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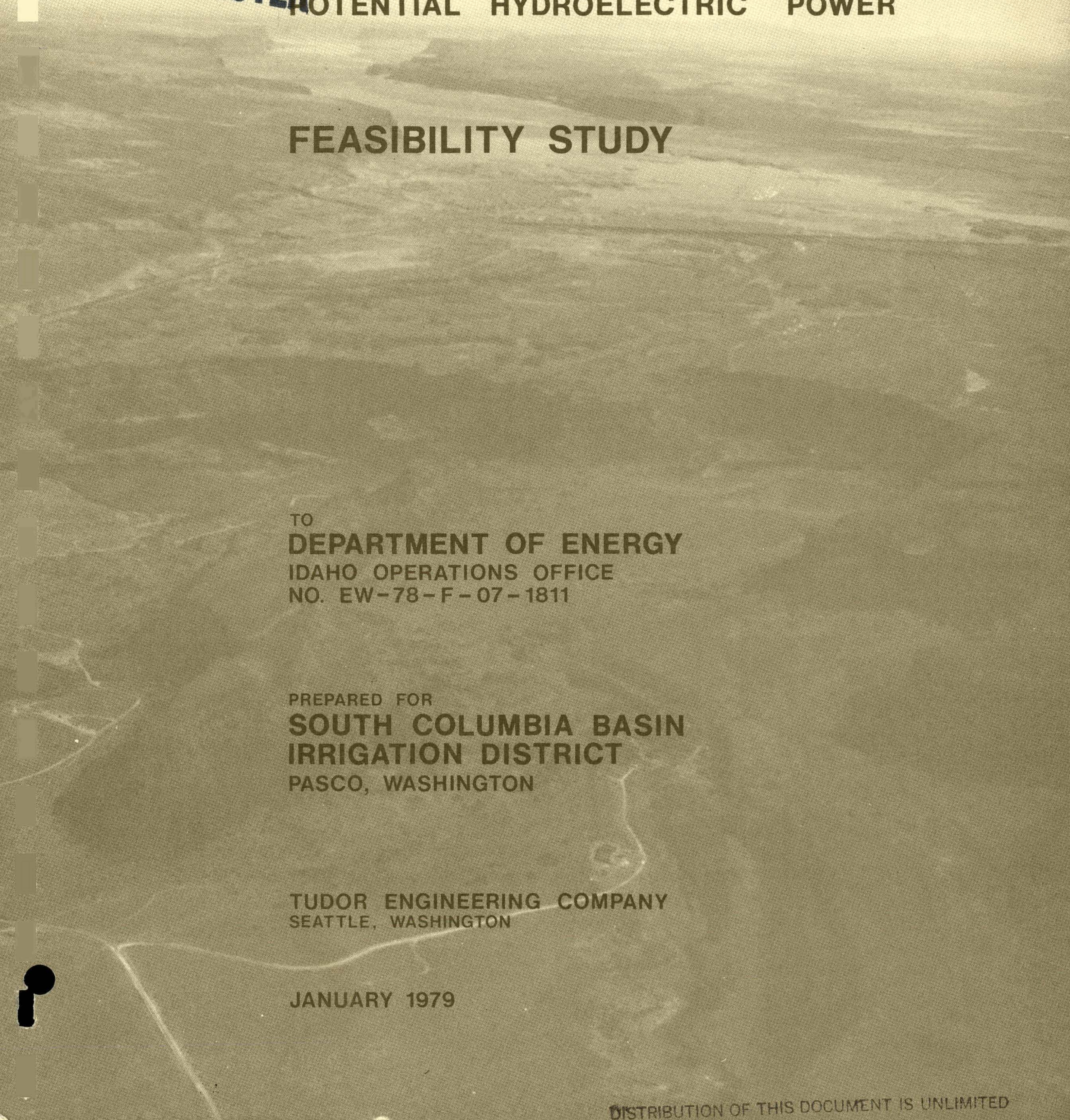
DRY FALLS DAM
POTENTIAL HYDROELECTRIC POWER



FEASIBILITY STUDY

TO

DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
NO. EW-78-F-07-1811

PREPARED FOR

SOUTH COLUMBIA BASIN IRRIGATION DISTRICT
PASCO, WASHINGTON

TUDOR ENGINEERING COMPANY
SEATTLE, WASHINGTON

JANUARY 1979

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January 29, 1979

Mr. Rogers R. Neff, President
South Columbia Basin Irrigation District
Post Office Box 1006
Pasco, Washington 99301

Power Development at Dry Falls Dam
Columbia Basin Project

Dear Mr. Neff:

We take pleasure in presenting the report of our studies relating to the installation of power generating facilities at Dry Falls Dam. Our studies were conducted in accordance with the provisions of Cooperative Agreement No. EW-78-F-07-1811 between the U.S. Department of Energy and the District.

The recommended project would consist of a 12 MW power plant installed adjacent to the existing Main Canal Headworks. Annual energy production would be approximately 56 million kilowatt-hours at an initial cost estimated at 21.2 mills/kWh. It is expected that the power output will be purchased by the cities of Seattle and Tacoma.

A summary of the principal findings of the study follows this letter, responding to the specific areas of interest identified in Article I of the Cooperative Agreement.

Tudor Engineering Company sincerely appreciates the opportunity to prepare this study. We believe that it is important to develop all economical small-scale hydroelectric sites where energy is presently being wasted. The South Columbia Basin Irrigation District should be commended for their action in initiating this study.

Very truly yours,

TUDOR ENGINEERING COMPANY

Harry P. Hosey, P.E.
Manager, Water Resources

POTENTIAL POWER PLANT INSTALLATION AT THE DRY FALLS DAM

Summary of Findings

(The numbering of the findings corresponds with the items requested in Article I of Cooperative Agreement No. EW-78-F-07-1811)

1. The proposed development will consist of two 6 MW adjustable-blade propeller turbines, in a powerhouse to be constructed on the left bank of the Main Canal, immediately downstream of Dry Falls Dam, which impounds Banks Lake.

2. Power generation will occur only when irrigation discharges take place, during the period March through October each year. Under favorable hydraulic conditions, the maximum output of the installation will be 12 MW. Annual energy production will be within the range 55.0 - 56.9 million kWh.

3. Construction and operation of the power plant will not jeopardize or compromise the function of Banks Lake, the Main Canal, or other irrigation and water resource facilities of the area.

4. A market exists for the energy from the project. It is expected that the cities of Seattle and Tacoma will enter into a purchase contract for the entire output of the power development.

5. The requirements of the Federal, State and local agencies with jurisdiction over the project have been reviewed and are described in Chapter VI of the report.

6. Total investment, including escalation, contingencies, engineering, legal and financing costs, amounts to $1,144 per installed kilowatt. The cost of energy produced in the first year of operation will be 21.2 mills/kWh. Under the expected terms of the power purchase agreement, the minimum net return on investment to the District will be 0.67 percent. This may increase in future years, as a result of increases in the market value of electric power.

7. Annual operation and maintenance costs are estimated at $150,000 in 1982.

8. The project is anticipated to have a useful service life of 50 years.

9. An initial assessment of environmental effect has concluded that the impact of the project will not be significant. Socio-institutional impacts will be beneficial, although modest in extent.

10. No safety hazards are expected due to the construction or operation of the power development.

11. Initial analysis indicates that, in general, the proposed site is suitable for the type of development contemplated. The recommended configuration involves tunnelling beneath the existing dam. In the event that investigations reveal factors which render such a procedure infeasible, an alternative plant configuration can be developed.

12. Conventional vertical-shaft Kaplan turbines would be suitable for the contemplated development. As an alternative, adjustable-blade propeller turbines may be available in a "tube" or "bulb" configuration. Generators, switchgear and auxiliary equipment will be of conventional pattern.

13. Assuming that the FERC licensing procedure can be executed in timely fashion, procurement of equipment is expected to start in the fall of 1980, with the project ready to deliver power in mid-1982.

CONTENTS

LIST OF FIGURES

Figures are grouped at the end of the chapter to which they refer.

LIST OF FIGURES (Cont'd.)

I Introduction

CHAPTER I

INTRODUCTION

A. PURPOSE AND AUTHORIZATION

The purpose of this report is to present the results of a study to investigate the feasibility of developing hydroelectric power at an existing dam on the Columbia Basin Project in Eastern Washington. It is intended that the information presented in this report will provide the basis for a decision to proceed with development.

The report was prepared by Tudor Engineering Company for the South Columbia Basin Irrigation District, pursuant to a letter agreement dated September 14, 1978. Major funding for the study was contributed by the U.S. Department of Energy under Cooperative Agreement No. EW-78-F-07-1811 with the South Columbia Basin Irrigation District.

B. SCOPE

This report presents the results of studies relating to the technical and economic feasibility of installing hydroelectric generating facilities at Dry Falls Dam. The existing dam impounds water which is released during the irrigation season through the canal system of the Columbia Basin Project. The head available at the site for power generation is relatively low, but a potential exists for producing a significant quantity of electrical energy.

The scope of the report includes coverage of the following items, as listed in Agreement No. EW-78-F-07-1811:

1. Expected configuration and capacity of the hydropower facility.

2. Estimated performance characteristics of the hydroelectric power facility including the potential for peak power production and an estimate of average annual energy production

3. Expected impact of the hydropower installation on other perceived water resource needs of the area and the current use of the reservoir.

4. Marketing potential of the power produced.

5. The necessary requirements of the Federal Energy Regulatory Commission, the U.S. Army Corps of Engineers, and other appropriate Federal, State, regional and local agencies.

6. Capital investment per installed kilowatt, total cost per kwh, and return on investment.

7. Anticipated annual operation and maintenance costs.

8. Anticipated project life.

9. An initial assessment of the environmental impact and socio-institutional factors.

10. An initial assessment of the safety hazard, if any, introduced by the addition or rehabilitation of a power plant and other hydropower appurtenances.

11. Appropriate analyses resulting in sound judgment as to the engineering acceptability of the proposed site for hydroelectric power development.

12. Investigation of the availability of a suitable turbine(s), generator(s), and accessories required for the proposed hydroelectric power development.

13. Development plan (schedule) for putting power on-line.

Derivation of the study fundings is discussed in each chapter of the report. Plates, diagrams and supporting data are to be found following each chapter, and in the Appendices to the report.

C. AVAILABILITY OF DATA

Dry Falls Dam was designed by the Bureau of Reclamation in 1945 and construction was completed in 1953. The technical records of design and construction of the present facilities are contained in the Bureau reports entitled "Equalizing Reservoir Dams and the Feeder Canal" dated 1954, and "Long Lake Dam and Main Canal" published in 1955. Design Standards used by the Bureau for facilities of this type are published in their Design Standard #3, "Canals and Related Structures". Copies of the original drawings are maintained on microfilm by the Bureau and are available from the Denver Federal Center.

Soil logs used for construction of the original facility are also on record with the Bureau and will be used for foundation design. Topographic mapping of the site has not been performed since before the construction of the canal facilities, and will be required prior to implementation of the project.

Daily flow records for the Main Canal are recorded by the Bureau and maintained in the files of the USBR Regional Hydrographic Section. Historical development and expansion of irrigated land is recorded in the Crop Report Summary Sheets, issued annually by the Bureau's Project office.

D. ACKNOWLEDGEMENTS

Tudor Engineering Company is very appreciative of the assistance and cooperation extended by Mr. Russell D. Smith, Secretary-Manager of the South Columbia Basin Irrigation District, and his staff. Their collective knowledge and experience, gained through many years of participation in the design, implementation and operation of the various phases of the Columbia Basin Project activities provided valuable expertise not otherwise available.

Bureau of Reclamation personnel, and in particular, Messrs. Oliver Watson and Dave Norley, extended valuable assistance and cooperation. Without their timely assistance in data collection,

furnishing reports and arranging field trips, preparation of this report would have been considerably more difficult.

During the preparation of this report, consultations and conferences were held with Federal, State and local agencies including the Bonneville Power Administration; the Environmental Protection Agency; Department of the Army, Corps of Engineers; Department of Ecology, State of Washington; Department of Fisheries, State of Washington; Department of Game, State of Washington; Department of Parks and Recreation, State of Washington; Quincy Columbia Basin Irrigation District; East Columbia Basin Irrigation District; Columbia Basin Project, Reserved Works Committee; Grant County, State of Washington and Franklin County, State of Washington.

II Site and Resources

CHAPTER II

ASSESSMENT OF SITE AND RESOURCES

A. THE COLUMBIA BASIN PROJECT

The Columbia Basin Project is a multipurpose development constructed by the U.S. Department of the Interior, Bureau of Reclamation (USBR). The source of water is Franklin D. Roosevelt Lake, formed by the impoundment of the Columbia River at Grand Coulee Dam.

The Columbia River, America's second largest, drains 259,000 square miles, of which 220,000 are in the northwestern United States and 39,000 in Canada. About 74,000 square miles of this drainage are above Grand Coulee Dam. The river's average annual discharge at Grand Coulee Dam is 80 million acre-feet. Water derived from melting ice in the Columbia ice fields of British Columbia assures a sustained flow throughout the summer months. Releases of water through the turbines of Grand Coulee power plant generate power, some of which is used to pump irrigation water to the Columbia Basin Project.

Project irrigation facilities are designed to deliver water to 1,095,000 acres of irrigable land. These lands lie in the counties of Grant, Lincoln, Adams, Franklin, and Walla Walla in the state of Washington, as shown in Figure II-1. Layout of the facilities in the northern portion of the Project is shown in Figure II-2. The irrigation works, extending southward from the Grand Coulee Pumping-Generating Plant, begin with the 1.6-mile-long Feeder Canal which carries water to Banks Lake, an equalizing reservoir. This 27-mile-long reservoir occupies the floor of the upper Grand Coulee between North Dam, near the town of Grand Coulee, and Dry Falls Dam, near Coulee City. The Main Canal system extends southward from the headworks at Dry Falls Dam into the northern end of the irrigable area. The Main Canal system includes concrete-lined and unlined sections of canal, the 1,000-foot-long Bacon Siphon, the 2-mile-long Bacon Tunnel and Billy Clapp Lake. This lake is 6 miles long and is formed by the earthfill Pinto Dam. The Main Canal continues for 6.6 miles downstream from Pinto Dam to the Bifurcation Works where it divides to supply water to the West and East Low Canals. The two canals are a major segment of the system, providing water to a large portion of the Project area.

O'Sullivan Dam, in the central part of the Project area, creates Potholes Reservoir, from which the Potholes Canal system serves the southern part of the Project. The water source for this reservoir is irrigation return flows and natural runoff from a 4,000-square mile drainage supplemented as needed by water supplied from the Main Canal system fed directly to the reservoir through canal wasteways. Altogether, there are 333 miles of main canals and 1,936 miles of laterals on the Project and 2,223 miles of drains and wasteways. In 1977 irrigation water service was available to 543,230 acres. Water supply, agricultural economy, and environmental investigations and engineering design and cost estimate studies are in progress relating to the facilities necessary to serve an additional area of approximately 550,000 acres.

B. INSTITUTIONAL FRAMEWORK

Within the Columbia Basin Project, water users are represented by irrigation districts, which entities are responsible for payments to the USBR in accordance with repayment contracts, and for operation and maintenance of designated distribution facilities. Three irrigation districts have been formed for this purpose: Quincy Columbia Basin Irrigation District (QCBID): East Columbia Basin Irrigation District (ECBID); and South Columbia Basin Irrigation District (SCBID).

Irrigation or Reclamation Districts exist under the Revised Code of Washington Section 87.03 and are granted the following powers:

> "Acquire, construct, operate, and maintain an irrigation system of dividing conduits from a

natural source of water supply to the point of individual distribution for agricultural irrigation purposes. (May also generate, distribute, and sell electrical energy; operate a domestic water supply system; operate a drainage system; or assist in certain fire protection functions.)"

Within the Columbia Basin Project, there are several facilities whose function provides service to two or more of the Districts. Those which are common to all three Districts are known as Project Reserved Works and include the Grand Coulee Pumping Plant, Billy Clapp Lake, Pinto Dam, Dry Falls Dam and the Main Canal. Operation and maintenance of these works is performed by the Bureau of Reclamation, using funds provided by the Districts. Control is exercised by the Districts through a Reserved Works Committee, comprised of representatives of each of the districts. The Committee functions in the following areas:

1. The Committee makes adjustments in efficiency of the Canal systems.

2. The Committee determines the dates when water deliveries shall be made to the respective Districts both as to the commencement and the termination of each season's deliveries and advises the Bureau of Reclamation of such determination and requests the Bureau of Reclamation to operate and maintain the project and special reserved works involved so as to make deliveries possible on the date indicated annually.

3. The Committee reviews and consults with the Bureau of Reclamation in regard to the elevations to which reservoirs in the project and special reserved works will be filled and the time or times of feed or drawdown of such reservoirs.

4. The Committee annually reviews the proposed budget for the operation of the project reserved works and special reserved works as presented by the Bureau of Reclamation and shall advise and consult with the Bureau of Reclamation officials with respect thereto.

5. The Committee performs such other functions as are not inconsistent with the provisions of the repayment contract from time to time as assigned to them by the unanimous agreement of the three Districts.

The contract with the USBR also provides, for the project reserved works, that the Districts "may build plants for the production of power and energy and structures and facilities necessary for the operations of such plants and all such plants shall remain in exclusive control, possession and ownership of the districts" as provided by contract with the United States.

As the Reserved Works Committee is not yet a legal entity, the Committee and the respective districts have duly resolved to delegate, for the time being, the authority for contracting for, managing, administering and reviewing the feasibility assessments for contemplated hydropower developments at Project Reserved Works, to the South Columbia Basin Irrigation District.

C. EXISTING FACILITIES

Dry Falls Dam is located at the South end of Banks Lake, the primary equalizing reservoir for the Columbia Basin Irrigation Project. Also known as South Coulee Dam, the dam is an earthfill structure 115 feet high at its highest point, 9,880 feet long at crest elevation 1580. The active storage of the reservoir is 696,000 acre-feet, between elevations 1540 and 1570.

Current records of Grant County and Bureau of Reclamation records were searched to determine vested title to land at the site. Figure II-3 shows present legal title. The United States owns an easement in gross in the right of way of 225 feet from the centerline on each side of waterways, including canals in the project. Contiguous land is variously owned as shown.

As shown on Figure II-3, the Main Canal headworks is located at the left abutment of Dry Falls Dam. It consists of a rectangular six-cell barrel conduit, with warped inlet and outlet transitions. Each cell is controlled by a 12-foot by 18-foot top seal radial gate located slightly upstream of the dam axis. Figure II-4 shows the general arrangement of the structure, which was designed to pass a flow of 13,200 cfs with a water surface elevation of 1540 in Banks Lake.

Upstream of the headworks is the approach channel, with a bottom width of 120 feet and 1-1/2 to 1 side slopes, excavated up to 40 feet into the lake bed. Downstream of the headworks, the main canal consists of unlined and concrete-lined reaches, and includes the Bacon siphon and tunnel, over 2 miles long.

Irrigation releases are made during the period of mid-March through late October. In a typical season, daily flows are increased gradually over a two to three-month period; maintained at or near a maximum in June or July; and diminish thereafter until the end of the season. Daily flow records are available for the years 1970-77, from which average flows in selected years have been plotted and are shown in Figure II-5.

During the year, there is a fluctuation in the water surface elevation of Banks Lake. Figure II-6 shows the range of variation in the 11-year period 1968-78. Typically, the reservoir is filled to maximum capacity, elevation 1570, during the winter months. Initial irrigation releases result in a drawdown of the reservoir, usually to approximately elevation 1555. The water level rises as spring flood flows in the Columbia occur, and pumping to replenish the reservoir is commenced. Downstream of the headworks, water surface elevation in the canal varies as a function of the discharge. The rating curve, based on observations by the USBR, is shown in Figure II-7.

Due to the variations in head and tailwater surface elevations, discharges through the headworks have historically undergone a head loss in the range of 15-50 feet. The energy corresponding to this head loss is dissipated in the hydraulic jump downstream of the radial gates. Wave disturbances associated with the jump are largely suppressed in the portion of conduit barrel between the gates and the outlet. The normal operating regime is to open all 6 gates an equal amount, to produce an equal discharge through each conduit barrel.

D. FUTURE CONDITIONS

Future flows through the headworks, and energy potential available for power generation will be influenced by the following:

a. Completion of the second barrel of the Bacon siphon and tunnel, scheduled for service in the 1980 irrigation season.

b. Operation of Banks Lake for pumped storage generation, using pump-turbine units at Grand Coulee Pumping Plant.

c. Expansion of the acreage irrigated by the Columbia Basin Project.

The first two items above relate to construction activities currently underway under the sponsorship of the U.S. Bureau of Reclamation. The Bureau was requested to furnish, if available, information based upon their engineering studies regarding the downstream rating curve to be expected when the second Bacon siphon/tunnel is commissioned, and the intended operating regime for Banks Lake as a pumped-storage facility.

Estimation of future tailwater conditions was based upon the findings reported in the Bureau's publication REC-ERC-72-22, "Hydraulic Model Studies of the Canal Structures adjacent to Bacon Siphon and Tunnel". The report included a chart of flow depth versus discharge upstream of the siphon inlet. From this, the backwater profile was determined for the range of discharges considered and used to derive the tailwater rating curve shown in Figure II-7.

Future headwater (Banks Lake) surface elevations have been taken as follows:

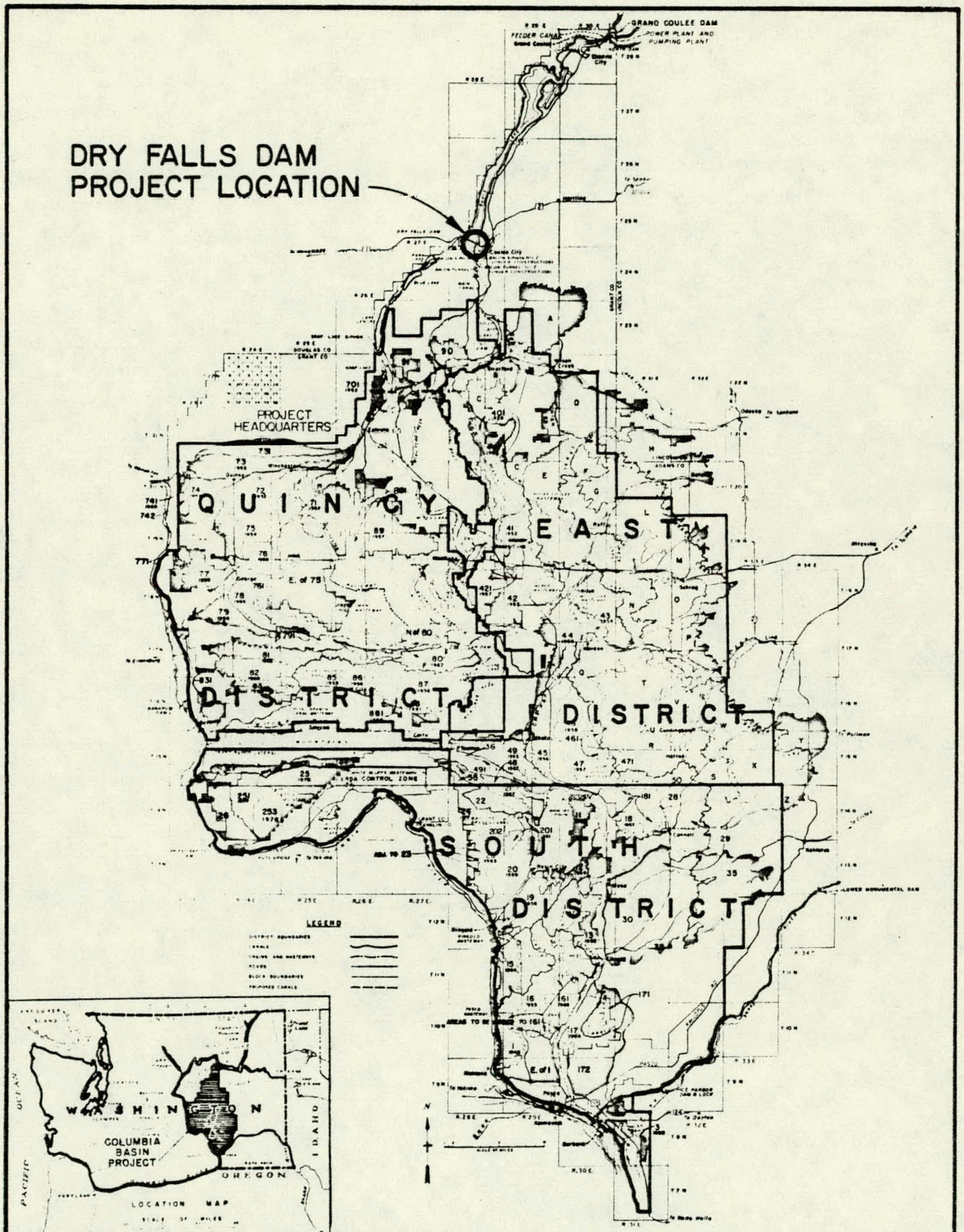
March 31 - May 31:	Drawdown at a uniform rate from Elevation 1569 to Elevation 1555.
May 31 - July 31:	Rise at a uniform rate from Elevation 1555 to Elevation 1569.
July 31 - March 31:	Elevation 1569 (average).

These elevations are, generally, consistent with historical experience, excepting the years when drawdown was to lower elevations as required for construction. The assumptions described may have to be modified if the USBR furnishes information on the intended operating regime of the pumped storage project.

Estimates of future irrigation flows have been made by the USBR's Columbia Basin Project. The estimates were based upon providing service to the ultimate acreage encompassed by the project, 1,095,000 acres, and are summarized in the report "Second Bacon Tunnel and Siphon" dated August 1975. The requirements of the present as well as future irrigated lands were considered. Changes in cropping patterns and irrigation methods, including increased use of sprinkler irrigation, are being experienced on the project which have an effect on irrigation peaking demands. Using different assumptions regarding the extent of sprinkler irrigation, the USBR estimated peak flows at ultimate development would be in the range 17,650 to 20,600 cfs. Peak discharges experienced currently approach 8,000 cfs. Design of the second Bacon siphon and tunnel provides for a maximum flow of 19,300 cfs through the twin facilities.

Irrigation releases fluctuate throughout the year as described previously, and as illustrated in Figure II-5. For the purpose of the power studies reported in Chapter III, an idealized hydrograph was developed to represent the variation in discharge through the irrigation season. The hydrograph expresses daily flow as a proportion of the annual peak flow, and is shown on Figure III-2, following the text of Chapter III. For a year in which the maximum discharge is 18,000 cfs, the hydrograph corresponds with an annual discharge of 5,000,000 acre-feet, consistent with the USBR projections (given on page I-31 of the Draft EIS for the Columbia Basin Project, published by the USBR in January 1975).

For an indication of the pattern of future expansion of irrigated acreage in the Columbia Basin Project, reference may be made to Figure II-8. The figure shows the historical growth of Project acreage, from 1950 to date, and various projections of future development. Current forecasts indicate that full development may be expected by about year 2005. For the purpose of power studies, this has been taken as the year in which a peak discharge of 16,000 cfs will be attained.



DRY FALLS DAM POWER DEVELOPMENT

COLUMBIA BASIN PROJECT - LOCATION MAP

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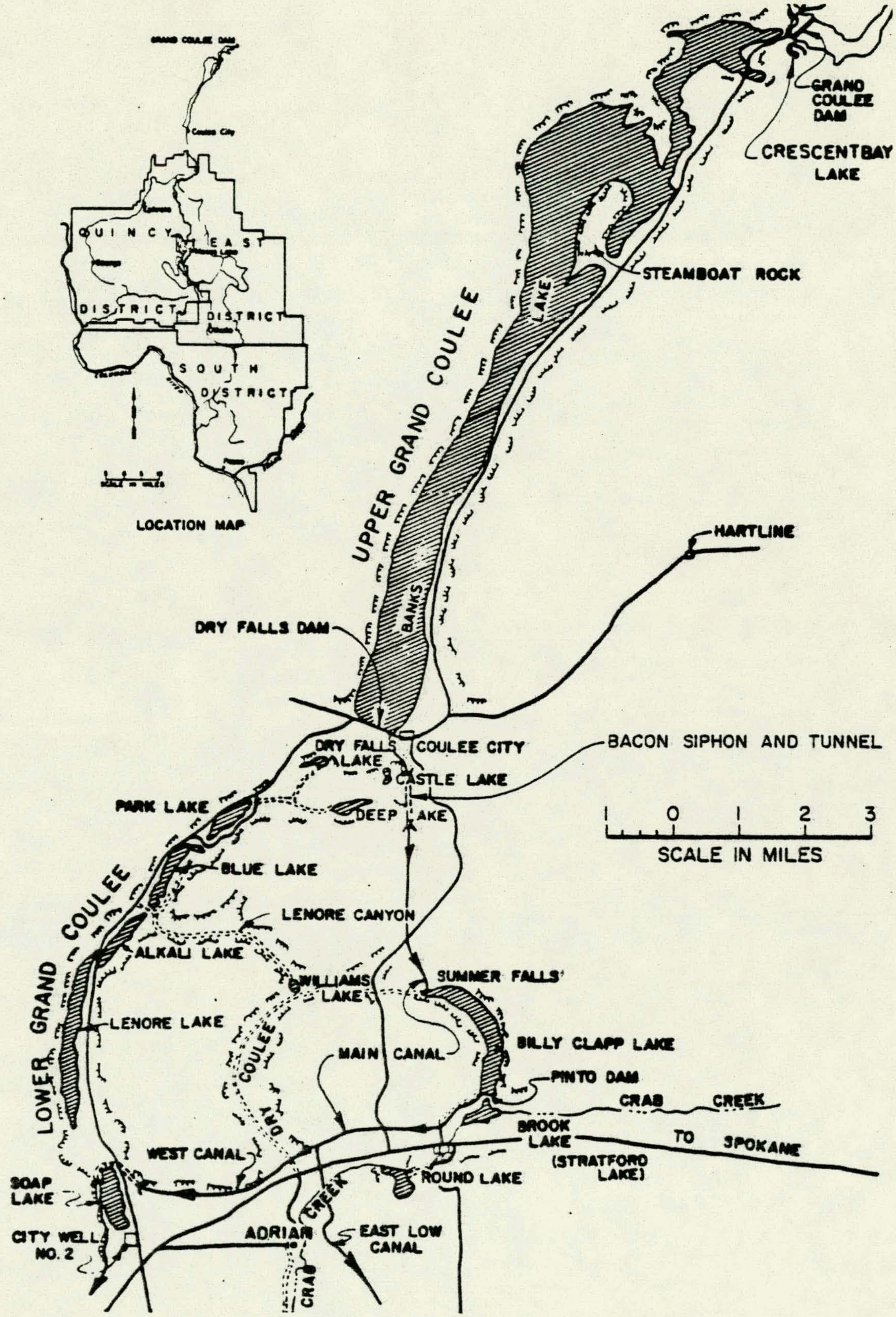
FIGURE
II-1



DRY FALLS DAM POWER DEVELOPMENT BANKS LAKE AND MAIN CANAL	**TUDOR** ENGINEERING COMPANY SEATTLE WASHINGTON	**FIGURE** II-2

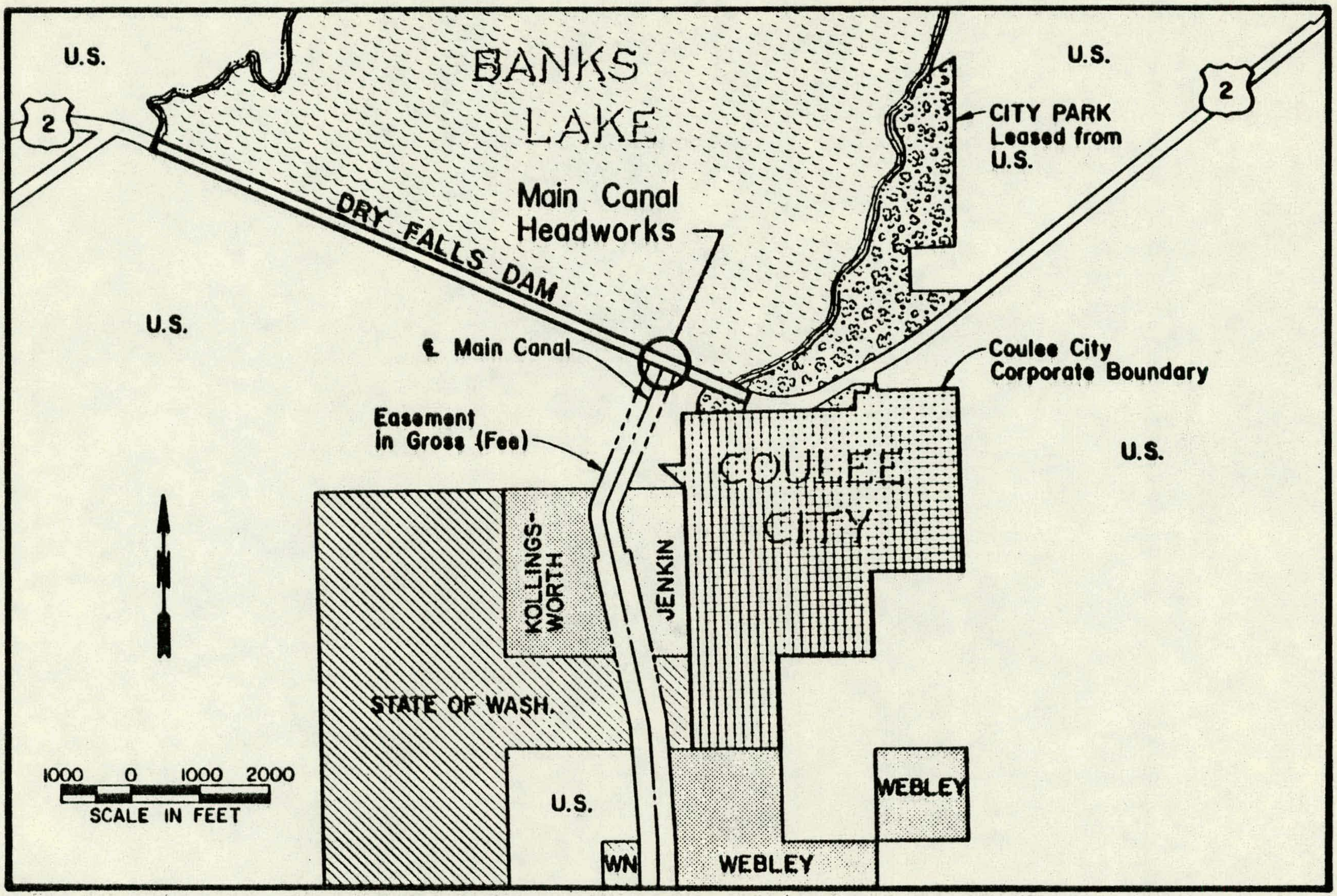


FIGURE II-3

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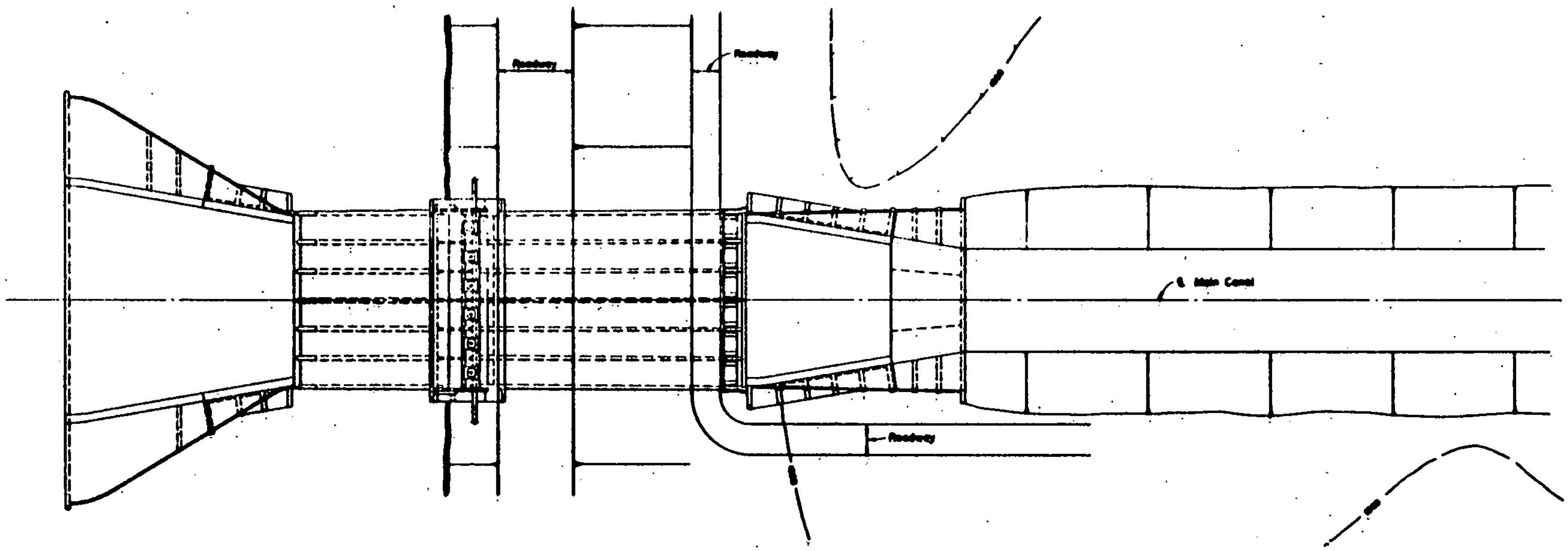
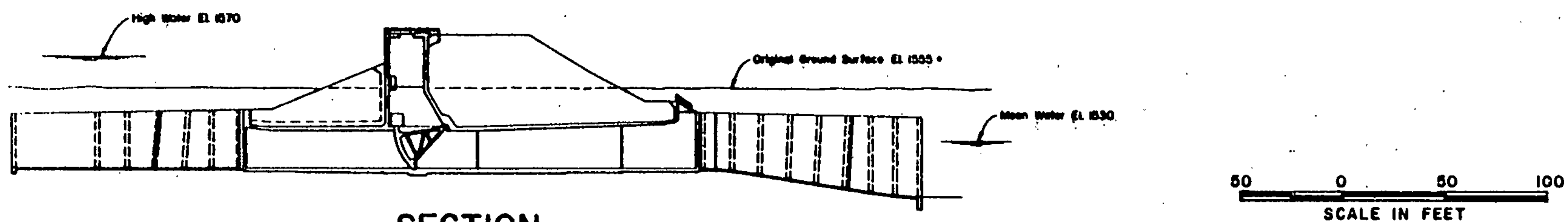
DRY FALLS DAM POWER DEVELOPMENT

