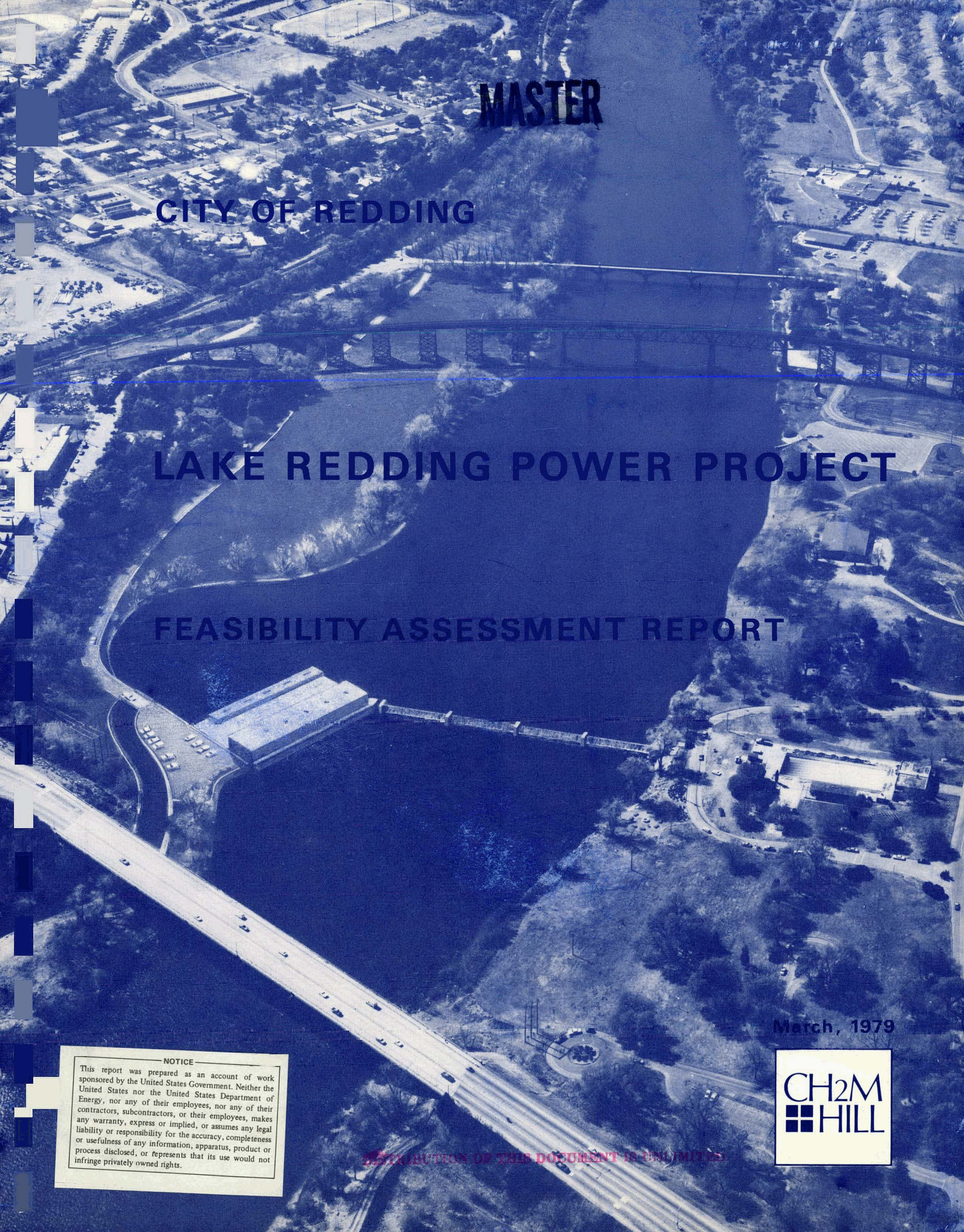
MASTER

CITY OF REDDING

LAKE REDDING POWER PROJECT

FEASIBILITY ASSESSMENT REPORT



March, 1979

CH2M HILL

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950 8721

27 March 1979

R-4014.E0

Mr. Jim Simpson, Director
Electric Department
City of Redding
760 Parkview Avenue
Redding, California 96001

Dear Mr. Simpson:

Subject: Lake Redding Power Project
Feasibility Assessment Report

We are pleased to submit our Feasibility Assessment Report for the Lake Redding Power Project. This report has been prepared in accordance with our agreement of 22 November 1978.

The feasibility assessment study has demonstrated the technical and economic feasibility of the project. We therefore recommend that the City proceed with preparation of the Federal Energy Regulatory Commission (FERC) license application and the required exhibits. Environmental reports and fisheries resources surveys required for the FERC license application will require considerable time and effort to complete, so these tasks should be undertaken as soon as possible.

We have thoroughly enjoyed working with you on this project thus far and look forward to continuing with the FERC license application and environmental and fisheries studies. We want to thank you for your cooperation and assistance.

Sincerely,

Joseph E. Patten

Joseph E. Patten
Vice President
Director Water Resources

ht
Enclosure

Redding Office
1525 Court Street, Redding, California 96001 916/243-5831

CITY OF REDDING: ##

LAKE REDDING POWER PLANT,
FEASIBILITY ASSESSMENT REPORT

Prepared by

CH2M HILL
1525 Court Street
Redding, California 96001

March 1979

R-4014.E0

ORGANIZATION

CITY COUNCIL

*Donald Demsher, Mayor

Lee D. Fulton, M.D.

*Archer Pugh

Barbara Gard

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*William M. Brickwood
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Project Manager

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SUMMARY

This feasibility investigation has demonstrated the feasibility of constructing a hydroelectric generation facility at the Anderson-Cottonwood Irrigation District (ACID) diversion on the Sacramento River in Redding. Characteristics of the proposed plant are as follows:

Rated flow	15,000 cfs
Gross head	14 feet
Installed capacity	14,500 kW
Number of generating units	5
Average annual energy production	79,000,000 kWh

The proposed facility will have no significant impact on water resource needs or use of Lake Redding. ACID diversions will be maintained through the construction period and during project operation. The plant will be a run-of-the-river facility with no flow regulating capability and, therefore, no impacts on downstream uses. Energy output of the project will be utilized entirely within the distribution system presently operated by the City. There will be an interim period during which less than full project output will be needed to augment the City's present resource. Potential markets for the energy during this interim period have been identified.

Licenses, permits, and agreements must be obtained from a number of Federal, State, local, and private entities. These entities have been identified along with requirements, and estimated time required to obtain the license, permit, or agreement.

Feasibility analyses of the project are based on the following criteria:

■ Begin construction	1981
■ Project startup	1984
■ Capital cost	$44.3 million
■ Annual OM&R cost (1984)	$415,000
■ Discount rate	6-7/8 percent
■ Period of repayment	40 years
■ Project life	50 years
■ Market value of power (1984)	43.1 mills/kW

With a total annual cost in 1984 of $3.69 million, the estimated 1984 cost of project power is 46.7 mills/kWh. Assuming no escalation of OM&R costs or market value of power, the project would have a benefit/cost ratio of .87 and an internal rate of return of 6.1 percent. If a 25-percent construction grant were to be made available for the project, the benefit/cost ratio would be 1.09. The cost of project power would be 37.8 mills/kWh.

Consideration of the impact of 5.5 percent escalation in the market value of power and 5 percent general inflation results in a benefit/cost ratio of 1.70, without grant assistance.

Project designs will be subjected to review of the California Department of Water Resources, Division of Safety of Dams to ensure the safety of project features.

Detailed evaluation of project impacts on fisheries of the Sacramento River will require an in-depth study to define the affected resources and suggest mitigative measures. No insurmountable problems were identified during the preliminary assessment. Visual impacts will be an important aspect of project design. The project, as conceived, will be compatible with park use and aesthetic considerations. Impacts on recreation and historical and cultural resources will not be significant.

The project will afford an opportunity for the City of Redding, through development of a local resource, to begin generation of part of their energy requirement, thus contributing to solution of the energy crisis facing our society and reducing dependency on foreign oil by some 130,000 barrels per year.

The 2,900 kW fixed- and adjustable-blade tube-turbine generators selected for this project are currently available domestically. The project will be on-line by early 1984.

Chapter 1
INTRODUCTION

GENERAL

The City of Redding has distributed electric power to customers within its service area since 1921. Power is obtained from the U.S. Department of Energy Western Area Power Administration (WAPA) over transmission lines owned by Pacific Gas and Electric Company (PG&E). A City-owned direct transmission line from the Keswick switchyard is now under construction.

The City, recognizing the limited capability of WAPA to meet future power needs, has initiated a program to develop additional power sources before the entitlement of the existing WAPA contract is exceeded. It is currently estimated that this entitlement will be exceeded sometime after 1984.

Anderson-Cottonwood Irrigation District (ACID) owns and operates a diversion dam and related facilities on the Sacramento River within the City limits of Redding.

The City is interested in determining the feasibility of installing a low-head hydroelectric power plant at the ACID diversion dam. The project will have a power generating capacity of 14.5 MW. Energy from the project will ultimately be used directly within the existing City electrical power distribution system.

The alternate source of energy to meet future demands in excess of the WAPA allotment will be purchase from PG&E. Since PG&E obtains its peaking power from oil-fired generation facilities, implementation of the Lake Redding power project will reduce dependency on oil for electric power in Northern California.

AUTHORIZATION

This feasibility assessment has been prepared under and in accordance with Cooperative Agreement No. EW-78-F-07-1797 between the U.S. Department of Energy and the City of Redding. CH2M HILL has prepared the feasibility report under an agreement with the City of Redding dated 22 November 1978.

THE STUDY AREA

The City of Redding (incorporated in 1887) is located at the north end of the Great Central Valley of California (see Figure 1). The mild climate, pleasant surroundings and ready access to a variety of recreational opportunities make the Redding area a very desirable place to live. This, along with an agressive economic development policy on the part of the City, County, and other local agencies, has resulted in the Redding area being one of the fastest growing areas in the State.

Annexation of the Cascade and Enterprise areas in 1976 and 1977, respectively, more than doubled the City's population. Electrical customers in the Cascade area are now being served by the City. City electric service in the Enterprise area is awaiting the finalization of arrangements for City purchase of PG&E facilities in the area.

Continuation of the present rapid rate of growth is anticipated.

PREVIOUS STUDIES

Previous studies relating to the project include:

1. A preliminary assessment of potential small hydro-power sites in the Redding area and Northern California (Reference 1).

2. A hydraulic study of the relationship between established tailwater conditions at Keswick power plant and forebay water surface elevation at the Lake Redding site (Reference 2).

More will be said of the results of the hydraulic study later.

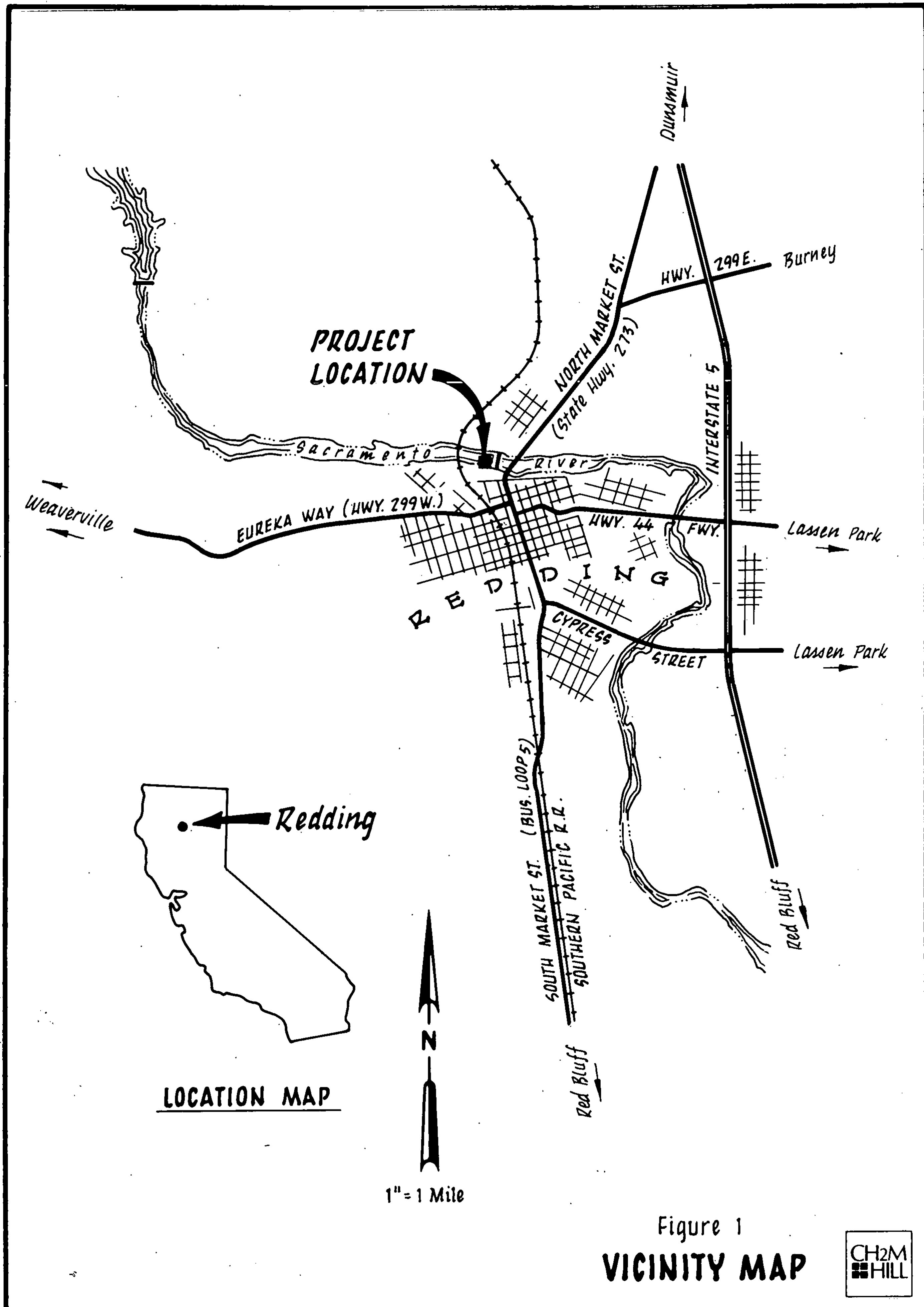

Figure 1
VICINITY MAP

Chapter 2
SITE DESCRIPTION

EXISTING FACILITIES

Existing facilities contributing to, or affected by the proposed project are described below. These facilities are shown on Figure 2.

ACID Diversion

Original construction of the diversion facility dates back to 1916. ACID diverts 400 cfs at the site for irrigation of bottom lands on the west side of the valley between Redding and Cottonwood. The dam is a 450-foot-long structure consisting of 2 abutments and 69 concrete piers on which removable steel A-frames are mounted to support timber stoplogs.

Diverted flows are directed through a short open channel section to the intake of a 2,300-foot-long tunnel and on through the ACID main canal. A bypass weir with removable stoplogs provides for the return to the river of diverted flows not admitted to the tunnel. Fish screens are provided at the entrance to the tunnel and are operated seasonally to prevent loss of juvenile salmon.

Each spring at the beginning of the irrigation season, usually in March or April, the stoplogs and bypass weir boards are set up. In November they are dismantled to allow passage of winter flows with minimum damage to the structures and adjacent properties.

Recreation Facilities

The waterfall and lake created by the ACID diversion facility are focal points of the popular 85-acre Lake Redding/Caldwell Park complex. The parks, owned and operated by the City of Redding, contain picnic facilities, children's playground equipment, an open-air swimming pool, boat launching facilities, athletic fields, and City museum. A lighting system has been installed to enhance nighttime viewing of the falls.

The City also owns the 36-acre Diestlehorst and Bennett properties on the south bank across from Lake Redding Park. A 19-acre property on the north bank downstream from the

North Market Street bridge has also been acquired by the City. The City also owns some 85 acres further upstream on both sides of the river. Ultimate use of these properties will probably be for park, recreation, and riparian natural habitat.

North Market Street Bridge

The four-lane Sacramento River crossing for North Market Street (State Highway 273) is located approximately 750 feet downstream from the ACID dam. In 1961 the original two-lane structure was widened to accommodate four traffic lanes. The bridge is owned by California Department of Transportation (Caltrans).

GEOTECHNICAL SITE EVALUATION

This section presents the results of preliminary geotechnical exploration at the Lake Redding power project site. The purpose of the exploration was to assess the geotechnical feasibility of building a powerhouse and required diversion facilities at the site.

Field Exploration

At the time of the exploration, the stoplogs were out of the ACID dam and Keswick release was 6,000 cfs. Under these conditions a flat expanse of cobbles is exposed inside the south bank upstream from the diversion channel. A test pit was excavated on this area. This material is a very loose, well graded mixture of silt, sand, gravel, and cobbles. Water was encountered at shallow depth.

An exploratory hole was drilled on the south bank about 200 feet south of the western tip of the island created by the ACID diversion channel. An air-rotary drilling rig was used to drill and set casing through 38 feet of cobbles. The underlying bedrock was then cored to a total depth of 76 feet.

Regional Geology and Geotechnical Interpretation

The project site is situated across the Sacramento River in the northern portion of the California Great Valley geologic province. The Sacramento River valley has been filled with nonmarine alluvial deposits of Pliocene and Pleistocene ages. Terraces 50 to 100 feet high have been cut by river erosion and form very striking nearly vertical reddish-brown cliffs along portions of the valley. The deposits in these cliffs are part of the Red Bluff formation. This formation occurs commonly in the Redding area; however, it does not

Figure 2

SITE MAP-

EXISTING CONDITIONS

MARCH, 1979

DATE of PHOTOGRAPHY: 11/19/76

APPROX. SCALE: 1"= 500'

directly underlie the proposed site. At lower elevations and within the eroded Red Bluff terraces are shallow terraces formed by Recent river deposits of silt, sand, gravel, and cobbles. The riverbanks and island on the proposed site are composed of such material near the surface.

