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ASIAN DEVELOPMENT BANK
PHILIPPINES

FEASIBILITY STUDY FOR INSTALLATION OF SPILLWAY GATES AT KAJAKAI RESERVOIR AFGHANISTAN

AUGUST 1971

IECO INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY ST · SAN FRANCISCO · CALIFORNIA

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PREFACE

The study on the technical and economical feasibility of installing spillway gates at the Kajakai reservoir, commissioned by the Asian Development Bank under its technical assistance program for Afghanistan, has been undertaken by International Engineering Company, Inc. (IECO), the consultants contracted for this purpose. The Consultants retain full responsibility for the contents of this report and for the views expressed therein, which do not necessarily coincide with those of the Bank or of the Government of Afghanistan.

The projections of future production developments and resulting benefits from the installation of the gates and from anticipated irrigation investments are, of necessity,based on the knowledge and experience presently available and using the assumptions indicated. However, it is recognized that given changed circumstances, development may proceed differently and, in particular, that with concentrated efforts and under favourable conditions, progress may be faster than has been projected.

KAJAKAI GATES

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ABBREVIATIONS

UNITS

Area

ac-ft	acre-feet
ha	hectare (1 ha = 10,000 m^2, 2.471 acres)
sq km	square kilometer
sq mm	square millimeter

Electrical

amp	ampere
kV	kilovolt
kVA	kilovolt-ampere
kW	kilowatt
mVA	megavolt-ampere

Energy

Btu	British thermal unit
kWH	kilowatt-hour
mWH	megawatt-hour
gWH	gigawatt-hour

Length

cm	centimeter
km	kilometer (1 km = 1000 m, 0.6214 miles)
lm	linear meters
m	meter (1 m = 3.28 feet, 39.37 inches)
mm	millimeter

Volume

cfm	cubic feet per minute
cu ft	cubic foot
cu m	cubic meter
cu yd	cubic yard
MCM	million cubic meters

Weight

gal	gallon
kg	kilogram (1 kg = 1000 grams, 2.2046 lb)
lb	pound aviordupois (1 lb = 453.6 grams)
QQ	quintal (1 QQ = 45.4 kg, 100 lb)
t	metric ton (1 t = 1000 kg, 2204.6 lb)

Monetary Units

Afs	Afghanis
US $	US dollar (1 US $ = 83.5 Afs)

Miscellaneous

%	percent
avg	average
B/C	benefit to cost ratio
°C	degree Centigrade (0°C = 32° Fahrenheit, 100°C = 212° Fahrenheit)
cap	capita, per capita
El.	elevation above mean sea level
HACU	Helmand Arghandab Construction Unit
HAVA	Helmand Arghandab Valley Authority
max	maximum
min	minimum
MKA	Morrison-Knudsen Afghanistan
rel	relative
sec	second
vel	velocity
USAID	U. S. Agency for International Development
USBR	U. S. Bureau of Reclamation

CHAPTER I

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1.1 GENERAL

International Engineering Company, Inc. (IECO) was retained by the Asian Development Bank - presently providing technical assistance to the Royal Government of Afghanistan - to evaluate the technical and economic feasibility of installing spillway gates at the existing Kajakai Reservoir. Field support of the IECO study team was provided by the Helmand Arghandab Valley Authority, Lashkar Gah, Afghanistan.

1.2 SUMMARY OF STUDIES

The report discusses the following subjects:

- Preparation of preliminary designs and plans for the required spillway structure and gates in the existing ungated spillway channel.

- Study of the construction requirements for the spillway structure and of the agencies that might carry out the construction.

- Reservoir operation studies made to determine the mode of operation and the yield and characteristics of the reservoir, with and without gates and under present conditions. Studies were also made for anticipated future conditions.

- Evaluation of the benefits likely to result from the gate installation. These include estimates of the effects of flood control, improvement of the supply of irrigation water to present irrigated farmlands; provision of additional water to permit the development of new irrigation projects and installation of hydroelectric power facilities at Kajakai Reservoir.

- Study of hydrologic and agricultural information to provide data for the technical studies and economic evaluations described above.

- Study of the effects of improvements in agricultural practices in the Helmand Valley and of possible improvements to traditional irrigation systems.

- Study of the need and requirements for flood forecasting for the Helmand River and Kajakai Reservoir.

- Economic analyses of the costs and benefits associated with construction of the spillway gate structure and of the associated irrigation and power developments.

1.3 CONCLUSIONS AND RECOMMENDATIONS

The conclusions or recommendations resulting from the studies made for this report are as follows:

1. It is technically feasible to install spillway gates in the present ungated spillway channel at Kajakai Reservoir. The installation would consist of eight power-operated radial gates, each 12.19 m wide by 12.0 m high. While some erosion of the terrace gravels in the middle reach of the spillway channel has taken place in the past and will continue in the future, it is not considered necessary or desirable to attempt to protect this reach from further degradation. Only a short length of protective apron downstream of the gate structure is proposed.

2. The capital cost of the spillway gates and structure is estimated to be U.S. $4,575,000, of which $3,280,000 is in foreign currency and the balance of $1,295,000 or Afs 108,100,000 in local currency. The exchange rate used is 83.5 Afghanis equivalent to one U.S. dollar.

3. Operation studies show that, based on the hydrologic period 1947-1970, the present reservoir without gates is capable of providing the optimum theoretical water requirement for the Helmand Valley lands presently under cultivation in Afghanistan except for acceptable shortages in the 1947-48 critical dry period. The reservoir could simultaneously supply the power needs of the near future and provide a measure of flood control when compared with the natural condition of the river before construction of the reservoir. Uncontrolled flood discharges would, however, occur from the reservoir in most years regardless of the mode of operation adopted.

4. Operation of the reservoir to meet increased irrigation demand in the Seraj, Kajakai-Shamalan and Garmsel areas, and the need for additional power, would require the addition of gates on the spillway. The need for the gates for this purpose would depend on the timing of new irrigation developments and on the power load growth in the Helmand-Arghandab Valley. Planning studies are to be conducted for new irrigation projects in the next 5-year developmental plan of the valley. The additional power which would result from the gate installation may not be required for about 20 years.

5. The present addition of gates would provide an increase in flood protection, principally to farmland and canals in the traditional (or non-project) agricultural areas. The reservoir, however, even with gates installed will still permit spills to occur in most of the wet seasons. However, in operation over the 24 years of the study period, spill would be

reduced from an occurrence of 20 times in 24 years to 16 in 24 years by the addition of the gates. Flood discharge peaks from the reservoir would be reduced every year in which spill took place by amounts ranging from 7 percent to 58 percent.

6. The additional flood protection, while economically significant, is not considered to be sufficient to allow any marked change in the nature or design of the traditional canals or headings except perhaps in individual cases.

7. The controlled release of the flood water stored behind the gates will permit better application of water during the irrigation season to farmland currently under cultivation in these traditional areas and will result in improved crop yields.

8. Following installation of gates in the spillway, benefits would be realized from flood control and the improved supply of irrigation water to the traditional farming areas. With agricultural produce valued on the basis of local market prices, these benefits are estimated to produce an internal rate of return of 9.15 percent when compared against the costs of installing and maintaining the spillway gates. At interest rates of 4 percent, 6 percent and 7 percent, the ratios of benefits to costs would be 1.90, 1.44 and 1.27, respectively (see Table IV-3). With agricultural produce valued on the basis of export-import prices, the corresponding rate of return would be 10.1 percent and the benefit cost ratios would be 1.98, 1.52, and 1.35 (see Table IV-11).

9. In satisfying the demand for new irrigation projects and for additional power, the flood control and improved irrigation water supply benefits would be reduced. If the total costs and benefits of the spillway gates, the new irrigation projects, and power development are compared, the internal rate of return would lie between 7.60 and 7.82 percent depending on the schedule of development assumed, and using local market prices to evaluate agricultural benefits. The corresponding ratios of total benefits to total costs for the project development schedule referred to herein as Scheme I (Figure IV-1) would be 1.67, 1.24 and 1.08, for interest rates of 4 percent, 6 percent and 7 percent, respectively (see Table IV-14 and IV-5).

When the agricultural benefits are based on export-import prices the internal rate of return for Scheme I then becomes 7.85 percent and benefit-cost ratios are 1.67, 1.25 and 1.10 for interest rates of 4, 6 and 7 percent, respectively (see Table IV-14 and IV-13).

10. If the rate of return --9.15 percent, based on local market prices for agricultural produce, or 10.1 percent based on export-import prices-- obtained by the provision of partial flood protection and improved water supply to present traditional farmland is considered adequate, the spillway gates should be built as soon as reasonably possible. If not, the installation of gates should be postponed until they are required by the development of new irrigation projects or additional stages of the

Kajakai power installation. Postponing the installation of the gates for a period such as five years, while assuming any of the project development schedules utilized herein, does not improve the economics of the project.

11. Assuming that approval of the project could be obtained by the end of September, 1971 and that a construction contract were awarded by June, 1972, installation of the spillway gates could be completed before the flood season of 1974. If approval of the project is delayed by about six months until March, 1972, the gates could not then be completed until the flood season of 1975.

12. The planning for future developments should endeavor to set up criteria to optimize multiple-purpose operation of the reservoir for flood control, irrigation and power.

13. The need to improve agricultural and irrigation practices and the technicalities involved are well understood by the agencies responsible for development in the Helmand Valley. The main barriers to be overcome are sociologic and economic, rather than technical. Additional effort, however, is required to obtain and maintain records and data on flood damage, irrigation water use, and agricultural practices in the traditional or Non-Project Areas for use in future planning studies.

14. Construction of the spillway gates and structure is a major undertaking requiring considerable skill and experience and should be carried out by an established experienced outside contractor or agency. It is, however, desirable to utilize both the personnel and equipment of the Helmand Arghandab Construction Unit to the greatest possible extent either as a sub-contractor or joint venture partner. This, it is believed, would minimize the mobilization period; facilitate use of local resources; provide experience for local personnel; and minimize investment for heavy equipment, which might not be economically utilized after construction of the gate structure.

CHAPTER II

INTRODUCTION

2.1 PURPOSE

This report is prepared for the Asian Development Bank and concerns a Technical Assistance Agreement between the Royal Government of Afghanistan and the Bank for assistance in preparing certain technical studies relating to the Helmand River, Afghanistan.

The report evaluates the economic feasibility of installing spillway gates on the spillway of Kajakai Reservoir. The project location is shown in Exhibits 1 and 2.

2.2 AUTHORITY

The engineering services were authorized under an agreement dated 15 October 1973, between the Asian Development Bank and International Engineering Company, Inc., San Francisco, California, U.S.A.

2.3 SCOPE

The scope of the engineering services covered by this report is as outlined for Part A of the Project in the Terms of Reference of the contract. In general, the services consist of the preparation of designs and estimates for the spillway gates, quantification of flood damage and agricultural and power benefits, preparation of first-stage reservoir operation studies, and recommendations on related hydrologic and agricultural features.

2.4 PRIOR STUDIES

Engineering studies for provision of spillway gates on Kajakai Reservoir were made by IECO during the initial design and construction period of the Kajakai Project (Reference 5). No prior studies have been made on the economic benefits of installing gates, but related reports dealing with agricultural benefits in the areas downstream of Kajakai Reservoir have been made by USAID-USBR. Power studies for Kajakai Reservoir were also made by R.W. Beck, and benefits of the power installations were evaluated. Several operation studies have been made in the past by IECO, R.W. Beck, and the USAID-USBR. These studies are discussed hereunder in the appropriate place.

2.5 ACKNOWLEDGMENTS

The authors of this report gratefully acknowledge the excellent cooperation and willing assistance provided by staff members of the Ministries of Works and Planning of the Royal Government of Afghanistan, the Helmand Arghandab Valley Authority, the Helmand Arghandab Construction Unit (HACU), the U.S. Agency for International Development and the U.S. Bureau of Reclamation.

2.6 ADDENDUM

At the time of completion of this report, additional stream flow data for Kajakai reservoir became available. These data show that the water year 1971 is likely to have less inflow than the year 1947 which has until now been considered as the driest year of record. With 1970 also a year of low runoff, the critical period 1970-1971 will be more severe than that assumed in this report. See pages A-5 and A-7 in Appendix A.

It is not possible to revise the studies to conform with this data; however the basic effect would be to require a greater carry-over storage in the reservoir to satisfy irrigation and power requirements which would then reduce the space available for flood control storage and for implementing river flows in the irrigation period. Since these conditions prevail for both the gated and ungated conditions, the general effect is to make the provision of additional reservoir storage space more beneficial. It is therefore considered that the economic analyses made herein are still valid; however, some revision of the reservoir operation criteria would be necessary in practice.

CHAPTER III

SPILLWAY DESIGN AND CONSTRUCTION

3.1 INTRODUCTION

The spillway for Kajakai Reservoir now consists basically of an unlined channel in the right abutment. This channel, which was excavated through rock, located about 700 meters distant from the dam, leads to a natural depression that curves back to join the main river about 300 meters below the toe of the dam. The overall length of the spillway channel is about 1450 meters. In the upstream rock cut, the channel is 113.6 meters wide at its invert and is controlled by a concrete slab with a sharp upstream crest located at El. 1033.5. Details of the existing spillway are shown on Exhibit 3.

When initially designed, the reservoir was intended to be raised by adding a future gated structure in the spillway, and a tentative design was prepared beforehand. The discharge capacity of the spillway, both gated and ungated, would be sufficient to pass the discharge resulting from routing the floods, described hereunder, through the reservoir. The larger of these two floods would have an anticipated outflow of approximately 430,000 cfs with only a nominal freeboard. Dimensioning of the present spillway cut was thus affected by the needs of both present and future conditions.

The arrangement of the dam outlet works and proposed future power plant are shown on Exhibit 6. For further details of the original designs see Reference 5.

3.2 DESIGN FLOOD AND OPERATING CRITERIA

The criterion for establishing the original spillway capacity both gated and ungated was to pass the following floods:

- a hypothetical flood with a peak inflow of 318,000 cfs without encroachment on normal freeboard, and
- a hypothetical flood with a peak inflow of 480,000 cfs to be routed through the reservoir without overtopping the dam.

For the present study, the spillway design flood was reviewed as discussed in Appendix C and resulted in a peak inflow of 440,000 cfs. The spillway was then sized to pass this flood through the reservoir and provide a freeboard of about 1.0 meter. Under these criteria, the maximum reservoir water surface would be El. 1049.0, and the peak outflow would be 408,000 cfs. The discharge rating curve for the spillway is shown on Exhibit 4. At 430,000 cfs, the discharge previously designed for, the freeboard would be reduced to about 0.50 meters, which is a small improvement on present conditions.

Routing of the design flood was done so that the outflow was less than the inflow until the reservoir was surcharged to El. 1045.9, at which point the outflow was made equal to the uncontrolled crest capacity. In any final design, an operation procedure should be stipulated to avoid excessive spills from the gates when the reservoir is full or nearly full. The discharge of the eight gates fully open with the reservoir at El. 1045 would be about 250,000 cfs.

3.3 SPILLWAY LAYOUT

A. Geology - The main spillway cut is located in a body of sound dolomitic limestone whose bedding planes are gently tilted in a downstream direction. The spillway cut at the existing crest is about 50 meters high, and the rock, after some twenty years of exposure, is still fresh and sound. Marked joints are observed in directions transverse and parallel to the spillway centerline. A distinct fault is observed running the length of the spillway and dipping towards the left abutment. Drill Hole DH 101, see Exhibit 3, located near the crest structure, shows the fault to exist at about 7.0 meters below the present channel level, and to be 2 meters in thickness and filled with gouge material. Treatment of the fault, however, should present no unusual difficulties. In general, the rock is sound and suitable for supporting the proposed spillway structure.