DRY FALLS DAM - LAYOUT AND LAND OWNERSHIP



PLAN



SECTION

FIGURE II-4

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DRY FALLS DAM POWER DEVELOPMENT

EXISTING MAIN CANAL HEADWORKS

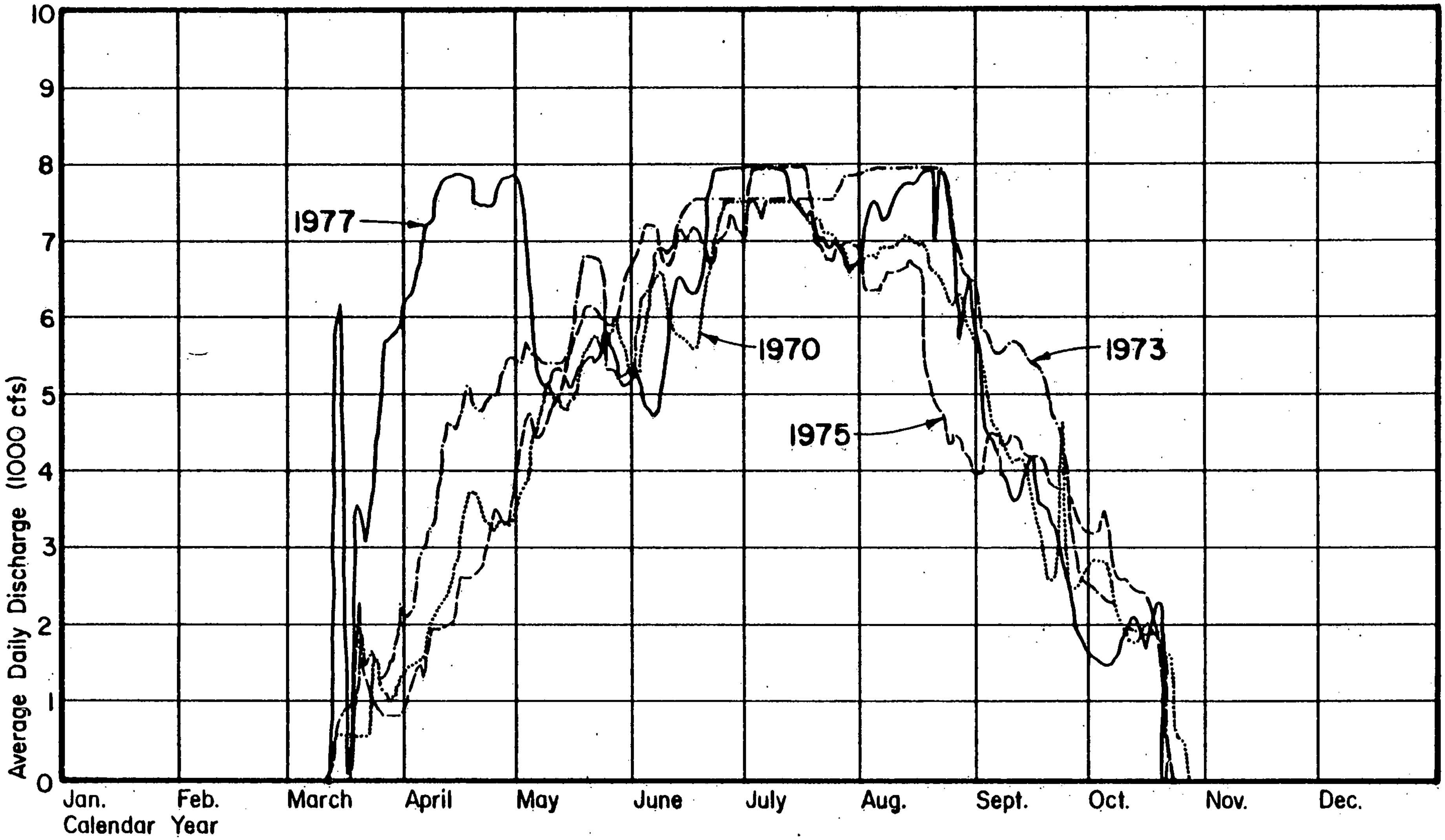

FIGURE II-5

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DRY FALLS DAM POWER DEVELOPMENT

MAIN CANAL DISCHARGE AT DRY FALLS DAM - SELECTED YEARS 1970-1977

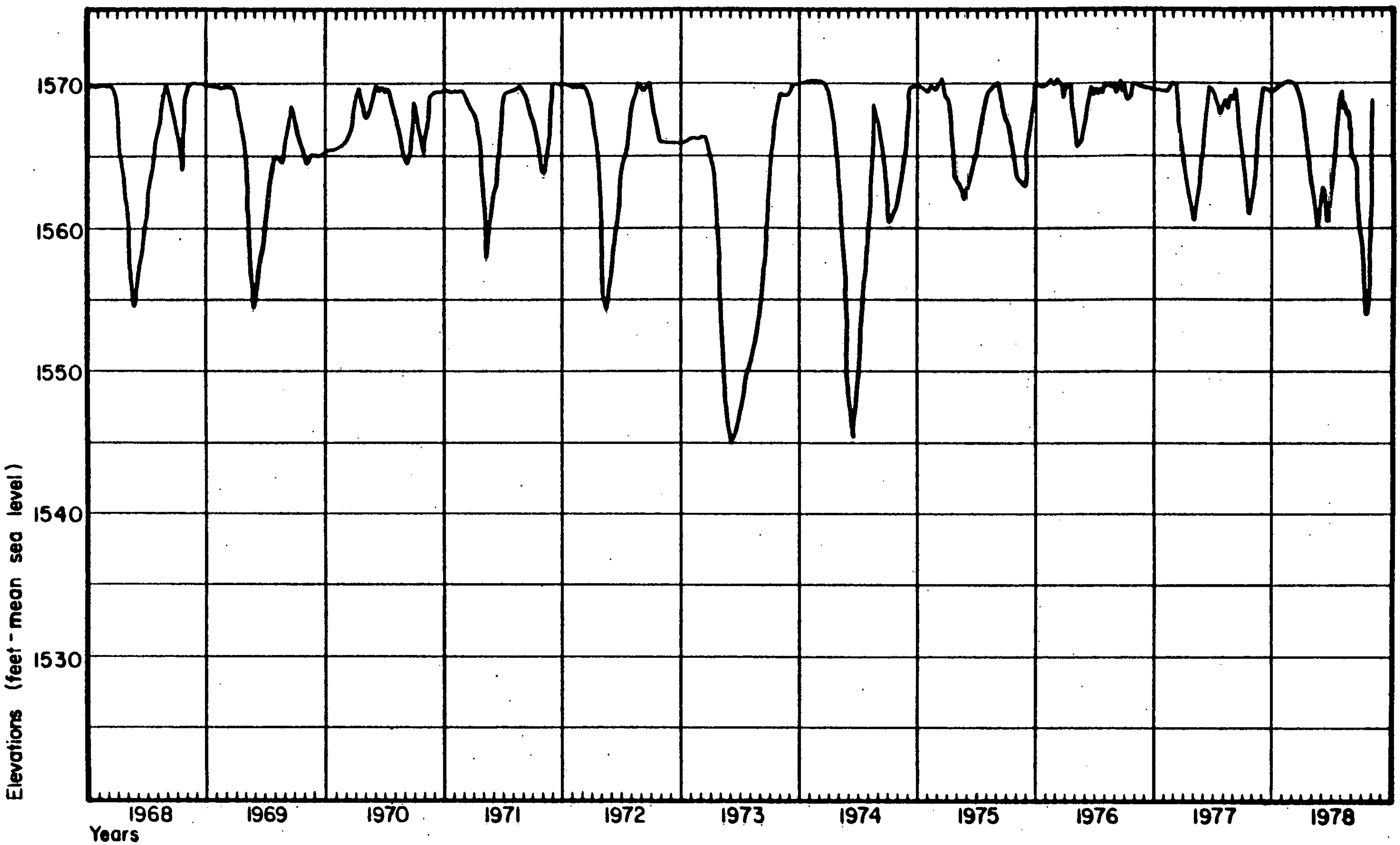

FIGURE II-6

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DRY FALLS DAM POWER DEVELOPMENT

BANKS LAKE WATER SURFACE ELEVATION 1968-1978

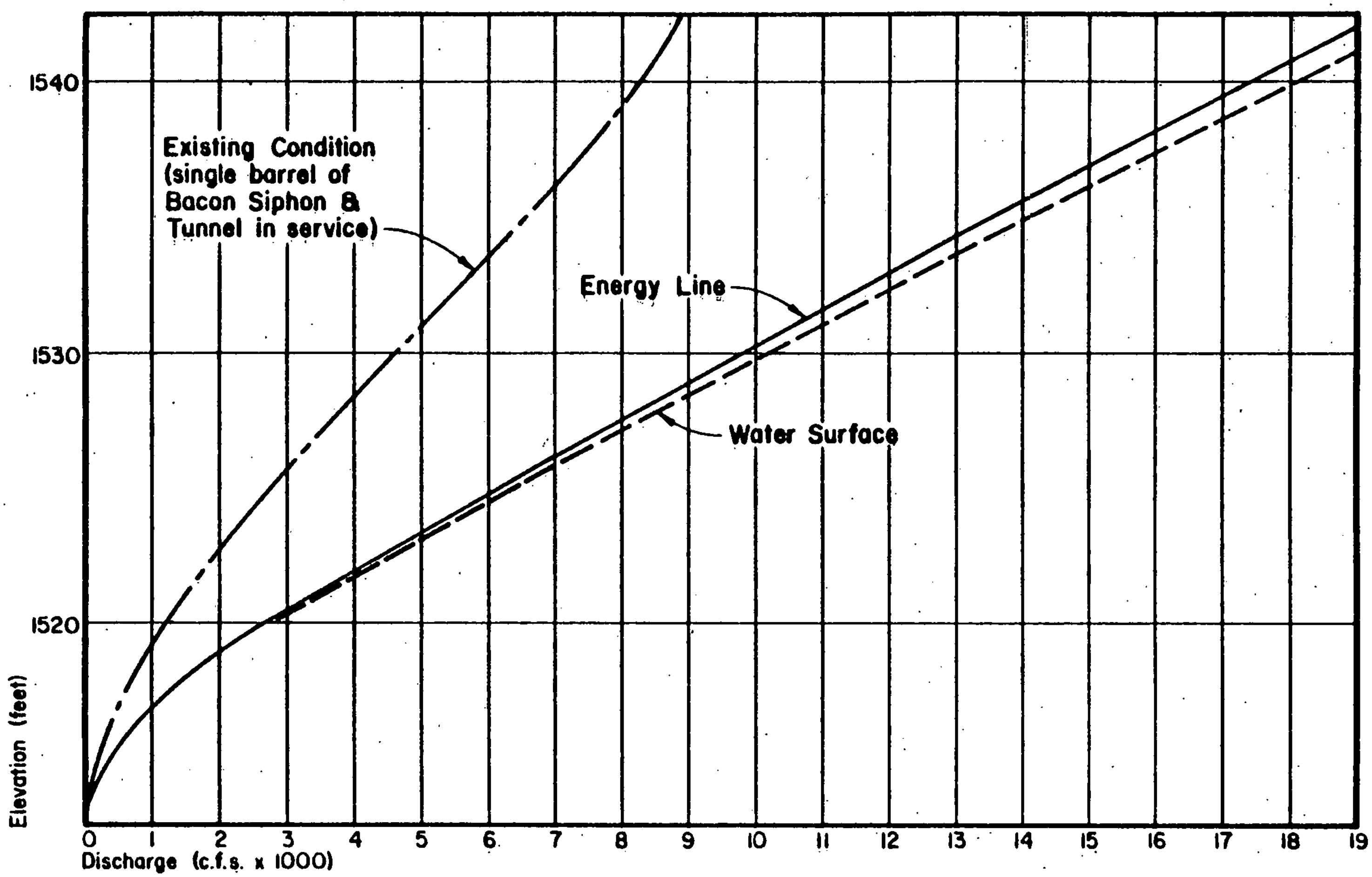

FIGURE II-7

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DRY FALLS DAM POWER DEVELOPMENT

TAILWATER RATING CURVE: MAIN CANAL, 400' DOWNSTREAM OF DRY FALLS DAM

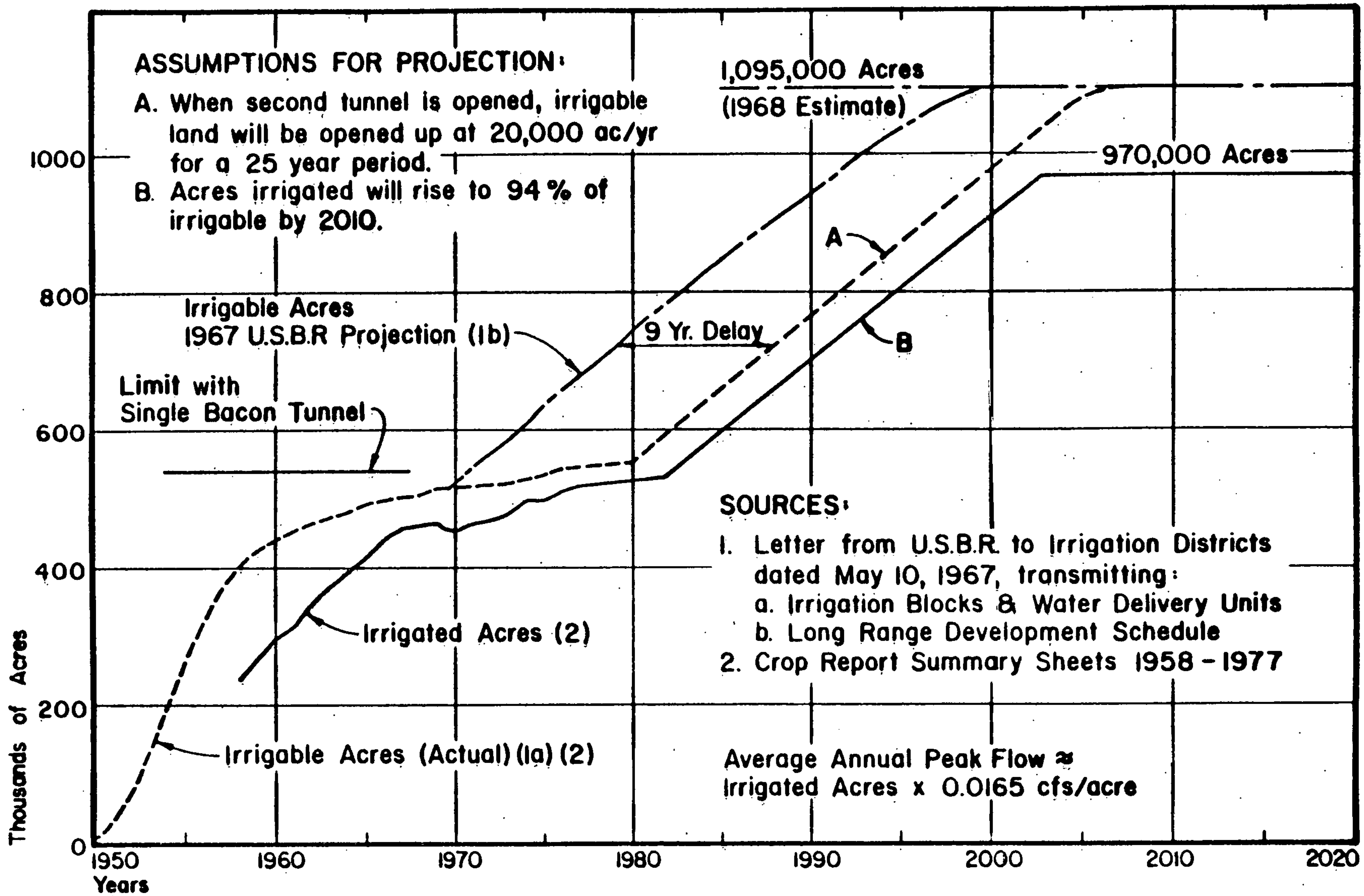

FIGURE II-8

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SEATTLE WASHINGTON

DRY FALLS DAM POWER DEVELOPMENT

COLUMBIA BASIN PROJECT - ACREAGE DEVELOPMENT

III Power Potential

CHAPTER III

POWER POTENTIAL

A. GENERAL

In order to evaluate the feasibility of a hydroelectric development, an estimate must be made of the power and energy output from the development. Power production is a function of the amount of flow and the "effective head" of the water passing the site, and the size and efficiency of the generating plant installed.

Several terms commonly used in power studies need to be explained, since they are necessary for the discussion which follows. These terms are defined below:

1. <u>Energy</u>

   Energy is the ability to do work, and work is the utilization of energy. Both energy and work are measured in foot pounds; electrical generation and usage are measured in kilowatt-hours (kWh).

2. <u>Power</u>

   Power is the rate of doing work. The customary unit for power is horsepower, equivalent to 550 foot pounds per second. In electrical generation and usage the usual units of power are kilowatts (kW) or megawatts (MW), equal to 1000 kilowatts.

3. <u>Head</u>

   The total hydraulic head available to a turbine refers to the difference in elevation between the water surface in the reservoir or forebay and that of the downstream tailwater. In this report "hydraulic head" will be shortened to "head". As the water passes through the intake, penstock and tailrace, some energy is dissipated in hydraulic losses, thus reducing the head available to drive the turbine. The head remaining after losses is known as the "effective head".

4. <u>Efficiency</u>

Turbine efficiency refers to the ratio between the actual power output of the turbine and the theoretical power output for a "perfect" turbine. Efficiency can refer to the turbine by itself, or to the plant as a whole, including the generator and any gear box, clutch or similar unit. In this report, efficiency refers to the power production of the plant as a whole.

B. POWER GENERATION POTENTIAL

The amount of energy theoretically obtainable from a hydro-electric power installation is a function of the energy of the falling water at the site. If all of the hydraulic energy can be mobilized, the rate of power production is a function of the discharge, net head and plant efficiency at any given moment. For the purpose of this study the following formula is used:

$$\text{Output (kW)} = \frac{Q \times H \times E}{11.8}$$

where: Q = discharge in cubic feet per second (cfs)
H = effective head in feet
E = combined turbine and generator efficiencies

In Chapter II, the present and future regime of irrigation releases at the Dry Falls Dam site was discussed. A typical pattern of releases was established, together with a forecast of the peak flow likely to occur in future years. The maximum theoretical power output from the site would occur under a combination of peak flow and maximum head. Figure III-1 shows the relationship between annual peak flow and power potential, assuming a maximum water surface elevation in Banks Lake, and an overall plant efficiency of 80 percent, including conduit losses. As the flow increases, tailwater rises, and causes a reduction in power potential. The diagram also shows the power output possible with various sizes of units installed.

In order to estimate the amount of energy which can be produced annually by a power development at the site, the variation in flow and effective head must be considered. Based on the historical patterns observed, as described in Chapter II, idealized assumptions were adopted for the purpose of power studies, and are shown in Figure III-2.

A preliminary calculation of annual energy potential was made, using the assumptions as to headwater elevation and seasonal fluctuation in irrigation discharges described above. It was further assumed that no generation would occur when discharges fall below 20 percent of the annual peak. Under present-day flow conditions, the site has a maximum potential of producing 67.1 million kilowatt-hours of energy annually, with an average power output of 14.5 MW during the 193-day period when flows are sufficient to permit generation. In the future, when peak annual irrigation releases reach 16,000 cfs, the annual energy potential will be 106 million kWh, at an average output of 22.9 MW. The power studies also indicated that, if the water surface level in Banks Lake were maintained at or near 1570 throughout the irrigation season, the potential output of energy would be increased by approximately 5 to 10 percent.

C. POWER STUDIES

The preliminary studies described above indicate that potential power output varies over a wide range, consequent upon the variations in head and discharge. The actual amount of energy produced will be less than the potential amount, due to a number of factors, including the following:

1. Maximum discharge through the turbines will be, for economic reasons, less than the peak irrigation flow. Flows in excess of the turbine discharge capacity will bypass the power plant.

2. The generator capacity may be less, for economic reasons, than the maximum power output of the turbines.

3. The turbines are capable of operating within a limited head range (approximately 65 percent to 140 percent of "design head" for adjustable-blade propeller turbines). At lower heads, the plant has to be shut down; at higher heads, operations can continue only if the head across the plant can be throttled by means of gates.

4. When operating under head and discharge conditions other than the design rating, turbine efficiency is reduced. The reduction is substantial as the conditions approach the permissible limits for operation.

In order to assess the effect of these factors, and to provide a basis for a preliminary selection of the number and size of units to be installed, further power studies were made. These utilized a computer program designed to simulate a wide range of potential hydraulic and design characteristics. A flow chart delineating the organization of the program is presented in Figure III-3.

The computer runs derived the power and annual energy output from the power development, given the number, rating, and design head for the turbines installed. Power output under varying head conditions was calculated using values for turbine efficiency obtained from a variety of published texts and information received from manufacturers. For each case considered, the computer produces a graphical display of the power output, and a numerical total for the annual energy production in the year for which the flow conditions apply. A selection of the graphics produced is reproduced in Appendix A.

Computer runs were made to determine the effect of varying the number of units installed in a plant of given total capacity. These demonstrated that plants with multiple turbine-generators are capable of a greater energy output than single-unit plants. A two-unit plant would produce approximately 2.4 percent more energy annually than a single-unit plant of the same rated capacity, and a three-unit plant 3.6 percent. Appendix A includes copies of the computer output applicable to 1- , 2- and 3- unit plants of 12 MW capacity.

As discussed in Chapter IV, a 2-unit plant is selected as a base alternative for consideration in this study. A series of computer runs was made to compare the energy output of 2-unit plants of varying capacity. The runs were made for 1982, assumed as the first year of full operation of the power project. The results are summarized in Figure III-4, as they relate to two possible conditions affecting the water surface elevation in Banks Lake. Copies of the computer output for the runs are included in Appendix A.

Projections were also made, using the computer, of annual energy production over a 40-year period of plant operation for 2-unit installations of various capacities. The projections are shown graphically on Figure III-5, and copies of the computer output are included in Appendix A.

D. CAPACITY OF THE DEVELOPMENT

The optimum capacity of the power generation facilities installed at Dry Falls Dam depends upon physical, operational and economic factors. The physical factors include available head and streamflow, which determine the potential maximum energy production; and the availability of storage, which influence the plant's capability of generating a higher output during periods of peak power demand. Operational factors relate to the number and size of installed units; the efficiency of the equipment; and the operating regime. Economic factors comprise the costs of construction, operation and maintenance; the market value of the power, or the cost from an alternative source; the method and cost of financing the development; and the financial or economic goals and constraints of the owner.

Although the physical factors can be identified with some precision, their significance is only in establishing upper limits to the extent or output of the planned development. Selection of the appropriate size of installation is primarily a matter of economics. It follows that the installed capacity at a particular site needs to be reviewed periodically, in light of current economic conditions. From time to time such analysis will indicate that modification to the size or operating regime of the installation is desirable. For the purpose of this report, a preliminary selection is made, based upon the estimated unit cost of energy which can be produced at Dry Falls Dam.

Figure III-6, which presents the relationship between installed capacity and construction cost of power installations ranging from 5 MW to 20 MW, was developed using costs of recent, similar plants at existing dams, adjusted to reflect the detailed cost estimates for Dry Falls, referred to in Chapter V. The figures given are representative of construction bid prices current as of September 1978. From the construction costs, annual costs were derived, allowing for development and financing costs, and operation and maintenance expenditures. Annual costs were calculated based upon two methods of financing the project, using tax-exempt bonds with an interest rate of 7 percent, retired over a 30-year and 40-year period.

From the annual costs and the estimate of annual energy production in 1982, the estimated unit cost of energy can be calculated for each size of installation considered. The results of these calculations are summarized on Figure III-7, showing the estimated 1982 cost of energy from plants of various capacities. The figure shows that cost would be a minimum for a plant in the capacity range 9 to 13 MW. Based upon this finding, if 40-year financing is employed, a 12 MW plant will produce energy at a unit cost in 1982 which is likely to be readily marketable. It is apparent that, as irrigation releases increase from year to year, and if current economic trends continue, additional units will become feasible in the future. The development considered in the succeeding portions of this report, therefore, consists of an initial installation of two 6 MW units, with provision for the construction of further units in later years.

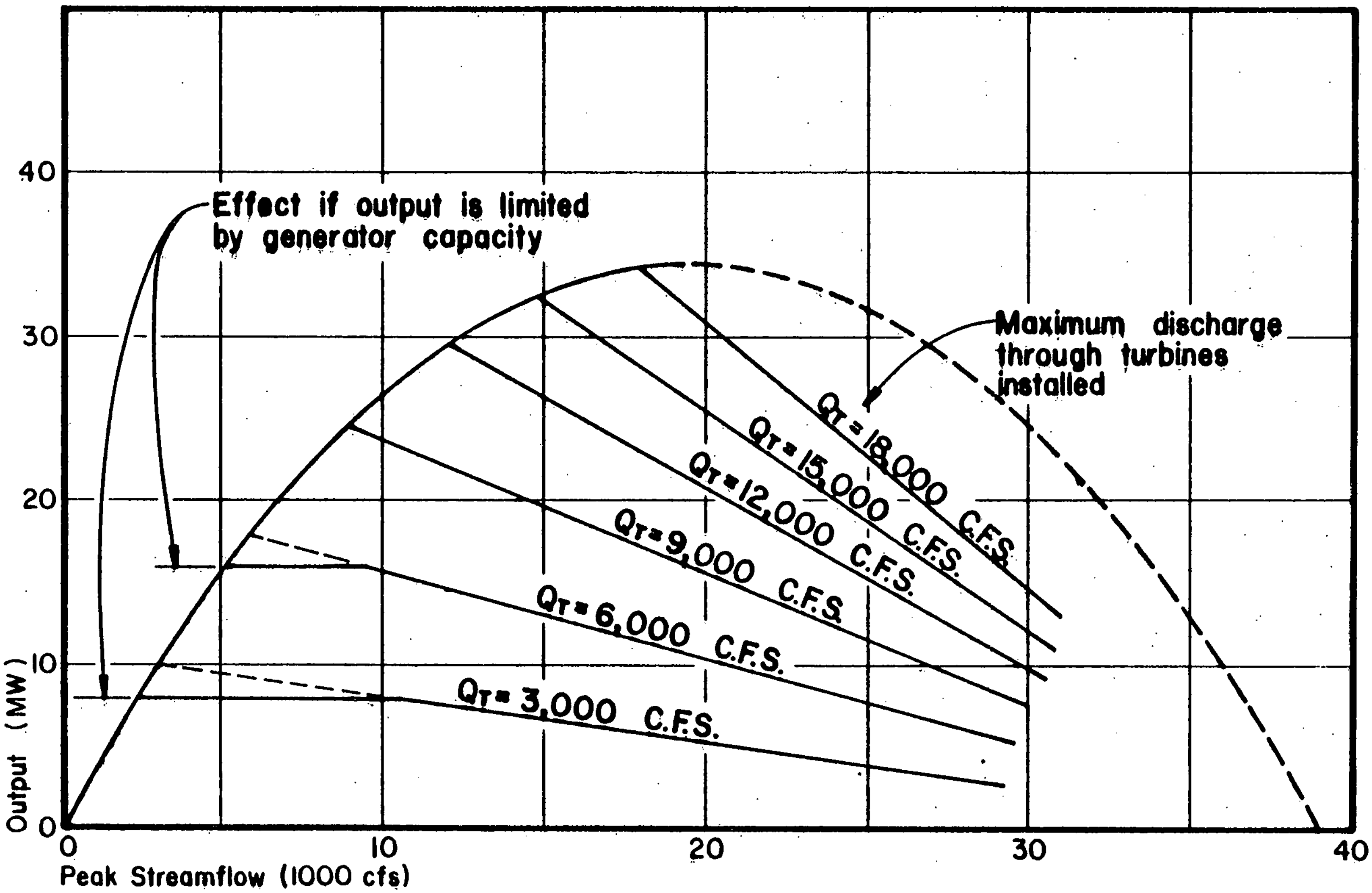

FIGURE III-1

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DRY FALLS DAM POWER DEVELOPMENT

MAXIMUM THEORETICAL POWER POTENTIAL

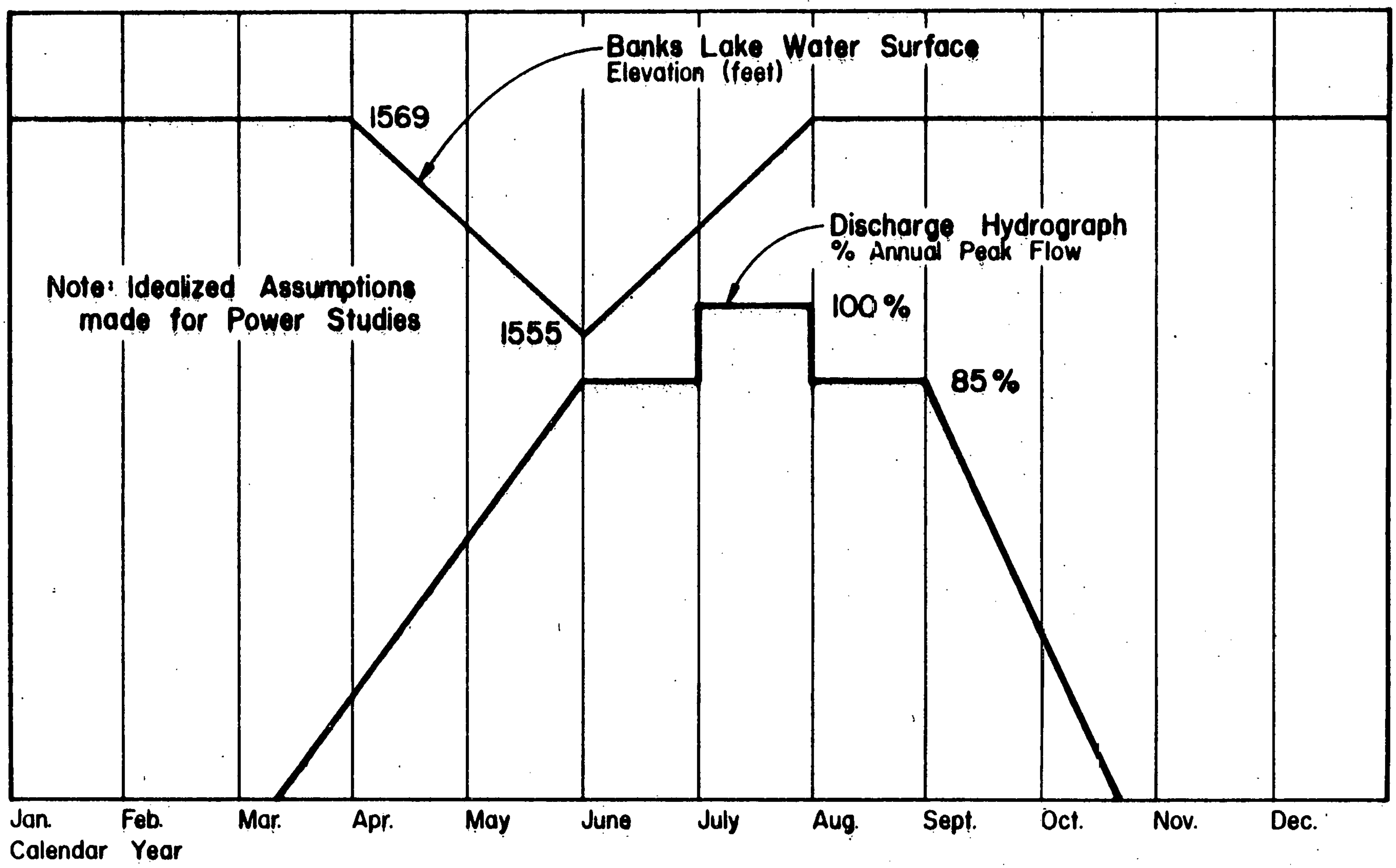

FIGURE III-2

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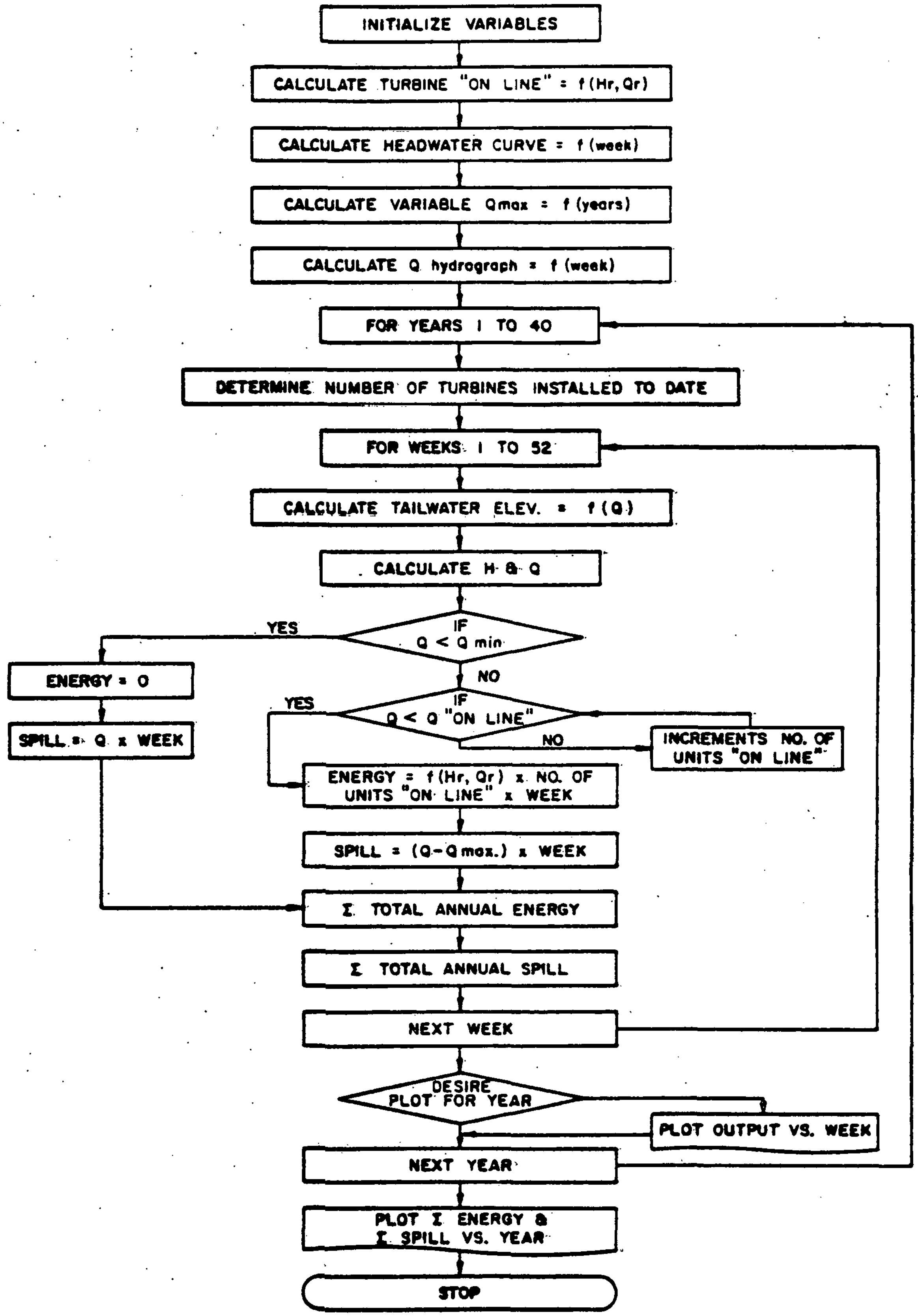
DRY FALLS DAM POWER DEVELOPMENT