Underlying these alluvial deposits at depths of from a few to more than 35 feet is the Cretaceous age Chico formation. In the vicinity of the site, this formation consists of fairly uniform siltstone; it does not appear to vary in rock type within the depth explored (to 76 feet below the surface). Based on our core samples, this rock is moderately weathered within the top few feet of its surface, and below that only slightly weathered. Joint spacing appears to be moderately close (1 to 3 feet), while the Rock Quality Designation (RQD) is good to excellent (75 to 95 percent). RQD equals 100 times the ratio of the length of core pieces 4 inches and longer divided by the length of the run.

Caltrans' foundation exploration record for the Market Street Bridge has been reviewed. This record indicates the Chico formation underlies the riverbed at depths of 5 feet (north side) to greater than 25 feet (south side) near the bridge. The bedrock surface appears to slope moderately toward the south across the width of the river. These data were further verified by actual visual inspection when the river flows were reduced to 3,500 cfs. Exposed bedrock is evident under the north span of the bridge and generally throughout the streambed on the north half of the river at the site.

Based on our field exploration, site reconnaissance, riverbed cross sections, and the Market Street Bridge foundation exploration, it appears that the alluvium-bedrock interface on the site may be irregular. It is apparent, however, that all proposed structures will be founded on competent bedrock.

Seismicity

Shasta County is an area of historic low seismicity. A search of the Earthquake Data File of the National Geophysical and Solar-Terrestrial Data Center (NOAA, 1977) and another reference (Coffman, 1973) showed 469 epicenters within 62 miles of the site. The largest of these events had a local magnitude of 5.5 and an epicentral distance of 50 miles. None of these historic seismic events were large enough or close enough to the proposed site to produce bedrock accelerations at the site exceeding 0.05g.

No faults are known to exist at or within 2 miles of the site, and no signs of recent faulting were observed during the field reconnaissance. The nearest fault known to have moved in Quaternary time (the last 2 million years) is located about 18 miles southeast of the site (Jennings, 1975). The Maximum Credible Earthquake and estimated maximum bedrock acceleration at the site from this and other faults of known Quaternary movement located within 100 miles of the site are shown in Table 1.

Because of the site's low historic seismicity, there does not appear to be a significant potential seismic hazard to the proposed project. However, due to the nature of the project and the potential loss of life and damage to property which might result from its failure, it is recommended that the powerhouse and dam be designed to withstand a maximum bedrock acceleration of 0.15g.

HYDROLOGY

Sacramento River flow records from the USGS gage near Keswick (about 2.8 miles upstream from the ACID diversion dam) have been available since 1942. Flows at the gage have been regulated since 1944 by Shasta Dam. With completion of the Trinity River element of the Central Valley Project, inter-basin transfer from the Trinity River basin began in 1964. The imported flow is released to the Sacramento River upstream from Keswick Dam through the Spring Creek power plant.

The proposed Lake Redding power plant will be a run-of-the-river plant with no flow regulating capability. Flow available for generation at the site is therefore equal to flow at the Keswick gage, less a maximum of 400 cfs ACID diversion during the irrigation season. Another 50 cfs has been deducted for maintenance of the waterfall effect at the dam. This is deemed necessary because the existing dam and waterfall is a focal point of the City's Lake Redding Park.

The operating program for Keswick Dam results in a flow regime at the site with little day-to-day variation and no perceptible hourly variation. Average monthly flows are therefore sufficient for definition of generating capability of the site. Average monthly flows for 1964-78 are shown on Figure 3. Figure 4 shows the flow-duration curve for the same period.

Table 1
Site Seismicity

Fault	Maximum Credible Earthquake[1] (Richter Magnitude)	Distance From Site in Kilometers	Estimated Maximum Bedrock Acceleration at Site[2]
San Andreas Fault	8.3	155	<0.05g
Likely Fault	7.5	158	<0.05g
Freshwater Fault	7.3	124	0.05g
Unnamed Quaternary Faults	6.75	63	0.08g
	6.6	30	0.18g

(1) Estimated from fault length (Bonilla, 1970)
(2) Using distance attenuation relationships of Schnabel and Seed (1972)

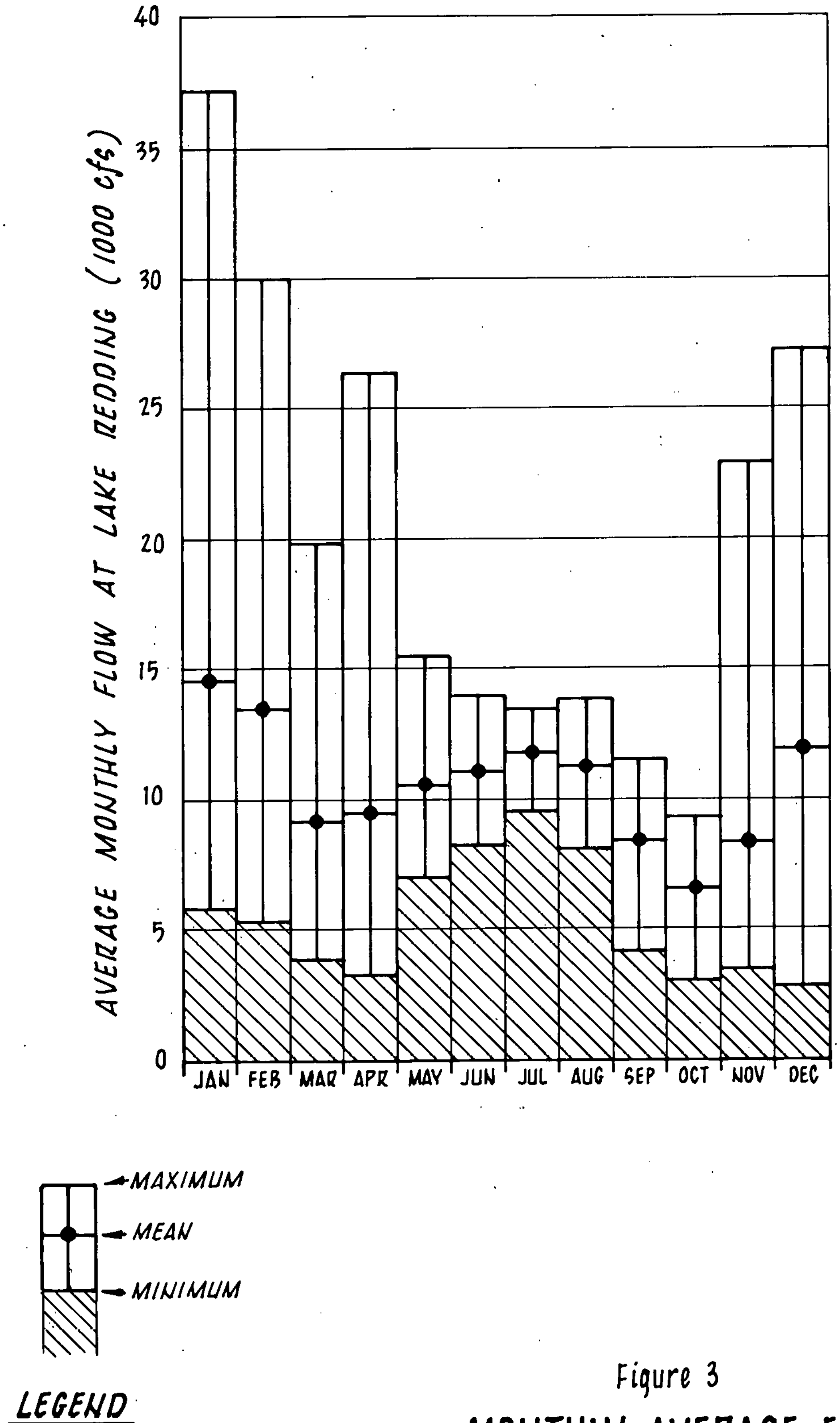

Figure 3

MONTHLY AVERAGE FLOW
1964 - 1978

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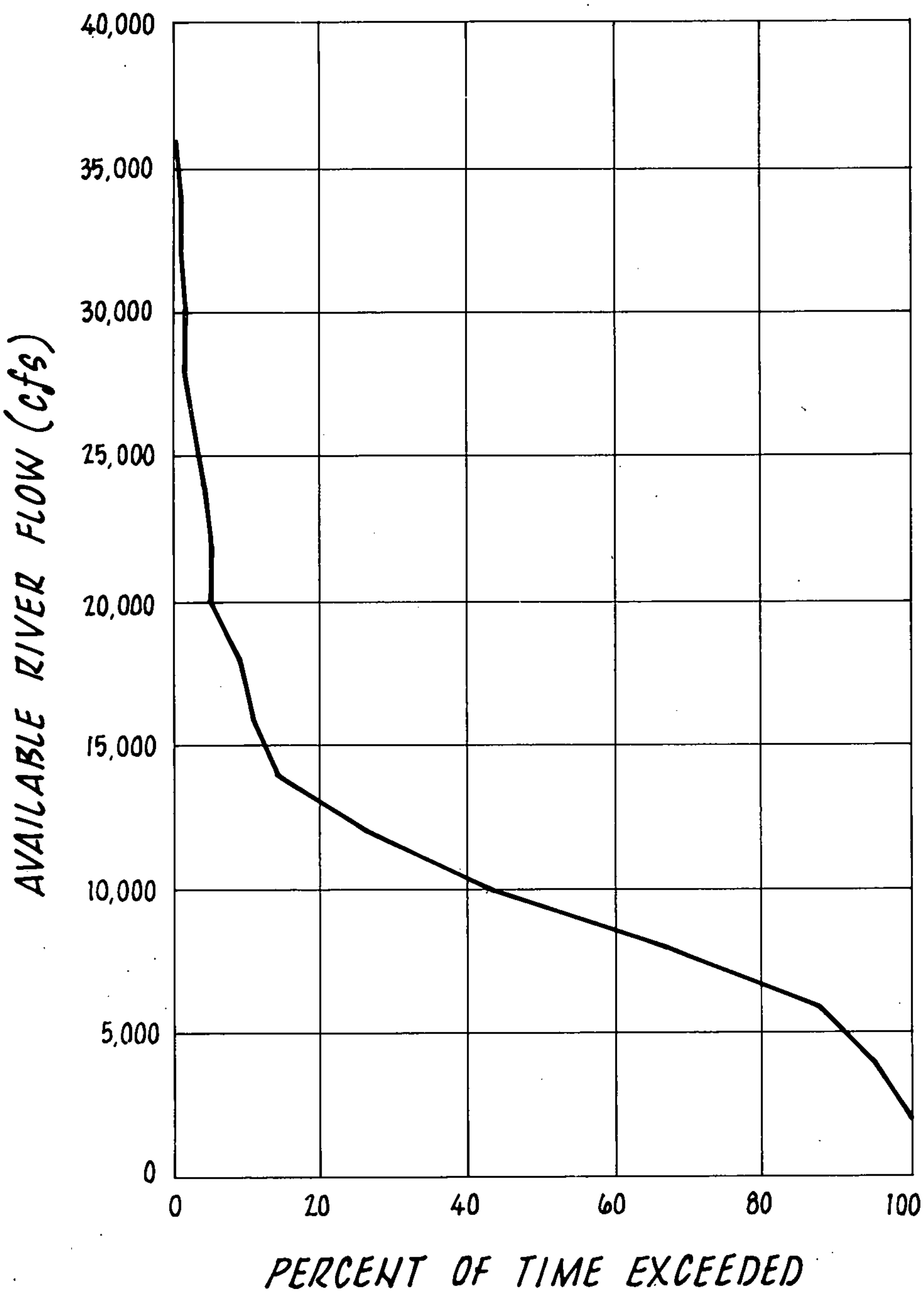

Figure 4

FLOW-DURATION CURVE

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Chapter 3
THE CONCEPT

GENERAL

The concept for development of hydroelectric power at the Lake Redding site involves diversion of the Sacramento River through a run-of-the-river generating facility. Diverted flows will be returned to the river channel immediately downstream from the diversion dam. No change in river flows will result. ACID diversions will be unaffected.

AVAILABLE HEAD

At normal summer releases of 12,000 cfs, the river upstream from the ACID dam stands at about 488 feet in elevation. This produces a drop of about 8 feet. This head is not sufficient for economic power generation.

A detailed hydraulic investigation has been conducted to assess the technical feasibility of increasing generating head at the site. Results of the study are summarized here. For a more detailed discussion, refer to the report "Proposed Lake Redding Power Project-Phase II Hydraulic Study" dated March 1977 (Reference 2).

Generating head for a power generating facility may be increased by either raising the forebay elevation, lowering tailwater elevation, or a combination of the two. At Lake Redding, the amount of head to be gained by either of these actions is limited.

Computer simulation utilizing the U.S. Corps of Engineers Hydraulic Engineering Center Water Surface Profile Program "HEC2" was employed in assessing the impact of potential actions.

The degree to which downstream channel modifications may be made is limited by the Redding Riffle. This is a very productive reach of Salmon spawing gravels extending from 3,000 feet downstream to 5,000 feet downstream from the ACID dam. The maximum channel modification deemed feasible without adversely impacting the riffle would be to excavate a trapezoidal section with bottom elevation of 468 feet and existing channel width from the dam downstream to approximately 100 feet below the North Market Street bridge.

Two factors limit the elevation to which the forebay may be raised:

1. Damage to facilities along the river could result if the forebay is raised above Elevation 492 (established high water level for 79,000 cfs flow). The 79,000 cfs flow is the operating criteria for Keswick, established to minimize downstream flood damage.

2. Generating capacity of Keswick powerhouse could be impaired if backwater conditions caused by raising the forebay extend upstream to Keswick.

The simulation program was used to develop upstream and downstream rating curves for the dam subject to the above constraints. Available generating head with improved tailwater conditions and raised foreway was calculated as the difference between these two curves. The resulting relationship between flow and available head is depicted on Figure 5.

GENERATING CAPACITY

An estimate of the rated generation capacity at the Lake Redding site has been computed and ranges from 14,500 kilowatts to about 2,500 kilowatts at minimum flow conditions. These calculations include an allowance for 0.3-foot hydraulic head loss. The resulting generation capacity versus flow curve is shown on Figure 6. Efficiencies assumed for these calculations are as follows:

Turbine efficiency	91 percent
Gear box efficiency	98 percent
Generator efficiency	97 percent
Overall efficiency	86.5 percent

Preliminary capacity studies indicate that the plant should be designed for total rated flow of 15,000 cfs and generating capacity of 14,500 kilowatts.

ENERGY PRODUCTION

Table 2 shows total energy output, based on 1964 to 1978 flow history, to be 79 million kilowatt hours. Monthly distribution of energy output is shown in Table 3.

Table 2
Energy Production

Flow Range (cfs)	Average Generating Flow (cfs)	Avg Net Head (ft) (.3' loss)	Flow* Correction Factor	Effective Flow (cfs)	Power N = .865 (kW)	Portion of Year at This Flow	Annual Hours	Energy Output (10^6 kWh)
2,000								
	3,000	11.9	.98	2,940	2,561	.046	403	1.032
4,000								
	5,000	12.3	.98	4,900	4,413	.074	648	2.859
6,000								
	7,000	12.7	.99	6,930	6,444	.211	1,848	11.908
8,000								
	9,000	12.9	1.00	9,000	8,500	.235	2,059	17.502
10,000								
	11,000	13.3	1.00	11,000	10,711	.171	1,498	16.045
12,000								
	13,000	13.6	1.01	13,130	13,074	.120	1,051	13.740
14,000								
	15,000	13.2	1.00	15,000	14,496	.034	298	4.320
16,000								
	15,400	12.6	.99	15,250	14,068	.018	158	2.223
18,000								
	15,400	11.9	.98	15,096	13,152	.040	350	4.603
20,000								
	15,400	11.5	.97	14,942	12,581	0	0	0
22,000								
	15,400	10.9	.97	14,942	11,924	.011	96	1.145
24,000								
	15,400	10.5	.96	14,788	11,368	.011	96	1.091
26,000								
	15,400	10.0	.96	14,788	10,827	.012	105	1.137
28,000								
	15,400	9.6	.96	14,788	10,394	0	0	0
30,000								
	15,400	9.1	.95	14,634	9,750	.006	53	.517
32,000								
	15,400	8.7	.95	14,634	9,321	0	0	0
34,000								
	15,400	8.4	.95	14,634	9,000	.005	44	.396
36,000								
	15,400	7.9	.94	14,480	8,375	.006	53	.444
38,000								
						Total		79.062

*USBR Curve 106-D-136 (Fig. 1, Par. 1.1)

Table 3
Monthly Distribution of Energy Output

Month		Energy Output (10^6 kWh)	Energy Output Distribution (%)
Jan		5.9	7.5
Feb		6.0	7.6
Mar		6.4	8.1
Apr		6.4	8.1
May		7.6	9.6
June		8.3	10.5
July		8.6	10.9
Aug		8.2	10.4
Sept		5.4	6.8
Oct		4.5	5.7
Nov		5.7	7.2
Dec		6.0	7.6
	TOTAL	79.0	100.0