Downstream of the present spillway cut the depression is overlain by terrace gravels, which have been weakly cemented but become more strongly cemented with depth. Operation of the spillway has eroded much of this material, leaving numerous large holes some 5 to 8 meters or more in depth. The gravels are of variable thickness. Drill hole DH 104 was carried through 25 meters of this material without hitting bedrock. Operation of the spillway either under present or future conditions will continue to erode this material some of which will be deposited, as it has in the past, in the main river channel. The terrace gravels form a part of a large deposit extending across the basin, which lies to the north and northeast of the spillway channel. The deposit thins out, however, along the lower east/west portion of the spillway escape channel and limestone is again seen on the invert about midway along this channel. Two other drill holes (DH 102 and DH 103) assist in defining the terrace gravel and rock profile near the end of the original spillway cut.

B. Spillway Layouts - In determining the spillway layout, a basic factor is how the erodible terrace gravels should be dealt with. No special treatment should be given to these materials, since it would require a large expenditure to excavate this material, to form the required channel in rock or terrace gravels, and to provide concrete lining. It is preferable to continue to permit erosion to take place and treat this as a maintenance measure as is now being done. The channel should eventually tend to stablize itself because of its shape and the harder underlying bedrock.

The crest structure should then be located in the rock cut at a sufficient distance upstream of the beginning of the erodible material to avoid undermining of the terminal structure. On the other hand, economic studies indicate the desirability of locating the crest structure as far downstream in the rock cut as possible to minimize excavation costs. The location shown in Exhibit 4 was selected to optimize the above factors.

The new crest structure was therefore located just downstream of the existing crest, and a short length of downstream apron was provided to protect the new crest structure. The apron is provided with a mild flip bucket and a cut-off excavated into the rock.

The crest structure was sized to use eight 40-ft wide gates due to the constraint of the existing channel width. Economic studies were made to optimize the costs of the gate height and the excavation required upstream and downstream of the crest. These studies resulted in the configuration shown on Exhibits 4 and 5.

Due to the jointed nature of the rock, a grout curtain and drains will be required under the crest structure and in the abutment walls. Rock anchors will be utilized on the abutments at the crest structure and under the slab and side walls of the downstream apron. Underdrains will be provided and special treatment of the faulted zone will be required. This zone will be excavated over the width of the crest to a depth of 20 to 30 meters, as found necessary and backfilled with concrete. The fault channel can be used to carry the main drainage header. The downstream apron and cut-off will also be reinforced and deepened where made necessary by the fault.

Eight steel radial gates 12.19 m wide x 12.0 m high will be provided. These will be operated by electrically driven hoists. Power will be supplied by a 3-phase, 4-wire, 380/220-volt line from the proposed powerhouse. The estimate includes a standby diesel unit in case of power failure.

Access to the spillway will be by a roadway to the left side of the bridge deck crossing the spillway. Since the reservoir will be drawn down below crest level every year, no provision is made for stop logs upstream of the gates.

Earlier reports have indicated that additional excavation of the spillway channel at the exit to the main river is needed to protect the power plant. While this appears to be desirable and necessary, no cost is considered herein for this feature as it is independent of the proposal to install gates.

3.4 COSTS

The total construction cost of the spillway structure and gates is $4,351,000, as discussed in Chapter IV. The capital cost, assuming a composite interest rate of 6 percent for both foreign and local currency, would be $4,575,000 of which $3,280,000 would be in foreign currency and the balance of $1,295,000 in local currency. At an exchange rate of 83.5 Afghanis to one U.S. dollar, this would be equivalent to Afs 108,100,000.

3.5 PLAN OF IMPLEMENTATION

A. Schedule for Construction - A program for installing the spillway gates, assuming that such installation is to be made following completion of this report, is shown in Figure III - 1. A period of one year has been allowed for administrative approval, final design, preparations of plans and specifications and bidding. This would permit construction to commence shortly after mid-1972. The main factor affecting construction is that the spillway normally operates for considerable periods in the wet season of April through June (see Table A-3). Construction operations are therefore assumed to be virtually suspended in this wet season. Preferably, the mid-1972 date should be met to allow time for excavation of the spillway channel before the wet season of 1973 and (to catch the spring runoff) construction of the spillway structure and gates before the subsequent wet season in 1974. With this schedule, the stand-by generating unit would be required for gate operation until the power plant, which would also be under construction, is completed. If approval of the project is delayed by a further six months until March 1972, the effect would be to delay construction by one year. This is illustrated in an alternative construction schedule shown in Figure III - 2.

B. Design and Construction - The spillway installation is a major hydraulic structure some 20 meters in height that will be operated to pass discharges for considerable periods in about two out of every three years. It is important that both the design and the construction be carried out by organizations experienced in this type of work.

Construction will principally involve hard rock excavation, rock drilling and grouting, concrete placement, and installation of structural steel gates. The safest and the most expeditious method of construction would be to employ, following normal bidding procedures, an established contracting firm who would be responsible for all facets of the construction, including the supply of labor and materials. An exception would be the supply of radial gates and hoists, which would be handled by separate contract.

There would, however, be advantages to some form of association between the main contractor and the Helmand Arghandab Construction Unit (HACU) as discussed hereunder. In this way, the main contractor would provide the most economical use of heavy equipment available in his own organization, and potential conflict with other HACU projects - such as the Shamalan Unit, if constructed at the same time - would be avoided. The period for which equipment will be used will be short; such equipment, if purchased especially for the project, would have to be used in similar projects if it is to be used economically. Construction of the gates to follow the schedule in Figure III - 1 would mean that construction was being done concurrently with work on the new powerhouse. It would also reduce mobilization costs if the same contractor were to carry out both operations.

3.6 HELMAND ARGHANDAB CONSTRUCTION UNIT (HACU)

The Helmand Arghandab Construction Unit has been in existence since about 1955. It was originally set up as a part of Morrison-Knudsen Afghanistan (MKA) at the request of the Afghanistan government. The original intent was to train and equip the organization to be the construction division of the Helmand Valley Authority and, as such, to handle new construction as well as maintenance work for the Authority.

Upon completion of MKA operations in 1962, the equipment, shop facilities, warehouses, spare parts and tools were turned over to HACU to supplement what they had acquired during their organizational and training years. HACU set up their headquarters at Chah-i-Anjirs, which is near the Helmand Valley Development works and only a few miles from Lashkar Gah - the location of the Helmand Arghandab Valley Authority headquarters.

HACU also acquired, and still has, a well-trained labor force consisting of equipment operators, carpenters, masons, welders, steel workers, drillers, heavy and light duty mechanics, and warehousemen as well as a considerable number of foremen. The organization has broadened its scope in the past few years and now bids on a more or less competitive basis for building and civil construction works.

At present, HACU is preparing to carry out the reconstruction works of part of the Shamalan Land Development Area. For this work, they have secured an AID Loan, valued at about $1,900,000, for new construction equipment, spare parts and tools. Of these, the following items could be used for construction of the Kajakai spillway structure provided the construction schedules of the two projects were compatible:

2 Tractor Shovels	2 cu yd
1 Truck Tractor and Lo-Bed Trailer	75 tons
6 Dump Trucks (for Aggregate Hauling)	10 cu yd
2 Rubber-Tired Dozers	
2 Welding Machines	300 amp
11 Pickups, 3/4 tons	
2 6-in. Water Pumps	
3 Flat-Bed Trucks	
6 Pneumatic Vibrators	
2 Truck Cranes	25-30 tons
1 Generator, Diesel-Driven	75 kW
2 Generators, Diesel-Driven	30 kW
1 Truck-Mounted Lubricator	
1 Fuel Truck Tanker	1,200 gal.

With a new value of about $412,000, the above equipment is estimated to require about $45,000 worth of parts for rehabilitation if used subsequent to the completion of the Shamalan and this should then be sufficient to serve through the gate construction period.

For the rock work, HACU has eight or nine w[illegible] drills, secured through USAID several years ago. These are still [illegible] and it is understood that they were new when received. Drill steel and bits are also available but blasting supplies would, however, be required.

The investment required for HACU to do the work entailed in this project without outside assistance, assuming that equipment was available from the Shamalan construction as described above, is estimated as follows:

		Cost/U.S. $
Spare Parts (for Rehabilitation of Shamalan equipment)		45,000
3 Air Compressors - Rehabilitate		27,000
1 Rock Shovel - Rehabilitate		17,500
1 80 D-Dragline - Rehabilitate		17,500
1 Screening Plant - Rehabilitate		10,000
1 Motor Patrol - Rehabilitate		5,000
Grout Equipment		20,000
400 Amp Welders - New		7,500
End Dump-Rock Bed Trucks - New		153,000
Concrete Plant - New		35,000
Spare Parts (during Construction)		34,000
Subtotal		371,000
Contingency		55,000
TOTAL Investment	U.S. $	427,000

If the spillway structure were to be built at the same time as the Shamalan construction so that the Shamlan equipment would not be available, the following investment would then be required:

		Cost/U.S. $
3 Air Compressors - Rehabilitate		27,000
1 Rock Shovel - Rehabilitate		17,500
2 D-8 Dozers - Rehabilitate		20,000
1 80-D Dragline - Rehabilitate		17,500
1 Screening Plant - Rehabilitate		10,000
1 2-cu yd Loader - Rehabilitate		10,000
1 Motor Patrol - Rehabilitate		5,000
2 6-in. Pumps - Rehabilitate		5,000
4 Welders, 400 Amp - Rehabilitate		4,000
Grout Equipment - New		20,000
4 Pickups (Transport) - New		16,000
3 15-cu yd End Dumps - New		153,000
1 Service Truck - New		25,000
1 100-kW MG Plant - New		10,000
1 15-kW Light Plant - New		3,000
1 300-Amp Welder - New		2,000
1 Concrete Plant - New		35,000
1 Flat Bed Truck - New		8,000
Spare Parts (during Construction)		39,000
Subtotal		427,000
Contingency		64,000
TOTAL Investment	U.S. $	491,000

In selecting a construction organization for the spillway gate construction, there are apparent advantages to employing HACU, particularly if difficulty should exist in obtaining contractors willing to undertake the problems of mobilizing for a relatively small contract. Apparently also restrictions in the terms of the financing for the spillway and the powerhouse construction would render it unlikely that foreign contractors other than HACU could operate on both projects. On the other hand, the magnitude and importance of the concrete work, the tolerances for assembly and installing the gates, and the extent of the rock excavation are outside the past experience of HACU and its supervisory personnel.

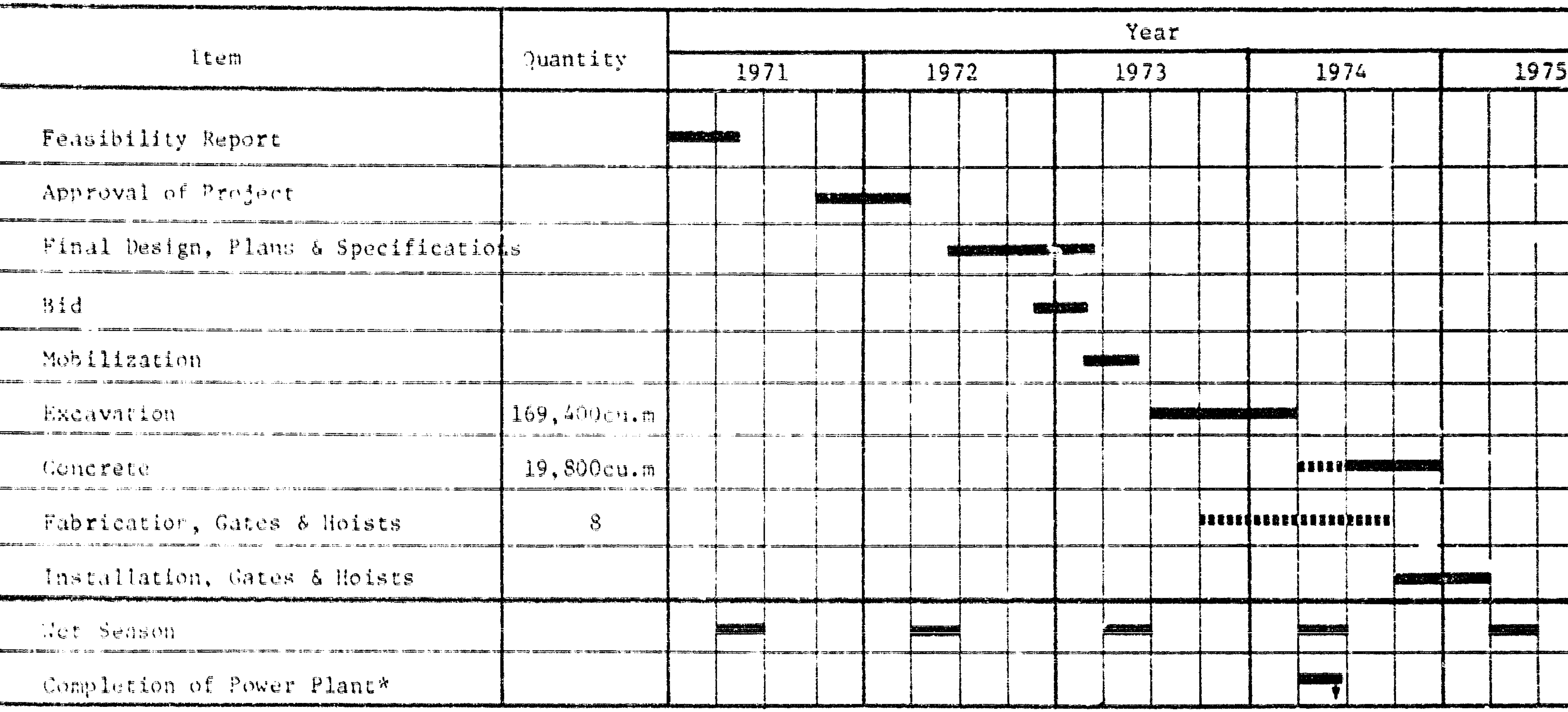
The preferred method would therefore be to employ HACU as a joint venture partner or subcontractor, supplying local labor and some equipment items rather than as a sole or main contractor. Alternatively, the use of a construction management team to supplement HACU supervisory and technical staff could be considered provided such a team had sufficient authority to implement any steps required for satisfactory prosecution of the work.

Item	Quantity	Year 1971	1972	1973	1974
Feasibility Report					
Approval of Project					
Final Design, Plans & Specifications					
Bid					
Mobilization					
Excavation	169,400 cu.m				
Concrete	19,800 cu.m				
Fabrication, Gates & Hoists	8				
Installation, Gates & Hoists					
Wet Season					
Completion of Power Plant*					

* Separate project, by others

CONSTRUCTION SCHEDULE FOR SPILLWAY STRUCTURE

(ALTERNATIVE I)



* Separate project, by others.

CONSTRUCTION SCHEDULE FOR SPILLWAY STRUCTURE

(ALTERNATIVE II)

CHAPTER IV

ECONOMIC EVALUATION

4.1 COSTS

A. Definitions - The following definitions are used in this report:

1. Total direct cost - The sum of all costs directly chargeable to the construction of the project, excluding contingencies.

2. Contingency - An allowance to cover the cost of minor items n estimated in detail, unforeseen conditions and other miscellaneous expenditures not directly covered.

3. Engineering and administration - Costs for design engineering (office and field), supervision of construction and administrative charges.