HYDROLOGIC ASSUMPTIONS USED IN POWER STUDIES



DRY FALLS DAM POWER DEVELOPMENT

POWER ANAYLSIS PROGRAM FLOW CHART

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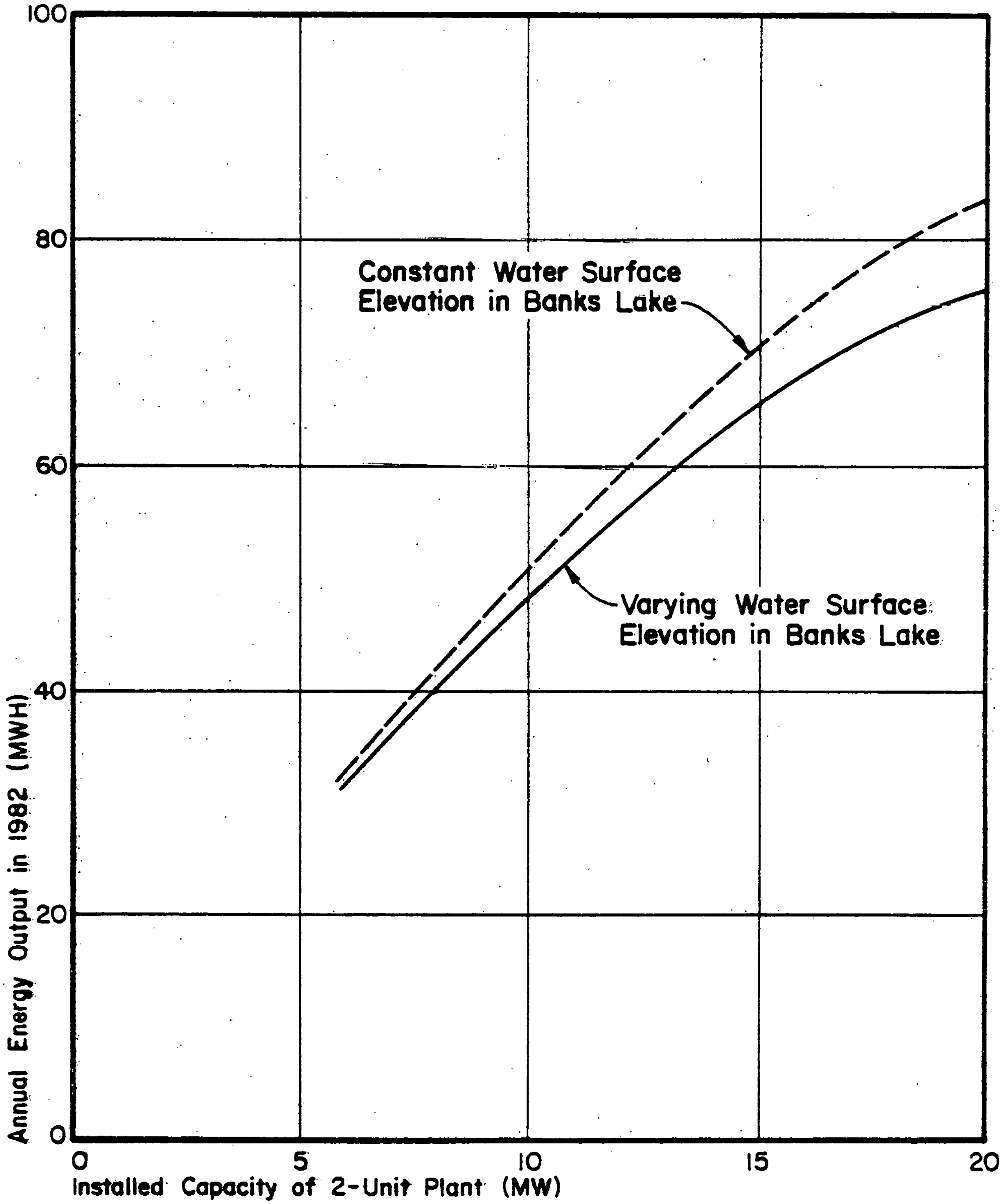
FIGURE III-3

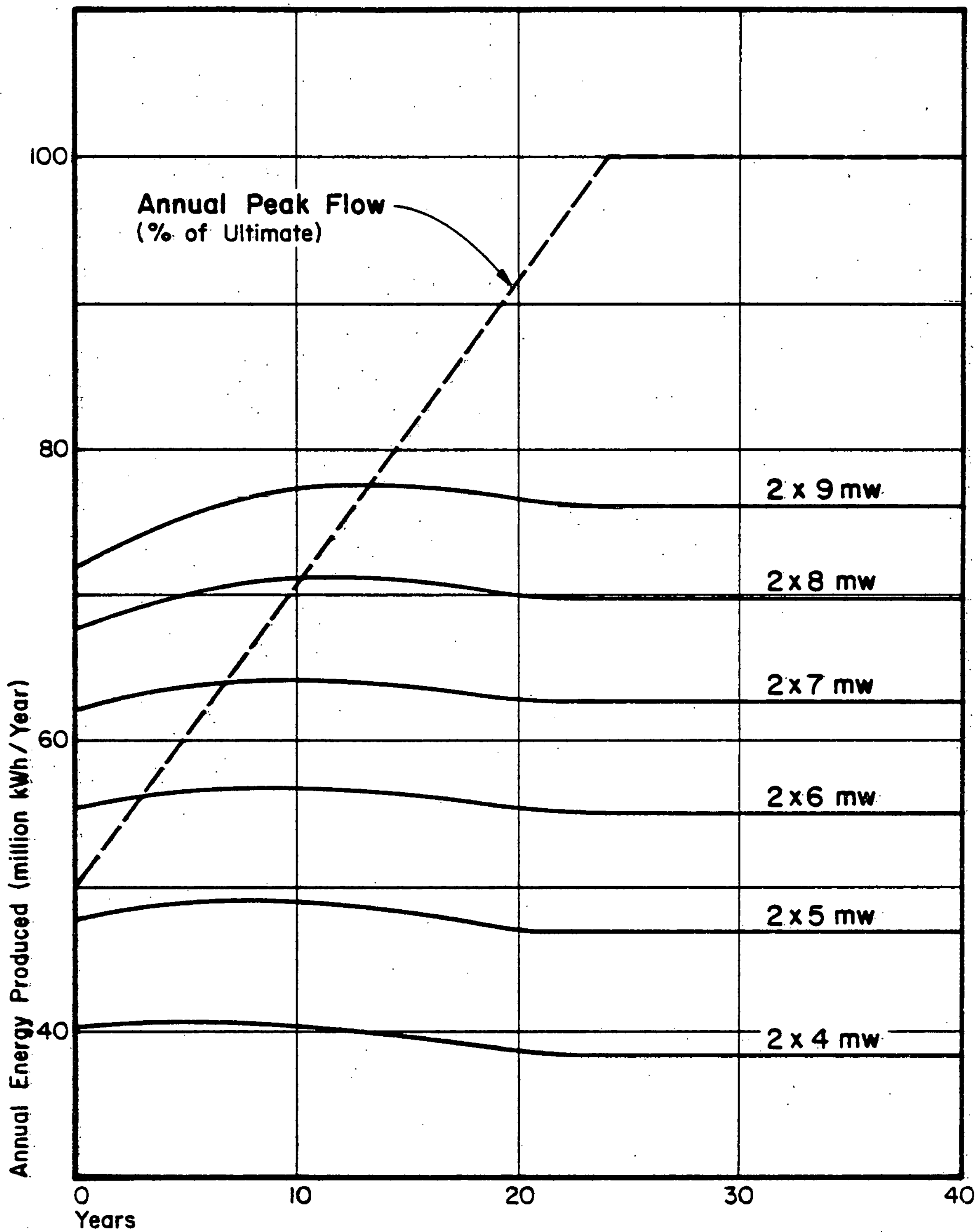


DRY FALLS DAM POWER DEVELOPMENT

ENERGY OUTPUT VS PLANT CAPACITY

TUDOR
ENGINEERING COMPANY
SEATTLE WASHINGTON

FIGURE
III-4



DRY FALLS DAM POWER DEVELOPMENT

ANNUAL ENERGY OUTPUT VS
YEAR OF PROJECT LIFE

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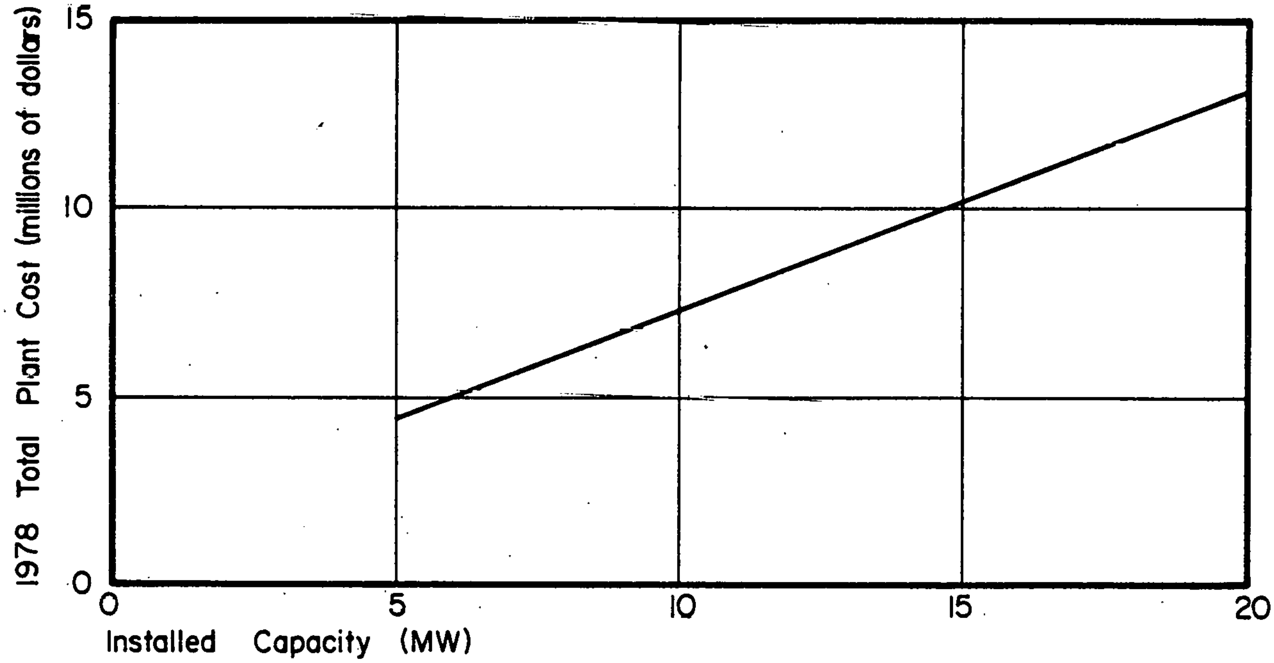
FIGURE
III-5



DRY FALLS DAM POWER DEVELOPMENT

CONSTRUCTION COST VS
INSTALLED CAPACITY

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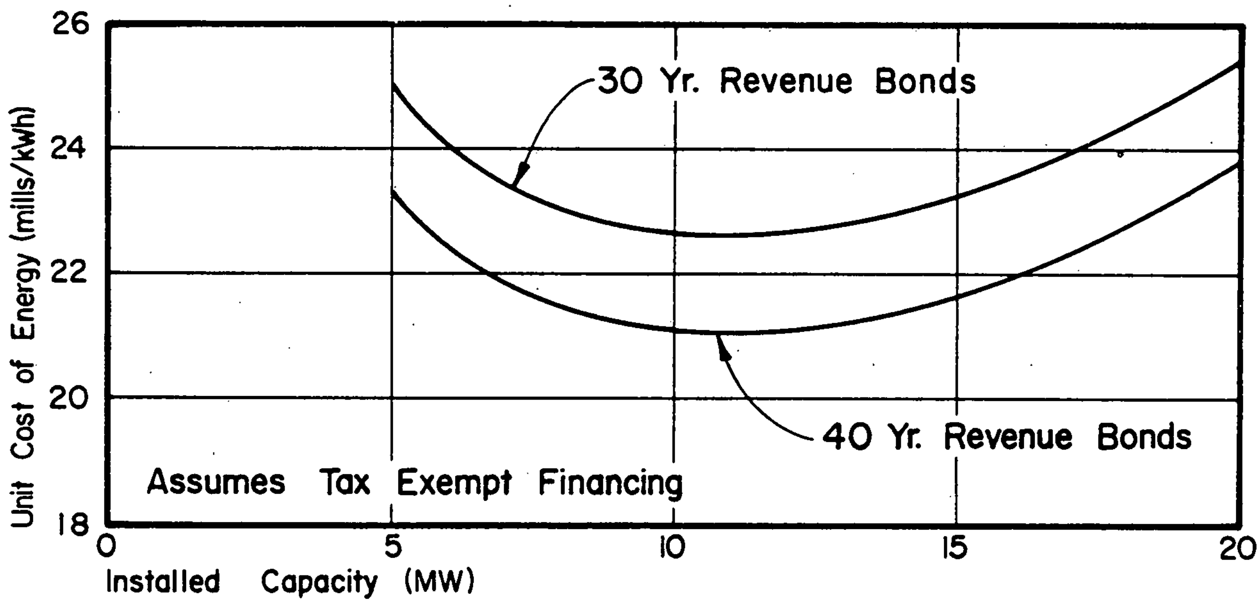
FIGURE
III-6



DRY FALLS DAM POWER DEVELOPMENT

ENERGY COST VS INSTALLED CAPACITY

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FIGURE
III-7

IV Project Development

CHAPTER IV

PROJECTED DEVELOPMENT

A. LOCATION OF POWER FACILITIES

Alternative locations for the power plant, penstock and tailrace were considered. The alternative arrangements differed primarily in the use of existing and new water passages through the dam, and comprised the following:

Alternative 1: No new conduits through dam; certain of the 6 existing conduit barrels designated for power flows; the remainder for flows bypassing the power plant.

Alternative 2: No new conduits through dam; discharges pass through a forebay downstream of the existing headworks, either through the power plant, or directly to the canal.

Alternative 3: No change to existing headworks; flows through power plant use a new conduit (open channel or closed penstock) clear of the existing structure.

Alternative 4: Power plant constructed at headworks structure outlet; flows bypassing power plant carried by a new conduit, clear of existing structure.

Of the above alternatives, 1 and 4 were eliminated from detailed study, based upon the following considerations. Under Alternative 1, the headworks structure would be required to pass at least the design flow of 13,200 cfs through those conduit barrels not set aside for power releases, with a water surface elevation in Banks Lake of 1,540. These conditions would require at least four barrels of the conduit to be in service. Unless agreement were reached to adopt less stringent criteria for the operation of the headworks structure, an unacceptable limitation would be placed upon the power generation capability of the site.

Since it is not in the interest of either the Districts or the Bureau of Reclamation to compromise the function of the irrigation facilities, further study of Alternative 1 was not pursued.

Alternative 4 can be compared with Alternative 3, since both incorporate a new conduit through the dam. Alternative 4 will involve higher capital costs, arising from the need to reconstruct the downstream portion of the headworks structure, and provide energy-dissipating facilities at the outlet of the new conduit. Alternative 3 is thus favored, economically and functionally, over Alternative 4.

Figures IV-1 through 4 illustrate possible layouts to effect Alternatives 2 and 3 outlined above. Figure IV-1 shows an arrangement providing for a powerhouse on the left bank of the outlet channel, to accommodate a single Kaplan turbine (Alternative 2A). The existing downstream apron would be completely removed, and replaced with a forebay structure to impound water at the same elevation as Banks Lake, with gates to permit the release of water to the Main Canal bypassing the power plant. The existing headworks structure would have to be modified to function as a pressure conduit and to limit the additional maintenance required to the gates and mechanism operating under submergence.

Alternative 2B provides for the installation of tube turbines fed from a similar forebay downstream of the existing headworks conduits (Figure IV-2). Provision for the future expansion of power facilities is indicated for both alternatives illustrated.

Figures IV-3 and IV-4 illustrate arrangements incorporating steel-lined penstocks and a 2-unit power plant with vertical-shaft Kaplan turbines. In these arrangements, there is no modification to the existing headworks structure. An arrangement similar to Alternative 3A, but using an open channel through the dam in lieu of a penstock, was considered and found to be more expensive in construction cost. The two arrangements illustrated (Alternative 3A and 3B) differ in the location of the powerhouse. Reduction in the length of penstock in Alternative 3A is offset by the need for a corresponding length of tailrace channel. Future expansion of generating capacity at the site could be obtained by constructing a second powerhouse on the right bank.

Selection between the location alternatives was guided by several considerations. Reduction in conduit diameter and the additional flexibility in operation, and greater energy output, compared with a single-unit plant, were the basis for selecting a 2-unit arrangement. Accordingly, Alternative 2A is not favored. Comparative construction costs for the three other alternatives were derived as follows:

Alternative 2B (Fig. IV-2)	$1,500,000
Alternative 3A (Fig. IV-3)	$1,600,000
Alternative 3B (Fig. IV-4)	$1,800,000

The above costs do not include items common to each alternative such as turbine-generators, mechanical and electrical equipment, and miscellaneous civil/structural provisions.

Alternative 2B shows a slight apparent cost advantage over Alternative 3A, with 3B at the highest cost of the three arrangements. Alternative 3A was selected, however, for the project development studied in further detail, in recognition that it can be accomplished with less impact upon the existing irrigation facilities.

Further consideration of single-unit plants, and of the possible application of tube or bulb units, will be made in the course of selecting generating equipment, based upon the combined costs of associated civil/structural requirements and the life-cycle cost of hydroelectric machinery.

B. SELECTION OF TURBINE AND GENERATOR

Selection of the type of turbine most suitable for the project conditions requires the consideration of power output over the expected range of operating conditions. A general description of the range of turbine types available is given in Appendix B. Generating plants operating under a head in the range of 10 to 80 feet are considered "low head" installations, and call for the selection of a hydraulic turbine which can be designed to have a high specific speed. The most suitable turbine runner to meet these conditions is the propeller type, which can be incorporated in a variety of configurations. The efficiency of a turbine varies with the head and flow under which it operates. Typical relationships are shown in Figure IV-5. In order to obtain acceptable performance throughout the wide range of operating conditions at Dry Falls, a propeller with adjustable blades would be required.

Vertical-shaft adjustable-blade units known as "Kaplan" turbines represent the traditional approach to propeller turbine design for large-output installations. The units require an extensive surrounding structure in connection with the layout of water passages leading to the turbine runner, and of the elbow draft tube. The inlet to this type of turbine may be an open flume, a concrete semi-spiral case, or a steel-lined spiral case. In open flume construction, the wicket gate mechanisms are located within the water passageways and are water lubricated. This is sometimes the most economical configuration but the maintenance requirements are high. If the turbine location requires a penstock leading from an intake some distance away, the spiral case arrangement is appropriate.

As an alternative to the vertical-shaft arrangement, propeller turbines may be obtained in a "Tube", "Bulb" or "Rim" configuration. These types, more fully described in Appendix B, usually involve a horizontally-aligned turbine shaft, and require a powerhouse less deep, but larger in plan area, than the vertical-shaft units.

The "tube" turbine consists of a propeller-type runner mounted in a circular water passage. Downstream of the runner, the turbine shaft passes through the wall of the draft tube at a shallow elbow, and is connected to the generator. In the bulb design, the configuration of the water passage and turbine runner is similar, but the generator is directly connected to the turbine, and contained within a watertight "bulb" housing upstream of the turbine runner. In the "rim" type of turbine, the mechanical arrangement differs in that the rotor of the generator is attached to the rim of the runner. The rim of the runner has a seal which uses filtered water at a higher pressure than the turbine effective head. The generator operates in air outside of the passageway. The design has been successfully operated in Europe and would appear to offer cost benefit for certain size units. To date, none have been installed in the United States. The general arrangement of Kaplan, Tube, Bulb and Rim-type units is shown in Figures IV-6 through 9, from which an indication may be obtained of the respective requirements for housing the equipment within the power plant structure.

For smaller hydroelectric installations, manufacturers are now offering standardized "Tube" package units which are economically attractive and relatively simple to install. As yet, however, the rating of the package units is less than that contemplated for installation at Dry Falls. For the purpose of comparing alternative power plant locations, and as a basis for the financial analysis of the project, the use of conventional vertical-shaft, Kaplan turbines, has been assumed. Selection of the most suitable type will be reviewed in the course of final design, based upon firm quotations to be obtained from equipment suppliers.

Generators can either be of the synchronous or induction type. Induction generators are often considered more practical for the smaller turbine-generator installations because they cost less and require less maintenance. They do not run at exact synchronous speed, and complex equipment is not needed to bring them on line. They cannot be used to establish frequency, however, and must be connected to a system with synchronous generators, as they take their excitation from system current. However, the size of currently-available units is limited to about 2 MW. Accordingly, synchronous generators will be required at Dry Falls. It should be noted that the generator usually rotates at the same speed as the turbine. With the "tube" turbine, however, a speed increaser can be used to connect the turbine and generator shafts, and permit the use of a higher-speed generator. Such a unit has smaller physical dimensions, and a correspondingly reduced first cost.

C. MECHANICAL AND ELECTRICAL EQUIPMENT

The power studies reported in Chapter III established the recommendation to install two 6 MW turbine-generators to provide a total installed capacity for the power project of 12 MW. Each turbine would be rated at 8000 HP when operating under 30 feet effective head. The generator associated with each turbine would be synchronous type, rated at 6000 KW, producing 3-phase, 60 cycle power at 4160 volts, and a power factor of 0.9.

Control of each of the generators would be by static excitation and voltage regulation equipment. Sequential operation and monitoring of the units will be accomplished through a main control board located in the power plant. The control panel will include suitable control switches, indicator lights, protective and interposing relays, and recording instruments. All power plant auxiliary systems, such as pumps, motors, lighting and heaters with fans will be operated from the plant low voltage motor control center and switchgear located in the powerhouse.

Output from each generator would be fed through a generator breaker to a common bus to a step-up transformer located in a switchyard adjacent to the powerhouse. The step-up transformer will be a three-phase, oil-filled, 12,000 KVA sub-station type unit. The transformer will include suitable protective equipment and have a control panel. Switchyard equipment associated with the plant will include air break switches, oil circuit breaker, switchgear, protective equipment and takeoff tower for the outgoing transmission line. It is assumed that connection will be made to the existing 115 KV line approximately 2000 feet to the south. Figure IV-10 shows the plant one-line diagram; and Figure IV-11 a typical switchyard arrangement.

In addition to the electrical and mechanical equipment mentioned above, the power plant will include such miscellaneous mechanical equipment as cranes, hoists, pumps, compressed air system, water supply systems, heating and ventilating system, fire protection system, drainage and dewatering systems; such accessory electrical equipment as low-tension switchgear, station service equipment, d.c. power supply, control and protection equipment, and lighting.

D. INTAKE, PENSTOCK AND POWERHOUSE

The layout of the proposed power facilities is presented on Figure IV-12. The facilities will be located to the east of the headworks structure, at a sufficient distance to ensure that no disturbance is caused to the existing structure. A new approach channel will be cut into the lake bed to join the existing approach channel to the penstock inlet structure. The approach channel will be excavated in rock with a total length of approximately 300 feet and would be most economically constructed during annual low water on Banks Lake. The channel section will have a 26-foot bottom width, and 1/2 to 1 side slopes.

Where the penstocks cross the axis of the dam, it consists of an embankment approximately 26 feet high, on a foundation of bedrock. In order to preserve the integrity of the dam's rolled earth core, the penstocks will be placed in a tunnel excavated through the foundation rock. Individual, 14-foot diameter penstocks are proposed for each unit in order to keep tunnel excavation as far beneath the dam foundation contact surface as possible. Strict control and monitoring will be necessary during tunnel operations to assure protection of the existing dam.

Flow through each penstock will be controlled by a slide gate, and the inlet will also contain slots for stop logs and trash racks. Access to the operating platform of the inlet structure will be obtained from the existing dam crest by means of a walkway on structure or fill. Consideration should be given to the possibility of drawing down the water level in Banks Lake for part of the construction period in order to permit the inlet structure to be built in the dry with a minimum of dewatering.

The powerhouse will be located immediately downstream of the toe of the existing dam embankment. As illustrated in Figure IV-12, for the case in which Kaplan turbines are selected, the powerhouse will be a rectangular concrete structure with plan dimensions approximately 117 feet by 48 feet. The generator floor will be at elevation 1553; turbine and auxiliary equipment at elevation 1525; and a roof will be provided above the generator floor, with access to the equipment afforded through hatches in the turbine floor.

Downstream of the powerhouse, the tailrace will consist of a concrete-lined transition section, and an unlined channel excavated in rock to join the existing Main Canal. The switchyard will be located adjacent to the powerhouse. Concrete foundations will be provided for the step-up transformer, takeoff towers and related equipment.

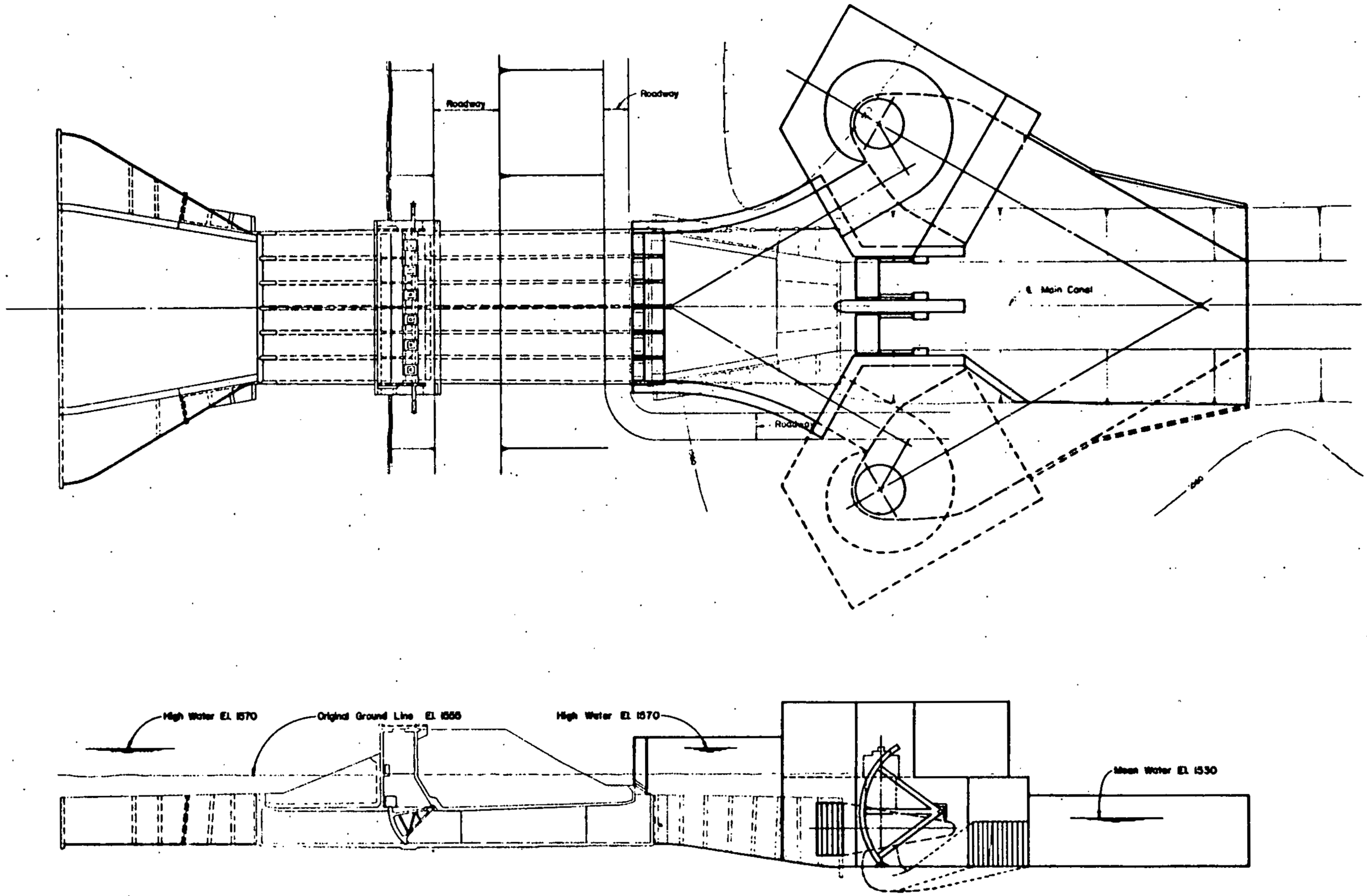

FIGURE IV-1

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DRY FALLS DAM POWER DEVELOPMENT

POWER PLANT LOCATION ALTERNATIVE 2A

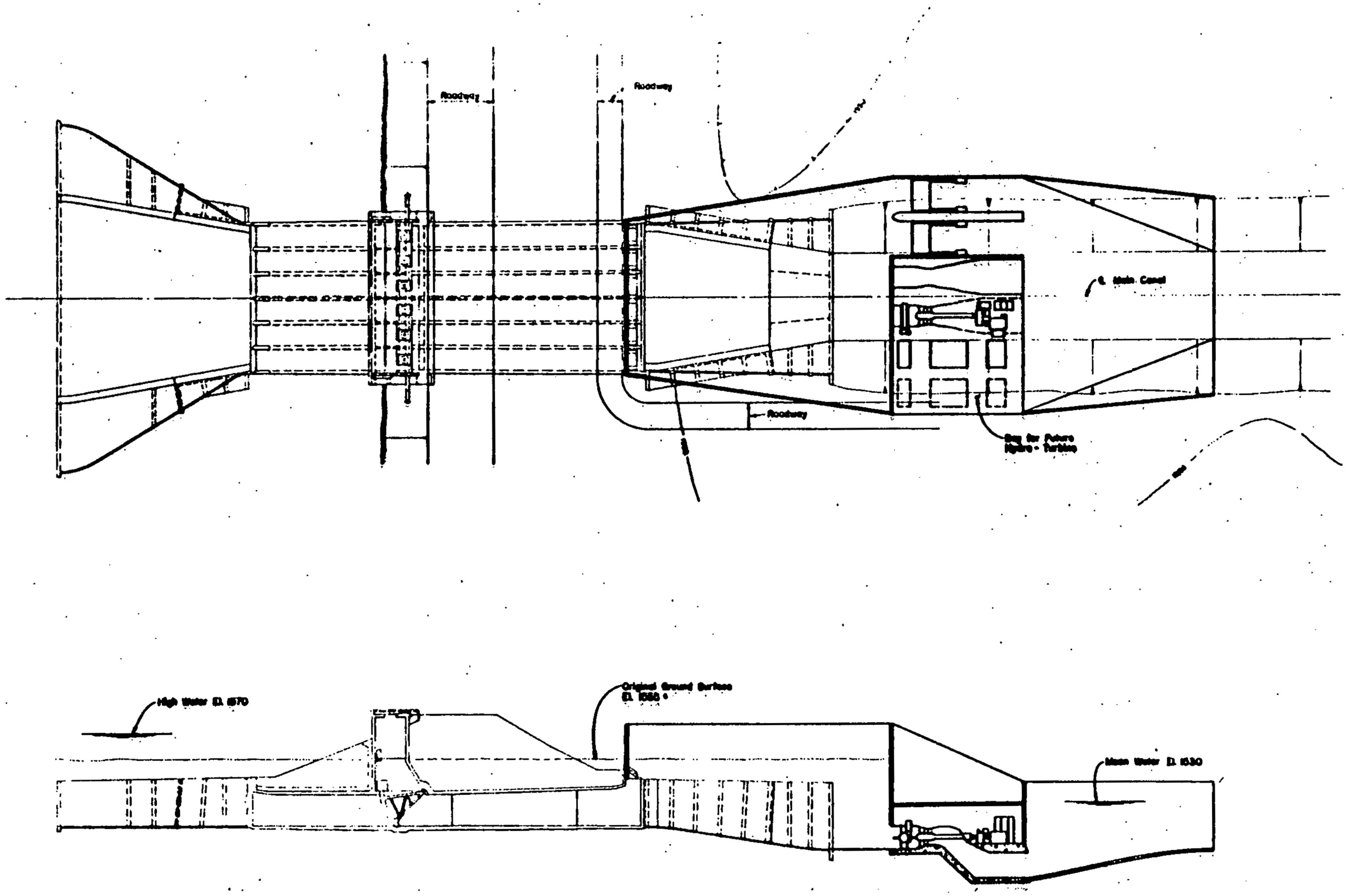

FIGURE IV-2

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DRY FALLS DAM POWER DEVELOPMENT

POWER PLANT LOCATION ALTERNATIVE 2B

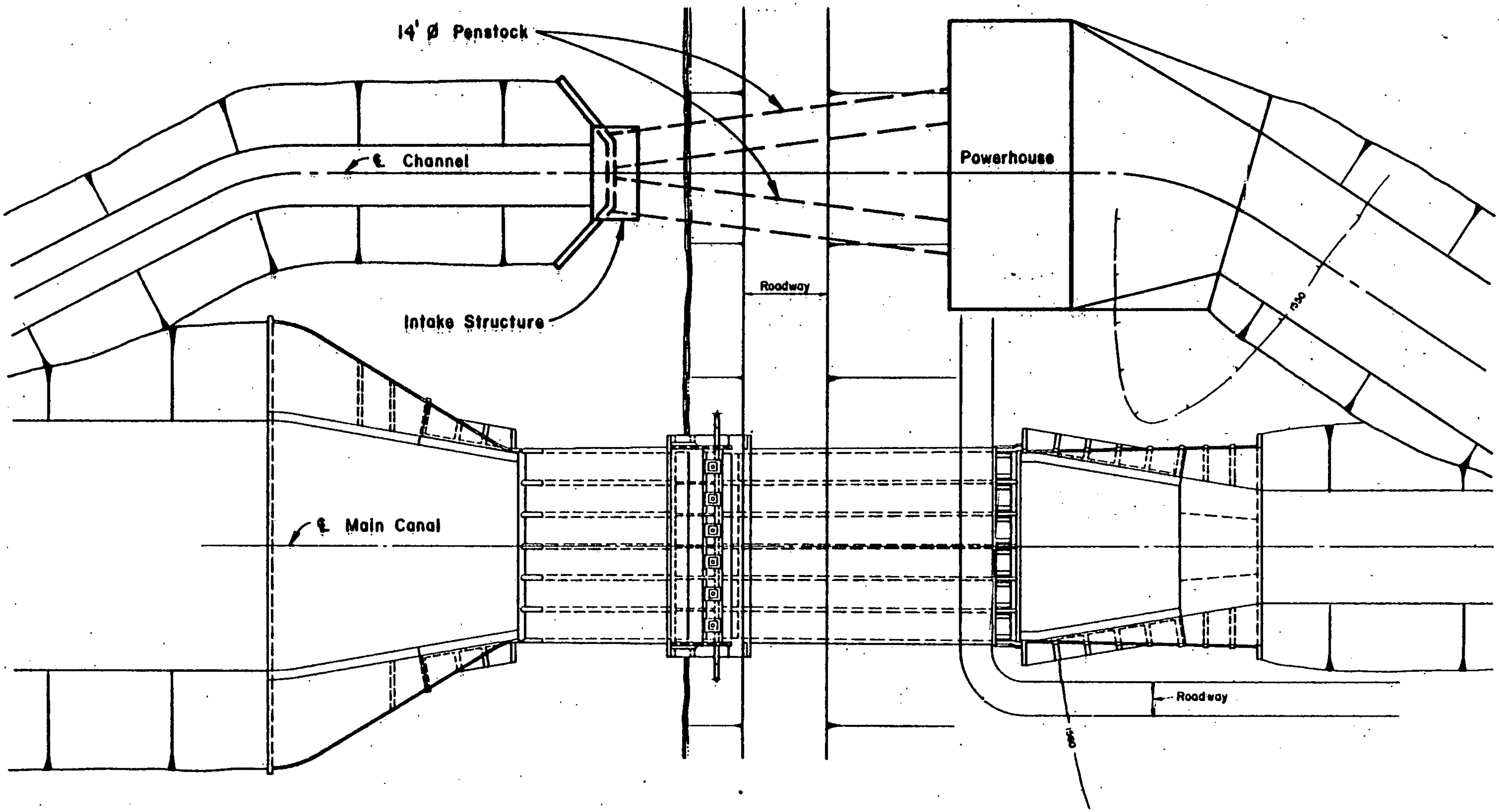

FIGURE IV-3

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DRY FALLS DAM POWER DEVELOPMENT

POWER PLANT LOCATION ALTERNATIVE 3A

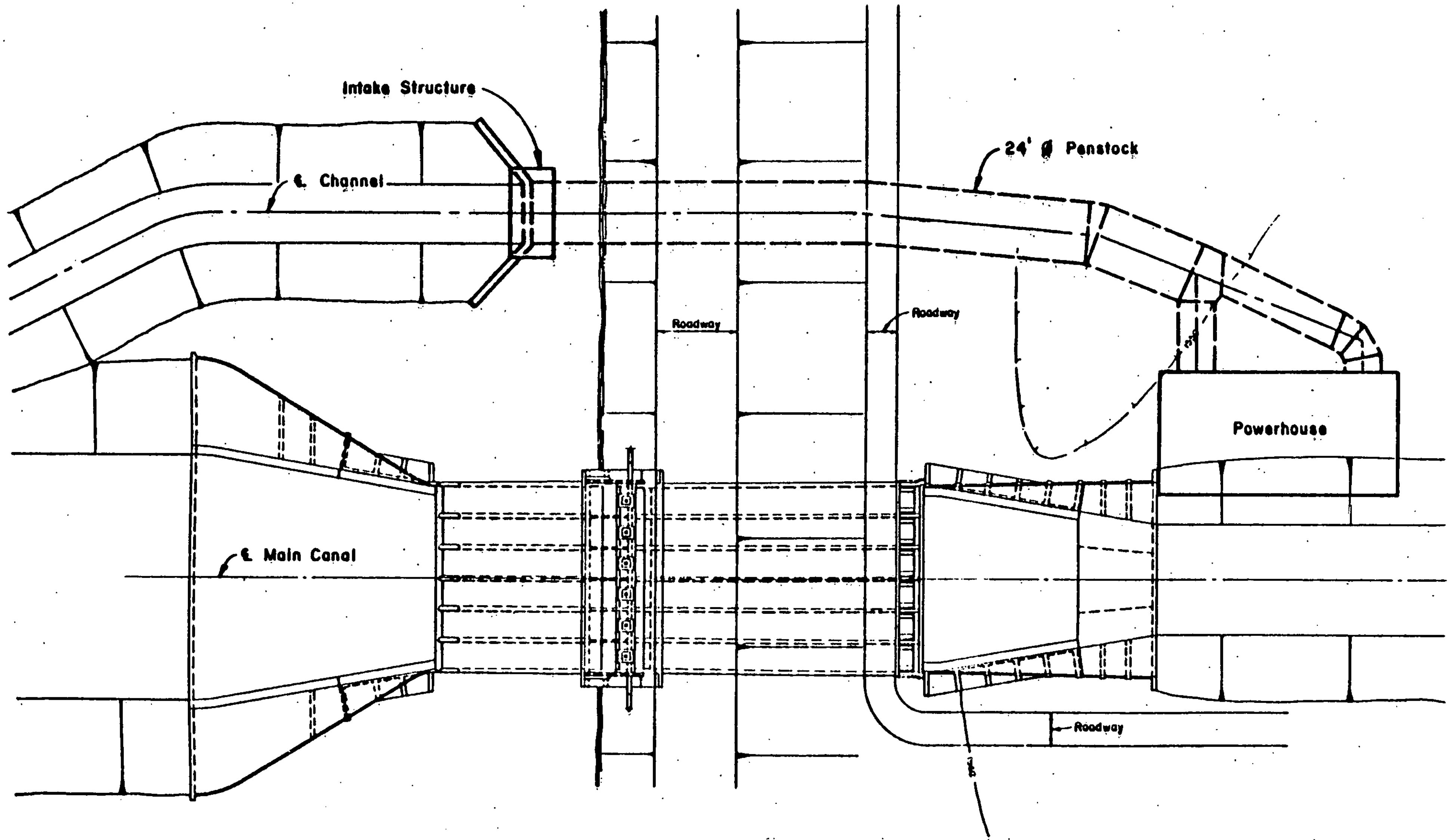

FIGURE IV-4

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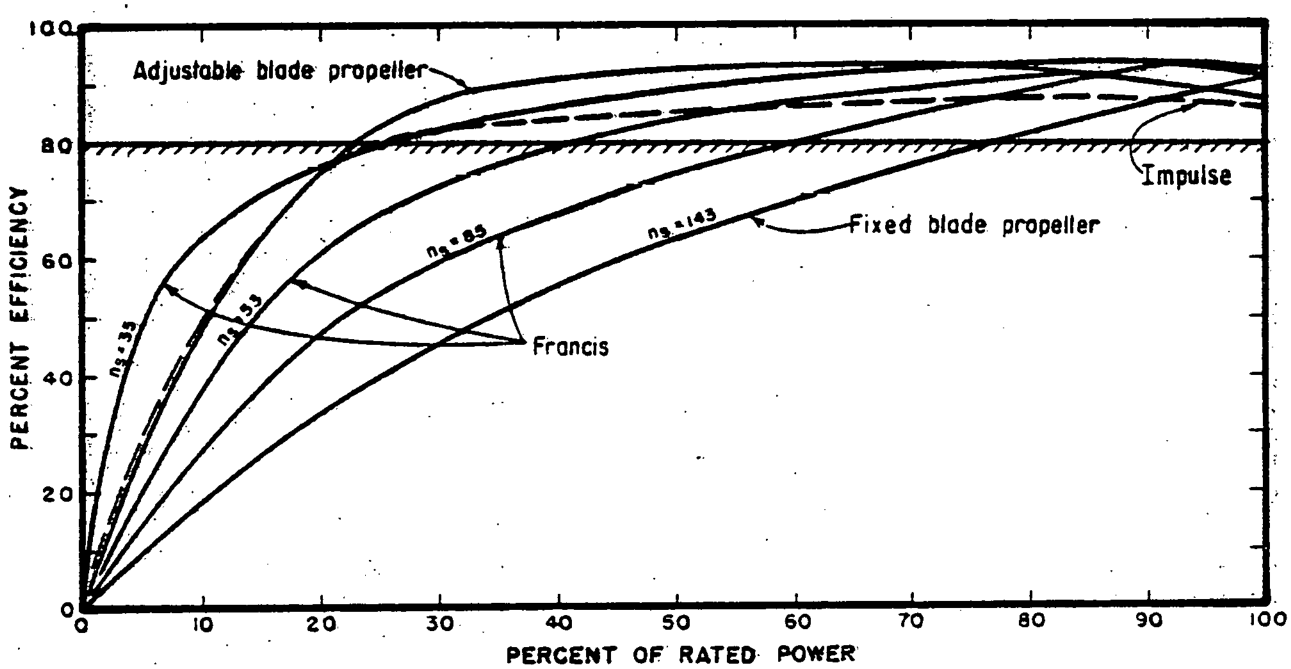
DRY FALLS DAM POWER DEVELOPMENT