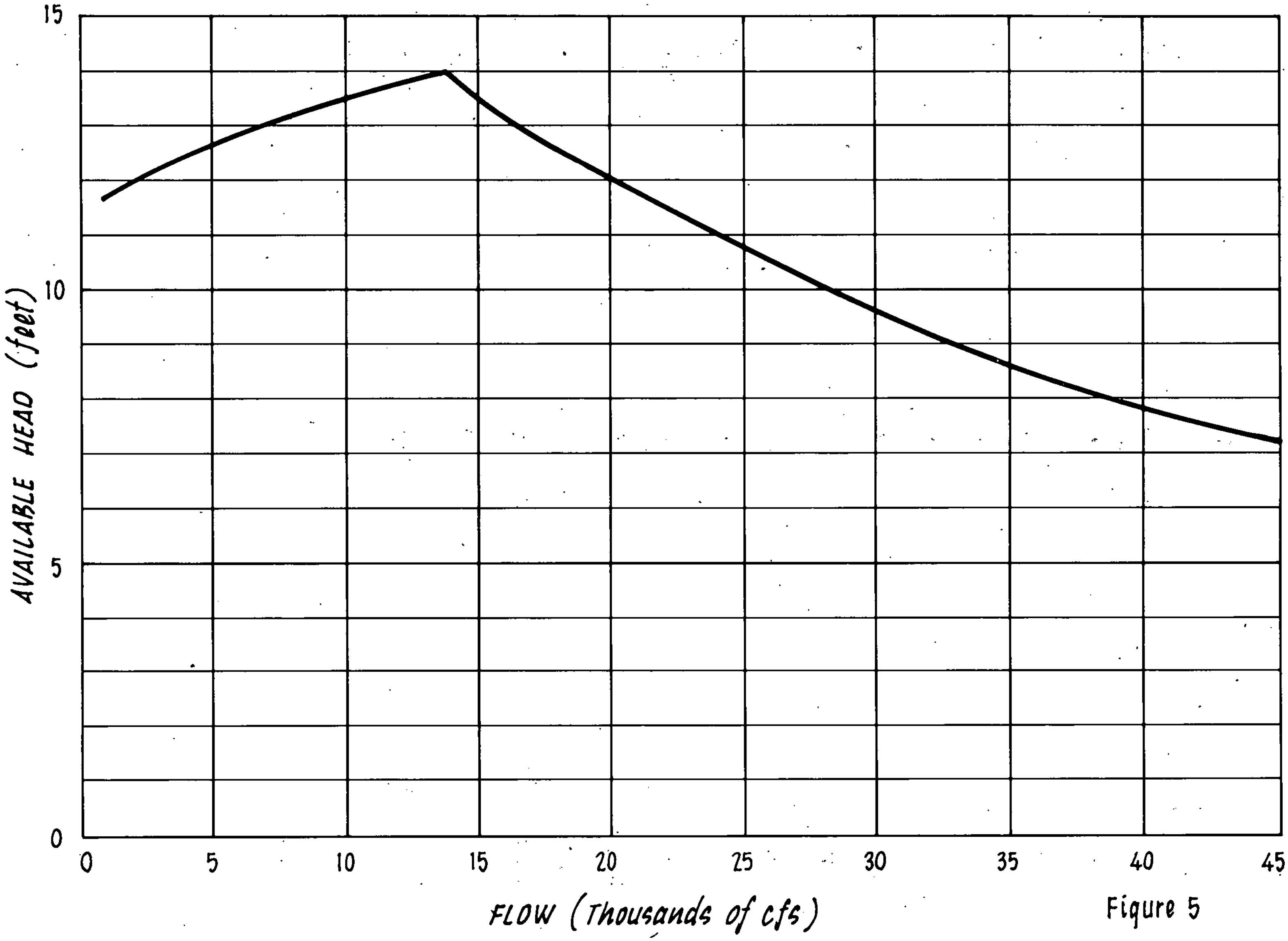

Figure 5

AVAILABLE HEAD VS. DISCHARGE

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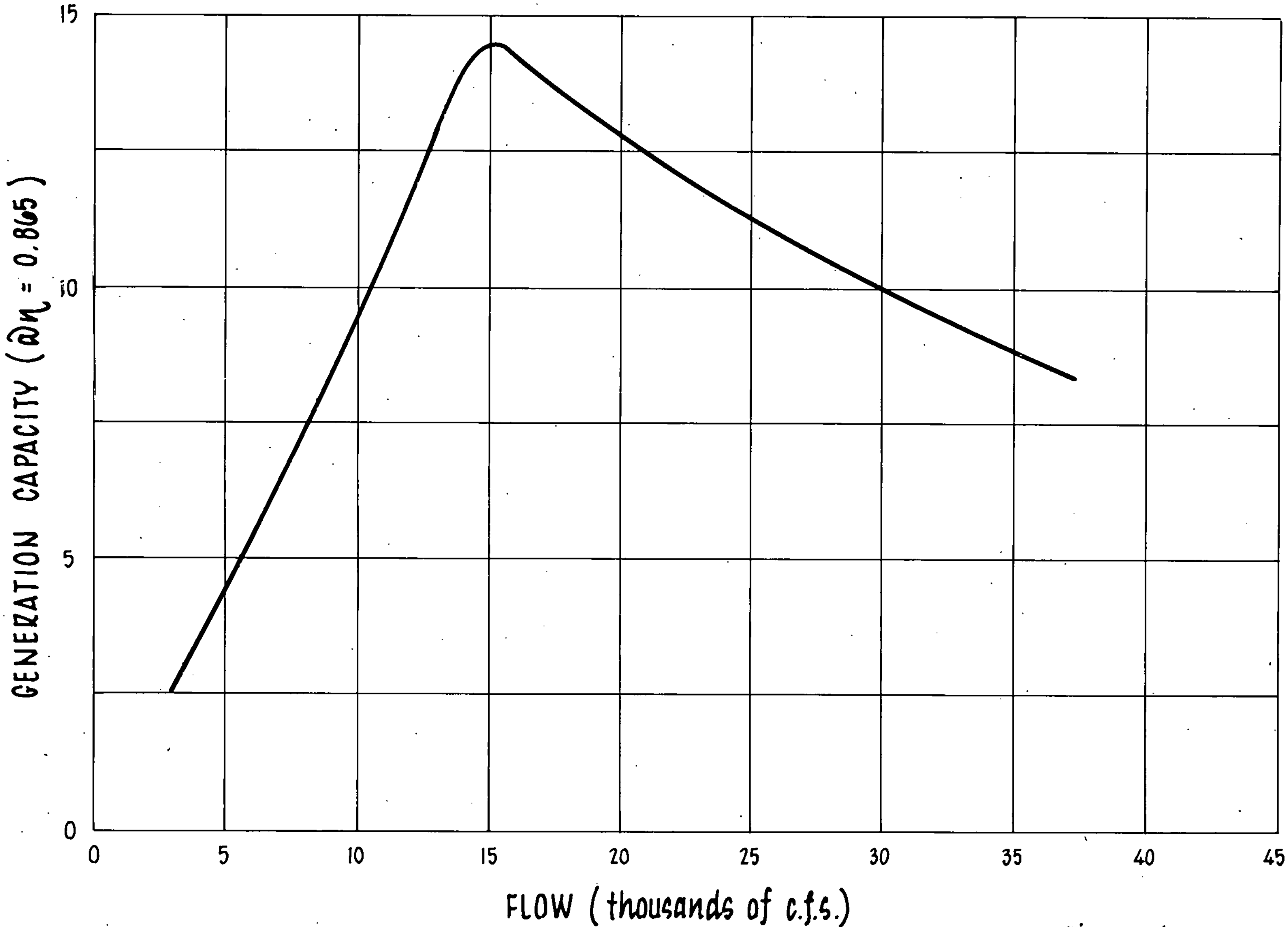

Figure 6

GENERATION CAPACITY vs. DISCHARGE

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Chapter 4
PROJECT DESCRIPTION

GENERATING EQUIPMENT

Using the flow-duration and available-discharge curves presented in Chapters 3 and 4, respectively, a preliminary study of the economics of generation has been conducted in order to select the most economic combination of equipment type and capacity.

Alternatives Considered

The following turbine types have been considered:

- Fixed Blade Propeller
  - Vertical shaft
  - Horizontal or inclined shaft, tube type
  - Horizontal shaft, bulb type
- Adjustable Blade Propeller
  - Vertical shaft
  - Horizontal or inclined shaft, tube type
  - Horizontal shaft, bulb type

Suppliers contacted include Allis Chalmers, Leffel, and Sulzer.

Comparison of Alternatives

Fixed blade turbines are somewhat less costly, in terms of both first cost and operation and maintenance cost, than adjustable blade turbines. Efficiencies of fixed and adjustable blade units are comparable at rated capacity, but efficiency of fixed blade units decreases rapidly as the operating point is moved away from the rated capacity. Adjustable propeller turbines, on the other hand, offer a much flatter efficiency curve over a broad operating range. Because of the wide range in flows at this site, at least part of the generating capacity should be powered by adjustable propeller turbines. Multiple unit alternatives could include a combination of fixed and adjustable blade turbines.

The inclined shaft tube-type turbine has been selected as most economical for this site, primarily on the basis of machine cost and depth of excavation required.

Three alternative generating equipment configurations have been investigated:

A. Five 2,900 kW generators with 15'-3" turbines
B. Three 4,800 kW generators with 19'-8" turbines
C. Two 7,250 kW generators with 24'-0" turbines

The two-generator alternative requires much more rock excavation and concrete placement than either of the other powerhouse configurations. Preliminary estimates of the resultant construction costs indicate considerably higher overall cost for the two-unit alternative. Costs of the three- and five-unit alternatives were close enough that feasibility-level construction cost estimates were prepared for both alternatives to ensure selection of the most cost-effective alternative.

Table 4 shows the estimated construction cost of the 5-unit plant to be somewhat less than that of the 3-unit system. The 5-unit alternative has been selected on the basis of cost operational flexibility and reduced impact on the river from bedrock excavation for the powerhouse, forebay, and tailrace. Figure 7 shown power plant layout and cross section for this alternative.

CONTROL

The plant will be automatically controlled with remote supervisory control and data acquisition (SCDA) by dedicated telephone line to the offices of the City Electric Department. Twenty-four-hour alarm monitoring could be accomplished by connecting a branch from this line into the Redding Police Station or Fire Station.

SYSTEM INTEGRATION

The following is a discussion of the various methods of integrating the proposed generation project into the City's electric system.

Table 4
Powerhouse Alternatives--Cost Comparison

	Comparative Cost ($ million) Alternative A (5 Units)	B (3 Units)
Civil - Structural	7.0	10.0
Generating Equipment	11.4	11.1
Electrical Control and Transmission	0.7	0.6
General Mechanical/Electrical	0.4	0.3
Trash Racks	0.5	0.5
Upstream Gates	0.6	0.6
Total	20.6	23.1

The City now has two lines within 300 feet of the proposed plantsite--one a 115 kV transmission line, the second a 12.5 kV three-phase distribution circuit. The City's Oregon Street Substation is located about 0.62 mile south of the generation site, and the City's Sulphur Creek Substation is approximately 1.34 miles north of the site.

Studies discussed previously have determined the optimum Lake Redding generating capacity to be 14.5 megawatts (75 amps at 115 kV or 700 amps at 125 kV). Two methods of integrating this capacity into the City's system have been examined, a direct tie into the 115 kV line and a direct connection into the 12.5 kV system.

It is estimated that 12.5 kV generators will cost about 40 percent more than 4.16 kV generators.

Work Required to Connect Into System

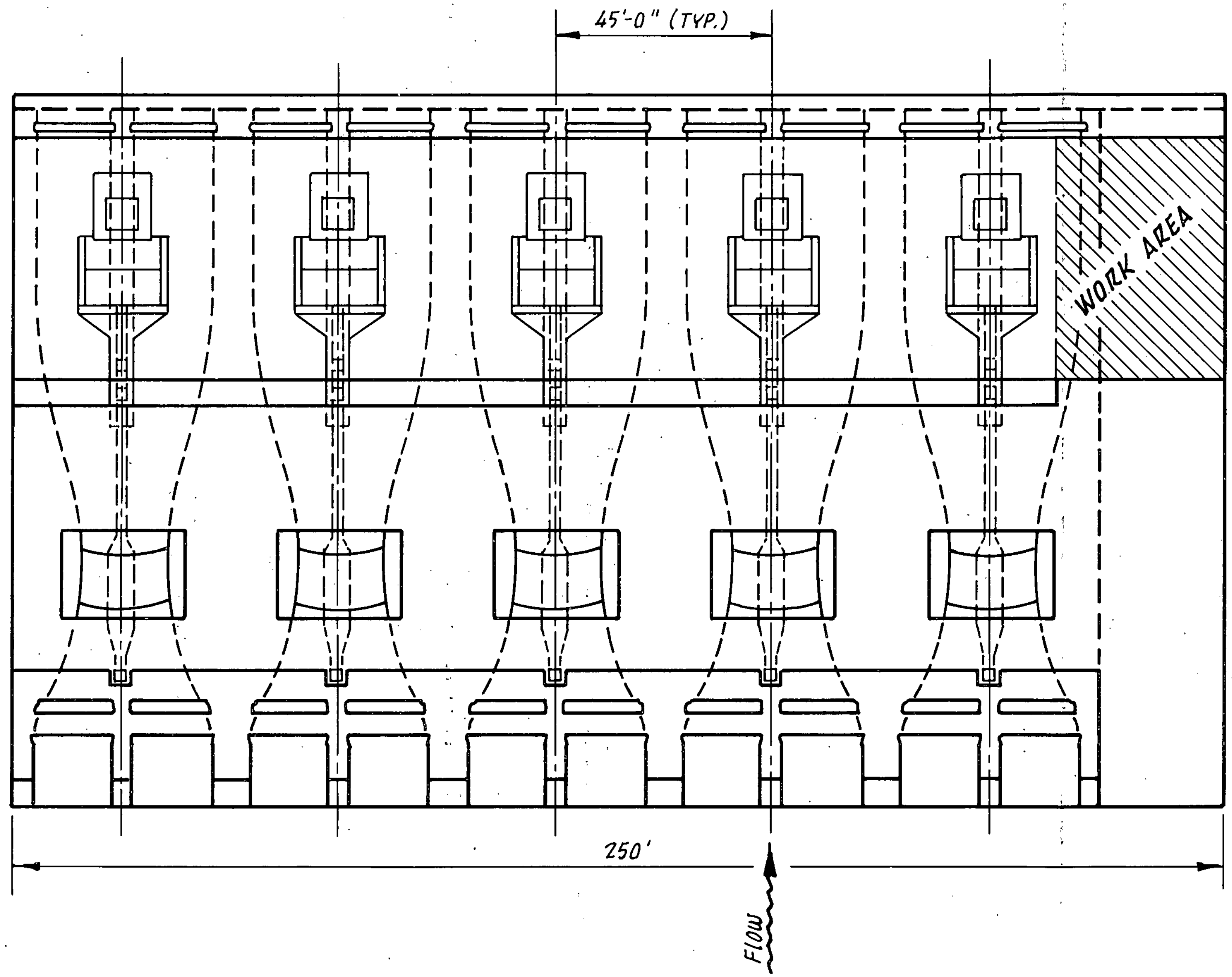
A-115 kV. This plan will require a low voltage (4.16 kV) structure with one bay for each generator, one 12-16-MVA step-up transformer (4.16 to 115 kV), Hi Side protection (a circuit breaker, a circuit switcher, or a Trans-Rupter), Hi Side structure with a three-phase gang operated disconnect switch, and one span of 115 kV line from the substation to the existing 115 kV transmission line.

The estimated cost of this work is $210,000.

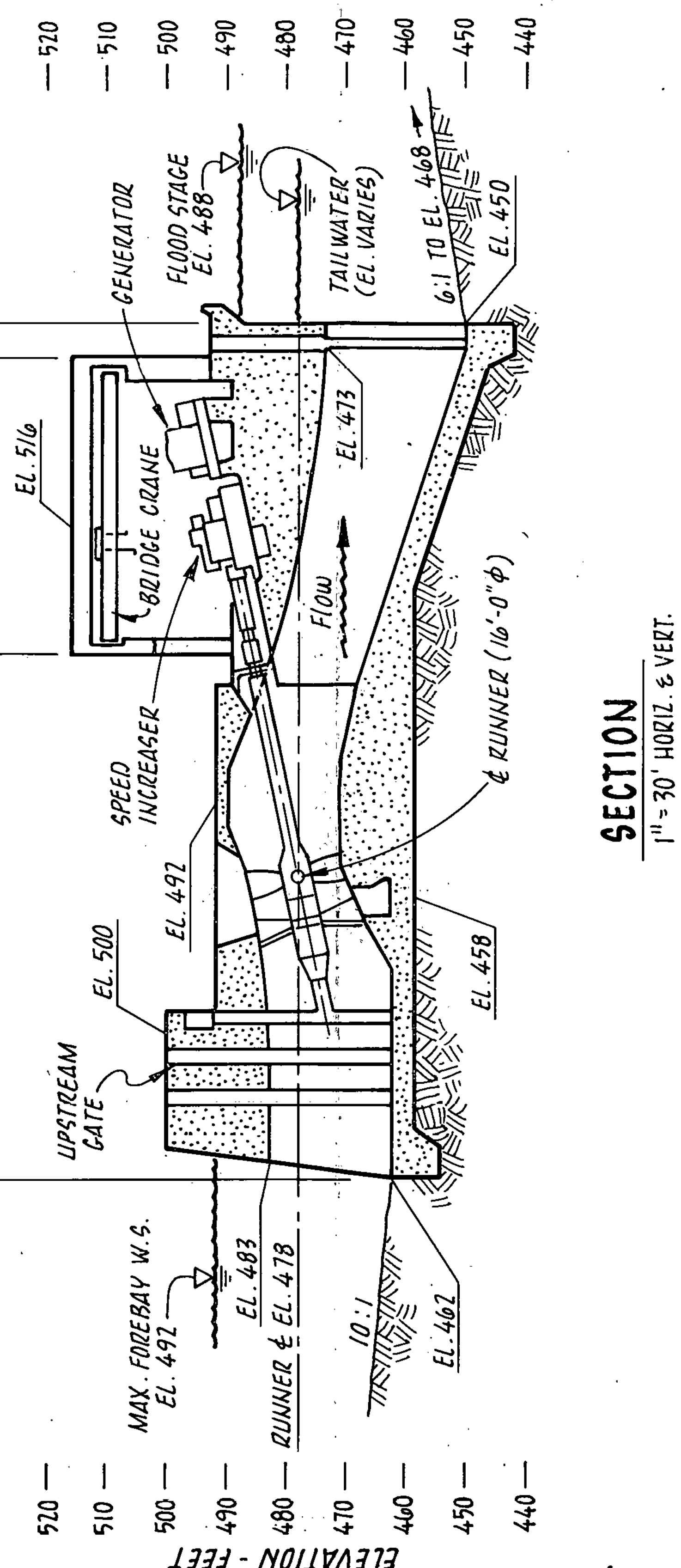
B-12.5 kV. This plan will require a Lo Voltage (4.16 kV) structure with one bay for each generator, one 12-16-MVA step-up transformer (4.16 to 12.5 kV), one Hi Side structure with one three-phase gang operated disconnect switch, and a 12.5 kV circuit breaker. An express 12.5 kV feeder will be constructed as underbuild on the existing transmission line from this substation to the existing Oregon Street Substation about 3,300 feet away. At the Oregon Street Substation a dead-end structure with a three-phase disconnect switch and a 12.5 kV circuit breaker will be installed, together with a heavy capacity tie to the existing 12.5 kV substation bus.

The estimated cost of this work is $267,100.