4. Total construction cost - The sum of the total direct costs, the contingency allowance and the cost of engineering and administration.

5. Total capital cost - The total construction cost plus the value of interest charged on capital during the construction period.

6. Interim replacement costs - Costs for replacing facilities, including gates, hoists and electrical equipment, whose estimated useful life is shorter than the assumed project life.

B. Cost Estimates - Cost estimates for the gated spillway are shown in Table IV-1 and are based on the layouts shown in Exhibits 3, 4, and 5 and described in Chapter III. Estimates of quantities are generally based on takeoffs from these drawings. Unit costs are obtained by breakdown of component costs or from experience data for items of lesser importance. The costs of gates and hoists are based on estimates provided by manufacturers undertaking international bidding. Contingencies are estimated as being 15 percent of the direct costs for all items. Costs for engineering and administration are estimated to be 14 percent of the total direct cost. The total construction cost of the spillway structure, as shown in Table IV-1, is $4,351,000. As defined above, this cost does not include interest during construction.

This estimate is based on prices as of April, 1971. No allowance is made for future escalation except that unit prices assume normal escalation within the construction period. The exchange rate used in this report is 83.5 Afghanis equal to one U.S. dollar.

C. Capital Costs - Interest during construction is based on the construction schedule shown in Figure III-1 at the appropriate interest rate.

D. Annual and Replacement Costs - Allowances for these costs are as follows:

1. Interim replacement costs were assumed to be 1 percent of their construction cost.

2. Insurance includes an allowance for damage, vandalism, property damage and public liability. A rate of 0.1 percent of the construction cost of the gates and hoists was used as an estimate of these costs.

3. No allowance was made for taxes of any kind.

4. Operation and maintenance annual values were based on experience data for similar projects. Allowances of 0.2 percent of the construction cost of the concrete structures and 1 percent of the construction cost of the gates, hoists and electrical equipment were adopted.

The total annual cost based on the above values was found to be $30,000.

4.2 BENEFITS

A. General - The benefits which will accrue from installing spillway gates comes from utilizing the additional 819,000 ac-ft of storage made available in the reservoir. A detailed discussion of these benefits and their derivations is contained in Appendix B, and the benefits have been divided into the following categories:

- Flood control,
- Improved supply of irrigation water to present farmland,
- Provision of irrigation water for new farmland, and
- Power generation.

B. Flood Control Benefits - Flood control benefits are considered to be applicable only to the Non-Project Areas in the Upper Area delineated in Exhibit 2 and Appendix B, with the exception of minor amounts resulting from improvements in maintenance costs of structures in the Project Areas. Operation studies, which are discussed in Appendix A, show that the addition of spillway gates will not completely control flooding but will produce a partial improvement in the effects of flooding. This improvement, however, results in a reduction of about 17 to 22 percent in damage to the canals and headings and to flooded farmland, and will increase the yield from the farmland where it has been affected by floods. The annual benefits attributable to the reduction in the above damages are detailed in Appendix B and listed in Table IV-2. As operation of the reservoir changes from the present mode to meet future requirements, it is assumed that the effect of flood control will be reduced, and the annual benefits are assumed to be reduced to 30 percent of the values shown in Table IV-2.

C. Improved Supply of Irrigation Water - An improved supply of irrigation water to present farmland is considered to be applicable to both the Lower and Upper Areas defined in Exhibit 2 and Appendix B; however, the Chakhansur subdivision of the Lower Area will be examined independently in some of the following analyses.

The benefits attributable to improved supply of irrigation water stem from the fact that the increased volume of water stored every year in the reservoir and released in the irrigation season will permit the application of additional beneficial water to farmland served by individual canals. This will result in an increased yield from the farmland, the benefits of which are tabulated by areas in Table IV-2. These benefits would also be reduced to 30 percent of their values shown when the operating mode of the reservoir is changed to meet future irrigation and power demands.

D. Irrigation of New Land - The irrigation of new land would be possible by using the additional stored water since - if unacceptable shortages are to be avoided in a critical dry period - the ungated reservoir would only be able to meet present irrigation, flood control, and first stage power demand. With the addition of gates, more water is then made available to develop new lands in the Upper Area (Kajakai-Shamalan and Seraj) and the Garmsel subdivision of the Lower Area. No provision is made for increased supply to the Chakhansur Area in this analysis. The annual net benefits attributable to these developments are derived in Appendix B and summarized by area in Table IV-2, together with the construction costs required to develop the areas. These benefits are the values which would result from full development of the area and would begin to accrue only after these areas were developed.

E. Power - Power will be supplied to the Helmand Arghandab Valley system, which is soon to be expanded by the power facilities at Kajakai Reservoir. By installing gates, the increased yield will permit additional power generation for when the system demand increases above the capabilities of the present reservoir. If the gates were not installed, the power demand would have to be met by the construction of other facilities. The power benefits would, therefore, be the difference in costs between the Kajakai facilities and the alternative facilities, which are assumed to consist of a series of diesel generating plants, as discussed in Appendix B. The costs of the Kajakai facilities and the alternative thermal facilities are summarized in Table IV-2. These benefits would begin to accrue when new power capabilities are required and installed.

4.3 ECONOMIC ANALYSIS

A. General - A study of the potential benefits and the operation studies shows that the benefits are in two categories: the first, which includes flood control and an improved water supply to present land, has the benefits beginning with the installation of gates and entails no other development costs; the second, which includes water supply to new farmland and power, has the benefits commencing only when these projects are constructed, and expenditures are considerably in excess of those required for the spillway. However, under the assumptions made in the operation study, the gates are necessary to permit these new projects to be undertaken.

The following analysis is made on the basis of total costs and benefits, including the additional projects, and it was not considered necessary to allocate only a portion of the benefits from other projects to the spillway gates. The analysis is made on a present-worth basis due to scheduling of costs and benefits.

B. Schedule of Development - The analysis is made on the basis of a 50-year life for all the projects considered. The development schedule for the irrigation projects is shown in Scheme I of Figure IV-1. The development schedule of the new irrigation projects used herein is an estimated one, as no firm prospects presently exist for these developments. However, items in the 5-year plan currently being prepared include provision for planning studies to develop the Seraj and Garmsel areas. The adopted schedule calls for continuous development of the areas, with the construction period for each spanning over five years. A gap is provided between the Seraj and Kajakai-Shamalan developments to permit possible development of land in the Darweshan area (see Table B-1) although no benefit is taken for the Darweshan development. Construction expenditures are assumed to occur at the end of the second year of construction. Benefits are assumed to begin after the third year of construction and to reach full development, in each case, after 10 years. While these projects are assumed to have the same life as the spillway gates, only those portions of the benefits occurring within the period assigned to the gates (50 years) are included. To account for the inclusion of all the construction costs of these projects, a salvage value is allowed for each project by straight-line depreciation and occurring at the end of the 50-year gate life.

The power developments follow the schedule as shown in detail for the 5 percent projection rate in Figure B-1, and summarized in Scheme I (Figure IV-1). Again, benefits are aggregated only in the period of the gate life, with salvage values assigned to both hydro and thermal construction costs on a straight-line basis. Replacement of the diesel plants is assumed to be at 15-year intervals, while the hydro plant is assumed to have the same life used for the gates (50 years).

Benefits from flood control and improved water supply to present land are taken to begin one year after completion of the gates and to continue for the life of the gates. Without the addition of other projects, they would continue at the annual amounts shown in Table IV-2. However, with the inclusion of the other projects, these benefits would accrue at these maximum rates until the benefits from the Kajakai-Shamalan Development begin, reducing linearly thereafter until the last of the hydroelectric installations is complete. From this point, these benefits would continue at the reduced rate (30 percent) to the end of the period studied. The schedule for this is shown in Scheme I (Figure IV-1).

The above schedule is based on the construction schedule in Figure III-1, showing completion of the gates in 1974. The analysis is assumed to run from January, 1974, and interest during construction is allowed on the gate construction cost from mid-1973.

C. Summation of Costs and Benefits - If no other developmental projects were built, the flood control and water supply benefits would continue for the full 50-year period. Table IV-3 shows the present worths of costs and benefits and the benefit-cost ratios with only these benefits charged against the cost of the spillway gates. The internal rate of return under these assumptions is 9.15 percent with the Chakhansur water supply benefit included and 5.6 percent, excluded. As discussed in Appendix B, the Chakhansur benefits for improved irrigation water supply should, however, be included, and further discussion will be restricted to this criterion. Hence, with no other development projects considered, the internal rate of return would be 9.15 percent and the benefit-cost ratios would vary from 1.90 to 1.01 for interest rates at 4 percent to 9 percent (see Table IV-3).

When the other developmental projects for new irrigation lands and power are included, the costs and benefits associated with each project form a time series as shown on Table IV-4 for the Scheme-I schedule of development. The present worths of this time series for various interest rates are shown in Table IV-5, which also shows the benefit-cost ratios. Table IV-14 shows the internal rates of return for the various components of the project and for the combined project. With the projects thus combined, the internal rate of return is found to be 7.60 percent if the gates are constructed by 1974.

The effect of the individual projects on these rates should be reviewed. When the flood control and improved irrigation water supply benefits are reduced to account for the influence of the other projects, the internal rate of return for these reduced benefits compared alone against the gate costs falls to 8.25 percent from 9.15 percent obtained above for the full benefits. Under the combined project benefit and cost summation, the gates represent 31 percent of the present worth cost and the flood control and improved irrigation water supply represent 33 percent of the benefits, using an interest rate of 8 percent which approximates the internal rate of return.

The internal rates of return for the irrigation projects on new land are shown in Table IV-14 to vary from 6.04 percent to 7.78 percent for the Scheme I schedule. These rates, however, which do not include any allocation of gate cost, serve to depress the average rate of return. At an 8 percent interest rate, these figures represent approximately 62 percent worth of the costs and 59 percent of the benefits.

The power benefits have an internal rate of return of 9.29 percent, excluding any allocation of gate cost. Power may therefore been seen as improving the average rate of return, and, at an 8 percent interest rate, represents 7 percent of the present worth of the costs and about 8 percent of the benefits.

The above present-worth cost percentages may be compared with the actual construction cost expenditures as shown in Table IV-2, which are $4,351,000, $22,250,000 and $13,660,000 for the gates, irrigation projects and power installation, respectively, and represent 11 percent, 55 percent and 34 percent of the total construction cost of $40,261,000.

Because of the above factors, to evaluate the rate of return, careful consideration must be given to the effects of the new irrigation projects. It was not considered realistic at this juncture, to attempt to evaluate the effect of modifying or eliminating the irrigation projects in favor of other project functions.

D. Effect of Variations in the Period of Analysis - As discussed earlier, only a portion of the costs and benefits of the new irrigation and power developments is included in the analysis under a 50-year gate life because these developments are required much later than the date assumed for construction of the gates. To check the effects of the above assumptions, an analysis was run for Scheme I on the same basis as that described above but using a 75-year life instead of 50-year life for the project. The effect of this was found to be small. By comparing the internal rates of return for 50 and 75 years in Table IV-14, the internal rate of return for the combined projects can be seen to increase from 7.6 percent to 7.9 percent. All additional analyses were therefore made on the basis of the 50-year life.

E. Effect of Variations in the Development Schedules - The effect of delaying the new irrigation projects was studied by assuming that each one was delayed by five years as illustrated in Schemes II and IV of Figure IV-1. The schedule shown for these projects in Scheme III is the same as for Scheme I.

The effect of variation of the power development was considered to be best incorporated by advancing the development to meet the 8 percent load projection shown in Figure B-1. This development schedule is summarized in Schemes III and IV of Figure IV-1. The power schedule in Scheme II is the same as that in Scheme I. Accelerating the power development has the effect of increasing the internal rate of return of this feature alone from 9.29 percent to 11.28 percent.

Table IV-6 shows a cost-benefit stream for Scheme IV that follows the pattern in Table IV-4 for Scheme I. Permutation of the values in Table IV-4 and IV-6 will give the costs and benefits for Schemes II and III, with some modification of the flood control and unproved water supply benefits.

Present worths, benefit-cost ratios and internal rates of return were then obtained for these schemes, the results being shown in Tables IV-7 through IV-14.

As might be anticipated from studying Figure IV-1, these variations made little difference to the overall economic picture, and Scheme I may therefore be taken as representative for the economic analysis.

F. Effect of Postponing the Gate Construction - The effect of postponing the gate construction by five years was considered by making an analysis for schedules similar to Schemes I and IV but with the gates constructed by 1979, instead of 1974. The basic effect of this is to reduce the flood control and improved water supply benefits by five years, initially, while accumulating additional discounted benefits at the end of the 50-year period. The overall effect of this is insignificant as seen by the internal rates of return obtained for these conditions shown in Table IV-14.

Since the flood control and improved water supply benefits begin immediately upon completion of the gates but those from the new projects begin only on completion of these projects, it can be seen that the timing of the gate construction is basically a question of whether to provide the flood control and improved water supply functions immediately or to postpone construction until it is required by the development of new projects.

4.4 ALTERNATIVE ECONOMIC ANALYSIS

The foregoing analysis has been based on using local market prices to derive the value of agricultural benefits. An alternative approach is to use socio-economic prices, in which the value of farm products is based on their export or import prices. The main effect of this approach is a change in the prices applying to wheat and cotton. In addition the opportunity cost of labor has been assumed to be zero in relation to agricultural income, which results in a reduction in the value of flood damages to the extent of the cost of labor in this item. A more detailed discussion of the derivation of prices for wheat and cotton may be found in Appendix B, Paragraph B.5.

Wheat is considered to be imported at prevailing prices and in equal quantities from USSR and USA, and transported to a common point at Lashkargah. This price is taken as applying for a period of ten years after installing the gates. After this period Afghanistan is considered as having become self-sufficient in wheat production, and local market prices are again assumed to apply.

Cotton is considered to be exported predominantly to the USSR and a price has been derived for this commodity which is considered applicable over the entire economic life of the gate project. The revised benefits based on the above criteria are shown in Table IV-10. This table may be compared with Table IV-2 from which it differs only to the extent of the value of agricultural benefits, as affected by the prices of wheat, cotton and labor as discussed above. As can be seen, the above assumptions result in an increase in these benefits, particularly in the early years of the project.

An economic analysis was made using these alternative benefits in the same way as that discussed earlier in Paragraph 4.3. However, in view of the conclusions reached therein, the alternative analysis was made only for Scheme I of Figure IV-1. Table IV-11 shows the present worths of costs and benefits if no developmental projects, other than the gate installation, are constructed. The benefit-cost ratios for this condition are found to be 1.98, 1.52, and 1.22 for interest rates of 4%, 6% and 8%, respectively, and the internal rate of return is found to be 10.1%, including the Chakhansur benefits.

When the other development projects for new lands and power are considered, the costs and benefits form a time series as shown in Table IV-12 for the Scheme I schedule of development. The present worths of costs and benefits of this series are shown on Table IV-13 for various interest rates. The resulting benefit to cost ratios are found to be 1.67, 1.25 and 0.98 for 4%, 6%, and 8%, respectively, and the internal rate of return is 7.85%, with the projects thus combined. The above rates of return are listed on Table II-14 where they may be compared with the corresponding rates of return for the analysis based on local market prices.

The alternative analysis thus results in higher rates of return than for the former analysis, 10.1% compared with 9.15% without additional irrigation developments, and 7.85% versus 7.60% including the new irrigation developments. Postponement of the gate installation would tend to reduce these differences since the principal increase comes from the higher cost of wheat in the initial ten years.

