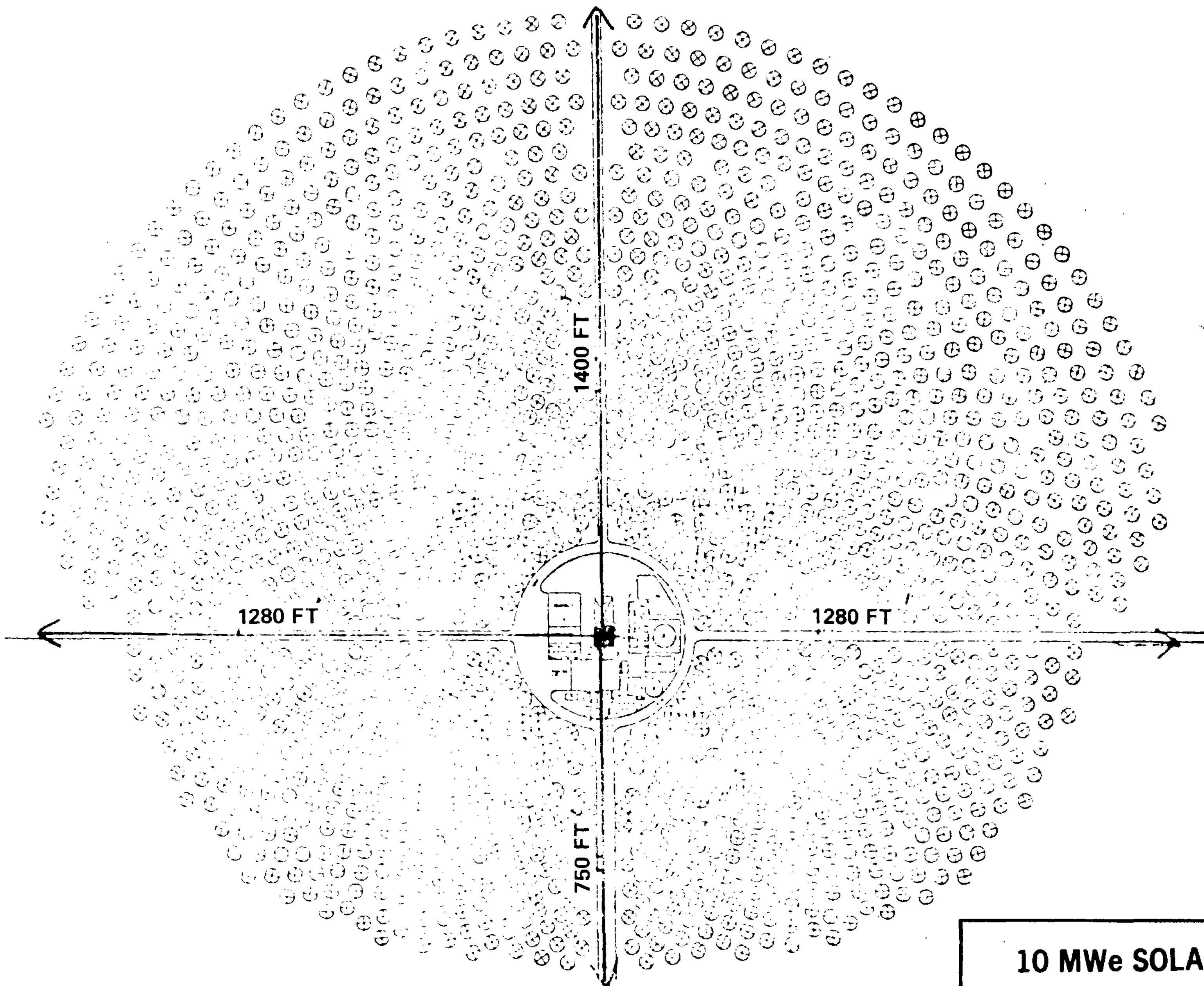
- Interface controls between above systems
- Data logging computer

The facility will occupy approximately 100 acres of the 130 acre site. Estimated land-use requirements, broken down by major components, are approximately as follows:

• Heliostats	3×10^6 square feet (90 acres)
• Tower Receiver	4,000 square feet
• Conventional Plant Facilities (including master control)	20,000 square feet
• Parking	3,000 square feet
• Thermal Storage System	50,000 square feet

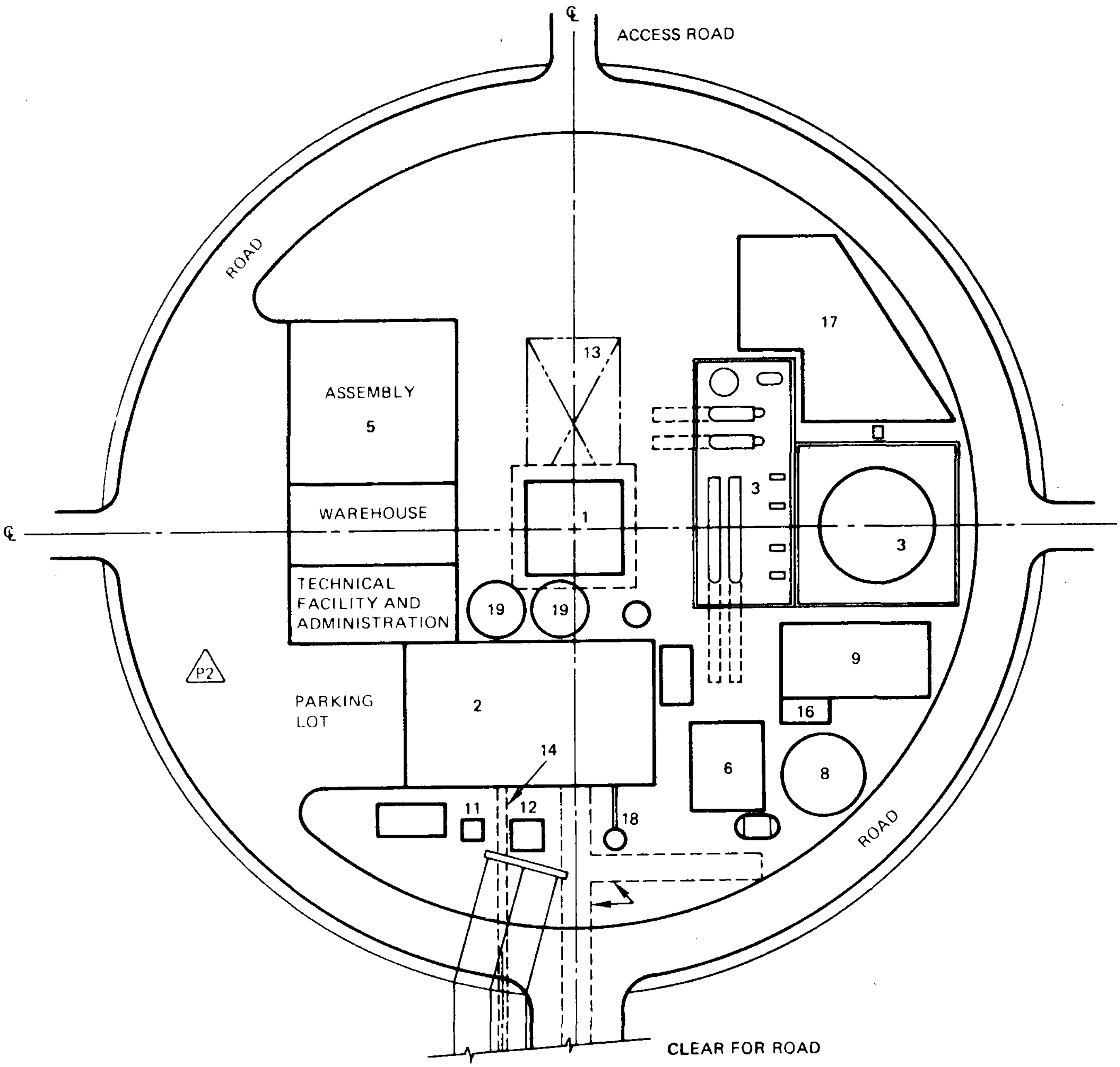
Following is a summary of total plant facilities: (see Exhibits II-9 and II-10).

- Collector Field
- Receiver Tower
- Power House
- Thermal Storage System
- Heat Rejection Condensers
- Administration/Control Building
- Maintenance Building/Warehouse
- Access Roads
- Fencing



10 MWe SOLAR PILOT PLANT

CENTRAL RECEIVER
COLLECTOR FIELD LAYOUT
(CONCEPTUAL)
EXHIBIT II-9



1 RECEIVER TOWER AND FOUNDATION
2 POWER HOUSE
3 THERMAL STORAGE SUBSYSTEM
4 CONDENSATE STORAGE TANKS
5 ASSEMBLY. AS NOTED
6 WATER TREATING BLDG
7 DEMINERALIZER ACID STORAGE TANK
8 LIME SOFTENER
9 CLEARWELL (COVERED)
10 SEWAGE UNIT
11 AUX TRANSFORMER
12 MAIN TRANSFORMER
13 RECEIVER PANELS LAYDOWN AREA
14 POWER AND CONTROL CABLE TRENCH
15 BURIED PIPING LANE
16 TREATED WATER AND FIRE PUMPS
17 ROCK-FILLED CATCH BASIN
18 LUBE OIL STORAGE TANK
19 CONDENSATE STORAGE TANKS P2

10 MWe SOLAR PILOT PLANT

CONCEPTUAL POWER HOUSE
AND AUXILIARIES
EXHIBIT II-10

2. Detailed Description of Proposed Solar Thermal Operation

In the conceptual design stage, Pilot Plant sizing to produce 10 MW_e output at the design point (2pm, day of worst collector field cosine) has been based on an insolation level of 0.950 kilowatts per square meter (kW/m^2), which is the typical insolation value used for desert areas. Final sizing of the plant will be done using insolation data that has been collected by SCE near the actual Pilot Plant site. (See Section X-E-e Solar Radiation.)

The central receiver system requires:

- Collection and concentration of solar energy;
- Conversion of solar energy to thermal energy and thermal energy transport to an electric generator;
- Conversion of the thermal energy to mechanical energy and transformation and distribution of electrical energy produced
- Storage of thermal energy in excess of that needed in the conversion process to cover periods when solar energy is not available; and
- Master plant supervisory control for operation and safety;

and therefore consists of five main systems:

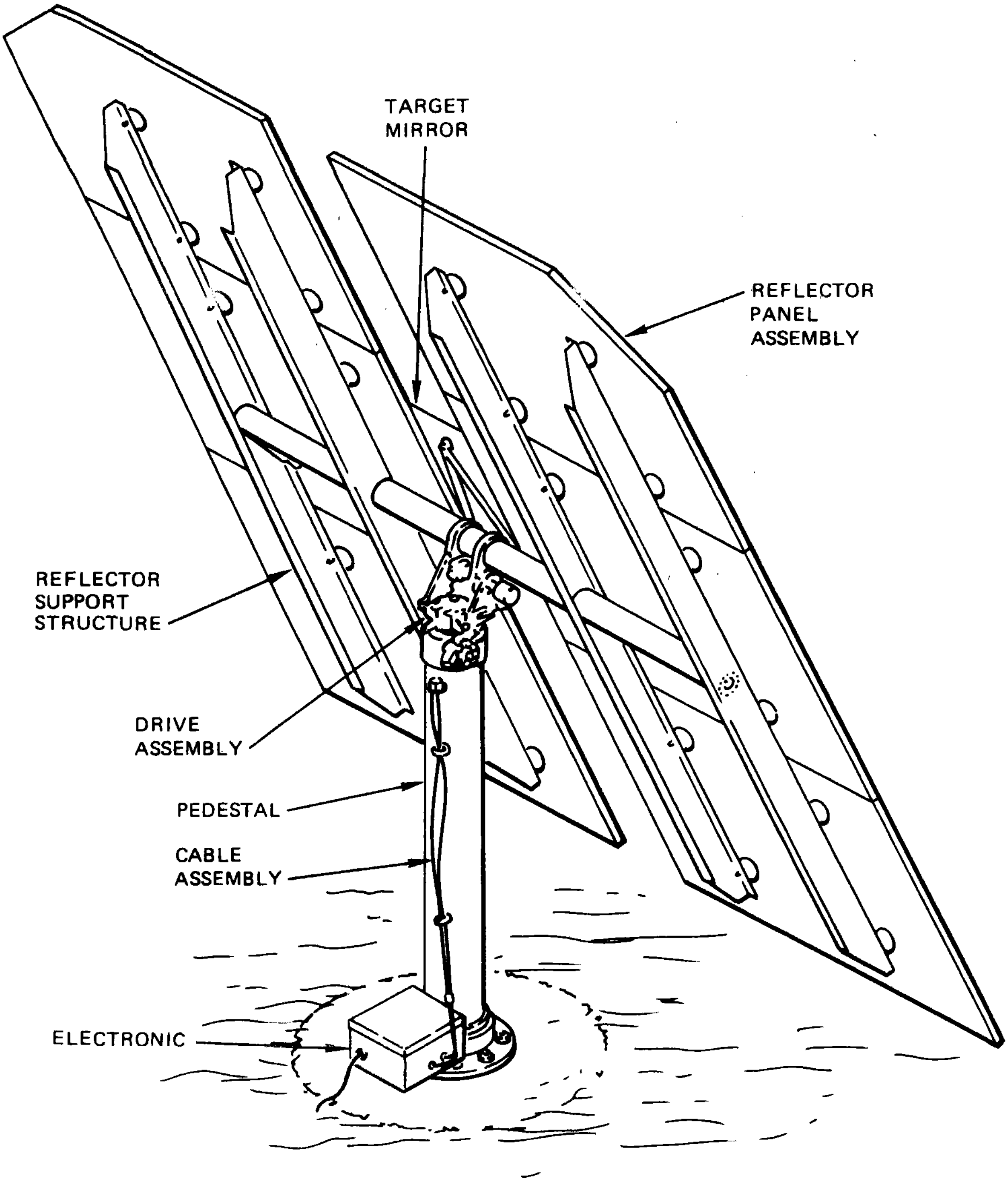
1) Collector System
2) Receiver System
3) Electric Power Generation System (EPGS)
4) Thermal Storage System
5) Master Control System

a. <u>Collector System</u>

The collector system has as its basic function the interception, redirection, and concentration of direct solar radiation to the receiver system. The collector system consists of a field of heliostats (reflecting mirrors) and a computerized control system to continuously track the sun and maintain focus on the central receiver on top of the tower. The high temperatures produced by this focused concentration of solar radiation (heat) results in approximately 21% overall (sunlight to electricity) conversion efficiency.

The selected system uses an external surface receiver. Heat is absorbed on the outside surface of the receiver and can accept energy from all directions. Accordingly, the tower could be placed in the center of the field. However, because the sun is always in the southern hemisphere at Barstow's latitude, more effective energy collection will be accomplished by placing the tower somewhat south of center.

Each heliostat will consist of panels of flat glass mirrors bonded to a backing sheet. (See Exhibits II-11.) Each heliostat will provide a total reflective surface area of about 430 square feet. The conceptual design calls for approximately 2300 complete heliostat units comprising a "mirror" of approximately 22 acres (an overall heliostat ground covering density of approximately 24% of the 90 acres required). This number of heliostats provides for design point power generation plus excess to charge the thermal storage system. This excess is called solar multiple and is



10 MWe SOLAR PILOT PLANT

HELIOSTAT
ASSEMBLY
EXHIBIT II-11

approximately 1.5. The heliostats rotate on axes, which enable sun-position tracking and allow for rotation to a "stowed" position (mirrors facing ground) during nighttime, sand storms and inclement weather. The mirrors will require periodic washing. (See Section X-C-2-b.)

Facilities appurtenant to the collector field will consist of:

- Field wiring for distribution of power, command/control and grounding cable (underground).
- 8 foot high galvanized chain link fencing around collector field.
- Approximately 200,000 square feet of asphalt paved road surface.
- Approximately 3,000 square feet of asphalt paved parking surface.

b. <u>Receiver System</u>

The receiver system consists of the support tower, the receiver/boiler and the working fluid (water/steam) conduits. The outer surface of the externally heated receiver/boiler absorbs the focused radiant energy from the collector field. Boiler tubes with an absorptive coating containing the working fluid are placed on the exterior side of the receiver. The water in the tubes is heated until it is completely vaporized and then heated further to super heated steam. The steam is collected from all tubes and then transported down the tower for conversion and/or storage.

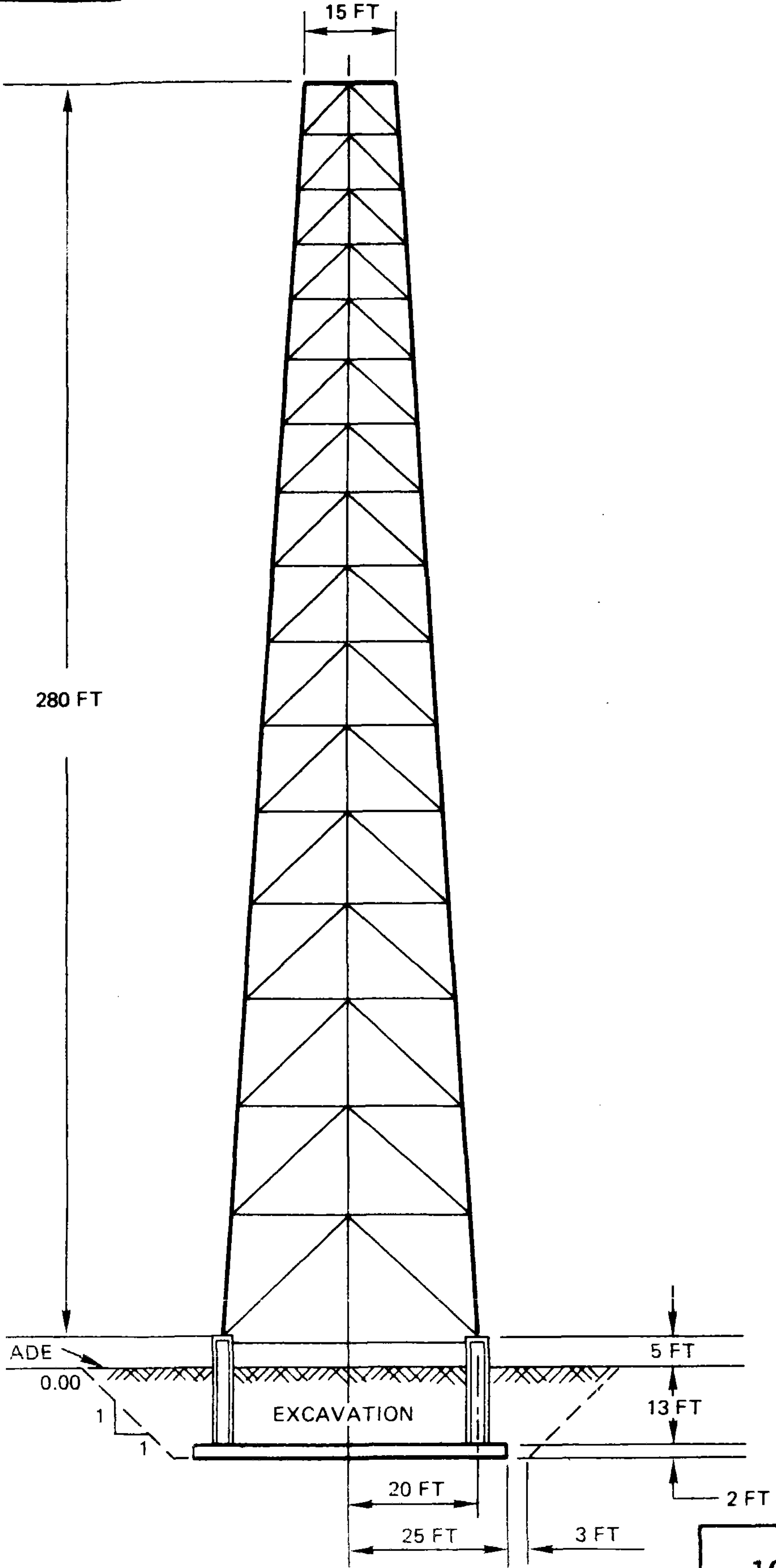
The structural steel tower (without receiver) will be approximately 280 feet high from the ground surface and will be approximately 40 square feet at the foundation and 15 square feet at its top at the connecting point with the receiver. The tower foundation will be an approximately 50 square foot reinforced concrete mat. Fifteen feet of the tower foundation will be below the ground surface. (See Exhibit II-12.)

The cylindrical receiver at the top of the tower will be approximately 46 feet in height with a 26 foot diameter. (See Exhibit II-13.) A riser will conduct water between the ground and the receiver at the tower top. Similarly a downcomer will transport steam down the tower. The total height of the combined tower and receiver will be approximately 325 feet.

c. Electric Power Generation System (EPGS)

The main function of the EPGS is to transform the thermal energy from the solar-heated working fluid into electric power. A conventional steam turbine electric generator is used to convert the thermal energy of high pressure/high temperature steam into rotative mechanical energy in the turbine which then transmits this energy to the generator where electrical energy is produced. The spent steam is then transported to the wet cooling towers for waste heat rejection to the atmosphere. The turbine condensate (condensed spent steam) is returned via the feedwater train to the receiver unit where the cycle begins again.

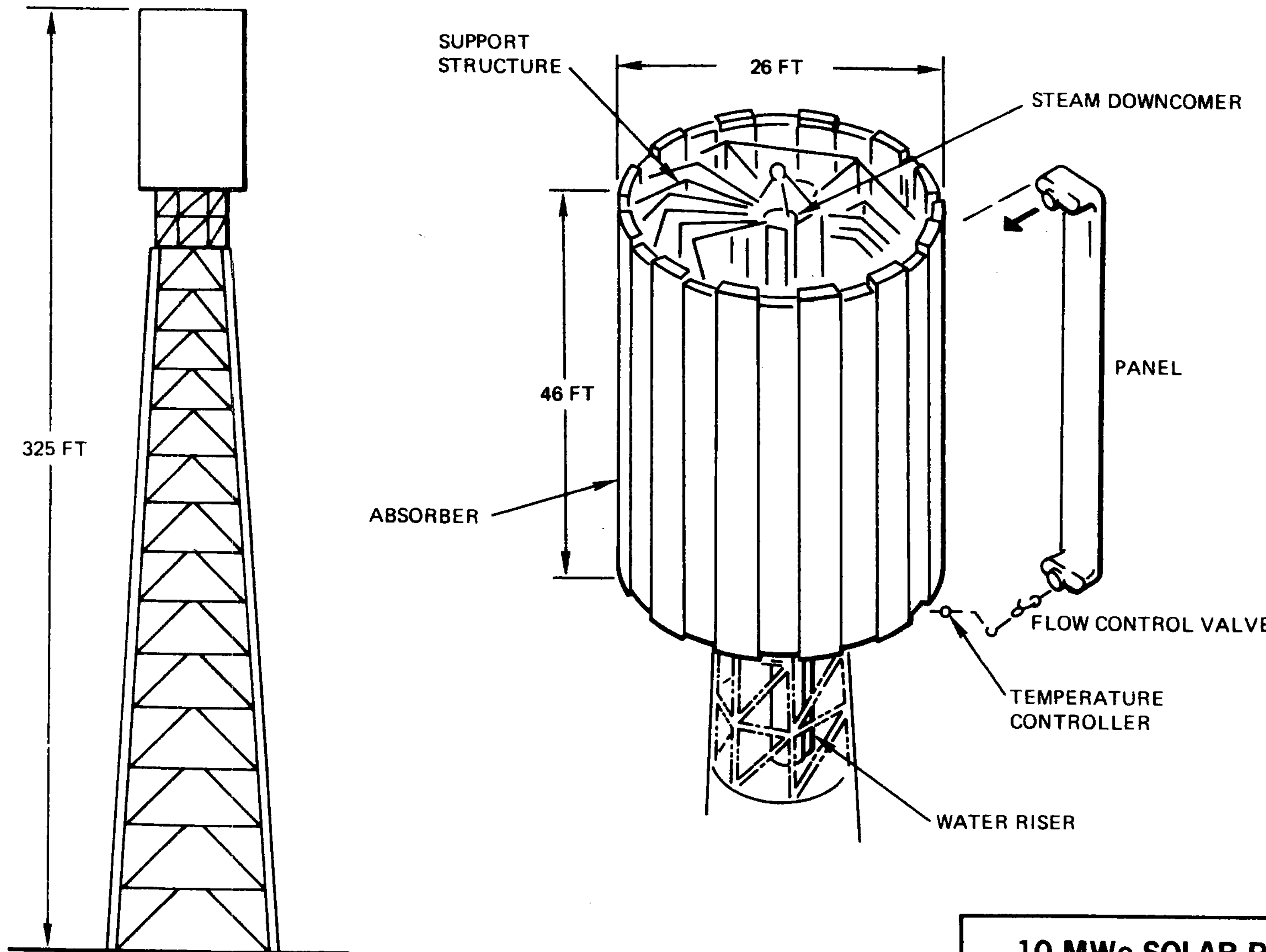
The turbine generator facilities will include a steam turbine generator set, a heat rejection system (condenser and cooling tower), feedwater heaters, pumps, water treatment facility and electrical power conditioning equipment for distribution of the



10 MWe SOLAR PILOT PLANT

PILOT PLANT STEEL RECEIVER TOWER

EXHIBIT II-12



10 MWe SOLAR PILOT PLANT

PILOT PLANT RECEIVER

EXHIBIT II-13

plant output. The turbine generator will transform the thermal energy of the steam originating in the solar receiver, into 60 Hz electrical power at 10 MWe net or originating in the thermal storage system at 7 MWe net. The power conditioning equipment will include transformers, switches, regulators and controls needed for the proper integration into an existing power transmission network.

The output from the turbine-generator facilities will be fed into the SCE transmission system which is interconnected with utilities in Arizona, New Mexico, Nevada, throughout California and the Pacific Northwest. The SCE system is also interconnected at four points with the DWP transmission system. The Pilot Plant will be connected to the transmission system through existing sub-station facilities at the Coolwater site. No new off-site trans-mission lines or microwave stations will be required.

d. Thermal Storage System

The function of the thermal storage system is to store thermal energy generated by the collector and receiver systems collected in excess of that required for normal plant operation and to later supply this stored energy for use at times when direct solar radiation is not available (i.e., because of cloud cover or darkness). The storage system will utilize the favorable thermal properties of granite rock and high temperature oils which will absorb and retain heat from the working fluid via heat exchangers. When storage energy is required, heat from the oil/rock media is transferred to receiver feedwater to produce steam for the EPGS.