POWER PLANT LOCATION ALTERNATIVE 3B



DRY FALLS DAM POWER DEVELOPMENT

HYDRAULIC TURBINE CHARACTERISTIC EFFICIENCY CURVES

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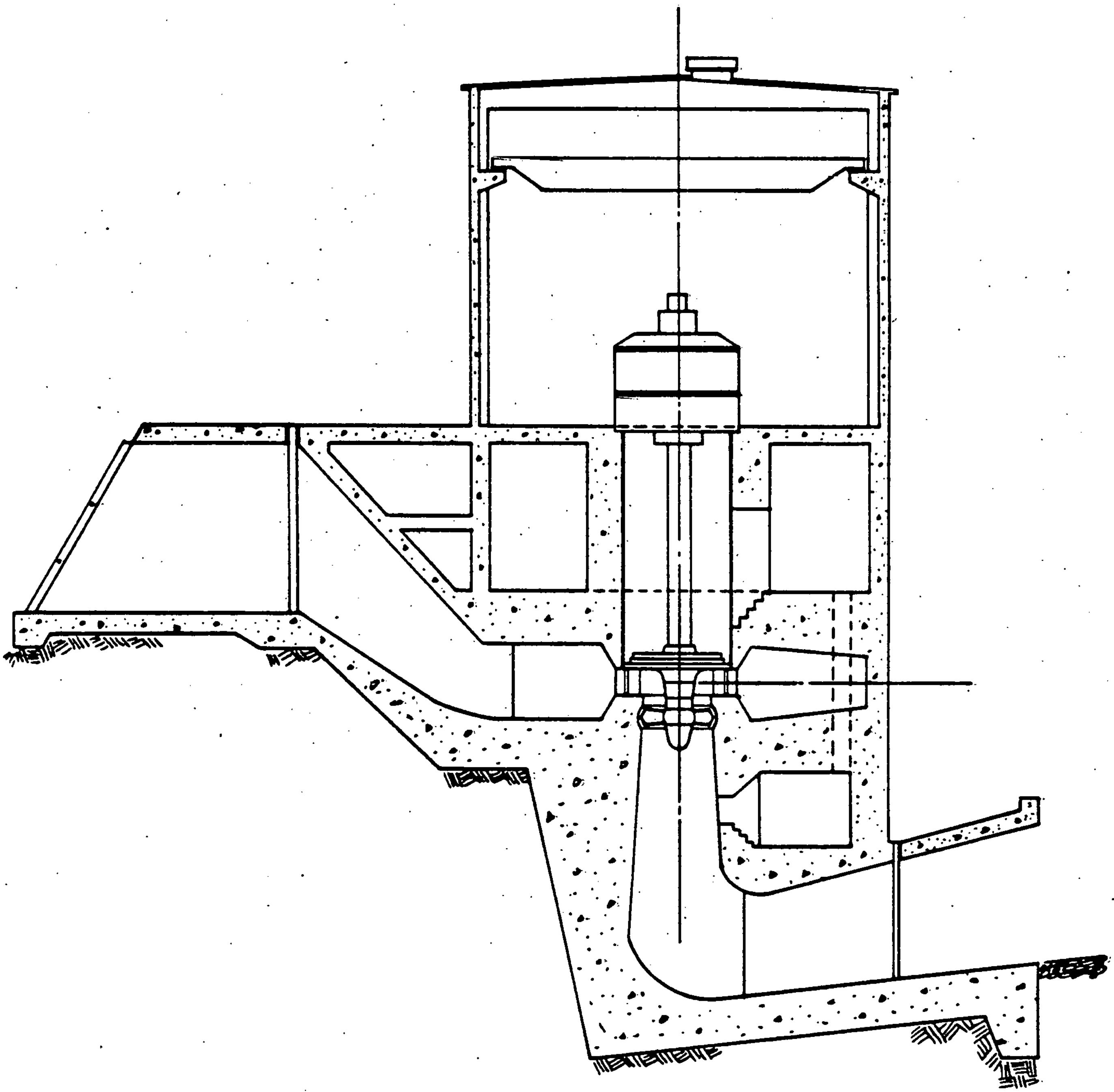
FIGURE IV-5



DRY FALLS DAM POWER DEVELOPMENT

TYPICAL PROPELLER TURBINE INSTALLATION

TUDOR ENGINEERING COMPANY
SEATTLE WASHINGTON

FIGURE IV-6

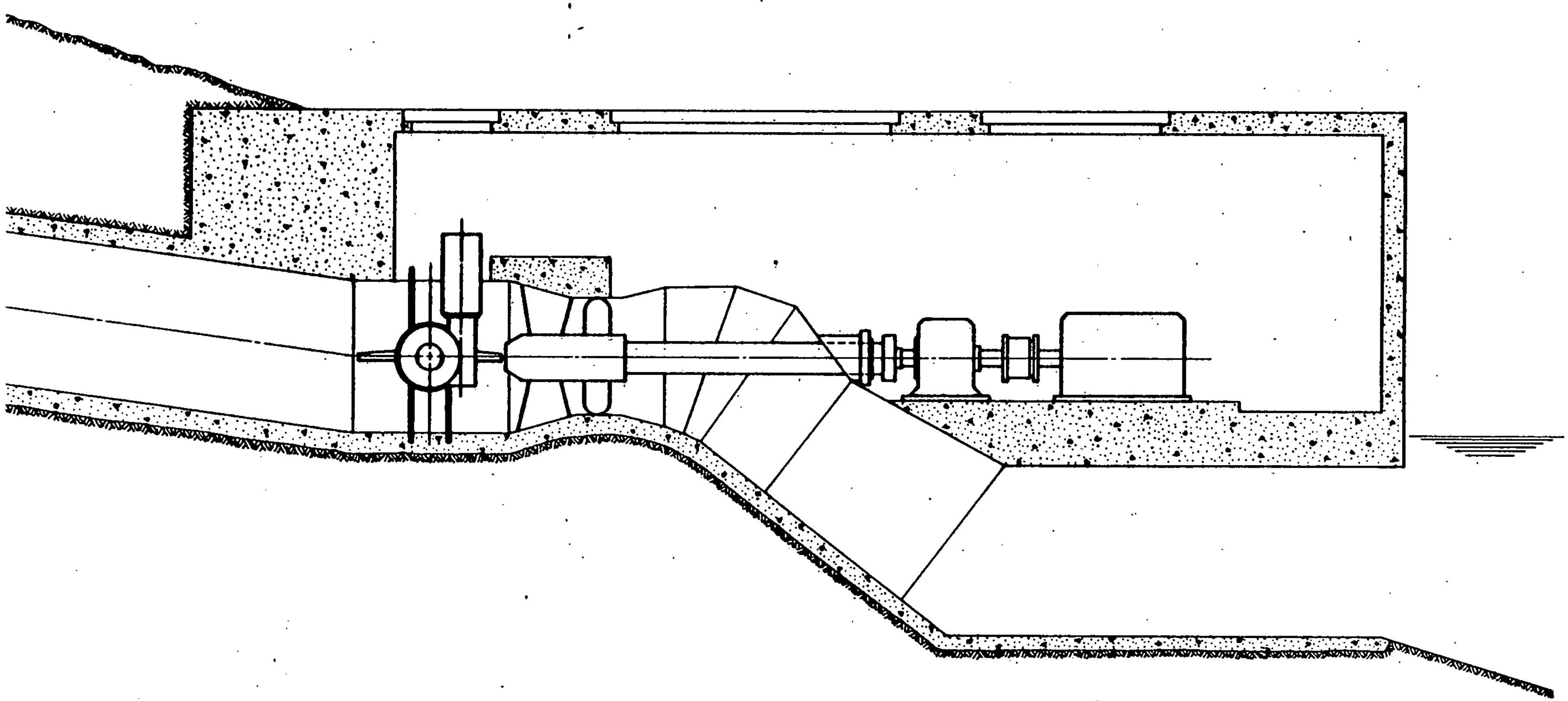


FIGURE IV-7

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DRY FALLS DAM POWER DEVELOPMENT

TYPICAL TUBE TURBINE INSTALLATION

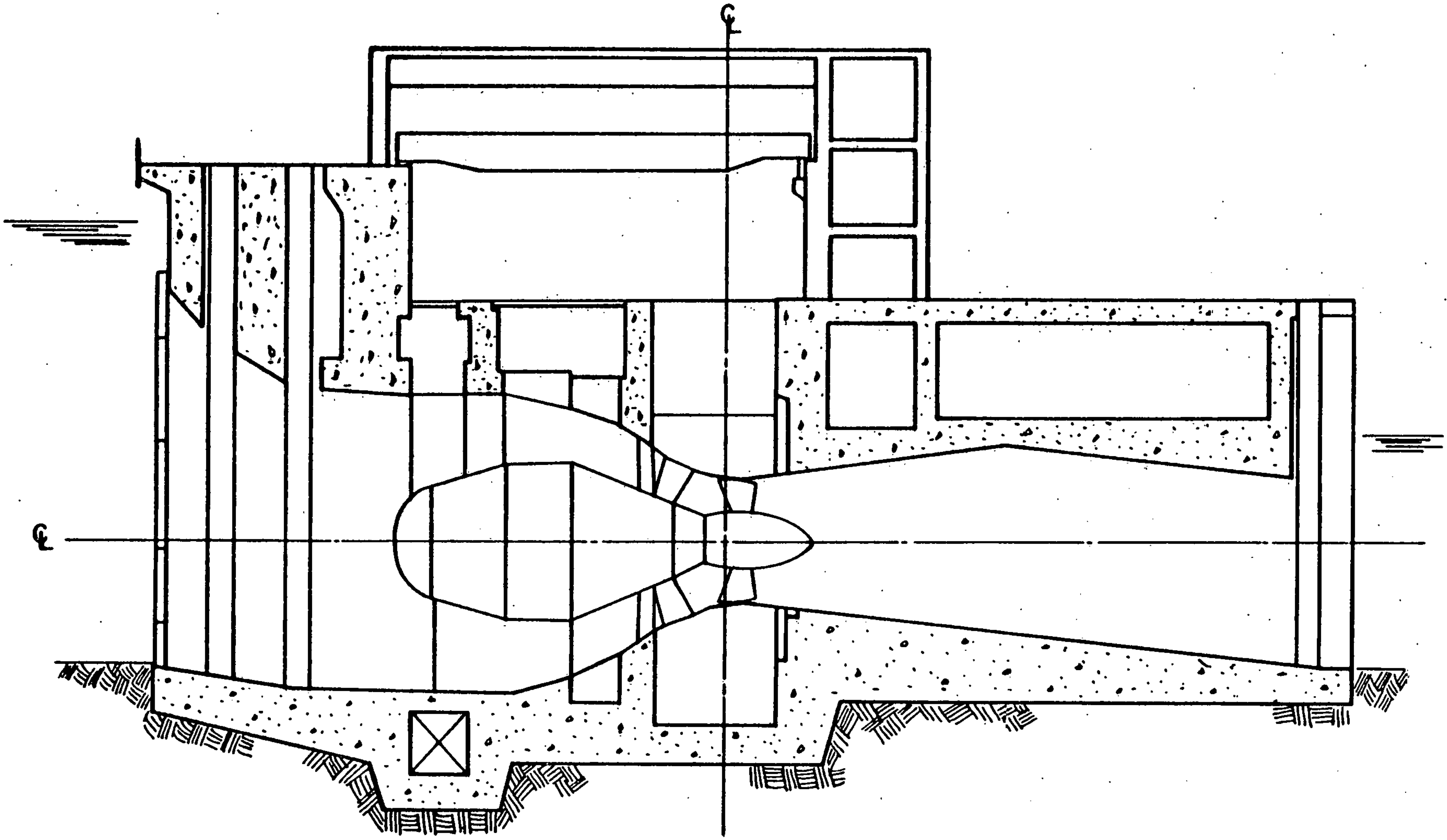

FIGURE IV-8

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DRY FALLS DAM POWER DEVELOPMENT

TYPICAL BULB TURBINE INSTALLATION

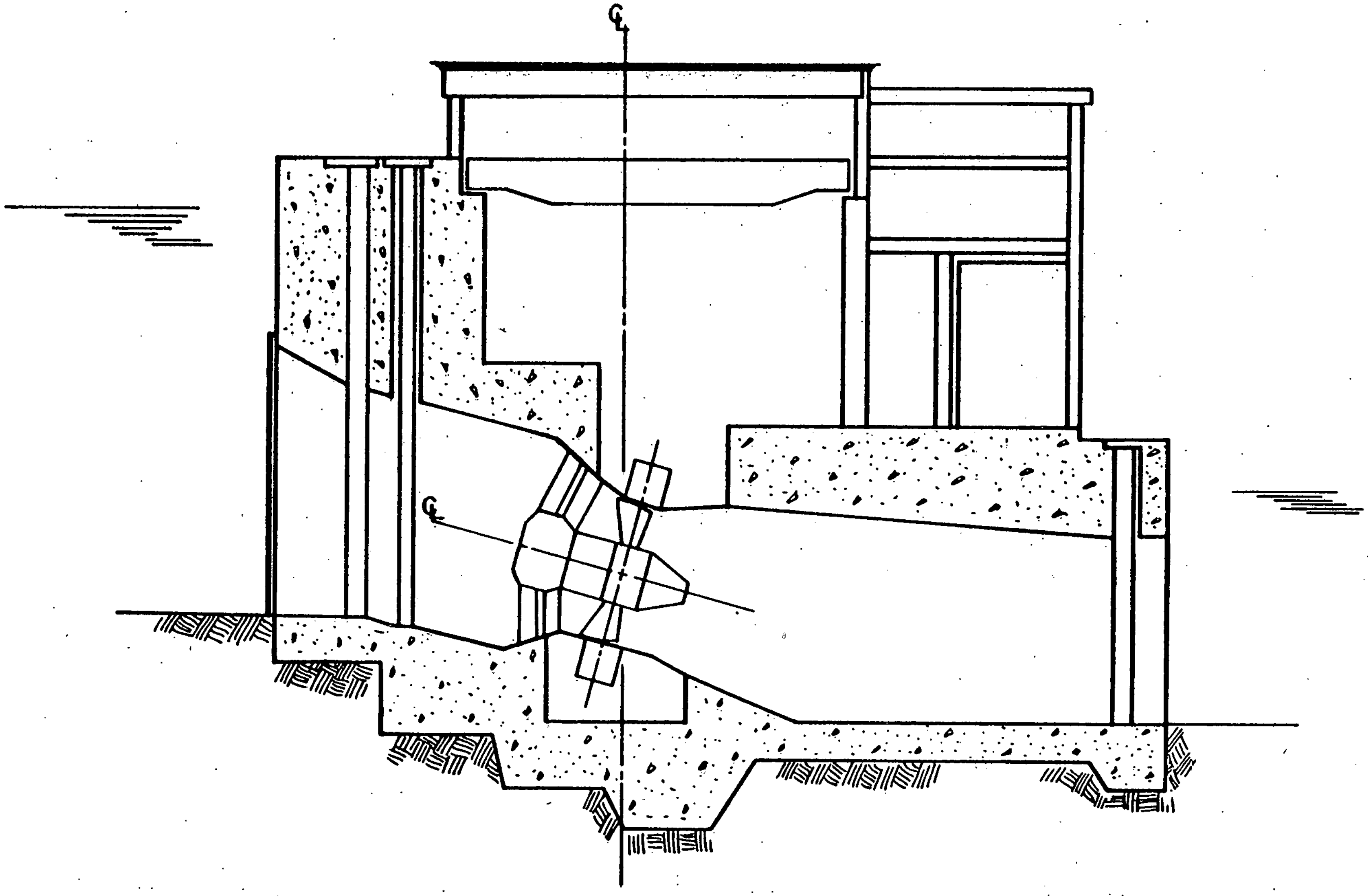

FIGURE IV-9

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DRY FALLS DAM POWER DEVELOPMENT

TYPICAL RIM-TYPE "STRAFLO" TURBINE INSTALLATION

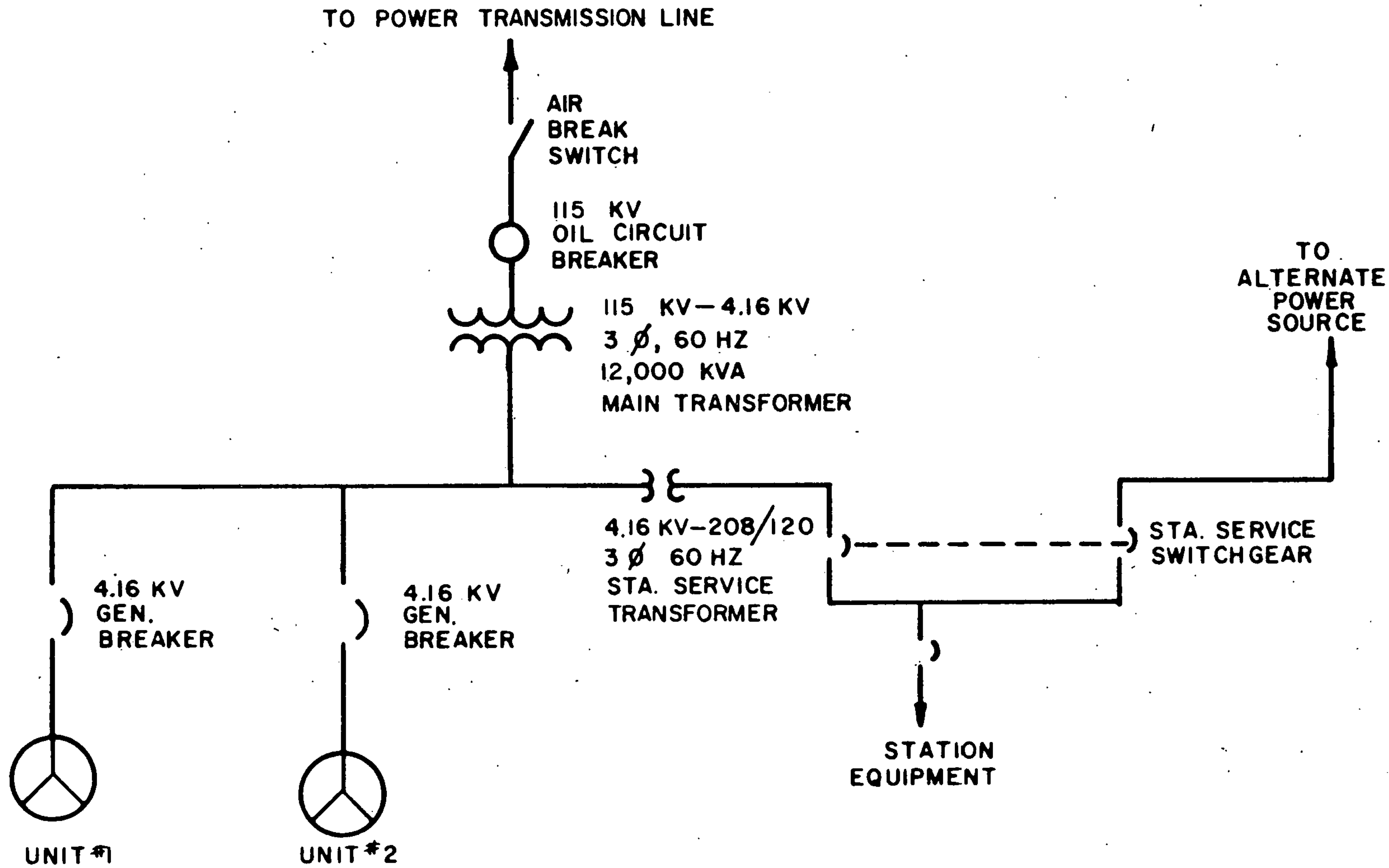

FIGURE IV-10

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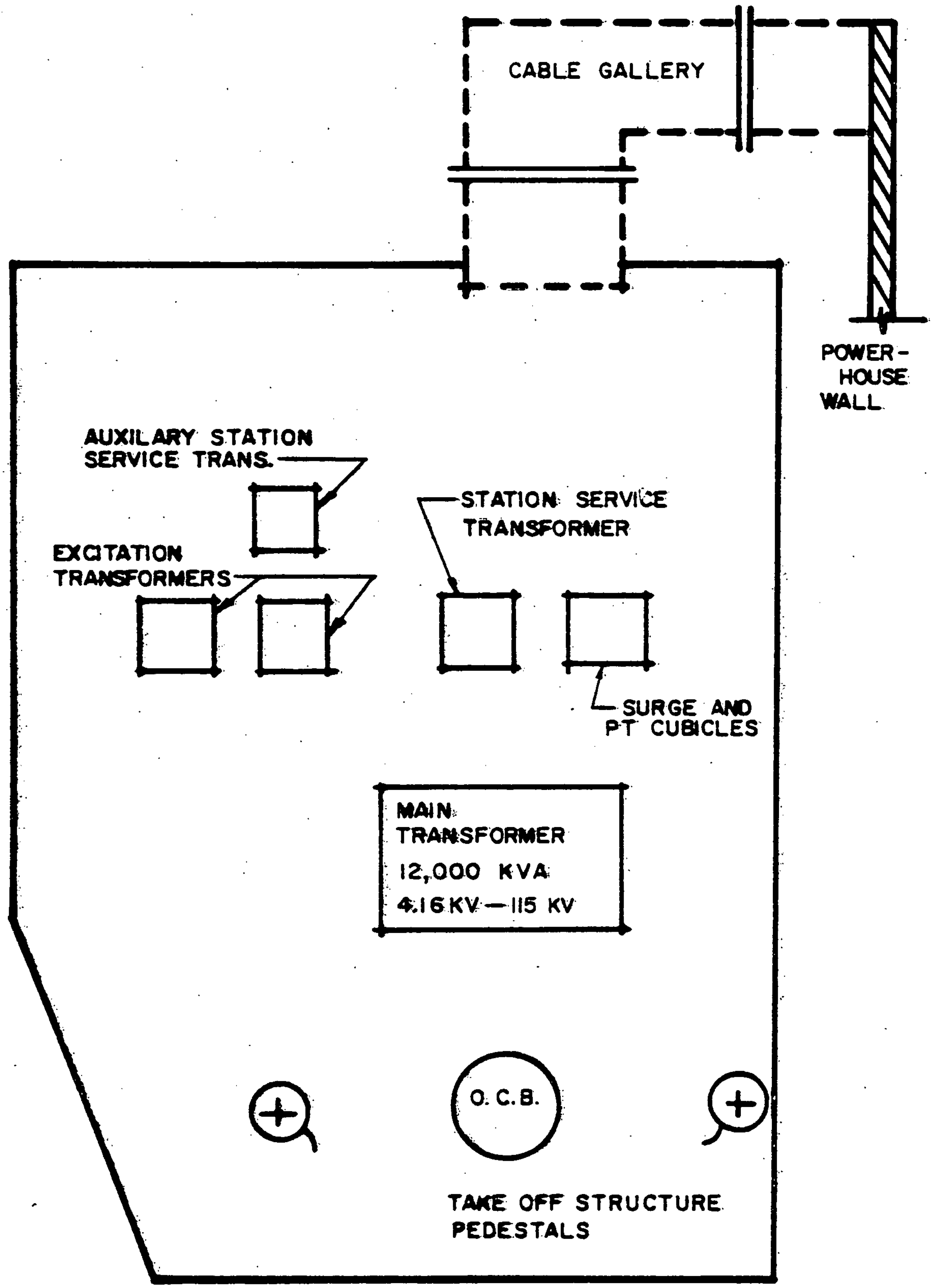
DRY FALLS DAM POWER DEVELOPMENT

PLANT ONE-LINE DIAGRAM



DRY FALLS DAM POWER DEVELOPMENT

TYPICAL SWITCHYARD ARRANGEMENT

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FIGURE IV-11

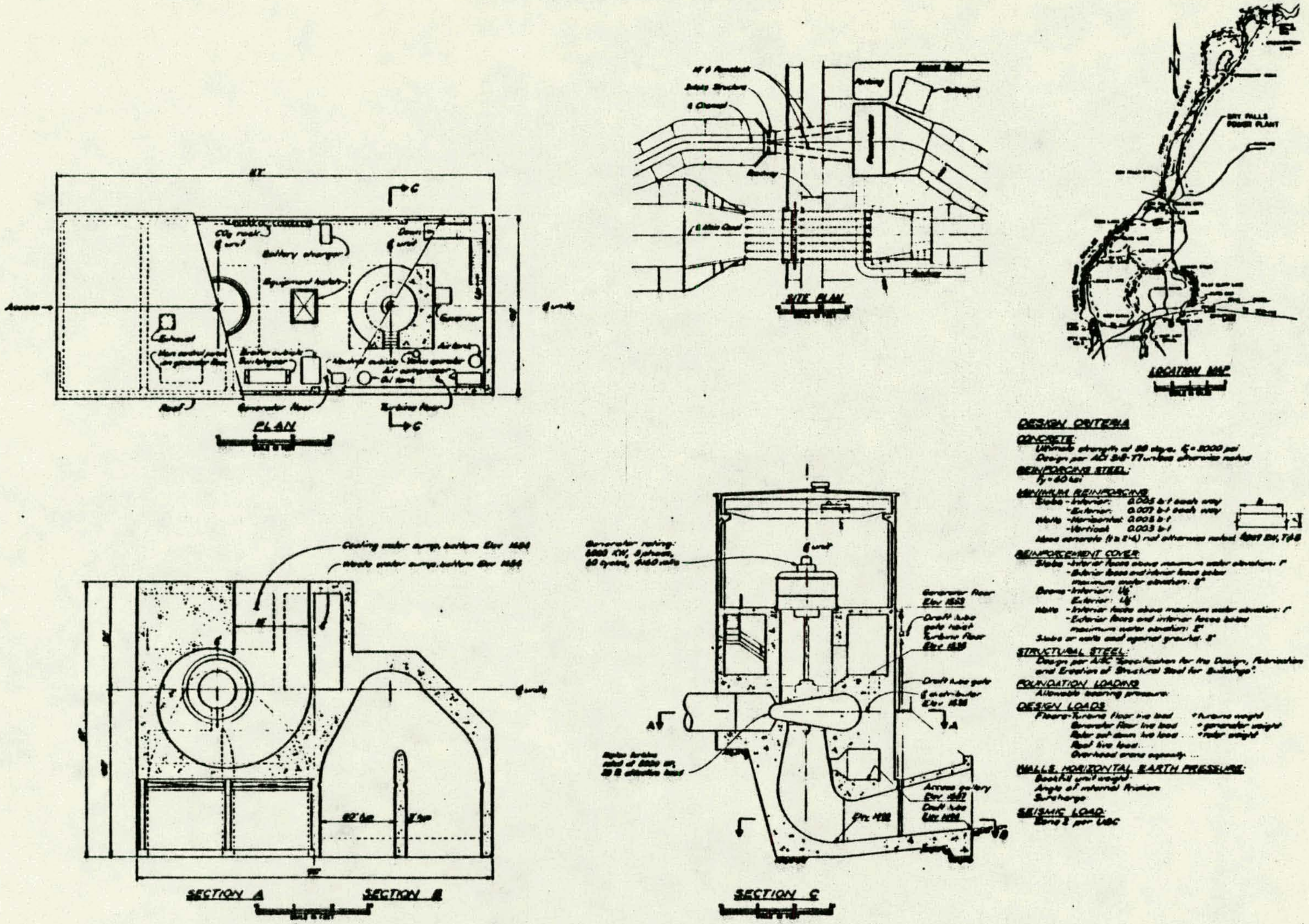

FIGURE IV-12

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DRY FALLS DAM POWER DEVELOPMENT

POWER PLANT - PLANS AND SECTIONS

V Financial

CHAPTER V

FINANCIAL ANALYSIS

A. ESTIMATED CONSTRUCTION COST

The estimated capital cost of the project is presented in Figure V-1. Cost estimates for the various project features were prepared on the basis of the layout and details described in the preceding chapter. Construction costs were estimated at September 1978 price levels, to a level of detail consistent with the preliminary nature of the project definition. Costs for equipment were based on quotations obtained from manufacturers, and recent quotations for comparable auxiliary equipment. To these cost elements, a contingency allowance of 15 percent was added. This allowance is considered appropriate in view of the relative consistency of equipment price quotations received, and the possibility of alternative plant arrangements with a lower initial cost. The estimated construction cost, representing a contractor's bid price in September 1978, is approximately $8.0 million, excluding state sales tax. Details are given in Appendix C. The total represents a cost per kilowatt of installed capacity of $664.

The total construction investment required was determined by adding the cost of engineering, design, supervision, and contract administration to the estimated construction cost, and allowing for sales tax and escalation to the date of construction. The cost of engineering and design was assumed to be 8 percent of the construction cost. The cost of construction supervision and contract administration was assumed to be 5 percent of the construction cost. Escalation was calculated at 8 percent annually, for a 31-month period, on the assumption that bids would be submitted in the spring of 1981. As shown on Figure V-1, the total construction investment, reflecting these allowances, is estimated as $11.54 million.

B. PROJECT FINANCING

To obtain the total capital cost of the project, such costs as establishing bond reserve funds, fees for legal services and bond counsel, and various miscellaneous costs related to project implementation should be added to the investment cost. In addition, the financing of the development must provide for the payment of interest on borrowed funds during construction. The actual requirements will be dependent upon the selection of a power purchaser, and advice by the District's financial consultant and bond counsel concerning the method of financing. At this state of study, the following assumptions were made concerning these factors.

1. Revenue bonds repayable over a 40-year period will provide funds for the capital cost of the project. Debt service will be paid from guaranteed annual revenues from a single bulk purchaser of project power.

2. Power would be purchased by a publicly-owned electrical utility, in which case revenue bond interest would be exempt from Federal income tax.

3. Tax-exempt bonds would bear a 7 percent interest rate.

4. Construction funds would earn interest at a 6 percent rate until required for disbursement.

5. A period of 17 months would elapse between bond sale and final payment of construction expenditures.

6. Legal and miscellaneous costs will amount to approximately 2 percent of the capital cost of the project.

7. A bond reserve fund, equal to the maximum annual debt service on the bonds, would be established from the bond proceeds.

Given the above assumptions, the project could be financed by means of a $13,730,000 bond issue. The amount of the bond issue would be slightly different if a longer or shorter repayment period were adopted, since the annual payment required as debt service on the bonds would be affected, with a consequent effect on the reserve requirement.

For a $13,730,000, 7 percent bond issue with a 40-year maturity, annual debt service will be approximately:

$13,730,000 x	0.07501	=	$1,030,000
(principal)	(capital recovery factor)		

In the event that 30-year financing were contemplated, the bond issue would be in the amount of $13,815,000 and the annual debt service $1,113,000.

C. COST OF ENERGY

The unit cost of energy produced by the project can be obtained by dividing the annual project cost by the amount of energy produced annually. An estimate for the latter was derived in Chapter III, amounting to 55.71 million kilowatt-hours in the first year of project operation.

The total annual cost is the sum of the fixed annual charges for capital recovery or amortization and the annual operating expenditures, covering administration, insurance, operations and maintenance personnel, allowance for equipment replacement, license costs, fees and other miscellaneous expenses. The following criteria were used as a guide to determining estimated operating expenditures:

Insurance: Coverage will be required for fire and storm damage, vandalism, property damage and public liability. In the present analysis, an average rate of 0.2 percent of construction cost, which is representative of current practice, was used to determine insurance costs, amounting to an estimated $20,000 annually.

Operation and maintenance costs: Allowance is made to cover the costs for manpower, wages, services, offices, repair shops, equipment and parts incurred in project operation and maintenance, including periodical replacement of components and facilities that have an estimated useful life significantly shorter than the 40-year amortization period for the project capital costs. These facilities include hydraulic turbines, generators, governors and valves, switching facilities, transformers, substations and other auxiliary mechanical and electrical equipment. For the power facilities, interim replacements were assumed to amount to 0.8 percent of the investment annually. Operation and maintenance of the unattended plant is estimated to require 12 man-months of labor annually which, with an allowance for transportation and miscellaneous expenses, is forecast at $35,000 annually, in 1982.

General expenses: Administrative and other miscellaneous general costs required during the project operation for supervision and administration, in connection with power production, transmission and distribution, and other overhead costs are estimated at 0.3 percent of the cost of the power facilities.

Estimated annual operating expenditures in the first year of project operation (1982) are $150,000. On this basis, total annual costs are estimated as $1,180,000 ($1,030,000 plus $150,000). The unit cost of energy, at the line-side terminals of the power transformer in the switchyard, is given by:

$$\frac{\$1,180,000 \text{ annual cost}}{55,710,000 \text{ kWh}} = 21.2 \text{ mills/kWh}$$

In the case that 30-year financing is considered, annual costs would amount to $1,263,000, resulting in a power cost in the first year of operation of 22.7 mills/kWh.

In subsequent years of operation, the cost of operation and maintenance will escalate at an average rate estimated at

5 percent annually. The unit cost of energy will also be influenced by the effect of backwater conditions in the Main Canal upon annual energy output. By the year 2000, the cost of energy from the Dry Falls development is estimated to be 25.2 mills/kWh. The variation is illustrated graphically in Figure V-2.

D. MARKETABILITY OF POWER

The value of electrical energy in the Pacific Northwest is heavily influenced by the availability of resources, and the role of the Federal government as a major marketing agent for power in the region. Hydroelectric developments have provided a major share of the region's energy needs to date. These resources have been developed by privately- and publicly-owned utilities, as well as the Federal government. Development of the region's major resources of low-cost hydropower is approaching saturation, and it follows that future expansion of generating capacity will involve higher-cost thermal, small hydro, and nuclear plants.

The Bonneville Power Administration (BPA) markets power as marketing agent for all Federal production of power in the Northwestern United States. In 1977, the energy generated for BPA at plants operated by the Bureau of Reclamation, Corps of Engineers, Washington Public Power Supply System (Hanford), Centralia thermal plant, Trojan nuclear plant and public shares of Priest Rapids, Wanapum and Wells projects was 69,072,218 million KWH. Through BPA transmission line network and wheeling arrangements under the Pacific Northwest Coordination Agreements, BPA received an additional 55,539,916 million KWH.

Until recently, BPA has been meeting the full requirements of all the public utilities. For the first time in history, BPA has informed such utilities that its resources will not be sufficient to meet their growth needs after 1983. BPA, by statute, cannot purchase or create more power generation; it can only reallocate the resources it has been authorized to market from Federal projects. BPA has notified the aluminum, chemical, nickel and other basic industries which it serves directly that it cannot renew their power contracts when they expire in the mid-1980's.

Against this background of demand outstripping supply, forecasts have been made of the possible trend of future power costs. Figure V-2 shows the projected values for the "BPA Preference Customer Rate" through the year 2000. The "Preference Customer Rate" is the rate at which public utilities may purchase power from BPA, and is based upon BPA's costs incurred in acquiring power. The projections through 1995 were prepared by BPA, assuming that regional load growth would follow the forecasts developed by the Pacific Northwest Utilities Conference Committee (PNUCC). It may be seen from Figure V-2 that, as growth in demand requires BPA to call upon higher-cost energy sources from 1985, the preference customer rate will rise rapidly. The rate is arrived at by "melding" the cost of energy from new resources, shown on Figure V-2, with that from the Federal base system, whose costs will remain relatively stable.