4.5 INVESTMENT

The total construction cost of the spillway structure is U.S. $4,351,000, of which U.S. $3,112,700 is in foreign currency. The balance of equivalent U.S. $1,238,300, which is in local currency, would correspond to Afs 103,378,000 at an exchange rate of 83.5 Afghanis to one U.S. dollar. These values should be increased for interest during construction, according to the loan terms applicable. Using an interest rate of 6 percent as an index, the addition of interest during construction would increase the above values to give a total capital cost of U.S. $4,575,000 of which U.S. $3,280,000 would be in foreign currency and equivalent to U.S. $1,295,000 in local currency. The latter amount would correspond to Afs 108,100,000.

Annual costs, exclusive of amortization and interest, would include interim replacements and insurance. Operation and maintenance would amount to U.S. $30,000. Of this amount, U.S. $15,300 would be in foreign currency, and U.S. $14,700 or Afs 1,227,450 in local currency.

The benefits that would result would come from improvements in the agricultural sector and from power. The flood control and improved irrigation water supply benefits would come from incremental improvements whose value would be difficult to assess to individuals. Repayment for such benefits would have to come either from government contributions or general levies on the affected land. Such revenues could begin as soon as construction of the gates was complete. Repayment of benefits to both irrigation and power projects would be dependent on the implementation schedules and details for these projects. Revenues from these would not be forthcoming for about 10 years for irrigation projects and for 25 years for power. In view of the uncertainties involved, no attempt has been made to determine a repayment schedule or to allocate repayment among the functions.

COST ESTIMATE FOR SPILLWAY STRUCTURE

Item	Quantity	Unit	Unit Cost US $	Costs in US $ & Equivalent US $ Local Equiv. $	Foreign US $	Total Equiv. $
Excavation, rock, access road	2,410	cu m	3.90	1,722	7,678	9,400
Excavation, rock, spillway	165,000	cu m	3.90	115,800	527,700	643,500
Line drilling	1,350	lm	2.00	810	1,890	2,700
Excavation, fault zone	2,000	cu m	20.00	36,000	4,000	40,000
Drill grout holes	1,380	lm	4.00	1,656	3,864	5,520
Drill drain holes	1,400	lm	4.00	1,680	3,920	5,600
Drill anchor holes	10,710	lm	4.00	12,852	29,988	42,840
Grout foundation & abutments	LS			6,278	2,322	8,600
Concrete, piers & abutments	6,100	cu m	60.00	237,900	128,100	366,000
Concrete, crest structure & apron	11,410	cu m	50.00	376,530	193,970	570,500
Concrete, channel walls	150	cu m	75.00	6,525	4,725	11,250
Concrete, bridge deck	140		80.00	6,075	5,175	11,250
Concrete, backfill	2,000	cu m	37.00	51,800	22,200	74,000
Reinforcement steel	422,000	kg	0.50	40,090	170,910	211,000
Anchor bars, supply & grout	LS			63,600	42,400	106,000
Drains	LS			1,389	12,501	13,890
Waterstop	LS			2,400	2,400	4,800
Structural steel bridge	91,000	kg	0.60	6,552	48,048	54,600
Miscellaneous metal	LS			6,360	46,640	53,000
Miscellaneous	LS			131	719	850
Radial gates	8	ea	103,000	41,200	782,800	824,000
Radial gate hoists	8	ea	31,750	12,700	241,300	254,000
Powerline & electrical system	LS			6,300	28,700	35,000
Diesel stand-by unit	LS			1,250	23,750	25,000
TOTAL DIRECT COST				1,037,600	2,335,700	3,373,300
ENGINEERING AND ADMINISTRATION				45,700	427,000	472,700
CONTINGENCY				155,000	350,000	505,000
TOTAL CONSTRUCTION COST				1,238,300	3,112,700	4,351,000

SUMMARY OF COSTS AND BENEFITS
(U.S. $)

Item	Costs: Construction Costs	Costs: Annual Costs	Benefits: Construction Costs	Benefits: Annual Benefits
Flood Control*				
Canals & Headings				25,000
Structures				9,700
Farmland Flooded				6,900
Reduced Crop Yield				44,000
Subtotal				86,000
Improved Irrigation Water Supply to Present Farmland*				
Kajakai-Shamalan				75,200
Seraj				75,800
Garmsel				62,000
Subtotal				213,000
Chakhansur				155,000
Subtotal				368,000
Irrigation				
Kajakai-Shamalan	5,250,000			588,000
Seraj	8,750,000			1,050,000
Garmsel	8,250,000			814,000
Subtotal	22,250,000			2,452,000
Power				
Hydro - 5th Unit	1,840,000	30,000		
- 6th Unit	5,910,000	97,000		
- 7th Unit	5,910,000	97,000		
Thermal - 1st Stage			3,050,000	183,500
- 2nd Stage			3,050,000	183,500
- 3rd Stage			3,050,000	183,000
Subtotal	13,660,000	224,000	9,150,000	550,000
Spillway Gates	4,351,000	30,000		

*Benefits for these items should be reduced to 30% when full demand at intermediate level is reached.

FLOOD CONTROL AND IMPROVED WATER SUPPLY BENEFITS ONLY

(All Costs and Benefits in U.S. Dollars)

	Present Worth of Costs and Benefits					
	4%	6%	7%	8%	9%	11%
COSTS						
Spillway Gates	5,108,200	4,983,200	4,946,000	4,921,400	4,905,400	4,891,100
BENEFITS						
Flood Control	1,847,500	1,355,500	1,186,900	1,052,100	942,700	777,600
Improved Irrig. Water Supply						
- Without Chakhansur	4,575,700	3,357,300	2,939,600	2,605,700	2,334,800	1,925,900
- Chakhansur Only	3,329,700	2,443,100	2,139,100	1,896,200	1,699,000	1,401,500
TOTAL BENEFITS						
- Without Chakhansur	6,423,200	4,712,800	4,126,500	3,657,800	3,277,500	2,703,500
- Including Chakhansur	9,752,900	7,155,900	6,265,600	5,554,000	4,976,500	4,105,000
BENEFIT/COST RATIO						
- Without Chakhansur	1.25	0.95	0.84	0.74	0.67	0.55
- Including Chakhansur	1.90	1.44	1.27	1.12	1.01	0.84

COSTS

Year	Spillway Gates Construction Costs	Spillway Gates Annual Costs	Irrigation Projects Seraj	Irrigation Projects Kajakai Shamalan	Irrigation Projects Garmsel	Hydro Power Cost Construction Costs	Hydro Power Cost Annu[al] Cost[s]
1	4.351.000*	30.000					
2							
3							
4							
5			8,750.000				
6							
7							
8							
9							
10							
11							
12							
13							
14							
15				5,250,000			
16							
17							
18							
19							
20					8.250.000		
21							
22							
23							
24							
25							
26							
27							
28						1,840,000	
29							30.
30							30.
31							30.
32						5,910,000	30.
33							127.
34							127.
35							127.
36						5.910.000	127.
37							224.
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50		30.000					224.
51			(- 875.000)	(-1.575.000)	(-3.300.000)	(-9.304.000)	

* The Construction Cost of the gates is increased by interest during construction for 1/2 year

NOTE: Values in parentheses are the salvage values at the end of the 50th year.

STREAM FOR SCHEME I

enefits in U.S. Dollars)

	BENEFITS							
	Flood Control & Improved Irrig. W.S.			Irrigation Project			Thermal Power	
	Flood Control	Imp. W.S. Chakhansur	Imp. W.S. to Chakhansur	Seraj	Kajakai Shamalan	Garmsel	Construction Costs	Annual Costs
	86,000	213,000	155,000					
				0				
				105,000				
				210,000				
				315,000				
				420,000				
				525,000				
				630,000				
				735,000				
				840,000				
				945,000				
				1,050,000	0			
	86.000	213.000	155,000		58,800			
	83.000	205,500	149.600		117,600			
	80.000	198.100	144.200		176,400			
	77.000	190.600	138.700		235,200			
	74.000	183.200	133.300		294.000	0		
	71.000	175.700	127,900		352,800	81,400		
	67.900	168.300	122.500		411,600	162,800		
	64.900	160.800	117.000		470,400	244,200		
	61.900	153.400	111.600		529,200	325,600		
	58.900	145.900	106,700		588,000	407,000		
	55.900	138.500	100.800			488,400		
0	52,900	131.000	95.300			569,800		
00	49.900	123.500	89.900			651,200		
00	46 900	116.100	84.500			732,600	3,050,000	0
00	43.900	108.600	79.000			814,000		183,500
00	40.900	101,200	73.600					183,500
00	37.800	93.700	68.200					183,500
00	34.800	86.300	62.800				3,050,000	183,500
00	31.800	78.800	57.400					367.000
00	28.800	71.400	51.900					367,000
00	25.800	63.900	46,500				3,050,000	367,000
								550,000
							3,050,000	
							3.050.000	
00								
	25.800	63.900	46.500	1.050.000	588,000	814.000	(-5.286.000)	550,000

TABLE IV-5

(All Costs and Benefits in U.S. Dollars)

	Present Worth of Costs and Benefits					
	4%	6%	7%	8%	9%	11%
COSTS						
Spillway Gates	5,108,200	4.983,200	4,946,000	4.921,400	4,905.400	4.891,100
Irrigation Projects						
Seraj	7,356,400	6,883.300	6.645.600	6,412.900	6,187,000	5.759,200
Kajakai Shamalan	2,810,100	2,236,600	1.982.600	1,753.800	1.549.900	1,209.400
Garmsel	3,451,400	2,547.600	2,169.200	1,841,300	1.560.200	1,118.000
Subtotal Irrigation Projects	13.617.900	11.667.500	10,797.400	10,008,000	9.297 100	8,086.600
Hydro Power	3,388,700	2,010.000	1,537,600	1.173,700	895,100	520.800
BENEFITS						
Flood Control and Improved Irrigation Water Supply						
- Flood Control	1,491.400	1.169.900	1.051,000	951.700	867.900	735,000
- Without Chakhansur	3.693,800	2.897.500	2.602.900	2.357.000	2.149.500	1,820,400
- Chakhansur Only	2,688.000	2.108.600	1.894,200	1.715.200	1,564,200	1,324,700
Subtotal Flood Control and Improved Irrigation Water Supply	7,873,200	6,176,000	5,548,100	5,023,900	4,581,600	3,880,100
Irrigation Projects						
Seraj	14.506.000	9.252.200	7.528,200	6.193,600	5.147.300	3.651,400
Kajakai Shamalan	4.816.800	2.658,200	2.002.900	1.522,400	1.166,800	701,400
Garmsel	4.970.800	2,563,700	1,863.600	1,365,100	1,007.300	559.900
Subtotal Irrigation Projects	24,293.600	14,474,100	11.394.700	9.081,100	7,321,400	4.912,700
Thermal Power Alternative	4,730,300	2,406,000	1,729.500	1,249.500	907,200	485,300
TOTAL COSTS	22,114,800	18.660.700	17,281,000	16,103,100	15,097.600	13.498,500
TOTAL BENEFITS	36,897,100	23,056.100	18,672.300	15,354,500	12,810.200	9,278,100
BENEFIT/COST RATIO	1.67	1.24	1.08	0.96	0.85	0.69

(All Costs and Bene

Year	COSTS: Spillway Gates: Construction Costs	Spillway Gates: Annual Costs	Irrigation Projects: Seraj	Irrigation Projects: Kajakai Shamalan	Irrigation Projects: Garmsel	Hydro Power: Construction Costs	Hydro Power: Ann[illegible] Cos[illegible]
1	4,351,000*	30,000					
2		↓					
3							
4							
5							
6							
7							
8							
9			8,750,000				
10							
11							
12							
13							
14							
15							
16							
17							
18							
19				5,250,000			
20						1,840,000	
21							3[illegible]
22							3[illegible]
23						5,910,000	3[illegible]
24					8,250,000		12[illegible]
25							12[illegible]
26						5,910,000	12[illegible]
27							22[illegible]
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49		↓					
50		30,000					2[illegible]
51			(-1,750,000)	(-2,100,000)	(-4,125,000)	(-7,075,000)	

* The construction cost of the gates is increased by interest during construction for 1/2 yea[illegible]

[illegible] are the salvage values at the end of the 50th year.

TABLE IV-6

EAM FOR SCHEME IV

efits in U.S. Dollars)

nual sts	BENEFITS: Flood Control & Improved Irrig. W.S.	Irrigation Projects: Seraj	Irrigation Projects: Kajakai Shamalan	Irrigation Projects: Garmsel	Thermal Power: Construction Costs	Thermal Power: Annual Costs
	0					
	454,000					
		0				
		105,000				
		210,000				
		315,000				
		420,000				
		525,000				
		630,000				
		735,000				
		840,000				
		945,000				
		1,050,000	0			
30,000	454,000		58,800			
30,000	401,000		117,600		3,050,000	
30,000	348,000		176,400			183,500
27,000	295,000		235,200		3,050,000	183,500
27,000	242,000		294,000	0		367,000
27,000	189,200		352,800	81,400	3,050,000	367,000
24,000	136,200		411,600	162,800		550,000
			470,400	244,200		
			529,200	325,600		
			588,000	407,000		
				488,400		
				569,800		
				651,200		
				732,600		
				814,000		
					3,050,000	
					3,050,000	
					3,050,000	
24,000	136,200	1,050,000	588,000	814,000	(-2,501,000)	550,000

ECONOMIC ANALYSIS — SCHEME II

(All Costs and Benefits in U.S. Dollars)

	Present Worth of Costs and Benefits					
	4%	6%	7%	8%	9%	11%
COSTS						
Spillway Gates	5,108,200	4,983,200	4,946,000	4,921,400	4,905,400	4,891,100
Irrigation Projects	10,735,900	8,518,900	7,566,800	6,724,700	5,985,400	4,774,200
Hydro Power	3,388,700	2,010,000	1,537,600	1,173,700	895,100	520,800
BENEFITS						
Flood Control and Improved Irrigation Water Supply	8,183,400	6,374,200	5,707,400	5,152,400	4,685,600	3,948,800
Irrigation Projects	18,431,500	10,255,200	7,782,900	5,971,700	4,630,100	2,866,400
Thermal Power Alternative	4,730,300	2,406,000	1,729,500	1,249,500	907,200	485,300
TOTAL COSTS	19,232,800	15,512,100	14,050,400	12,819,800	11,785,900	10,186,100
TOTAL BENEFITS	31,345,200	19,035,400	15,219,800	12,373,600	10,222,900	7,300,500
BENEFIT/COST RATIO	1.63	1.23	1.08	0.96	0.87	0.72

TABLE IV-7

ECONOMIC ANALYSIS – SCHEME III

(All Costs and Benefits in U S Dollars)

	Present Worth of Costs and Benefits					
	4%	6%	7%	8%	9%	11%
COSTS						
Spillway Gates	5,108,200	4,983,200	4,946,000	4,921,400	4,905,400	4,891,100
Irrigation Projects	13,617,900	11,667,500	10,797,400	10,008,000	9,297,100	8,086,600
Hydro Power	5,755,100	3,755,600	3,025,100	2,436,000	1,962,400	1,277,800
BENEFITS						
Flood Control and Improved Irrigation Water Supply	7,357,200	5,858,600	5,297,800	4,825,800	4,424,200	3,779,800
Irrigation Projects	24,293,600	14,474,100	11,394,700	9,081,100	7,321,400	4,912,700
Thermal Power Alternative	8,651,900	4,858,400	3,679,800	2,805,800	2,153,200	1,290,900
TOTAL COSTS	24,481,200	20,406,300	18,768,500	17,365,400	16,164,900	14,255,500
TOTAL BENEFITS	40,302,700	25,191,100	20,372,300	16,712,700	13,898,800	9,983,400
BENEFIT/COST RATIO	1.65	1.23	1.08	0.96	0.86	0.70