The round, steel-shelled thermal storage tank will be installed adjacent to the receiver tower. A thermal storage system schematic is shown in Exhibits II-14.

The heat storage/exchanger system, when fully charged, can store sufficient thermal energy to generate approximately 7 Megawatts of electricity for 5 hours without sunlight.

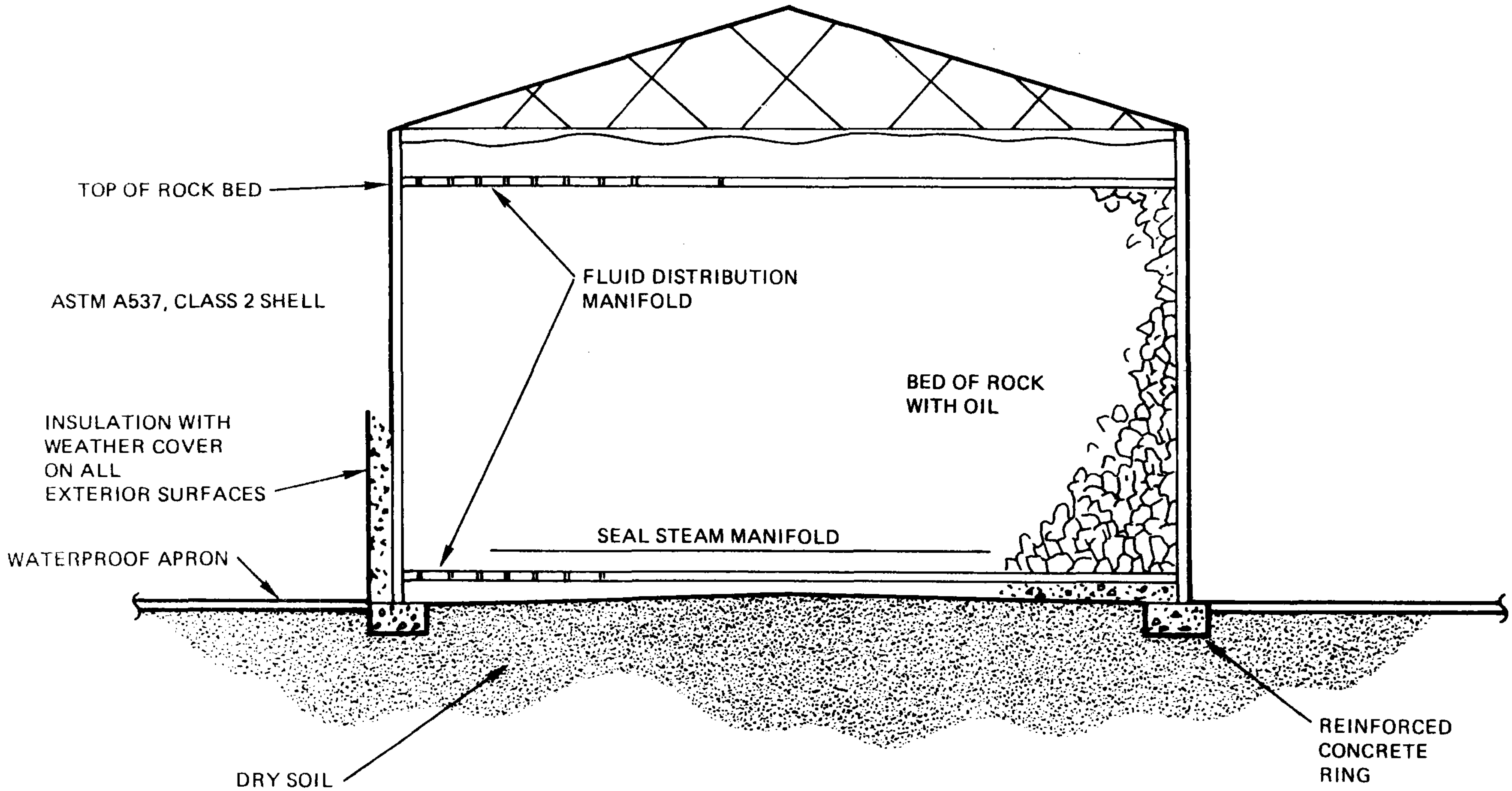
A dirt containment basin and dike will surround the thermal storage unit in order to contain petrochemicals in the event of spills and leaks as part of the fire protection system.

Heat exchangers and pumps are utilized to transfer heat from steam to charge storage and for the reverse extraction process.

e. Plant Master Control System

The plant master control system is a series of computers which are preprogrammed to perform supervisory activity over all of the plant subsystems. These computers are dedicated to control the plant in response to operator demand for power and also provide automatic plant protective functions.

The master control functions to assure that the subsystems operate in concert with one-another and that the entire plant responds to the demands in a rapid and safe manner. Exhibit II-7 presents basic schematics on the integration of each system.



10 MWe SOLAR PILOT PLANT

PILOT PLANT THERMAL
STORAGE UNIT

EXHIBIT II-14

3. Additional Plant Description

a. Water Use

Preliminary estimates indicate that approximately 220 acre-feet of water will be required annually for cooling and other uses such as boiler make-up water and heliostat washing. This will be supplied by water diverted from agricultural use and will not require additional pumping from the ground water basin. (See "Hydrology" for detailed assessment of water use.)

b. Access

Access to the Pilot Plant site is available from Interstate Highway 40, Interstate 15, County and private roads. Unpaved portions of the private roads will be improved and adequately maintained during and after the construction period.

Two main railroad lines cross the Mojave Desert and pass near the Coolwater site. The Atchinson-Topeka and Santa Fe (AT&SF) Railroad extends northwest and southeast of Barstow and is adjacent to the south property line of the Coolwater Generating Station. The Union Pacific (UP) Railroad is northeast of Barstow and passes north and west of SCE'S property. Both railroads share portions of the same roadbed from the community of Daggett to Riverside. Both the highways and rail lines will be used to transport construction materials to Daggett.

The Barstow-Daggett airport is located 2.5 miles east of Coolwater on 1,082 acres of land. A heliostop (without refueling facilities) will be located near the Pilot Plant site.

c. Visitor Center

The novelty and uniqueness of the Pilot Plant will attract the curiosity of the travelling public. Availability of information will enhance the development of a general public understanding of solar power and its application. As part of this effort, a visitor's center will be constructed on the north side of International Trails Highway (old Route 66) approximately 1-1/2 miles south of the Pilot Plant site. (See Exhibit II-4 and II-4a). The facility will include a small building and a paved parking lot.

d. Development Schedule

As presently scheduled, site preparation and construction will begin mid-year 1978. Construction is expected to be completed in July of 1980. Initial plant operation will commence in December of 1980 and the test period will continue over a five year period.

e. Construction Practices

A construction management firm will act as prime contractor for all site construction work within DOE responsibility. SCE's construction management group will manage all site work within the utility consortium responsibility.

Standard practices used throughout the utility industry will be followed in the construction of the Pilot Plant. Access for material transport to the construction site will be permitted by an existing paved road, an existing overland dirt road to the construction site and if necessary, a railroad spur already next to the existing power plant.

Major excavation work will be required to construct the central receiver tower, heliostat foundations, steam turbine generator pedestal, storage tanks, cooling tower basin and the circulating water system between the cooling towers and the condenser.

On completion of construction activities, the contractors will be required to remove construction debris from the site for recyling or for deposition in a sanitary landfill.

Temporary facilities will be provided as follows during the construction period.

- Power - Initial construction power may be derived from onsite diesel-driven generators or electrical tie lines to the existing Coolwater Generating Station.
- Water - Construction water supplies will be obtained from existing wells located on or adjacent to the site.
- Sanitary - Sanitary waste facilities for administrative forces will be provided by a septic tank and leach line system, which will become a part of the permanent facilities for normal plant operation. Portable chemical units will be provided for construction forces.
- Communication - A communication system utilizing both microwave and common carrier that can be integrated into the existing Company network is presently planned.
- Storage - A conventional combined warehouse, shop and assembly building will be constructed.
- Worker Facilities - The use of air conditioned trailers is being considered for the construction-related offices.

4. Total Plant Operation and Maintenance

SCE will be responsible for providing the services necessary to operate and maintain the Pilot Plant in a competent manner. As the plant may only be in service for 5 years, the manner in which services are provided must recognize its temporary status.

Objectives will be altered somewhat from those that would be assumed in a conventional or commercial electrical generating station. The purpose of the Pilot Plant is to provide information necessary to evaluate equipment selection and design changes that would be required to construct a full-sized commercial solar plant. Operating procedures will be designed and implemented to maximize the conversion of solar incident energy into electrical energy while accomplishing the research and development objectives of the projects.

The project participants will prepare detailed test and evaluation plans and schedules which will delineate the required operating and testing tasks to be performed. These plans will be given to the Pilot Plant operating supervision who will assume the responsibility for preparing, implementing, and reporting upon the detailed procedures necessary to accomplish the plan.

Operating and maintenance supervision and administrative services will be provided by the existing Coolwater Generating Station personnel with support from other SCE groups. Substantial technical support will be provided by SCE's Research and Development Department, DWP, DOE, Sandia Laboratories, and equipment vendors.

Operating manpower will require a minimum of three men on day shift, three men on swing shift, and two men on graveyard shift. During normal daytime working hours, many technical personnel will be on duty to aid operations and to obtain and analyze test data.

Maintenance manpower assigned full time to the Pilot Plant will consist of two men on day shift and two men on swing shift. In addition, approximately six men may be assigned full time to accomplish heliostat mirror washing; however, this function may be assigned to outside contractors. Additional maintenance manpower will be provided as required from the Coolwater Generating Station. Maintenance requirements that cannot be completed by SCE will be contracted.

A typical day is envisioned as beginning shortly before sunrise when operators begin placing equipment in service in preparation for receiving the early morning solar energy. When the sun rises to a predetermined elevation above the horizon, a portion of the heliostat field will be moved from their stowed position and directed so as to reflect the solar energy on the receiver. A warm-up process then begins to raise the metal temperature of the receiver, piping, turbine and other equipment to the proper operating level. The generator will then be connected to the electrical network and the remaining heliostats placed in service to increase the receiver input energy to the maximum available. Receiver output energy will be used to directly generate power. Excess output energy, as it becomes available, will be directed to the thermal storage unit for recharge and later recovery. In the event that sufficient solar insolation is unavailable, thermal storage can be tapped to supplement receiver steam. The EPGS can accept receiver and storage produced steam simultaneously. As sunset approaches, the reverse of morning start-up procedures takes place. If thermal storage is to be used for generation, it will be placed in service as the receiver is being removed from service. At the termination of thermal storage operations, the remaining systems will be placed in hot lay-up, which minimizes heat losses to facilitate a rapid start-up on the following morning.

III. ENVIRONMENTAL SETTING

(The following environmental factors are described in detail in Section X.)

The site is located in the Western portion of the Mojave Desert Geomorphic Province, in a broad alluvial valley on the old flood plain of the ephemeral Mojave River. The 4 mile wide valley is flanked by the Calico Mountains to the north and the Newberry and Rodman Mountains on the south, which are primarily of volcanic and sedimentary origins.

Mid valley topography is generally flat along the flood plain. The site elevation is 1942 feet. The 130 acre parcel has a relief of approximately 2 feet, falling in a northerly direction toward the Mojave River channel.

The valley's deep, sandy soil results from ancient river flooding and from deposition of alluvial material from the sloping plain to the south.

The site is in a region of moderate seismicity due to the existence of active northwest trending faults within a 25 mile radius and due to a potential quake on the more distant San Andreas fault to the southwest.

The region is drained by the mostly ephemeral Mojave River which flows northward from its primary watershed in the

San Bernardino Mountains through Victorville, then eastward through Barstow and Daggett, along its course immediately north of the site, terminating at Soda Dry Lake in the eastern Mojave Desert 40 miles east of Daggett. The 130 acre plant site is drained by minor sheet and rill flow. Various closed basins in the region contain dry (ephemeral) lake beds.

The site's and region's water is pumped from the Lower Mojave River Valley's groundwater basin. Water quality is generally good except where polluted by the migrating "slug" of untreated domestic and industrial wastewater percolated into the upstream river bed many years ago.

This region's low annual precipitation and high rate and intensity of solar radiation (somewhat unique even to the arid Mojave Desert) offer distinct advantages to solar plant siting. Occasional high winds are common. Ambient air quality is periodically degraded by gaseous and particulate pollutants, primarily migrating from the upwind and populated South Coast Air Basin which contains the Southern California metropolis.

The viability and diversity of the valley's typical desert plant and animal life have been partially reduced due to urbanization and land clearing. However the natural creosote-scrub habitat on peripheral BLM lands is fair to good except in those regions heavily mined or degraded by off-road vehicle use. The proposed 130 acre Pilot Plant site had been an alfalfa field in conjunction with the SCE Coolwater Ranch operation. The parcel has been fallow long enough to produce a variety of native and exotic pioneering desert vegetation. The property immediately east of the site is a climax creosote community. Site soils are partially re-stabilized.

The site contains no man-made improvements other than marginal dirt roads, 2 recently drilled water wells on the south and east boundaries, and a buried water pipeline.

The existing Coolwater Generating Station, evaporation ponds and alfalfa fields are west of the site, and wooden pole and steel tower transmission lines cross the parcels on the east. The 130 acre site is in the eastern portion of the SCE-owned 2,337 acre Coolwater property (ranch and generating station). See Exhibits II-4 and II-5.

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS

The following summary lists impacts in three categories: Major; Moderate and Minor. Impacts under each category are not ranked by degree. Mitigation potential is listed as full, partial or none. Some impacts are both adverse and beneficial. For a detailed assessment refer to the pertinent section in this report. Many of the impacts will stem from the existing environment and will effect Pilot Plant operation.

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
MAJOR:				
If chemical additives are used in heliostat wash solutions, effects on soil, vegetation and wildlife could be significant.	Partial	X-C-2-b-(2) X-F-2-b	X	
Misdirected solar radiation beams and in-plant power outages could present significant on and off-site hazards.	Partial-full	XI-F-2-3), 4) and 5)	X	

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS (Continued)

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
The Pilot Plant's contribution to the long-range commercialization of STE generation could be extremely beneficial to society and the national environment, however siting-related impacts in the southwest could be significant.	Partial	XI-c-2-b and V - VII	X	X
MODERATE:				
There is a 2½% probability of a seismic event causing .25g (or greater) acceleration on the site within 5 years and 14% within the next 30 years.	Partial	X-A-2-b	X	
Levelling and excavating will disturb soils and induce fugitive dust during construction. On-site vehicle use will perpetuate dust during operation.	Partial	X-B-2-a & b	X	

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS (Continued)

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
The Pilot Plant's water requirement will not constitute a net increase in SCE's historic groundwater withdrawal, but it will be an increase over SCE's 1977 pumping rates. More water will be evaporated than formerly lost via irrigation. The project will contribute to groundwater basin overdraft. Surface subsidence will be negligible. Pumping from the new wells will elongate cones of depression to the east of the site.	Partial	X-c-2-b-(1)	X	

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS (Continued)

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
Blowing sand could pit mirror surfaces. Plant operation may induce micro-climatic alterations to the site's air-flow, ambient temperature balance and humidity levels. Meteorological factors in turn will affect solar collection and reflection efficiency by an undetermined amount.	Partial	X-D-2	X	
Particulate matter, Coolwater Plant emissions, water vapor and imported ambient pollutants will absorb and scatter incoming and reflected solar radiation, reducing optimum plant efficiency by a small but undetermined amount.	None-Partial	X-E-2-c	X	

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS (Continued)

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
Construction will remove approximately 100 acres of semi-productive vegetation and wildlife habitat, displacing some animal species. Replanting in the collector field may be dependent on composition of heliostat wash fluids and soil compaction. Use of vegetation in collector field by wildlife will be dependent on availability of access through perimeter fencing. Weeds may become a problem. The receiver tower and radiation beam may present hazards to bird life.	Partial	X-f-2	X	
Net socio-economic effects on Barstow and Victorville will be negligible, however the Pilot Plant's novelty will induce tourist visitation.	Partial	X1-B-2		X

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS (Continued)

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
The 130 acre zone change to M-2 would facilitate other utility-related development on the site subsequent to Pilot Plant dismantling.	Partial	X1-C-2-a	X	X
Capitalizing on the Pilot Plant's novelty could result in unwarranted, short-term, non-beneficial development in Daggett.	Partial-Full	X1-C-2-b and X1-E-3-b-(2)	X	
The effects of increased traffic from construction, operation and visitation will be minor except during peak periods.	Partial	X1-D-2	X	

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS (Continued)

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
Noise, conventional safety hazards, security requirements, tower-related obstacles to aircraft, and boiler/heat storage failures could present potentially significant problems during construction and operation.	Partial	X1-f-1	X	
The Pilot Plant's visibility will moderately alter the area's aesthetic values over the short-term.	Partial	X1-G-2	X	X (Tourist attraction)
MINOR:				
Plant material requirements are relatively intensive per unit of power produced.	None	X-A-2-c	X	X
Construction will require approximately 100 acres of minimal topographical alteration.	Partial	X-A-2-a	X	

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS (Continued)

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
Soil compaction is possible, especially when wet.	Partial	X-B-2-d	X	
Sheet flow run-off from the unpaved site after project completion may increase by 15%.	Partial	X-C-1-b	X	
Pilot Plant operation will have minimal effect (if any) on groundwater quality (assuming a chemical mirror-washing solution will not be used).	Partial-Full	X-C-2-b-(3)	X	
Air quality impacts from Pilot Plant construction and operation will be negligible, mostly in the form of fugitive dust.	Partial	X-E-2-a and b	X	

IV. SUMMARY OF ADVERSE AND BENEFICIAL ENVIRONMENTAL EFFECTS (Continued)

IMPACT	MITIGATION	SECTION	ADVERSE	BENEFICIAL
At worse case, the Pilot Plant may only produce as many units of usable energy as it consumes.	Partial	X-G-2	X	X (if R&D is productive)
Construction personnel will average 250-300 at any given time during 1977-80. Operation will only require 12 permanent employees. R&D related visitation will periodically be substantial.	None	X1-A-2-a, b and c		X
Subsurface archeological and palentological remains (if any) could be damaged during construction.	Partial	X1-E-1-b and 2-b	X	
Project impact on general utilities and public services will be minimal.	Partial-Full	X1-H-2	X	

V. THE RELATIONSHIP BETWEEN SHORT-TERM USE OF RESOURCES AND LONG-TERM PRODUCTIVITY

The site, construction materials, fossil fuel energy, human resources and time will be utilized over a 5 year period for promoting and researching the long-term use of solar radiation for electricity production. This Pilot Plant can be considered a capital investment in the attempt to reduce our nation's use of exhaustible energy sources.

If the results of the Pilot Plant research project indicate that central receiver/solar thermal electric technology will not be economically suitable for our future needs, the project's short-term use and consumption of resources will be of less direct benefit. However it must be realized that the credibility of the rejection or even limitation of STE application without a thorough test program afforded by the Pilot Plant study would always be in question. Technological advancements in our society have generally proceeded through an orderly transition from bench or lab scale to pilot and demonstration scale. Solar research experiments established the feasibility of individual components. The Pilot Plant will be used to validate the feasibility that such components can operate reliably together. If the Pilot Plant establishes technical feasibility, then future demonstration plants will be used to demonstrate economic feasibility.

Even the indirect benefits associated with a less than totally successful pilot STE endeavor could hasten the implementation of other forms of efficient solar technologies. Whatever benefit results, it is the present intention that the gain in technology will be worth the expenditure of resources.

VI. IRREVERSIBLE ENVIRONMENTAL CHANGES - IRRETRIEVABLE COMMITMENT OF RESOURCES - SITE RESTORATION

At the end of the 5 year Pilot Plant test period, two options are viable: SCE could purchase the solar portion of the facility from DOE and operate the Pilot Plant for electricity generation for an additional 25 years, or all structures could be dismantled. The 5 year (or longer) period of the Pilot Plant's existence on the site will not necessarily commit the parcel to irreversible environmental alterations. Site disruption and use will definitely lengthen the period before native biotic resources will re-occur, but assuming no subsequent degradation, the site will eventually revert to a resemblance of its present condition. It could even regain its native climax condition over the extreme long-term. On the other hand, the M-2 zoning on the 130 acre site could result in its long-term commitment to utility-related uses.

The Pilot Plant will not significantly induce irreversible off-site changes unless it contributes significantly to the conversion of fossil fuel electrical generation to solar generation. In this case, the change could be beneficially irreversible, but not without imposing new but hopefully less adverse impacts on society and the environment.

The only resources that will necessarily be irreversibly commited to or by the Pilot Plant will be: the fossil fuels consumed in material mining and manufacture, plant construction and operational support; and irreplaceable hours of human time required for construction, operation, research and support. If plant materials (mirror glass, common and rare metals, etc.) would be salvaged for re-use or recycling, they could be considered a "bank" of materials available for future use and therefore not irreversibly committed to the Pilot Plant. However, if buried in a landfill, they would constitute an irretrievable commitment to a short-term single use.

Eventual uninduced restoration of the site to a status similar to its present quasi-natural state could be accomplished 10-20 years after the Pilot Plant was dismantled. This assumes that heliostat and tower building foundations would also be removed and that dike breakdown and substantial grading would be required to fill in the holes. Net topographical alterations would be minimal. Reseeding with a variety of annual and perennial, pioneering and climax native desert plants (plus initial irrigation) would greatly hasten site restoration to a condition more advanced than what presently exists. SCE's continued use of the site for other utility related projects, facilitated by the potentially permanent M-2 zoning, would of course preclude restoration at least in the near term. Therefore the degree of site restoration is dependent upon SCE's future plans for its use. Farming could also be re-established after Pilot Plant dismantling.

VII. GROWTH-INDUCEMENT CHARACTERISTICS

The Pilot Plant is not a large enough project to be growth-inducing beyond its minor net contribution of operation populations to the Barstow region. Neither the Pilot Plant nor its personnel will directly initiate a substantial multiplier effect on local or regional economic characteristics. The Barstow/Victorville infrastructures can accommodate the minor increase in population without ramifications, however house-hunting might induce a few extra housing starts in Barstow. Any dwelling vacancies resulting from project completion should quickly be filled by the city's normal future growth.

Daggett's growth rate has not noticeably been affected by the installation of SCE's Coolwater Generating Station increments, and the even shorter-term Pilot Plant is not expected to induce or allow any substantial net population or economic expansion in the community. However, it is possible that developing interests could capitalize on the uniqueness and novelty of the project in an attempt to impose various quick profit-making schemes on the community. Daggett could benefit from basic and necessary economic advancement promoted by the Pilot Plant, but it cannot afford the development of an unstable infrastructure that is directly tied to the novelty of the new plant which may be dismantled after 5 years.

If present residents desire that the community maintain a sense of perspective while promoting beneficial long-term development, the County planning process could be a useful tool for them to meet that end.

The Pilot Plant's degree of direct contribution to the advancement of the long-term use of solar radiation for the centralized production of electricity is only speculative. However, since its purpose is for research of the environmental technological and economic viability of STE application, it will at least influence the role that large centralized, commercial STE projects will fill in the future. Success could result in the use of large areas of the southwest desert for solar plant siting which in turn will induce growth of rural or undeveloped regions at or near such sites. The impact would be magnified if water requirements for plant cooling were eliminated or even reduced, thus removing the major constraint to desert siting.

The long-term net growth impact to the southwestern deserts from large-scale STE projects would be similar to that anticipated from coal mining and large coal fired generating plants in the plateau country of Utah.

The long-term implications of commercial STE development in the southwest should be thoroughly assessed in a regional energy plan before siting decisions are made on a local basis without regard to regional resource-use efficiency.

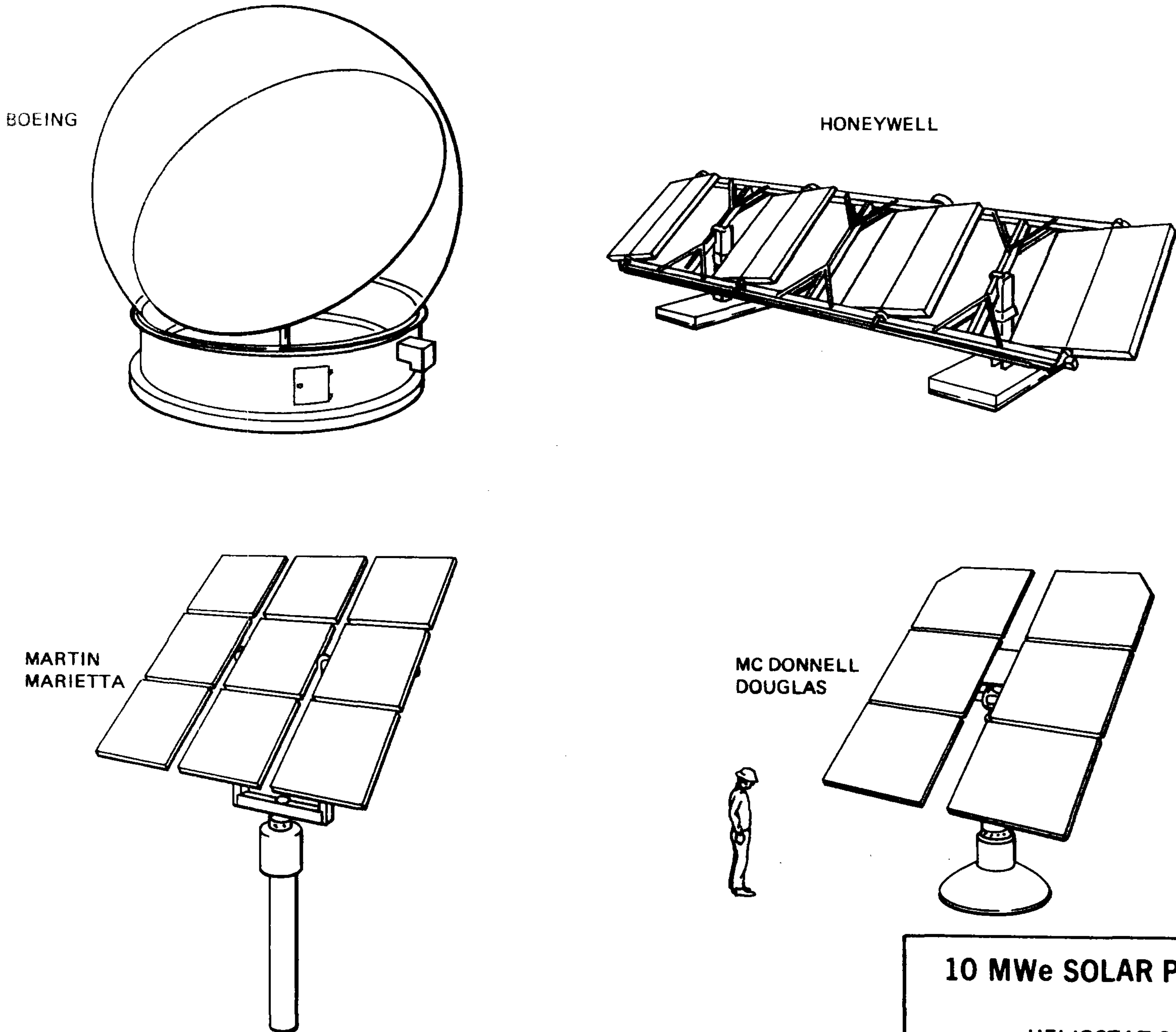
VIII. ALTERNATIVES TO THE PROPOSED PROJECT

The following description of project alternatives reflects those considered by DOE and the utility consortium prior to the selection of the Coolwater site and the MDAC design concept.