C-12.5 kV. This plan is based upon generation at 12.5 kV, thus not requiring a step-up transformer. This requires a Supply Voltage (12.5 kV) structure with one bay for each generator, one lead side structure, a three-phase gang operated disconnect switch, and a 12.5 kV circuit breaker. An express 12.5 kV feeder will be constructed from this substation to the Oregon Street Substation. At the Oregon



FLOOR PLAN
1" = 30'



SECTION
1" = 30' HORIZ. & VERT.

Figure 7
FIVE TUBE TURBINE PLANT LAYOUT

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Street Substation a dead-end structure with a three-phase disconnect switch and a 12.5 kV circuit breaker will be installed, together with a heavy capacity bus tie to the existing 12.5 kV substation bus.

The estimated cost for this work plus the additional cost of 12.5 kV generators is $217,700.

Conclusion

At this time, we believe that it is in the best interests of the City to tie directly into the 115 kV line. In summary, the reasons for selecting this alternative are:

- Least costly
- Most flexible way of distributing the power to the City's system
- Minimum line losses
- Best use of the existing system
- Easiest to install
- More aesthetically acceptable

CIVIL WORKS

Civil-structural facilities associated with the project include powerhouse, dam, channel modification, care of river and miscellaneous items such as access road, fish ladder, landscaping, and fisheries impact mitigating measures. Figure 8 depicts the general project layout. Major civil works elements are outlined in the following sections.

Powerhouse

Figure 7 shows layout and section for the five 15-foot 3-inch diameter inclined shaft turbine powerhouse. A 12,500-square-foot metal building houses generators, speed increasers, bridge crane, and 1,750-square-foot work area. Two of the five turbines will be adjustable blade Kaplan units to allow efficient matching of generation to river flow. An upstream slide gate is provided for control of flow through the turbines. Both upstream and downstream stoplog guides are provided to allow isolation and dewatering of the draft tubes for maintenance purposes.

Dam

The existing ACID dam will be replaced with four 14-foot by 115-foot bascule-type gates. These gates were selected for their ability to accurately control forebay elevation while maintaining the waterfall effect of the existing structure by overflow at the crest. The gates will be controlled by hydraulic rams on the downstream side.

In the down position, the gates will offer minimal resistance to flood flows up to 79,000 cfs. To further improve channel characteristics under high flow conditions, piers of the existing dam will be removed.

Figure 9 shows a typical section through the new dam. Rock bolts will be used as required to ensure stability of the structure. The hydraulic integrity of the structure will be carried from the cut-off wall on the north bank through the dam to the fish ladder and powerhouse, then through the south cutoff to the bluff south of the river.

Channel Modification

Two sections of river channel will require modification in order to achieve the head differential depicted on Figure 5. Two rock constrictions in the channel between 13,000 and 14,500 feet upstream from the existing ACID dam must be removed to improve the hydraulics of that section of river channel and avoid interference with Keswick power plant tailwater.

Channel modifications downstream from the dam consist of excavating a maximum of 800 feet of riverbed to reclaim head currently lost as the river flows over a section of exposed rock. In developing the available head curve shown in Figure 5, a trapezoidal section with width equal to existing channel width and bottom at Elevation 468 was assumed.

CARE OF RIVER

Construction of the dam, powerhouse, and downstream channel modifications will require diversion of river flows around construction areas and interception of subsurface flows presently moving through the powerhouse site. Because a construction period of 2 years is anticipated, it will be necessary to design protective cofferdams to accommodate winter flood flows or be prepared to evacuate the river channel when these flows occur. It will also be necessary to maintain the ACID diversion in operation during the April to November irrigation season.

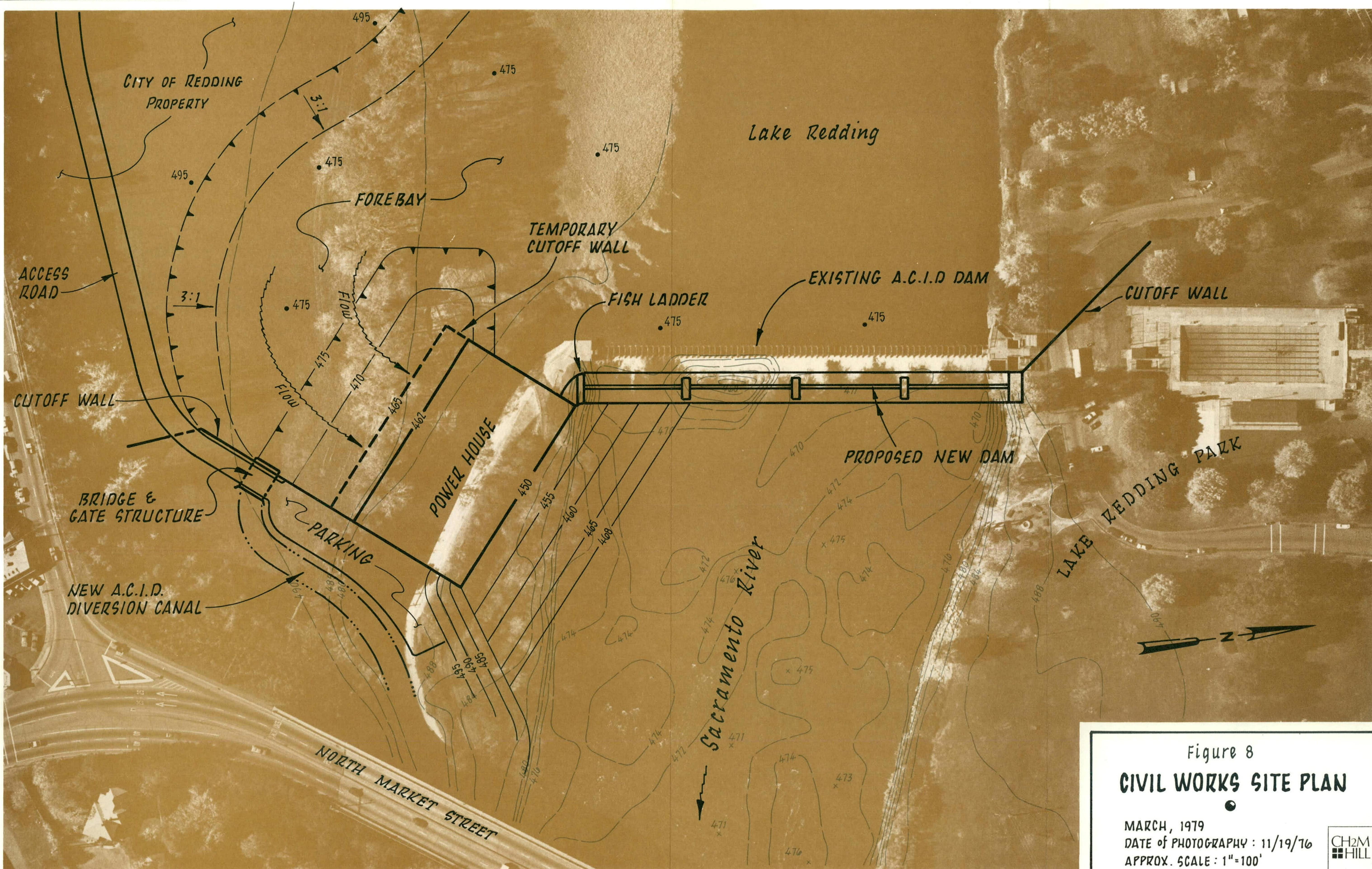

Figure 8

CIVIL WORKS SITE PLAN

MARCH, 1979
DATE of PHOTOGRAPHY: 11/19/76
APPROX. SCALE: 1"=100'

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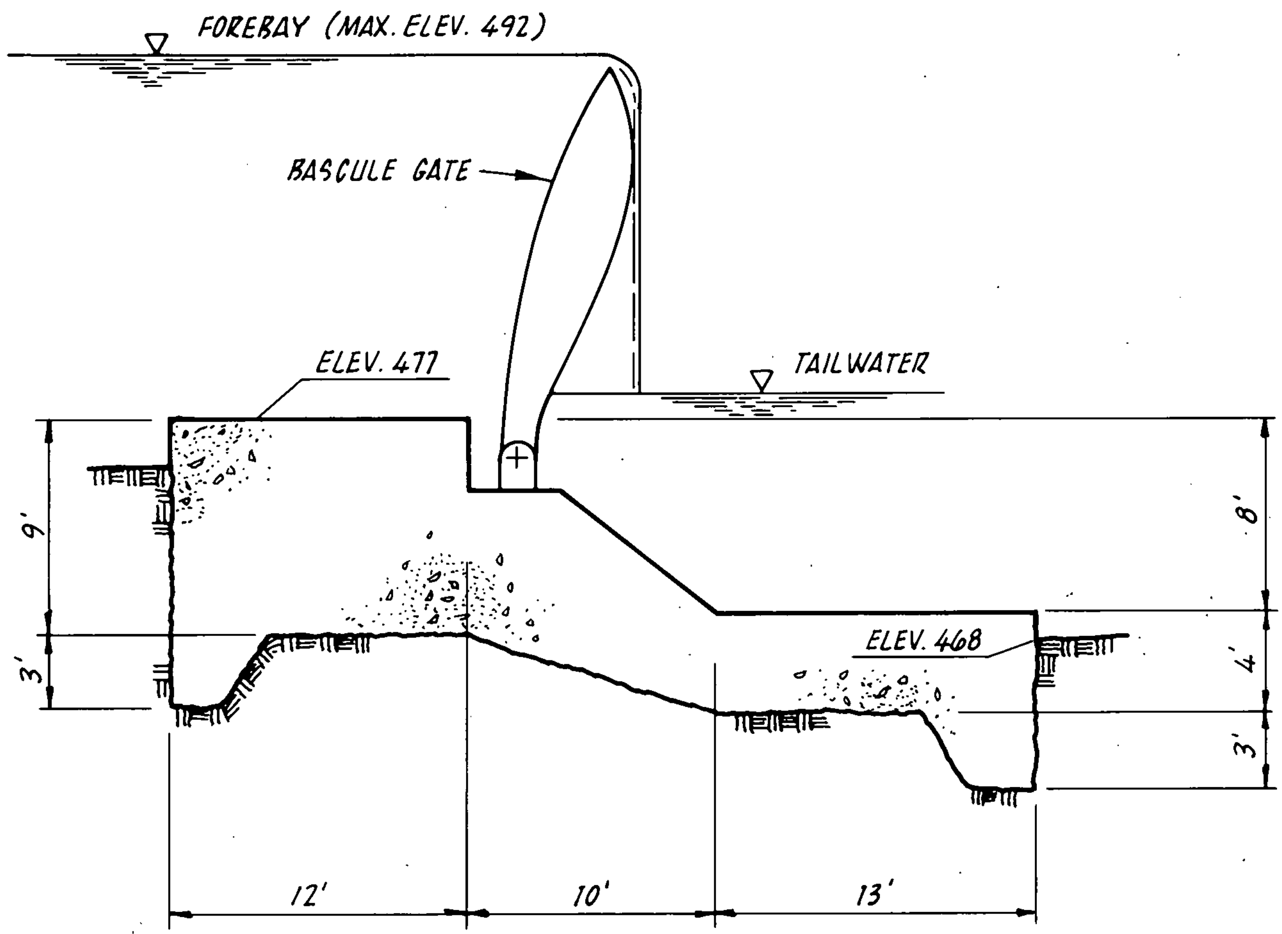

Figure 9

DAM TYPICAL SECTION

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The following care of river items have been included in the cost estimate:

- Slurry trench cutoff walls extending north of the north abutment, around the powerhouse, and south to the bluff south of the river
- The existing ACID dam to be modified to serve as the upstream coffer dam on one-half of the river at a time
- A gravel filled cellular sheet pile cofferdam down the center of the river from the existing ACID dam to below the channel reach to be modified
- Smaller gravel dike across one-half of the channel at a time, tying into the central coffer dam and the appropriate river bank
- Temporary ACID diversion around the construction site

Care must be exercised in placing and moving cofferdams, disposing of pumped water, and excavating in or near the channel to minimize the release of sediment and turbidity into the channel. Failure to do this may result in damage to downstream spawning areas.

Construction Sequence

The cost estimate presented in Chapter 7 is based upon the construction sequence depicted on Figure 10. It is imperative that the contract be awarded early enough that cofferdams can be in place and the site dewatered and ready for excavation to begin by the first of May. If work in the riverbed is not started by this date, it may not be possible to complete construction in one side of the riverbed in one construction season.

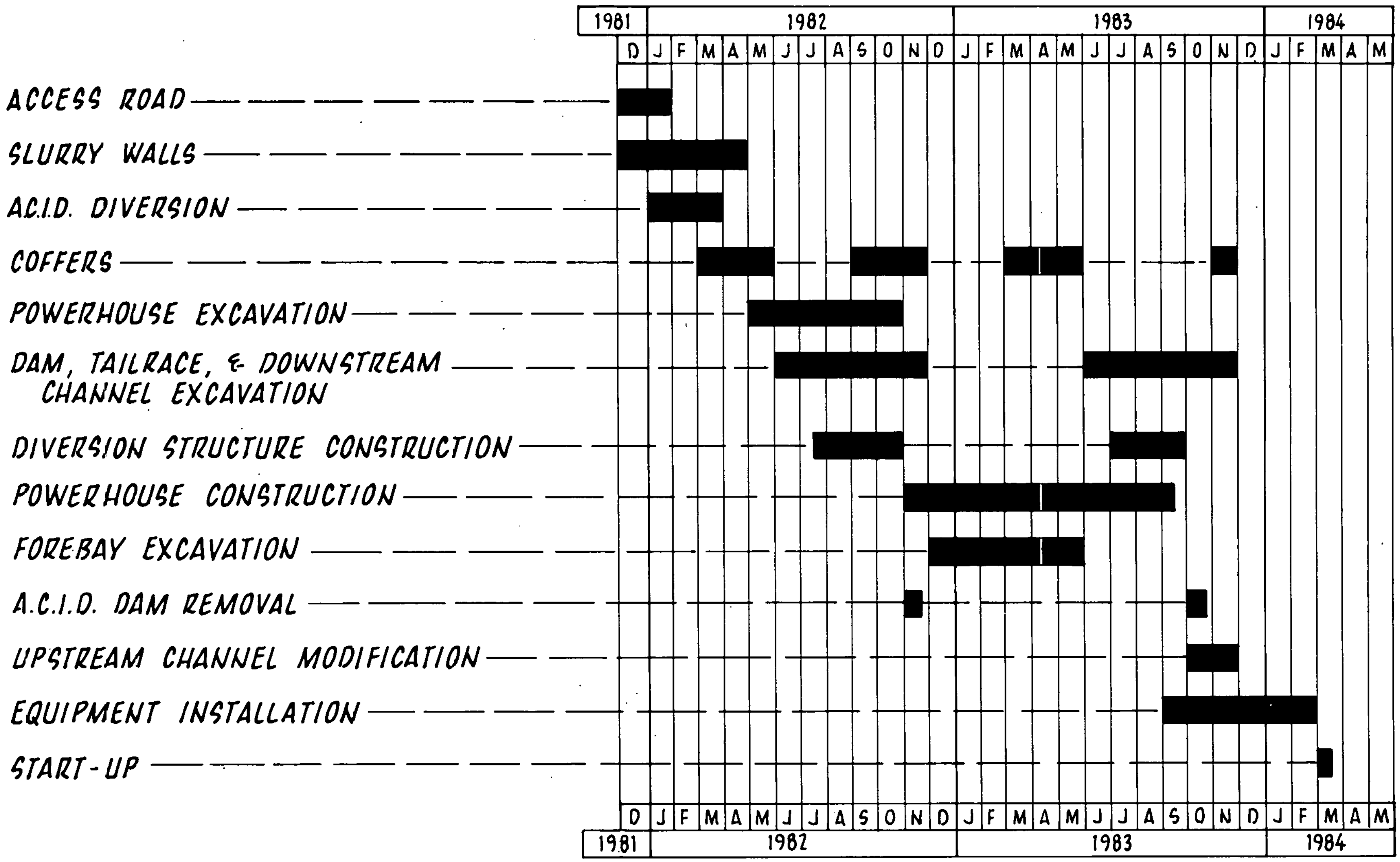

Figure 10
CONSTRUCTION SEQUENCE

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Chapter 5
ENVIRONMENTAL CONCERNS

Potential environmental concerns associated with the proposed project include fish and wildlife, aesthetic values, cultural resources, and recreation. A brief discussion of each of these areas of concern is presented in the following sections.

FISH AND WILDLIFE

The upper Sacramento River from Keswick to Woodson Bridge is widely recognized as a major king (chinook) salmon and steelhead trout spawning and rearing resource. Any activity involving the Sacramento River in a significant way must be critically evaluated with respect to its impact on this important resource.

With this in mind, a series of meetings has been held with representatives of California's Department of Fish and Game and U.S. Fish and Wildlife Service. These meetings were initiated to identify items to be considered in evaluating project impacts on fisheries of the Sacramento River.

The basic consensus arrived at as a result of these meetings was that a resource inventory survey should be conducted to assess the importance of the affected area to fisheries of the Sacramento River and assess possible impacts of the project.

The present diversion structure allows fish to ascend beyond the dam by way of a single fish ladder on the left abutment. Some of these fish are captured at the Keswick trap for transport to the Coleman fish hatchery for artificial spawning. Some natural spawning takes place upstream from the existing dam, but this is severely limited by availability of suitable gravels in this reach. Because of inadequate trapping facilities (inoperable under some flow conditions) and the limited spawning area, the current fishery is very inefficient.

One major question to be answered by the fisheries resource inventory survey is whether or not fish passage facilities should be included in the project. The answer to this question will depend upon the spawning and rearing capability of the reach above the site and the expected impacts of the project on this capability.

An assessment of expected turbine mortalities for adult and juvenile salmonids will also be made. A study of the juvenile turbine mortality problem is currently underway at Rock Island Dam in Washington. The study is being conducted on bulb-type turbines operating at heads of about 37 feet. The results of this study will be available in time for application on the Lake Redding project.

Project construction impacts will be given careful consideration, as will those on terrestial/riparian plant and animal communities. Methods of mitigating negative project impacts on aquatic and riparian terrestrial systems will be investigated.

It is expected that these studies will require from 1 to 2 years for completion.