TABLE IV-8

TABLE IV-9

ECONOMIC ANALYSIS - SCHEME IV

(All Costs and Benefits in U.S. Dollars)

	Present Worth of Costs and Benefits					
	4%	6%	7%	8%	9%	11%
COSTS						
Spillway Gates	5,108,200	4,983,200	4,946,000	4,921,400	4,905,400	4,891,100
Irrigation Projects						
Seraj	5,901,400	5,084,100	4,700,000	4,339,900	4,005,200	3,411,100
Kajakai Shamalan	2,196,400	1,621,200	1,380,400	1,171,700	992,800	711,400
Garmsel	2,638,100	1,813,600	1,486,400	1,213,100	987,400	651,700
Subtotal Irrigation Projects	10,735,900	8,518,900	7,566,800	6,724,700	5,985,400	4,774,200
Hydro Power	5,755,100	3,755,600	3,025,100	2,436,000	1,962,400	1,277,800
BENEFITS						
Flood Control and Improved Irrigation Water Supply	7.702,800	6,089,800	5,487,600	4,982,000	4,553.000	3,867,900
Irrigation Projects						
Seraj	11,265,100	6.673.700	5,221,300	4,125,800	3,290,400	2,145,900
Kajakai Shamalan	3,590,700	1,851.900	1,346,200	986,100	727,600	404,500
Garmsel	3,575,700	1,729,600	1,215,400	859,800	612,100	316,000
Subtotal Irrigation Projects	18,431,500	10,255,200	7,782.900	5,971,700	4,630,100	2,866,400
Thermal Power Alternative	8,651,900	4,858,400	3,679,800	2,805,800	2,153,200	1,290,900
TOTAL COSTS	21,599,200	17,257.700	15.537.900	14,082,100	12,853,200	10,943,100
TOTAL BENEFITS	34,786,200	21,203,400	16,950,300	13,759,500	11,336,300	8,025,200
BENEFIT/COST RATIO	1.66	1.23	1.09	0.98	0.89	0.74

ALTERNATIVE ANALYSIS

SUMMARY OF COSTS AND BENEFITS (U.S. $)

FARM INCOME BASED ON SOCIO-ECONOMIC PRICES

Item	Costs: Construction Costs	Costs: Annual Costs	Benefits: Construction Costs	Benefits: Annual Benefits Years 1-10	Benefits: Annual Benefits Years 11-50
Flood Control*					
Canals and Headings				7,500	7,500
Structures				9,700	9,700
Farmland flooded				9,700	7,000
Reduced crop yield				58,600	43,000
Subtotal				85,500	67,200
Improved Irrigation Water Supply to Present Farmland*					
Kajakai-Shamalan				103,000	75,000
Seraj				101,000	75,000
Garmsel				71,000	61,000
Subtotal				275,000	211,000
Chakhansur				176,000	153,000
Subtotal				451,000	364,000
Irrigation					
Kajakai-Shamalan	5,250,000			-	574,000
Seraj	8,750,000			1,613,000	1,025,000
Garmsel	8,250,000			-	737,000
Subtotal	22,250,000			1,613,000	2,336,000
Power					
Hydro - 5th unit	1,840,000	30,000			
- 6th unit	5,910,000	97,000			
- 7th unit	5,910,000	97,000			
Thermal - 1st stage			3,050,000	183,500	183,500
- 2nd stage			3,050,000	183,500	183,500
- 3rd stage			3,050,000	183,500	183,500
Subtotal	13,660,000	240,000	9,150,000	550,000	550,000
Spillway Gates	4,351,000	30,000			

*Benefits for these items should be reduced to 30% when full demand at intermediate level is reached.

ALTERNATIVE ECONOMIC ANALYSIS

FLOOD CONTROL AND IMPROVED WATER SUPPLY BENEFITS ONLY

All costs and Benefits in U.S. Dollars

Farm Income Based on Socio-Economic Prices

	Present Worth of Costs and Benefits					
	4%	6%	7%	8%	9%	11%
COSTS						
Spillway Gates	5,108.200	4,983,200	4,946,000	4,921,400	4,905,400	4,891,100
BENEFITS						
Flood Control	1,592,000	1,193,900	1,055,900	944,900	854,100	715,400
Improved Irrig. Water Supply (including Chakhansur)	8,525,200	6,377,700	5,634,500	5,036,800	4,548,400	3,803,500
Total Benefits	10,117,200	7,571,600	6,690,400	5,981,700	5,402,500	4,518,900
BENEFIT/COST RATIO	1.98	1.52	1.35	1.22	1.10	0.92

Internal rate of return: 10.1%

	COSTS						
	Spillway Gates		Irrigation Projects			Hydro Power Costs	
Year	Construction Costs	Annual Costs	Seraj	Kajakai Shamalan	Garmsel	Construction Costs	Annual Costs
1	4,351,000*	30,000					
2							
3							
4							
5			8,750,000				
6							
7							
8							
9							
10							
11							
12							
13							
14							
15				5,250,000			
16							
17							
18							
19							
20					8,250,000		
21							
22							
23							
24							
25							
26							
27						1,840,000	0
28							30,000
29							30,000
30							30,000
31						5,910,000	30,000
32							127,000
33							127,000
34							127,000
35						5,910,000	127,000
36							224,000
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50		30,000					224,000
51			(- 875,000)	(-1,575,000)	(-3,300,000)	(-9,304,000)	

* The Construction Cost of the gates is increased by interest during construction for 1/2 year.

NOTE: Values in parentheses are the salvage values at the end of the 50th year.

E ANALYSIS

TREAM FOR SCHEME I

ECONOMIC PRICES

fits in U.S. Dollars)

TABLE IV-12

BENEFITS						
Flood Control & Improved Irrig. W.S.		Irrigation Project			Thermal Power	
Flood Control	Improved Irrig. W.S. Including Chakhansur	Seraj	Kajakai Shamalan	Garmsel	Construction Costs	Annual Costs
85.500	451.000					
		0				
		161.300				
		322.600				
		483.900				
85,500	451.000	645.200				
67,200	364.000	512.500				
		615.000				
		717.500				
		820.000				
		922,500				
		1.025.000	0			
67,200	364.000		57.400			
64,850	351.250		114.800			
62.500	338.500		172.200			
60,150	325,750		229,600			
57.800	313.000		287,000	0		
55.450	300.250		344.400	73.700		
53,100	287.500		401.800	147.400		
50.750	274,750		459.200	221.100		
48.400	262,000		516.600	294.800		
46,050	249,250		574.000	368.500		
43,700	236.500			442.200		
41.350	223.750			515.900		
39.000	211.000			589.600		
36.650	198.250			663,300	3.050.000	0
34.300	185.500			737.000		183.500
31,950	172.750					183.500
29.600	160.000					183.500
27,250	147.250				3.050.000	183.500
24.900	134,500					367.000
22.550	121.750					367.000
20.200	109.000				3.050.000	367.000
						550.000
					3.050.000	
					3.050.000	
20.200	[illegible]	1.025.000	574.000	737.000	(-5.286.000)	550.000

TABLE IV-13

All Costs and Benefits in U.S. Dollars
Farm Income Based on Socio-Economic Prices

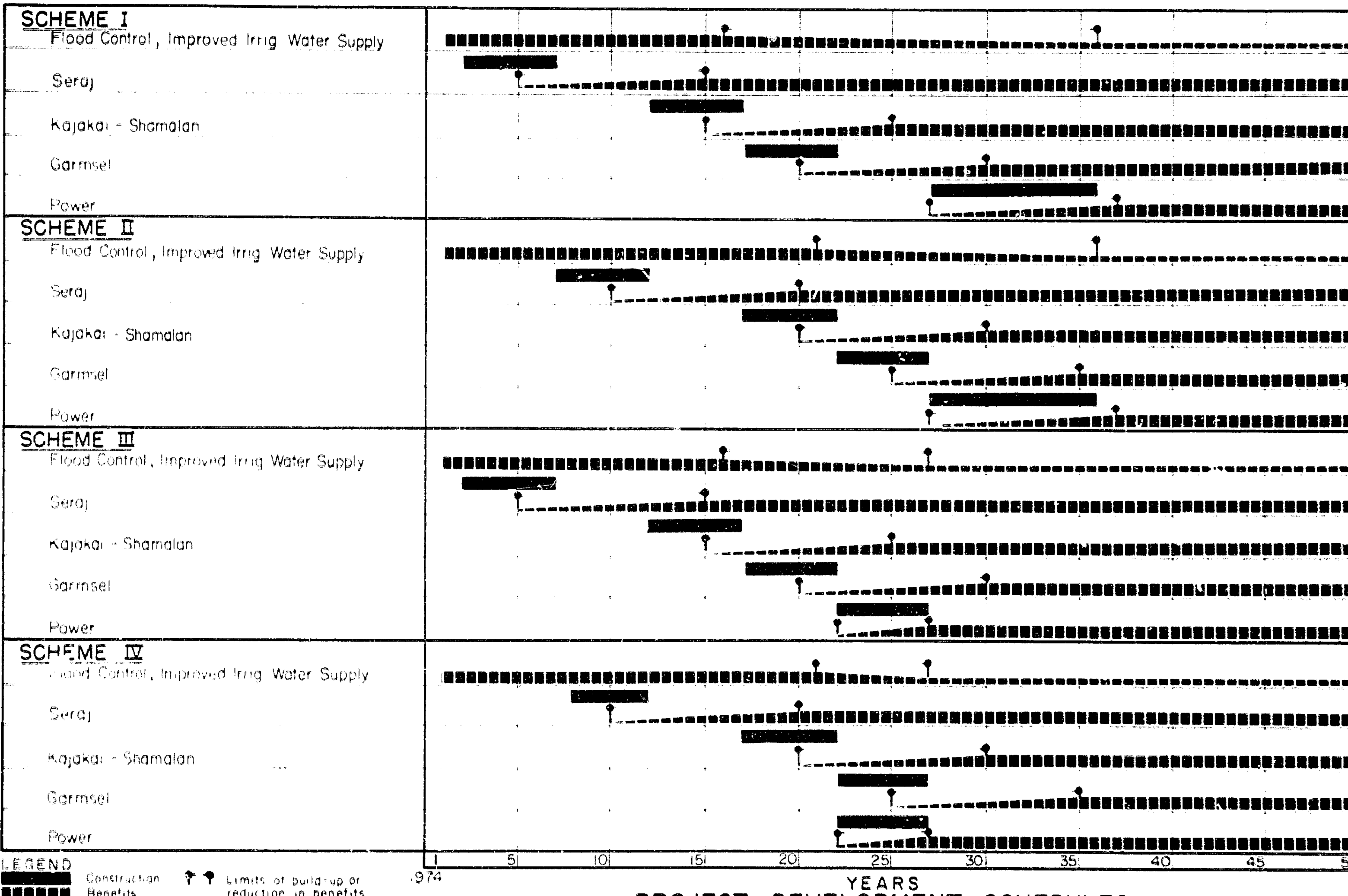
	Present Worth of Costs and Benefits					
	4%	6%	7%	8%	9%	11%
COSTS						
Spillway Gates	5,108,200	4,983,200	4,946,000	4,921,400	4,905,400	4,891,100
Irrigation Projects						
Seraj	7,356,400	6,883,300	6,645,600	6,412,900	6,187,000	5,759,200
Kajakai-Shamalan	2,810,100	2,236,600	1,982,600	1,753,800	1,549,900	1,209,400
Garmsel	3,451,400	2,547,600	2,169,200	1,841,300	1,560,200	1,118,000
Subtotal Irrigation Projects	13,617,900	11,667,500	19,797,400	10,009,000	9,297,100	8,086,600
Hydro Power	3,388,700	2,010,000	1,537,600	1,173,700	895,100	520,800
BENEFITS						
Flood Control and Improved Irrigation Water Supply						
Flood Control	1,313,800	1,048,900	949,800	866,500	795,600	688,100
Improved Irrig. Water Supply, incl. Chakhansur	7,017,800	5,591,800	5,059,100	4,647,200	4,231,500	3,623,200
Subtotal	8,331,600	6,640,700	6,008,900	5,513,700	5,027,100	4,311,300
Irrigation Projects						
Seraj	14,574,400	9,381,000	7,669,000	6,341,200	5,296,800	3,795,500
Kajakai-Shamalan	4,702,200	2,594,900	1,955,200	1,486,200	1,139,000	684,700
Garmsel	4,500,600	2,321,200	1,687,300	1,236,000	912,000	506,900
Subtotal	23,777,200	14,297,100	11,311,500	9,063,400	7,347,800	4,987,100
Thermal Power Alternative	4,730,300	2,406,000	1,729,500	1,249,500	907,200	485,300
TOTAL COSTS	22,114,800	18,660,700	17,281,000	16,103,100	15,097,600	13,498,500
TOTAL BENEFITS	36,839,100	23,343,800	19,049,900	15,826,600	13,282,100	9,783,700
BENEFIT-COST RATIO	1.67	1.25	1.10	0.98	0.88	0.72

Internal rate of return: 7.85

SUMMARY OF INTERNAL RATES OF RETURN
FOR VARIOUS SCHEMES

	Internal Rates of Return			
	Local Market Prices			Socio-Economic Prices
	50-Year Life		75-Year Life	50-Year Life
Item	1974*	1979*	1974*	1974*
PROJECT COMPONENTS				
Flood Control & Improved Irrigation Water Supply Only				
With No Reduction in Benefits:				
- without Chakhansur	5.65	5.65	5.9	
- including Chakhansur	9.15	9.15	9.3	10.1
With Reduced Benefits due to Other Projects:				
- including Chakhansur	8.25			
Irrigation of New Land**				
Schemes I & III:				
- Seraj	7.78	-	8.0	
- Kajakai-Shamalan	7.07	-	7.6	
- Garmsel	6.04	-	6.8	
Schemes II & IV:				
- Seraj	7.67	-	8.0	
- Kajakai-Shamalan	6.84	-	7.5	
- Garmsel	5.80	-	6.8	
Power**				
5% Load Projection	9.29	-	10.5	
8% Load Projection	11.28	-	11.7	
COMBINED PROJECTS				
Scheme I	7.60	7.60	7.9	7.85
Scheme II	7.62	-	-	
Scheme III	7.68	-	-	
Scheme IV	7.82	7.80	-	

*Year in which gates are installed
**The cost of the spillway gates is not included in these items.



PROJECT DEVELOPMENT SCHEDULES

APPENDIX A

RESERVOIR OPERATION

A.1 PRIOR STUDIES

Kajakai Reservoir, as originally designed, was basically intended to supply irrigation water. However, power facilities were planned as part of a future development. Flood control was not originally a basic purpose of the reservoir, although some reduction in the flood discharges would result if there was storage on the main stem of the river. The storage volume of the reservoir, however, is not capable of completely controlling all or even most of the wet season inflows. This can be seen by comparing the average monthly inflows for March, April and May - 667,786, 1,274,083 and 1,119,182 ac-ft, respectively - with the gated reservoir live storage of 1,739,000 ac-ft.

In designing the dam and reservoir, IECO made several operation studies under varying conditions of use, including the possibility of utilizing additional upstream storage. These studies did not reserve a portion of the reservoir exclusively for flood control. Limited hydrologic data were available, although these included the year 1947-48, believed to be the driest period within memory.