From a regionwide standpoint, energy produced by new resources at a cost equal to or below the BPA new resources cost index is potentially marketable. From the standpoint of a utility able to purchase unlimited power at the BPA preference customer rate, financial benefits will begin to be realized from the purchase of energy from a new source such as Dry Falls Dam when the BPA rate exceeds the cost of the energy. The existence of many uncertainties regarding the availability and ultimate price level of BPA power in the region adds to the economic attractiveness of new hydropower resources, even at a present day cost exceeding current market values.

As of January 1979, the South Columbia Basin Irrigation District is in the process of negotiating a Memorandum of Understanding with the cities of Seattle and Tacoma for the purchase of power from a 5 MW installation known as P.E.C. 22.7, near Othello, Washington. The Memorandum records the intent of the three Irrigation Districts and the cities to enter into purchase agreements covering power from subsequent developments within the Columbia Basin Project. Such purchase would be contingent upon the developments conforming with agreed cost criteria.

E. PROJECT BENEFITS

The project will yield financial benefits to the power purchasers and to the Districts, in addition to intangible benefits. The intangible benefits include:

- Provision of a power resource without the environmental pollution and fuel depletion attendant upon operation of fossil-fuel or nuclear plants

- Reduction of the economic impact upon consumers throughout the region of the cost of developing new power resources.

Benefits to the Districts and to the power purchaser are affected by the terms of the purchase agreement, and the rate at which the market value of power escalates in future years. The proposed terms of the agreement provide for a minimum payment of 1.65 mills per kWh above cost for energy made available from the project. At such time in the future that the average cost of energy from Seattle's and Tacoma's total power resources exceeds that from the project, the purchase price will be set so as to divide the difference equally between purchaser and seller.

Annual project generation over a 40-year period is estimated to vary between 55 and 56.9 million kWh. Under the proposed terms of the purchase agreement, this would produce a minimum net return to the Districts of approximately $92,000 annually. This amount, representing only the Districts' share of project benefits, is equivalent to a return of 0.67 percent of the total capital investment of $13,730,000. The rate of return to the Districts is expected to increase in later years, as escalation in the cost of power from other sources leads to increased payments under the power purchase agreement.

For the irrigation districts, which are non-profit organizations, the estimated rate of return is satisfactory as indicating that power development is economically feasible.

Present planning provides for financing the development with the proceeds from a revenue bond issue to be amortized over a 40-year period. At the end of the 40 years, the power purchase agreement would expire, and the development would be free from fixed annual capital charges.

However, the plant would not have reached the end of its economic life by that date. Hydroelectric generating equipment often has a service life well beyond 50 years when the equipment is properly maintained. Typical maintenance procedures consist of yearly repair of the runner, shaft seal and inspection of moving parts, refurbishing of bearings every 5 to 10 years and stator rewinding every 15 to 20 years. It can be assumed that an effective O&M program will be adopted that will incorporate periodic inspection and preventive maintenance procedures. Accordingly, the economic life can be taken as 50 years. This is the estimated length of time the project will be in service producing power and accruing benefits, and coincides with the period for which the initial FERC license will remain in effect.

Substantial benefits to the Districts can be expected to accrue after the 40th year of project life. Since these will be entirely dependent upon the price at which project generation can be sold at that time, no estimate of their extent can be made at present.

PROJECT CAPITAL COSTS

Dry Falls Dam Power Development

Estimated construction costs (September 1978)	
Civil and structural	1804000
Turbine and generator	4451000
Electrical and mechanical equipment	673000
	6928000
Contingencies(15%)	1039000
	7967000
Escalated 31 months @ 8 % p.a.	9720000
State sales tax (5.1%)	496000
ESTIMATED CONSTRUCTION COST	10216000
Design, construction management and construction administration	1328000
TOTAL CONSTRUCTION INVESTMENT	11544000
Interest during construction (net)	850000
Bond reserve fund	1030000
Legal and miscellaneous costs	306000
TOTAL CAPITAL COST (Amount of required revenue bond issue)	13730000
ANNUAL DEBT SERVICE (7 %, 40 yrs)	1030000

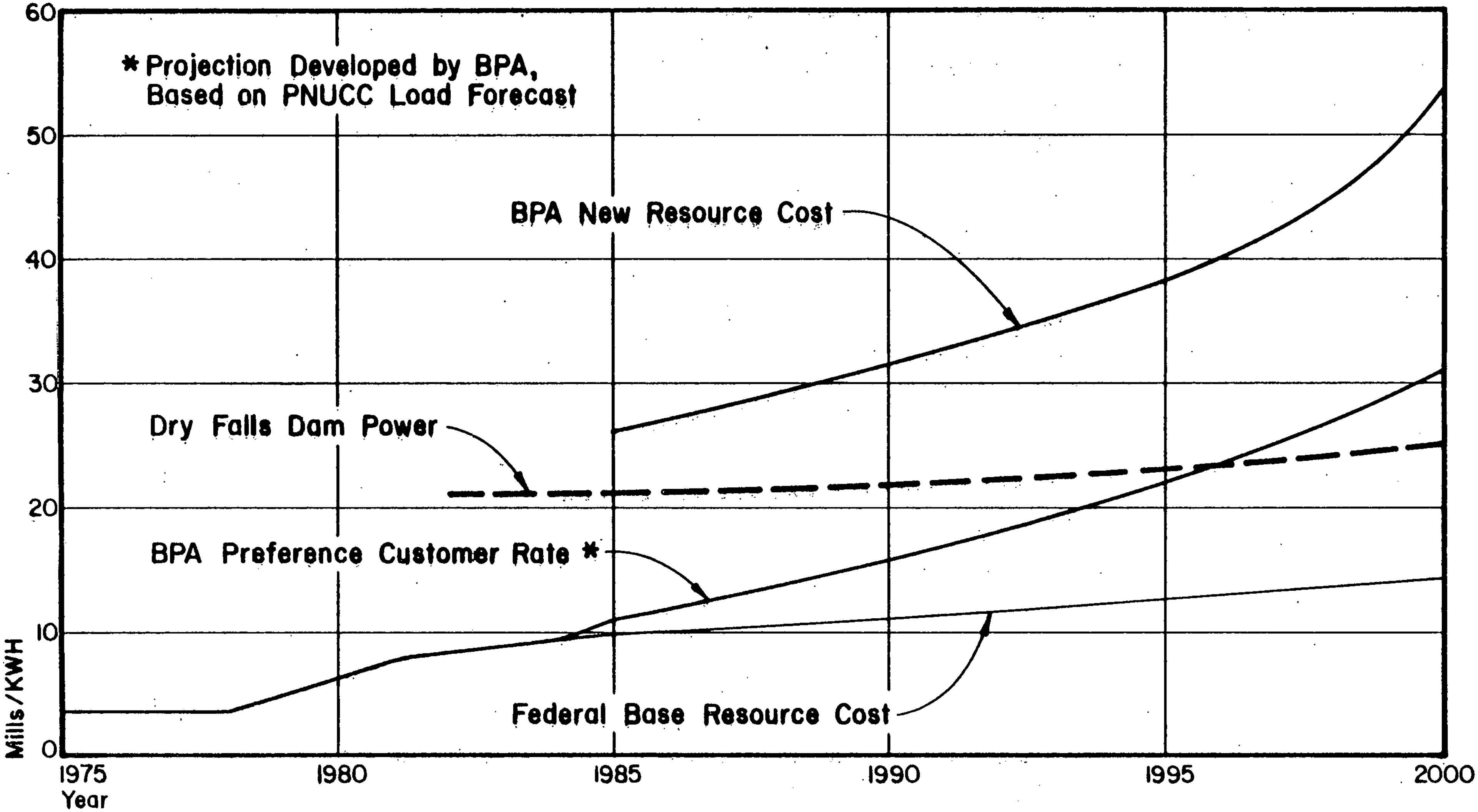


FIGURE V-2

TUDOR ENGINEERING COMPANY
SEATTLE WASHINGTON

DRY FALLS DAM POWER DEVELOPMENT

VALUE OF POWER

VI Implementation

CHAPTER VI

PROJECT IMPLEMENTATION

A. PROJECT ORGANIZATION

As related in the preceding Chapter, development of power facilities at Dry Falls Dam would involve an agreement with the cities of Seattle and Tacoma to purchase all of the energy generated by the project. Under this arrangement, the Districts would construct, own, and operate the facilities. Finance for the project would be provided by means of revenue bonds issued by the Districts. Repayment of principal and interest on the bonds would be made out of guaranteed annual revenues to be paid by the power purchaser. The bonds would be issued at the time major construction expenditures are committed, following execution of the power purchase agreement. The term of the agreement would extend at least for the full life of the bonds. Prior to the bond sale, the power purchaser would pay for development costs incurred for engineering, administrative, legal and other activities required to advance the project. Such costs would be refunded to the power purchaser from the bond proceeds.

Authority for the Districts to undertake development is subject to the terms of the repayment contracts with the U.S. Department of Interior, Bureau of Reclamation (USBR). Under these contracts, water rights within the Columbia Basin Project are vested in the United States, subject to the right of the Districts to the unimpaired use of the project water supply. The Contracts also provide that "with the prior approval of the Secretary, the District(s) ... may build plants for the production of power and energy ... and all such plants shall be and remain in the exclusive control ... of the District(s). All revenues from such powerplants ... shall be ... the property of the District(s)."

Construction of the power facilities on federally-controlled land, and use of the water supply for power generation purposes, is subject to the prior approval of the Secretary of the Interior.

Approval to proceed with development at Check 22.7 on the Potholes East Canal has been given to the South Columbia Basin Irrigation District. Development would be governed by an agreement with the USBR, containing provisions whereby the integrity of the irrigation system, the water rights of the United States, and its responsibilities for operation and maintenance of project reserved works are protected. In addition, the Bureau has requested that the financial returns from the proposed development be carefully evaluated to: (1) ensure that the District's contractual obligations are not impaired, and (2) establish water supply criteria to avoid any prejudice to the development of new project lands (water supply associated with the Second Bacon Siphon and Tunnel and disposition of net power revenues between the existing lands and the first phase continuation area). Similar provisions would apply at Dry Falls.

B. PROJECT SCHEDULE

The overall schedule of activities involved in implementing the Dry Falls Dam Power Development is shown graphically in Figure VI-1.

A preliminary activity involves negotiations with the power purchaser. The end result of the negotiations will be a "Memorandum of Understanding" in which the Districts will pledge to sell and the cities of Seattle and Tacoma will pledge to buy all power produced at the site. This document will stipulate all details, including a clause in which the selling price of the electric energy will be tied to a suitable escalation index. The power purchase agreement will be developed based on the Memorandum of Understanding, and will be finalized when design of the project is complete and all costs can be closely estimated.

The FERC application and design and construction activities will immediately start after the conclusion of the power negotiations. The recently passed energy bill directed the FERC to prepare some revised and simplified guidelines for small hydroelectric projects. However, no revised instructions concerning this matter are as yet available. On the schedule, one year has been allowed for the FERC license application approval process. However, this time may later be considerably shortened. Shown on the schedule but actually a part of the FERC application is the preparation of Exhibit W, an Environmental Impact Statement. It is shown separately since it is a major activity and is often also required by other agencies as well.

The process to obtain all other necessary permits and agreements will also be initiated following the completion of the power negotiations, as described below. Throughout the process of negotiating agreements, obtaining permits, and in connection with financing requirements, legal services and professional advice regarding financing would be obtained.

Major construction activity is scheduled for the period between irrigation seasons, to minimize the risk of interruption to irrigation system operations. Based upon contact with manufacturers of hydraulic and heavy electrical machinery, a period of 15 months has been allowed for delivery of the major equipment.

The schedule indicates that the development will produce power in mid-1982.

C. PERMITS, LICENSES AND AGREEMENTS

In order to proceed with the project a variety of agreements, licenses, permits, endorsements and approvals from various Federal, State and local agencies including various divisions of the several agencies are required. Agencies involved, types of permits, endorsements and approvals, and statutory or other authorities are listed on the following pages.

Agency	Permit/ Approval	Statute or Other Authority	Status
U.S. FEDERAL GOVERNMENT AGENCIES:			
Federal Energy Regulatory Commission	Power License	Federal Power Act of 1920 Section 4, 16 USCS797; NEPA (42 USC 4332) 18 CFR4 18 CFR 2.80, 2.81 (as amended)	To be filed
Federal Communications Commission	Approval of Communications Equipment	Section 301 of the Federal Communications Act of 1934 (47 USC S 301) 47 CFR 73-74	To be filed as required
Department of Interior	Prior authority to construct	Contract 14-06-100-6420 Section 55(b) Executed Dec. 18, 1968 Federal Reclamation Laws (32 STAT 388)(53 STAT 1187) (57 STAT 14)(76 STAT 677)	To be requested
Bureau of Reclamation	Geology and Survey Permit	Federal Reclamation Laws (32 STAT 388)(53 STAT 1187) (57 STAT 14)(76 STAT 677) (49 STAT 1028)(49 STAT 1039)	Letter permit requested
Bureau of Reclamation	Dam Safety Certification	Federal Reclamation Laws (32 STAT 388)(53 STAT 1187) (57 STAT 14)(76 STAT 677) (49 STAT 1028)(49 STAT 1039)	Statement obtained, State of Washington. See Appendix D.
Pacific Northwest Basins Commission	Project Recommendation	11 USC 200 (65 STAT 89-80)	Recommendation requested
U.S. Army, Corps of Engineers	Water Quality	Federal Water Pollution Control Act of 1972 PL 95-217 Sec. 401	Authority delegated to State
U.S. Army, Corps of Engineers	Dam Safety	Dam Inspection Act, PL92-367	Authority delegated to State
STATE OF WASHINGTON AGENCIES:			
Department of Ecology	Dam Safety	90.03.350 RCW	Letter of Suitability, see Appendix D
Department of Ecology	Power Production License	90.16.050 RCW	To be applied for as required
Department of Ecology	Reservoir Permit	43.21A RCW	Permit granted to U.S. Bureau of Reclamation, 1948
Department of Ecology	Flood Control Zone Permit	90.03.100 RCW	Exemption Granted
Department of Ecology	Water Rights	90.03.350 RCW	To be applied for as required for power generation.
Department of Ecology	Water Quality Certification	80.50 RCW	Certificate applied for
Department of Ecology	Environmental Policy Coordination (SEPA)	43.21C.100 RCW	Concurrence obtained, negative declaration, See Appendix E
Department of Fisheries	Hydraulics Project Approval	75.20.100 RCW	Application filed

Agency	Permit/ Approval	Statute or Other Authority	Status
STATE OF WASHINGTON AGENCIES (cont'd.)			
Department of Game	Hydraulics Project Approval	75.20.100 RCW	Application filed
Department of Ecology	Permit to Construct Power Facility	43.21A.050 RCW	Approval included in favorable review of environ. decl.
Energy Facilities Site Evaluation Council	Site Evaluation	80.50 RCW	Exemption granted See Appendix E
LOCAL AGENCIES: GRANT COUNTY:			
Grant County	Shoreline Permit	Ordinance 98.58 RCW	Exemption granted
Grant County	Building Permit	Ordinance	To be applied for as required
Grant County	Burning Permit	Ordinance	To be applied for as required
Grant County	Planning Permit Ecology	Ordinance 43.21C.100 RCW	To be applied for as required
Grant County	Conditional Use Permit	Ordinance	To be applied for as required

An application for preliminary permit for a power plant at Dry Falls Dam was filed with the Federal Energy Regulatory Commission in February 1978. The purpose of the filing is to secure and maintain priority for a license for the project under the Federal Power Commission Act while procuring data and securing the necessary agreements needed to perfect an Application for License.

D. PROJECT IMPACTS

1. Safety Aspects:

Construction of the power development will involve tunnelling beneath the existing dam, and excavation and construction in the immediate vicinity of the headworks structure. A preliminary assessment of the suitability of the existing dam as a site for a hydroelectric installation was made by the State of Washington Department of Ecology. The conclusions of that agency, indicating that no conditions were observed which would preclude installation, are contained in a letter of December 28, 1978 signed by Mr. Edward Garling, forming Appendix D.

All applicable and appropriate requirements of the Occupational Safety and Hazards Act (OSHA) and the Washington Industrial Safety and Hazards Act (WISHA) will be complied with in the design and construction of project facilities.

No major safety hazards are expected as a result of power plant operations. The plant will be fully enclosed, so there will be no electric shock hazard to casual site visitors. No moving parts of the plant will be exposed. Flows in the Main Canal will be unchanged by the operation of power facilities, although automatic control may be used to vary the proportion of flow passing through the power plant.

2. Environmental Considerations:

Based upon a preliminary environmental assessment of the project, the South Columbia Basin Irrigation District has filed a declaration of non-significant environmental impact, under the provisions of Chapter 197-10-300, Washington Administration Code. A copy of the filing, and of the responses received from various agencies, is contained in Appendix E. Since no negative responses were received from the agencies notified and no opposition or objections to the published and advertised declarations were entered within the period of time allowed by law, the declaration of non-significant environmental impact became final.

Based upon preliminary surveys, particularly with reference to the USBR's Draft Environmental Statement, Columbia Basin Project, the environmental assessment concluded that there would be no significant impact on the environment from the project. Salient findings included:

Water Flows - There would be no interruptions in irrigation flows through the present works since construction affecting such flows would be conducted during periods when there are no flows through the headworks. Operation of the proposed plant is non-consumptive and is designed to return all flows into the Main Canal. The plant will not alter the discharge delivery schedule dictated by irrigation demands.

Water Quality - No change would be made to water quality during either construction or operation.

Air Quality and Noise - The site is in a remote semi-arid, agricultural non-irrigable location. Construction noises and minor construction dust would be temporary during construction. No noises or emissions into the atmosphere are created by operation.

Vegetation - Loss of vegetation consisting of desert grasses covering an area of approximately 1-1/2 acres would occur by reason of the construction of the power plant, appurtenant structures and parking lot.

Terrestrial Wildlife - The project would result in the loss of approximately 1-1/2 acres of habitat which would result in displacement or loss of reptiles and small mammals which inhabit the area.

Aquatic Wildlife and Habitat - No effects on aquatic wildlife.

Rare and Endangered Species - None known to exist or in immediate vicinity of project site.

Land Use - No effect on lands surrounding site.

Solid Waste Disposal - Spoil from excavations will be graded to construct parking lot.

Recreation - None.

Water Use - No effect.

Economics - The total estimated construction cost in 1978 dollars is approximately $8,000,000. Of this amount approximately $3,100,000 will be for labor and materials to be acquired locally. The construction will take about 17 months and will go through the winter season.

Employment - During 17 months of construction the maximum work force will reach 25 workers. It is anticipated that since much of the construction is in the off-season, most of these workers will come from the local labor market. Operation and maintenance will be performed by the District staff.

Growth Inducing Impact - Localized only during construction period.

Traffic - Some additional traffic generated during construction only.

Scenic Values - Project site is adjacent to State Highway 2. Structures above grade will be architecturally pleasing, particularly adapted to the surrounding terrain and being consistent with intended use. Most structures will be at or below grade.

Archeology and Historical Significance - There are no known archeological or historical sites of interest which will be affected by the project.

A more detailed environmental assessment will be conducted as part of the FERC license application procedure; however, it is our experience that negative environmental impacts would not result from construction of the proposed plant. On the other hand, several positive impacts can be expected. Since five nuclear power plants are in various stages of design and construction in Washington State, and since other coal-fired plants are being considered in the region, the construction of the Dry Falls Dam power plant would be a pollution-free source of energy which would help reduce the future use of these alternative polluting fuels.

3. Socio-Institutional Impacts:

Construction and operation of a power plant at Dry Falls Dam should have a slightly beneficial impact on the regional and national economy. The power cost will be cheaper than most other options for future power that regional electric utilities are considering. The Dry Falls power plant thus will help hold down the cost of power for all consumers. In the long run, construction and successful operation of a hydropower development at Dry Falls Dam is likely to spark greater interest in construction of hydroelectric plants at similar sites throughout the region. Future construction projects of this type will directly benefit the local construction economy, and indirectly benefit the regional economy by helping to hold down power rates.

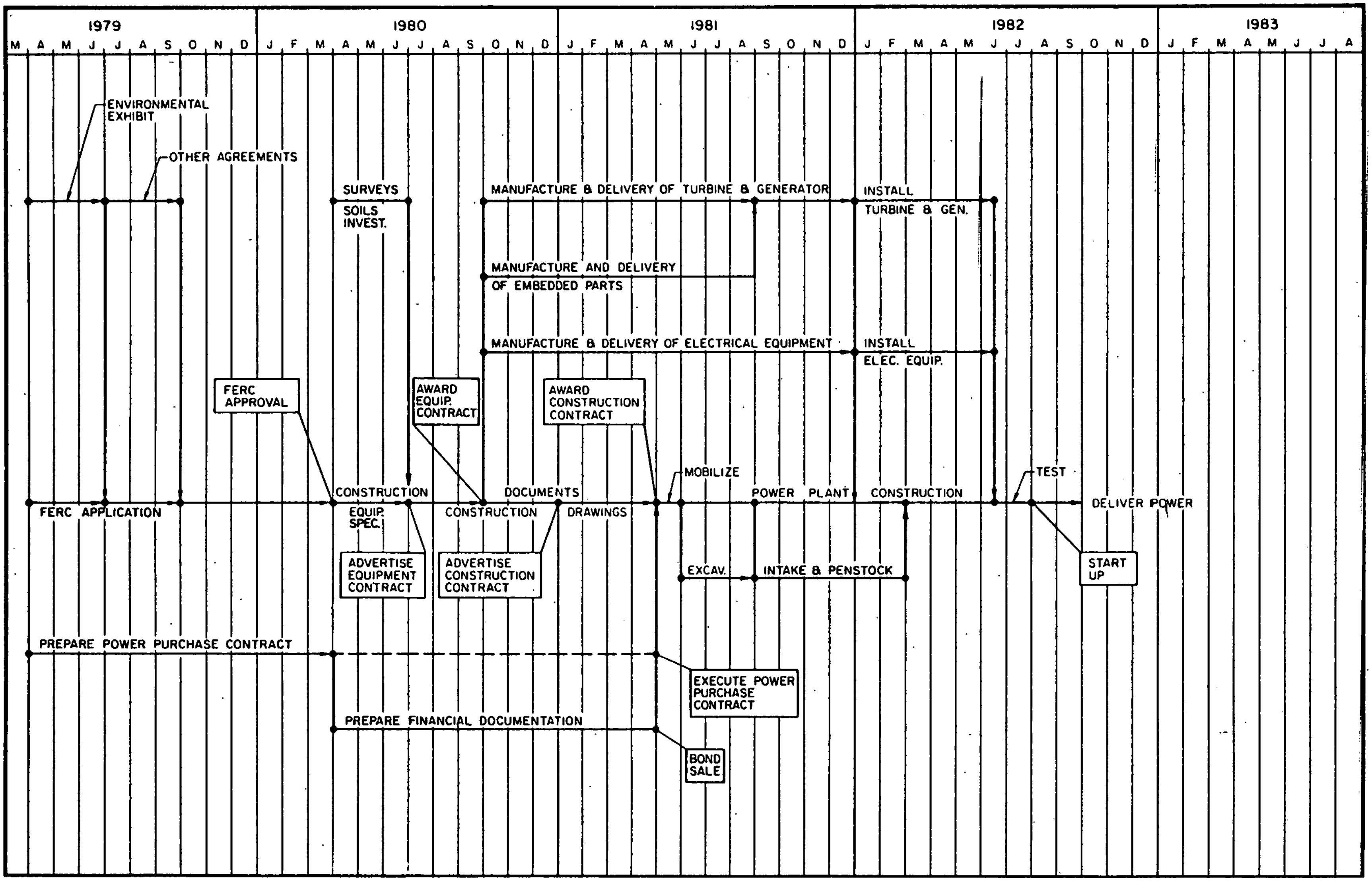


FIGURE VI-1

TUDOR ENGINEERING COMPANY
SEATTLE WASHINGTON

DRY FALLS DAM POWER DEVELOPMENT

PROJECT IMPLEMENTATION SCHEDULE

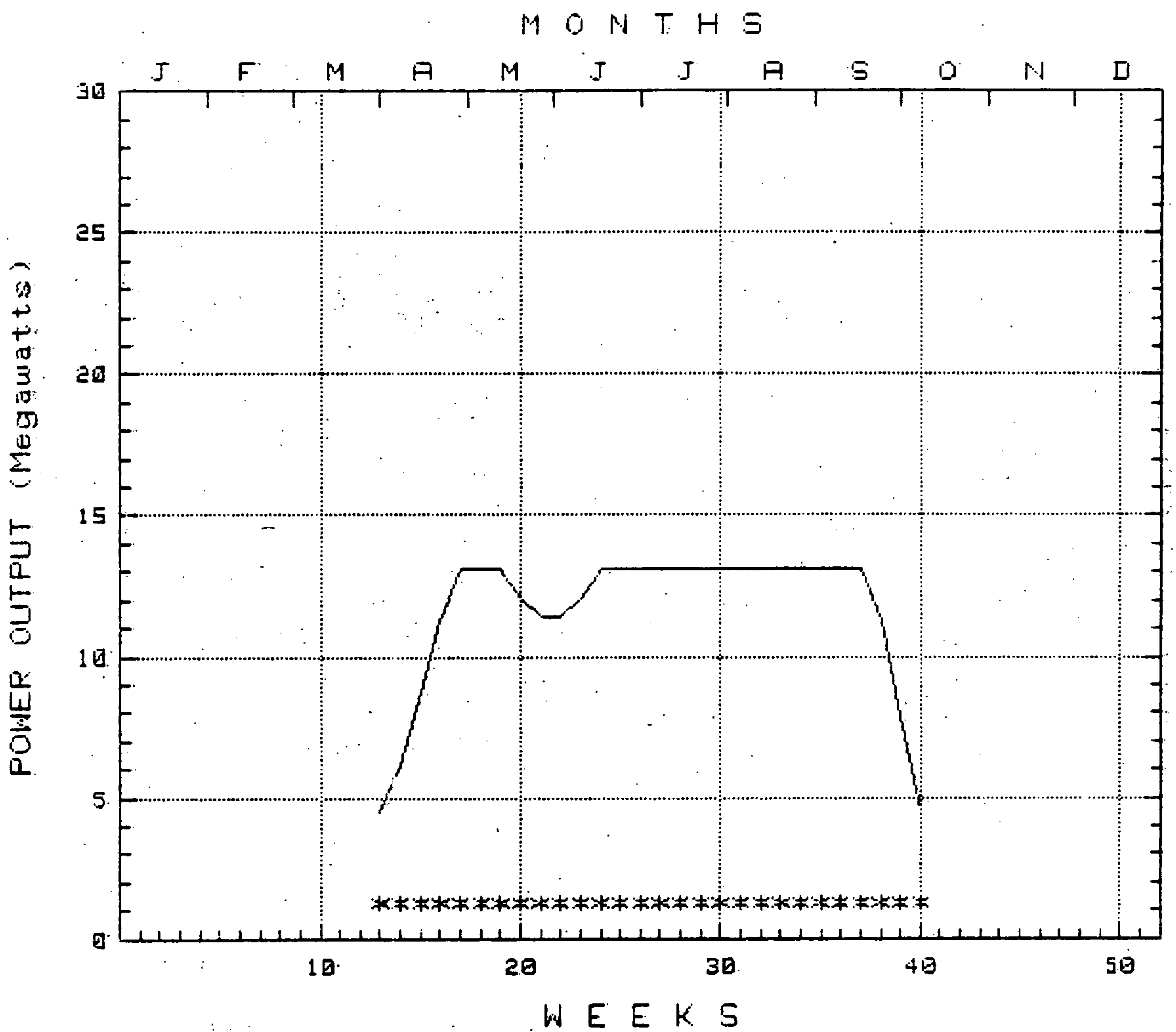
Appendices

APPENDIX A

SELECTED SUMMARIES OF POWER STUDIES

A-1,2,3	12 MW plants: 1-, 2-, 3- units
A-4 to 8	2-unit plants; 8-16 MW (varying W.S. Elevation in Banks Lake)
A-9 to 13	2-unit plants; 8-16 MW (Constant W.S. Elevation in Banks Lake)
A-14 to 19	40-year Energy Production, 2-unit plants 8-18 MW; varying W.S. Elevation in Banks Lake

DRY FALLS DAM



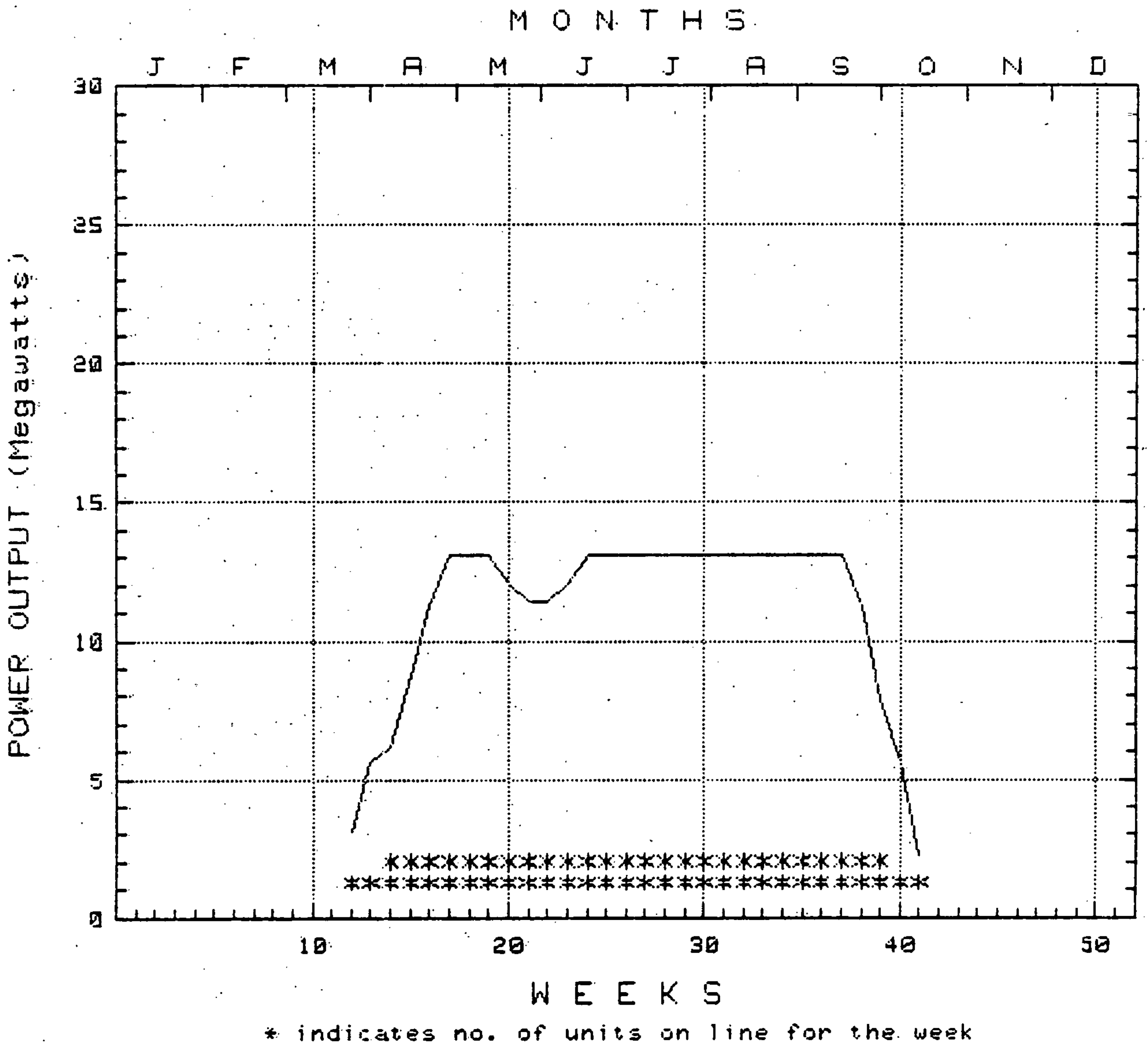
* indicates no. of units on line for the week

YEAR OF 1982

Rated Q................ 5139 CFS
Design head............ 30 FT
Installed capacity..... 12 MW per unit
No. of units........... 1

TOTAL ANNUAL ENERGY.... 54.42 MKWH

DRY FALLS DAM

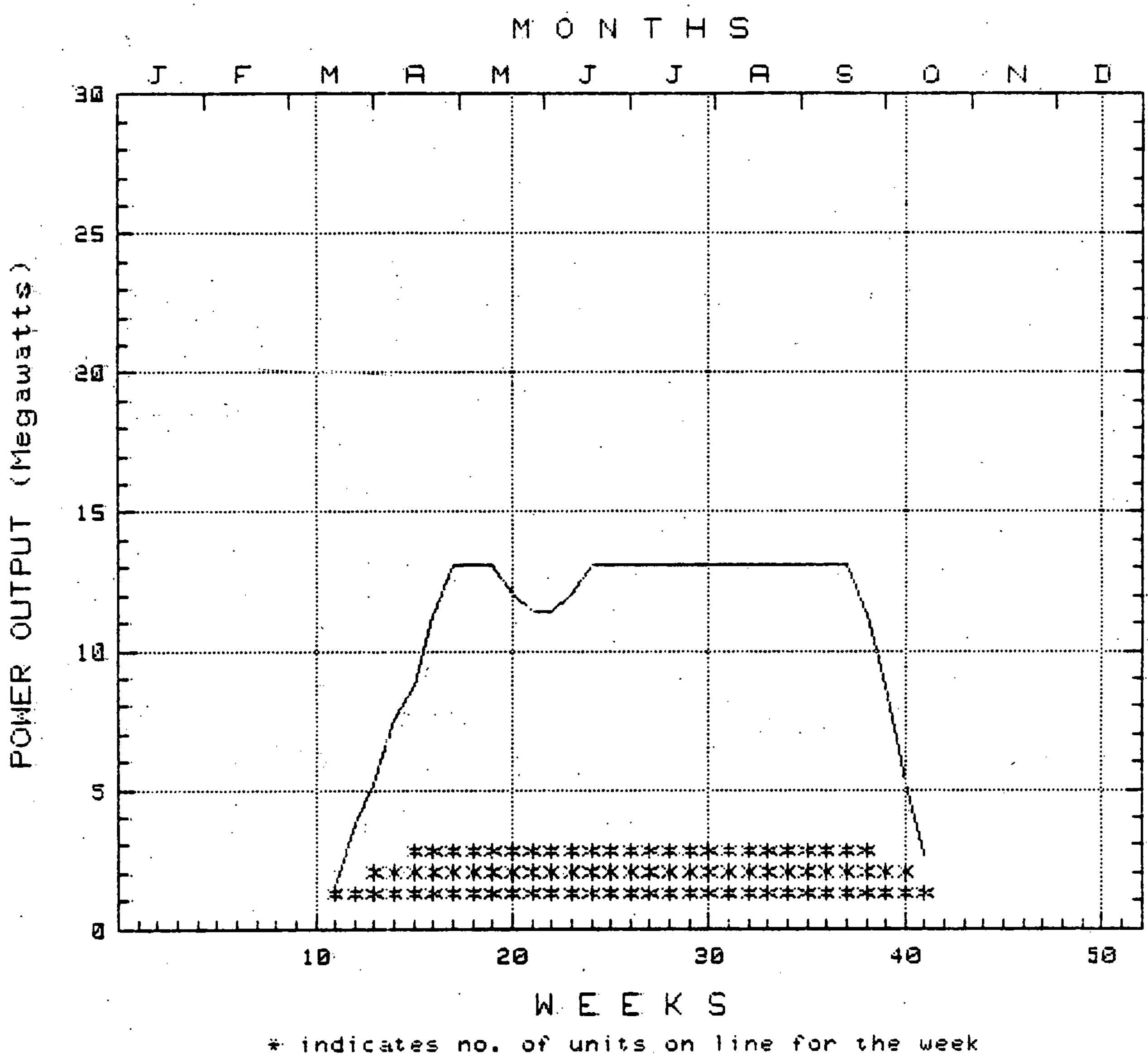


YEAR OF 1982

Rated Q................ 2570 CFS
Design head............ 30 FT
Installed capacity..... 6 MW per unit
No. of units........... 2