AESTHETIC VALUES

Aesthetic considerations at the site will be important in developing this project, because of its location with respect to the heavily used Lake Redding/Caldwell park. The new gates will be designed for overflow to retain the waterfall effect similar to the present structure.

Construction of the powerhouse will require removal of most of the trees in the vicinity of the south abutment of the existing dam. These trees now provide a pleasant backdrop for the falls. Judicious architectural treatment and landscaping of the powerhouse and forebay will minimize the visual impact of these changes.

Other factors to be considered in evaluating the visual impacts of the project include the effect of the 4-foot rise in the upstream water surface elevation on riparian vegetation. Some large cottonwood and willow trees growing at or near the present water line on both the north and south banks will be adversely affected and may die as a result of saturation of the root systems.

Property owned by the City on both banks of the river in the vicinity of the project are excellent from the standpoint of climate and location for use for park and recreational purposes. These values may be enhanced by judicious use of excavated material to fill and shape the land to suit the intended use. Vegetation lost as a result of construction activity and raising the forebay will be replaced.

CULTURAL RESOURCES

The project will cause removal or inundation of the existing ACID diversion dam. This dam, constructed in 1916, represents a landmark in Redding's history and had an important role in the agricultural development of lands surrounding Redding.

Before construction of Shasta Dam, the project area was frequently subjected to severe flooding. The destructive force of these floods has left little of historic or cultural value in the area. Several sites do exist on the north side of the river, but these are well out of the area affected by the project. An archaeological investigation of the area will be conducted to ensure that no important historic sites are endangered.

RECREATION

The project will not materially affect recreational opportunities available at the site. Surface area of Lake Redding will be increased somewhat by excavation of the powerhouse forebay. The new lake level will be near the top of the existing boat ramp. But this will not significantly affect its utility.

Access to the lake will not be affected by the project.

Fishing access to the south bank in the immediate vicinity of the powerhouse will be impaired.

Chapter 6
PROJECT BENEFITS

GENERAL

The City of Redding owns and operates a municipal electric system. Currently it purchases electricity from the Western Area Power Administration (WAPA) through a requirements contract and distributes the energy to the City's retail customers. It is estimated that WAPA will be able to serve all of Redding's load growth through the year 1984. Thereafter, Redding will either have to purchase power to meet its load growth from other sources or will have to generate power from plants it owns and operates, such as the Lake Redding power plant.

USE OF THE OUTPUT BY THE CITY OF REDDING

Since projects such as the Lake Redding Power project are discretionary on the part of the owner/sponsor, the major test of feasibility is whether the power is economic to use in the owner's system, or, alternatively, whether it is marketable to others.

Future tests of the economic value will be by comparison with alternative new costs and alternative time frames. Energy at 43 to 47 mills could become very attractive by the time this project is on-line. Some factors bearing on its need or value to the City of Redding are:

- Availability and cost of WAPA power
- Availability of other resources
- Continued cost escalation of alternate resources
- Load growth in the City's service area
- Effectiveness of conservation efforts

Initial generation from the Lake Redding project is expected in 1984. This is approximately the date when the City's demand is estimated to exceed available WAPA capacity. There will then be an interim period during which the combined WAPA and Lake Redding resources will exceed the City's load. During this period, in order for the City to make optimum use of the new plant, it will be necessary to either displace WAPA power or negotiate a relatively short-term sale of Lake Redding power. By 1988 the City will probably need all of the Lake Redding power and energy.

The City's average monthly load factor in 1978 was 62 percent. The annual load factor was 49 percent. Therefore, the projected annual plant factor of 62 percent for the Lake Redding plant indicates that it can supply the necessary energy at system load factor to go with its capacity.

WAPA is currently in the process of increasing its electric rates to its Central Valley Project customers in California. WAPA has not, however, announced the final rate schedules which will apply to sales during the 1979-85 period. At present, Redding and other customers are paying for their purchases of WAPA power under an interim rate schedule. It appears, however, that one of two rate structures will probably be adopted. These structures were described in WAPA's memorandum of 26 September 1978 addressed to "All CVP Power Customers and Interested Parties."

At 62-percent monthly load factor, WAPA proposed Rate Structure A results in a composite purchase cost of 9.8 mills per kWh. Also at 62-percent monthly load factor, "project supply" under Schedule C results in a composite purchase cost of 6.2 mills while "purchased supply" equals 19.2 mills. The overall cost of CVP power under Rate Schedule C depends upon each customer's mix of project and purchased power.

The current load forecast, furnished to WAPA by Redding on 8 January 1978 is:

Calendar Year	Demand kW	Energy MWh
1979	98,000	508,000
1980	102,000	529,000
1981	105,000	544,000
1982	108,000	560,000
1983	112,000	581,000
1984	116,000	601,000
1985	120,000	622,000
1986	125,000	648,000
1987	130,000	674,000

Our investigation did not address this load forecast, but, in view of current growth, the projection through 1987 appears to be reasonable and appropriate for planning purposes.

The City of Redding is clearly the entity which should own and ultimately utilize the output of the Lake Redding plant. However, there may be a period of 3 to 4 years during which the output is only partially needed. Conditions of sale of power with drawback provisions will require extensive negotiation.

The concept would be to sell the output of the Lake Redding project until it is needed to meet the City's growth. The contract for its sale should provide for Redding to reclaim the power, after due notice, to meet power requirements that cannot be met by Central Valley Project power or by power from other less expensive sources. It is very important to note that once the Lake Redding plant is in operation, its total cost of power will escalate very slowly, if at all, because the preponderance of its costs will be fixed, its operating costs will be low, and there will be no fuel costs. Thus, as the costs of fuel used in thermal plants for electric generation increase in the future, power from Lake Redding will become cheaper by comparison.

The regional need for the output of the Lake Redding plant was explored. Four potential users for the output of the Lake Redding project have been identified in the event that the project comes on-line prior to the need of the City for power to supplement its supply from WAPA. Three of these potential purchasers have been interviewed--the Sacramento Municipal Utility District (SMUD), the California Department of Water Resources (DWR), and the Northern California Power Agency (of which Redding is a member). Neither the name of the project nor the name of the project sponsor were discussed. All three are interested in purchasing power and asked that they be given an opportunity to purchase the power from a project if it becomes available.

A discussion of their requirements is included later in this chapter.

Transmission of Power

A key to sale of power from the Lake Redding project to any purchaser will lie in the ability to negotiate agreements to wheel power from the City of Redding. WAPA owns transmission or has wheeling agreements for CVP power and energy over transmission facilities which connect Redding to the Sacramento Municipal Utility District, the California Department of Water Resources, many members of the Northern California Power Agency, and the Pacific Gas & Electric Company. Mr. James Grimes, Chief of the Power Marketing Division of the Sacramento area office of WAPA, has responded favorably to our inquiry concerning the use of Federal transmission facilities to wheel power from non-Federal plants to load centers.

Market Value of Power

Appendix A illustrates the wide range of power costs. SMUD estimates cost of power in the year 1985 will range from 14.92 mills to 112.85 mills per kilowatt-hour. The lower values are for hydroelectric projects. These range in cost from 14.92 mills per kilowatt-hour to 62.67 mills per kilowatt-hour. The higher values are for the geothermal and combustion turbine projects, which range from 36.88 mills to 112.85 mills per kilowatt-hour. It will be noted that the estimated cost of energy from the Lake Redding project is in the lower range.

Another measure of the market value of power from the Lake Redding project is the estimated annual increase in the cost of power on the Pacific Gas & Electric system. We have recently made two estimates of this increase for future years--one for the Aerojet Company and one for the San Francisco Bay Wastewater Reclamation study. We now estimate that the cost of power to PG&E will increase more rapidly because of the rapid escalation of the price of fuel oil. Using PG&E's current wholesale power revenue per kilowatt-hour for sales for resale as a base, we forecast that its average revenue from sales for resale will be about 43.1 mills per kilowatt-hour in 1984.

In conclusion, the value of power for the Lake Redding project is conservatively estimated on this basis as 43.1 mills per kilowatt-hour at the time of initial generation in 1984. This value is expected to increase by 5-1/2 percent per year as a result of general inflation.

INTERIM MARKETING POTENTIALS

Northern California Power Agency

The forecast of peak demand and energy requirements for the Northern California Power Agency (which includes the City of Redding) over the period from 1977 to 2000 is presented in Appendix A. The 1977 peak demand of 644 MW is expected to increase to 1,204 MW by 1990 and 1,694 MW by the year 2000.

Sacramento Municipal Utility District

Currently, SMUD obtains energy from three sources: (1) Central Valley Project (CVP), (2) Upper American River Project

(UARP), and (3) Rancho Seco nuclear generating plant. The CVP power is obtained from WAPA under a contract extending to 1994.

In 1976 SMUD completed a 20-year forecast of customer demand and submitted it to the California Energy Resources Conservation and Development Commission (ERCDC). The ERCDC staff also has made a forecast of customer demand that differs from the SMUD estimates by about 16 percent for the year 1995. The SMUD forecast assumes a higher user rate for residential customers, a lower acceptance of energy conservation, and a lower rate of substitution of electricity for natural gas.

Studies by the SMUD staff have concluded it is imperative that a program for new generation and/or a program of mandatory load reduction be implemented at an early date if significant shortfalls are to be avoided. The hydro, gas turbine, combined cycle, geothermal, and coal alternatives are regarded as having the best potential for the 1980 to 1990 timeframe.

Department of Water Resources

The California Department of Water Resources (DWR) is responsible for operating the State Water Project (SWP). Energy needs in excess of SWP generation are purchased from other utilities. Any temporary surplus is either sold or exchanged.

A summary of the SWP energy requirements and the resources for the period 1975 through 1998 is presented in Appendix A. The future requirements and anticipated resources are shown graphically. While the long-range energy program for the SWP is based on using essentially all SWP generation, the projections reveal that substantial purchases of energy will be required each year through 1998 in addition to (1) planned recovery plants at Pyramid, Cottonwood, and San Luis Obispo power plants; (2) future power plants at Glenn Reservoir and Los Vaqueros Reservoir; (3) geothermal development in The Geysers area; and (4) anticipated purchases from hydroelectric developments from Pine Flat Dam and the water distribution system of the Metropolitan Water District (MWD). Thereafter, DWR will rely on generation from SWP power plants with supplemental capacity and energy purchased from other utilities under terms yet to be determined.

Pacific Gas & Electric Company System

We have not met with PG&E with respect to its load-resource balance or its interest in purchasing power from the Lake

Redding project. Until recently, the California Department of Energy had not approved for construction any new generating plants during its entire existence. The plant which received preliminary approval from the Department recently is an additional PG&E geothermal plant at The Geysers. Without new generating stations, PG&E will need to purchase power to meet its growing loads. We believe, therefore, that PG&E is a potential purchaser for any power developed in California.

Chapter 7
PROJECT COSTS

CAPITAL COST

Estimated capital costs are presented in Table 5. These estimates are based on the five-tube alternative described in Chapter 5. Construction costs were estimated at January 1979 price levels, to a level of detail consistent with the feasibility level of project definition including allowance for project contingencies. Equipment cost estimates are based on manufacturer quotations and recent bids on comparable equipment. Total project construction cost, representing a January 1979 contractor's bid price is estimated to be $30.3 million.

Total construction investment was determined by escalating construction costs to 1982 and adding estimated costs of environmental studies, engineering, and administration.

ANNUAL COSTS

Annual operating costs are composed of expenditures for administration, insurance, operation and maintenance staff, allowance for equipment replacement, license costs, fees, and other miscellaneous expenses. The following criteria were used as guides in estimating annual operating expenses:

- Insurance--Required coverage is assumed to include fire and storm damage, vandalism, property damage, and public liability. An average annual rate of 0.2 percent of construction cost, which is representative of current practice, has been assumed for this study. This amounts to an estimated $75,000 per year for insurance.

- Operation, Maintenance, and Replacement Costs--This category covers annual costs and allowances for staff wages, outside services, office expenses, repair shops, equipment and parts required for project operation and maintenance, and replacement of system components with economic life significantly less than the project amortization period. It is assumed that the automated plant will require the services of one full-time maintenance man. With

Table 5
Project Costs

	Cost ($ Million)
Powerhouse	
Structural - Civil	7.0
Generating Equipment	11.4
Electrical Control and Transmission	.7
Building Mechanical	.4
Trash Racks	.5
Upstream Gates	.6
Subtotal	20.6
Diversion Facility	
Bascule Gates	3.2
Structural - Civil	1.2
Subtotal	4.4
Channel Modification	1.1
Care of River	3.3
Miscellaneous	0.9
Total 1979 Construction Cost	30.3
*Estimated 1982 Construction Cost (3-year escalation @ 8%)	38.2
Environmental Studies, Engineering, Administration, Legal, and Misc.	6.1
Total Capital Cost	44.3

fringe benefits, transportation, and miscellaneous expenses, staff costs are estimated at $35,000. Other annual operation and maintenance costs were assumed to be 0.6 percent of construction cost ($230,000).

- General expenses--Administrative and other miscellaneous general costs related to project operation are estimated at 0.2 percent of construction cost (75,000).

Estimated annual operating costs are summarized in Table 6.

Table 6
Annual Operating Costs

	Annual Cost ($)
Insurance	$ 75,000
Labor	35,000
Operation, Maintenance, and Replacement	230,000
Administrative and General	75,000
TOTAL	$415,000

COST OF POWER

Assuming a 40-year payback period at an interest rate of 6-7/8 percent, the resulting cost of project power is 46.7 mills per kilowatt hour. If a 25-percent construction grant were made available, the cost of project power would be reduced to 37.8 mills per kilowatt hour.

Chapter 8
FEASIBILITY ANALYSIS

BASIS FOR ANALYSIS

Both the economic and financial feasibility of the Lake Redding Power Project have been evaluated. The test of economic feasibility involves the comparison of project benefits with costs and the computation of a benefit-cost ratio and internal rate of return. The benefits and costs were evaluated in terms of 1979 constant dollars. However, the construction cost estimate includes an allowance for anticipated cost escalation during the construction period. The period of analysis is based on an economic life for the facilities of 50 years.

The financial feasibility test is concerned with the ability to obtain funds for construction and operation of the project. This analysis considers alternative funding sources and shows discounted cash flows during the debt repayment period. Both revenue and cost stream projections reflect anticipated inflation over the period of analysis.

Three funding alternatives have been considered in the financial analysis. They include:

1. Thirty-year revenue bonds with an interest rate of 7.5 percent.

2. Forty-year government loan at 6-7/8 percent.

3. Forty-year government loan at 6-7/8 percent with 25 percent construction grant.

The total capital cost of the project is $44.3 million, including construction costs, engineering and administration, cost escalation during the construction period, fees for legal services and bond counsel, and various miscellaneous costs related to project implementation. Annual operation, maintenance and replacement costs are estimated to be $415,000 in the first full year of operation. Summaries of capital costs and annual operation and maintenance costs are presented in Tables 5 and 6.

ECONOMIC FEASIBILITY

The economic analysis indicates the project has a benefit-cost ratio of .87 at an interest rate of 6-7/8 percent. The internal rate of return is 6.1 percent. This is the interest rate at which the benefit-cost ratio would be 1.0.

The economic analysis is based on initial generation of power in 1984 and assumes average water conditions. A computer program was used in computing the benefit-cost ratio and internal rate of return. The computer output is presented in Appendix B.

The project benefits are based on the estimated annual energy production of 79 million kWh. On the basis of the "Value of Power" analysis, a rate of 43.1 mills per kWh has been used in estimating project benefits.

Although the economic test of feasibility indicates the project costs would exceed the benefits at 6-7/8 percent interest, this does not necessarily indicate the project would not be economically desirable. Only primary benefits to the City have been included in this analysis. Other secondary benefits will accrue to other segments of society. For example, the project will reduce dependence on foreign oil by some 130,000 barrels per year.

As previously indicated, the economic analysis does not reflect the influence of inflation. It also does not consider the possibility of obtaining grants to assist in project construction. These considerations are evaluated in the following financial analysis.

FINANCIAL ANALYSIS

A discounted cash flow analysis was performed for each of the funding alternatives considered. The escalation rate for energy revenues is expected to be 5.5 percent. This estimate is based on anticipated annual increases in PG&E rates for wholesale power for resale. Annual O&M costs are expected to escalate at 5 percent per year.

To test the sensitivity of this analysis to variations in the anticipated rates of escalation, the cash flow analysis was performed for the revenue bond method of financing, assuming 7.5 percent increases in energy revenues. Under this assumption, the revenues would exceed the costs on a present worth basis by $28.3 million. The benefit to cost ratio would be 1.75.

Computer printouts for each alternative are presented in Appendix C and the results are summarized below.

Financial Alternatives	Present Worth of Net Return ($ Million)	Benefit/Cost Ratio
Government loan without construction grant	29.7	1.70
Government loan with construction grant	37.6	2.11
Revenue bonds	12.5	1.33
Revenue bonds with 7.5 percent revenue escalation	28.3	1.75

CONCLUSION

The project economic analysis indicates on a constant dollar basis, the benefit-cost ratio is less than 1.0. However, the financial analysis indicates project benefits will far exceed costs if inflation is considered. Consideration of expected differential escalation of energy prices as compared to the general inflation rate would further enhance the financial feasibility of the project.

Hydroelectric projects have high initial capital costs and relatively low annual operating costs (zero fuel costs). They offer distinct financial advantages during periods of rising fuel prices. Therefore, it would appear advisable to proceed with project implementation.

The City of Redding should consider applying for a DOE construction loan and/or grant if they become available. The high initial capital cost may make it difficult to sell revenue bonds, but this alternative also should be considered if the DOE program does not materialize.

Chapter 9
PROJECT IMPLEMENTATION

LAND OWNERSHIP

The City owns affected lands on both banks of the River at the project site. Figure 11 shows lands owned by the City in the vicinity of the project. Lands within the riverbed are in State ownership.

PERMITS, LICENSES, AND AGREEMENTS

Construction of this project will require permits or agreements from a multiplicity of Federal, State, and local government and private entities. Table 7 lists identified permits, licenses, and agreements required for project implementation.

A Federal Energy Regulatory Commission (FERC) license will be required to operate a power plant on the Sacramento River. In September 1977, the City of Redding filed an application for preliminary permit to the Federal Power Commission (a division of FERC). Following review of the feasibility report, the City plans to prepare an application for FERC license. The application will include general and engineering exhibits on the project as well as recreation, fish and wildlife, and environmental reports. Completion and submittal of the application is scheduled for the end of 1979 with the comment and environmental hearings occurring in 1980. A permit for construction should be available from FERC by late 1981.