One of the alternative IECO studies made in 1954, showed that about 292,000 acres could be irrigated in Afghanistan, while making allowance for releases to other downstream users and having no gates on the reservoir. This would permit generation of 25 mW-years of prime power. With the installation of gates, the area that could be irrigated in Afghanistan could be increased to 395,000 acres, while generating 25.5 mW-years of prime power. This assumed an annual irrigation requirement of 5.25 ac-ft per acre, and accounted for the 1947-1948 dry period. Other possibilities exist, depending on the manner of operation of the reservoir concerning power, irrigation and downstream users. No account was taken of flood control. Minimum pool elevation was set at El. 1008 and minimum drawdown level before the dry season at El. 1020 (approximately 820,000 ac-ft). Dam, outlet works and proposed power plant are shown in Exhibit 6.

After construction, the reservoir, having no power installation, was operated only for irrigation. With some reduction in flooding resulting, increasing attention was devoted to operation of the reservoir for flood control also and the reservoir was drawn down before the wet season each year. Inspection of the historical record shows that in five of the last 10 years (1960-1970) the reservoir reached levels between El. 996 and 1005; in the remaining five years, including 1968, 69 and 70, it varied between El. 1010 and 1017. In some instances, releases made to achieve these levels have resulted in high discharges in the months of January and February when the water could not be used to its best advantage for irrigation.

In 1964, R.W. Beck (Reference 4) conducted studies to determine the capacity of the power installation to be made at Kajakai. The resulting installation was based on the assumption that the power demand should be met in the 1947-1948 dry season while also fully meeting an irrigation demand of 7.0 ac-ft per acre provided to 257,000 acres of land. The minimum pool elevation required was El. 1012, which the Beck report recommended as the future minimum operating pool elevation. This value has currently been adopted in designing the turbines for the first-stage installation, although operation down to El. 1008 will be possible. Dependable capacity of the turbines was therefore set as the output at El. 1012, or 22 mW for the first two units to be installed.

The most recent reservoir operation study for the ungated reservoir was done by the USAID/USBR team and presented in their draft operation and water management manual in 1968 (Reference 9). In this study, the reservoir was operated for irrigation and flood control with no power installed. A flood control rule curve was proposed in which reservoir outlet releases would be maximized whenever the reservoir storage exceeded 1,000,000 ac-ft in June, July, August and September and 300,000 ac-ft in January, February, March and April, with intermediate values in the intervening months. On the basis of the present reservoir capacity curve shown in Exhibit 7, the lower volume would correspond to a reservoir level at about El. 1004.

None of the above studies accounts for all the present operating requirements of irrigation, power and flood control. These requirements indicate that there will be a conflict in meeting the demands of each of these functions. Irrigation operation would call for maximum releases in the peak summer season, minimal flows in the winter, and a large carryover storage for dry years. Flood control operation would prefer minimizing the carryover storage before the flood season, creating a danger that irrigation requirements could not be met should a dry year follow.

Power operation would require discharge all year, which would determine the winter discharges and could reduce the amount of water available for irrigation. Fortunately, the needs of each can be met in the near future and with little conflict. However, as the need for power and irrigation water develops, an adequate solution will be necessary. It is important that long-term data be obtained to better evaluate the effects of flood control and to determine the full irrigation potential, and a schedule be developed vis-a-vis power use.

A.2 OPERATION AT PRESENT LEVEL OF DEVELOPMENT

The following bases have been used for the operation studies made herein.

A. Irrigation - The irrigation water will be supplied to the presently irrigated land area of 258,000 acres in Afghanistan, as shown in Table A-1. This demand is based on a gross annual requirement of 6.56 ac-ft per acre, except for the Gamsel and Chakhansur areas where the requirement has been set at 7.38 ac-ft per acre. After due allowance for return flows from the upstream areas, for losses due to non-beneficial vegetation, and for provision for other downstream users, the total annual demand was found to be 2,507,800 ac-ft. For details of the derivation of this amount and its distribution by months see Table D-1 in Appendix D. The monthly distribution is also shown in Table A-1.

Frequency studies indicate that the 1947 dry season would have a return period of at least one in 24 years. Since the April-May inflow is almost 60 percent of that for the corresponding period in the next driest year, it is likely that the return period is longer than this. Qualitative studies in the Delta Commission Report (Reference 13), however, also indicate a dry season return period of about once in 25 years over the preceeding 70 years. Attempting to meet the full demand in the driest year would, therefore, limit the extent of the economic development of the area during normal years. For the present study, it has been assumed that the irrigation release in the 1947-48 irrigation season could be reduced to 70 percent of the above demand or the minimum river flow, whichever is the less, as shown in Table A-1.

B. Minimum River Flows - Observations made during field reconnaissance indicate the importance of maintaining a minimum flow in the river to permit a high enough river stage so that canals along the river length can draw water. Further study is required to define these minimum flows for the various Non-Project Areas. The normal year minimum flows adopted for this report are shown in Table A-1. For operation in the driest year, these minimum flows were reduced as listed in Table A-1.

C. Power Requirements - Power requirements in the initial stage are based on meeting the full power demand in the 1947-48 dry period. Under the conditions assumed for dry season operation and shown in Table A-1, the minimum flow would be 2500 cfs for the ungated reservoir in January, 1948, and would correspond to a prime power output of about 29.0 mW-years, when generated at near minimum pool elevation.

D. Flood Control - For flood control operation, it is desirable to draw the reservoir down to the lowest level permissible before the April-May flood season. This can be done only through the three existing hollow jet valves, whose combined capacity ranges from about 6600 cfs at minimum pool El. 1012 to 7900 cfs at present spillway crest level. With the installation of turbines, additional capacity will be available; however, the discharge capability will be limited to the average power demand in the system, which will be low initially (see Table B-10 in Appendix B). The discharge capability of the initial two units is therefore taken to correspond only to an average generation of 7.5 mW-years or about 66,000,000 kWH for the initial period of reservoir operation. The outlet discharge would therefore be increased by about 440 to 630 cfs, depending on reservoir elevations, for a total outlet capacity varying from 7230 cfs at minimum pool to 8340 cfs at present spillway crest level. Reference to the historic inflow data shows that in 17 out of 26 years the March inflow exceeds this outlet capacity (460,000 ac-ft per month). Hence, to maximize the flood control effect, the reservoir must be drawn down to the minimum desired level by the end of February of each year. Since floods are basically due to snowmelt on the higher upstream catchment area, they occur predictably, peaking in April and May with carryover to June in about one in three years.

The flood control rule curve is therefore aimed at emptying the reservoir flood control space by the end of February; maintaining maximum possible releases in March, April May, and June when necessary; then, to meet the next February level, emptying the reservoir in any reasonable way consistent with the needs of irrigation, power and the outlet capacity. Since there is a good correlation between the total inflow between April and the following February and the sum of the April and May inflows, determination of the subsequent levels could be made as soon as the reservoir elevation at the end of May and the May-April inflow are known.

For the purpose of the present studies, a flood control rule curve was used that would ensure that the reservoir would be lowered by the end of February and that the discharges between June to February would follow the irrigation pattern in practice. This curve can be varied to suit inflow conditions and the minimum river flow requirements as discussed above. The minimum reservoir storage for flood control was set at 670,000 ac-ft to match the minimum drawdown level for February. The operation in the 1947-48 dry year is shown in Table A-1 and in Figure A-1. The minimum flood control pool, which would be at El. 1018.5, is somewhat above the levels used historically, see Section A.1. Therefore, the reservoir operating agency must make a choice between increasing the flood control space and the average controlled outflows on the one hand and risking a yet greater shortage in a repetition of the 1947-48 cycle on the other. Table A-2 compares the peak flows of the historic operation of the reservoir with the ungated operation used herein, and shows only a small improvement in flood peak for the lower historical reservoir levels. For the purpose of these economic studies, the minimum flood control pool of 670,000 ac-ft was used for comparison of the ungated and gated conditions. The flood control rule curves used for both gated and ungated conditions at present demand levels are shown in Table A-1 and in Figure A-1.

Operation of the reservoir with gates follows the same procedures as that without gates; however, gate operation must be done carefully to avoid excessive spills. With the present ungated reservoir, the effect of the surcharge storage automatically tends to cause the outflow to be less than the inflow. With a gated structure, at full pool, faulty operation could cause releases vastly in excess of those ever experienced. It is therefore of the greatest importance that a proper operating schedule be developed as part of the final design of any gated structure.

E. Operation of the Reservoir - The mode of operation of the reservoir in the driest period, 1947-48, is shown in Table A-1. This table shows the full irrigation demand and the shortage demand, discussed previously, to be used in this period. The resulting operation results in a minimum pool elevation of El. 1012 in February, 1948, and commences at the end of September, 1946, with a reservoir storage of 737,700 ac-ft, no inflow data being available before that time. Reference to the operation studies carried out for the remaining years shows that this amount of storage was available in every other year except the driest years, 1947 and 1970, which latter had a storage of 717,000 ac-ft. This mode of operation may be considered satisfactory for use and sets the minimum operating rule curve above which all downstream demands will be fully met by reservoir releases. No account was taken of the possible inflows from the Musa Qala and Arghandab rivers in the dry period, as these are considered negligible or utilized for irrigation elsewhere.

Operation for flood control follows the rule curves discussed earlier. The discharge through the valves would be made at 95 percent of their maximum capacity together with releases through the turbines so long as the reservoir lies above the flood control rule curve. The minimum operating and flood control curves are shown in Figure A-1.

Operation of the reservoir for both gated and ungated conditions was done by electronic computer for the remaining period of record after 1947. The results of these studies are given in Tables A-3 and A-4. From these results, it can be seen that the irrigation and power demands on the reservoir can be fully met in every year except the 1947-48 irrigation season discussed above and by which the reservoir yield has been determined.

As can be seen, the reservoir spills in 20 out of 24 years in the ungated condition and 16 out of 24 in the gated condition. Table A-5 shows a summary of the monthly average uncontrolled flows, which occurs in the months of April, May and June. These results show that the affect of the additional gated storage is to reduce the outflows in the first wet month, April, with smaller or no changes occuring in May and June.

Since these average monthly figures give no clear indication of the effect on peak discharges, further routings were made for the wetter years by electronic computer to obtain the peak discharge in each year, starting with the end-of-month reservoir volumes given by the reservoir operation studies. The peak discharges for gated and ungated conditions are shown in Table A-2 along with the corresponding peak natural inflows and peak outflows from the historical operation of the reservoir. The effect of adding the gates ranges from complete control in the years of small runoff to little or no control in the years of large runoff.

In operating the reservoir with gates for these routings, it was assumed that flood water would be stored behind the gates up to El. 1040, using only the valves and turbines for discharge. At this level, flows were passed under the gates, with the total discharge to the river increasing linearly with reservoir level to a maximum of 20,000 cfs at El. 1043, 23,000 cfs at El. 1044 and 38,000 cfs at El. 1045. The spillway, even with gates, will therefore operate in two out of three years and for periods of several weeks. Variations in this procedure could probably make small improvements in the peak discharges. The above procedure is consistent with the routing of the spillway design flood, in which a surcharge of approximately 0.9 meters was permitted above El. 1045 before operating the gates to give a maximum discharge, and is done to avoid excessively high spills when the reservoir reaches the normal maximum level.

Table A-2 also shows a general indication of the range of flows experienced and the ratio of the gated to ungated peak. A further tabulation gives an evaluation of the improvement in flood control for each year. Table A-6 shows the peak discharge for both conditions, listed in order of magnitude, for the years in which routings were made. Tables A-7 and A-8 show the significant peaks that occurred in downstream tributaries, the Musa Qala and Arghandab Rivers, in comparison with the flood peaks from the reservoir shown in Table A-2.

With the addition of gates, an increase of 819,000 ac-ft of storage is potentially possible each year. Table A-9 shows the additional yield obtained each year between the end of June and the end of February, according to the end-of-month storages for these months as obtained from the reservoir operations in Tables A-3 and A-4.

A.3 OPERATION AT FUTURE LEVELS OF DEVELOPMENT

A. General - As discussed earlier, operation of the reservoir to meet its ultimate demand will require balance between irrigation, power, and flood control use. Since the effects of flood control, from Kajakai Reservoir alone, primarily benefits the Non-Project canals, it is possible that the need for this flood control protection may decline if these canals are incorporated in some future development program. The problem will be to set the limits of irrigation development, formulate the criteria for satisfying demand in the dry seasons, and determine the resulting power installation. The Beck studies (Reference 4) indicate a future power potential of 66.0 mW-years of prime power, which would support a plant installation of 120 mW of dependable capacity with an actual installation of 150 mW; an irrigation demand based on providing 5.0 ft of water to 358,000 acres was incorporated in the 1946-48 dry period.

B. Operation for Intermediate Level of Demand - If the criteria illustrated by the determination of capacity in Table A-1 were to be adopted, it would not be possible to justify the above ultimate power installation. To provide a basis for determining benefits herein, it has been assumed that a power installation would be sized to provide for an intermediate level of irrigation demand for all potentially irrigable lands shown in Table B-1 - excluding the new lands in the Chakhansur - that is, for an area of 312,000 acres. This intermediate demand as well as the ultimate demand of all potentially irrigable land are shown in Table D-1 in Appendix D. The operation of the reservoir for this condition in the 1947-48 dry season, following the criteria used for the present level of demand, is shown in Table A-10. The power capability is shown to be 50 mW-years of prime power and would require an initial reservoir storage volume of 1,365,000 ac-ft at the end of September, 1946. Operation studies for the intermediate level of demand for the period 1947-70 indicate that this storage level could be achieved in every year except 1947 and 1970, which are the driest years and would have reached approximately this volume in 1948, 1962 and 1966. Use of this storage volume as a criterion would be satisfactory assuming the 1947-48 period was not preceeded by an exceptionally dry year. The power installation corresponding to these conditions is discussed in Section B.6.C.

With operation at the intermediate level, less flood control space is made available before the wet season, see Table A-10. This is only partially compensated for by the additional turbine discharges, which would bring the combined discharge capacity of the valve and turbines to 10,600 cfs at all reservoir elevations. The average monthly uncontrolled discharges for operation at the intermediate level of demand are shown in Table A-5, which indicates that the flood control effect of the gates has reverted to a value between the gated and ungated conditions when they are operated at the present level of development. In the same way, the additional yield available for maintaining river flows has been reduced as shown in Table A-9.

C. Operation for Ultimate Level of Demand - Operation studies for the ultimate condition were not formalized in this present study; however, increasing the irrigation allocation for the additional acreage would result in a drop in the prime power to about 30 to 35 mW-years, following criteria similar to that used previously herein. No account of this is taken in this study, since it has been assumed that no benefits would be assumed for potential development of new lands in the Chakhansur. The balance between these uses will have to be reconciled later when more data on power economics and irrigation in the Chakhansur are available.

D. Sedimentation of the Reservoir - The present and intermediate levels of development described above have been studied using the active reservoir volumes corresponding to the curve on Exhibit 7.

In 1968 a study was made by the U.S. Geological Service for USAID on the affects of sedimentation on the Kajakai Reservoir. The results presented in a report (Reference 7) dated December, 1968, indicated that the annual rate of sedimentation was 7800 ac-ft per year in the period 1953-68, and totalled 117,700 ac-ft below spillway elevation. The reservoir volumes follow this report (Exhibit 7) by extrapolation of data, a further 191,000 ac-ft could be lost below present spillway level over 40 to 45 years, allowing for compaction of the sediment in this period and for similar hydrologic conditions in the reservoir. The effect of this is assumed to be compensated for by forecasting procedures as discussed hereunder.