A. Central-Receiver Concept Design Alternatives

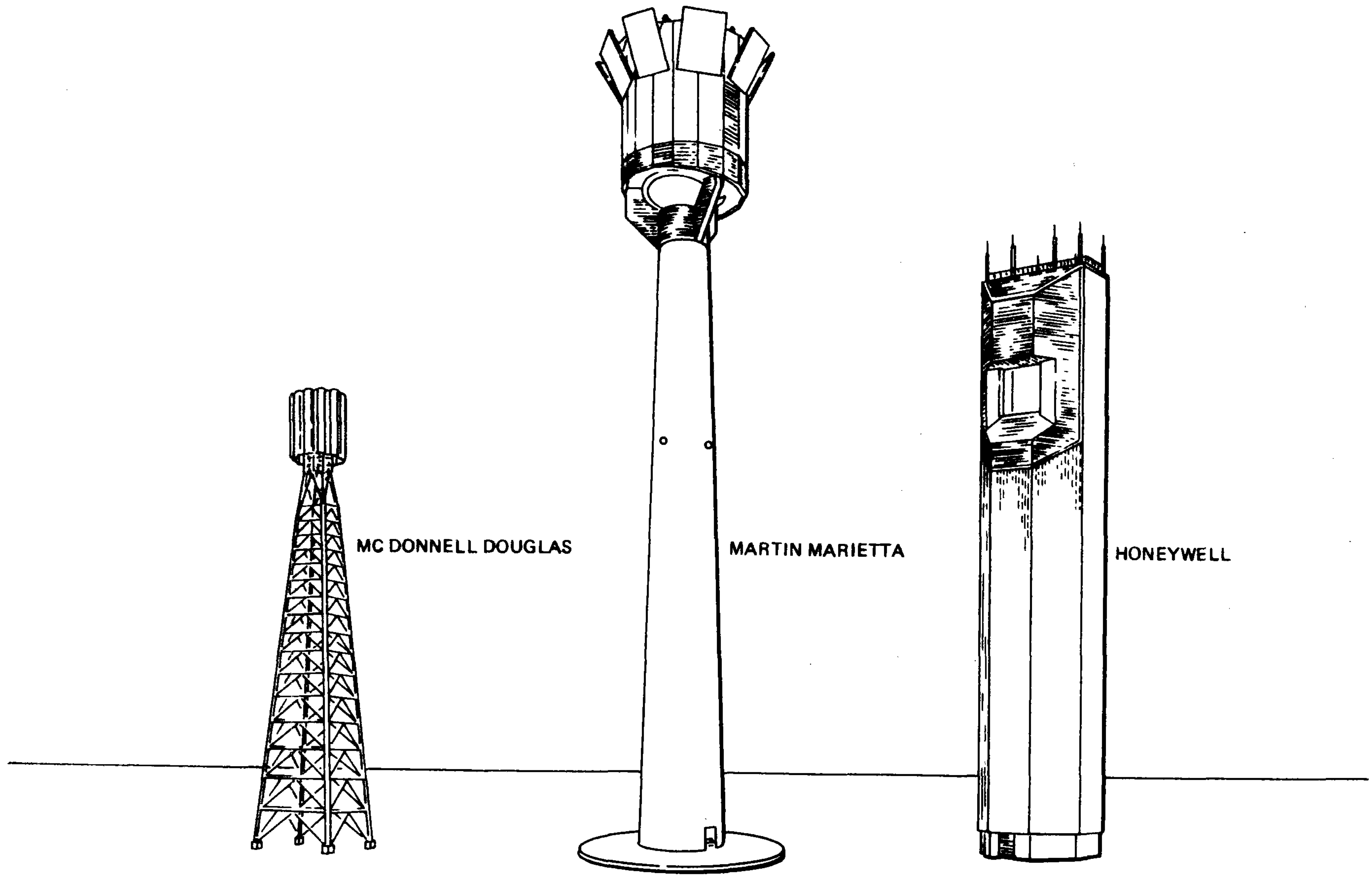
DOE considered central receiver-water/steam conversion cycle designs from four contractors before selecting the MDAC concept for the Coolwater site.

All of the systems developed for the Pilot Plant are based on the same overall concept of reflected energy from the sun being concentrated on a central receiver to generate steam. The differences are in technical detail to provide a broad base for optimization. Alternative heliostat, tower and collector field and tower arrangements considered by DOE, are shown in Exhibits VIII-1, VIII-2 and VIII-3, respectively. A detailed discussion of conceptual design alternatives and recommendations is presented in Sandia Laboratories Report No. 77-8035, entitled "Recommendations for the Conceptual Design of the Barstow, California, Solar Central Receive Pilot Plant - Executive Summary."



10 MWe SOLAR PILOT PLANT

HELIOSTAT CONCEPTS
EXHIBIT VIII-1



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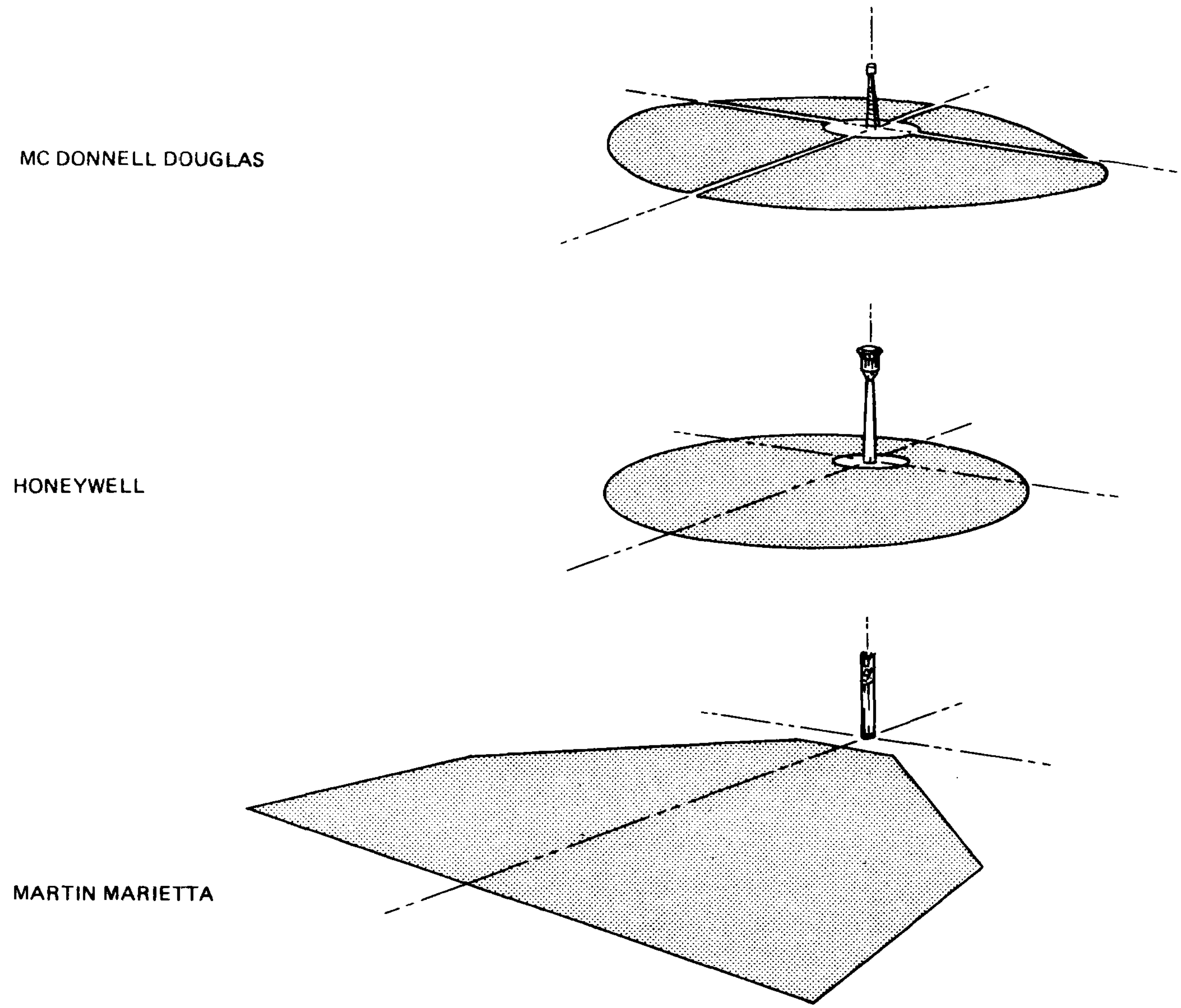
TOWER DESIGNS
EXHIBIT VIII-2



10 MWe SOLAR PILOT PLANT

COLLECTOR FIELD AND TOWER ARRANGEMENT

EXHIBIT VIII-3

B. Other Alternate Plant Designs

Detailed feasibility studies conducted by the National Science Foundation (NSF) and DOE in 1974-1975 indicated that the favored design for the first approach to solar thermal electric conversion plants, taking into account the state-of-the-art, costs, and technical risks, should be the central receiver concept, using the water/steam conversion cycle. Other approaches to plant design such as gas cycles, combined cycles (gas turbine-steam turbine), liquid metal working fluids, and chemical, electrical or compressed gas storage, were considered "advanced" technology systems and not appropriate technical risks for the first Pilot Plant.

Distributed collector systems (instead of the central receiver concept) were also considered. Distributed collectors focus solar radiation directly on an interconnected absorber pipe network which carries the heated working fluid to a heat exchanger unit which in turn generates steam to power the turbine generator.

Because of the limited working fluid temperatures associated with such systems, pumping losses due to extended absorber piping, and consequent lower conversion efficiencies, analyses to date have indicated that distributed collector systems are probably not suited to large-scale central station power generation. Thus it has been concluded that the central receiver system offers the most economic application of solar thermal energy to the production of electricity on a utility industry scale. Distributed collector systems, however, appear to be economically competitive for solar total energy systems and small community power plants (DOE).

Voltaic electrical generation (direct conversion of sunlight into electrical current via cells) would not require steam generation or plant cooling. Presently it is not viable, but prices per unit of production are dropping with each technological advance. This system may eventually compete with STE for solar electric application if land requirements can be reduced, price reductions per unit of production can be achieved and conversion efficencies can be increased.

C. Dry Cooling

STE plants operating in areas of low water availability may use dry cooling towers (DOE). However, dry or wet/dry towers transfer heat to ambient much less efficiently than do wet evaporative towers, thereby decreasing the power output of generating plants using dry cooling towers. Since the primary purpose of the Pilot Plant is the study of STE technology, the project participants decided not to incorporate variables (such as dry cooling) into this pilot project.

D. Heliostat Washing Alternative

A mirror washing method considered viable by DOE prior to identification of the potential requirement to collect wash and rinse water due to chemical cleaning additives in the solution (see Section X-C-2-b-(2) involved a "drive through" washing concept utilizing one or more pairs of trucks, with washing being accomplished while driving slowly past the heliostat (or pausing only briefly). Rinsing would be accomplished by a following truck in a similar manner. Apparent advantages of this concept would be effectively negated by a requirement to collect both wash solution and rinse water since the trucks would have to remain at the heliostat for a much longer period. A system of drainage trenches and sumps to trap run-off could be installed during site construction; however, a detailed evaluation and cost analysis would be required to determine the feasibility and economics of such an approach.

It should also be pointed out that the mirror washing concept presented here assumes that the wash water mixture would be disposed of in the evaporation pond. If water availability is very critical, the used water could be filtered and reclaimed for subsequent reuse, although the costs would probably be substantial. The technical and economic implications of this approach have not been addressed at this time.

The most viable method may still be the use of a wash solution without chemical cleaning additives so that mirror run-off could be utilized as irrigation for ground cover.

E. Alternate Sites

1. DOE Site Selection (Nation-wide)

Nine candidate sites were originally considered for the Pilot Plant. After thorough review and evaluation, using evaluation criteria which included site characteristics, schedules, organization and management, and environmental factors, the following three sites were considered acceptable by DOE:

- Barstow site, Southern Calif. Edison
- Gila Bend site, Arizona Solar Power Project
- Austin site, City Public Service Board, San Antonio, Texas

In the evaluation weightings, environmental factors such as land use, plant discharges, erosion control, etc., were assigned a maximum of 3.0 points for sites showing minimal potential adverse environmental impact of the plant on the site. Each of the above sites was assigned a value of 2.8 points, indicating (a) minimal and acceptable environmental impact, and (b) no "better" or "worse" site among the three finalists from an environmental viewpoint.

2. Utility Consortium Site Selection (California)

The utility consortium's criteria for the selection of a site were essentially the same as the evaluation criteria considered by DOE in reviewing proposals submitted in response to the PON.

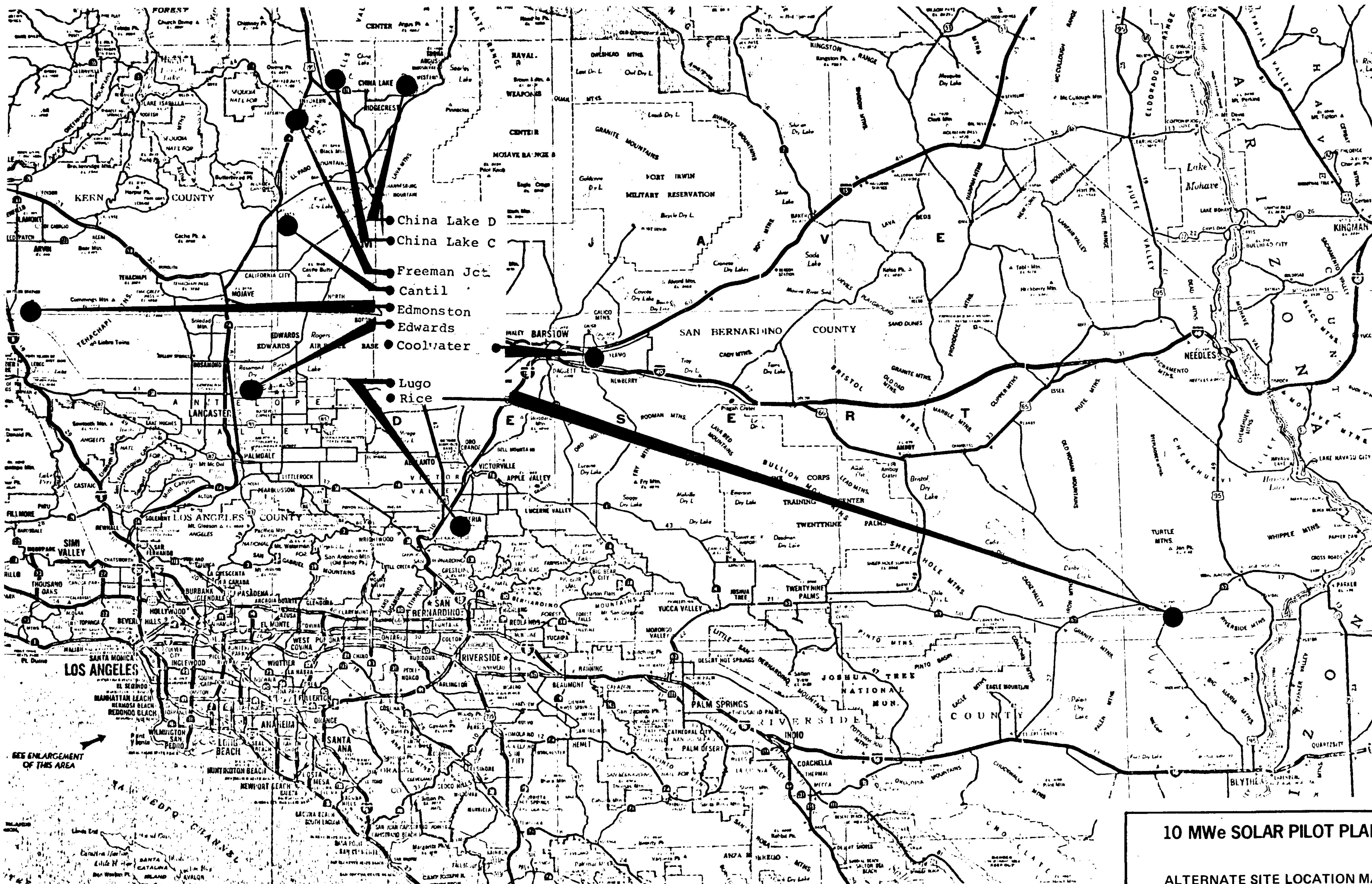
A group of nine initial sites were selected based on conformance with the above mentioned criteria. The sites were selected from several sources including:

- Previous studies conducted for DOE
- A Navy study evaluating sites on the China Lake Naval Weapons Center.
- Previous siting studies conducted by SCE and examination of currently developed sites where the Pilot Plant could most readily be integrated into the utility distribution system.
- High electric load requirements at one site near the Edmonston Pumping station.

All sites were observed via helicopter and ground reconnaissance. The locations of the nine sites are shown on Exhibit VIII-4, and are identified as follows:

- Lugo
- Coolwater
- China Lake D
- China Lake C
- Freeman Junction
- Cantil
- Edwards
- Edmonston
- Rice

Exhibit VIII-5 is a concise summary of technical information on each site.



10 MWe SOLAR PILOT PLANT

ALTERNATE SITE LOCATION MAP
EXHIBIT VIII-4

PARAMETER	LUGO	COOLWATER	CHINA LAKE D	CHINA LAKE C	FREEMAN JUNCTION	CANTIL	EDWARDS	EDMONSTON	RICE
1. Location	15 mi SE Victorville 4 mi SW Hesperia Adjacent & north of Lugo 500 kV Substation	12 mi E Barstow 2 mi E Daggett	9 mi E China Lake Southeast corner China Lake Naval Weapons Center	1 mi E Inyokern 8 mi W China Lake Southwest corner China Lake Naval Weapons Center	10 mi SW Inyokern	22 mi NE Mojave	7 mi NE Lancaster Pumping Station	1 mi N Edmonston	1 mi E Rice
2. Insolation									
a. Mean Annual Daily Insolation	Between 5.2-5.8 Kwh/m^2 [a] 450-500 Langleys [b]	Within 5.8 Kwh/m^2 contour within 500 Langley contour	568 Langley (inyokern)	568 Langley (Inyokern)	568 Langley (Inyokern)	Within 5.8 Kwh/m^2 contour within 500 Langley contour	Within 5.8 Kwh/m^2 contour within 500 Langley contour	5.2 - 5.8 Kwh/m^2 450 - 500 Langley	5.8 Kwh/m^2 500 Langley
b. Mean Total Annual Hours of Sunshine	3400-3600a	Approx. 3600	3870 (Inyokern)	3870 (Inyokern)	3870 (Inyokern)	3600 - 3800	3600 - 3800	Approx. 3400	3800 - 4000
c. Physical Shading	None	None	None	None	None	None	None	Moderate from mountains substantial from haze	None
3. Precipitation	6.1 days thunderstorms 2.6 in. snow annually	12.2 days thunderstorms 0.4 in. snow annually	2.4 days thunderstorms 0.1 in. snow annually	2.4 days thunderstorms 0.1 in. snow annually	2.8 days thunderstorms 0.1 in. snow annually	(Assumed) 2.8 Days thunderstorms 0.1 in snow annually	4.6 days thunderstorms 0.5 in snow annually	2.7 thunderstorms 0.0 in snow annually	8.9 days thunderstorms 0.0 in snow annually
4. Wind	30 mph 8.5 percent 40 mph 0.4 percent	30 mph 16.3 percent 40 mph 1.9 percent	30 mph 12.3 percent 40 mph 1.4 percent	30 mph 12.3 percent 40 mph 1.4 percent	30 mph 12.3 percent 40 mph 1.4 percent	30 mph 12.3 percent 40 mph 1.4 percent	30 mph 11.8 percent 40 mph 0.3 percent	30 mph 1.0 percent 40 mph 0.0 percent	30 mph 6.0 percent 40 mph 0.4 percent
5. Area	Proposed 100 acres, more available for purchase	Proposed 100 acres, more available	Proposed 100 acres, more available w/Navy approval	Proposed 100 acres, more available w/Navy approval	Proposed 100 acres, more available w/BLM approval	Proposed 100 acres, more available for purchase	Proposed 100 acres, more available for purchase	Proposed 100 acres, more available for purchase	Proposed 100 acres, substantially more owned by SCE
6. Topography	Even 2% slope, no flooding minimum site preparation	Nearly flat, sufficient slope for drainage, minimum site preparation	Locally rolling terrain net slope 4%, moderate site preparation	Nearly flat, sufficient slope for drainage, minimum site preparation	Even 3% slope, minimum site preparation	Nearly flat, minimum site preparation	Locally rolling, net nearly flat, moderate site preparation	Even 2% slope, minimum site preparation	Even 2% slope, minimum site preparation
7. Geology	Course sandy soil, good foundation	Consolidated alluvium, good foundation	Erroded alluvium good foundation	Consolidated alluvium good foundation	Consolidated alluvium good foundation	Coarse sandy soil on apparent alluvium	Dry lake bed type deposits of expansive soil. Poor foundation	Consolidated alluvium good foundation	
8. Seismicity	Near San Andreas Fault, ground acceleration .5+g	Estimated 0.2g ground acceleration	Minor faults, no estimate of ground acceleration	Important faults, no estimate of ground acceleration	Important faults, no estimate of ground acceleration	Not known	Not known	Not known	
9. Hydrology	No flooding	No flooding, ground water excellent	No flooding, ground water poor	No flooding, ground water variable in depth and quality	No flooding, ground water unknown	No flooding, possible groundwater	Much flooding apparent possible groundwater	No flooding, probable groundwater	No flooding, no groundwater
10. Rights of Way and Access	Site is private and would require purchase, Interstate 15 3 mi, access by paved and dirt roads	Site owned by SCE Interstate 15 4 mi, Interstate 40 2 mi, access by paved and dirt roads	Site owned by Navy, Hwy 178 3 mi, access road would have to be built	Site owned by Navy, Hwy 178 adjacent, Hwy 395 1/2 mi access by dirt road	Public land controlled by BLM, Hwy 14 1/2 mi, access by dirt road	Site is private and would require purchase. Highway 14 3 mi. Access by paved roads	Site is private and would require purchase. Hwy 14 5 mi. Access by paved road	Site is private used for cattle grazing would require purchase. I-5 6 mi access by paved and dirt road	Site is owned by SCE current open space. Adjacent to Hwy 62
11. Facilities and Services	Water supply California Aqueduct 1 mi, electricity from Lugo Substation, sewage disposal by leachfield, trash disposal same as substation. Traveler accommodations Victorville 15 mi	Water supply existing site wells, electricity from existing substation, sewage disposal by leachfield, trash disposal same as existing facilities. Traveler accommodations Barstow 12 mi	Water supply from Navy wells or sanitary effluent piped 7 mi, no nearby electricity sewage disposal by leachfield, trash hauled to dump. Traveler accommodations very limited in China Lake 9 mi	Water supply from Navy wells, Owens River Aqueduct or sanitary effluent, elect from distribution lines, other same as China Lake D	Water supply from Owens River Aqueduct 1 mi	Possible water supply from groundwater. No local electricity, possible sewage disposal by leachfield, probable haul trash to dump. Traveler accommodations limited in Mojave 22 mi	Possible water supply from groundwater. Local electric distribution lines, sewage disposal by sewer, probable haul trash to dump. Excellent travel accommodations 7 mi Lancaster	Water supply from aqueduct. Electricity 1 mi at pumping station, sewage disposal by leachfield, probable haul trash to dump. Travel accommodations 30 mi in Bakersfield	Water supply from Colorado River Aqueduct, sewage disposal by leachfield, trash to dump, Limited travel accommodations Parker 40 mi
12. Zoning and Land Use Restrictions	Land use is open space	Currently zoned "Desert Living." Requires zone change	Land use controlled by Navy. Within electromagnetic danger zone	Land use controlled by Navy. Within low level flight pattern	Land use controlled by BLM. BLM designation unknown	Land is open space adjacent to irrigated agriculture	Land is open space, we irrigated by flooding	Land use is cattle grazing	Land is open space
13. Air Quality	Substantial air pollution is blown over site during certain wind conditions source of pollution is San Bernardino area	Essentially clear	Essentially clear	Essentially clear	Essentially clear	Essentially clear	Essentially clear	Substantial fog and haze	Essentially clear
14. Airways	The site is not in the control zone or adjacent to any airport	The site is not in the control zone or adjacent to any airport	The site has limited effect on Navy flight patterns	Navy flight patterns would have to be altered	No known flight interference	No known flight interference	No known flight interference	No known flight interference	No known flight interference
15. Availability of Materials	Basic construction material available from Victorville 15 mi or San Bernardino 20 mi	Basic construction material available from Barstow 12 mi	Limited construction material available locally. Most would have to be trucked 75-150 mi	Limited construction material available locally. Most would have to be trucked 75-150 mi	Limited construction material available 20 mi Most must be trucked 40-50 mi	Basic construction material available Mojave 22 mi or Lancaster 40 mi	Basic construction material available from Lancaster 7 mi	Basic construction material available in Bakersfield 30 mi	Basic construction material Parker 40 mi Blythe 70 mi
16. Utility System Interface	Lugo Substation could be modified to receive power. However stepping up to high kV is not ideal	Through existing substation facilities	3 mi from 115 kV line. Substation would have to be built	115 kV substation adjacent could be modified to receive power	One mi from 138 kV line. Substation would have to be built	No nearby interface available	No nearby adequate interface available	Power would be tied to substation at Edmonston and used for pumping energy	No nearby power interconnection ayailable
17. Environmental Impact a. Biology b. Archaeology c. Aesthetics	a. Limited b. Moderate probability c. Receiver would be visible from I-15, Hesperia, Victorville, all populated sections in the area. Impact considered moderate	a. Very limited b. Moderate probability c. Receiver would be visible from I-15, I-40, Marine storage depots, Daggett, Calico ghost town	a. Moderate b. Moderate probability c. Limited visibility	a. Very limited b. Low probability c. Receiver would be visible from Inyokern, China Lake, Ridgecrest, Hwys 395, 178, 14	a. Moderate b. Low probability c. Interferes with natural views	a. Moderate b. Low probability c. Receiver would be visible from scattered ranches. Red Rock Road, Hwy 14	a. Moderate b. Moderate probability c. Receiver would be visible from Rosamond, Lancaster, Palmdale, Hwy 14, Edwards AFB	a. Minimum b. Low probability c. Receiver would be visible from Wheeler Ridge, Mettler, I-5, local ranches	a. Moderate b. Low probability c. Limited visibility

10 MWe SOLAR PILOT PLANT

TECHNICAL SUMMARY
EXHIBIT VIII-5

Based on a detailed assessment of site conformance with required criteria (on file with the County and DOE), the following conclusions were reached regarding individual site potential:

a. Conclusions

- Lugo - Considering most criteria, Lugo is acceptable but not the preferred site. Its major drawbacks being that: the land is privately owned and would require purchase; a pipeline would be required for water supply; and occasional substantial air pollution from San Bernardino reduces insolation.
- Coolwater - Coolwater is determined to be the best site and is rated excellent on most criteria. The least favorable factor is wind which will be considered during design.
- China Lake D - This site is determined to be unacceptable for the following reasons: Topography would require earth moving and drainage for site preparation, access roads would have to be built, facilities and services are poor, material availability is limited, use of the site may conflict with other Navy plans, and utility interface would require several miles of transmission line and construction of a substation.
- China Lake C - Considering most criteria, this is an acceptable site. The major drawback, interference with low level aircraft operations, would require mitigation by the Navy.