TOTAL ANNUAL ENERGY.... 55.71 MKWH

DRY FALLS DAM

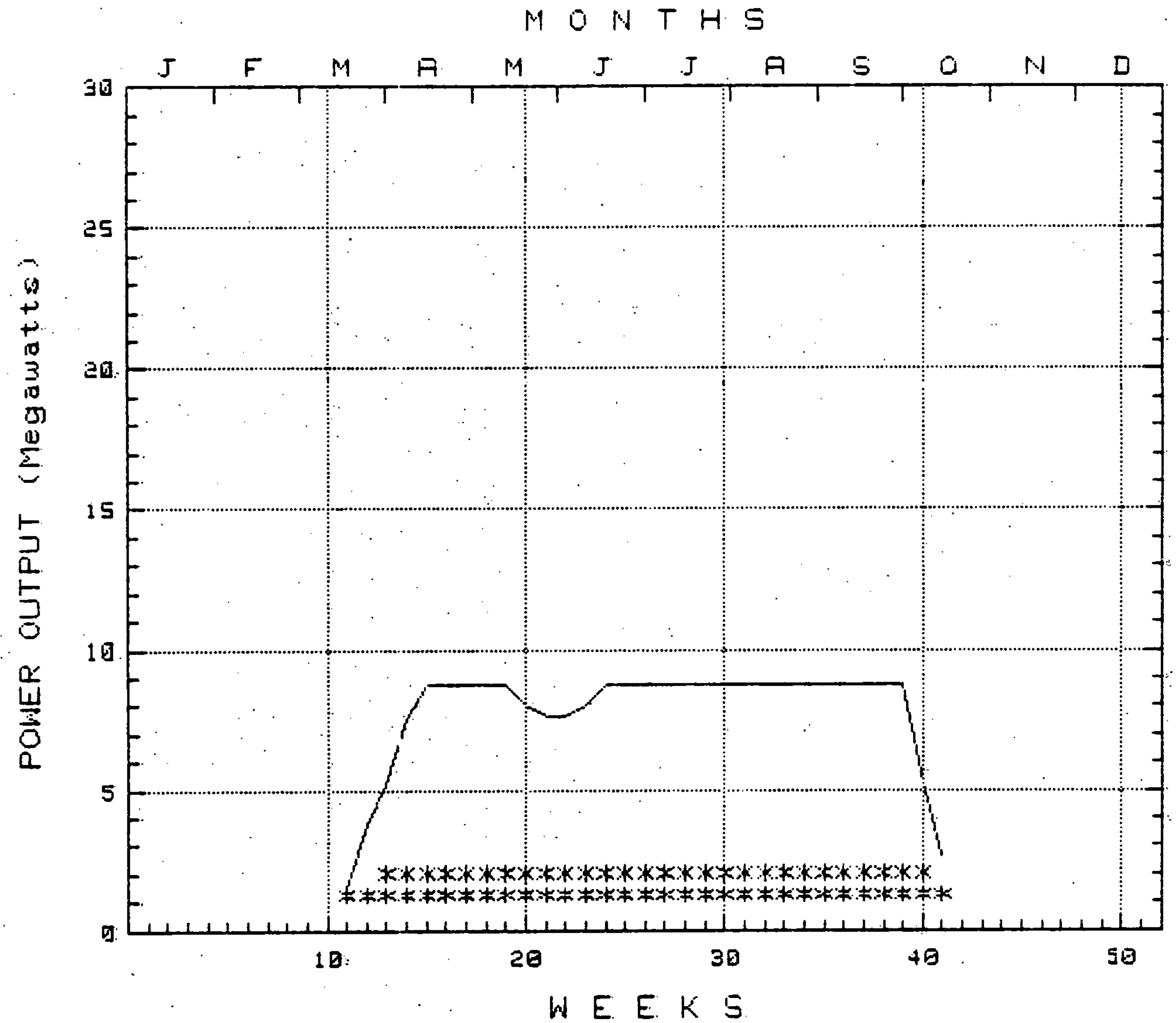


YEAR OF 1982

Rated Q................ 1713 CFS
Design head............ 30 FT
Installed capacity..... 4 MW per unit
No. of units........... 3

TOTAL ANNUAL ENERGY.... 56.39 MKWH

DRY FALLS DAM



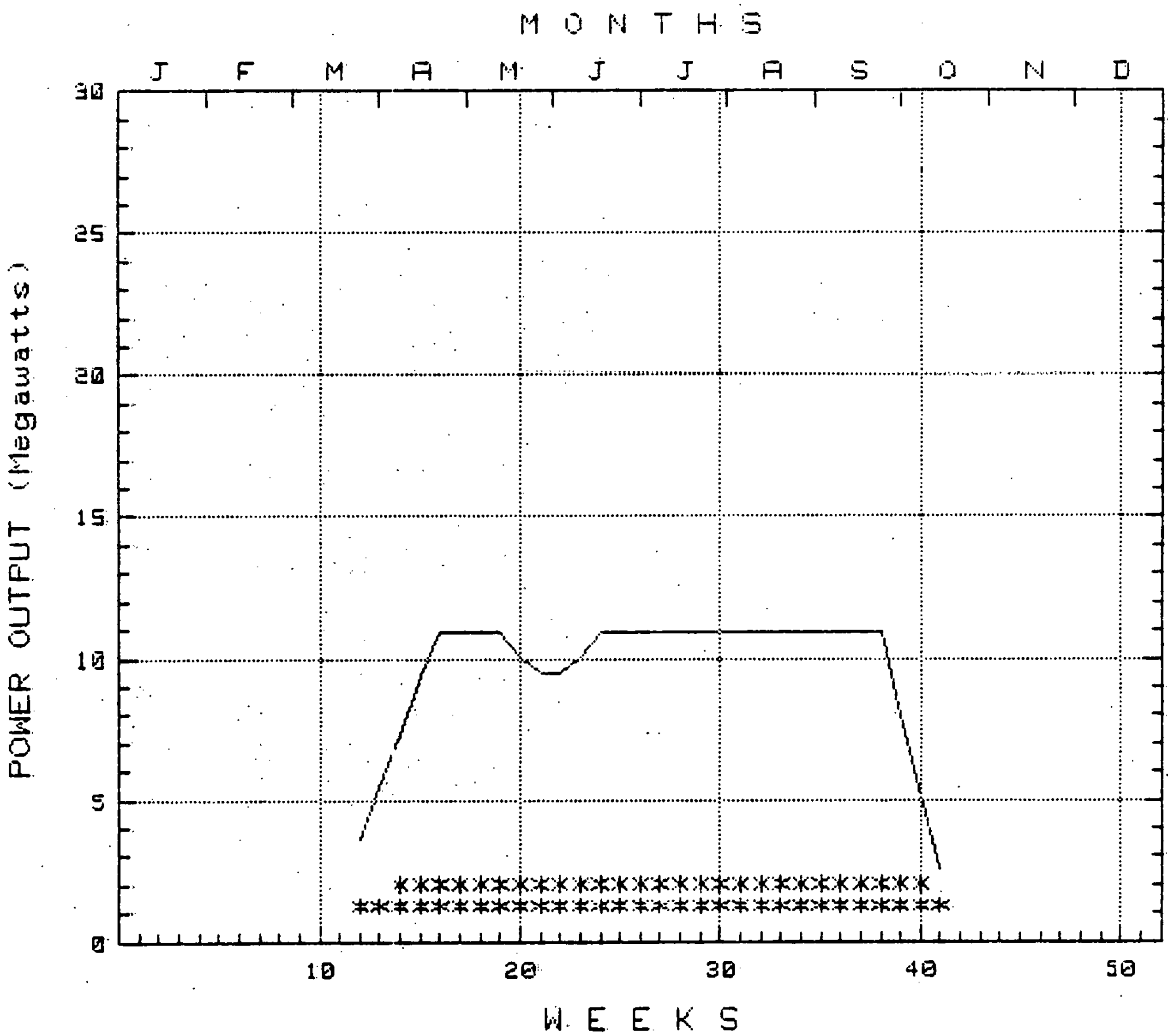
* indicates no. of units on line for the week

YEAR OF 1982

Rated Q................ 1713 CFS
Design head............ 30 FT
Installed capacity..... 4 MW per unit
No. of units........... 2

TOTAL ANNUAL ENERGY.... 40.43 MKWH

DRY FALLS DAM



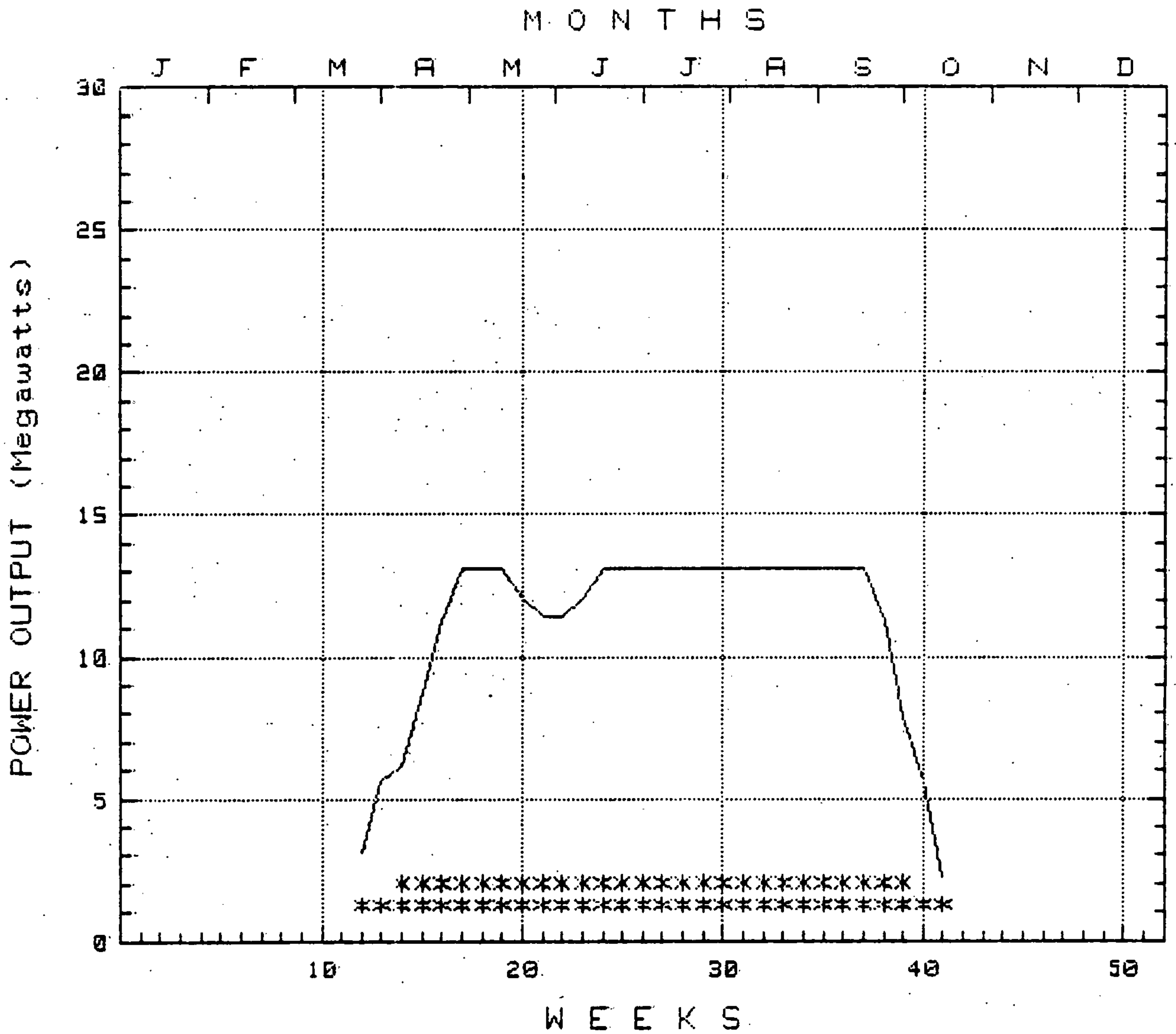
* indicates no. of units on line for the week

YEAR OF 1982

Rated Q.................. 2141 CFS
Design head............. 30 FT
Installed capacity..... 5 MW per unit
No. of units........... 2

TOTAL ANNUAL ENERGY.... 48.39 MKWH

DRY FALLS DAM



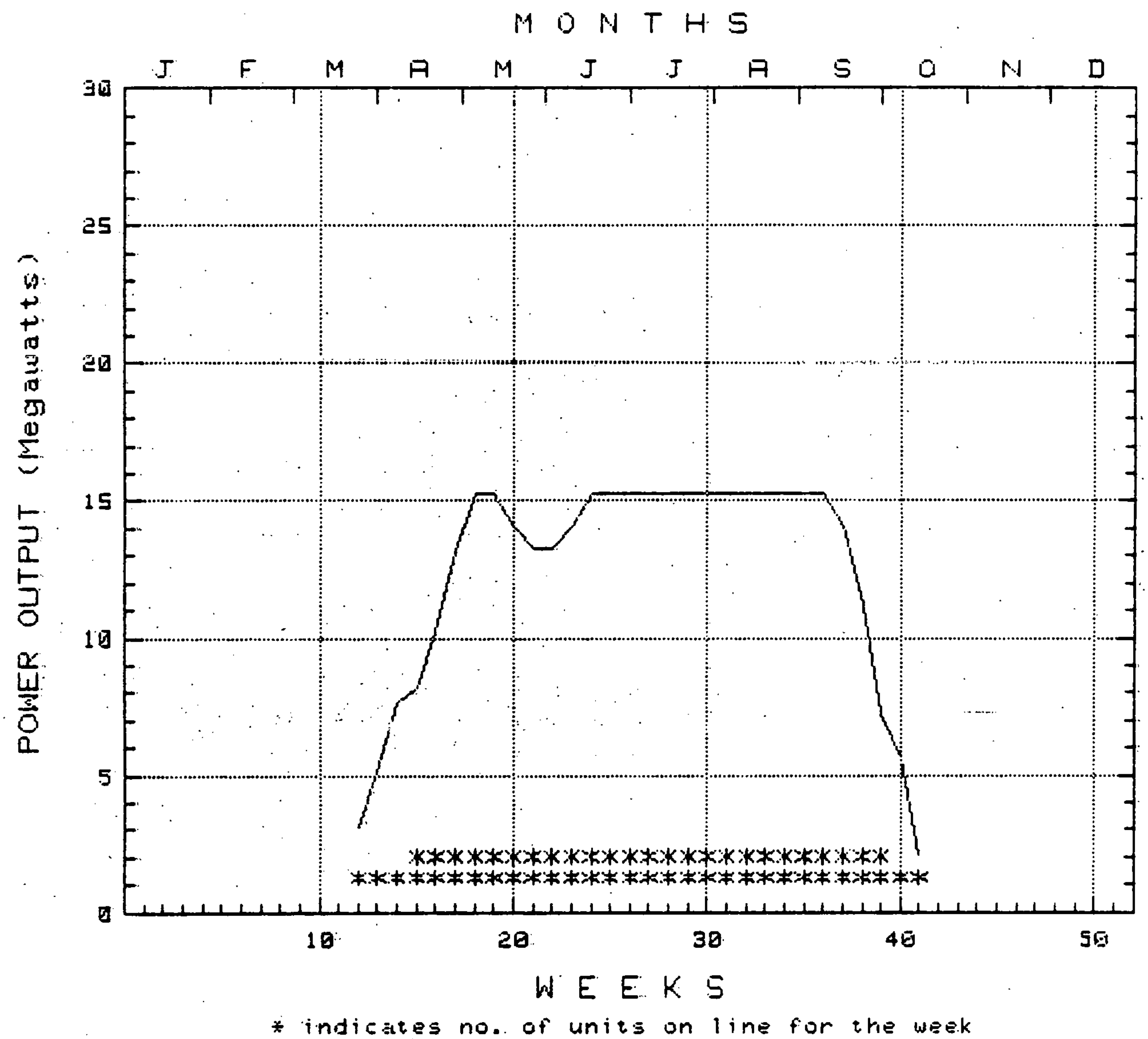
* indicates no. of units on line for the week

YEAR OF 1982

Rated Q.................. 2570 CFS
Design head.............. 30 FT
Installed capacity..... 6 MW per unit
No. of units............ 2

TOTAL ANNUAL ENERGY.... 55.71 MKWH

DRY FALLS DAM

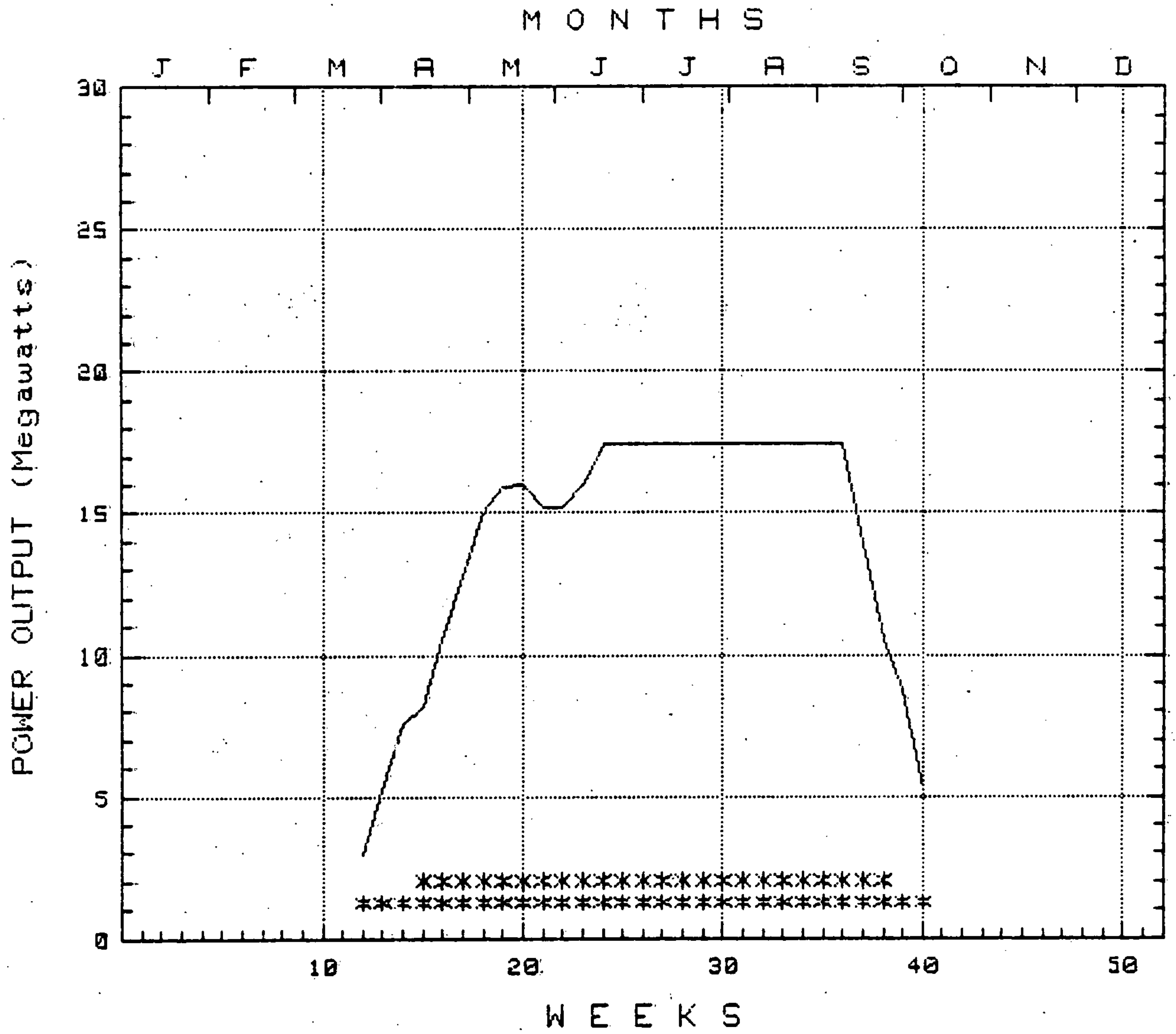


YEAR OF 1982

Rated Q.................. 2998 CFS
Design head.............. 30 FT
Installed capacity..... 7 MW per unit
No. of units........... 2

TOTAL ANNUAL ENERGY.... 62.42 MKWH

DRY FALLS DAM



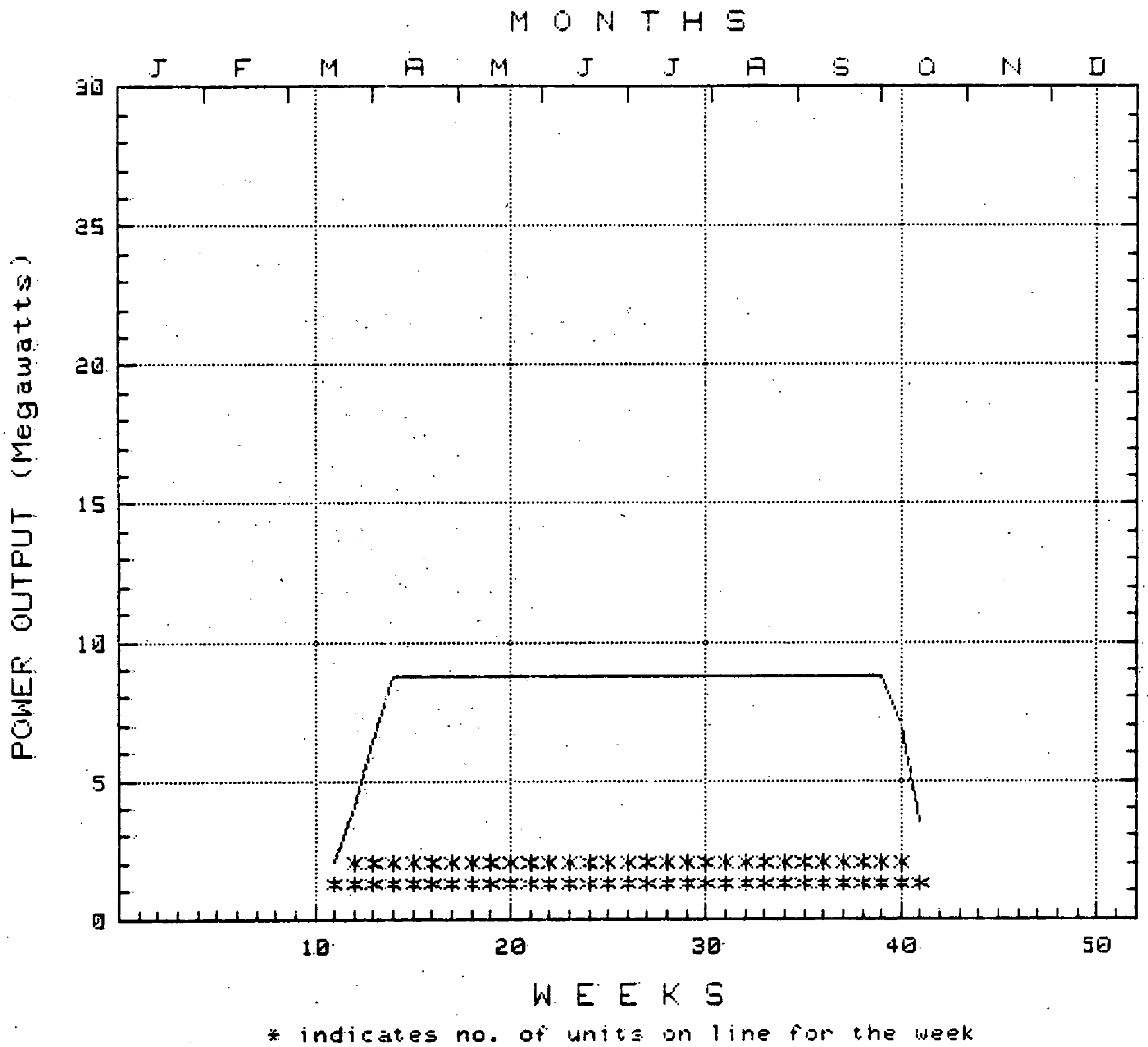
* indicates no. of units on line for the week

YEAR OF 1982

Rated Q................. 3426 CFS
Design head............. 30 FT
Installed capacity...... 8 MW per unit
No. of units............ 2

TOTAL ANNUAL ENERGY.... 68.24 MKWH

DRY FALLS DAM

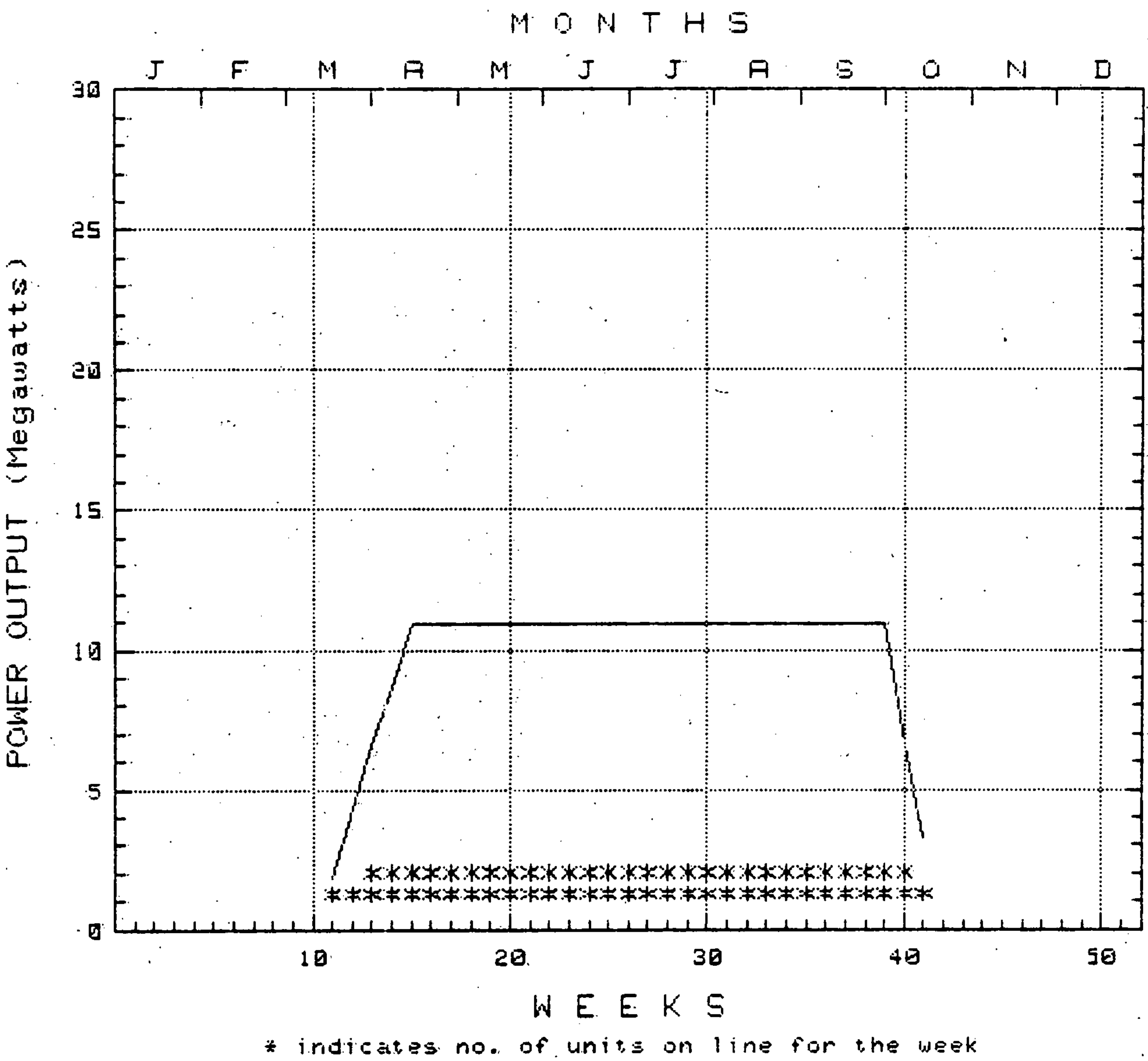


YEAR OF 1982

Rated Q.................. 1389 CFS
Design head.............. 37 FT
Installed capacity....... 4 MW per unit
No. of units............. 2

TOTAL ANNUAL ENERGY.... 42.04 MKWH

DRY FALLS DAM

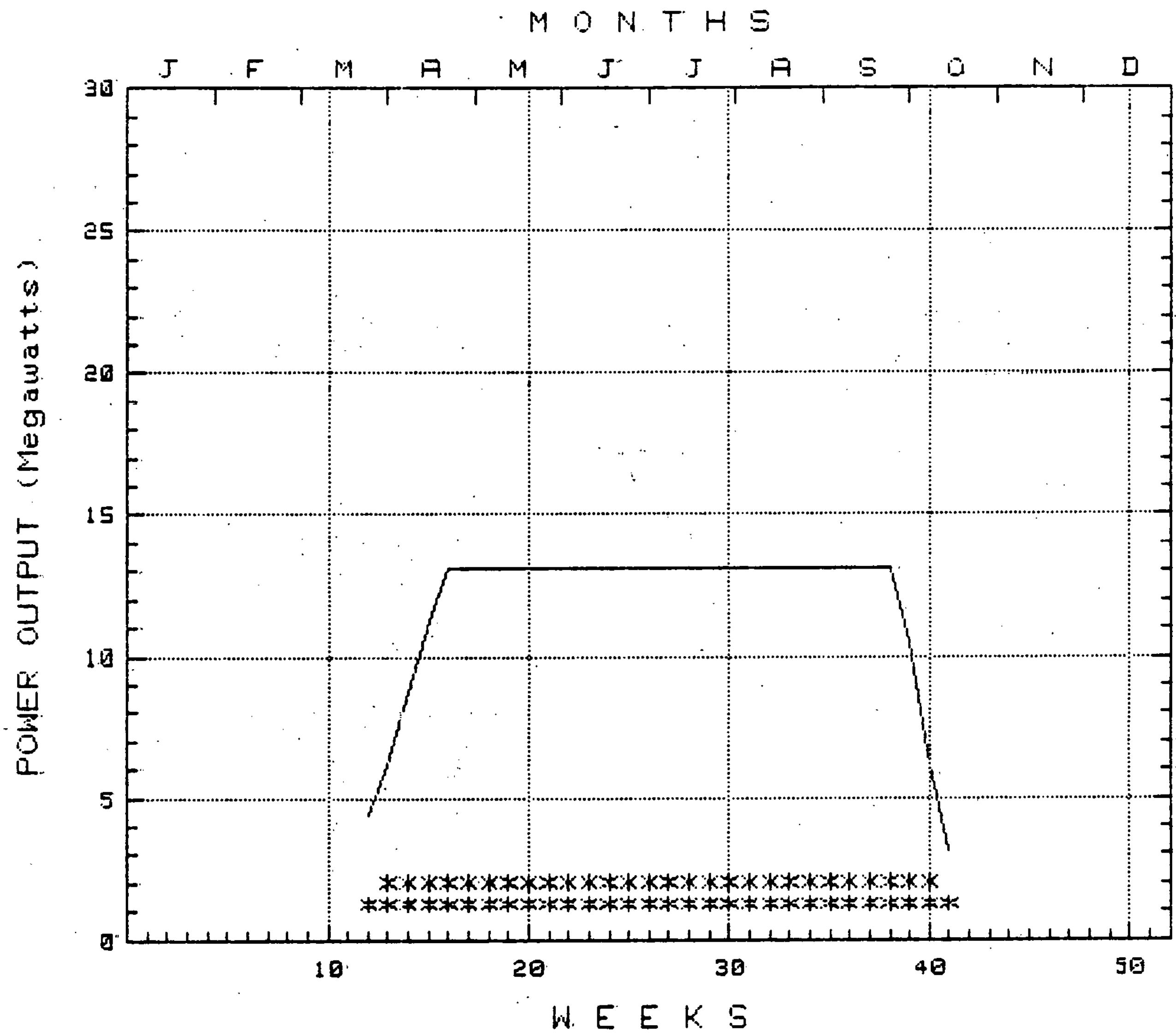


YEAR OF 1982

Rated Q.................. 1736 CFS
Design head............. 37 FT
Installed capacity...... 5 MW per unit
No. of units........... 2

TOTAL ANNUAL ENERGY.... 51.14 MKWH

DRY FALLS DAM



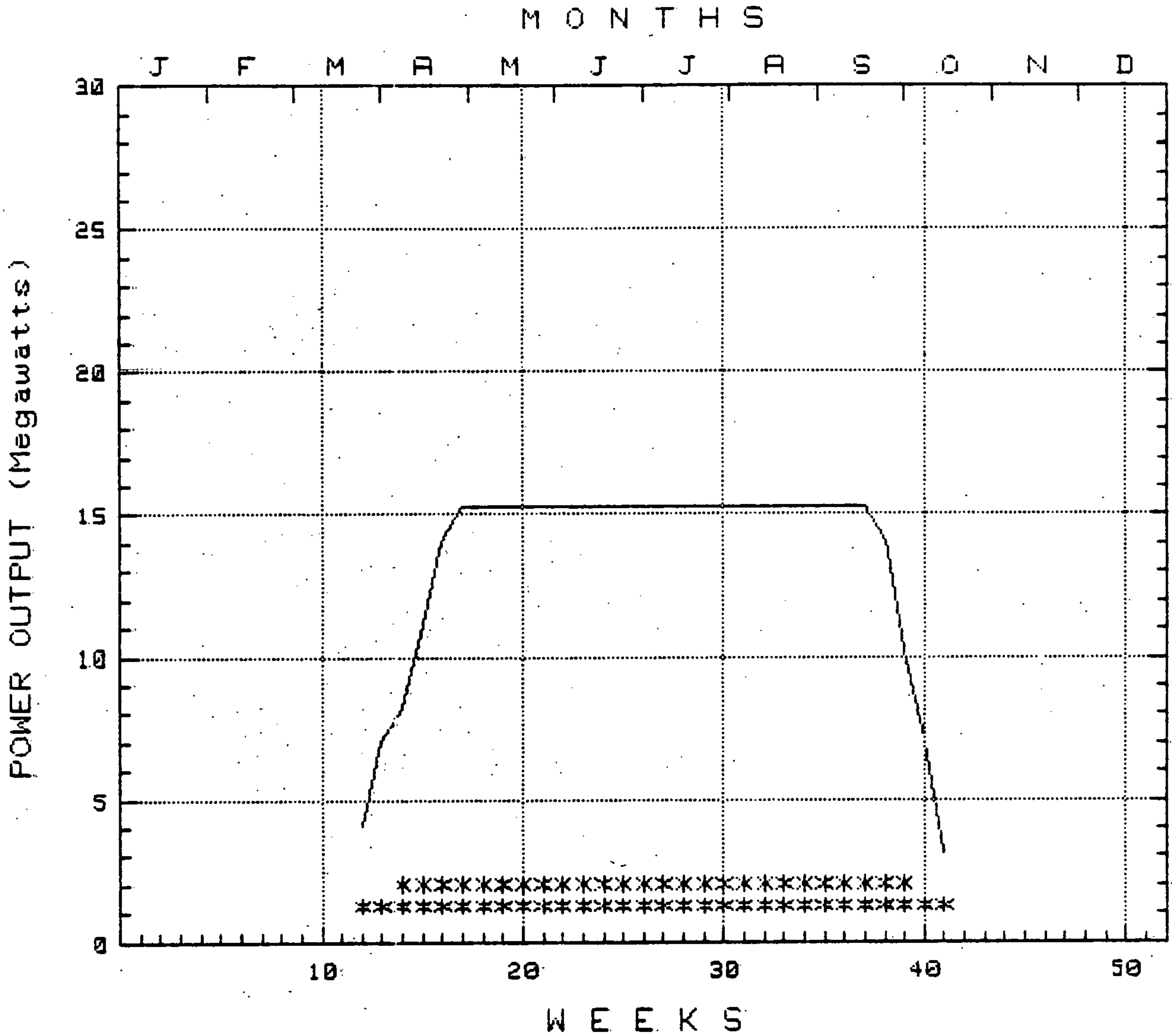
* indicates no. of units on line for the week

YEAR OF 1982

Rated Q................ 2083 CFS
Design head............ 37 FT
Installed capacity..... 6 MW per unit
No. of units........... 2

TOTAL ANNUAL ENERGY.... 59.09 MKWH

DRY FALLS DAM



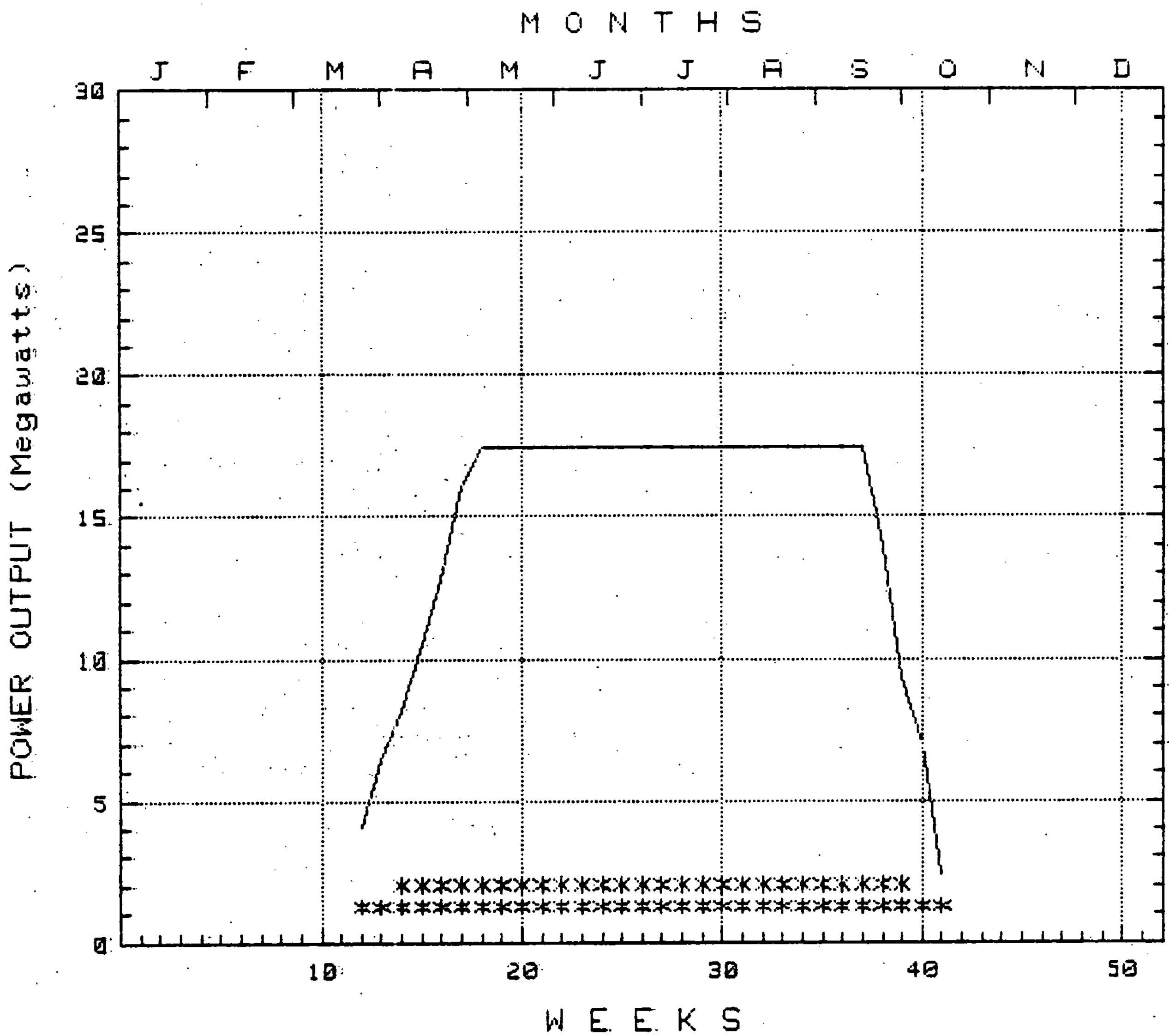
* indicates no. of units on line for the week