Other permits required from Federal agencies for construction of the proposed power plant include a Section 404 permit from the U.S. Corps of Engineers (COE), an operations agreement with the U.S. Bureau of Reclamation (USBR) on Keswick power plant tailwater levels, and an agreement with U.S. Fish and Wildlife (USF&W) on river flow modifications at the proposed plant. Tentative agreements with the USBR and USF&W will need to be included in the operations exhibit and fish and wildlife report, respectively, of the application for FERC license. An application for the COE 404 permit should be submitted concurrently with the FERC application.

Table 7
Required Licenses, Permits, and Agreements

Agency	Requirement	Schedule	Comments
State Water Resources Control Board	Power Generation Water Right	1-2 Years	$6,000 Filing Fee Permit fee = 1/2 filing fee Coordinate with EIS
Federal Energy Regulatory Commission	License	2 Years	EIS will limit
Corps of Engineers	404 Permit		
California Department of Fish and Game	Gravel removal permit Agreement required for water right		Coordinate with FERC Exhibit "S"
Regional Water Resources Control Board	Construction Discharge Permit	<1 Year	
State Reclamation Board	Encroachment Permit	<1 Year	Need plans and specs Coordinated with Dam Safety and FERC
Department of Water Resources Division of Dam Safety	Dam Safety Approval	<1 Year	File at same time as FERC Plans Need approval before advertising for bids Fee is required
Anderson-Cottonwood Irrigation District	Agreement for use of site	Obtain as soon as possible	Probable issues: Deliveries to ACID O&M Agreement

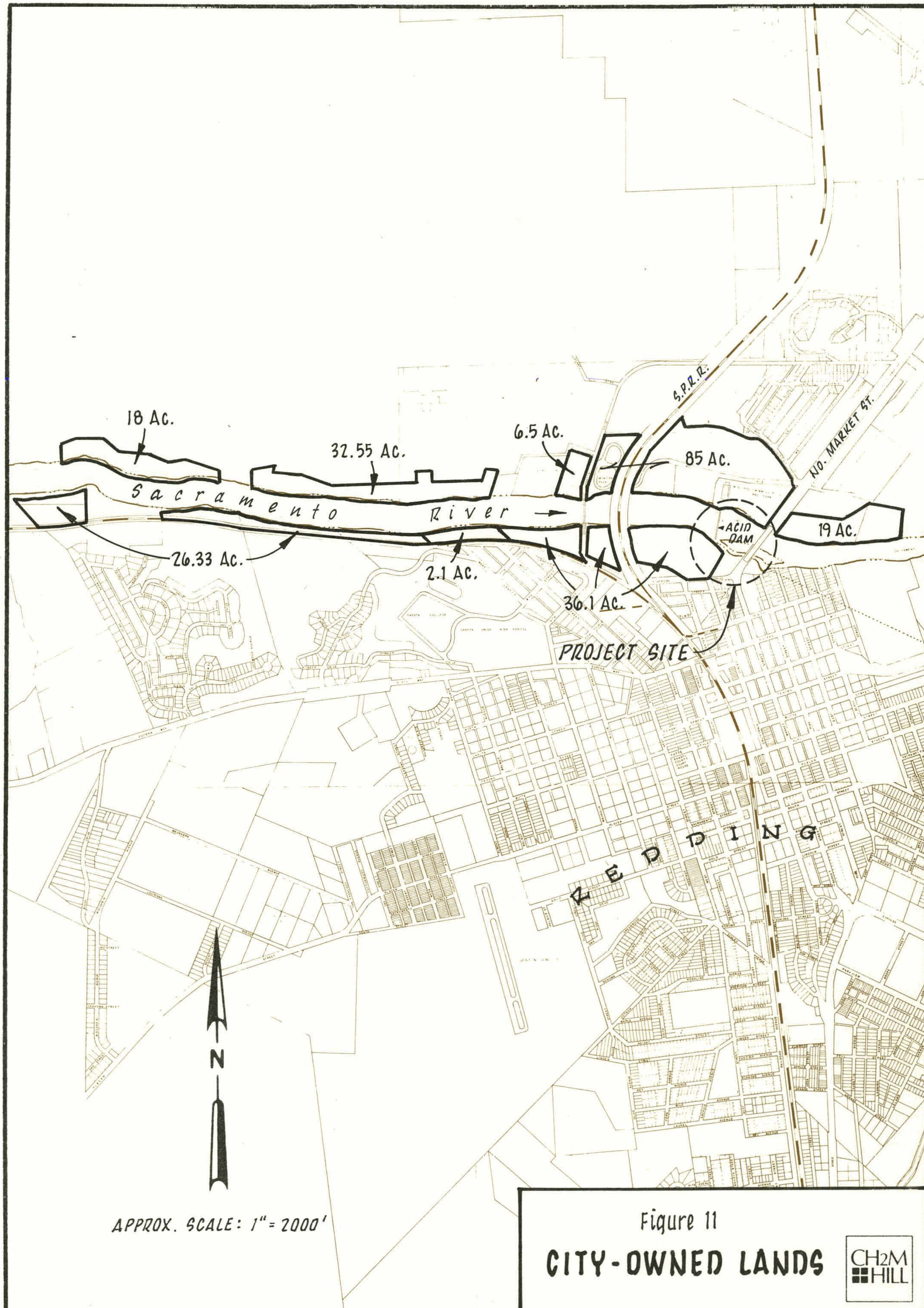

Figure 11

CITY-OWNED LANDS

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Agency	Requirement	Schedule	Comments
U.S. Bureau of Reclamation	Agreement on upstream benefits Power exchange		Coordinate with WAPA
Western Area Power Administration	Wheeling agreement		Coordinate with USBR
California Department of Transportation (Caltrans)	Bridge protection agreement		
Power Purchaser	Purchase contract for power		
Bureau of Land Management	Access for upstream channel modification		

State permits required for construction of the Lake Redding power project include the water rights permits described earlier, a Reclamation Board permit for construction in the river, an agreement with Fish and Game on river flow modifications at the proposed plant, and a Division of Safety of Dams permit for construction of the new diversion dam. A tentative agreement with Fish and Game will need to be included with the application for FERC license. Applications for the Reclamation Board and Division of Safety of Dams permits should be filed during 1980 or early 1981 so approvals will be available prior to the start of construction. An agreement and construction permit will also be required with the California Department of Transportation (Caltrans) for excavation in the area of Highway 273 bridge piers. Submittals will need to be made to Caltrans as planning and design progresses so they can have some input into proposed construction near the bridge.

Locally, recommendation and support of the City of Redding Parks Department, will be required relative to construction and change in water levels at the Lake Redding Park. As noted previously an agreement will be required with the Anderson-Cottonwood Irrigation District relative to their intake structure and land.

Power purchase agreements will be required for the period prior to the City's need for full output from the plant. A tentative agreement for such purchase should be included in the FERC application.

IMPLEMENTATION SCHEDULE

A graphic schedule identifying required activities and recommended implementation periods is shown on Figure 12.

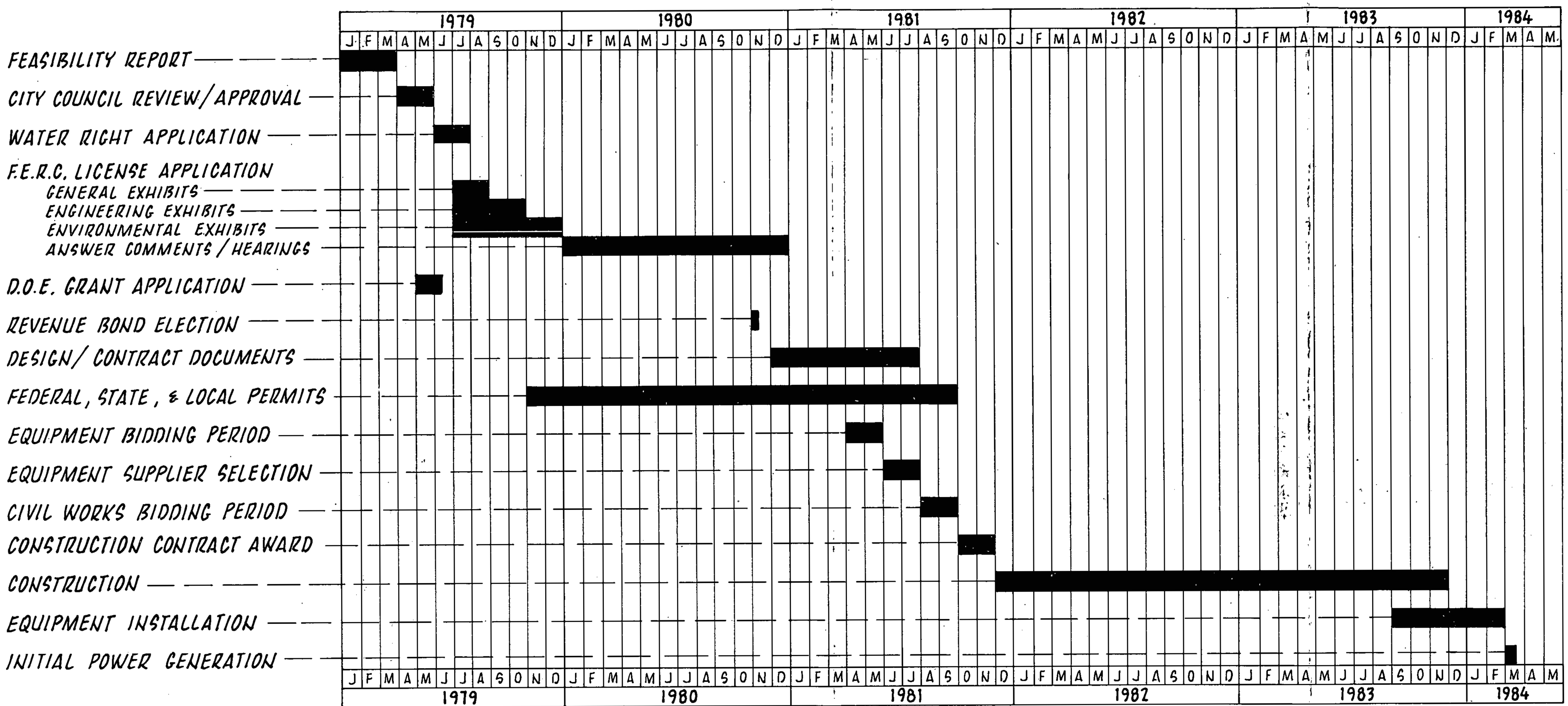

Figure 12

IMPLEMENTATION SCHEDULE

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REFERENCES

1. City of Redding, 1976. *Alternative Hydroelectric Power Potentials*.

2. City of Redding, 1977. *Proposed Lake Redding Power Project--Phase II Hydraulic Study*.

Northern California Power Agency

The forecast of peak demand and energy requirements for the Northern California Power Agency over the period from 1977 to 2000 is presented in Table A-1. The 1977 peak demand of 644 MW is expected to increase to 1,204 MW by 1990 and 1,694 MW by the year 2000.

Table A-1
Peak Demand and Energy Forecast
Northern California Power Agency

Year	Peak Demand-MW	Energy-GWh
1977	644	3,238
1980	788	3,994
1985	988	5,025
1986	1,029	5,242
1990	1,204	6,154
1995	1,440	7,382
2000	1,694	8,710

Sacramento Municipal Utility District

Currently, SMUD obtains energy from three sources: (1) Central Valley Project (CVP), (2) Upper American River Project (UARP), and (3) Rancho Seco nuclear generating plant. The CVP power is obtained from the U.S. Department of Energy under a contract extending to 1994. The contract provides for a maximum monthly delivery of 360 megawatts at system load factor at an approximate cost of 4.1 mills/kWh (September 1977). This rate, however, is in the process of being raised as indicated earlier in this report.

Service became available from the 650-megawatt UARP in 1961. The energy cost from this hydroelectric project is approximately 7.5 mills/kWh.

In 1974, the Rancho Seco nuclear generating plant was completed. The project provides 890 megawatts of baseload energy at a cost of 9.8 mills/kWh.

The capabilities of the present SMUD resources are summarized in Table A-2.

Table A-2
Existing SMUD Resources

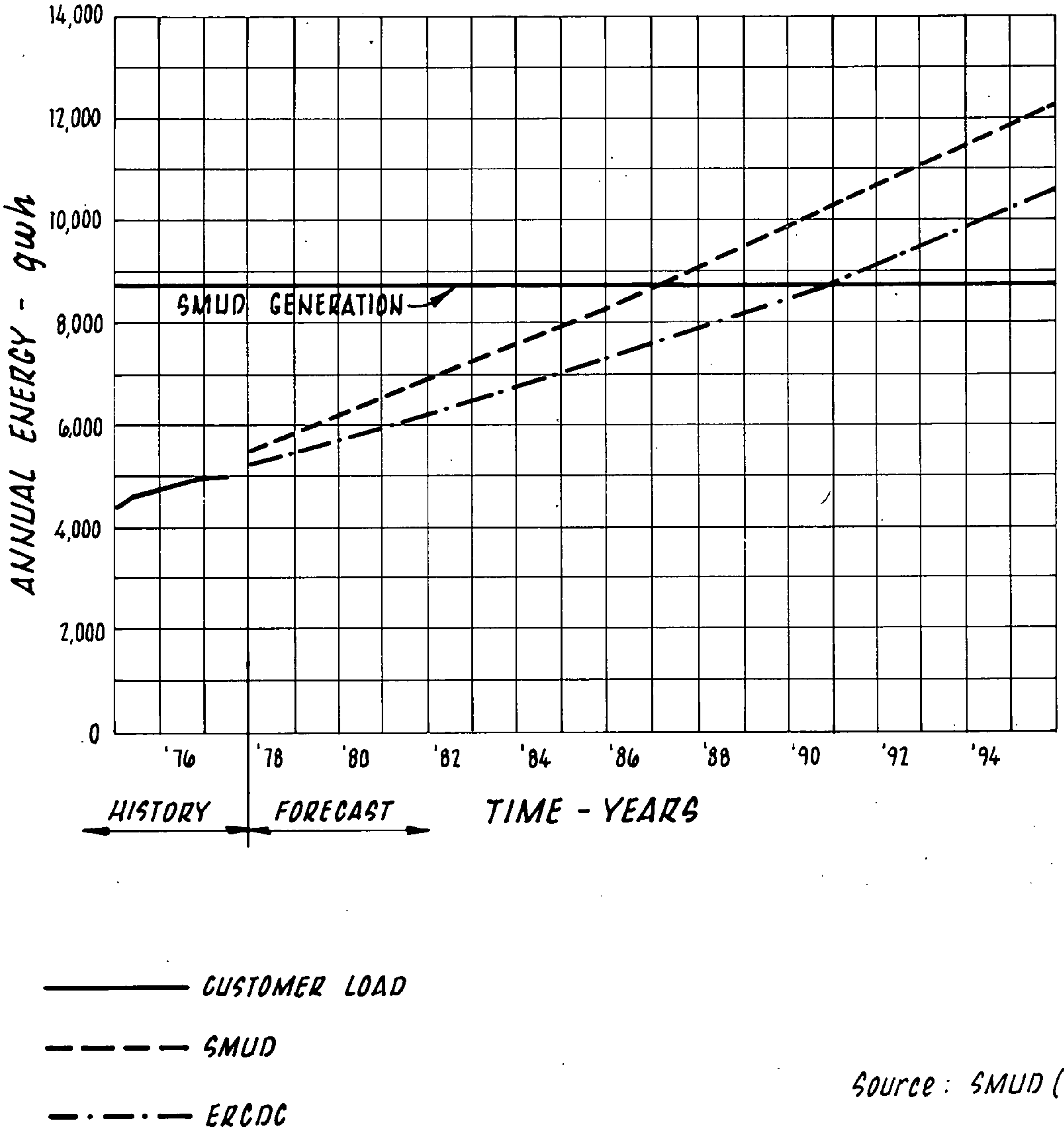
Resource		Peak-MW	Energy-GWh
CVP		360	1,820
UARP	Normal	650	1,800
	Adverse		1,030
Rancho Seco 75% cf		890	5,920
Total	Normal	1,900	9,540
	Adverse		8,770

In 1976 SMUD completed a 20-year forecast of customer demand and submitted it to the California Energy Resources Conservation and Development Commission (ERCDC). The ERCDC staff also has made a forecast of customer demand that differs from the SMUD estimates by about 16 percent for the year 1995. The SMUD forecast assumes a higher user rate for residential customers, a lower acceptance of energy conservation, and a lower rate of substitution of electricity for natural gas.

The forecasts of consumer demand by both SMUD and ERCDC are summarized in Figure A-1. Comparing the forecasts with existing generation, it appears SMUD will have a shortfall of annual energy supply sometime between 1987 and 1991.

A comparison of SMUD capacity with the SMUD and ERCDC staff estimates of summer peak loads is presented on Figure A-2. The projections indicate a shortfall will develop in SMUD's capacity resources for the summer months sometime between 1980 and 1982.