The site is excellent considering most solar specific criteria and water may be available from Navy wells. Other than aircraft, the local availability of materials and travel facilities are the site's only limitations.

- Freeman Junction - By most criteria, this is an acceptable site, but there are several considerations which combine to render it infeasible for the Pilot Plant. These include the following: A pipeline would be required to supply water; the land is controlled by the BLM and site approval could be difficult to obtain; local facilities and services are very limited; a substation would have to be built for interface; and natural aesthetic views would be disturbed.
- Cantil - By most criteria, this is an acceptable site. Its drawbacks are limited services, possible difficulty obtaining water, private land ownership and no local utility interface.
- Edwards - This is generally a poor site. By many criteria, it is marginal, but it is poor considering flooding, water supply, private land ownership, biological sensitivity, and no local utility interface.
- Edmonston - The site complies with most criteria, however, overriding considerations of substantial shading by haze and fog and private land ownership used for grazing livestock render it unacceptable.

- Rice - Based on most criteria, this is an excellent site for solar development. However, the site is best suited for large scale development rather than for a pilot plant. The site's drawbacks for the Pilot Plant are related to its remoteness. Transmission lines would be required which cannot be justified for a 10 MWe facility. Also, lack of visitor facilities limit the site's usefulness for public accessibility.

Based on this analysis, it was concluded that Coolwater is the preferred site in California for development of the 10 MWe Solar Pilot Plant.

F. Alternate Use of Funds

1. DOE Alternatives

The 10 MWe Pilot Plant is an essential part of DOE's Solar Electric Program, which is an important element of the National Solar Energy Program which, in turn, is an important element of the overall National Plan for Energy Research, Development and Demonstration. These two National Plans were prepared in response to the requirements of the Energy Reorganization Act of 1974 (PL93-438), the Solar Research, Development and Demonstration Act of 1974 (PL93-473) and other legislation, and represent the optimum balance of funding for the various energy projects, including the subject project.

2. State Energy Commission Alternatives

The Commission's commitment of up to $800,000 over the life of the project is subject to approval by the Legislature for each year's allocation. The Commission's current solar program places emphasis on 6 program areas:

- Active hot water and space heating
- Passive space conditioning for buildings
- Wind-electric generation
- Solar thermal electricity
- Consumer and professional information services
- Planning and governmental projects

Funds must be allocated each year to the program areas. Alternative uses of the Pilot Plant funds would be to increase the budget allotments of some or all of the remaining 5 solar program areas.

One of the purposes of this Pilot Plant is to determine the net benefits and drawbacks of solar thermal electric generation as compared with these other solar programs.

G. <u>No Project</u>

If the Pilot Plant is not constructed, certain research-related benefits will not be available for commercial STE application. Important elements of DOE's solar research program will not be realized. Utilities and DOE will be confined to data provided by research of the 5 MWe STE test facility located at Albuquerque, New Mexico.

IX. ENVIRONMENTAL TRADE-OFF ANALYSIS

A. Short-Term

The Pilot Plant's research benefits relative to the future application of commercial solar technology offset the plant's minor, short term environmental effects. However, the beneficial aspects would be somewhat negated if it was later determined that STE research and development activity never should have been performed due to unforeseen lack of merits relative to a superior form of solar generation.

B. Long-Range

The Pilot Plant will contribute to future decisions influencing the commercial use of solar energy which in turn will set in motion a series of environmental trade-offs. Assuming that coal, nuclear and solar energy forms will provide the major mix of future electrical generation, it is probable that solar energy's contribution will result in beneficial trade-offs. However, commercial STE application will not be without some adverse affects.

The degree of STE generation utilized could eliminate a proportional amount of coal mining, coal-induced air quality degradation, nuclear safety hazards and nuclear waste disposal. On the debit side, commercial STE plants will probably require (per unit of electricity produced) more mineral extraction for their material-intensive development and significantly more land area.

STE plant siting will not only be restricted by land and water constraints, but also by sunlight-diffusing air pollution. Locations near coal electric complexes where infrastructures could be conducive to increased populations in the southwest may prove to be unacceptable STE sites due to the consistent existence of fine-particle ash in the ambient air.

STE development will still require large amounts of oil and gas for mining, construction, operation and support in the foreseeable future.

Solar thermal development will probably be less net growth-inducing than similar capacity coal-fired plants due to less reliance on fuel mining, transportation and distribution; and due to its reduced manpower, air pollution control and other appurtenant requirements.

X. DETAILED ANALYSIS: NATURAL ENVIRONMENTAL RESOURCES

The significance and magnitude of many of the following solar-specific impacts are generally unquantifiable and probably will remain so until the full benefits of the Pilot Plant's research aspects are realized. This Pilot Plant is in essence a "capital investment" in the determination of future impacts.

Sections X and XI contain an assessment of this Pilot Plant's potential impact on the environment and the effect of the existing environment on the plant's operation. Commercial development of solar/thermal electric stations would magnify these effects, but this report is confined to the proposed Pilot Plant. The longer term issues and impacts associated with construction and use of commercial solar/electric facilities are generally described in various energy publications and should be specifically analyzed prior to large-scale development. Sections V through IX do, however, contain references to the Pilot Plant's contribution to the realization of some of these inferred long-range impacts. An objective of the plant design, construction and operation is to determine the environmental impacts of solar thermal central receiver plants.

A. Geology

1. Current Status

a. Regional Geologic Setting

The site is located in the western portion of the Mojave Desert Geomorphic Province, one of eleven major geomorphic provinces within California. This province is bounded by the Tehachapi Mountains and the Garlock fault on the north and northeast, by the San Andreas fault, the mountains of the Transverse Ranges and the Colorado Desert on the south and southwest; and by the Basin and Range geomorphic province on the east.

The western Mojave Desert consists of broad alluvial filled plains and basins ranging in elevation between 2,000 and 3,000 feet, interrupted by isolated hills and valleys. Discontinuous northwest trending mountain ranges rise from several hundred to almost 3,000 feet above the surrounding terrain. Alluvial fans blanket the base of the mountains. There are many basins of interior drainage, resulting in the formation of dry lakes ranging in area from hundreds of acres to about sixty square miles.

The western Mojave Desert is drained by the ephemeral Mojave River, which flows northward from the San Bernardino Mountains through Victorville, then eastward by Barstow and Daggett, terminating at Soda Dry Lake in the eastern Mojave Desert, fifteen miles east of Afton.

This desert area is underlain principally by Mesozoic intrusive igneous rocks ranging from granite to diorite. There are also limited occurrences of older metamorphic rocks. These basement rocks form many of the topographic highs in the region. Tertiary volcanic rocks intrude or overlie the basement rocks in many areas.

Tertiary non-marine sediments occur in limited regions. Alluvial deposits of Pleistocene and Holocene age, ranging to several hundred feet in thickness, cover more than 50% of this desert area.

The dominant structural features in the region are the many northwesterly trending faults, several of which are at least sixty miles in length. Many of the longer faults are active based on evidence of ground displacement during Holocene time and on earthquake epicenters located on or near their traces. Vertical displacements along these faults has formed many of the hills and mountains as well as adjacent basins of interior drainage. Most of the older igneous rocks are strongly jointed from the regional stresses which produced the faulting.

b. Site Geology

The site is located on the old flood plain of the Mojave River in a 4 mile wide alluvial-filled valley. A five mile long dry lake bed occurs two miles north of the site and about a mile north of the river bed.

The valley is flanked by the Calico Mountains to the north and the Newberry Mountains to the south, both of which are composed principally of Tertiary volcanic and sedimentary rocks. Rocks of a portion of the Calico Mountains have been folded and faulted and dip about 35° to the southwest. They are unfaulted in the portion of the mountains north of the Coolwater Generating Station.

Alluvial deposits in the valley consist of sand and gravel hundreds of feet in depth. These deposits, in turn, are underlain by indurated Pleistocene fanglomerates possibly several hundred feet in thickness. Based on sedimentary outcrops along the borders of the valley, Tertiary shale, sandstone and conglomerates many hundreds of feet in thickness are believed to underlie the alluvium and fanglomerates. Basement rock in the area consists of granite and diorite.

The site area was previously in alfalfa production and is nearly flat. Occasional small mounds of accumulated blow sand and small depressions exist throughout the 320 acre parcel that will contain the actual 130 acre plant site. A borrow pit exists at the southern portion of the 320 acre parcel.

c. Seismicity and Faulting

The site is considered to be in an area of moderate seismicity. The closest potential source for a major earthquake of magnitude 8 or more is the San Andreas fault, which passes sixty-five miles southwest of the site through Cajon Pass and north of the City of San Bernardino.

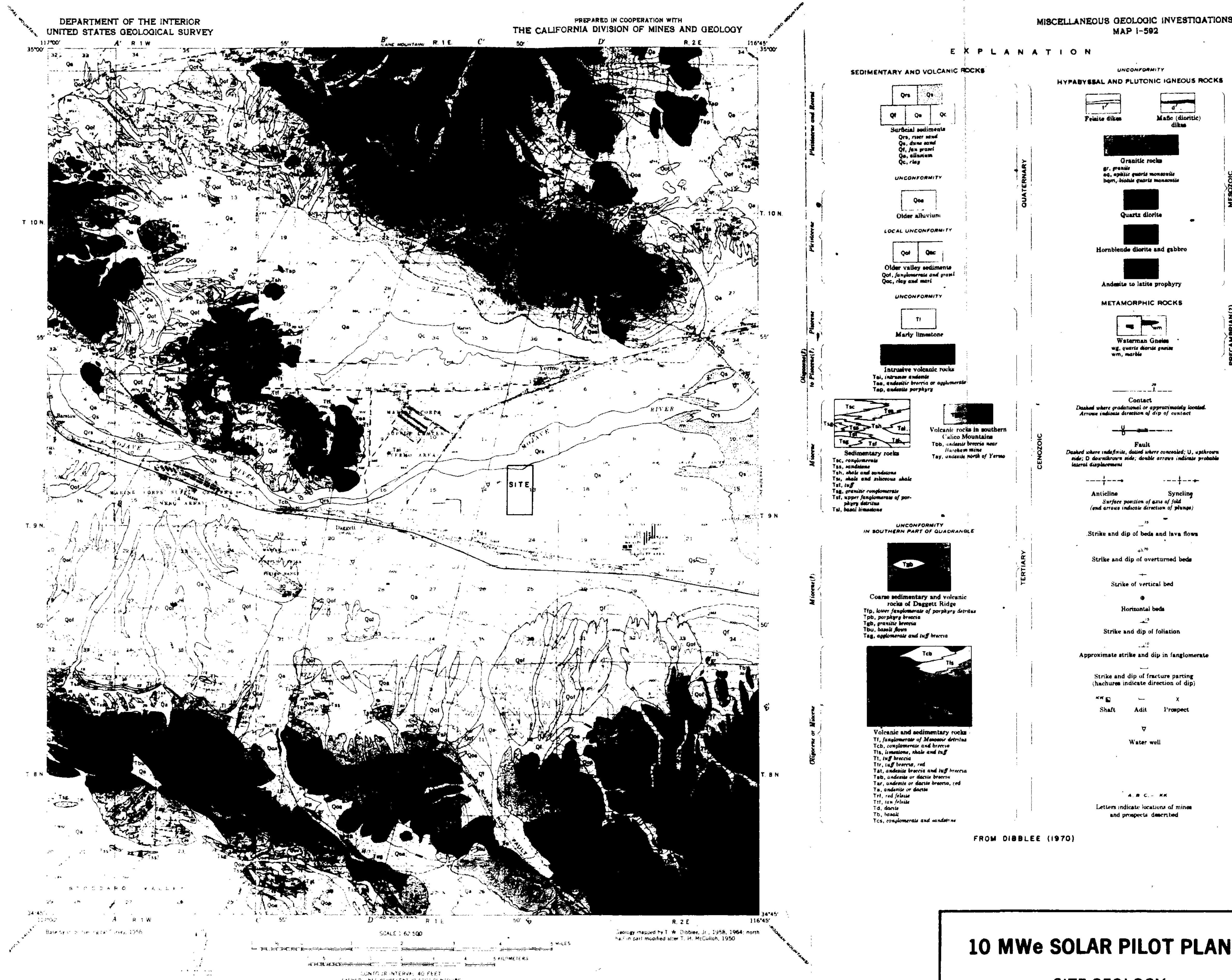
Within a radius of twenty-five miles from the site, there are five faults from fifteen to at least sixty miles in length, all of which can be considered active based on displacement of late

Holocene sediments and/or historic seismicity (Exhibits X-1 and X-2). All of these, except for the Manix fault, trend in a northwest-southeast direction. The faults appear to be steeply dipping with vertical displacements in the range of several thousand feet although there is also evidence for lateral displacement.

The longest of the five faults previously noted is the sixty mile-long Helendale fault, twenty-three miles southwest of the site. The forty mile-long Lenwood fault and the thirty mile-long Camp Rock faults are to the southwest, nine and three miles, respectively. The 50 mile-long Calico-Newberry fault is six miles to the northeast. The Manix fault, which trends east-northeast against the regional structural grain, ranges from eight to twenty-five miles northeast of the site.

Of the five faults previously noted, the Manix generated the largest historic earthquake, a magnitude 6.2 in 1947. A scattering of earthquake epicenters ranging from a magnitude of 4 to 4.4 have been recorded near the northern limit of the Calico-Newberry fault about nine miles northwest of the site. In addition to numerous earthquake epicenters near the southern terminus of the Helendale fault, recent trenching across its trace in Lucerne Valley, thirty miles south of the site, indicates relatively recent (Holocene) activity. (Exhibit X-2)

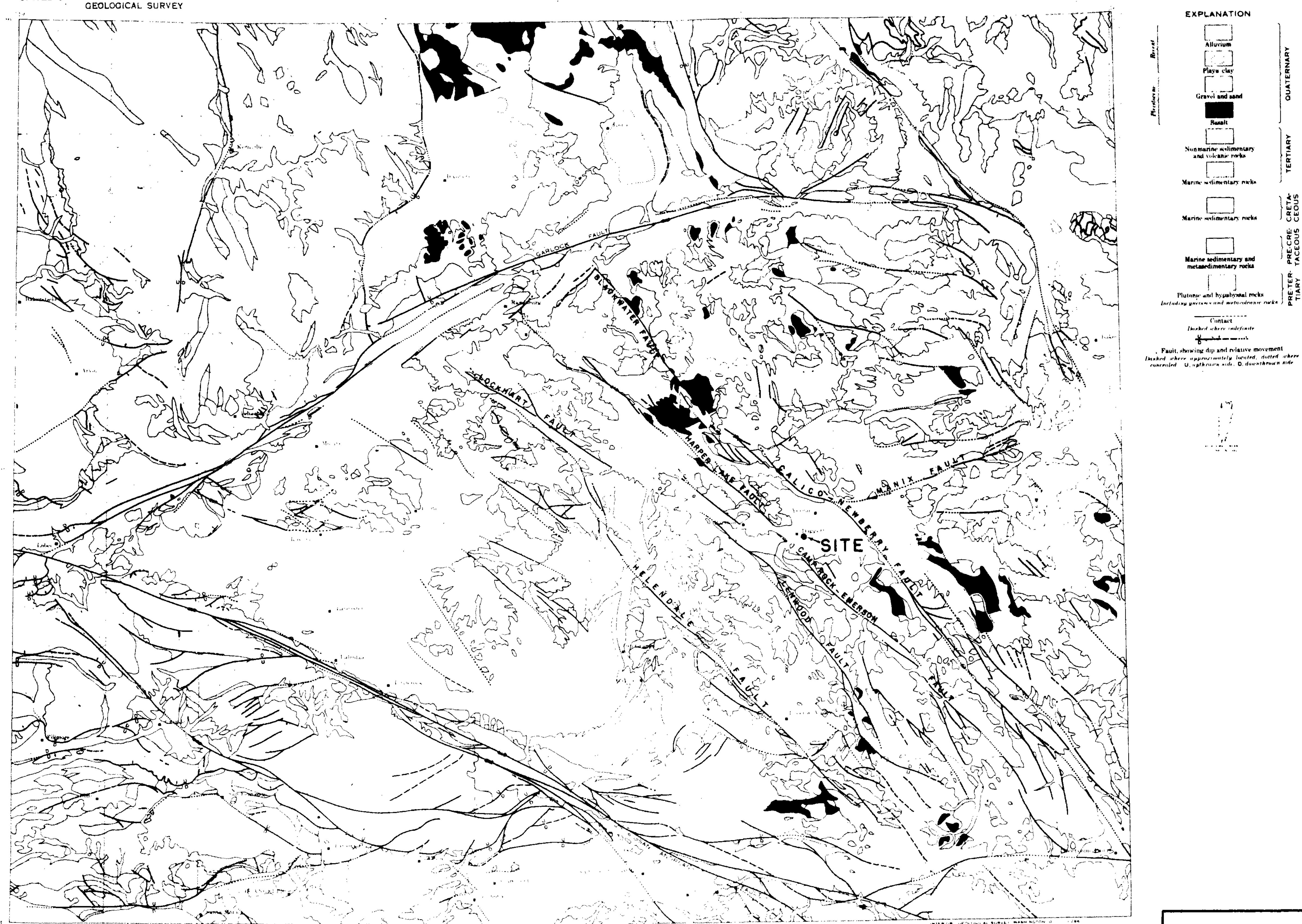
Probably the most likely source of strong shaking on the site would be an earthquake of a magnitude 8 or more on the San Andreas fault in the Cajon Pass/San Bernardino area or an earthquake on the Manix of a magnitude similar to the shock of 1947. It is



10 MWe SOLAR PILOT PLANT

SITE GEOLOGY
EXHIBIT X-1

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



GENERALIZED GEOLOGIC MAP OF THE MOJAVE DESERT REGION, CALIFORNIA

10 MWe SOLAR PILOT PLANT

REGIONAL FAULT MAP
EXHIBIT X-2

estimated that either event would produce an acceleration at the site on the order of 0.20 g to 0.25 g and a shaking intensity of about VII to VIII on the Modified Mercalli (MM) scale. Perhaps a slightly higher acceleration and more intense shaking would result from an earthquake centered near the site on the Calico-Newberry fault, but the possibility of such an event during the life of the project does not appear to be as great as strong shaking from an earthquake on the San Andreas or Manix faults.

d. Mineral Resources

Gold and silver have been mined in the Calico Mountains and Rodman Mountains north and south of the site respectively. Borates were taken from the region north of Daggett at the turn of the century.

Close inspection of the site did not disclose any economic mineral deposits or evidence of present or past mineral exploration, commercial mining or quarrying operations, other than the on-site borrow pit. The closest evidence of major commercial mineral production in the area is an old, deep borrow pit approximately a mile in length by 1000 feet wide adjacent to the railroad approximately 0.6 miles to the south (Exhibit II-4a). The coarse fanglomerate material removed was used for railroad track base. The river deposites at the site are much finer grained and do not contain sufficient gravel for this purpose (boring logs on file). The lack of gravel also precludes the potential for a profitable aggregate operation.

Bedrock is at least several thousand feet in depth and consists of continental sedimentary rocks and tuff breccia which would preclude the occurrence of oil and gas. Bowen (1954) states that Paleozoic rocks would be so highly metamorphosed that the possibility for the presence of oil and gas is extremely remote.

Within the near vicinity of the site there are no known faults or other structures which might be considered likely zones of significant mineral deposits. The great depth of alluvium in the area would essentially preclude bedrock mining operations even if valuable minerals were discovered in bedrock under or near the site.

2. Project Impact/Mitigation

a. Topographical Alteration

A minimum of surface ground leveling will be required over approximately 100 acres for heliostat and facility installation. Any new access roads to and around the site will follow the natural ground contour, therefore, landform alteration will be extremely minor. Although unlikely, if excess dirt is needed on the site, it will be taken from the local, existing borrow pit. (See Section B, "Soils", for additional impact assessment.)

- Mitigation

None Required.

b. Seismicity

Ground shaking from an earthquake is an impact of the existing environment on the Pilot Plant itself. Environmental impacts are not just those stemming from a project's effect on the environment. The only significant geologic hazard to the site would be ground shaking produced by a large magnitude earthquake on the San Andreas fault or an earthquake of moderate magnitude generated on a relatively nearby fault. There is no evidence to suggest surface faulting through the site area.

The probability of accelerations of 0.25g or greater at the site was computed knowing the life expectancy of the Pilot Plant and the number of events that are expected to occur. The probability of an event causing 0.25g acceleration or greater at the site within the next 5 years (expected period of research and development activity) is about 2-1/2% and about 14% within the next 30 years (SCE).

A quake of lesser magnitude might result in the need for major facility repairs. Surface rupture during ground shaking is a minute possibility. Vulcanism has historically occurred in the region, but its potential for affecting the site is unquantifiable and remote.

Even slight ground shaking could affect heliostat/receiver alignment, however the computerized solar tracking system would automatically make minor adjustments.

- Mitigation

The granular nature of the alluvium on the site, and the relative depth of the water table will preclude settlement or liquefaction from earthquake shaking.

The steel tower and the receiver structure will be designed to withstand a 0.25 "g" horizontal seismic load input at the base of the tower. (The Coolwater Generating Station is designed for a maximum ground acceleration of 0.25 g). This is based on a probable magnitude 6 quake, 10 miles from the site.

The occurrence of significant ground shaking during the Pilot Plant's 5 year research and development period might prove valuable in determining seismic design criteria for possible future commercial solar plants.

(c) Off-Site Geology

The mining of the minerals needed to produce the Pilot Plant equipment may be intensified since more glass and steel per megawatt capacity is required for a solar collection plant than for a fossil fuel station. (See Chapters V and VI and IX). Type B407 (nickel and chrome) material may be used in the receiver, requiring mining of semi-rare metals. (Exhibit X-3)

- Mitigation

The utilization of improved technology resulting from research and development of this Pilot Plant to reduce material requirements would be of significant value.

B. Soils

1. Current Status

The surface soils on the site are predominately well to poorly graded sand. Below 5 feet, the soils are predominately sandy. At depths greater than 10 feet, the soils are generally well

EXHIBIT X-3

CRITICAL MATERIALS REQUIREMENTS FOR STE PLANTS*
(tons/MWe)

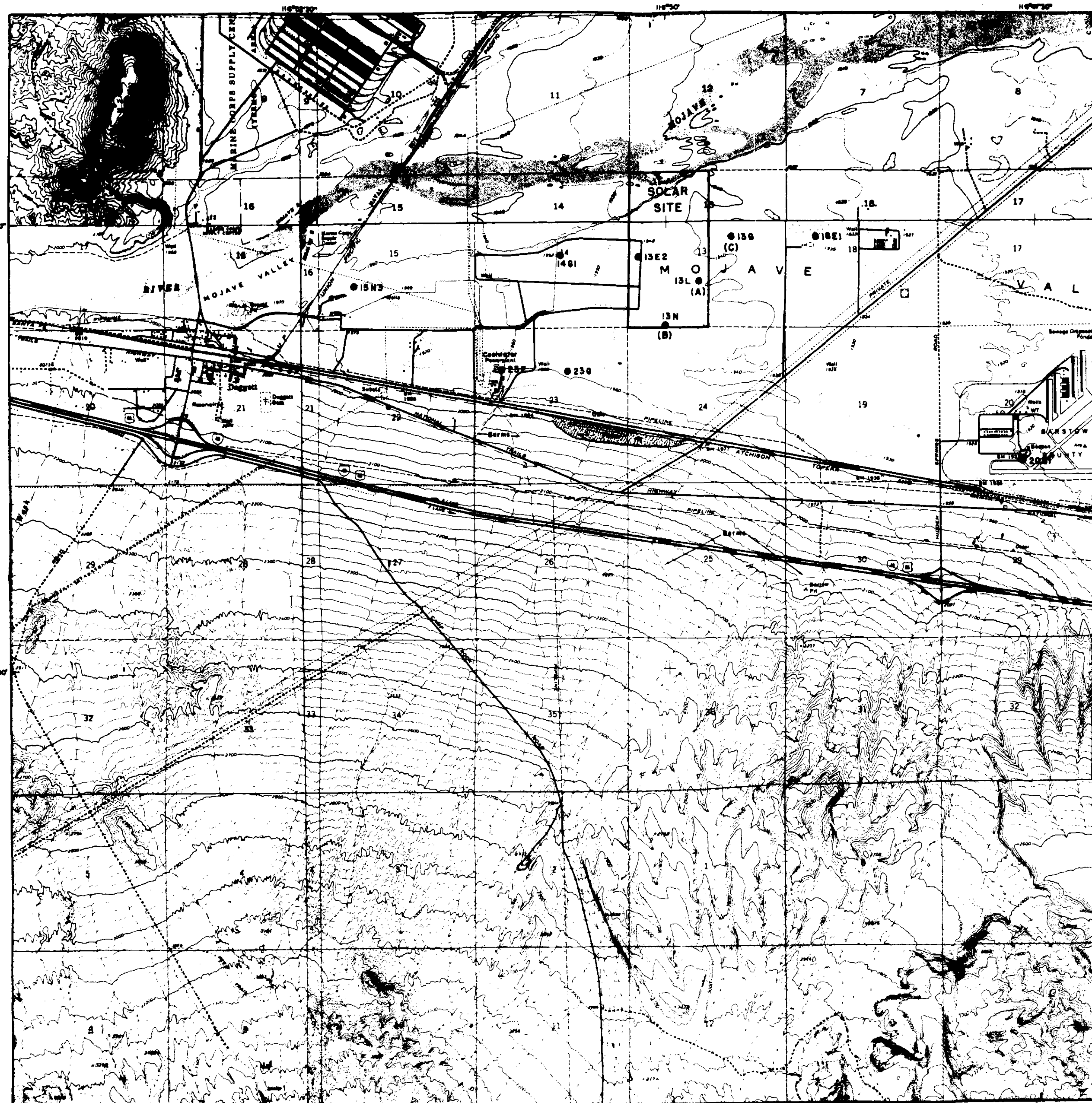
	Central Receiver
Steel	500-700
Concrete	1500-2500
Glass	50-100
Aluminum	20-50
Copper	5-10
Plastic	5-20
Insulation	20-40
Chrome/Titanium	1-2
Silver	0.01-0.05
Miscellaneous	5-10

*Source: MITRE Corporation, Analysis & Planning Support for DOE DSE.

graded sand with some silt and some gravel. Soil within the top five feet is only moderately firm and contains some silty sand lenses. Where moderately heavy foundation loads were imposed on spread or mat type foundation at the Coolwater site the top 5 feet of material was excavated and recompacted. Very heavy loads are adequately supported on the cemented, dense gravelly sands at a depth of 10 feet. There are no soft, compressible layers below a depth of 5 feet. At a depth of 5 feet, spread or mat type foundations have a bearing capacity of 5,000 pounds per square foot (psf).