YEAR OF 1982

Rated Q................ 2431 CFS
Design head............. 37 FT
Installed capacity..... 7 MW per unit
No. of units........... 2

TOTAL ANNUAL ENERGY.... 67.23 MKWH

DRY FALLS DAM

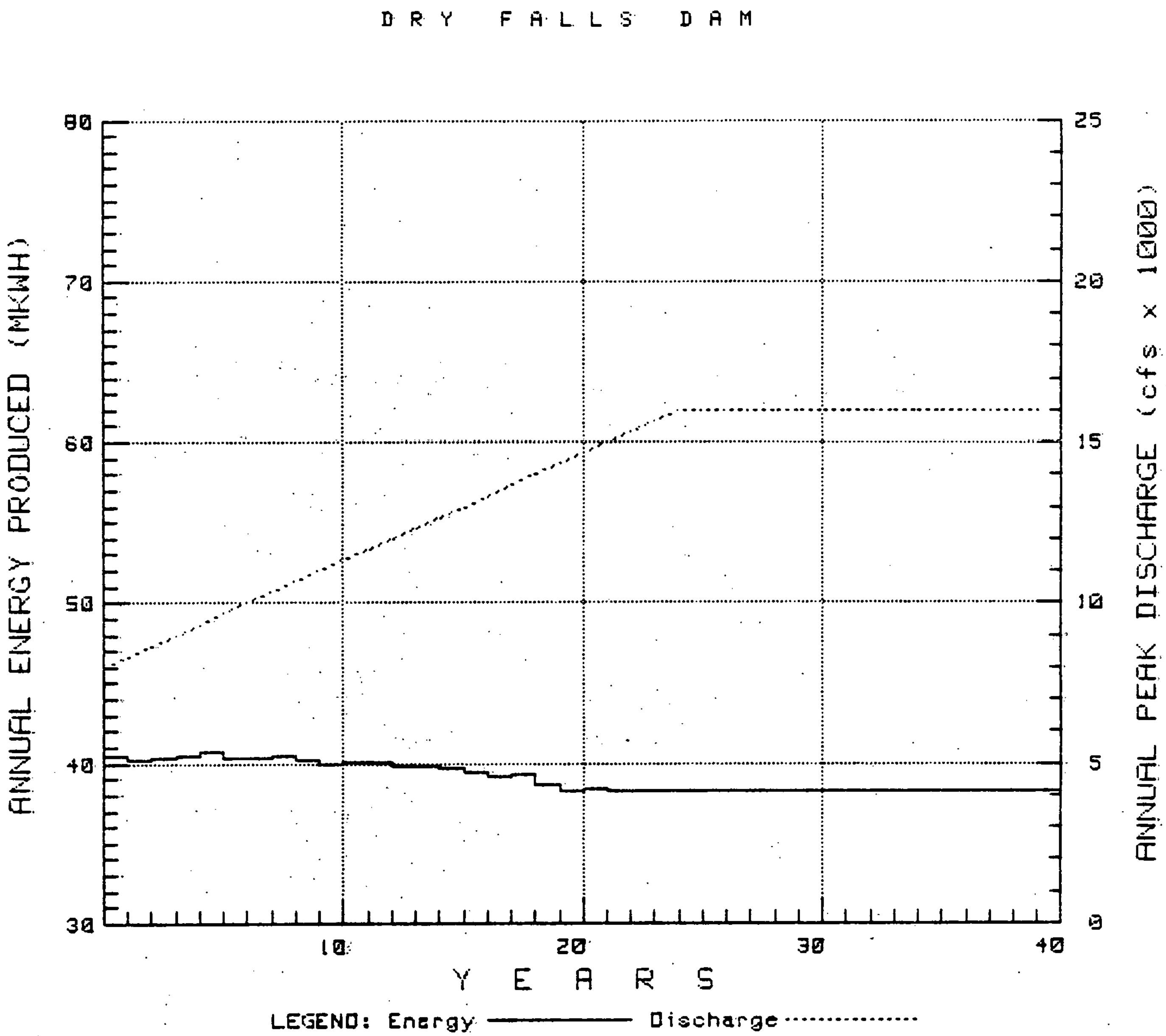


* indicates no. of units on line for the week

YEAR OF 1982

Rated Q.................. 2778 CFS
Design head............. 37 FT
Installed capacity..... 8 MW per unit
No. of units........... 2

TOTAL ANNUAL ENERGY.... 73.96 MKWH

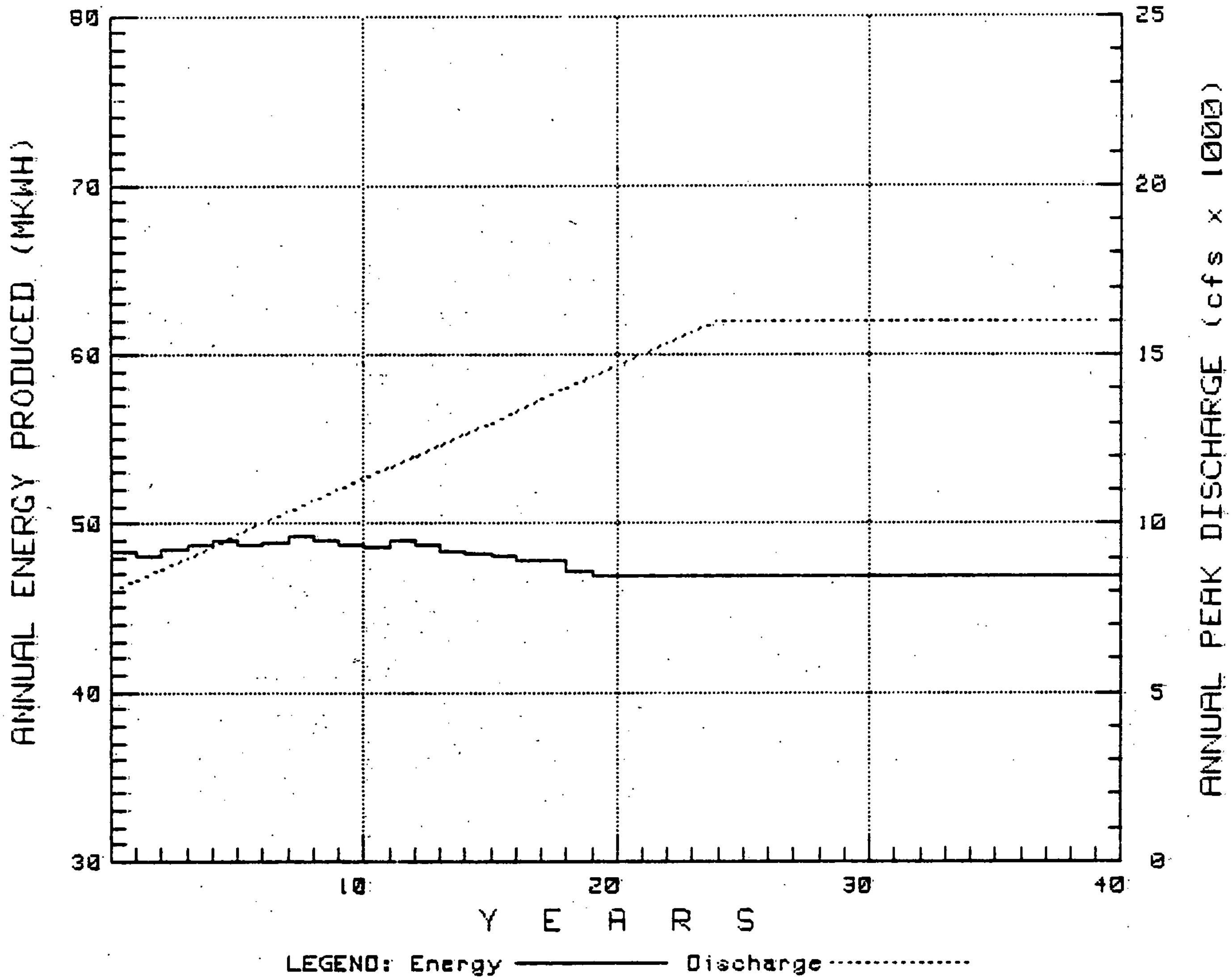


FORTY YEARS FROM 1982 TO 2021

Rated Q.............................. 1713 CFS
Design head.......................... 30 FT
Installed capacity................... 4 MW per unit
No. of initial units installed..... 2
No units added in the future

TOTAL ENERGY PRODUCED FOR PERIOD... 1563.26 MKWH

D R Y   F A L L S   D A M

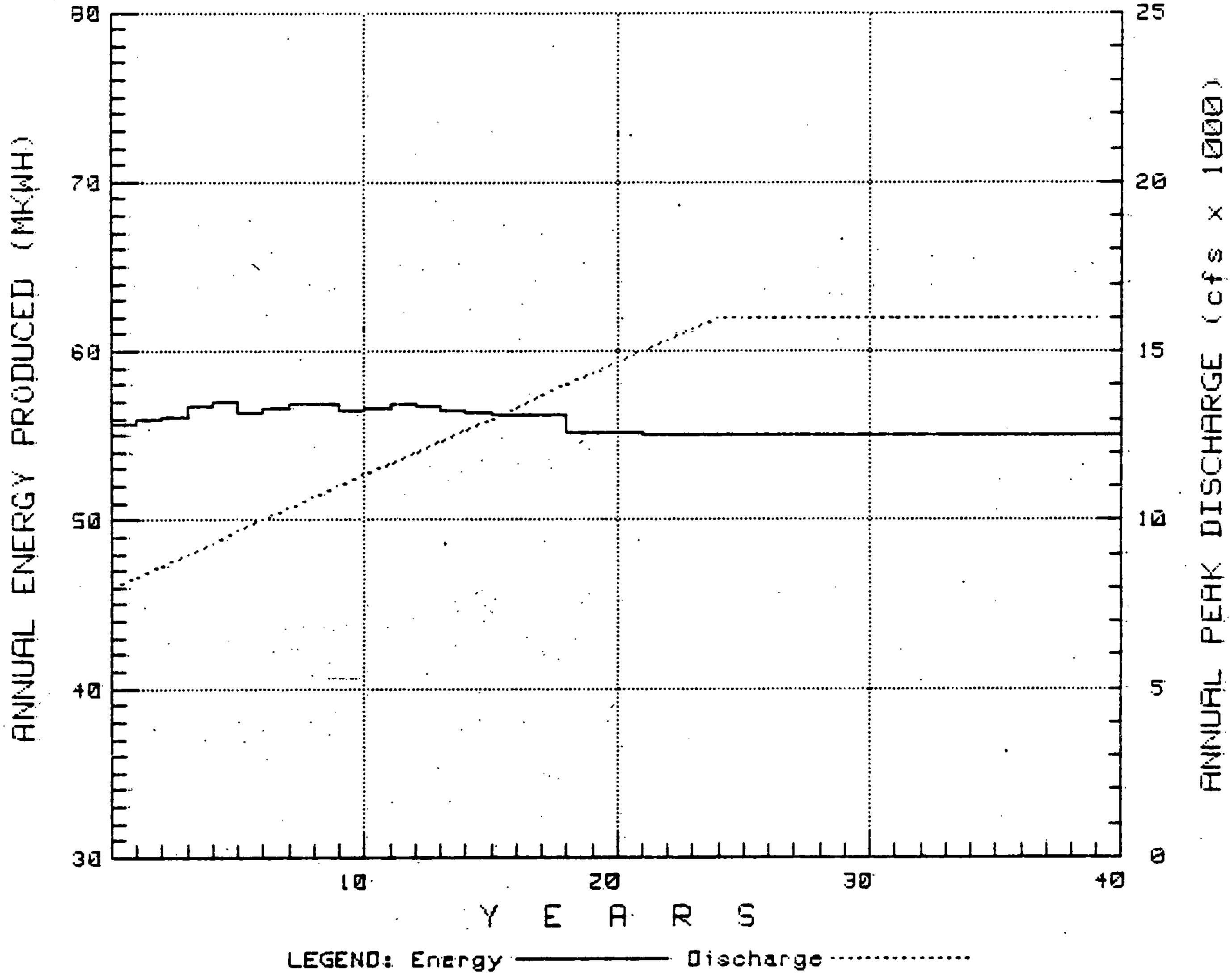


FORTY YEARS FROM 1982 TO 2021

Rated Q.............................. 2141 CFS
Design head.......................... 30 FT
Installed capacity................... 5 MW per unit
No. of initial units installed..... 2
No units added in the future

TOTAL ENERGY PRODUCED FOR PERIOD... 1905.2 MKWH

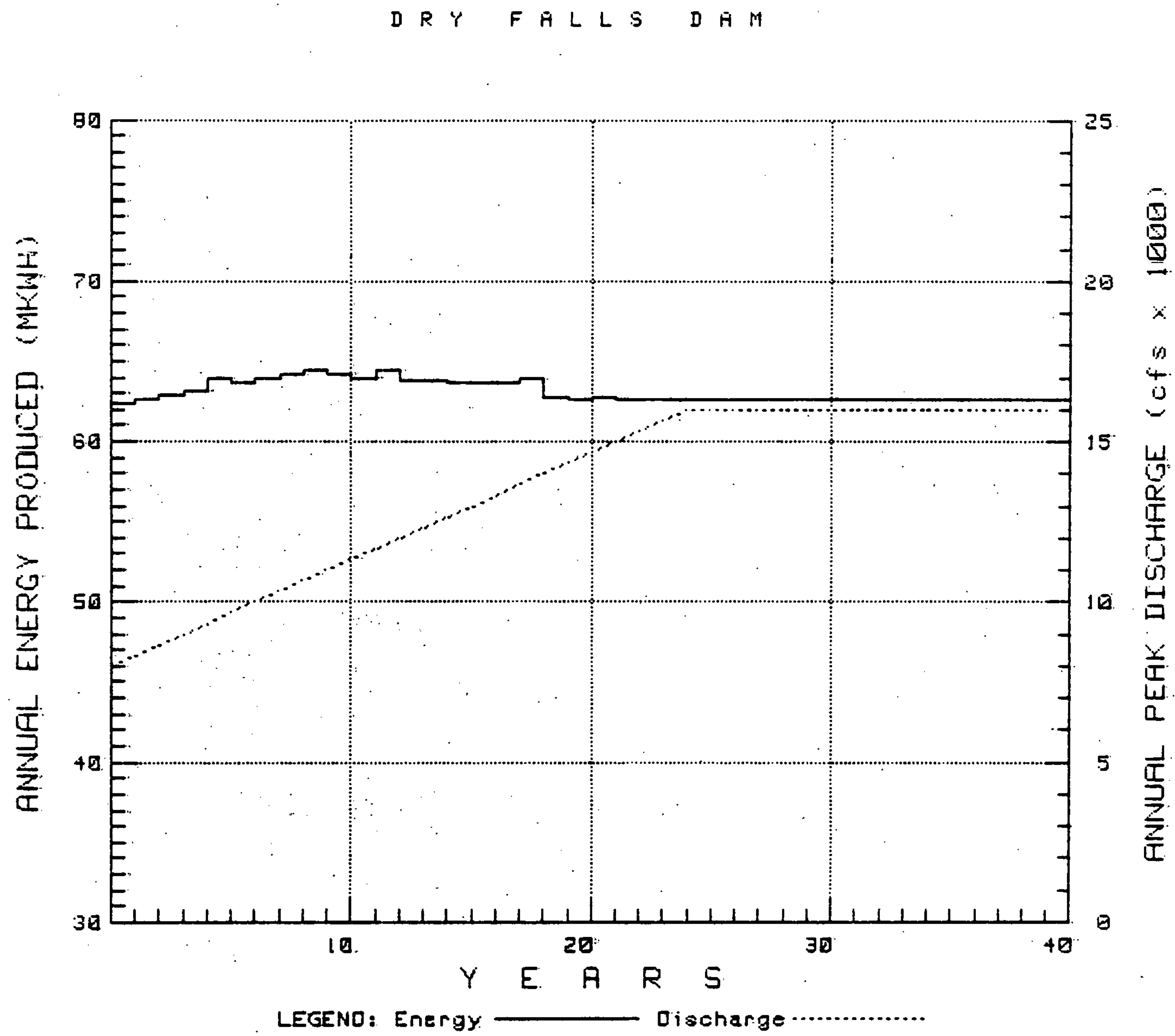
D R Y   F A L L S   D A M



FORTY YEARS FROM 1982 TO 2021

Rated Q............................. 2570 CFS
Design head......................... 30 FT
Installed capacity.................. 6 MW per unit
No. of initial units installed..... 2
No units added in the future

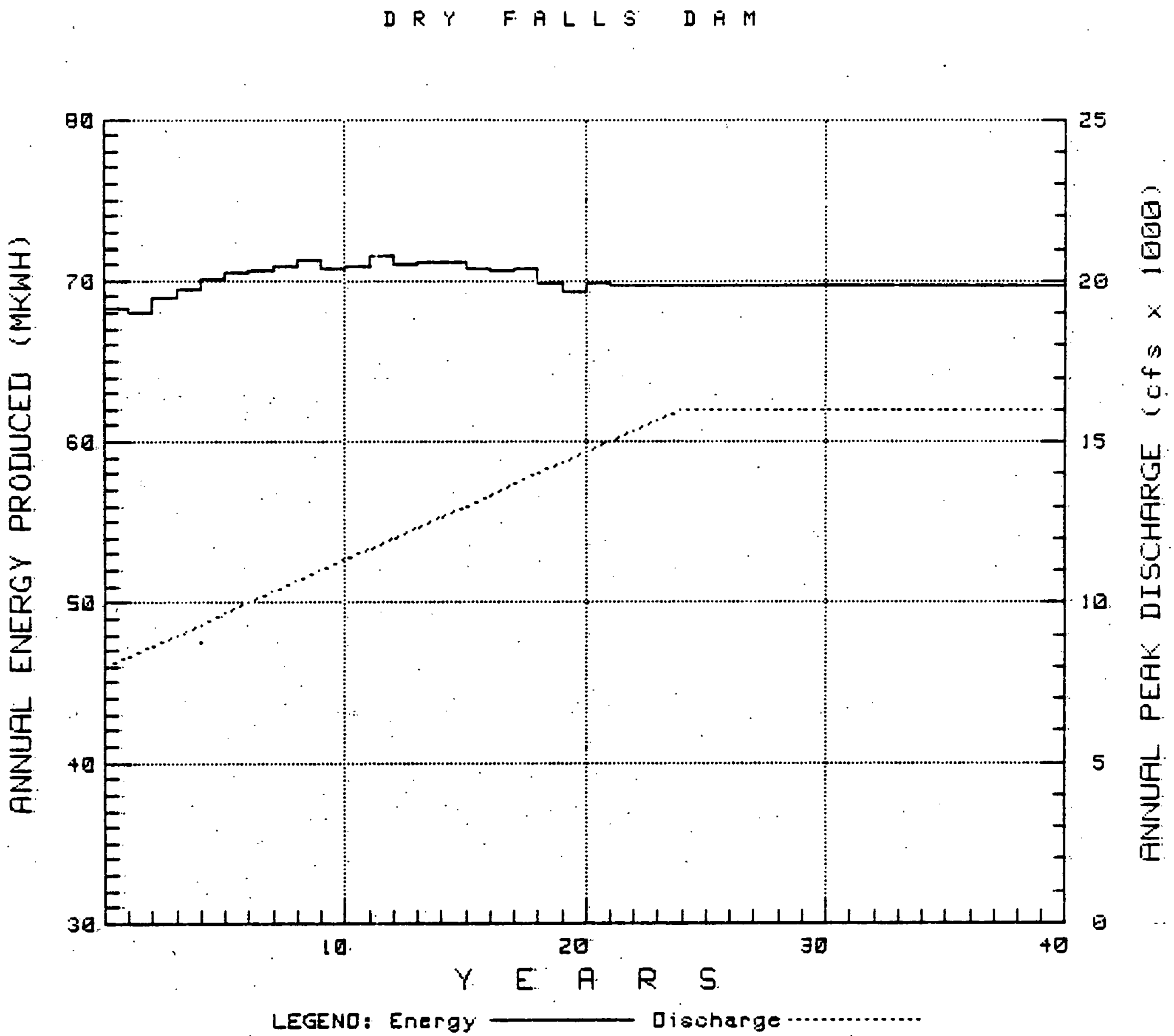
TOTAL ENERGY PRODUCED FOR PERIOD... 2226.09 MKWH



FORTY YEARS FROM 1982 TO 2021

Rated Q................................ 2998 CFS
Design head........................ 30 FT
Installed capacity................. 7 MW per unit
No. of initial units installed...... 2
No units added in the future

TOTAL ENERGY PRODUCED FOR PERIOD... 2525.58 MKWH

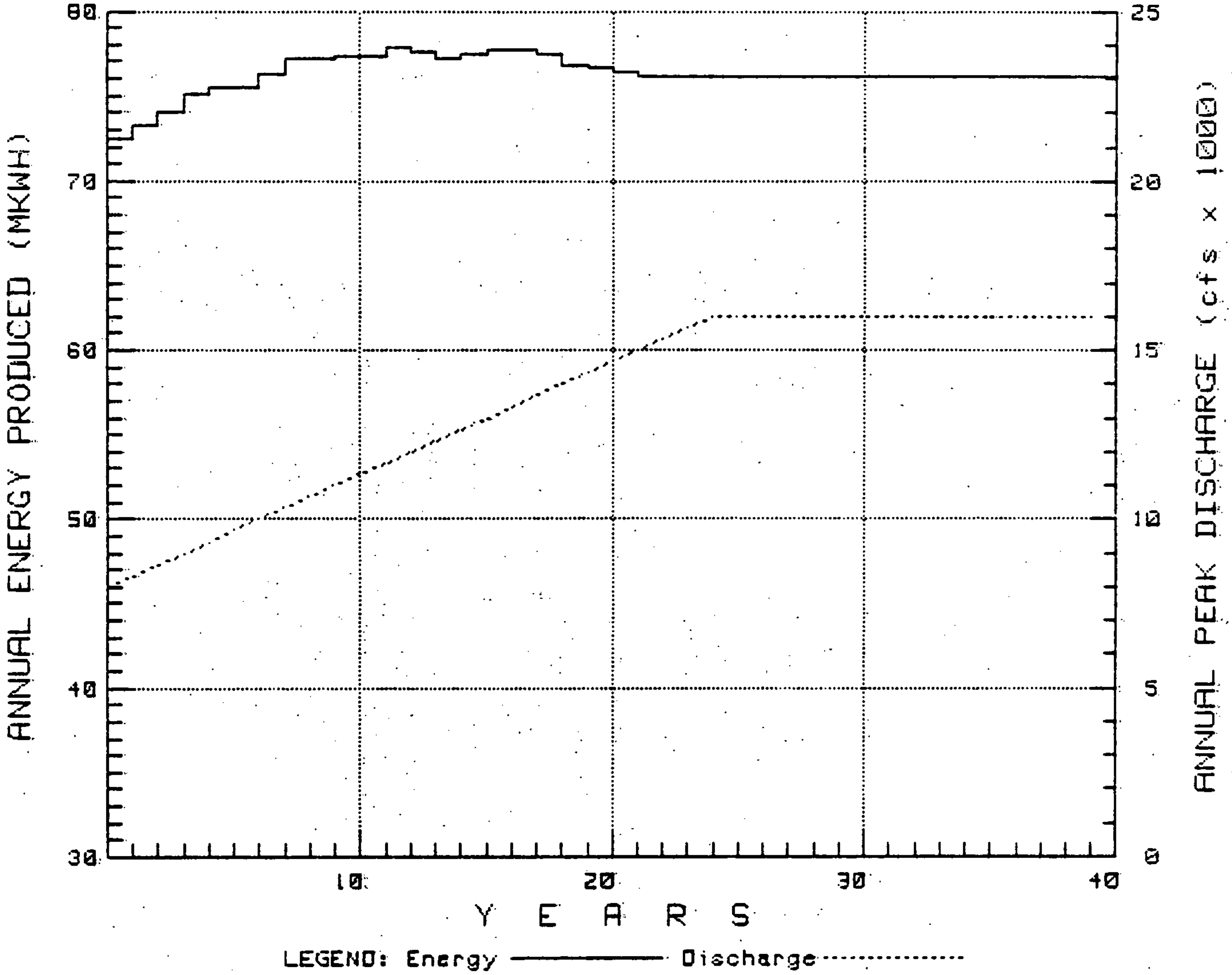


FORTY YEARS FROM 1982 TO 2021

Rated Q.................................. 3426 CFS
Design head.............................. 30 FT
Installed capacity....................... 8 MW per unit
No. of initial units installed..... 2
No units added in the future

TOTAL ENERGY PRODUCED FOR PERIOD... 2798.96 MKWH

DRY FALLS DAM



FORTY YEARS FROM 1982 TO 2021

Rated Q.............................. 3854 CFS
Design head.......................... 30 FT
Installed capacity................... 9 MW per unit
No. of initial units installed....... 2
No units added in the future

TOTAL ENERGY PRODUCED FOR PERIOD... 3051.33 MKWH

APPENDIX B
CLASSIFICATION OF TURBINES

APPENDIX B

CLASSIFICATION OF TURBINES

General. The net effective head available to the turbine dictates the selection of type of turbine suitable for use at a particular site. The rate of flow determines the capacity of the turbine. Hydraulic turbines have two general classifications, impulse and reaction.

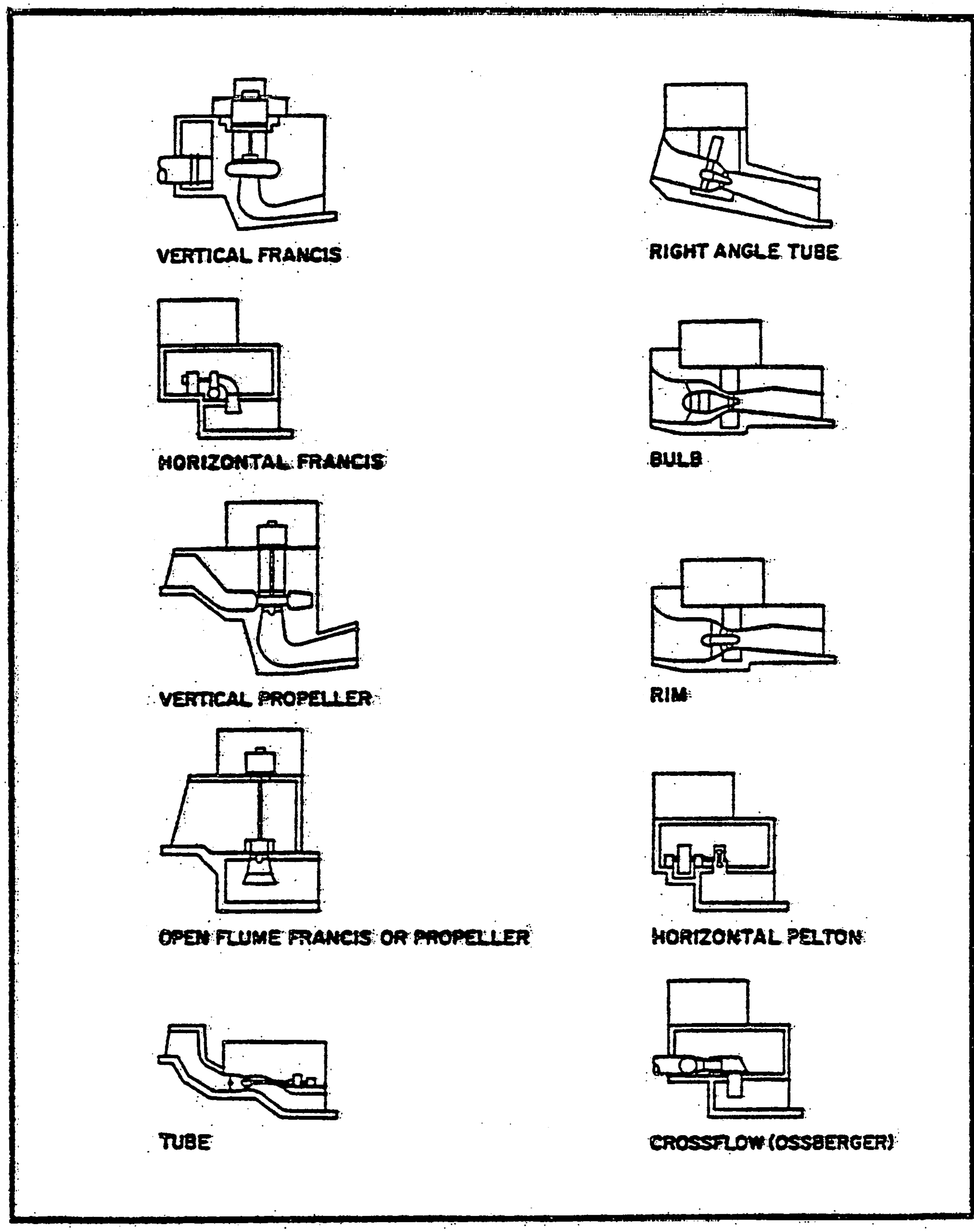
Reaction turbines are classified as Francis (mixed flow) or Propeller (axial flow). Propeller turbines are available with both fixed blades and variable pitch blades (Kaplan). Both Propeller and Francis turbines may be mounted either horizontally or vertically. Additionally, Propeller turbines may be slant mounted. Trade names have been applied to certain Propeller turbine designs such as Tube, Bulb and Straflo. The design principles, for the runner, however, are the same.

Impulse turbines may have some application for small hydropower installations. However, there are very few manufacturers interested in developing a standardized product line. In general, the cost to manufacture a reaction turbine of comparable head and capacity is less.

Proprietary turbines are available and discussed further in this section. These turbines have unique characteristics which may be beneficial for some projects.

Cross-sections of the various types of turbines commercially available are shown in the accompanying figure.

Francis Turbines. A Francis turbine is one having a runner with nine or more fixed buckets (vanes). Water enters the turbine in a radial direction, with respect to the shaft, and is discharged in an axial direction. Principal components consist



TURBINE CROSS-SECTIONS

of the runner, a water supply case to convey the water to the runner, wicket gates to control the quantity of water and distribute it equally around the runner and a draft tube to convey the water away from the turbine.

A Francis turbine may be operated over a range of flows from approximately 40 percent to 105 percent of rated discharge. Below 40 percent rated discharge, there can be an area of operation where vibration or power surges may occur. The upper limit generally corresponds to the generator rating. The approximate head range for operation is from 60 percent to 125 percent of design head. In general, peak efficiencies of Francis turbines used in "small hydro" installations, will be approximately 88 to 90 percent. The peak efficiency point of a Francis turbine is established at 90 percent of the rated capacity of the turbine. In turn, the efficiency at the rated capacity is approximately 2 percent below peak efficiency. The peak efficiency at 60 percent of rated head will drop to near 75 percent.

The conventional Francis turbine is provided with a wicket gate assembly to permit placing the unit on line at synchronous speed, to regulate load and speed, and to shut down the unit. The gate operating mechanism may be actuated by hydraulic or electric motors. It permits operation of the turbine over the full range of flows. In special cases, where the flow rate is constant, Francis turbines without wicket gate mechanisms may be used. These units will operate at a fixed load dependent upon the effective head. Start up and shut down of turbines without wicket gates is normally accomplished using a butterfly valve at the turbine inlet.

Francis turbines may be mounted with vertical or horizontal shafts. Vertical mounting allows a smaller plan area and permits a deeper setting of the turbine with respect to tailwater elevation without locating the generator below tailwater.

Generator costs for vertical units are greater than for horizontal units because of the need for a thrust bearing. However, the savings on construction costs for medium and large units generally offset this increase. Horizontal units are often more economical for small higher speed applications where standard horizontal generators are available.

The water supply case is generally fabricated from steel plate. However, open flume and concrete cases are available and used for the heads below 50 feet. Concrete and open flume cases are discussed in a subsequent section. The closed concrete and steel cases are also known as scroll cases.

Francis turbines are generally provided with a 90 degree elbow draft tube which has a venturi design to minimize head loss. Conical draft tubes are also available; however, the turbine efficiency will be lower.

Propeller Turbines. A propeller turbine is one having a runner with four, five or six blades in which the water passes through the runner in an axial direction with respect to the shaft. The pitch of the blades may be fixed or movable. Principal components consist of a water supply case, wicket gates, a runner and a draft tube.

The efficiency curve of a typical fixed blade Propeller turbine forms a sharp peak, more abrupt than a Francis turbine curve. For variable pitch blade units the peak efficiency occurs at different outputs depending on the blade setting. An envelope of the efficiency curves over the range of blade pitch settings forms the variable pitch efficiency curve. This efficiency curve is broad and flat. Fixed blade units are less costly than variable pitch blade turbines; however, the operating ranges are more limited.

Turbine manufacturers have developed runner designs for a head range of 15 to 110 feet. Four-blade designs may be used up to 35 feet of head, five blade designs to 65 feet and six blade designs to 110 feet. In general, peak efficiencies are approximately the same as for Francis turbines.

Propeller turbines may be operated at flows from 40 percent to 105 percent of the rated flow. Discharge rates above 105 percent may be obtained; however, the higher rates are generally above the turbine and generator manufacturers' guarantees. Many units are satisfactorily operated beyond these limits; however, for purposes of feasibility studies, it is suggested that these limits be maintained. Head range for satisfactory operation is from 60 to 140 percent of design head. Efficiency loss at higher heads drops 2 to 5 percentage points below peak efficiency at design head and as much as 15 percentage points at lower heads.

The conventional propeller or Kaplan (variable pitch blade) turbines are mounted with a vertical shaft. Horizontal and slant settings will be discussed separately. The vertical units are equipped with a wicket gate assembly to permit placing the unit on line at synchronous speed, to regulate speed and load, and to shut down the unit. The wicket gate mechanism may be actuated by hydraulic or electric motors. Variable pitch units are equipped with a cam mechanism to coordinate the pitch of the blade with gate position and head. The special condition of constant flow, as previously discussed for Francis turbines, can be applied to propeller turbines. For this case, elimination of the wicket gate assembly may be acceptable. Variable pitch propeller turbines without wicket gates are discussed subsequently.

The advantages and disadvantages discussed above with regard to vertical versus horizontal settings for Francis turbines apply also to propeller turbines.

The water supply case is generally concrete. Either an open flume or a closed conduit type of construction may be used. Open flume construction is economical when heads are below 35 feet, but at higher heads the turbine shaft length becomes excessive. Open flume construction is disadvantageous with regard to maintenance costs, since the wicket gate assembly and guide bearing are water lubricated causing additional maintenance particularly when silt or debris is in the water. At capacities above 1500 kw, wicket gate and guide bearing loading are such that open flume may not be a satisfactory choice. For closed conduits or scroll cases, steel or concrete may be used. However, the concrete case is generally less costly.

The choice of draft tube designs discussed for Francis turbines applies also to propeller turbines.

Tube Turbines. Tubular or tube turbines are horizontal or slant mounted units with propeller runners. The generators are located outside of the water passageway. Tube turbines are available equipped with fixed or variable pitch runners and with or without wicket gate assemblies.

Performance characteristics of a tube turbine are similar to the performance characteristics discussed for propeller turbines. The efficiency of a tube turbine will be 1 to 2 percent higher than for a vertical Propeller turbine of the same size since the water passageway has less change in direction.

The performance range of the tube turbine with variable pitch blades and without wicket gates is greater than for a fixed blade Propeller turbine but less than for a Kaplan turbine. The water flow through the turbine is controlled by changing the pitch of the runner blades.

Several items of auxiliary equipment are often necessary for the operation of tube turbines. All tube turbines without wicket gates should be equipped with a shut-off valve automatically operated to provide shut-down and start-up functions. Tube turbines may also be equipped with an air clutch between the turbine and generator. The clutch is normally set to disengage at 125 percent of design speed and is used to prevent damage to the equipment if a runaway condition occurs.

Tube turbines can be connected either to the generator or to a speed increaser. The speed increaser would allow the use of a higher speed generator, perhaps 900 or 1200 r/min, instead of a generator operating at synchronous speed. The choice to utilize a speed increaser is an economic decision. Speed increasers lower the overall plant efficiency by about 1 percent for a single gear increaser and about 2 percent for double gear increaser. This loss of efficiency and the cost of the speed increaser must be compared to the reduction in cost for the smaller generator.

The required civil features are different for horizontal units than for vertical units. Horizontally mounted tube turbines require more floor area than vertically mounted units. The area required may be lessened by slant mounting, however, additional turbine costs are incurred as an axial thrust bearing is required. Excavation and powerhouse height for a horizontal unit is less than that required for a vertical unit.

Standardization of tube turbines has been completed by the leading domestic turbine manufacturers. Ten sizes are currently available with up to 5000 kw of capacity and for heads up to 50 feet. Standardization should provide lower costs and shorter delivery periods.

Bulb Turbines. Bulb turbines are horizontal shaft units which have propeller runners directly connected to the generator. The generator is enclosed in a water-tight enclosure (bulb) located in the turbine water passageway. The Bulb turbine is available with fixed or variable pitch blades and with or without a wicket gate mechanism. Performance characteristics are similar to the vertical and tube type turbines previously discussed. The Bulb turbine will have an improved efficiency of approximately 2 percent over a vertical unit and 1 percent over a tube unit because of the straight water passageway.

Due to the compact design, powerhouse floor space and height for Bulb turbine installations are minimized. Maintenance time, however, will be greater than for either the vertical or the tube type turbines.

Standardized Bulb turbines are offered by some foreign manufacturers.

Rim Type. A rim type turbine is one in which the generator rotor is mounted on the periphery of the turbine runner blades. This turbine has been developed by Escher Wyss Ltd. of Zurich, Switzerland and given the name "Straflo". The concept was developed 40 years ago and approximately 75 units are now in service. Capacities range from 1000 to 1900 kw at heads of 26 to 30 feet. All units built to date have fixed blade propeller runners. The existing seal design, to prevent leakage of water into the generator annulus, is a rubber "lip" seal type. This design is not satisfactory for variable pitch runner nor for capacities over 2000 kw. A new seal design has been developed which will permit Escher Wyss to offer units with runner diameters up to 32 feet and head up to 130 feet. The old lip seal design will be used on units with runner diameters of 11.5 feet or less at heads of less than 50 feet.