Studies by the SMUD staff have concluded it is imperative that a program for new generation and/or a program of mandatory load reduction be implemented at an early date if significant shortfalls are to be avoided. Alternatives being investigated include energy conservation programs, load management, solar thermal electric, wind energy, biomass, municipal solid waste, hydroelectric, oil-fired gas turbines, combined cycle, geothermal energy, nuclear energy, and coal-fired plants. The hydro, gas turbine, combined cycle,



Source: SMUD (2)

Figure A-1

SACRAMENTO MUNICIPAL UTILITY DISTRICT
CUSTOMER LOAD & GENERATION PROJECTIONS

CH2M HILL

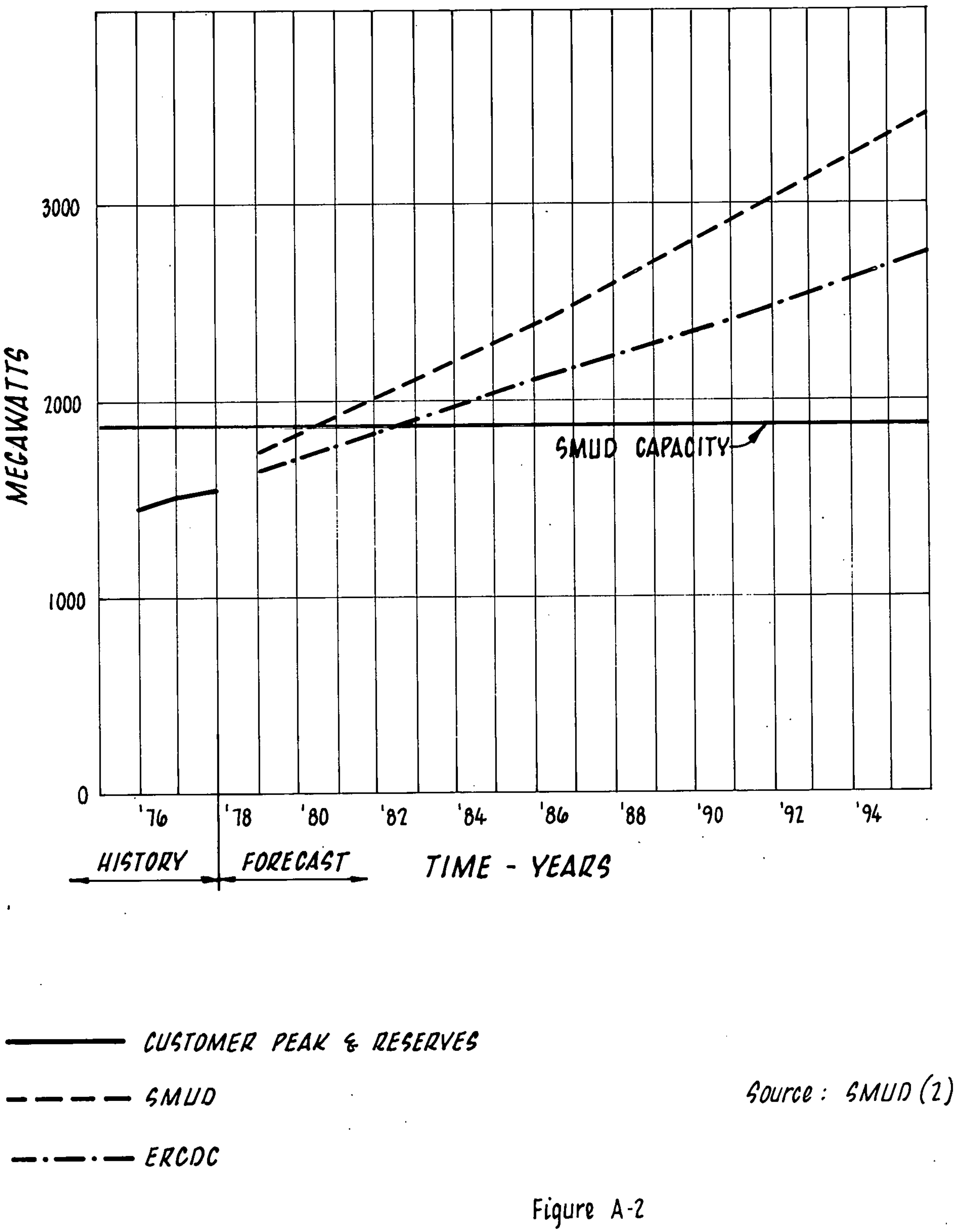


Figure A-2

SACRAMENTO MUNICIPAL UTILITY DISTRICT
PEAK DEMAND & CAPACITY FORECASTS

CH2M HILL

geothermal, and coal alternatives are regarded as having the best potential for the 1980 to 1990 timeframe.

Figure A-3 illustrates the wide range of power costs being considered by SMUD for additions to its system. The estimated cost of power in the year 1985 ranges from 14.92 mills to 112.85 mills per kilowatt-hour. The lower values are for hydroelectric projects. These range in cost from the 14.92 mills per kilowatt-hour estimated for the South Fork Rubicon-Loon Lake project to the 62.76 mills per kilowatt-hour for the Jones Fork project. The higher values are for the geothermal and combustion turbine projects, which range from 36.88 mills to 112.85 mills per kilowatt-hour. It will be noted that the mills now estimated as the cost of energy from the Redding project is in the lower range, although not as low as three of the projects now under consideration by SMUD. It is apparent that SMUD is looking at new sources to provide both peaking capacity and energy for its system. Some of the high-cost energy sources included on the SMUD chart would be economic now only for limited use during periods of maximum demand.

Department of Water Resources

The California Department of Water Resources (DWR) is responsible for operating the State Water Project (SWP). The long range energy program for the SWP is based on using essentially all SWP generation. However, energy needs in excess of SWP generation are purchased from other utilities. Any temporary excess is either sold or exchanged.

The DWR presently generates electric energy at the Hyatt, Thermalito, San Luis, and Devil Canyon power plants. In addition, generation is obtained from the cooperative development, with the City of Los Angeles Department of Water and Power (LADWP), of the Castaic power plant.

In recent years, DWR has used all of the recovery generation from the San Luis and Devil Canyon power plants, a part of its power entitlement from the Pacific Northwest during on-peak periods, and purchases from Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas and Electric (SDG&E), and LADWP to meet its power requirements. The remaining portion of the entitlement from the Pacific Northwest along with generation from Hyatt and Thermalito power plants is sold to PG&E, SCE, and SDG&E under an agreement that will continue through 31 March 1983. The DWR has given formal notice that, after 31 March 1983, the sale of power from the Hyatt and Thermalito power plants will be withdrawn to partially compensate for the loss of its power entitlement from the Pacific Northwest. Thereafter, DWR will rely on generation from SWP power plants with supplemental capacity and energy purchased from other utilities under terms yet to be determined.

A summary of the SWP energy requirements and the resources for the period 1975 through 1998 is presented in Table A-3. The future requirements and anticipated resources are shown graphically on Figure A-4. The projections reveal that substantial purchases of energy will be required each year in addition to (1) planned recovery plants at Pyramid, Cottonwood, and San Luis Obispo power plants; (2) future power plants at Glenn Reservoir and Los Vaqueros Reservoir; (3) geothermal development in The Geysers area; and (4) anticipated purchases from hydroelectric developments from Pine Flat Dam and the water distribution system of the Metropolitan Water District (MWD).

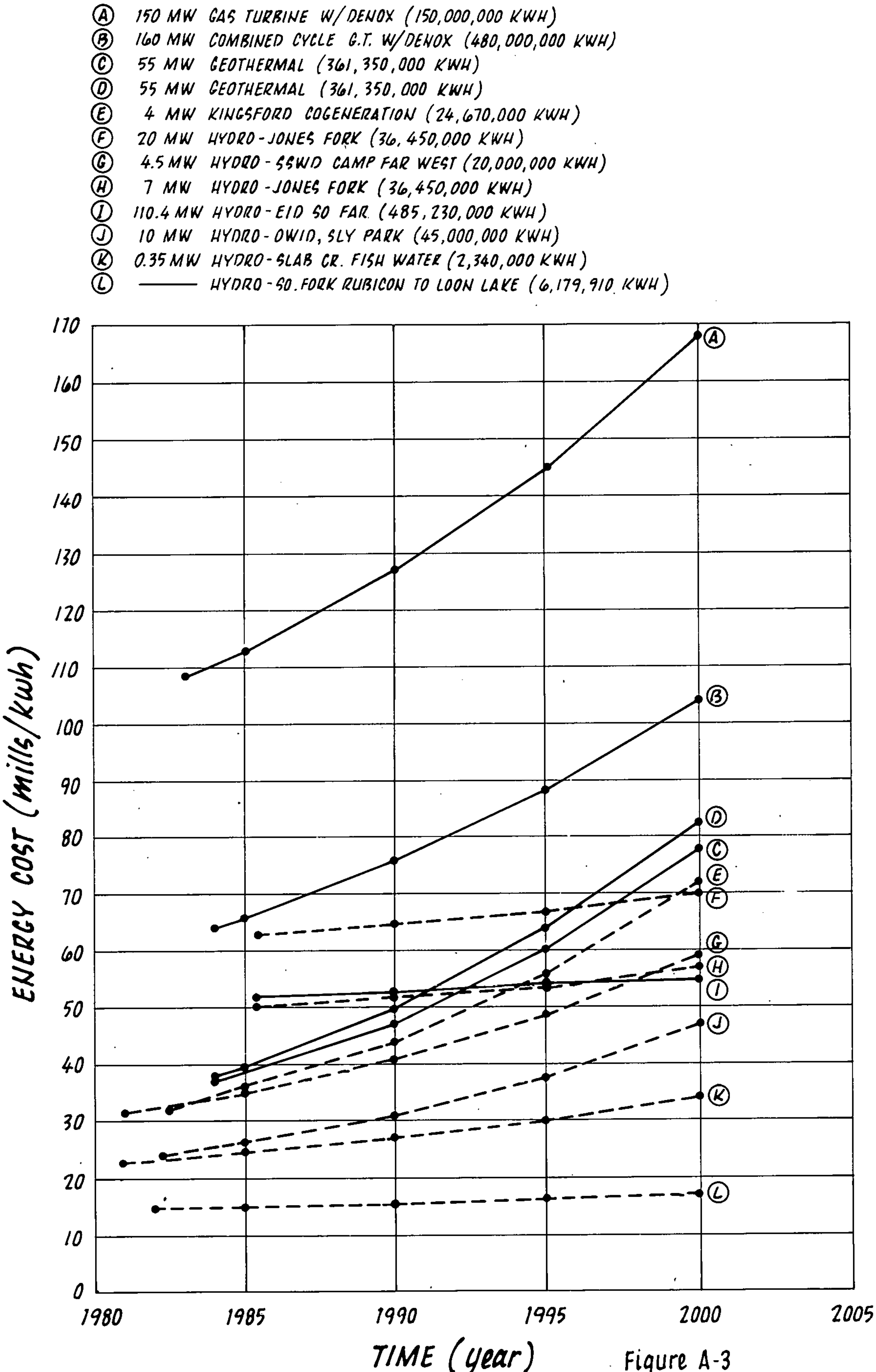


Figure A-3

ENERGY COST of VARIOUS SMUD ALTERNATIVES

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Table A-3
Summary of State Water Project Energy and Fuel Requirements
(Average Hydro Conditions)

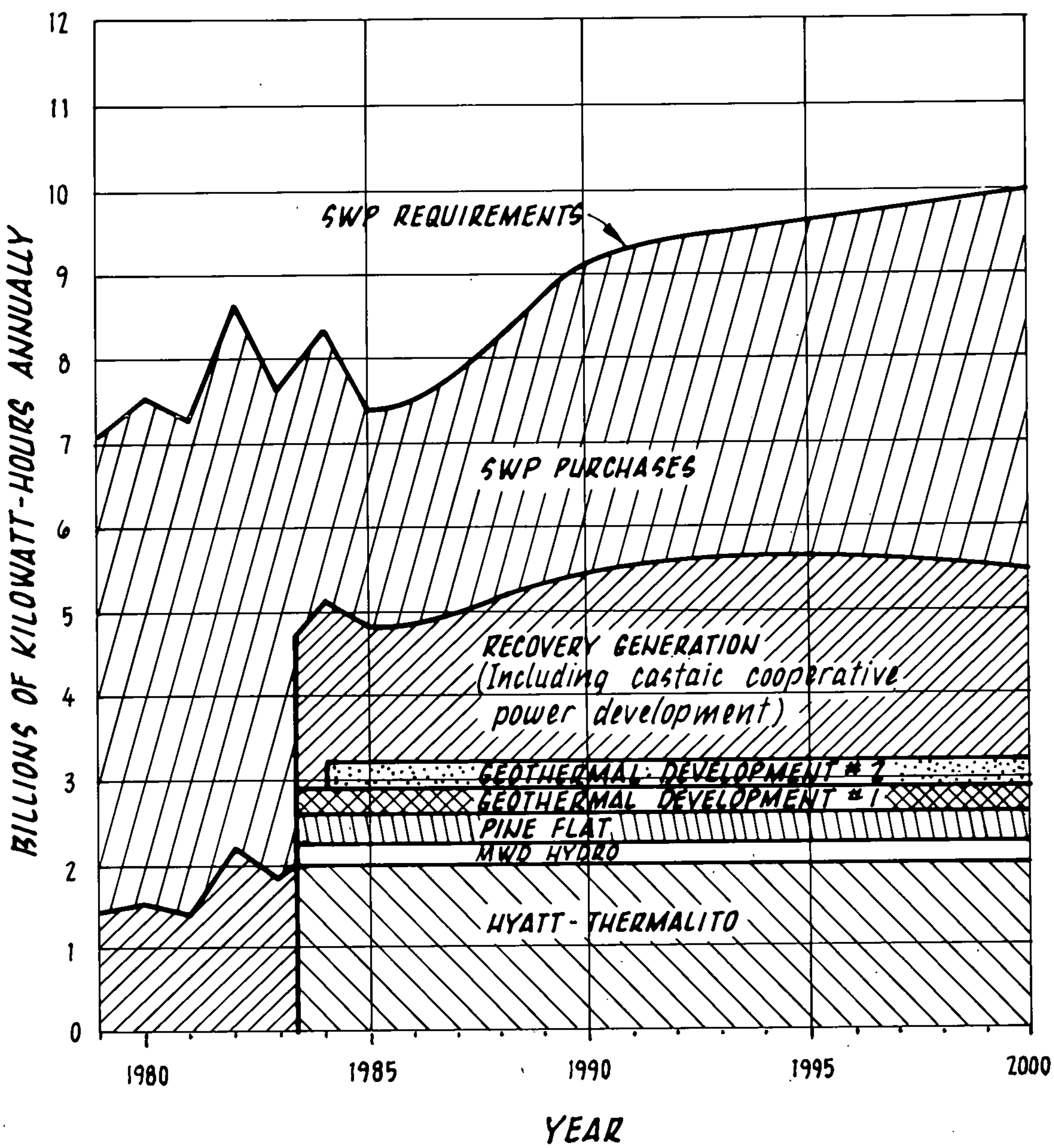
	1975 Actual	1976 Actual	1977 Actual	1978	1979	1980	1981	1982	1983	1984	1985	1986
1. Energy Load - Gigawatt-hours												
a. Project Load	3,675	3,321	1,654	6,529	7,067	7,493	7,265	8,637	7,618	7,777	6,865	7,037
b. Transactions	3,782	2,678	1,638	2,100	2,100	2,100	2,100	2,100	525	--	--	--
c. System Losses and Unaccounted for	38	41	67	70	74	74	71	77	440	583	515	527
d. Total Load (a+b+c)	7,495	6,040	3,359	8,699	9,241	9,667	9,436	10,814	8,583	8,360	7,380	7,564
2. Energy Production												
a. Hydro - Conventional	2,702	1,798	927	3,140	3,051	3,161	2,996	3,664	3,454	3,532	3,345	3,405
b. Hydro - Pumped Storage	- 195	- 147	- 249	--	--	--	--	--	--	--	--	--
c. Fossil - Thermal												
1) Oil and/or Gas	--	--	--	--	--	--	--	--	--	--	--	--
2) Coal	--	--	--	--	--	--	--	--	--	--	--	--
3) Turbines	--	--	--	--	--	--	--	--	--	--	--	--
4) Combined Cycle	--	--	--	--	--	--	--	--	--	--	--	--
d. Nuclear	--	--	--	--	--	--	--	--	--	--	--	--
e. Geothermal	--	--	--	--	--	--	--	--	272	723	723	723
f. Other (Itemize)	--	--	--	--	--	--	--	--	--	--	--	--
g. Net Firm Transfers	4,938	4,389	2,681	5,559	6,190	6,506	6,440	7,150	4,857	4,105	3,312	3,436
h. Non-Firm Transfers	--	--	--	--	--	--	--	--	--	--	--	--
i. Off System Losses	--	--	--	--	--	--	--	--	--	--	--	--
j. Total	7,495	6,040	3,359	8,699	9,241	9,667	9,436	10,814	8,583	8,360	7,380	7,530
k. Total Out-of-State	1,438	1,409	1,362	822	629	602	569	555	136	--	--	--
3. Fuel Requirements (1 - Billions of Btu 2 - Physical Units)	NOT APPLICABLE											
a. Gas												
1)												
2)												

Table A-3 (Continued)
Summary of Energy and Fuel Requirements
Average Hydro Conditions

		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1.	Energy Load - Gigawatt-hours												
a.	Project Load	7,255	7,776	8,243	8,699	8,777	8,856	8,933	9,012	9,091	9,134	9,177	9,221
b.	Transactions												
c.	System Losses and Unaccounted for	544	582	618	652	664	669	675	681	685	688	691	
d.	Total Load (a+b+c)	7,799	8,348	8,861	9,351	9,435	9,520	9,602	9,687	9,772	9,865	9,912	
2.	Energy Production (GWERS)												
a.	Hydro - Conventional	3,464	3,523	3,582	3,658	3,655	3,616	3,649	3,647	3,642	3,639	3,635	3,632
b.	Hydro - Pumped Storage	-	--	--	--	--	--	--	--	--	--	--	--
c.	Fossil - Thermal												
	1) Oil and/or Gas	--	--	--	--	--	--	--	--	--	--	--	--
	2) Coal	--	--	--	--	--	--	--	--	--	--	--	--
	3) Turbines	--	--	--	--	--	--	--	--	--	--	--	--
	4) Combined Cycle	--	--	--	--	--	--	--	--	--	--	--	--
d.	Nuclear	--	--	--	--	--	--	--	--	--	--	--	--
e.	Geothermal	723	723	723	723	723	723	723	723	723	723	723	723
f.	Other (Itemize)												
g.	Net Firm Transfers	3,612	4,102	4,556	4,970	5,051	5,181	5,230	5,317	5,407	5,457	5,507	5,557
h.	Total	7,799	8,348	8,861	9,351	9,439	9,520	9,602	9,687	9,772	9,819	9,865	9,912
i.	Total Out-of-State	--	--	--	--	--	--	--	--	--	--	--	--

3. Fuel Requirements
(1 - Billions of Btu)
2 - Physical Units))
) NOT APPLICABLE
a. Gas)
1))
2))

Source: Department of Water Resources



Source : DWP

Figure A-4

STATE WATER PROJECT ENERGY REQUIREMENT

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APPENDIX B

ECONOMIC ANALYSIS

CASH FLOW, NOT DISCOUNTED

PERIOD	YEAR	NET CASH FLOW AT BEG OF PERIOD ($1000)	CUML. CASH FLOW END OF PERIOD ($1000)
0	1979	-200.00	-200.00
1	1980	-300.00	-500.00
2	1981	-3600.00	-4100.00
3	1982	-16000.00	-20100.00
4	1983	-18600.00	-38700.00
5	1984	-3359.00	-42059.00
6	1985	2988.00	-39071.00
7	1986	2988.00	-36083.00
8	1987	2988.00	-33095.00
9	1988	2988.00	-30107.00
10	1989	2988.00	-27119.00
11	1990	2988.00	-24131.00
12	1991	2988.00	-21143.00
13	1992	2988.00	-18155.00
14	1993	2988.00	-15167.00
15	1994	2988.00	-12179.00
16	1995	2988.00	-9191.00
17	1996	2988.00	-6203.00
18	1997	2988.00	-3215.00
19	1998	2988.00	-227.00
20	1999	2988.00	2761.00
21	2000	2988.00	5749.00
22	2001	2988.00	8737.00
23	2002	2988.00	11725.00
24	2003	2988.00	14713.00
25	2004	2988.00	17701.00
26	2005	2988.00	20689.00
27	2006	2988.00	23677.00
28	2007	2988.00	26665.00
29	2008	2988.00	29653.00
30	2009	2988.00	32641.00
31	2010	2988.00	35629.00
32	2011	2988.00	38617.00
33	2012	2988.00	41605.00
34	2013	2988.00	44593.00
35	2014	2988.00	47581.00
36	2015	2988.00	50569.00
37	2016	2988.00	53557.00
38	2017	2988.00	56545.00
39	2018	2988.00	59533.00
40	2019	2988.00	62521.00
41	2020	2988.00	65509.00
42	2021	2988.00	68497.00
43	2022	2988.00	71485.00
44	2023	2988.00	74473.00
45	2024	2988.00	77461.00
46	2025	2988.00	80449.00
47	2026	2988.00	83437.00
48	2027	2988.00	86425.00
49	2028	2988.00	89413.00
50	2029	2988.00	92401.00
51	2030	2988.00	95389.00
52	2031	2988.00	98377.00
53	2032	2988.00	101365.00
54	2033	2988.00	104353.00

ZERO-INTEREST BREAKEVEN POINT IS 19.08 PERIODS

DISCOUNTED RATE OF RETURN I = 6.1341 PERCENT.