At a depth of 10 feet the bearing capacity is 10,000 psf. Both of these recommended bearing capacities consider a settlement of about 1/2-inch with 90% of the total settlement occurring during construction. The angle of internal friction of these sandy soils is approximately 35°. Foundation problems at this site due to weak or compressible soils are not anticipated even for very high loading.

In late 1976, and early 1977, three new water wells (A,B&C) were drilled for Coolwater Units 3 and 4. These wells are located in Section 13 to the south and east of the preferred 130 acre site (Exhibit X-3a) and are the closest deep borings to the site. Boring depths were 371 feet for Well A, 400 feet for Well B and 380 feet for Well C. Each boring was continually logged and sampled every 10 feet. (Boring logs are on file for reference.) Soils logged from Well A, consisted of a medium to coarse grained sand. Well B showed predominately medium to



EXPLANATION

● 13E2 WATER WELL

SCALE 1:24000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10 FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

10 MWe SOLAR PILOT PLANT

TOPOGRAPHIC MAP OF SITE REGION WITH LOCATION OF WATER WELLS
EXHIBIT X-3a

coarse grained sand to 300 feet. Below 300 feet a distinctive lithologic change occurred with a high percentage of volcanic gravel in a sandy clay matrix. This is interpreted to be Pleistocene fanglomerate originating in and sloping north from the Newberry Mountains. Well C material consisted primarily of medium to coarse sand. A cross section was not made because of the lensing nature of the river deposits.

In 1972, percolation tests were conducted for the design and installation of a commercial sewage disposal system for the Coolwater Generating Station. Six trenches were excavated near the existing cooling towers to depths ranging from 58 to 132 inches. Soil logs are presented in Appendix A. Hand-dug percolation holes 6 to 18 inches in diameter and 8 to 12 inches deep were then placed in the bottom of the excavations. The percolation holes were pre-saturated overnight before the tests were conducted. Procedures used for the tests are outlined in the "Manual of Septic Tank Practices", 1971 edition, published by the U. S. Department of H.E.W.

The percolation time of the test holes ranged from a low of 2 to a high of 4 minutes per inch with an average of 3 minutes per inch. The percolation time is considered adequate for septic tank usage. A tabulation of the test results is shown on Exhibit X-4.

2. Project Impact/Mitigation

a. Surface Leveling - Wind Erosion

Approximately 100 acres may be surface graded if necessary to provide adequate drainage off of the heliostat field and central

EXHIBIT X-4

PERCOLATION TEST RESULTS

Test Hole	Depth Below Adjacent Grade in Inches: Bottom Backhoe Pit	Depth Below Adjacent Grade in Inches: Bottom Percolation Hole	Percolation Time in Minutes per Inch
1	66	77	3
2	62	74	2
3	69	77	3
4	58	68	4
5	62	73	2
6	63	73	2

facility area. (The site's topography includes small depressions and dune hummocks that possibly formed after farming ceased.) Leveling will strip the parcel of vegetation and will break the recently formed thin soil crusts created by particle sorting thereby exposing some of the finer silts and clays in the top soil layer (see log borings) to wind and water erosion. Since the site is essentially flat, most soil loss will be via wind erosion. After an unknown period of time the fines will have been carried off by moderate to heavy winds and/or will combine by rain action to form additional crusts. Even the relatively large sand particles will be moved by heavy wind storms. This lack of ground cover and soil crusts will persist well beyond the construction stage and resulting dust may effect the heliostat's solar collection potential, thereby necessitating a more intense mirror washing schedule.

A non-SCE farming operation 1/2 mile east of the site would be the closest downwind recipient of blowing dust and sand.

- Mitigation

Surface leveling might be avoidable if sufficient alignment compensation for slightly uneven terrain could be incorporated into each heliostat base. However, construction activity alone will probably disturb site soils as much as would leveling. Temporary erosion control measures are available including sprays, blanket materials and wind screens, but will probably not be required. The heliostats, combined with alterations of ground heating, may decrease wind speeds thereby reducing wind erosion within the collector field, but increased turbulence could create the need for additional mirror washing. (See X-D/Climate) Water run-off to the ground from heliostat cleaning will aid in combating wind erosion.

Shade tolerant grasses could be planted under the heliostats for soil retention and dust prevention. (See X-E/Air Quality). A layer of gravel could also be considered. However, soil erosion and dust are probably not significant enough constraints to the Pilot Plant operation to warrant paving or other forms of soil cover or treatment since the projected use of the Pilot Plant is relatively short term. (See "Air Quality" section for an additional analysis of fugitive dust potential.)

b. Various Excavations

Construction of tower, heliostat and building foundations will result in an approximate net soil displacement (excavated volume) of 5000 cubic yards. Trenching for cable and pipeline laying will probably not displace significant amounts of soil. The containment basin to be constructed around the heat storage unit (to retain oil leaks) should not result in excess excavation since all excavated dirt from the basin will be used for the dikes.

- Mitigation

The well logs indicate that soil types are fairly consistent to the depth that would be excavated for the deepest foundation. Therefore the excess soil could be distributed over the 100 acre portion of the parcel to be distributed without substantial effect, other than a possible increase in fines susceptible to short-term wind erosion and a slight dilution of soil organics. The excess soil could also be utilized for the containment basin dikes. Plant construction will not require soil stock piling on or exportation off the site since any excess can be spread out over the disturbed area.

c. Soil Settlement/Consolidation

The 200 ton, 325 foot high receiver tower will result in significant pressure under its 50 square foot foundation. Settlement, especially after soil saturation from heavy rains, could affect tower (and even heliostat) alignment. Slight ground subsidence from ground-water overdraft is also a possibility (see "Hydrology").

- Mitigation

The foundation design will incorporate soil constraint engineering data stemming from recent construction of Units 3 and 4 at SCE's Coolwater Generating Station, 1/4 mile west of the Pilot Plant site. The proposed foundation (built to a depth of 15 feet below surface) should adequately support the tower at that soil depth. Site-specific soil strengths will be determined and utilized in foundation design.

d. Soil Compaction

After site leveling is finished, construction and operation vehicles will compact soils, especially on dirt roads and in the collector field along heliostat washing routes. Soil compaction increases velocities and amount of runoff, decreases percolation, decreases aeration, reduces soil moisture, increases soil temperature fluctuations, restricts plant growth/seed germination and displaces or kills burrowing wildlife. (Wilshire et al. - See Bibliography).

- Mitigation

Moist soils will be more susceptible to compaction than when dry. Roots of bermuda or other type grasses could help to keep soil pores open even along paths used by trucks for automated heliostat washing. Off-road driving should be held to a minimum. Rejuvenation and aeration of the site's sandy soils for future farming uses (for example) could be achieved by deep plowing.

C. Hydrology

1. Surface Runoff

a. Current Status

Precipitation accumulates in the Newberry Mountains south of the site and flows down the alluvial fan toward the Mojave River bed via dendritic channels and ephemeral washes. Most of the runoff that would normally reach the site is diverted by the railroad berm and the deep borrow pit south of Interstate 40 and is also channelled away from the site through culverts. The remainder of the runoff is directed to a drainage course through the Coolwater site and channelled eastward where it spreads over the flat terrain in Section 23. The Department of Water Resources (1967) estimated that 800 acre-feet of water was the annual runoff from the 140,000 acres of mountains surrounding the entire lower Mojave

Basin using a higher than average annual rainfall of 6.9 inches. Only a small portion of this total runoff flows along the fan as indicated by its lack of significant erosion.

The extreme northern portion of the SCE property is traversed by the wide ephemeral multi-braided Mojave River bed. Surface river flow in the site area occurs only during floods. Over-flowing of the river banks is a minute possibility and therefore does not pose a serious threat to the site (County Flood Control Department). Major site flooding has never occurred during SCE's tenure on the property.

The site is located on a nearly flat, (maximum 2 foot relief) old flood plain adjacent to and above the existing flood plain of the Mojave River. The surface of the site contains several broad shallow channels crossing from the southwest toward the northeast. Runoff on this surface would be sheet flow toward the river. There are no major gullying or other forms of severe erosion on the site. A small closed depression exists in the southwestern portion and probably ponds water during heavy storms. Some gullying and headward erosion occurs at the river bluff on the northern part of the site. The potential for water induced erosion on the site is very low due to the flat terrain, permeable sandy soil and the diversion of most of the runoff from the Newberry Mountains away from the site.

b. Project Impact/Mitigation

(1) Surface Runoff

Surface levelling will remove ponding depressions and will generally augment sheet flow along the existing north east trending gradiant to the River. Small runoff diversions may be constructed around the various foundations to prevent localized ponding. The thermal storage containment basins and surrounding dikes will require slight channelization of normal sheet flow drainage.

The heliostats, with mirrors in a "collection position", will actually cover approximately 22 acres (24%) of the 90 acre collector field. Rain water running off the imprevious collector surfaces will therefore be more concentrated, but should not significantly increase runoff amounts or velocity since the porous sandy soils will still accomodate normal precipitation. Runoff from heavy rainfall (i.e., thundershowers) falling on the field may be slightly increased, resulting in some gullying, but will not require major channelization. Paving the surface under the 90 acre heliostat field would definitely increase runoff velocity and amounts thereby affecting downstream conditions, but such impacts will not be quantified since paving is not presently being considered. Compacted dirt roads in the heliostat field used for automated heliostat washing will tend to channel and increase speed and amounts of runoff. General soil compaction will increase runoff. Application of a dust control chemical could decrease soil permeability and thereby also increase runoff.

The off-site visitor center's paved parking lot will also concentrate runoff, slightly modifying down stream flow patterns. The Pilot Plant would be more affected by flooding than would the adjacent Coolwater Generating Station due to the large, spread out collector field, however, the proposed site is not vulnerable to significant flooding potential.

The following quantification (cubic feet/second) of increase in storm runoff from the site after project completion was performed by the County Flood Control District.

An accurate value for increase in runoff from the site cannot be calculated at this time because the final plant layout has not been developed and detailed studies of soil and hydrologic conditions have not been made. However, an approximation of the surface runoff can be made based on using a runoff coefficient typical of flood plain deposits occurring along the Mojave River and by taking the average historic maximum intensities between stations at Red Mountain, 56 miles to the northwest, and the town of Needles, 112 miles to the east.

The maximum land area to be covered by structures and parking facilities is expected to be approximately 80,000 square feet. Assuming an additional 80,000 square feet of paved roadway and considering that the total area of the heliostat foundations would probably not exceed 40,000 square feet, the combined area of essentially 100 percent runoff would be 200,000 square feet, or approximately 5 acres within the 130 acre site. Site earthwork and grading in unpaved areas is not expected to significantly affect the runoff coefficient. Using a runoff coefficient for the existing undeveloped site of 0.2 and a one hour maximum rainfall intensity of 1.1 inch, maximum runoff from the site under present conditions would be 26 cubic feet per second. Runoff from the developed site would total approximately 30 cubic feet per second, representing an increase of 15%.

Because of the nearly flat terrain (0.004 percent gradient) and near absence of well developed drainage courses, most of this runoff would be in the form of sheet flow which would not cause significant erosion on or off the site.

- Mitigation

If heavy runoff from the heliostats causes gullying in the collector field, the mirrors could be placed in vertical positions thereby significantly reducing the amount of impervious surface (mirror faces) and increasing available porous surface (soil).

Paving in the collector field should be avoided if possible. If dust control measures requiring paving or some sort of soil erosion control become necessary, runoff collection devices should be installed north and east of the field to accomodate increased flows and keep them from eroding non-paved areas. Possibly a culvert would be required to channel runoff to the river bed in order to reduce chances of headward erosion on the river bank.

Roads in the heliostat field should include runoff berms or channels. Less total net soil compaction might result over the field

field if dirt or paved roads were not constructed along each row or "arc" of mirrors. Heliostat-washing trucks could probably traverse the field without graded roads. A study should be made to determine the actual need for roads in the field and runoff facilities should be designed accordingly.

The actual 130 acre site consisting of 90-100 acres of concentrated facilities should be positioned on the 320 acre parcel far enough south of the Mojave River bluff to be free of erosion channels leading to the bluff and the headward erosion affecting the bluff.

2. Ground Water Supply and Quality

a. Current Status

(1) Hydrogeologic Conditions

The Lower Mojave River Valley is an irregularly shaped north-easterly trending valley that covers an area of about 300 square miles. It contains the Lower Mojave Hydrologic Subunit, the Troy Hydrologic Subunit and the Caves Hydrologic Subarea as delineated by the Department of Water Resources.

These various subunits and subareas essentially cover the Mojave River tributary drainage area between the U.S. Geologic Survey stream gaging stations at Barstow and Afton. The groundwater within the Lower Mojave River Valley occurs primarily within alluvial deposits. The recent alluvial channel between Barstow and Daggett is quite narrow. East of Daggett in the vicinity of the site, the alluvial area widens considerably.

The alluvial materials that comprise a large part of the water-bearing deposits in the Lower Mojave River Valley are composed of sand, gravel, silt and some clay. A study of available water well logs indicates that there are no continuous fine-grained beds that would create confined or perched water conditions. The fine-grained materials appear to be in the form of lenses within sand and gravel deposits.

Rising water occurs at several locations along the channel of the Mojave River, namely, upstream of the Calico-Newberry fault at Camp Cady Ranch and at Afton Canyon.

The heterogeneous, water-bearing alluvial deposits that constitute the ground water basin are primarily the result of stream erosion of the adjacent highlands. These alluvial deposits average about 300 feet in thickness, within a range of a few feet to over 1,000 feet. The saturated portion of these deposits averages about 360 feet in depth.

The specific yield of the water-bearing alluvial deposits varies throughout the basin. The average specific yield is approximately 14% with a range from 3 to 25%.

(2) <u>Groundwater Movement</u>

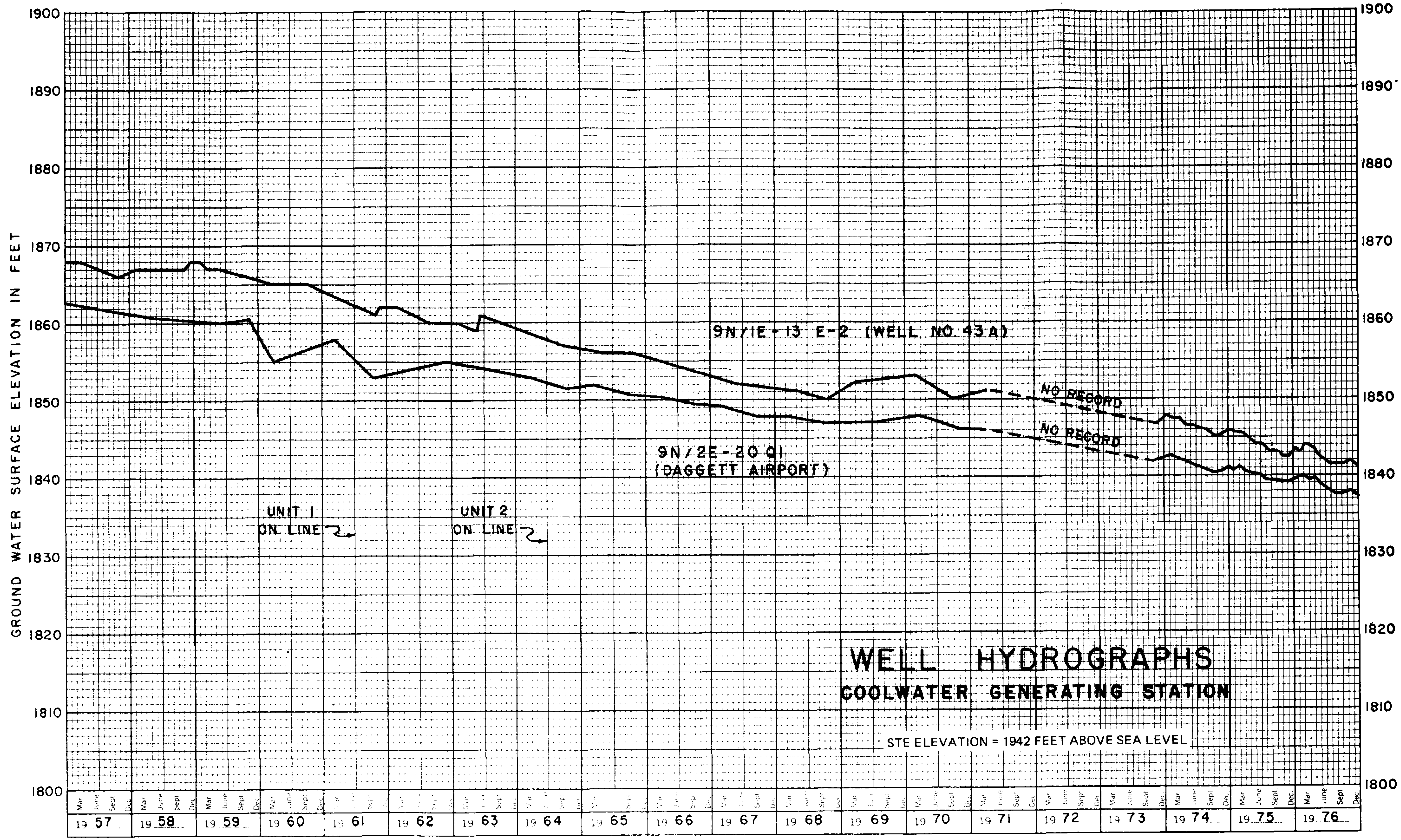
The groundwater within the Lower Mojave River Valley moves in a general easterly direction. The source is the north slopes of the San Bernardino Mountains to the south.

There are at least two faults in the lower Mojave River Valley that have a known effect on the movement of groundwater. The

Waterman fault creates an offset in the ground water surface of about 45 feet just easterly of the Nebo Supply Depot as determined by exploratory drilling performed by the U.S. Geologic Survey. The Calico-Newberry fault causes a difference in water levels of 50 to 60 feet on either side. It diverts the groundwater (on the western side) southeasterly toward Newberry and therefore it has the most pronounced effect on the movement of groundwater in the Lower Mojave River Valley.

Exhibit X-5 illustrates historic fluctuations in groundwater level in the vicinity of the site and downstream in the Lower Mojave River Valley. A cumulative water supply surplus or deficiency curve is presented in DWR Bulletin No. 84 for the base period of 1936 to 1961. Comparison of the two figures shows that, in general, water levels in the area increased from 1936 to about 1945, but decreased from 1945 to the present. Overdraft conditions began in about 1953. Coolwater Units 1 and 2 went on line in 1961 and 1964, respectively, (as shown on Exhibit X-5), using ranch water previously used for farming.

Groundwater gradients through the Lower Mojave River Valley vary widely. The narrow alluvial trench between Barstow and Daggett has a very steep gradient of about 20 feet per mile. The area between the site and the Calico-Newberry fault has a very flat gradient of about 1.5 feet per mile. The gradient from the Calico-Newberry fault to Camp Cady is about 10 feet per mile.



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WELL HYDROGRAPHS
EXHIBIT X-5

(3) Sources of Water Supply

a) Surface Water

The main source of surface water into the Lower Mojave River area is that of the Mojave River through the Barstow Narrows. The U.S. Geological Survey (U.S.G.S.) has established gaging stations on the Mojave River at Deep Creek, West Fork of the Mojave, Victorville, Barstow and Afton. The surface flow into and out of the lower Mojave River Valley is measured by the gages at Barstow and Afton. It should be noted that the cumulative flow at Victorville generally exceeds 25,000 acre-feet in a water year before any surface flow is measured at Barstow. The studies of W. P. Rowe indicate that 12,500 acre-feet must pass Barstow before water levels in the Lower Mojave River Valley rise. As mentioned above, rising water occurs at Afton, therefore, surface flow occurs throughout most of the year. The mean annual surface flow passing the Barstow gage for the period 1930-1965 is 16,430 acre-feet per year. The average surface discharge at Afton based on 16 years of record is 1,350 acre-feet per year.

b) Subsurface Inflow

A reliable estimate of underflow does not seem possible at present because of the absence of more data pertaining to permeability of the river alluvium and adjacent older alluvium, an area of the saturated underflow section. The minimum estimated annual underflow, using the U.S.G.S. estimated permeability and an average hydraulic gradient, is about 1,750 acre-feet per year. The maximum underflow estimated by employing the Department of Water Resources average measured permeability of 2,700 gallons per day per square foot (gpd/ft^2) and the same average hydraulic gradient is about 4,700 acre-feet per year. A reasonable reconciliation of these could be obtained by using a median permeability of about 2,000 gpd/ft^2, therefore the average annual underflow is estimated to be about 3,500 acre-feet per year. For comparison, SCE pumps approximately 8,000 acre-feet of water per year.

(4) Chemical Analysis of Groundwater

Chemical analysis of groundwater from those wells located in the area of the project are on file with the County. U.S.G.S. well number 9N/1E-15N3 is located approximately 2 miles west of the site. U.S.G.S. well number 9N/1E-13E2 is located on the site and U.S.G.S. well number 9N/2E-18E1 is located approximately one mile east of the site. These analyses cover a period from 1952 to present. The groundwater is considered to be of high quality, suitable for beneficial uses as outlined in the following section.

(5) Beneficial Water Uses

The California Regional Water Quality Control Board, Lahontan Region, is the agency responsible for water quality control in the Barstow area. In its "Water Quality Control Plan Report" May, 1975, Lahontan has identified beneficial water uses for the Mojave River groundwater as follows:

- Municipal and domestic supply - includes usual community use and individual use for domestic purposes.

- Agriculture supply - includes crop, orchard and pasture irrigation, stock watering, and all uses in support of farming and ranching operations.
- Industrial supply.
- Water-contact recreation - includes all recreational uses involving actual body contact with water, such as swimming, wading, water sports (water skiing, skin diving and sport fishing).
- Non-water-contact recreation - recreational uses which involve the presence of water but do not require contact with water, such as picnicking, sun-bathing, hiking, aquatic life study, camping, aesthetic enjoyment, pleasure boating, and water fowl hunting.
- Freshwater habitat - provides freshwater habitat for fish, water fowl and wildlife.

(6) <u>Groundwater Pumpage</u>

It is estimated that about 1/3 of the pumpage for the City of Barstow or about 1,500 acre-feet comes from the area downstream of the Barstow stream gaging station. The 1969 pumpage within the Lower Mojave River Valley is estimated to be on the order of 45,900 acre-feet (approximately 6 times that of SCE's). The 5-year average pumpage of SCE has been 7,836 acre-feet. This includes agricultural use as well as industrial use.

SCE and the 13 other parties, who pump more than 1,000 acre-feet per year, constitute more than 55 percent of the pumpage in the Lower Mojave River Valley. Municipal and other industrial uses account for about 10 percent of the pumpage, the remainder being agricultural use.

(7) Well Water Characteristics

Water needs at Coolwater Generating Station are supplied by deep well turbines at SCE Well No. 11, 12, and 13, developed in 1957, 1961 and 1972, respectively. Three new supply wells designated A, B and C were developed in late 1976 to early 1977 for Coolwater Units 3 and 4. Available data on these wells are shown in Appendix B. Well logs are on file and well locations are shown on Exhibit X-3a. The water-bearing formation is predominately a medium to coarse grained sand. Twelve hour pump tests show that the sediments have a high permeability with a 30 minute recovery for a 30 foot drawdown. The tests show a sustained yield of 3,000 gallons per minute (gpm) for 35 feet of drawdown. Wells A, B and C were designed for a sustained yield of 2,000 gpm. The tests results are on file.

(8) SCE's Current Water Use

Edison currently pumps approximately 8,000 acre-feet of water annually from groundwater beneath the site. Approximately 2,800 acre-feet are used for Coolwater Units 1 and 2 and the remainder is used for irrigation in SCE's agriculture operations. In 1978, Coolwater Units 3 and 4 will be in operation and will divert an additional 4,000 acre feet annually from agriculture use. For the purpose of this EIR, it is assumed that 50% of the Ranch's irrigation water (flood application) will percolate to groundwater. This estimate is probably high, but is accepted by the State Department of Water Resources and the local Mojave Water Agency (per Coolwater EIR).