Performance characteristics of the Straflo turbine are similar to those of the Bulb unit. Rim turbines are offered with or without wicket gates, and are also available with partial closure wicket gates. Units with partial closure wicket gates must have shut-off valves in addition. The compact design of the Straflo turbine provides the smallest power house dimensions of all the turbine types considered.

Proprietary Turbines-Crossflow Type. A crossflow turbine may best be described as an impulse type turbine with partial air admission. This type of turbine is offered by Ossberger Turbine Fabrik Co. of Weissenburg, Germany and has the name "Ossberger Turbine."

Performance characteristics of this turbine are similar to an impulse turbine, and consist of a flat efficiency curve over a wide range of flow and head conditions. The wide range is accomplished by use of a guide vane at the entrance which directs the flow to a limited portion of the runner depending on the flow. This operation is similar to operation of multi-jet impulse turbine.

Peak efficiency of the Ossberger turbine is less than that of other turbine types previously discussed. Guaranteed maximum efficiency is 83 percent and expected peak efficiency is 85 percent.

At the present time, the largest size runner produced by Ossberger is 4 feet in diameter. This limits the unit capacity but multi-unit installations are often used. Allowable heads range from 20 to 600 feet.

Ossberger turbines are equipped with a conical draft tube creating a pressure below atmosphere in the turbine chamber. Therefore the difference between the turbine centerline elevation and the tailwater is not lost to an Ossberger turbine as is the case for an impulse turbine. Air is admitted into the chamber through an adjustable air inlet valve used to control the pressure.

Ossberger turbines are free from cavitation, but are susceptible to wear when excessive silt or sand particles are in the water. Runners are self-cleaning and, in general, maintenance is less complex than for the other types of turbines discussed in this volume.

Floor space requirements are more than for the other turbine types, but a less complex structure is required and a savings in cost might be realized.

Impulse Turbines. An impulse turbine is one having one or more free jets discharging into an aerated space and impinging on the buckets of a runner. Efficiencies are often 90 percent and above. Application of the impulse turbine within the capacity and head range of this volume is limited. In general, an impulse turbine will not be competitive in cost with a reaction turbine below 1000 feet of head. However, certain hydraulic conditions or surge protection requirements may warrant investigation into the suitability of an impulse turbine in the 100 foot range.

Single nozzle impulse turbines have a very flat efficiency curve and may be operated down to loads of 20 percent of rated capacity with good efficiency. For multi-nozzle units, the range is even broader because the number of operating jets can be varied.

Control of the turbine is maintained by hydraulically-operated needle nozzles in each jet. In addition, a jet deflector is provided for emergency shutdown. The deflector diverts the water jet from the buckets to the wall of the pit liner. This feature provides surge protection for the penstock without the need for a pressure release valve because load can be rapidly removed from the generator without changing the flow rate.

Control of the turbine may also be accomplished by the deflector alone. On these units the needle nozzle is manually operated and the deflector diverts a portion of the jet for lower loads. This method is less efficient and normally used for speed regulation of the turbine under constant load.

Runners on the modern impulse turbine are a one-piece casting. Runners with individually attached buckets have proved to be less dependable and, on occasion, have broken away from the wheel causing severe damage to the powerhouse. Integral cast runners are difficult to cast, costly and require long delivery times. However, maintenance costs for an impulse turbine are less than for a reaction turbine as they are free of cavitation problems. Excessive silt or sand in the water however, will cause more wear on the runner of an impulse turbine than on the runner of most reaction turbines.

Draft tubes are not required for impulse turbines. The runner must be located above maximum tail water to permit operations at atmospheric pressure. This requirement exacts an additional head loss for an impulse turbine not required by a reaction turbine.

Impulse turbines may be mounted horizontally or vertically. The additional floor space required for the horizontal setting can be compensated for by lower generator costs on single nozzle units in the lower capacity sizes. Vertical units require less floor space and are often used for large capacity multi-nozzle units.

APPENDIX C
ESTIMATED CONSTRUCTION COST

BASIC DATA: DRY FALLS, DOUBLE PENSTOCK,
6 MW EA, 2 UNITS 6200 CFS, 30'H, D3 = 13' - 0

Item	Quantity	Unit	Unit Price	Amount
STRUCTURES AND IMPROVEMENTS				
Mobilization and Demolition	--	LS	$ --	$ 35,000
Excavation, common	350	CY	2.00	700
Excavation, rock	3,100	CY	10.00	31,000
Foundation preparation	2,500	SF	1.00	2,500
Drains	250	LF	2.00	500
Concrete	2,100	CY	170.00	357,000
Reinforcing steel	262,500	LB	0.35	91,875
Backfill	2,800	CY	2.00	5,600
Miscellaneous metal	27,500	LB	1.25	34,375
Pressure grouting	--	LS	--	5,000
Hatches, stoplogs, etc.	--	LS	--	5,000
O.H. crane/gantry crane	--	LS	--	25,000
SUBTOTAL				$ 593,550
RESERVOIR, DAM AND WATERWAYS				
Excavation, common	9,000	CY	2.00	18,000
Excavation, rock	38,700	CY	10.00	397,000
Tunneling	2,250	CY	125.00	281,250
Concrete	470	CY	170.00	79,900
Reinforcing steel	18,000	LB	.35	6,300
Foundation preparation	3,000	SF	1.00	3,000
Drains	450	LF	2.00	900
Penstock	254,300	LB	1.25	317,875
Miscellaneous metal	24,000	LB	1.00	24,000
Gates and stoplogs	--	LS	--	60,000
Shotcrete	60	CY	200.00	12,000
Site development	--	LS	--	10,000
SUBTOTAL				$1,210,225
TOTAL CIVIL AND STRUCTURAL				$1,803,775
WATER WHEELS, TURBINES AND GENERATORS				$4,451,000
STATION ELECTRICAL EQUIPMENT				$ 594,000
MECHANICAL PLANT EQUIPMENT				$ 79,000
ESTIMATED CONSTRUCTION COST				$6,927,775

APPENDIX D

Letter from State of Washington
Department of Ecology, Dated
December 28, 1978

STATE OF WASHINGTON
Dixy Lee Ray
Governor

DEPARTMENT OF ECOLOGY
Olympia, Washington 98504 206/753-2800
Mail Stop PV-11

December 28, 1978

Mr. Harry P. Hosey
Tudor Engineering Company
Consulting Engineers and Planners
1401 Dexter Horton Building
710 Second Avenue
Seattle, Washington 98104

Dear Mr. Hosey:

Proposed Hydroelectric Installations at PEC 22.7 and Dry Falls Dam

In response to a request dated November 8, 1978 from Mr. Rogers R. Neff, President of the Board, South Columbia Basin Irrigation District, a visual surfacial examination of the canal drop structure, designated PEC 22.7, located about nine miles southeast of Othello, was conducted by the writer on December 13, 1978 in the company of Messrs. Francis Jensen, U.S. Bureau of Reclamation, Ephrata; Max Van Den Berg, U.S. Bureau of Reclamation, Boise; Merle Gibbens, South Columbia Basin Irrigation District; and Lin Wilson, Tudor Engineering Company, Seattle.

Although not specifically requested at this time by Mr. Neff, in anticipation of future action by the Board, this same team made a similar visual examination of Dry Falls (South Banks Lake) Dam on the same date.

Regarding the PEC 22.7 canal drop structure, the examination revealed no significant deficiencies that would preclude this structure from being suitable for the installation of a hydroelectric generating facility as proposed by the South Columbia Basin Irrigation District. Care should be taken in the design and construction, however, to protect the proposed powerhouse and penstock from possible damage that might result from the scouring or splashing action that apparently occurs during high discharge, adjacent to the hydraulic jump at the toe of the spillway chute. A sizable scour hole was observed in the fill material behind the left training wall at this location. In addition, if nearly all of the canal flow will be diverted through the power plant, the design should incorporate features to rapidly adjust from a no flow condition over the spillway to full flow when a sudden plant shutdown occurs. Without such a system, it is possible that the main spillway structure could be damaged and suddenly overtopped, possibly resulting in partial or total failure of the silty embankment materials abutting these structures. In conjunction with this system, all controls and mechanisms should be well protected from vandalism. The existing self actuating controls for the spillway have in the past sustained damage from gun fire. Fencing around the facility, particularly along the spillway training walls, was in disrepair and is totally inadequate. In order to minimize access by unauthorized personnel and cattle and as further protection against vandalism, the entire project should be enclosed (except in the canal) with a high chain link and barbed wire topped fence. Debris and siltation control apparently is an annual problem, suggesting that a better maintenance program will be necessary if and when a power plant is installed.

Concerning the proposed project at Dry Falls Dam — again, there was nothing observed to indicate that this dam would be unsuitable for a hydroelectric installation. Previously reported cracks in the highway surface were repaired by recent repaving and were considered to be superficial with respect to the integrity of the embankment. Seepage lakes have existed below the dam for years, however, there was no evidence of active seepage emerging at the toe of the rockfill. Although seals on the spillway gates leaked considerably and some structural members were exposed to rusting where the original tar coating was missing, all of the gate facilities were operational and appeared to be generally well maintained. Cathodic protection has been installed to minimize further deterioration, and the Bureau is currently considering repainting the gates and repairing the seals. A sizable quantity of rock-rubble which eroded below the end of the concrete spillway channel was deposited in a mound about 100 to 200 feet below this structure. This material was partially obstructing the channel and should be removed to improve its hydraulic capacity. The eroded bed of the channel should be monitored periodically to assess the effect on the spillway structure. Although this currently is not considered a problem, continued erosion in this area might eventually affect the integrity of the concrete spillway channel. Since the proposed power plant will apparently necessitate disturbing the existing dam near the left spillway abutment, it is extremely important that the design incorporate measures to assure the stability of the dam in this area.

Please extend my thanks to all of the participants in this inspection. Their assistance was most helpful and is appreciated.

Very truly yours,

M. Edward Garling

M. Edward Garling
Supervisor, Dam Safety Section
Office of Field Operations

MEG:mg

cc: Rogers R. Neff, South Columbia Basin Irrigation District
Russell D. Smith, South Columbia Basin Irrigation District
John Walker, U.S. Bureau of Reclamation, Boise
Dave Norley, U.S. Bureau of Reclamation, Ephrata

APPENDIX E

Declaration of Non-Significance of Environmental Impact of Dry Falls Dam Power Plant:

Submittal of 11-9-78 and agency responses

FORM S.F. 146 (REV. 1/77)

STATE OF WASHINGTON ENVIRONMENTAL IMPACT

DECLARATION OF SIGNIFICANCE OR NON-SIGNIFICANCE

TYPE OF DECLARATION: [X] PROPOSED [X] FINAL

LEAD AGENCY	PROPONENT
South Columbia Basin Irrigation District	South Columbia Basin Irrigation District

LOCATION OF PROPOSAL

Dry Falls Dam, Coulee City, Grant County, Washington

DESCRIPTION OF PROPOSAL

To construct and operate a 15 MW Hydroelectric Generation Plant contiguous with downstream canal at Dry Falls Dam near Coulee City, Washington. No change is contemplated in existing works or structure, except to divert water therefrom through turbines and to release water at or near present points of discharge within existing works. Purpose and integrity of irrigation project is unchanged.

This proposal has been determined to [ ] HAVE [X] NOT HAVE a significant adverse impact upon the environment. An Environmental Impact Statement [ ] IS [X] IS NOT required under RCW 43.21C.030(2)(c). This decision was made after review by the lead agency of a completed Environmental Checklist and other information on file with the lead agency.

RESPONSIBLE OFFICIAL	TITLE/POSITION	SIGNATURE	DATE
Rogers R. Neff	President of the Board	Rogers R Neff	11-9-78

DISTRIBUTION: ORIGINAL - ENVIRONMENTAL REVIEW CANARY - PROJECT FILE

Formerly ECY 010-4-108

ENCLOSURES:

1. Threshold Statement and Negative Declaration
2. Preliminary Assessment of Environmental Effect
3. Environmental Check List Form

DISTRIBUTION: (29)

Federal Energy Regulatory Commission
Department of Interior, Bureau of Reclamation (6 copies)
Pacific Northwest River Basins Commission
Department of Army, Corps of Engineers
Department of Ecology, State of Washington (6 copies)
Department of Fisheries, State of Washington
Department of Game, State of Washington (2 copies)
Charles H. Odegaard, Parks and Recreation
Grant County Planning Department (3 copies)
Tudor Engineering Company
James Leavy, Esq., Leavy, Tabor, Shultz, Bergdhal & Sweeney
Quincy Irrigation District
East Columbia Basin Irrigation District
South Columbia Basin Irrigation District
Reserved Works Committee
File

PART I

THRESHOLD STATEMENT AND NEGATIVE DECLARATION

UNDER CHAPTER 197-10-300 WAC (WASHINGTON)

PROPOSED HYDROELECTRIC PLANT AT DRY FALLS DAM
(NEAR COULEE CITY)

ADAMS COUNTY, WASHINGTON

COLUMBIA BASIN PROJECT

<u>PROPOSER:</u> South Columbia Basin Irrigation District
Post Office Box 1006, Pasco, Washington 99301
(Correspondence) Russell D. Smith, Secretary to Board of Directors
(Principal Officer) Rogers R. Neff, President Board of Directors
(Telephone) 509-547-1735

<u>LEAD AGENCY:</u> South Columbia Basin Irrigation District
Post Office Box 1006, Pasco, Washington
(Correspondence) Russell D. Smith, Secretary Board of Directors
(Official Representative) Rogers R. Neff, President Board of Directors
(Telephone) 509-547-1735

<u>NATURE AND BRIEF DESCRIPTION OF PROPOSAL</u>: Dry Falls Dam is located on Banks Lake, an Equalizing Reservoir forming a part of irrigation facilities of the Columbia Basin Project operated by South Columbia Basin Irrigation District and owned by the United States, Administered by the Secretary of Interior through the Bureau of Reclamation. As far as proposer knows, the canals carry no commerce.

South Columbia Basin Irrigation District is a public entity existing and operating under Irrigation District Laws of the State of Washington, Chapter 87.03 Revised Code of Washington. The District is in privity of contract with the United States under Contract No. 14-06-100-6420 executed December 18, 1968 by which certain works were transferred for operation and management to the District.

Dry Falls Dam power plant will consist of two 7.5 MW turbine and generator units with an aggregate total installed capacity of 15 MW. Provisions for a third 7.5 MW turbine and generator unit will be provided in the powerhouse construction to produce an aggregate total of 22.5 MW when peak annual irrigation releases reach 16,000 cfs in response to planned future developments by the United States Bureau of Reclamation. Present planned power production is 67.1 million KWH of energy annually, and ultimately 106 million KWH. Two alternative powerhouse arrangements are being considered, namely: (1) locating the turbines within the existing works structure of the dam, and (2) locating the turbines adjacent to present works structures whereby water will be delivered to the turbines through a newly constructed diversion canal from the forebay of Banks Lake, through the dam to the turbines. In either event turbine discharge will be released into the main canal at points currently conducting water to the system. The physical features of the existing irrigation works and system will remain unchanged, preserving the purpose and integrity of the system of irrigation.

Power produced will be transmitted directly from a switchyard to be constructed adjacent to the proposed powerhouse to an existing 115 KV transmission line located at the proposed plant.

All proposed construction will be on the right bank of the canal when facing the head works from downstream of the main canal located adjacent the left bank of the canal will not be disturbed at anytime during or after construction.

ESTIMATED DATE FOR COMPLETION: Late 1982

PERMITS, LICENSES AND APPROVALS:

Power Generation License -	Federal Energy Regulatory Commission (FERC) Honorable Kenneth F. Plumb, Secretary Federal Energy Regulatory Commission 825 North Capitol Street Washington, D.C. 20426
Prior Authority to Construct - Geological Survey Permit, Dam Safety Section (G.S. Tarbox)	Honorable Cecil B. Andrus Secretary of Interior through Bureau of Reclamation Columbia Basin Project P.O. Box 815 Ephrata, Washington 98823 (2 copies)
Project Recommendation -	Pacific Northwest River Basins Commission Mel Gordon, Chairman 1 Columbia River Vancouver, Washington 98660
Hydroelectric Power Review - Columbia Basin Project	District Engineer - Seattle Department of the Army Corps of Engineers 4735 East Marginal Way South Seattle, Washington 98134 Attn: Chief Operations Division
Power Production License - Dam Safety Certification Exception to Water Control Studies Reservoir Permit Flood Control Zone Permit Water Rights	State of Washington Department of Ecology Olympia, Washington 98504 (6 copies)
Hydraulics Project Approval -	Fisheries Biologist Department of Fisheries 5803 Capitol Boulevard Tumwater, Washington 98501
Hydraulic Project Approval -	Regional Fisheries Biologist Department of Game P.O. Box 1237 Ephrata, Washington 98823

State-wide Hydraulics Coordinator
Department of Game
600 North Capitol Way
Olympia, Washington 98504

Charles H. Odegaard
Parks and Recreation
Olympia, Washington 98504

Shoreline Management
Substantial Development Permit
Building Permit

- ECPA Permit Coordinator
Grant County Planning Department
County Courthouse
Ephrata, Washington 98823

CERTIFICATE OF MAILING OF NOTICES: A copy of this notice of Non-significance (Form S.F. 146, Rev. 1-77) together with enclosures of this Threshold Statement and Negative Declaration, Preliminary Assessment of Environmental Effect and Environmental Check List Form has been mailed, postage prepaid to each entity above listed at the address shown.

FUTURE EXPANSION: None

PLANS BY OTHER AFFECTING SITE: None

REFERENCE AND RELATED REPORTS:

FERC Preliminary Permit Application Dry Falls Dam and Summer Falls Power Plants
Tudor Engineering Company

Environmental Statement, Columbia Basin Project
Bureau of Reclamation, Department of Interior
(includes works, structures of proposal)

PART II

PRELIMINARY ASSESSMENT OF ENVIRONMENTAL EFFECT:

Based upon preliminary surveys, particularly with reference to Draft-Environmental Statement, Columbia Basin Project, it is concluded that there would be no significant impact on the environment from the project. Initial assessments arrived at the following findings:

Water Flows - There would be no interruptions in irrigation flows conducted through the present works since construction affecting such flows would be conducted during periods when there are no flows through the works. Operations of the proposed plant is non-consumption and is designed to return all flows into the works. The plant will not alter the discharge delivery schedule dictated by irrigation demands.

Water Quality - No change would be made to water quality during either construction or operation.

Air Quality and Noise - The site is in a remote semi-arid, agricultural non-irrigable location. Construction noises and minor construction dust would be temporary during construction. No noises or emissions into the atmosphere are created by operation.

Vegetation - Loss of vegetation consisting of desert grasses covering an area of approximately 1-1/2 acres would occur by reason of the construction of the power plant, appurtenant structures and parking lot.

Terrestial Wildlife - Loss of approximately 1-1/2 acres of habitat which would result in displacement or loss of reptiles and small mammals which inhabit the area.

Aquatic Wildlife and Habitat - No effects on aquatic wildlife.

Rare and Endangered Species - None known to exist or in immediate vicinity of project site.

Power Resources - Project to generate approximately 22.7 million Kilowatt hours per year.

Land Use - No effect on lands surrounding sit.

Solid Waste Disposal - Spoil from excavations will be graded to construct parking lot.

Recreation - None

Water Use - No effect.

Economics - The total estimated construction cost in 1978 dollars is 7.0 Million Dollars. Of this amount approximately 2.7 Million Dollars will be for labor and materials to be acquired locally. The construction will take about 14 months and will go through the winter season.

Employment - During 14 months of construction the maximum work force will reach 25 workers. It is anticipated that since the construction is in off season, these workers will come from the local labor market. Operation and maintenance will be performed by the existing staff of the district.

Growth Inducing Impact - Localized only during construction period.

Traffic - Some additional traffic generated during construction only.

Scenic Values - Project site is adjacent State Highway 2. Structure above grade will be architecturally pleasing, particularly adapted to the surrounding terrain and being consistant with intended use. Hose structures are below grade.

Archeology and Historical Significance - There are no known archeological or historical sites of interest which will be affected by the project.

PART III

ENVIRONMENTAL CHECKLIST FORM

Note: A copy of the Feasibility Study for Dry Falls Dam prepared by Tudor Engineering Company is on file at the Department of Ecology, State of Washington, Olympia, Washington.

ENVIRONMENTAL IMPACTS

(Explanations of all "yes" and "maybe" answers are required)

	Yes	Maybe	No
1. Earth. Will the proposal result in:			
(a) Unstable earth conditions or in changes in geologic substructures?			X
(b) Disruptions displacements, compaction or overcovering of the soil?	X		
(c) Change in topography or ground surface relief features?	X		
(d) The destruction, covering or modification of any unique geologic or physical features?			X
(e) Any increase in wind or water erosion of soils, either on or off the site?			X
(f) Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet or lake?			X

Explanation: Excavation for construction.

	Yes	Maybe	No
2. Air. Will the proposal result in:			
(a) Air emissions or deterioration of ambient air quality?	___	___	X
(b) The creation of objectionable odors?	___	___	X
(c) Alteration of air movement, moisture or temperature, or any change in climate, either locally or regionally?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
3. Water. Will the proposal result in:			
(a) Changes in currents, or the course or direction of water movements, in either marine or fresh waters?	___	___	X
(b) Changes in absorption rates, drainage patterns, or the rate and amount of surface water runoff?	___	___	X
(c) Alterations to the course or flow of flood waters?	___	___	X
(d) Change in the amount of surface water in any water body?	___	___	X
(e) Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen or turbidity?	___	___	X
(f) Alteration of the direction or rate of flow of ground waters?	___	___	X
(g) Change in the quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations?	___	___	X
(h) Deterioration in ground water quality, either through direct injection, or through the seepage of leachate, phosphates, detergents, waterborne virus or bacteria, or other substances into the ground waters?	___	___	X
(i) Reduction in the amount of water otherwise available for public water supplies?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
4. Flora. Will the proposal result in:			
(a) Changes in the diversity of species, or numbers of any species of flora (including trhes, shrubs, grass, crops, microflora and aquatic plants)?	___	___	X
(b) Reduction of the numbers of any unique, rare or endangered species of flora?	___	___	X
(c) Introduction of new species of flora into an area, or in a barrier to the normal replenishment of existing species?	___	___	X
(d) Reduction in acreage of any agricultural crop?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
5. Fauna. Will the proposal result in:			
(a) Changes in the diversity of species, or numbers of any species of fauna (birds, land animals including reptiles, fish and shellfish, benthic organismx, insects or microfauna)?	___	___	X
(b) Reduction of the numbers of any unique, rare or endangered species of fauna?	___	___	X
(c) Introduction of new species of fauna into an area, or result in a barrier to the migration or movement of fauna?	___	___	X
(d) Deterioration to existing fish or wildlife habitat?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
6. Noise. Will the proposal increase existing noise levels?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
7. Light and Clare. Will the proposal produce new light or glare?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
8. Land Use. Will the proposal result in the alteration of the present or planned land use of an area?	___	___	X
Explanation: ____________________			
9. Natural Resources. Will the proposal result in:			
(a) Increase in the rate of use of any natural resources?	___	___	X
(b) Depletion of any nonrenewable natural resource?	___	___	X
Explanation: ____________________			
10. Risk of Upset. Does the proposal involve a risk of an explosion or the release of hazardous substances (including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?	___	___	X
Explanation: ____________________			
11. Population. Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?	___	___	X
Explanation: ____________________			
12. Housing. Will the proposal affect existing housing, or create a demand for additional housing?	___	___	X
Explanation: ____________________			
13. Transportation/Circulation. Will the proposal result in:			
(a) Generation of additional vehicular movement?	___	___	X

	Yes	Maybe	No
(b) Effects on existing parking facilities, or demand for new parking?	X		
(c) Impact upon existing transportation systems?			X
(d) Alterations to present patterns of circulation or movement of people and/or goods?			X
(e) Alterations to waterborne, rail or air traffic?			X
(f) Increase in traffic hazards to motor vehicles, bicyclists or pedestrians?			X

Explanation: ____________________

____

14. Public Services. Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:

	Yes	Maybe	No
(a) Fire protection?			X
(b) Police protection?			X
(c) Schools?			X
(d) Parks or other recreational facilities?			X
(e) Maintenance of public facilities, including roads?			X
(f) Other governmental services?			X

Explanation: ____________________

____

15. Energy. Will the proposal result in:

	Yes	Maybe	No
(a) Use of substantial amounts of fuel or energy?			X
(b) Demand upon existing sources of energy, or require the development of new sources of energy?			X

Explanation: ____________________

____

	Yes	Maybe	No
16. Utilities. Will the proposal result in a need for new systems, or alterations to the following utilities:			
(a) Power or natural gas?	___	___	X
(b) Communications systems?	___	___	X
(c) Water?	___	___	X
(d) Sewer or septic tanks?	___	___	X
(e) Storm water drainage?	___	___	X
(f) Solid waste and disposal?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
17. Human Health. Will the proposal result in the creation of any health hazard or potential health hazard (excluding mental health)?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
18. Aesthetics. Will the proposal result in the obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
19. Recreation. Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?	___	___	X

Explanation: ____________________

____

	Yes	Maybe	No
20. Archeological/Historical. Will the proposal result in an alteration of a significant archeological or historical site, structure, object or building?	___	___	X

Explanation: ____________________

____

SIGNATURE

I, the undersigned, state that to the best of my knowledge the above information is true and complete. It is understood that the lead agency may withdraw any declaration of nonsignificance that it might issue in reliance upon this checklist should there be any willful misrepresentation or willful lack of full disclosure on my part.

PROPONENT: Rogers R. Neff, President of the Board
SCBID

TUDOR ENGINEERING CO.
SEATTLE

JAN 2 1979

KDS		FGM
MBH		LW
HPH		WCB
BV		BH
		DJH
		BTK
		JWK
		PSP
		DPT
KAD		ADJ
FILE		

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

OEPR-LP
Project No. 2840-
Washington

DEC 27 1978

Tudor Engineering Company
710 Second Avenue, Room 1401
Seattle, Washington 98104

Gentlemen:

This acknowledges receipt of a letter dated November 9, 1978, and environmental declaration documents from Mr. Rogers R. Neff, President of the Board of the South Columbia Basin Irrigation District, requesting our comments on environmental matters pertaining to proposed hydroelectric generating plants on the Potholes East Canal near Othello, Washington, and on the Main Canal at Dry Falls Dam near Coulee City, Washington, FERC Project No. 2840.

At present, our staff has no comments on the environmental declarations; however, we will conduct an independent environmental analysis of the application for license when it is filed with this Commission.

Sincerely,

William W. Lindsay

William W. Lindsay
Director, Office of Electric
Power Regulation

United States Department of the Interior

BUREAU OF RECLAMATION
PACIFIC NORTHWEST REGION
FEDERAL BUILDING & U.S. COURTHOUSE
BOX 043-550 WEST FORT STREET
BOISE, IDAHO 83724

IN REPLY REFER TO: 440
602.

NOV 30 1978

Tudor Engineering Company
Room 1401
710 Second Avenue
Seattle, Washington 98104

Gentlemen:

By letter dated November 9, 1978, Mr. Rogers R. Neff, President of the Board of the South Columbia Basin Irrigation District, requested our comments on a proposed hydroelectric generating plant on the Main Canal at Dry Falls Dam. The environmental impacts of the proposal are being evaluated pursuant to the requirements of Washington State Law.

Based upon the information provided in the November 9, 1978, letter and its enclosures, we have no objections to the Declaration of Non-significance. It will, of course, also be necessary to comply with the Federal environmental statutes, and we presume that the Federal Energy Regulatory Commission will take whatever action is necessary to satisfy the requirements of the National Environmental Policy Act.

Sincerely,

Rod Vissia

Regional Director

cc: Mr. Rogers R. Neff, President
Board of Directors
South Columbia Basin Irrigation District
P.O. Box 1006
Pasco, Washington 99301

Federal Energy Regulatory Commission
825 North Capitol Street
Union Center Plaza
Washington, D.C. 20426

STATE OF WASHINGTON

Dixy Lee Ray
Governor

DEPARTMENT OF ECOLOGY

Olympia, Washington 98504 206/753-2800
Mail Stop PV-11

RECEIVED
SOUTH COLUMBIA BASIN
IRRIGATION DISTRICT
NOV 27 1978
CLAIMS CLK
PAYROLL CLK

November 22, 1978

Mr. Rogers R. Neff
South Columbia Basin Irrigation
District
P. O. Box 1006
Pasco, Washington 99301

Dear Mr. Neff:

Thank you for providing us with review copies of your proposed declarations of nonsignificance on your 5 MW and 15 MW Hydroelectric Generation Stations near Othello and Dry Falls Dam, respectively.

Your environmental documents were reviewed by Department of Ecology (DOE) staff in Olympia and in our Eastern Regional Office in Spokane. Our only comment is to remind you that DOE will have to issue Section 401 Water Quality Certifications (with possible conditions) prior to implementation of the proposals.

Should you have questions, please contact Mr. Claude Sappington in our Spokane Office (456-2926).

Yours very truly,

Peter R. Haskin

Peter R. Haskin
Environmental Review Section

No. 265071

RECEIPT FOR CERTIFIED MAIL

NO INSURANCE COVERAGE PROVIDED—
NOT FOR INTERNATIONAL MAIL
(See Reverse)

SENT TO	Mr. Steve Mitchell
STREET AND NO.	Dept. of Ecology State of Washington
P.O., STATE AND ZIP CODE	Olympia, Wa. 98504
POSTAGE	$ 1.86
CERTIFIED FEE	80 ¢
SPECIAL DELIVERY	¢
RESTRICTED DELIVERY	¢
SHOW TO WHOM AND DATE DELIVERED	45 ¢
SHOW TO WHOM, DATE, AND ADDRESS OF DELIVERY	¢
SHOW TO WHOM AND DATE DELIVERED WITH RESTRICTED DELIVERY	¢
SHOW TO WHOM, DATE AND ADDRESS OF DELIVERY WITH RESTRICTED DELIVERY	¢
TOTAL POSTAGE AND FEES	$ 3.11
POSTMARK OR DATE	

CONSULT POSTMASTER FOR FEES — OPTIONAL SERVICES — RETURN RECEIPT SERVICE

PS Form 3800, Apr. 1976

SENDER: Complete items 1, 2, and 3. Add your address in the "RETURN TO" space on reverse.

1. The following service is requested (check one).
- ☐ Show to whom and date delivered .... ¢
- ☐ Show to whom, date, and address of delivery .... ¢
- ☐ RESTRICTED DELIVERY Show to whom and date delivered .... ¢
- ☐ RESTRICTED DELIVERY Show to whom, date, and address of delivery $____

(CONSULT POSTMASTER FOR FEES)

2. ARTICLE ADDRESSED TO:
Mr. Steve Mitchell, Dept. of Ecology
Olympia, Washington 98504

3. ARTICLE DESCRIPTION:

REGISTERED NO.	CERTIFIED NO.	INSURED NO.
	265071	

(Always obtain signature of addressee or agent)

I have received the article described above.
SIGNATURE ☐ Addressee ☐ Authorized agent

4. DATE OF DELIVERY NOV 1 5 1978 — POSTMARK

5. ADDRESS (Complete only if requested)

6. UNABLE TO DELIVER BECAUSE: — CLERK'S INITIALS

☆GPO: 1977-0-249-595

STATE OF
WASHINGTON

Dixy Lee Ray
Governor

DEPARTMENT OF FISHERIES
115 General Administration Building, Olympia, Washington 98504 206/753-6600

December 11, 1978

Mr. Rogers R. Neff, President of the Board
South Columbia Basin Irrigation District
402 West Lewis Street
Pasco, Washington 99301

Dear Mr. Neff:

Proposed Hydroelectric Plants on
Potholes East Canal and at Dry Falls Dam;
Declaration of Non-Significance

The Department of Fisheries has reviewed the documents pertaining to these proposed projects. Neither site has salmon and we therefore expect no adverse impacts on the resources that this Department is charged with managing.

It is most gratifying to see that hydroelectric generating facilities are feasible at these existing structures.

Sincerely,

Herb Tegelberg

Herb Tegelberg, SEPA Coordinator
Fisheries Natural Production

jp

STATE OF WASHINGTON
Dixy Lee Ray
Governor

DEPARTMENT OF GAME
600 North Capitol Way/Olympia, Washington 98504 206/753-5700

RECEIVED
SOUTH COLUMBIA BASIN
IRRIGATION DISTRICT
NOV 27 1978
ENGR.
CLAIMS CLK.
PAYROLL CLK.

November 20, 1978

Mr. Rogers R. Neff
President of the Board
South Columbia Basin Irrigation District
402 West Lewis Street
Pasco, Washington 99301

RE: Dry Falls Dam 15 MW Hydroelectric Generation Plant, Potholes East Canal 5 MW Hydroelectric Generation Plant; Threshold Determinations and Negative Declaration

Mr. Neff,

Your documents have been reviewed by our staff as requested. Comments follow.

All environmental documents sent to the Department of Game for review should be addressed to our headquarters in Olympia. Untimely delays may be caused by sending these documents to the regional offices.

We found both the Preliminary Assessment of Environmental Effects and the environmental checklists generally provided accurate descriptions of existing conditions, and probable impacts of the proposals. However, mention should have been made of the existence of kokanee in Banks Lake, as well as rainbow trout, lake whitefish, and various spiny rays. These fish descend the canal and would go through the turbine of the proposed generators if a net, installed by the Fisheries Research Institute under contract to the Bureau of Reclamation were to be removed.

Although we have no objection to the project as proposed, we feel that the potential for damage to these fisheries should have been noted.

Thank you for the opportunity to review your document. We hope our comments are helpful.

Sincerely,

THE DEPARTMENT OF GAME

Douglass A. Pineo

Douglass A. Pineo, Applied Ecologist
Environmental Management Division

STATE OF WASHINGTON
Dixy Lee Ray
Governor

WASHINGTON STATE PARKS AND RECREATION COMMISSION
7150 Cleanwater Lane, Olympia, Washington 98504
206/753-5755

RECEIVED
SOUTH COLUMBIA BASIN
IRRIGATION DISTRICT
NOV 27 1978
MANA...
ASST. MGR. & ENGR.
ASST. SE...
CLAIMS CLK.
PAYROLL CLK.

November 20, 1978

35-2640-1820
D-197
Dry Falls Dam
Generation Plant

D-198
Potholes East
Canal Generation Plant

Rogers F. Neff
President of the Board
South Columbia Basin Irrigation District
402 West Lewis Street
Pasco, Washington 99301

Dear Mr. Neff:

The Washington State Parks and Recreation Commission has reviewed these two proposed declarations of non-significance and offers the following comments:

1. In both cases, we can see no demonstrable adverse impacts upon recreation, our area of expertise.

2. Further, we are encouraged to learn that these represent a viable way to generate additional electrical energy to meet the growing demands of the Northwest.

Thank you for the opportunity to review and comment on these declarations. I appreciate Mr. Hosey sending me maps of the areas in question.

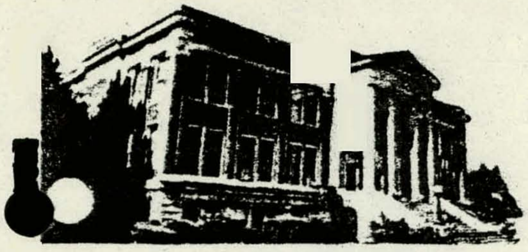
Sincerely,

David Heiser

David Heiser, P.E., Chief
Environmental Coordination

er

cc: Tudor Engineering Company
Steve Mitchell, Department of Ecology



JULIAN S. AGRANOFF, DIRECTOR

GRANT COUNTY PLANNING DEPARTMENT

COURT HOUSE

EPHRATA, WASHINGTON 98823

509/754-2011

GRANT COUNTY COURT HOUSE IS LISTED IN THE NATIONAL HISTORIC REGISTER.

Rogers Neff
President of the Board of Directors
South Columbia Basin Irrigation District
c/o:
Tudor Engineering
710 Second Avenue
Seattle, Wa. 98104

Dear Mr. Neff,

We have reviewed the environmental checklist for the hydroelectric facilities at Dry Falls Dam and have no comment on the declaration of non-significance.

Sincerely,

Bill Henager

Bill Henager
Assistant Director

EXEMPTION FROM SHORELINE
MANAGEMENT ACT SUBSTANTIAL
DEVELOPMENT PERMIT REQUIREMENT

To: ______________________________

The proposal by South Columbia Basin Irrigation District to undertake

the following development Construct hydroelectric generating facilities

upon the following property Dry Falls Dam Sec. 33 T 25N. R.28E.W.M.

____

____

within Banks Lake and/or its associated wetlands is exempt from the requirement of a substantial development permit because the development

is an irrigation related project and is within an artificially created shoreline

The proposed development is consistent or inconsistent with:

CHECK ONE

CONSISTENT	INCONSISTENT	
☒	☐	Policies of the Shoreline Management Act
☒	☐	The guidelines of the Department of Ecology where no master program has been finally approved or adopted by the department.
☒	☐	The master program

12-19-78
(Date)

W. H. Hedager
(Signature of Authorized Local Governmental Official)

STATE OF
WASHINGTON
Dixy Lee Ray
Governor

ENERGY FACILITY SITE EVALUATION COUNCIL
820 East Fifth Avenue, Olympia, Washington 98504
206/753-7384

November 27, 1978

Mr. Rogers R. Neff
President of the Board
South Columbia Basin Irrigation District
402 West Lewis Street
Pasco, WA 99301

Subject: Proposed Small Hydroelectric Generating Facility P.E.C.22.7--Potholes East Canal Columbia Basin Project

References: (1) Your letter of November 8 subject as above, signed by R. R. Neff

(2) Your letter of November 9 transmitting documentation assessing the impact of potholes east canal and dry falls dams, signed by R. R. Neff

Dear Mr. Neff:

This letter provides a statement of applicability confirming that the proposed projects do not fall under the authority of RCW 80.50 because of size and because of the statute's silence on the matter of hydroelectric energy facilities. We, therefore, will not be making comment upon the materials forwarded by reference (2).

Sincerely,

William L. Fitch
Executive Secretary

WLF:se