E. Discharge Forecasting - Since the main inflow to Kajakai Reservoir comes from snow melt, it is possible, using snow survey techniques, to closely predict the inflow for water supply for April through August. However, this can only be done once the snowpack has formed in the period December through February. A firm forecast can therefore be made only in early March. A reasonably good estimate could be made in early February and only a rather unreliable one in early January. This limits the usefulness of snow surveying for flood control, and, of course, for maximizing releases to the river in the prior period of June through December. In the early stages of operation, the reservoir pool must be drawn down by the end of February because the March inflows, which average 667,786 ac-ft, exceed the monthly valve discharge capacity of about 420,000 ac-ft at low pool levels or of about 460,000 ac-ft if the early turbine output is included. The operating agency must therefore determine the pool level for flood control in early January and February to maximize the flood control effect, or make an earlier decision to maximize river regulation for irrigation benefits. The main benefit of snow surveys would be to enable an early determination of poor snowpack conditions in order to minimize outflows in March, April and, as far as possible, in February so that shortages in the following irrigation season can be avoided. The ability to predict a coming dry season, however, would allow the reduction of carryover storage in wetter years and allow the adoption of a lower level for the flood control pool, producing attendant flood control improvement. As the turbine installation increases to say 50 mW of prime power, the combined reservoir discharge capacity will rise to about 600,000 ac-ft per month. With the demand in March, requiring about 236,000 ac-ft per month, a substantial volume (about 360,000 ac-ft) is left for operational flexibility. If the power system load was to change so that the average turbine output could be increased, this flexibility would be further improved.

It should therefore be possible to devise differing rule curves of operation, depending on the estimated snowpack at the beginning of February and, more accurately, at the beginning of March.

With forecasting and gradual power load increases, it should be possible to improve the flood control effect, at least sufficiently to compensate for the storage that would be lost to sediment accumulation in the reservoir.

TABLE A-1

RESERVOIR OPERATION IN CRITICAL PERIOD -
PRESENT LEVEL OF DEVELOPMENT

(Units are ac-ft x 1,000 except as noted)

Year/ Month	Irrigation Demand: 100% all Months	Irrigation Demand: Months of 30% Shortage	Minimum Flow Requirements: 100% All Months cfs	Minimum Flow Requirements: 100% All Months 1,000 af	Minimum Flow Requirements: Months of 30% Shortage cfs	Minimum Flow Requirements: Months of 30% Shortage 1,000 af	Total Demand: 100%	Total Demand: With Shortage	Reservoir Inflow	EOM Storage in Reservoir	Reservoir Rule Curves EOM Storage: Minimum Operation	Reservoir Rule Curves EOM Storage: Flood Control Ungated	Reservoir Rule Curves EOM Storage: Flood Control Gated
1946													
Sep										730.7	730	920	1,070
Oct	201.6		3,000	184.5			201.6	201.6	131.7	660.8	660	850	870
Nov	107.9		3,000	178.5			178.5	178.5	151.2	633.5	635	800	840
Dec	82.8		2,500	153.7			153.7	153.7	171.2	651.0	650	750	810
1947													
Jan	87.4		2,500	153.7			153.7	153.7	185.4	682.7	680	730	760
Feb	177.2		3,000	166.6			177.2	177.2	200.7	706.2	700	700	700
Mar	220.4		3,200	196.8			220.4	220.4	373.7	859.5	735*	880	880
Apr	228.5		3,200	190.4			228.5	228.5	461.9	1,092.9	1,015*	1,130	1,130
May	277.2	194	4,000	246.0	3,400	209.1	277.2	209.1	305.0	1,188.8	1,190	1,350	2,140
Jun	302.3	212	5,000	297.5	3,500	208.3	302.3	212.0	158.8	1,135.6	1,135	1,320	2,050
Jul	321.7	225	5,000	307.4	3,500	215.2	321.7	225.0	67.6	978.2	980	1,170	1,730
Aug	285.4	200	4,000	246.0	3,400	209.1	285.4	209.1	41.8	810.9	810	1,060	1,340
Sep	215.4	151	3,500	208.3	3,200	190.4	215.4	190.4	50.9	671.4	670	920	1,070
Oct	201.6	141	3,000	184.5	3,000	184.5	201.6	184.5	84.0	570.9	570	850	870
Nov	107.9	76	3,000	178.5	2,700	160.7	178.5	160.7	111.1	521.3	520	800	840
Dec	82.8	58	2,500	153.7	2,500	153.7	153.7	153.7	132.6	500.2	500	750	810
1948													
Jan	87.4	61	2,500	153.7	2,500	153.7	153.7	153.7	129.6	476.1	476	730	760
Feb	177.2	124	3,000	166.6	2,600	149.6	177.2	149.6	144.8	471.3	471.3	700	700
Mar	220.4		3,200	196.8			220.4	220.4	595.3	846.2	846		
Apr	228.5		3,200	190.4			228.5	228.5	1,261.2	1,878.9**			

*Values adjusted to account for year 1963 operation

**Ungated reservoir would spill above 1,391,000 ac-ft

TABLE A-2

SUMMARY OF PEAK FLOOD DISCHARGES FROM KAJAKAI RESERVOIR (CFS)
PRESENT LEVEL OF DEMAND

	Peak Daily Discharge (cfs)										Comparison of Peak Discharges			Improvement in Gated Performance (see note)				
	Natural Flow		Historical Outflow		Ungated			Gated			Range of Flows during Peak Period		Ratio of Peak Discharges					
Year	April	May	April	May	April	May	June	April	May	June	Ungated	Gated	(%)	1	2	3	4	5
1947														1				
1948	29,200				24,720	24,420		7,720	8,000		14,000-24,000	8,000	32					1
1949	45,000				39,600	33,790		24,000	20,000		30,000-32,000	20,000-24,000	60				1	
1950	24,000	36,200			13,640	33,310	19,230	7,530	23,500	19,500	19,000-32,000	17,900-23,500	71			1		
1951	34,200	47,500			30,450	40,140	26,070	7,780	32,000	23,000	26,000-38,000	23,000-32,000	80			1		
1952	28,600	23,500			25,380	21,940		8,000	12,000		14,000-25,000	12,000	55				1	
1953	23,600				14,470	15,280		7,580	7,720		13,000-15,000	7,500	50					1
1954	33,800	33,000	31,200	32,200	30,840	32,160		23,000	25,000		20,000-32,000	17,000-25,000	78		1			
1955	-	22,740		9,300	-	11,450		-	7,580		10,000-11,000	7,500	67					1
1956	51,220		44,500	28,900	44,280			39,700			30,000-43,000	27,000-40,000	90		1			
1957	50,770		46,600	59,800	46,870			42,500			- No improvement -		91		1			
1958			24,800	22,500									-			1		
1959	-		22,000	16,900									-			1		
1960	-	32,200		23,900	-	23,910		-	13,000		20,000-24,000	13,000	55				1	
1961	35,000	31,600	21,300	32,150	27,850	31,000		10,000	21,000		18,000-30,000	18,000-22,000	68			1		
1962	-												-	1				
1963	-	29,950	4,630	5,090									-					1
1964	37,660		25,400	26,000	32,910	28,770		19,000	20,500		18,000-30,000	19,000-20,500	62				1	
1965	37,220	38,050	40,270	40,980	37,690	37,210	25,010	34,000	35,000	25,300	25,000-36,000	25,000-35,000	93		1			
1966														1				
1967	83,100		54,700	51,240	59,370	49,880		14,670	25,000		30,000-45,000	25,000	42					
1968	34,900		23,020	27,140	26,000	28,220		7,680	13,000		16,000-24,000	13,000	46				1	
1969	67,230	34,710	43,079	26,133	45,880	27,950		28,000	23,000		26,000-40,000	23,000-28,000	61				1	
1970	16,000													1				
													Totals	4	4	5	6	4

NOTE Improvement is listed in the following categories -

1. No prior flooding
2. No improvement
3. Little improvement
4. Significant improvement
5. Floods controlled completely by gates
6. Major improvement

*Reduced control by Kajakai due to Mus Qala inflow.

1. **Basis** - The headings used in this study are defined as follows:

Inflows - Net values after deducting evaporation and losses.

End-of-Month Storage - The reservoir is operated between storages given in columns headed "min" and "max". These storages are the minimum operating and flood control rule curves determined in Tables A-1 and A-10. No use is made of the "Buffer" storage in this study. The values given under the heading "Actual" are those obtained by operating the reservoir to meet the various criteria.

Release to River - The minimum permitted flows in the river (REQ); the actual monthly discharge from the reservoir; any shortages in the prescribed minimum flow (SHRTG); and the maximum permitted discharge, in this case, unlimited.

Case - The indication of the governing condition for determining reservoir discharges:

1 - Release restricted by outlet and turbine capacity
4 - Release to satisfy downstream irrigation water requirements
5 - Release to satisfy minimum flow requirements
6 - Release to satisfy power requirements
8 - Release to avoid overfilling reservoir (spill plus outlet)
10 - Release restricted by minimum operating level
11 - Release for flood control to meet flood rule curve

Power - The minimum required monthly generation in 1,000 kWH; the actual generation possible from the discharges made; and any shortages occuring. The actual generation is limited by the turbine capacity, assumed to average 81.0 mw without gates and 144 mw with gates.

Flow at Downstream Control Point - Any local inflow below the dam; water rights; the irrigation demand (ADD REQ) and the actual flow in the river composed of reservoir discharges plus local inflow; any shortages in irrigation demand; and the maximum permissible discharge (unlimited in this case). Local inflow was assumed to be zero for the 1947-48 dry season, and constant minimum values were used for all other years based on flows in 1962-63 for the Musa Qala and Arghandab Rivers. The irrigation demand may be obtained from Table D-1.

2. Results - The following averages are obtained from the study:

Average inflow (less evaporation and losses)	6854 cfs
Average local inflow	120 cfs
Average irrigation demand	3464 cfs
Average shortage in irrigation demand	23 cfs
Average annual power required	254.3 gWH
Actual annual power generated	569.8 gWH

YEAR 1947

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2142.	570000.	570000.	660790.	850000.
11	2540.	520000.	520000.	633435.	800000.
12	2785.	500000.	500000.	650964.	750000.
1	3016.	476000.	476000.	682683.	730000.
2	3613.	471300.	471300.	700000.	700000.
3	6077.	735000.	735000.	853280.	880000.
4	7763.	1015000.	1015000.	1086700.	1130000.
5	4961.	1190000.	1190000.	1190000.	1350000.
6	2668.	1135000.	1135000.	1135000.	1320000.
7	1100.	980000.	980000.	980000.	1170000.
8	680.	810000.	810000.	810000.	1060000.
9	856.	670000.	670000.	670000.	920000.
YR	3177.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3279.	0.	999999.	4
3000.	3000.	0.	999999.	5
2500.	2500.	0.	999999.	5
2500.	2500.	0.	999999.	5
3000.	3301.	0.	999999.	11
3200.	3584.	0.	999999.	4
3200.	3840.	0.	999999.	4
4000.	3261.	719.	999999.	10
5000.	3592.	1408.	999999.	10
5000.	3621.	1379.	999999.	10
4000.	3445.	555.	999999.	10
3500.	3208.	292.	999999.	10
3494.	3261.	365.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	32265.	0.	0.	0.	3279.	3279.	0.	999999.
11	20900.	27879.	0.	0.	0.	1813.	3000.	0.	999999.
12	21600.	23942.	0.	0.	0.	1348.	2500.	0.	999999.
1	21600.	24252.	0.	0.	0.	1421.	2500.	0.	999999.
2	19500.	29278.	0.	0.	0.	3191.	3301.	0.	999999.
3	21600.	36651.	0.	0.	0.	3584.	3584.	0.	999999.
4	20900.	40690.	0.	0.	0.	3840.	3840.	0.	999999.
5	21600.	36025.	0.	0.	0.	4508.	3261.	1227.	999999.
6	20900.	40509.	0.	0.	0.	5080.	3592.	1488.	999999.
7	21600.	41180.	0.	0.	0.	5232.	3621.	1611.	999999.
8	21600.	36937.	0.	0.	0.	4642.	3445.	1196.	999999.
9	20900.	31222.	0.	0.	0.	3620.	3208.	411.	999999.
YR	254300.	403030.	0.	0.	0.	3464.	3261.	499.	999999.

YEAR 1948

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	1366.	570000.	570000.	570000.	850000.
11	1667.	520000.	520000.	520000.	800000.
12	2157.	500000.	500000.	500000.	750000.
1	2108.	476000.	476000.	476000.	730000.
2	2607.	471300.	471300	471300.	700000.
3	9681.	735000.	735000.	669837.	880000.
4	21195.	1015000.	1015000.	1391000.	1130000.
5	13163.	1190000.	1190000.	1391000.	1350000.
6	3781.	1135000.	1135000.	1314290.	1320000.
7	1942.	980000.	980000.	1112375.	1170000.
8	1164.	810000.	810000.	898840.	1060000.
9	1371.	670000.	670000.	765308.	920000.
YR	5201.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	2992.	8.	999999.	10
3000.	2707.	293.	999999.	10
2500.	2482.	18.	999999.	10
2500.	2498.	2.	999999.	10
3000.	2692.	308.	999999.	10
3200.	3200.	0.	999999.	5
3200.	12437.	0.	999999.	8
4000.	13163.	0.	999999.	8
5000.	5070.	0.	999999.	4
5000.	5226.	0.	999999.	4
4000.	4637.	0.	999999.	4
3500.	3615.	0.	999999.	4
3494.	5070.	50.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	28307.	0.	0.	0.	3279.	2992.	286.	999999.
11	20900.	23727.	0.	0.	0.	1813.	2707.	0.	999999.
12	21600.	21943.	0.	0.	0.	1348.	2482.	0.	999999.
1	21600.	21743.	0.	0.	0.	1421.	2498.	0.	999999.
2	19500.	20945.	0.	0.	0.	3191.	2692.	499.	999999.
3	21600.	31101.	0.	524.	0.	3584.	3724.	0.	999999.
4	20900.	58320.	0.	789.	9.	3840.	13225.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	13177.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	5080.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	51603.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	36621.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	473160.	0.	113.	0.	3464.	5182.	63.	999999.

YEAR 1949

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	1878.	570000.	570000.	680723.	850000.
11	2363.	520000.	520000.	642808.	800000.
12	2508.	500000.	500000.	643287.	750000.
1	2529.	476000.	476000.	645366.	730000.
2	3997.	471300.	471300.	692623.	700000.
3	11563.	735000.	735000.	957169.	880000.
4	30656.	1015000.	1015000.	1391000.	1130000.
5	16397.	1190000.	1190000.	1391000.	1350000.
6	6013.	1135000.	1135000.	1320000.	1320000.
7	2914.	980000.	980000.	1170000.	1170000.
8	1991.	810000.	810000.	1007265.	1060000.
9	1869.	670000.	670000.	904533.	920000.
YR	7049.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3254.	0.	999999.	4
3000.	3000.	0.	999999.	5
2500.	2500.	0.	999999.	5
2500.	2500.	0.	999999.	5
3000.	3141.	0.	999999.	4
3200.	7261.	0.	999999.	1
3200.	23366.	0.	999999.	8
4000.	16397.	0.	999999.	6
5000.	7266.	0.	999999.	11
5000.	5354.	0.	999999.	11
4000.	4637.	0.	999999.	4
3500.	3615.	0.	999999.	4
3494.	6656.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	32453.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	28093.	0.	36.	0.	1813.	3036.	0.	999999.
12	21600.	23953.	0.	32.	0.	1348.	2532.	0.	999999.
1	21600.	23965.	0.	26.	0.	1421.	2526.	0.	999999.
2	19500.	27549.	0.	50.	0.	3191.	3191.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7784.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	24154.	0.	999999.
5	21600	60264.	0.	14.	0.	4508.	16416.	0.	999999.
6	20900	58320.	0.	10.	0.	5080.	7216.	0.	999999.
7	21600	60264.	0.	6.	0.	5232.	5360.	0.	999999.
8	21600	53124.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	38293.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300	524866.	0.	126.	0.	3464.	6983.	0.	999999.