DISCOUNT RATE (PERCENT)	PRESENT WORTH (NET CUML.)	BENEFIT/COST RATIO
6.87	-3434.02	0.87

APPENDIX C

FINANCIAL ANALYSIS

LAKE REDDING POWER PROJECT-DISCOUNTED CASH FLOW
REVENUE BOND FINANCING

7.500 PERCENT

YEAR	FACTOR	CONSTRUCTION COSTS		O&M EXPENSE		REVENUES-ENERGY		TOTAL	
		EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND
1979	1.000000	-200000	-199999	0	0	0	0	-200000	-199999
1980	0.930233	-300000	-279069	0	0	0	0	-300000	-279069
1981	0.865333	-3600000	-3115196	0	0	0	0	-3600000	-3115196
1982	0.804961	-16000000	-12879368	0	0	0	0	-16000000	-12879368
1983	0.748801	-18600000	-13927689	0	0	0	0	-18600000	-13927689
1984	0.696559	-5600000	-3900727	-296430	-206480	2552000	1777618	-3344430	-2329591
1985	0.647962	0	0	-415000	-268903	3590000	2326182	3175000	2057278
1986	0.602755	0	0	-435750	-262649	3787450	2282904	3351700	2020254
1987	0.560702	0	0	-457537	-256541	3995759	2240431	3538222	1983889
1988	0.521583	0	0	-480414	-250575	4215526	2198749	3735112	1948173
1989	0.485194	0	0	-504435	-244748	4447380	2157842	3942945	1913093
1990	0.451343	0	0	-529656	-239056	4691986	2117696	4162329	1878639
1991	0.419854	0	0	-556139	-233497	4950045	2078297	4393906	1844800
1992	0.390562	0	0	-583946	-228066	5222298	2039631	4638351	1811564
1993	0.363313	0	0	-613144	-222762	5509524	2001685	4896380	1778921
1994	0.337966	0	0	-643801	-217582	5812548	1964444	5168747	1746861
1995	0.314387	0	0	-675991	-212522	6132239	1927896	5456247	1715373
1996	0.292453	0	0	-709790	-207579	6469512	1892028	5759721	1684448
1997	0.272049	0	0	-745280	-202752	6825335	1856828	6080055	1654075
1998	0.253069	0	0	-782544	-198037	7200729	1822282	6418184	1624244
1999	0.235413	0	0	-821671	-193431	7596769	1788379	6775097	1594947
2000	0.218989	0	0	-862755	-188933	8014591	1755107	7151836	1566173
2001	0.203711	0	0	-905892	-184539	8455394	1722454	7549501	1537914
2002	0.189498	0	0	-951187	-180247	8920440	1690408	7969253	1510160
2003	0.176277	0	0	-998746	-176056	9411065	1658959	8412318	1482902
2004	0.163979	0	0	-1048684	-171961	9928673	1628095	8879989	1456132
2005	0.152539	0	0	-1101118	-167962	10474750	1597804	9373632	1429841
2006	0.141896	0	0	-1156174	-164056	11050862	1568078	9894687	1404021
2007	0.131997	0	0	-1213983	-160241	11658659	1538904	10444676	1378663
2008	0.122788	0	0	-1274682	-156514	12299886	1510274	11025203	1353758
2009	0.114221	0	0	-1338416	-152874	12976380	1482176	11637963	1329300
2010	0.106252	0	0	-1405337	-149319	13690081	1454600	12284743	1305280
SUB-TOTALS			-34302048		-5497882		50079751		10279791
LESS SALVAGE VALUE		21264000	2259345	0	0	0	0	0	0
TOTALS			-32042703		-5497882		50079751		12539166

LAKE REDDING POWER PROJECT-DISCOUNTED CASH FLOW
REVENUE BOND FINANCING - 7.5 PERCENT REVENUE ESCALATION

7.500 PERCENT

YEAR	FACTOR	CONSTRUCTION COSTS		O&M EXPENSE		REVENUES-ENERGY		TOTAL	
		EXPEN- DITURE	DISCOUNT CASH EXPEND	EXPEN- DITURE	DISCOUNT CASH EXPEND	EXPEN- DITURE	DISCOUNT CASH EXPEND	EXPEN- DITURE	DISCOUNT CASH EXPEND
1979	1.000000	-200000	-199999	0	0	0	0	-200000	-199999
1980	0.930233	-300000	-279069	0	0	0	0	-300000	-279069
1981	0.865333	-3600000	-3115196	0	0	0	0	-3600000	-3115196
1982	0.804961	-16000000	-12879368	0	0	0	0	-16000000	-12879368
1983	0.748801	-18600000	-13927689	0	0	0	0	-18600000	-13927689
1984	0.696559	-5600000	-3900727	-296430	-206480	2650000	1845880	-3246430	-2261328
1985	0.647962	0	0	-415000	-268903	3798000	2460958	3383000	2192054
1986	0.602755	0	0	-435750	-262649	4082850	2460958	3647100	2198307
1987	0.560702	0	0	-457537	-256541	4389063	2460958	3931526	2204416
1988	0.521583	0	0	-480414	-250575	4718243	2460958	4237829	2210382
1989	0.485194	0	0	-504435	-244748	5072111	2460958	4567676	2216209
1990	0.451343	0	0	-529656	-239056	5452520	2460958	4922863	2221901
1991	0.419854	0	0	-556139	-233497	5861459	2460958	5305319	2227460
1992	0.390562	0	0	-583946	-228066	6301068	2460958	5717121	2232890
1993	0.363313	0	0	-613144	-222762	6773648	2460958	6160504	2238194
1994	0.337966	0	0	-643801	-217582	7281672	2460958	6637871	2243375
1995	0.314387	0	0	-675991	-212522	7827797	2460958	7151806	2248435
1996	0.292453	0	0	-709790	-207579	8414882	2460958	7705091	2253377
1997	0.272049	0	0	-745280	-202752	9045999	2460958	8300718	2258205
1998	0.253069	0	0	-782544	-198037	9724449	2460958	8941904	2262920
1999	0.235413	0	0	-821671	-193431	10453782	2460958	9632111	2267526
2000	0.218989	0	0	-862755	-188933	11237816	2460958	10375061	2272024
2001	0.203711	0	0	-905892	-184539	12080652	2460958	11174759	2276418
2002	0.189498	0	0	-951187	-180247	12986701	2460958	12035514	2280710
2003	0.176277	0	0	-998746	-176056	13960704	2460958	12961957	2284901
2004	0.163979	0	0	-1048684	-171961	15007757	2460958	13959073	2288996
2005	0.152539	0	0	-1101118	-167962	16133339	2460958	15032220	2292995
2006	0.141896	0	0	-1156174	-164056	17343339	2460958	16187165	2296901
2007	0.131997	0	0	-1213983	-160241	18644090	2460958	17430107	2300716
2008	0.122788	0	0	-1274682	-156514	20042396	2460958	18767714	2304443
2009	0.114221	0	0	-1338416	-152874	21545576	2460958	20207160	2308083
2010	0.106252	0	0	-1405337	-149319	23161494	2460958	21756157	2311638
	SUB-TOTALS		-34302048		-5497882		65830788		26030827
LESS SALVAGE VALUE		21264000	2259345	0	0	0	0	0	0
	TOTALS		-32042703		-5497882		65830788		28290203

LAKE REDDING POWER PROJECT-DISCOUNTED CASH FLOW
GOVERNMENT FINANCING WITHOUT CONSTRUCTION GRANT

6.875 PERCENT

YEAR	FACTOR	CONSTRUCTION COSTS		O&M EXPENSE		REVENUES-ENERGY		TOTAL	
		EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND
1979	1.000000	-200000	-199999	0	0	0	0	-200000	-199999
1980	0.935673	-300000	-280701	0	0	0	0	-300000	-280701
1981	0.875483	-3600000	-3151738	0	0	0	0	-3600000	-3151738
1982	0.819165	-16000000	-13106646	0	0	0	0	-16000000	-13106646
1983	0.766471	-18600000	-14256352	0	0	0	0	-18600000	-14256352
1984	0.717165	-5600000	-4016126	-296430	-212588	2552000	1830206	-3344430	-2398509
1985	0.671032	0	0	-415000	-278477	3590000	2409005	3175000	2130527
1986	0.627866	0	0	-435750	-273592	3787450	2378012	3351700	2104419
1987	0.587477	0	0	-457537	-268792	3995759	2347418	3538222	2078625
1988	0.549686	0	0	-480414	-264076	4215526	2317217	3735112	2053140
1989	0.514326	0	0	-504435	-259443	4447380	2287405	3942945	2027961
1990	0.481241	0	0	-529656	-254892	4691986	2257976	4162329	2003084
1991	0.450284	0	0	-556139	-250420	4950045	2228926	4393906	1978506
1992	0.421318	0	0	-583946	-246026	5222298	2200250	4638351	1954223
1993	0.394216	0	0	-613144	-241710	5509524	2171943	4896380	1930232
1994	0.368857	0	0	-643801	-237470	5812548	2144000	5168747	1906529
1995	0.345129	0	0	-675991	-233303	6132239	2116416	5456247	1883112
1996	0.322928	0	0	-709790	-229210	6469512	2089188	5759721	1859976
1997	0.302155	0	0	-745280	-225189	6825335	2062309	6080055	1837119
1998	0.282718	0	0	-782544	-221238	7200729	2035777	6418184	1814537
1999	0.264532	0	0	-821671	-217357	7596769	2009585	6775097	1792227
2000	0.247515	0	0	-862755	-213544	8014591	1983731	7151836	1770186
2001	0.231593	0	0	-905892	-209797	8455394	1958209	7549501	1748411
2002	0.216695	0	0	-951187	-206117	8920440	1933016	7969253	1726898
2003	0.202756	0	0	-998746	-202501	9411065	1908147	8412318	1705645
2004	0.189713	0	0	-1048684	-198948	9928673	1883598	8879989	1684649
2005	0.177509	0	0	-1101118	-195458	10474750	1859364	9373632	1663906
2006	0.166090	0	0	-1156174	-192029	11050862	1835443	9894687	1643413
2007	0.155406	0	0	-1213983	-188660	11658659	1811829	10444676	1623168
2008	0.145409	0	0	-1274682	-185350	12299886	1788519	11025203	1603168
2009	0.136056	0	0	-1338416	-182098	12976380	1765509	11637963	1583410
2010	0.127303	0	0	-1405337	-178903	13690081	1742794	12284743	1563890
2011	0.119114	0	0	-1475604	-175765	14443035	1720373	12967431	1544607
2012	0.111452	0	0	-1549384	-172681	15237402	1698239	13688018	1525557
2013	0.104283	0	0	-1626853	-169651	16075459	1676391	14448606	1506738
2014	0.097574	0	0	-1708196	-166675	16959610	1654823	15251414	1488147
2015	0.091298	0	0	-1793605	-163751	17892389	1633533	16098783	1469781
2016	0.085425	0	0	-1883286	-160878	18876470	1612517	16993184	1451638
2017	0.079930	0	0	-1977450	-158056	19914676	1591771	17937226	1433714
2018	0.074788	0	0	-2076323	-155283	21009983	1571292	18933660	1416008
2019	0.069977	0	0	-2180139	-152559	22165533	1551077	19985393	1398517
2020	0.065476	0	0	-2289146	-149882	23384637	1531121	21095491	1381238
	SUB-TOTALS		-35011562		-7692369		71596929		28892961
	LESS SALVAGE VALUE	12404000	812158	0	0	0	0	0	0
	TOTALS		-34199404		-7692369		71596929		29705156

LAKE REDDING POWER PROJECT-DISCOUNTED CASH FLOW
GOVERNMENT FINANCING WITH 25 PERCENT CONSTRUCTION GRANT

6.875 PERCENT

YEAR	FACTOR	CONSTRUCTION COSTS		O&M EXPENSE		REVENUES-ENERGY		TOTAL	
		EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND	EXPEN-DITURE	DISCOUNT CASH EXPEND
1979	1.000000	-200000	-199999	0	0	0	0	-200000	-199999
1980	0.935673	-300000	-280701	0	0	0	0	-300000	-280701
1981	0.875483	-1850000	-1619643	0	0	0	0	-1850000	-1619643
1982	0.819165	-8200000	-6717156	0	0	0	0	-8200000	-6717156
1983	0.766471	-18600000	-14256352	0	0	0	0	-18600000	-14256352
1984	0.717165	-5600000	-4016126	-296430	-212588	2552000	1830206	-3344430	-2398509
1985	0.671032	0	0	-415000	-278477	3590000	2409005	3175000	2130527
1986	0.627866	0	0	-435750	-273592	3787450	2378012	3351700	2104419
1987	0.587477	0	0	-457537	-268792	3995759	2347418	3538222	2078625
1988	0.549686	0	0	-480414	-264076	4215526	2317217	3735112	2053140
1989	0.514326	0	0	-504435	-259443	4447380	2287405	3942945	2027961
1990	0.481241	0	0	-529656	-254892	4691986	2257976	4162329	2003084
1991	0.450284	0	0	-556139	-250420	4950045	2228926	4393906	1978506
1992	0.421318	0	0	-583946	-246026	5222298	2200250	4638351	1954223
1993	0.394216	0	0	-613144	-241710	5509524	2171943	4896380	1930232
1994	0.368857	0	0	-643801	-237470	5812548	2144000	5168747	1906529
1995	0.345129	0	0	-675991	-233303	6132239	2116416	5456247	1883112
1996	0.322928	0	0	-709790	-229210	6469512	2089188	5759721	1859976
1997	0.302155	0	0	-745280	-225189	6825335	2062309	6080055	1837119
1998	0.282718	0	0	-782544	-221238	7200729	2035777	6418184	1814537
1999	0.264532	0	0	-821671	-217357	7596769	2009585	6775097	1792227
2000	0.247515	0	0	-862755	-213544	8014591	1983731	7151836	1770186
2001	0.231593	0	0	-905892	-209797	8455394	1958209	7549501	1748411
2002	0.216695	0	0	-951187	-206117	8920440	1933016	7969253	1726898
2003	0.202756	0	0	-998746	-202501	9411065	1908147	8412318	1705645
2004	0.189713	0	0	-1048684	-198948	9928673	1883598	8879989	1684649
2005	0.177509	0	0	-1101118	-195458	10474750	1859364	9373632	1663906
2006	0.166090	0	0	-1156174	-192029	11050862	1835443	9894687	1643413
2007	0.155406	0	0	-1213983	-188660	11658659	1811829	10444676	1623168
2008	0.145409	0	0	-1274682	-185350	12299886	1788519	11025203	1603168
2009	0.136056	0	0	-1338416	-182098	12976380	1765509	11637963	1583410
2010	0.127303	0	0	-1405337	-178903	13690081	1742794	12284743	1563890
2011	0.119114	0	0	-1475604	-175765	14443035	1720373	12967431	1544607
2012	0.111452	0	0	-1549384	-172681	15237402	1698239	13688018	1525557
2013	0.104283	0	0	-1626853	-169651	16075459	1676391	14448606	1506738
2014	0.097574	0	0	-1708196	-166675	16959610	1654823	15251414	1488147
2015	0.091298	0	0	-1793605	-163751	17892389	1633533	16098783	1469781
2016	0.085425	0	0	-1883286	-160878	18876470	1612517	16993184	1451638
2017	0.079930	0	0	-1977450	-158056	19914676	1591771	17937226	1433714
2018	0.074788	0	0	-2076323	-155283	21009983	1571292	18933660	1416008
2019	0.069977	0	0	-2180139	-152559	22165533	1551077	19985393	1398517
2020	0.065476	0	0	-2269146	-149882	23384637	1531121	21095491	1381238
	SUB-TOTALS		-27089977		-7692369		71596929		36814546
	LESS SALVAGE VALUE	12404000	812158	0	0	0	0	0	0
	TOTALS		-26277819		-7692369		71596929		37626741