The net water use will be as follows:

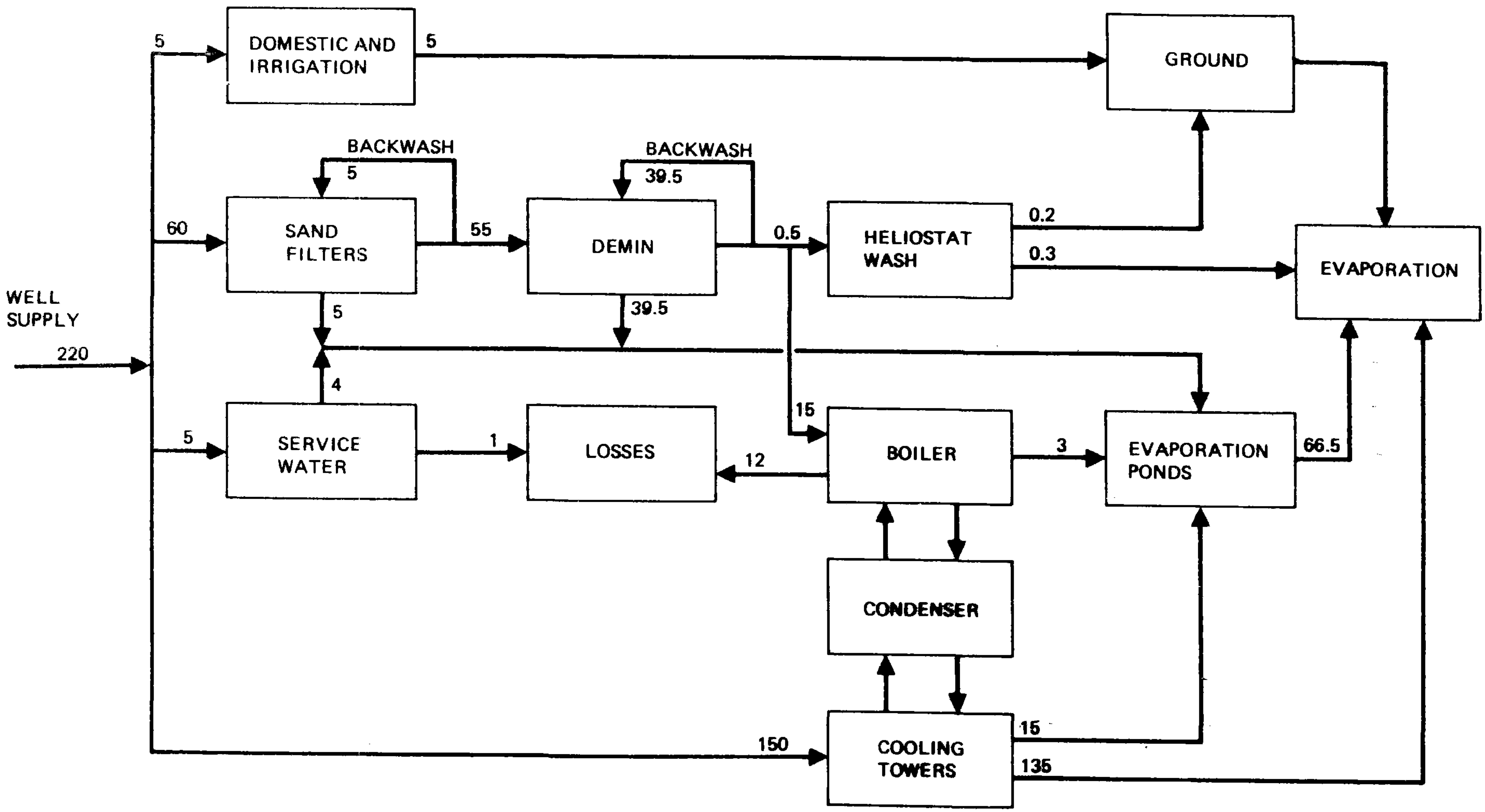
Coolwater Units 1 and 2	-	2,800 acre-feet
Coolwater Units 3 and 4	-	4,000 acre-feet
Pilot Plant	-	220 acre-feet
Irrigation	-	980 acre-feet
Total		8,000 acre-feet

b. Project Impact/Mitigation

(1) Groundwater Use

The Pilot Plant will require approximately 220 acre-feet of water per year for plant cooling, steam supply make-up, heliostat washing, domestic uses, etc. (See Exhibit X-6 for a graphic description of water requirements). This water will be supplied by one or a combination of the new wells (A, B & C) recently drilled on and adjacent to the site. (See Exhibit X-3a) A net increase in SCE's pumping rates will not be required since the Pilot Plant's water will be diverted from recent SCE agricultural use. It must be noted that some of SCE's Coolwater Ranch alfalfa plots were taken out of production in the past few years, so while the 220 acre-feet of water will not constitute a net increase in SCE's historic groundwater withdrawal, it will be an increase over SCE's present pumping as of 1977.

The Pilot Plant's water requirements will be approximately 3% of SCE's most recent 5-year average agriculture and power plant pumpage. After Coolwater Units' 3 and 4 are on line, the Pilot Plant's requirements will constitute the same percentage since the new units



NOTE: NUMBERS ARE IN ACRE-FEET PER YEAR AND ARE BASED ON PARTICIPANTS BEST ESTIMATE UTILIZING PRELIMINARY ENGINEERING DATA.

10 MWe SOLAR PILOT PLANT

WATER USE DIAGRAM
EXHIBIT X-6

annual 4,000 acre-foot requirement will be diverted from agriculture.

An exchange of water from alfalfa irrigation to Pilot Plant use results in more consumptive water use. Approximately 50% of irrigation water (by flooding method in the sandy soil of the Coolwater Ranch) is eventually recharged to groundwater and the other 50% is transmitted to the relatively dry atmosphere by evapo-transpiration (combination of direct evaporation and transpiration to air through vegetation). The Pilot Plant's use of water for cooling will result in direct evaporation to the atmosphere via the cooling towers. The remaining water's total dissolved solids (TDS) content will be too high to allow percolation to groundwater since groundwater quality is superior to the plant's wastewater. High TDS blowdown effluent will be conveyed to the existing Coolwater evaporation ponds where it will evaporate to the atmosphere, leaving behind a mineral residue. Therefore the use of 220 acre-feet of water for irrigation recharges 110 (+ or -) acre-feet to groundwater but the project's use of approximately 220 acre-feet of water is almost totally consumptive. Only a small fraction of the heliostat wash water and treated domestic waste water will reach the groundwater table. <u>Although the project will require no net increase in historical or recent pumping, approximately 110 acre-feet more water will be consumed</u>, assuming worst case condition.

This impact is not considered significant due to the Pilot Plant's low water requirement relative to available groundwater. However any use of overdrafted groundwater in the desert should be totally assessed. Presently proposed increases in upstream pumping by the City of Barstow and others may eventually contribute to the Lower Mojave River Basin's overdraft.

The potential for significant surface subsidence due to ground water withdrawal in the vicinity of the Pilot Plant is small. The water table at well No. 43A, at the west side of the site, has dropped 27 feet in the last 19 years, at an average rate of 1.4 feet per year. No significant settlements have been observed in this time interval. In the proposed 5 year life of the project, the water table will drop approximately 7 feet. It is unlikely that significant settlements due to groundwater withdrawal will occur during this period because the aquifers are composed of dense river alluvium. The amount of further consolidation expected to occur as a result of the removal of water is very slight.

Current information indicates that the project's required water pumping rates can easily be met by existing wells without significant drawdown or "cone of depression" interference with adjacent wells. The cone of depression for SCE supply wells 11, 12, and 13 has been closely monitored. At the end of 1976 the limit of the cone of 10 foot drawdown covered an area of approximately 3 square miles, centered at well no. 11. The limit of 30 feet of drawdown covered about 2/3 square mile, and occupied the lower portion of section 14. With the addition of three new wells to the supply system, the cone of depression due to SCE's industrial and agricultural use will expand in area. Because the total withdrawal of groundwater will remain constant at 8,000 acre-feet per year, the maximum drawdown will be less at any location than that produced by a smaller well field. The new wells - designated A, B, and C - are located in section 13, and will therefore cause the cone of depression to elongate to the east, parallel to the Mojave River.

The Pilot Plant's water requirement is compared with that of a fossil fuel combined cycle plant approximately as follows:

$$\text{Solar} - \frac{220 \text{ acre-feet/year}}{10 \text{ megawatts}} = 22 \text{ acre-feet/megawatt/yr.}$$

$$\begin{array}{l}\text{Combined Cycle}\\ \text{Fossil Fuel}\end{array} - \frac{15{,}000 \text{ acre-feet/year}}{1250 \text{ megawatts}} = 12 \text{ acre-feet/megawatt/year}$$

The higher water requirement of the Pilot Plant (relative to a combined cycle plant) per unit of electricity production is due to the reduced cycle efficiency of the Pilot Plant when compared with fossil fuel cycles.[4]

- <u>Mitigation</u>

Although the Pilot Plant's use of groundwater does not constitute a significant environmental impact, certain mitigation measures relative to the use of overdrafted groundwater supplies should be considered by the utility consortium.

SCE could eliminate even additional alfalfa production in order to further negate the impact of the Pilot Plant's water requirement and also to reduce SCE's contribution to the Lower Basin's groundwater overdraft. However, SCE has leased the farming operation not only for profit, but also for the ability to continue groundwater pumping in order to establish historical pumping "rights" in case groundwater is adjudicated (apportioned) in the future. Groundwater is presently available to any legal landowner who can install a well. However, if groundwater was to be adjudicated, only certain users would be allowed to pump certain amounts based on a factor of their past usage.

SCE is caught in a dilemma typical to regions where groundwater is being overdrafted. In order to "preserve" the legal right to continue pumping at historic rates when water rights are adjudicated, pumpers must presently extract groundwater, thereby contributing to the overdraft, even if they would prefer not to. If SCE determined that alfalfa farming was not marginally profitable relative to its use of water that could be "preserved" for future power plant cooling purposes, SCE would still be obligated to continued pumping to protect longterm water interests. In essence, water must be currently used to protect rights to its future use. This system is hastening the need for eventual importation of water from northern California.

The Pilot Plant's water consumption rates per unit of electricity could possibly be reduced comparable to those required by combined cycle plants by increased technology. The research aspects of this Pilot Plant could include reduction of water requirements. If the desert areas of the nation are to become logical sites for solar thermal plants, the critical siting constraints related to water shortages will have to be circumvented. It should be noted however, that the main purpose of the Pilot Plant is to develop and demonstrate solar related technology. Adding another variable (such as dry cooling) to the effort may only complicate the research and development program.

A significant reduction in the project's slight contribution to groundwater overdraft could be achieved by SCE's utilization of the polluted subsurface "slug" of historic wastewater that is presently creeping downriver toward the marine supply station, which is upstream from SCE's property.

This "slug" is thought to contain phenols, high levels of TDS, detergents, etc. all stemming from historic, unregulated percolation of waste effluents from Barstow's old sewage system and from the Santa Fe Railroad switching yard's oil disposal and train washing operation.

SCE, the City of Barstow, AT&SF Railroad, and the Lahontan Regional Water Quality Control Board staff are presently determining the feasibility of using 500-1500 gpm of this wastewater in the cooling towers of Coolwater Units 1 and 2. (1000 gpm = 1612 acre-feet per year assuming full time pumping. This is 57% of Units 1 and 2 annual requirement.) A recent Lahontan mandate requires the slug's withdrawal from the groundwater basin (by pumping) and subsequent disposal by means other than percolation. The wastewater plume is probably sufficiently intact to allow extraction via strategically placed wells. SCE's use of this "water" would fulfill Lahontan's order and would reduce extraction of good quality groundwater by a like amount. Ownership of the "slug" would have to be negotiated prior to actual use. It is possible that the City of Barstow could obtain federal and state Clean Water Grant Funds and reimburse SCE for subsidizing the City's and Santa Fe's cleanup responsibilities. SCE's customers will not have to absorb the cost.

The wastewater could probably not be used in the Pilot Plant's cooling towers because:

1. The plant requires high quality water for research and development purposes. (Detergents in the "slug" could create foam in the cooling towers).
2. The Pilot Plant is 1/2 mile further from the "slug" than Coolwater Units 1 and 2.
3. The Pilot Plant's operating lifetime of 5 years is too short to justify the extra capital cost of accomodating the wastewater (purifiers, anti foaming chemical, mixing tanks, extra pipelines, etc.).
4. The City of Barstow, Santa Fe Railroad and Lahontan would require a longer term commitment for the use of the water since it could take 10-35 years to cleanout both the "slug" and the mixed groundwater that will eventually be drawn into the "slug" due to heavy pumping.

If 1600 acre-feet of the "slug" could be used annually in Coolwater Units 1 and 2, a like amount of good quality water will remain in the basin, thereby more than mitigating the Pilot Plant's annual withdrawal of 220 acre-feet per year. This assumes that SCE could still retain pumping credit relative to use of the wastewater slug.

The possible use of wastewater for Coolwater Units 1 and 2 will not be described further since it only indirectly mitigates the Pilot Plant's water-related impact. It can be concluded that the benefit to groundwater conservation would be well worth the effort if it is feasible and if grant funds can be obtained.

(2) Heliostat Washing

Mirror washing could be required at least once a month in order to allow optimum solar reflectivity to the receiver (DOE). This section will include a detailed description of washing techniques. The water requirement probably constitutes mirror washing's greatest degree of impact, however periodic cleaning could also provide added moisture to soil at localized areas, distribute mirror cleaning additives onto the soil and into the surface/subsurface water supplies, and contribute to vehicular traffic over otherwise undisturbed areas of the Pilot Plant site. (See other related sections for additional analysis of the impact).

The following is exerpted from MDAC's proposal to DOE:

- Mirror Washing Frequency

Reflector cleaning may be required every 30 days rather than as corrective maintenance, thereby permitting realistic washing equipment quantity/sizing and manpower estimates with the least risk of error. Variable weather conditions are the most important factor in determining when cleaning is required; however, the data obtained during the limited test period tends to indicate a 30-day frequency is a reasonable approach. The scheduled maintenance concept requires two tanker trucks (operated by two men each) approximately four hours to clean 88 mirrors each day. Cleaning will be accomplished in the pre-dawn and early morning hours and will require approximately 20 working days to complete an entire field of approximately 2300 heliostats.

Only limited data have been obtained to date for heliostat washing and reflectivity degradation under field conditions. The above maintenance approach is based on these data and the relative merit of alternative concepts to provide an acceptable cleaning technique. Additional field test data are required to fully define reflectivity degradation rates, especially for seasonal effects and severe weather conditions. Natural cleaning resulting from dew, frost deposits, rain and snow also need to be further evaluated to determine the effects on cleaning frequency requirements. The optimum heliostat orientation during various weather conditions needs to be identified to minimize reflectivity degradation and/or take advantage of natural cleaning.

- Quantity of Cleaning Solutions Used:

The MDAC mirror washing procedures developed during the Collector Subsystem Research Experiment (SRE) Program may utilize a proprietary cleaning concentrate made by the McGean Chemical Company, Inc., designated CB120.

- Approximately one gallon of wash solution is used, comprised of 5% cleaning concentrate and 95%

deionized water. (Deionization is necessary to rid groundwater of total dissolved solids and will be performed on site. Details of this procedure are not yet available.)

- Approximately five gallons of deionized water are used for rinsing each of the mirrors. (Assuming 6 gallons of water for each heliostat per month, total water requirements will amount to 1/2 acre-feet per year or approximately .2% of total project water use.)

- <u>Mirror Washing Concept and Procedures</u>:

Results of the testing program performed during the Phase I contract indicate that the heliostat reflective surfaces can be effectively washed using pressure spray nozzles and the following application technique:

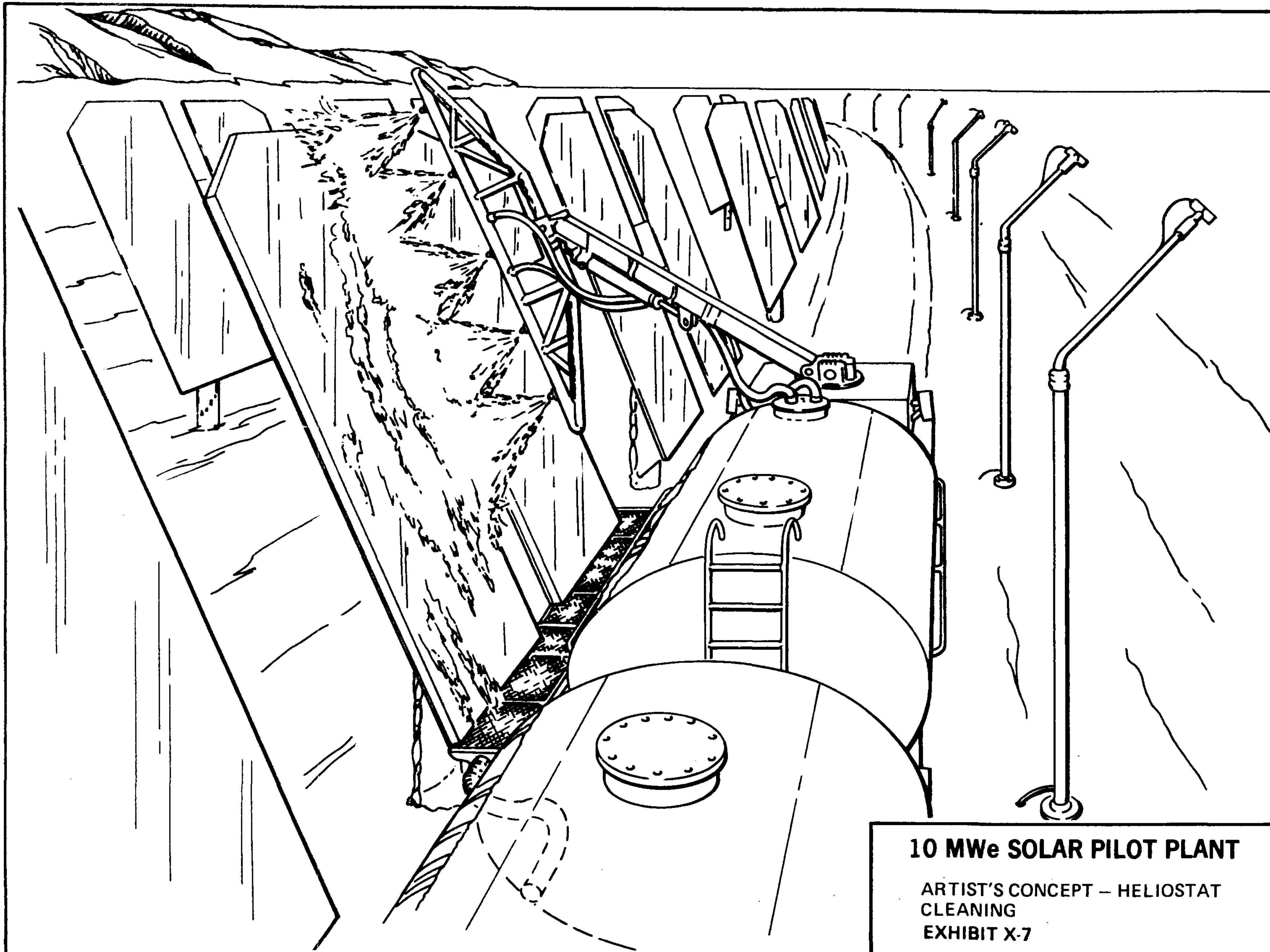
1. Apply approximately one gallon of wash solution (5% cleaning concentrate, 95% deionized water) in approximately one minute to heliostats oriented with surfaces near vertical.
2. Allow approximately one minute dwell time for the wash solution to act on surface contaminates.
3. Rinse with approximately 5 gallons of deionized water applied in approximately 2 minutes.

The washing operation should be conducted with the heliostat surfaces facing away from the sun and/or preferably during the pre-dawn and early morning hours. This procedure takes advantage of the cleaning action afforded by any dew which may have formed and avoids premature drying of wash solution or rinse water.

Implementing this technique involves utilization of a tanker truck (see Exhibit X-7) which carries both the wash solution and rinse water, as well as a holding tank. The truck is fitted with the necessary valving, controls, and pressurization system for fluid application at the flow rates indicated. Fluid is applied by a multiple nozzle array which extends from the side of the truck and provides the controlled spray patterns necessary for both wash and rinse functions. A fluid catch basin extends from the truck and is positioned under the heliostat to retrieve and transfer the wash solution and rinse water into a holding tank. This assumed requirement to prevent spillage of wash solution and rinse water was a significant factor in selecting this approach over other promising alternative methods.

- Mitigation

It has been assumed by DOE that the wash/rinse water solution would be collected by the cleaning trucks either for reclamation and re-use or for disposal to the existing Coolwater evaporation pond. Since cleaning water availability is not a significant constraint (unless made so by the deionization process) and since heliostat washing requires a small amount of water relative to the total plant's requirements; energy - equipment - manpower costs could be reduced by allowing the used washwater to percolate into the soil. This assumes that the cleaning solvent proposed by DOE does not contain chemical substances harmful to soil, vegetation, wildlife, humans, etc. As long as the solvent's contents remain proprietary, it is difficult to assess its net impacts and the best re-use and disposal methods. Modification of



10 MWe SOLAR PILOT PLANT

ARTIST'S CONCEPT – HELIOSTAT CLEANING

EXHIBIT X-7

the MDAC cleaning method could be very cost effective, especially in terms of less energy requirements for shorter truck operating times for both washing and disposal. The washwater could irrigate shade tolerant vegetation (i.e. bermuda grass) which would reduce both soil erosion and fugitive dust. If the cleaning solvent would be harmful to soil, vegetation or groundwater quality (assuming it would percolate through 110 feet of sandy soil), and if some form of vegetation under the heliostats is desirable, it might be cost effective to use another, less harmful solvent or none at all. Firm commitments to a particular cleaning fluid should not be made until various products have been tested. (See Sections VIII and X-F.)

(3) Groundwater Quality

Water quality degradation resulting from the Pilot Plant's normal operation is not a significant concern for the following reasons:

1) There is no perennial surface water on or near the site.
2) The groundwater table is 100-110 feet below the surface.
3) Percolation through most desert soils purifies domestic wastewater of most harmful bacteria.
4) No new technology specific to solar power is required. As in the case of a conventional electric plant, the bulk of the Pilot Plant's blowdown wastewater from cooling towers, filters, boiler, and demineralizers will be ejected to the existing 130 acre sealed Coolwater evaporation pond in a controlled manner. Wastewater will not percolate to groundwater.

The evaporation pond contains cooling water effluent from the existing Coolwater Units 1 and 2, and is large enough to accomodate wastewater from pending Coolwater Units 3 and 4 plus wastewater from the Pilot Plant. Appendix C contains a description of the normal and potential sources, quality and disposal of plant wastewater.

- Mitigation

The level of project effect on potential groundwater quality is low due to the inherent mitigating factors described in Appendix C. The existing Coolwater evaporation ponds will easily accomodate the cooling and blowdown effluent emenating from normal operation of the Pilot Plant. The ponds have been constructed to withstand any flooding or seismic shaking expected on the site, thereby protecting groundwater from percolating pond spillage. An on-going groundwater monitoring program further protects groundwater quality from percolating effluents.

The content of heliostat wash water should be confined to demineralized water (without chemical cleaning additives) in order to allow "irrigation" of ground cover on the heliostat field and to eliminate the minute possibility of groundwater contamination.

Site soils will adequately "treat" coliform and other bacteria in septic tank effluent before it reaches groundwater. Its TDS content will not noticeably add to the groundwater's dissolved solids.

The possibility of spillage of heat storage oils is remote. The containment basin and dikes would prevent spilled oil from spreading, however the unsealed basin bottom would allow slow percolation. The relative depth to groundwater minimizes the impact.

The containment structure's primary purpose is fire control. Spent fluids should be reclaimed and re-used. Presently available industrial chemical disposal methods will be adequate to handle non-reclaimable flushed fluids.

D. Climate/Meteorology

1. Current Status (provided by SCE, ERDA, & County)

In 1972 Hovind, et al.,[5] conducted an on-site meteorological field study for the Coolwater Units 3 and 4 expansion approximately 1 mile west of the 10 MWe Pilot Plant site. The data provides significant insight to the area's existing climatology.

The field program was designed to provide the following data:

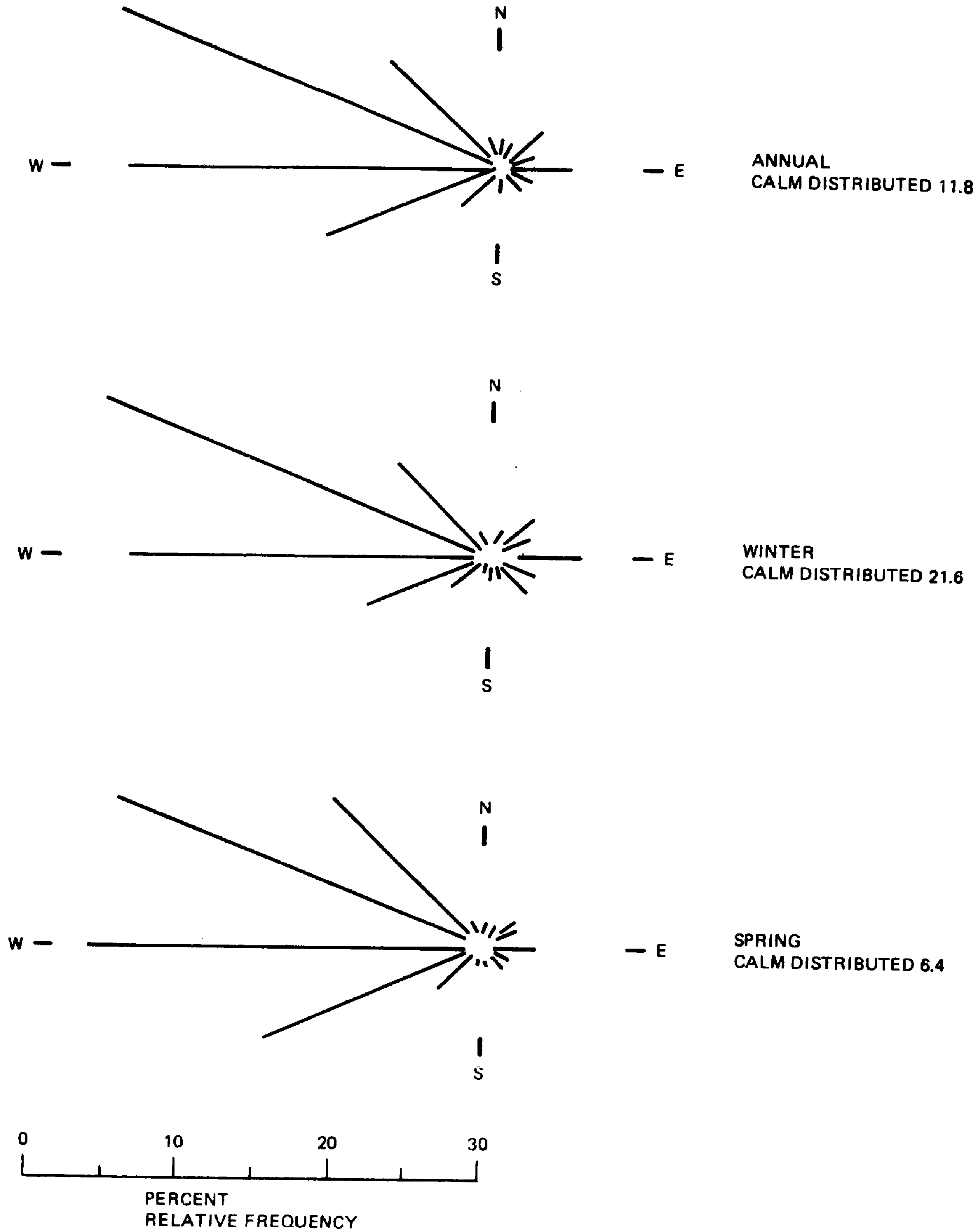
- Continuous collection of wind and temperature data at the Coolwater site and Barstow-Daggett Airport during the period from February 4, 1972 to May 31, 1972, in order to determine the suitability of extrapolating the climatological data from airport records relating to site data.
- Operation of special aircraft flights during morning and afternoon twice per week, during the period February 21 to March 30, 1972, to record vertical profiles of temperature and humidity above the station.
- Collection of air quality data to determine the concentrations of basic air pollutants in the immediate vicinity of the station.

The results of this analysis are presented in this report. Since these data are the most recent and representative available, and in view of the positive correlations between the separate meteorological data collected at the station and the airport, the results provide a reasonable representation of the year-around meteorological conditions likely to exist at the Coolwater Generating Station and the Pilot Plant site.

a. Winds and Streamline Patterns

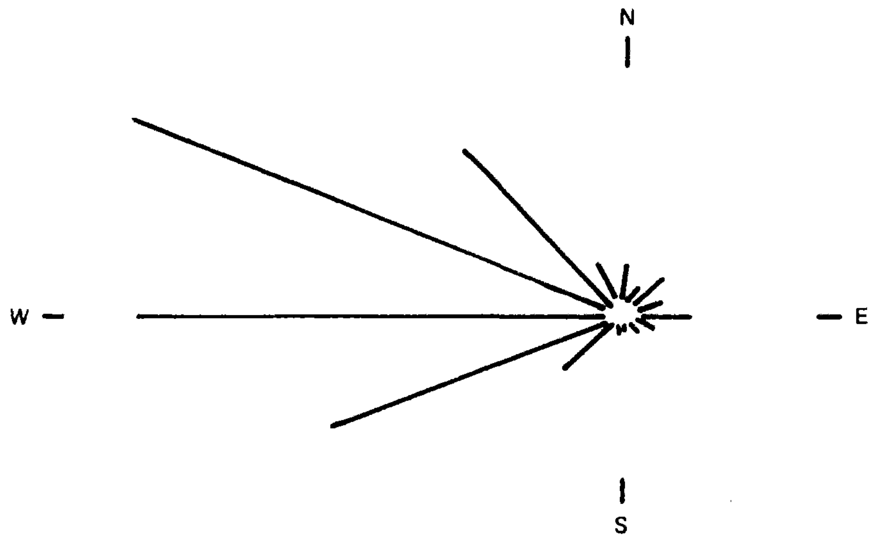
The basic wind flow patterns over Southern California are largely the result of seasonal semi-permanent weather features in the general circulation pattern of the atmosphere. In addition, the low level winds in the complex terrain of the desert are influenced to a large degree by local topographical features. The historical wind data available for the Barstow-Daggett Airport with the annual and seasonal wind roses for the period (1955-1964) are shown in Exhibit X-8. The predominance of wind from the west-south-west, west, west-northwest, and northwest directions at the airport are the direct result of wind channeling and large scale flow through the Mojave River area west of the Coolwater Generating Station. The above four direction sectors comprise a total of 74% of the annual wind direction frequencies.

A recording aneometer was installed at Coolwater during the period February 4 to April 12, 1972 in order to determine whether the historical wind records from the airport 2-1/2 miles east of the Pilot Plant site were suitable for making dispersion calculations appropriate for the station. Concurrent wind records for both

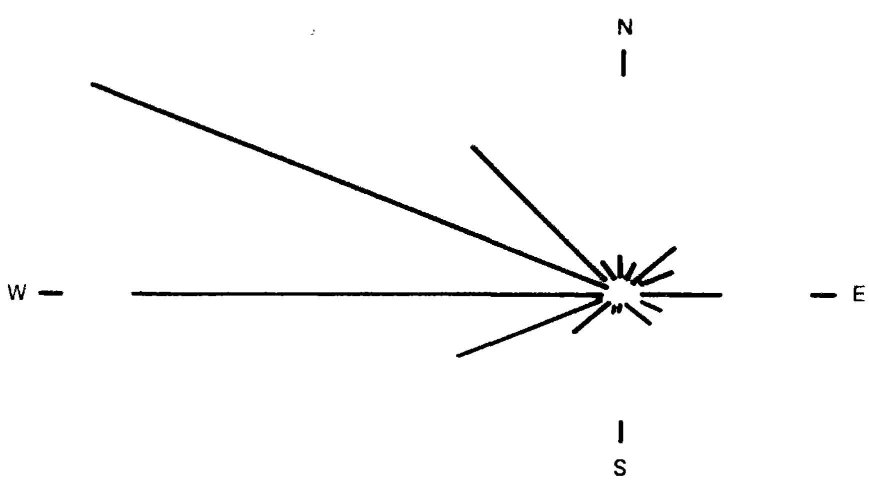


10 MWe SOLAR PILOT PLANT

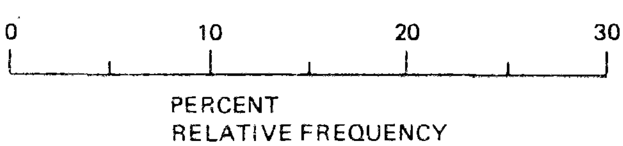
ANNUAL AND SEASONAL WIND ROSES (1955-1964)
BARSTOW-DAGGETT AIRPORT
EXHIBIT X-8



SUMMER
CALM DISTRIBUTED 5.1



FALL
CALM DISTRIBUTED 14.4



10 MWe SOLAR PILOT PLANT

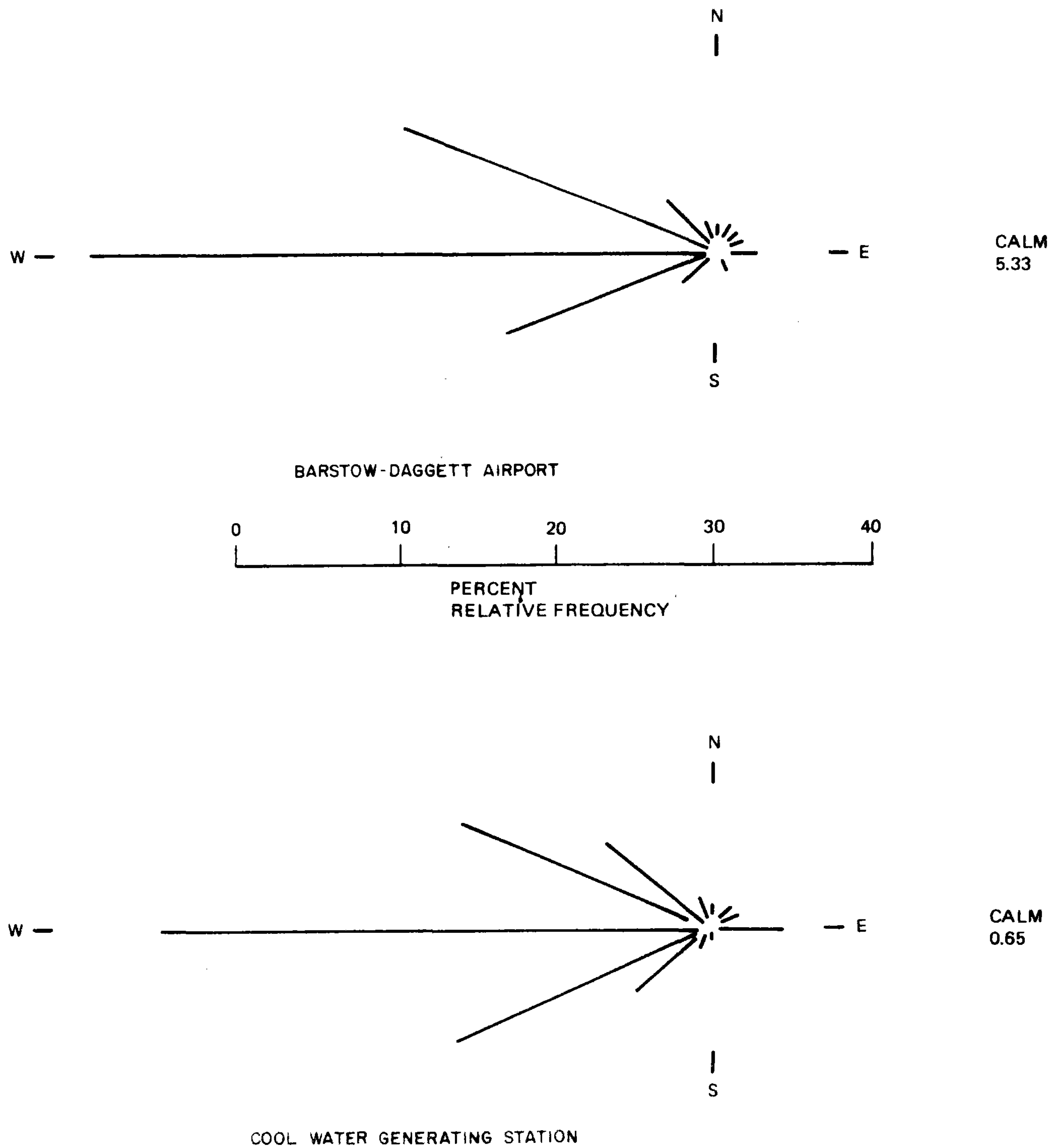
ANNUAL AND SEASONAL WIND ROSES (1955-1964)
BARSTOW-DAGGETT AIRPORT
EXHIBIT X-8 (CONTINUED)

locations for the above period were tabulated into wind rose form, the results of which are shown in Exhibit X-9. This exhibit shows that there are no significant differences in wind direction between the site and the airport during the two-month sample period. The remaining part of the year is expected to be equally as comparable, however, there may be slight variations (SCE).

A comparison of average wind speeds between the two sites was also made. Calm conditions occurred less frequently at the Pilot Plant site (0.65%) than at the airport (5.33%). This difference is due in large part to differences in anemometer sensitivity, the Coolwater anemometer being more sensitive than the wind sensor at the airport. Overall, however, wind speeds tended to be slightly greater at the airport than at Coolwater. This difference is attributed to wind speed measurement procedures. Wind speed measurements at the airport are taken on ten minute averages. The measurements at Coolwater were determined by an observer making an hourly, quantified observation typically over a one- to two-minute period.

It was concluded from the above analysis of concurrent wind measurements that: (1) significant wind differences between the two sites were not evident and (2) historical wind data from the airport were applicable for determining air-mass dispersion characteristics at the Pilot Plant site.

From all the data available, it can be concluded that the percentage of occurrence for winds of 30 mph velocity would be approximately 2-3% of the time, and winds with a velocity of 40 mph



10 MWe SOLAR PILOT PLANT

WIND ROSE (FEBRUARY 4 – APRIL 12, 1972)
BARSTOW-DAGGETT AIRPORT (UPPER)
AND COOLWATER GENERATING STATION
(LOWER) EXHIBIT X-9

would occur 1% or less. Blowing dust and sand may be a problem in the region 7-10 days out of a year.

b. Temperature and Relative Humidity

The temperature and relative humidity variations in the Coolwater-Daggett area are typical of the desert. Diurnal temperature fluctuations are large, ranging up to 30° to 40°F or greater.

Maximum temperatures in January range from 55° to 65°F. The maximum July temperatures vary from 95° to 105°F. An analysis of fifteen years of data (1956-1970) presented in Exhibit X-10 shows a January average maximum temperature of 60.0°F and a July average maximum of 103.3°F. The January average minimum is 34.9°F, and the July average minimum is 72.6°F.

Humidity values in the Coolwater-Daggett area are typically low during the afternoon (15-25%) increasing to a maximum in early morning as the minimum temperature is reached. Based upon data from nearby locations, the typical morning maximum humidity should be on the order of 60-70% during winter and 30-40% during the summer. This pattern is altered with the passage of winter and spring storm systems and with the periodic intrusion of tropical air over Southern California during the summer.

c. Precipitation

Precipitation in the high desert area is quite variable from season-to-season and year-to-year. Analysis of fifteen year of precipitation data (1956-1970) for the airport is listed in Exhibit X-11 The monthly average precipitation is at a minimum in May and June

Exhibit X-10. Temperature Data Barstow-Daggett Airport (1956-1970)
10 MWe Pilot Plant Site

Temperature (F)	Month J	F	M	A	M	J	J	A	S	O	N	D
Mean Maximum*	60.9	65.7	70.9	77.9	87.2	96.8	103.3	101.4	94.2	82.8	69.2	61.1
Mean Minimum**	34.9	39.9	44.0	49.7	57.7	65.9	72.6	71.7	64.2	54.1	42.7	35.2
Monthly Average	47.9	52.8	57.4	63.8	72.4	81.3	87.9	86.5	79.2	68.4	55.9	48.1

Average Annual 66.8

*Mean Maximum - Average of daily maximum values
**Mean Minimum - Average of daily minimum values

Exhibit X-11. Precipitation Summary Barstow-Daggett Airport (1956-1970)
10 MWe Pilot Plant Site

Precipitation (Inches)	Month J	F	M	A	M	J	J	A	S	O	N	D
Average	0.31	0.32	0.28	0.31	0.07	0.05	0.31	0.60	0.51	0.22	0.37	0.35
Maximum 24-Hour	0.73	0.70	0.88	0.65	0.37	0.32	0.96	2.06	1.11	0.66	1.08	1.01
Maximum Monthly	0.98	1.50	1.01	1.83	0.49	0.32	0.96	3.22	2.31	1.01	1.74	2.02
Minimum Monthly	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Average Annual 3.70

with 0.07 and 0.05 of an inch, respectively. The maximum usually occurs in August and September with 0.060 and 0.51 of an inch, respectively, reflecting the occurrence of late summer thunderstorms. Both the 24-hour maximum of 2.06 inches and the greatest monthly average of 3.22 inches of precipitation have occurred in August, however it should be noted that thunder shower activity is not widespread. The average annual precipitation at the site is 3.70 inches.

Precipitation in the area is usually in the form of rainfall. Occasionally, however, an exceptionally strong cold frontal system will move through the area with precipitation in the form of snow. During the period 1956-1970, a total of fifteen snowfall occurrences have been noted at the airport, with eleven amounting to only a trace. The greatest monthly snowfall during the above period was 13.0 inches in December, 1967.

d. Air-Mass Dispersion Characteristics

Distributions of atmospheric stability were determined from hourly meteorological data from the airport according to a method recommended by Turner[6]. The data base covered a ten-year period (January 1955 - December 1964). The stability distributions are divided into six classes that range from extremely unstable (A) to moderately stable (F). Unstable conditions (A, B, C) typically occur during the late morning and afternoon hours with clear skies and light wind speeds. Neutral conditions (D) are commonly associated with overcast conditions and moderate winds during day or night. Plume dispersion is most effective with unstable and neutral atmospheric stabilities and least effective with stable conditions.

Neutral stability (D) occurs most frequently from February to September. Stable conditions (E, F) are most frequent from October through January. In desert regions, a large portion of stable conditions occur at night or early morning hours during calm, clear conditions. Unstable conditions (A, B, C), while occurring less frequently than either neutral or stable conditions, reach a maximum frequency of occurrence during the summer months, especially during thunder storm and frontal activity.

Exhibit X-12 lists the monthly seasonal relative percent frequency of occurrence of each stability class. The exhibit shows, for example, that for a typical December, meteorological stability types A, B, C, D, E, and F occur 0, 5.6, 12.8, 30.8, 20.5, and 30.3% of the time, respectively. Exhibit X-13 presents the annual distribution of stability class categorized by wind direction. This exhibit shows, for example, that a north-westerly wind is associated with the meteorological stability types A, B, C, D, E, and F: 0.3, 1.0, 2.4, 3.1, 1.7, and 1.5% of the time, respectively. Vertical temperature soundings were made over the Coolwater Generating Station, during the period February 21 to March 10, 1972, by an instrumented aircraft in order to define the inversion characteristics at the site. A total of twelve days of soundings (morning and afternoon) were made. The results showed that in six of the morning sounds, a low level temperature inversion base existed between the surface and 2000 feet above ground. By afternoon, the low level or surface based inversions, in all cases, were destroyed by the strong afternoon heating. More intense inversions are known to occur in the fall and winter months (EAD).

Exhibit X-12. Barstow-Daggett Airport Monthly and Seasonal Relative Percent Frequency of Occurrence of Stability Types* 10 MWe Pilot Plant Site

	A	B	C	D	E	F
January	0.3%	5.4%	12.1%	36.3%	17.9%	27.8%
February	2.0	6.1	10.1	42.7	18.6	20.5
March	1.8	5.8	10.0	53.7	16.4	12.3
April	3.0	6.4	13.1	56.5	14.0	7.0
May	3.2	5.6	15.5	60.9	11.8	2.9
June	4.1	7.1	17.8	54.6	13.2	3.2
July	4.9	9.5	17.0	47.4	17.8	3.5
August	5.5	9.3	15.7	42.4	21.2	5.8
September	3.3	8.7	14.6	37.4	22.9	13.1
October	2.9	8.1	11.9	35.9	21.8	19.4
November	1.1	6.0	11.4	34.1	22.8	24.6
December	0.0	5.6	12.8	30.8	20.5	30.3
D, J, F (Winter)	0.7	5.7	11.7	36.4	19.0	26.4
M, A, M (Spring)	2.7	6.0	12.9	57.0	14.1	7.4
J, J, A (Summer)	4.8	8.7	16.8	48.0	17.4	4.1
S, O, N (Fall)	2.5	7.6	12.6	35.8	22.5	19.0
Annual	2.7	7.0	13.5	44.4	18.2	14.1

*Meteorological Stability Types

A - Extremely Unstable
B - Moderately Unstable
C - Slightly Unstable
D - Neutral
E - Slightly Stable
F - Moderately Stable

Exhibit X-13. Barstow-Daggett Airport Annual Average Percent Frequency Occurrence of Stability Types* Categorized by Wind Direction (1955-1964) 10 MWe Pilot Plant Site

N	0.3%	0.6%	0.4%	0.3%	0.2%	0.2%
NNE	0.1	0.4	0.3	0.4	0.1	0.2
NE	0.3	0.7	0.8	0.6	0.2	0.3
ENE	0.2	0.5	0.7	0.5	0.1	0.3
E	0.3	0.7	1.4	1.2	0.3	0.7
ESE	0.1	0.3	0.6	0.7	0.2	0.5
SE	0.1	0.2	0.4	0.3	0.3	0.7
SSE	0.0	0.1	0.1	0.1	0.1	0.3
S	0.0	0.1	0.0	0.1	0.1	0.5
SSW	0.0	0.0	0.0	0.2	0.1	0.2
SW	0.1	0.1	0.1	2.3	0.5	0.6
WSW	0.1	0.2	0.5	8.8	1.5	1.1
W	0.2	0.5	1.7	12.5	6.2	3.4
WNW	0.2	0.9	3.6	12.6	6.4	3.3
NW	0.3	1.0	2.4	3.1	1.7	1.5
NNW	0.2	0.5	0.6	0.4	0.2	0.3

*Meteorological Stability Types

A - Extremely Unstable
B - Moderately Unstable
C - Slightly Unstable
D - Neutral
E - Slightly Stable
F- Moderately Stable

e. Solar Radiation

SCE has established a network of solar monitoring stations over the Southern California area.[7] Study of the data collected suggests a similarity of solar radiation characteristics among the sites in the desert. The closest of these stations to the Pilot Plant site is in Barstow. The data indicate daily total radiation on a horizontal surface ranges from a low of 3.0 kW-hrs/m^2 in December up to 8.4 kW-hrs/m^2 in June, with an annual average of 5.8 kWhrs/m^2/day. These values follow closely other solar ratiation measurements available in the region[8]. The Pilot Plant site will average approximately 3500 hours of sunshine annually. Additional insolation data is available from the Jet Propulsion Laboratory, via monitoring at the Goldstone Tracking Station 25 miles north of the Pilot Plant site.

Cloud cover that would inhibit solar radiation occurs less frequently over the site than almost any other region of the relatively developed western portion of the California desert. Scattered cumulus clouds can still provide large amounts of diffuse radiation, according to a September 1977 progress report prepared by Arizona State University under contract to DOE

Lawrence Berkeley Laboratory is also performing studies on the effect of radiation diffusion from cloud cover.

2. Project Impact/Mitigation

Pilot Plant construction will not noticeably affect local meteorological conditions. Pilot Plant operation will induce minor alterations to the site's air flow, ambient temperature/ heat balance, and local humidity levels - all on a micro-climatic scale that will in most cases be immeasurable. Various climatic factors will in turn influence plant operation. (Most of the following assessment stems from existing DOE and SCE data with an analysis provided by the County.)

a. Wind Velocity and Air Turbulence

Site wind patterns will be slightly modified on the lee side of the receiver tower, and probably to a similar extent as wind patterns downwind of the existing Coolwater emission stacks.

Air flow near ground level in the flat collector field will be modified and slowed due to drag forces created by the upwind heliostats.[9] The net effect in the field will be a reduction of wind velocity near ground level which could naturally aid in mitigating potential soil erosion and resulting fugitive dust. Wind speed above the heliostat field will resemble normal profiles above open terrain except for minor but distinct vertical swirls and eddies (DOE).

Disturbances in air flow patterns over and within the heliostat field may alter the convective and conductive transfer modes of the site's solar heating budget (DOE). (See following analyses.)

Heliostat shading will cause net ground cooling. Light wind speeds and cooler temperatures beneath the heliostats would probably also reduce evapotranspiration within the field. Light wind speeds at this level also could increase snow accumulation, snow-drifting, and the deposition of windblown debris within the site enclosure. Otherwise, modification of the air flow patterns attributable to the heliostats is not expected to be important.

- Mitigation

Pilot Plant research should include a determination of air flow pattern changes in the collector field that will result from commercial STE development.

b. Ambient Temperature/Heat Balance/Heat Transfer

The following analysis of the Pilot Plant's potential micro-climatic effect on the site's natural heat balance is primarily excerpted from DOE's Solar Program Assessment. (See bibliography.)

(1) Natural Balance

Solar energy entering the earth's atmosphere undergoes a variety of transformations and exchanges within the atmosphere before being lost as long-wave radiation back into space. As radiant energy from the sun (which is primarily in the short-wave region of the spectrum) enters the atmosphere, it is reflected, scattered, absorbed, and converted to other energy forms by the earth's surface and various constituents of the atmosphere. Diffuse or scattered short-wave light from the sky and direct insolation which arrive at the ground surface are the primary sources of all forms of energy for both the desert microclimate and the global atmosphere as a whole. For any given region, the interaction between the energy response characteristics of the ground surface and these two components of solar radiation determines to a large extent the state of the local climate.

The ratio of diffuse to direct insolation varies considerably with latitude, the water vapor content of the air, cloud cover, particulate concentrations, and site elevation. However, it is possible to obtain annual average values at different latitudes. Between the latitudes 30°N and 40°N in the southwestern United States, approximately 60 percent of the solar radiation reaching the ground is direct and the remaining 40 percent is diffuse. Although desert skies are likely to have somewhat higher proportions of direct insolation, these figures are adequate for a general consideration of the site's radiation budget.

A surface exposed to radiation absorbs part of the radiation and reflects the remainder back into the atmosphere. The percent reflected is called the "albedo." Typical albedos for various surfaces are listed in Exhibit X-14. Desert soils can be expected to reflect about 30 percent of the total incident short-wave radiation. One of the potential sources of STE plant impacts to be discussed in this section is the effect of heliostat mirrors on the average short-wave reflectivity of the STE facility and any resultant impact on climate.

Exhibit X-14. Albedos (Percent) For The Shortwave Portion*
of The Electromagnetic Spectrum
(Wave Lengths Less Than 4.0 Microns)

Snow, Fresh Fallen	75 - 95
Snow, Several Days Old	40 - 70
Desert	25 - 30
Savanna, Dry Season	25 - 30
Savanna, Wet Season	15 - 20
Chaparral	15 - 20
Meadows, Green	10 - 20
Forest, Deciduous	10 - 20
Forest, Coniferous	5 - 15
Dundra	15 - 20
Crops	15 - 25

*Source: W. D. Sellers, Physical Climatology.

Radiation absorbed at the ground can be converted to soil heat storage, long-wave radiation from the surface, conductive heat transferred between the ground and the air, convective transfer, and latent heat of evaporation. The intensity of long-wave radiation depends on the surface temperature and is directly proportional to a parameter known as the infrared emissivity. Conductive, convective, and latent heat transfer are each functions of several variables. It is therefore difficult to relate these three components of the energy balance to STE site conditions. However, this section will address approximate magnitudes of energy balance charges when possible and consider the general tendencies of those relevant aspects of the balance that are impossible to quantify in a generic analysis of this sort.

(2) Heliostat Field Impacts on the Energy Balance

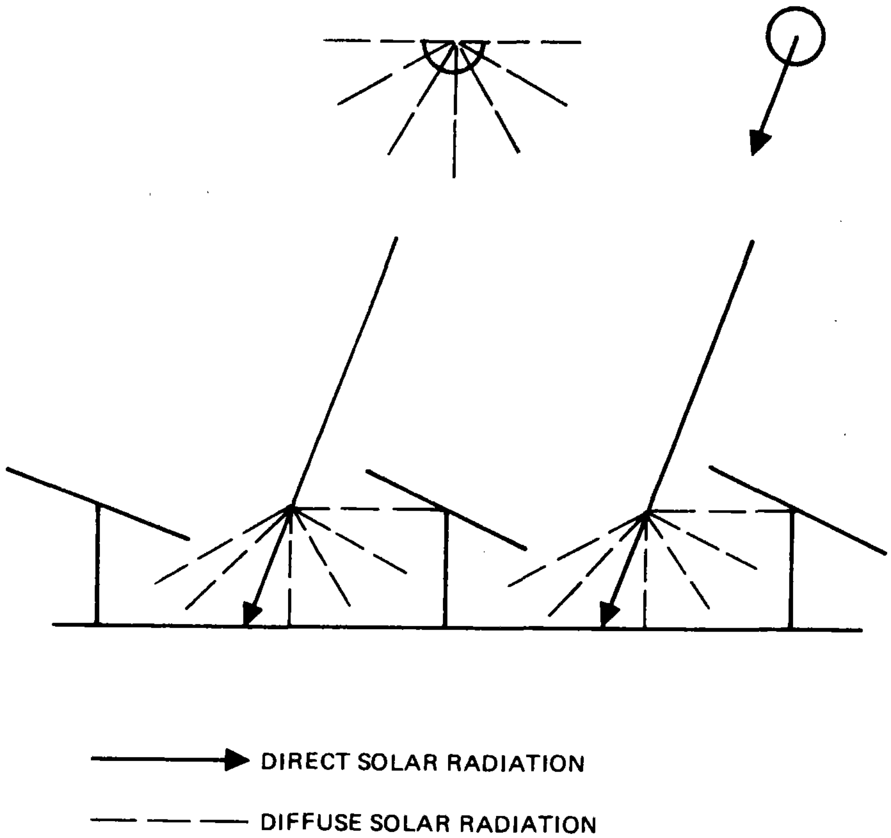
It is expected that the array of heliostats will modify significantly the net absorption of direct and diffuse insolation within the site boundaries. The extent of this modification can be approximated.

The ratio of mirror surface area to ground area in the heliostat field will average 0.23 for the Pilot Plant. Consequently, mirrors will intercept as little as 23% of the direct insolation incident on the field at summer solar noon and could intercept as much as 90% of the direct radiation when the sun is low on the horizon.

Interception of diffuse radiation by heliostat mirrors is complicated by the fact that this type of radiation arrives at nearly uniform intensities from all points in the sky (see Exhibit X-15). When a heliostat is tilted with respect to the horizontal plane, both sides of the mirror are exposed to diffuse light. Therefore, the effective absorptive area for diffuse radiation within the field will be greater than the absorptive area for the same quantity of land under natural conditions. In this case 40 percent represents an upper limit for effective interception of diffuse light by reflective mirror surfaces. The lower limit cannot be estimated as easily.

For purposes of approximating the change in the net shortwave albedo, the lower limit for direct radiation shading (23%) and the upper limit for the diffuse radiation shadings will be used in the same analysis. This strategy provides the most direct approach and tends to yield a net albedo figure which falls in the mid-range of possible estimates.

Heliostat mirrors will reflect about 90% of the incident direct solar radiation. The other 10% is either absorbed or reflected diffusely. For this approximation it will be assumed that 5% of the incident light is absorbed and 5% is reflected diffusely (each of these two components can vary between 0% and 10%, but the actual choice of values has only a slight effect on the final calculations). It follows that 95% of the diffuse insolation reaching the mirrors will be reflected diffusely, while the other 5% is absorbed.



10 MWe SOLAR PILOT PLANT

SCHEMATIC OF RECEPTION OF DIRECT AND DIFFUSE SOLAR RADIATION WITHIN THE HELIOSTAT FIELD

EXHIBIT X-15

Based on these assumptions and estimates for the mirror to ground area ratio, the average annual proportions of direct and diffuse light, and the albedo of the desert land within the site boundary, it is possible to calculate the distribution presented in Exhibit X-16. Some of the original insolation is directed to the central receiver and removed from the intermediate microclimate of the heliostat field. Some is reflected by mirrors and the soil. The resulting albedo is almost twice as high as the albedo for land outside of the plant, and it is close to the typical albedo for a several-day-old snow layer.

This increased reflectivity could cause an appreciable cooling of air flowing over the mirror field during the daytime hours. With less energy absorption, the total input of energy into the air in the form of long-wave radiation, convective, conductive, and latent heat will be less. Since these portions of the heat budget are responsible for sensible heat increases in the air, some cooling would necessarily occur in the lower layers of the air over the field. It should be noted, that while collectors will decrease in-coming solar radiation in the daytime, they will also trap some out-going long-wave radiation during the day and night. Net heat loss will therefore be tempered somewhat. Shading of the desert surface has a more significant influence on diurnal variability of environmental temperatures than an absolute or mean values. Winter night-time temperatures under heliostats could be warmer than in adjacent open areas unless winter "inversion" conditions are created (University of Arizona, 1977).

Exhibit X-16. Heliostat Field Solar Heat Balance *

Short-Wave Radiation Directed to Collector	-
Short-Wave Radiation Reflected Diffusely by Mirrors	-
Short-Wave Radiation Absorbed by Mirror	3%
Short-Wave Radiation Reflected by Desert Soil	17%
Short-Wave Radiation Absorbed by Desert Soil	41%

*Source: DOE

So far the discussion has centered on a consideration of the impact of modifications on the short-wave radiation absorption of the energy balance. Long-wave radiation is operative at all hours of the day and is the primary night-time output of radiation energy from the surface. The long-wave absorptivity of a substance is equivalent to its infrared emissivity. Since mirror glass has an emissivity of 0.87 to 0.94 and desert land has an emissivity of 0.91, there should be no significant differences between overall long-wave radiation absorption within the field and in the surrounding environment. Consequently, differences between nighttime temperatures of the air over the heliostat field and the surrounding environment should not be encountered.

The previous change in ground albedo due to the reduction of alfalfa production has insignificantly contributed to the local area's net heat balance alteration.

(3) Heat Loss From Receiver

The receiver will lose 3-6% of the heat conveyed to it by the collectors before the heat can be converted into steam (SCE). Receiver heat losses are transmitted to the atmosphere in the vicinity of the receiver by convection, radiation and, to a much lesser extent, by conduction. Radiated heat losses are relatively constant while the convection losses will be dependent on wind velocity and direction. Heat loss to the atmosphere via the receiver constitutes a shift of long-wave radiation normally dispersed throughout the undeveloped site to a concentrated long-wave radiation that will be emitted from a single point (receiver at the top of the tower).

c. Waste Heat Rejection and Cooling

STE power plants can be expected to operate at efficiencies of about 24%. Therefore, of the 21% fraction of the total solar energy incident of the mirrors, 5% will be converted to electrical energy via the receiver and will be transported out of the region. The remaining 16% will be rejected into the atmosphere as waste heat (unusable heat collected at the site) and most of this will leave the power plant system via the cooling tower. For the entire STE facility, roughly 60% of the total incident solar radiation is absorbed and returned to the atmosphere as sensible heat, latent heat, or long-wave radiation. This compares to 70% for the undisturbed desert environment, excluding alfalfa. Despite heat rejection from the cooling tower, the establishment of an STE facility could conceivably cause a net loss of energy available to drive local climatic processes.

Because of the high intensity of concomitant energy fluxes, heat rejection from the power generation system and cooling tower has the potential to disturb the microclimate. For example, a commercially feasible 100 MWe STE plant occupying one square mile (2.6 million square meters) will have a power generation complex that occupies about 13 acres (52610 m^2). A wet cooling tower for a 100 MWe steam turbine plant can release heat at a rate as high as 232 MW. Even if the cooling tower occupied the entire 13 acres (52610 m^2) of the complex area, the heat flux would still be as high as 410 watts per square foot (4410 watts/m^2). This compares to a typical annual average daytime heat flux away from the ground surface of about 36 watts per square foot (390 watts/m^2).

This concentrated release of waste heat could enhance convective updrafts, turbulence, and possibly the formation of small cumulus clouds above the plant. This especially would be the case if the locus of the heat rejection is in the center of the heliostat field where there could be strong contrasts between the temperature of the ambient air cooled by passage over heliostats and the temperature of the air heated by waste heat rejection.

A preliminary study of the impacts of cooling towers associated with nuclear power plants suggests that waste heat rejection from plants with capacities as high as 1000 MWe is not likely to have a significant large-scale effect on the local climate. In other words, there is little likelihood for changes in convective storm or precipitation frequencies. Consequently, it is not anticipated that the Pilot Plant will alter the characteristics of the atmosphere beyond the microclimate scale. (This ends DOE's generalized - not project specific - assessment of solar-related impacts to the natural heat balance.)

External surfaces of other plant thermally charged components will be warmer than ambient, contributing to the total redistribution of thermal energy (waste heat) from the collector field. For example, the thermal storage unit will lose to the atmosphere 5400 kWhrs thermal per day (based on 3% of 180 MWHr thermal loss/ 24 hours - per MDAC).

When comparing the heat rejected by a fossil plant with that rejected by the Pilot Plant, it should be recognized that the fossil fuel plant adds imported heat at a rate of approximately 1-2 MW of thermal energy to the atmosphere for every 1 MWe generated, whereas the Pilot Plant removes about 10% of the net incident solar radiation. The local heat output by the cooling tower per unit of electricity output will be equivalent for the Pilot Plant to a fossil fuel plant because its turbine efficiency is comparable to that of a fossil fuel power plant (DOE).

- <u>Mitigation</u>

The Pilot Plant's temperature/heat balance impacts, at least those that present technology has enabled us to understand, will be minimal. Monitoring of the plant's operation should include an assessment of the potential magnitude of such impacts relative to operation of commercial-size STE facilities.

It should be noted that the characteristic of a solar-thermal plant is that the total thermal emission level is less than the former site's natural emission level, by the amount of energy transported away from the site in electrical form. But regardless of the design's total thermal emission load, there will be a concentration of heat and a redistribution of long wave radiation different than that occurring on the site in its natural condition. The site's convective thermals may be altered accordingly.

d. Humidity Levels

Moisture release to the atmosphere will primarily occur via evaporation of water from: the cooling tower, blow down effluent in the evaporation ponds, heliostat washing, and domestic use. The total annual amount of water to be consumed (evaporated) will approximate 198 acre-feet, or roughly 90% of the 220 acre-feet annual plant requirement (County estimate). The cooling tower will directly emit the bulk of this evaporation. Of the remaining 20 acre-feet some water from heliostat washing and domestic/general plant use will remain as soil moisture and a minute amount may percolate to groundwater. Evaporation from the Pilot Plant's operation will be approximately 3-5% of that from Coolwater Generating Station and farming operation after Units 3 and 4 are on line. This amount is relatively minimal, resulting in an increase in local ambient humidity of approximately .2%.

Cloud and fog formation directly above the Pilot Plant is a slight possibility since condensation may form by the mixing of moist, waste heated air from cooling tower and receiver emissions with the ambient air cooled by its passage over the relatively cool heliostat field (see previous assessment). This vapor could periodically diffuse and scatter insolation, thereby reducing plant output.

- Mitigation

Since the Pilot Plant's incremental contribution to local humidity is slight, and since the receiving ambient air is relatively dry, no mitigation is required. Existing groundwater supply constraints will preclude significant cumulative additions to humidity levels in the future unless water is imported to the area.

Dry cooling would eliminate most of the evaporation but the impact is not important enough to warrant the extra cost.

The reduction in alfalfa production to provide water for pending Coolwater Units 3 and 4 will result in a slight contribution to ambient humidity since more water will be evaporated by plant use than by agricultural use.

No net increase in evaporation will occur from the existing evaporation ponds stemming from added Pilot Plant waste water. Pond surface areas will not be enlarged since the present pond will accommodate all of the Coolwater Generating Station's and the Pilot Plant's projected flows.

e. <u>Climatic Effects on Plant Facilities and Operation</u>

(Primarily Supplied by the County)

Climatic factors could in turn significantly effect plant operation and maintenance. The ideal weather condition for plant operation is bright sunlight with calm winds. Overcast skies associated with winter storm fronts (from the northwest) and summer thunderstorms (moist tropical air from the gulf) will decrease plant utility. Occasional cloud cover and precipitation during winter months when electricity demand is relatively low will be of less significance than rain and cloud cover during summer months when electricity demand usually peaks. However these infrequent summer thundershowers are usually of short duration.

Of more concern to plant operation and maintenance will be the effects of natural climatic hazards such as wind, dust, rain, hail, snow, lightning and temperature variations, all of which have been considered in the plant design. Environmental design criteria are listed in Exhibit X-17.

Extremely high winds could rock the tower, but should not be permanently damaging. Blowing sand will pit the glass mirror surfaces and reduce effective reflectivity if the heliostats are not stowed during high winds. Settling dust will also reduce mirror efficiency. Hail could also pit glass surfaces at certain sizes and speeds if the heliostats are not stowed during such storms (see Exhibit X-17). Heavy rain storms would not be permanently damaging, unless heavy runoff affected heliostat and tower foundations. Commonly occurring during desert storms is wind blown dust integrated with light rainfall which would require immediate heliostat washing. Snowfall in the site region should never be so heavy as to overload the heliostat structures. Lightning could be attracted to the receiver tower resulting in repairable damage to the tower's electrical system. Extreme wintertime diurnal ambient temperature variations on the site can range from a low of 20^{o}F to a high of 70^{o}F, but will probably not be rapid enough to create differential stress on the glass and

Exhibit X-17. Environmental Design Criteria

Parameter	Pilot Plant Value
Wind Speed:	
Operational	30 MPH
Survival	90 MPH
Temperature (Operational)	0F to 120F
Humidity (Relative)	5% to 70%
Operational without permanent damage	
Hail	0.8 in. dia @ 50 mph
Survival without damage	
Lightning	
Survival with repairable damage	
Earthquake	UBC Zone 3, NRC Reg. Guide 1.60. 0.25 g horizontal
(Survival without damage)	
Rain	*2.95 inches max/24 hr.
Snow	5 lb/ft^2 loading

*It is unlikely that 2.95 inches of rainfall would be evenly distributed over a 24-hour period in the Mojave Desert. Such a relatively high amount would most likely result from a cloudburst (i.e., .80-1.20" in 30 minutes or at a rate of 6"/hour for 1 or 2 minutes).

steel heliostats. Although a remote occurrence, rapid temperature variations could however cause the mirror glass to crack (i.e., heliostat washing during daylight hours). Interrupted insolation by transient clouds will change the local wall temperature in the receiver, possibly causing stress fatigue of the metal, thereby reducing receiver life expectancy. Freezing "working fluid" water could crack the receiver tubes.

- Mitigation

Periodic cloud cover during periods of peak electricity demand will not severely affect the Pilot Plant's contribution of power to the utility grid system since it is not expected to be a significant net energy contributor. Plant research will take precedence over power generation.

The Pilot Plant components and systems will be designed to produce the specified performance when subjected to the credible ranges of environmental conditions. Further, these facilities will be designed to survive the extremes of environmental conditions to which they may be exposed. The design process will employ the accepted techniques applicable to the engineering disciplines involved and in accordance with the techniques invoked by the applicable regulatory agencies to which portions of the plant are subject (DOE).

The heliostats can be stowed (mirror face down) during periods of blowing dust and sand, hail, rain, etc. to eliminate damage to reflective surfaces. Snow will fall from the mirror faces by rotating heliostats to a vertical position. It is presently known that the scraping action of snow on mirror faces acts as a non-scouring, natural cleaning agent.

The receiver tower will be grounded to mitigate lightning strikes.

Differential stress on metal and glass caused by extreme temperature fluctuations may be reduced by stowing heliostats face down during cold winter mornings.

At present, the exact effect of the varying stresses has not been quantified, however the receiver and heliostats will be designed to compensate for foreseeable fluctuations. Heliostat washing will be performed during morning hours when mirror surfaces are relatively cool. The boiler will be drained during freezing temperatures.

Monitoring of Pilot Plant operations will provide a data base for determining climatological impacts from and on large scale, commercial STE facilities.

E. Air Quality

1. Current Status

The Pilot Plant site is within the Southeast Desert Air Basin of California. Air quality in the San Bernardino County portion of this air basin is administered by the County Desert Air Pollution Control District. The County Board of Supervisors has the authority to adopt and implement District air quality rules and regulations, but it contracts with the South Coast Air Quality

Management District (administrator of air quality in the southern California coastal air basin) for personnel, monitoring equipment, enforcement and technical services.

The air quality monitoring stations maintained by the Air Quality Management District closest to the site are in Victorville and Barstow. Both stations measure levels of nitrogen oxides (NO_x), nitrogen dioxides (NO_2), oxidants, carbon monoxide (CO), and ambient suspended particulates on a daily basis. There is an insufficient amount of available site-specific air pollution data to assess the exact ambient quality over the Daggett area, therefore site air quality can only be extrapolated from upwind data.

The bulk of the air pollution affecting the region around the site originates in the populated South Coast Air Basin to the southwest and migrates to the desert through canyons of both the San Bernardino and San Gabriel Mountains. Victorville's monitoring station data indicate that the Hesperia and Victorville areas probably receive the heaviest concentration of pollutants that flow north over the San Bernardino mountains. The Barstow station's data indicate that some of the pollutant concentrations disperse between Victorville and Barstow. Pollutants are carried over the Pilot Plant site via normal air flow through the Mojave River "Valley".

Air pollution generated in the site region stems from mobile sources such as automobiles, trains and aircraft; and from stationary sources such as industry, mining, populated communities and fugitive dust from soil disturbance.

Pollution data for the following assessment is taken from Victorville and Barstow station records. Daggett could be expected to have better air quality than Barstow, at least relative to oxidant and NO_x concentrations.

When Coolwater Units 3 and 4 are on line, utilizing liquid distillate fuel, at a 25% capacity factor, maximum one hour ground level concentrations of .047 ppm of SO_2 and .022 ppm of NO_x will result. These maximums are expected to occur less than .1% of the time on an annual basis (SCE). Since existing average ambient air quality has not been determined on the site, it is difficult to project net ambient quality after all units are operating.

Pollutants that diffuse or scatter sunlight will be the most detrimental to plant operation. Pollutants found or expected to be periodically found in the region's ambient air, and their recent concentrations, are described in Appendix D (Form S. B. County APCD 1974 Annual Report). Pollutants existing in the site's air shed may diffuse and absorb solar radiation by an undetermined amount. Of primary concern is particulate matter (fine particulate aerosols) and possibly NO_2 and SO_2.

2. Project Impact/Mitigation

a. Plant Construction

Plant construction will disturb delicate soil crusts, resulting in periodic emissions of fugitive dust during heavy winds (30 plus mph). Motorized equipment used for material hauling and plant assembly will emit an undetermined amount of combustion contaminants during the construction period. Long-distance commuting by construction workers will slightly contribute to highway source emissions. The Pilot Plant's research-related activity (primarily vehicular use) will also produce conventional contaminants. These emissions will be relatively insignificant but will incrementally contribute to the region's advancing air shed degradation.

- Mitigation

Disturbed soils will be water sprayed when necessary to reduce dust and sand blow. Vehicular and equipment emissions can be reduced by normal measures, but adequate mitigation will require more efficient internal combustion systems, etc. that are beyond the scope of the project. Commuting distances could be reduced by temporarily housing workers on or near the site.

This Pilot Plant's contribution toward successful development of non-polluting commercial STE generation will be a significant air quality mitigation measure within itself.

b. Effects From Plant Operation

Plant operation does not require combustion of fossil fuels for steam generation. The only gaseous pollutants produced will be limited to that from support vehicles and research and development equipment. Periodic driving over the collector field for general maintenance purposes and heliostat washing will not allow soil stabilizing crusts to form over much of the field, therefore fugitive dust (from fine grain particles mixed with sandy loam) may coat heliostat surfaces during high winds. Dust settlement on mirrors will reduce the efficiency of solar collection and plant operation.

- Mitigation

The peripheral heliostats will automatically slow wind speeds within the collector field, thereby reducing dust blow. Periodic heliostat washing will remove mirror dust. The wash water should contain non-toxic elements (preferably deionized water only) so that runoff would be of sufficient quality to irrigate shade-tolerant, soil-binding vegetation on the collector field.

c. Effects On Plant Operation

The most potentially significant air quality effect will be diffusion and absorption of incoming solar radiation by existing ambient pollutants in the site's air shed. This is a good example of an environmental impact on the project. Solar collection efficiency will be reduced during certain meteorological and ambient air quality conditions. The extent of interference cannot presently be quantified due to lack of technical data, however the following assessment generally describes possible effects that should be studied during project research.

(1) Particulate Matter

Disturbance of site soils will induce dust fall on mirrors (see previous section). The stowing of heliostats (mirror down) will reduce sand pitting and dust deposition, however blowing silty soil particles occurring over parts of the site may still adhere to the mirrors even when they are in inverted positions. Upwind soil disturbance and general urbanization in the valley will increase periodic levels of ambient, radiation-diffusing pollutants, which may or may not be of consequence to the Pilot Plant over its relatively short life expectancy.

The removal of some Coolwater ranch land from cultivation in order to balance water requirements for Coolwater Units 3 and 4 and the Pilot Plant has left land in a fallow condition upwind of the Pilot Plant site. High winds will carry fine soils over the collectors until the former fields are restabilized by formation of crusts and by growth of ground-covering, pioneering weedy species.

Particle size is an important factor in insolation interference (South Coast Air Quality Management District - SCAQMD). Aerosols (extremely small particles) probably diffuse more light than would an equivalent portion of larger particles. Relatively coarse particulate matter generated from the natural desert environment has less effect on the visible spectrum than does the finer, man-made particle matter migrating to the region from the South Coast Air Basin (SCAQMD). Therefore exported matter will probably interfere with insolation more than local sources. Variables relative to solar diffusion potential also depend on organic vs. inorganic composition of particles, and the wavelength of incoming radiation.

Fugitive dust size measurements are not available from the Coolwater site. Such measurements have, however, been made at the JPL Goldstone tracking station located some 38 air miles north of Coolwater. These measurements were collected as a part of an extensive aerosol characterization study sponsored by the California Air Resources Board and reported by Hidy, et al, 1974[10]. On the basis of several samples obtained from Goldstone, the following conclusions were drawn:

- During "typical" desert conditions, the number of particles in the submicron size range were considerably less than measurements made in urban atmospheres.
- During the conditions sampled, about 60 to 70 percent of the aerosol volume was greater than 1 μm in diameter (aerosol volume provides a useful measure of aerosol mass).
- Although large amounts of windblown dust were expected, no evidence of such dust was recorded during the 1-week sampling period (regional data suggest that visibility reducing dust storms will occur about 0.5% of the time).
- Aerosol size distributions are dependent on origin of air reaching the Mohave Desert.

Although ambient particulate levels in the region exceed Federal and State standards, particle size and composition and level and frequency of occurrence will have to be determined before the site's constraints to efficient radiation collection can be accurately measured. Special emphasis should be placed on the effect of fine, aerosol-type matter exported long distance from the South Coast Air Basin.

- Mitigation

Disturbance of area soils should be kept to a minimum during plant operation. Soil-binding, shade-tolerant vegetation could be planted in the collector field and irrigated with non-toxic heliostat wash water. This ground cover should be hardy enough to withstand truck traffic from heliostat washing, general maintenance, etc. A layer of gravel over collector field soil might be a secondary option. Alfalfa fields taken out of production should not be disturbed (i.e., leave plant roots intact, keep vehicles off, etc.) in order to allow natural crust formation and natural revegetation of exotic, pioneering weeds. If fallow fields become significant sources of fugitive dust, they could be replanted with fast growing native vegetation and irrigated a few times to establish natural plant regeneration.

Mirrors will be stowed at night and during wind storms. Heliostat washing will provide the best means of maintaining optimum collection and reflection efficiency.

Migration of aerosols and fine particulate matter from the South Coast Air Basin to the area, and fugitive dust from regional soil disruption will continue and possibly increase over the 5 year anticipated life of the plant. The only reasonable mitigation available is to research all the variables associated with particulate-induced radiation interference (i.e. particle size, organic/inorganic composition, fallout rate, distribution, concentrations, etc.) in order to determine total impact on commercial STE development.

(2) Agricultural Spraying

Spraying and dusting of alfalfa fields adjacent to the Pilot Plant for pest and weed control will have an insignificant soiling effect on heliostats compared to that from local natural dust sources. However certain agricultural spray mists could induce corrosion of heliostat metals.

\- Mitigation

Alfalfa spraying (dusting) should be done only under favorable wind conditions in order to reduce spray drift into the heliostat field.

(3) Existing and Potential Emissions From Coolwater Units 1 - 4

The Pilot Plant will be located generally downwind of the Coolwater Generating Station. Coolwater Units 1 and 2 are conventional steam turbines presently fired by natural gas. Daily average emissions in 1974 were as follows (from S. B. County APCD 1974 Annual Report):

Organic Compounds	.01 tons/day
Particulates	.02 tons/day
NO_x	1.92 tons/day
SO_x	.20 tons/day
CO	.18 tons/day
Total	2.33 tons/day.

(This total reflects predominate use of clean-burning natural gas and is representative of 1976 emission totals.)

Coolwater Units 1 and 2 are presently among the last electrical generators in Southern California predominately fueled with natural gas. It is possible that future restricted gas supplies may be unavailable for Coolwater especially since it is in the Southeast Desert Air Basin which is much less populated and has better air quality than the South Coast Air Basin. If Units 1 and 2 were to be fired by conventional oils containing higher sulfur and ash content than natural gas, SO_2 and particulate emissions would undoubtedly increase and the resulting periodically-appearing plume may diffuse incoming radiation. The impact cannot be accurately quantified, but is expected by SCE to be of minor importance except for periods of air inversions occurring mostly during winter mornings.

Coolwater Units 3 and 4 will be operating by the time the Pilot Plant is completed. The only fuel that can be combusted in this combined-cycle plant is a low sulfur/low ash distillate, somewhat resembling jet fuel. Conversion to more polluting oil or coal combustion would require major burner alterations.

Projected daily average emissions from Coolwater Units 3 and 4 are as follows: (assuming 45% capacity factor)

Particulate	.2 tons/day	(per 1975 Coolwater EIR)
NO_x	3 tons/day	
SO_x	2.3 tons/day	
Total	5.5 tons/day	(assuming the probable predominate use of distillate fuel).

Units 3 and 4's contribution of radiation-scattering pollutants to the ambient air cannot be quantified yet, but are expected to be minimal due to combustion of relatively clean fuels.

The combined effect of emissions from all Coolwater units on radiation diffusion may generally be insignificant except for periods of intense plume-trapping inversion layers. Such instances of poor dispersion may occur for approximately 5-10% of the time when stable atmospheric conditions prevail during winter mornings from October to January (See Climate Section). In comparison, local sources of fugitive dust will be ambient more often in spring months when wind velocities are normally high.

Gaseous pollutants (hydrocarbons, CO, etc.) at the relatively low concentrations likely to exist over the site in the near future will probably not reduce plant efficiency. NO_x may present more of a problem.

- Mitigation

Effects of the Coolwater Units emissions on the Pilot Plant's operation can and will be mitigated in a number of ways. The collectors will be located northeast of the Coolwater Units. Available wind data for the site area indicate that Coolwater's combustion and vapor emission plumes will be transported over the collector