YEAR 1950

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2462.	570000.	570000.	850000.	850000.	3000.	3349.	0.	999999.	11
11	2916.	520000.	520000.	800000.	800000.	3000.	3756.	0.	999999.	11
12	3025.	500000.	500000.	750000.	750000.	2500.	3838.	0.	999999.	11
1	3604.	476000.	476000.	730000.	730000.	2500.	3929.	0.	999999.	11
2	4049.	471300.	471300.	700000.	700000.	3000.	4590.	0.	999999.	11
3	7792.	735000.	735000.	880000.	880000.	3200.	4364.	0.	999999.	11
4	17078.	1015000.	1015000.	1391000.	1130000.	3200.	8490.	0.	999999.	8
5	27472.	1190000.	1190000.	1391000.	1350000.	4000.	27472.	0.	999999.	8
6	9932.	1135000.	1135000.	1391000.	1320000.	5000.	9932.	0.	999999.	8
7	3402.	980000.	980000.	1170000.	1170000.	5000.	6996.	0.	999999.	11
8	1833.	810000.	810000.	997565.	1060000.	4000.	4637.	0.	999999.	4
9	1860.	670000.	670000.	893133.	920000.	3500.	3615.	0.	999999.	4
YR	7135.					3494.	7151.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	35699.	0.	25.	0.	3279.	3374.	0.	999999.
11	20900.	37933.	0.	36.	0.	1815.	3782.	0.	999999.
12	21600.	39218.	0.	32.	0.	1348.	3870.	0.	999999.
1	21600.	39510.	0.	26.	0.	1421.	3955.	0.	999999.
2	19500.	41182.	0.	50.	0.	3191.	4639.	0.	999999.
3	21600.	50022.	0.	524.	0.	3584.	5388.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	9279.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	27485.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	9942.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	7003.	0.	999999.
8	21600.	53064.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	38139.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	571935.	0.	126.	0.	3464.	7277.	0.	999999.

YEAR 1951

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2391.	570000.	570000.	840048.	850000.	3000.	3254.	0.	999999.	4
11	2647.	520000.	520000.	800000.	800000.	3000.	3320.	0.	999999.	11
12	2654.	500000.	500000.	750000.	750000.	2500.	3467.	0.	999999.	11
1	2755.	476000.	476000.	730000.	730000.	2500.	3080.	0.	999999.	11
2	3160.	471300.	471300.	700000.	700000.	3000.	3700.	0.	999999.	11
3	10867.	735000.	735000.	921179.	880000.	3200.	7270.	0.	999999.	1
4	22338.	1015000.	1015000.	1391000.	1130000.	3200.	14442.	0.	999999.	8
5	32253.	1190000.	1190000.	1391000.	1350000.	4000.	32253.	0.	999999.	8
6	12535.	1135000.	1135000.	1391000.	1320000.	5000.	12535.	0.	999999.	8
7	4394.	980000.	980000.	1174160.	1170000.	5000.	7921.	0.	999999.	1
8	2303.	810000.	810000.	1030625.	1060000.	4000.	4637.	0.	999999.	4
9	2160.	670000.	670000.	920000.	920000.	3500.	4039.	0.	999999.	11
YR	6399.					3494.	6362.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	34538.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	33459.	0.	36.	0.	1815.	3356.	0.	999999.
12	21600.	35429.	0.	32.	0.	1348.	3499.	0.	999999.
1	21600.	30973.	0.	26.	0.	1421.	3106.	0.	999999.
2	19500.	33201.	0.	50.	0.	3191.	3750.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	15231.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	32267.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	12545.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	7927.	0.	999999.
8	21600.	53294.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	43089.	0.	5.	0.	3620.	4043.	0.	999999.
YR	254300.	561415.	0.	126.	0.	3464.	8486.	0.	999999.

YEAR 1952

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2472.	570000.	570000.	850000.	850000.	3000.	3610.	0.	999999.	11
11	2968.	520000.	520000.	800000.	800000.	3000.	3608.	0.	999999.	11
12	3046.	500000.	500000.	750000.	750000.	2500.	3359.	0.	999999.	11
1	3183.	476000.	476000.	730000.	730000.	2500.	3508.	0.	999999.	11
2	5382.	471300.	471300.	700000.	700000.	3000.	5922.	0.	999999.	11
3	12186.	735000.	735000.	1002279.	880000.	3200.	7270.	0.	999999.	[illegible]
4	22342.	1015000.	1015000.	1391000.	1130000.	3200.	16309.	0.	999999.	8
5	14730.	1190000.	1190000.	1391000.	1350000.	4000.	14730.	0.	999999.	8
6	5574.	1135000.	1135000.	1320000.	1320000.	5000.	6767.	0.	999999.	11
7	2607.	980000.	980000.	1158985.	1170000.	5000.	5226.	0.	999999.	4
8	1682.	810000.	810000.	977250.	1060000.	4000.	4637.	0.	999999.	4
9	1961.	670000.	670000.	878816.	920000.	3500.	3615.	0.	999999.	4
YR	6543.					3494.	6600.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	38587.	0.	25.	0.	3279.	3635.	0.	999999.
11	20900.	38460.	0.	36.	0.	1813.	3844.	0.	999999.
12	21600.	39434.	0.	32.	0.	1348.	3891.	0.	999999.
1	21600.	35274.	0.	26.	0.	1421.	3534.	0.	999999.
2	19500.	53135.	0.	50.	0.	3191.	5972.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	58320	0.	789.	0.	3840.	17096.	0.	999999.
5	21600.	60264	0.	14.	0.	4508.	14743.	0.	999999.
6	20900.	58320	0.	10.	0.	5080.	6777.	0.	999999.
7	21600.	60264	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	52871.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	37899.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	593093.	0.	126.	0.	3464.	6726.	0.	999999.

YEAR 1953

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2522.	570000.	570000.	833833.	850000.
11	2914.	520000.	520000.	800000.	800000.
12	2924.	500000.	500000.	750000.	750000.
1	2957.	476000.	476000.	730000.	730000.
2	4606.	471300.	471300.	700000.	700000.
3	12542.	735000.	735000.	1024179.	880000.
4	15600.	1015000.	1015000.	1391000.	1130000.
5	11670.	1190000.	1190000.	1391000.	1350000.
6	6452.	1135000.	1135000.	1320000.	1320000.
7	2337.	980000.	980000.	1142385.	1170000.
8	1713.	810000.	810000.	982550.	1060000.
9	1914.	670000.	670000.	861318.	920000.
YR	5677.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3254.	0.	999999.	4
3000.	3483.	0.	999999.	11
2500.	3737.	0.	999999.	11
2500.	3282.	0.	999999.	11
3000.	5146.	0.	999999.	11
3200.	7270.	0.	999999.	1
3200.	9436.	0.	999999.	8
4000.	11670.	0.	999999.	8
5000.	7645.	0.	999999.	11
5000.	5226.	0.	999999.	4
4000.	4637.	0.	999999.	4
3500.	3615.	0.	999999.	4
3494.	5701.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT LOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	34597.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	35154.	0.	36.	0.	1813.	3519.	0.	999999.
12	21600.	38187.	0.	32.	0.	1348.	3769.	0.	999999.
1	21600.	33001.	0.	26.	0.	1421.	3308.	0.	999999.
2	19500.	46175.	0.	50.	0.	3191.	5196.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	10225.	0.	999999.
5	21600.	60264.	0.	14.	0.	4506.	11684.	0.	999999.
6	20900.	58320.	0.	10.	0.	5066.	7655.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	52629.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	37709.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	574584.	0.	126.	0.	3464.	5827.	0.	999999.

YEAR 1954

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2365.	570000.	570000.	808633.	850000.
11	2643.	520000.	520000.	785418.	800000.
12	2825.	500000.	500000.	750000.	750000.
1	3428.	476000.	476000.	730000.	730000.
2	6018.	471300.	471300.	700000.	700000.
3	14019.	735000.	735000.	1114979.	880000.
4	27262.	1015000.	1015000.	1391000.	1130000.
5	21344.	1190000.	1190000.	1391000.	1350000.
6	7638.	1135000.	1135000.	1374171.	1320000.
7	3625.	980000.	980000.	1170000.	1170000.
8	2335.	810000.	810000.	1028465.	1060000.
9	2227.	670000.	670000.	920000.	920000.
YR	7975.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3254.	0.	999999.	4
3000.	3000.	0.	999999.	5
2500.	3401.	0.	999999.	11
2500.	3754.	0.	999999.	11
3000.	6558.	0.	999999.	11
3200.	7270.	0.	999999.	1
3200.	22643.	0.	999999.	8
4000.	21344.	0.	999999.	8
5000.	7921.	0.	999999.	1
5000.	6944.	0.	999999.	11
4000.	4637.	0.	999999.	4
3500.	4049.	0.	999999.	11
3494.	7892.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT LOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	34087.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	29931.	0.	36.	0.	1813.	3036.	0.	999999.
12	21600.	34642.	0.	32.	0.	1348.	3433.	0.	999999.
1	21600.	37744.	0.	26.	0.	1421.	3779.	0.	999999.
2	19500.	54432.	0.	50.	0.	3191.	6607.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	23432.	0.	999999.
5	21600.	60264.	0.	14.	0.	4506.	21358.	0.	999999.
6	20900.	58320.	0.	10.	0.	5066.	7931.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	6950.	0.	999999.
8	21600.	53255.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	45139.	0.	5.	0.	3620.	4054.	0.	999999.
YR	254300.	584712.	0.	126.	0.	3464.	8019.	0.	999999.

YEAR 1955

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2525.	570000.	570000.	850000.	850000.
11	3240.	520000.	520000.	800000.	800000.
12	3114.	500000.	500000.	750000.	750000.
1	3245.	476000.	476000.	730000.	730000.
2	3227.	471300.	471300.	700000.	700000.
3	10251.	735000.	735000.	883279.	880000.
4	10611.	1015000.	1015000.	1130000.	1130000.
5	13292.	1190000.	1190000.	1391000.	1350000.
6	6458.	1135000.	1135000.	1320000.	1320000.
7	2835.	980000.	980000.	1170000.	1170000.
8	1612.	810000.	810000.	983965.	1060000.
9	1662.	670000.	670000.	[illegible]	920000.
YR	5230.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3963.	0.	999999.	11
3000.	4060.	0.	999999.	11
2500.	3726.	0.	999999.	11
2500.	3576.	0.	999999.	11
3000.	3767.	0.	999999.	11
3200.	7270.	0.	999999.	1
3200.	6665.	0.	999999.	11
4000.	9647.	0.	999999.	6
5000.	7662.	0.	999999.	11
5000.	5276.	0.	999999.	11
4000.	4637.	0.	999999.	4
3500.	3615.	0.	999999.	4
3494.	5306.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT LOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	42359.	0.	25.	0.	3279.	3986.	0.	999999.
11	20900.	[illegible]	0.	36.	0.	1813.	4117.	0.	999999.
12	21600.	40131.	0.	32.	0.	1348.	3959.	0.	999999.
1	21600.	[illegible]	0.	26.	0.	1421.	3595.	0.	999999.
2	19500.	[illegible]	0.	50.	0.	3191.	3815.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	7453.	0.	999999.
5	21600.	60264.	0.	14.	0.	4506.	9061.	0.	999999.
6	20900.	58320.	0.	10.	0.	5066.	7671.	0.	999999.
7	21600.	60254.	0.	6.	0.	5232.	5282.	0.	999999.
8	21600.	[illegible]	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	37690.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	581046.	0.	126.	0.	3464.	5426.	0.	999999.

YEAR 1956

	CFS	END OF MONTH STORAGE IN AC-FT			
PER	INFLOW	MIN	BUFFER	ACTUAL	MAX
10	2161.	570000.	570000.	801748.	850000.
11	2571.	520000.	520000.	776233.	800000.
12	3669.	500000.	500000.	750000.	750000.
1	3389.	476000.	476000.	730000.	730000.
2	4145.	471300.	471300.	700000.	700000.
3	15670.	735000.	735000.	1209360.	880000.
4	37921.	1015000.	1015000.	1391000.	1130000.
5	15847.	1190000.	1190000.	1391000.	1350000.
6	5371.	1135000.	1135000.	1320000.	1320000.
7	6523.	980000.	980000.	1237680.	1170000.
8	2319.	810000.	810000.	1060000.	1060000.
9	2338.	670000.	670000.	920000.	920000.
YR	8490.				

RELEASE TO RIVER IN CFS				
REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3254.	0.	999999.	4
3000.	3000.	0.	999999.	5
2500.	4096.	0.	999999.	11
2500.	3715.	0.	999999.	11
3000.	4685.	0.	999999.	11
3200.	7386.	0.	999999.	1
3200.	34869.	0.	999999.	8
4000.	15847.	0.	999999.	8
5000.	6564.	0.	999999.	11
5000.	7862.	0.	999999.	1
4000.	5209.	0.	999999.	11
3500.	4690.	0.	999999.	11
3494.	8420.	0.	999999.	

	1000 KW-HR POWER			FLOW IN CFS AT DOWNSTREAM CONTROL POINT					
PER	REQ	ACTUAL	SHRTG	QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	34106.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	29842.	0.	36.	0.	1813.	3036.	0.	999999.
12	21600.	41636.	0.	32.	0.	1348.	4127.	0.	999999.
1	21600.	37351.	0.	26.	0.	1421.	3740.	0.	999999.
2	19500.	42039.	0.	50.	0.	3191.	4735.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7909.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	35658.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	15861.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	6574.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	7868.	0.	999999.
8	21600.	60264.	0.	4.	0.	4642.	5215.	0.	999999.
9	20900.	50269.	0.	5.	0.	3620.	4695.	0.	999999.
YR	254300.	592939.	0.	126.	0.	3464.	8546.	0.	999999.

YEAR 1957

	CFS	END OF MONTH STORAGE IN AC-FT			
PER	INFLOW	MIN	BUFFER	ACTUAL	MAX
10	3061.	570000.	570000.	850000.	850000.
11	3104.	520000.	520000.	800000.	800000.
12	2981.	500000.	500000.	750000.	750000.
1	5881.	476000.	476000.	730000.	730000.
2	4566.	471300.	471300.	700000.	700000.
3	16989.	735000.	735000.	1391000.	880000.
4	40738.	1015000.	1015000.	1391000.	1130000.
5	41178.	1190000.	1190000.	1391000.	1350000.
6	17276.	1135000.	1135000.	1391000.	1320000.
7	6637.	980000.	980000.	1324360.	1170000.
8	3791.	810000.	810000.	1073616.	1060000.
9	2791.	670000.	670000.	920000.	920000.
YR	12628.				

RELEASE TO RIVER IN CFS				
REQ	ACTUAL	SHRTG	MAX	CASE
3000.	4199.	0.	999999.	11
3000.	3944.	0.	999999.	11
2500.	3794.	0.	999999.	11
2500.	6206.	0.	999999.	11
3000.	5106.	0.	999999.	11
3200.	7751.	0.	999999.	8
3200.	40738.	0.	999999.	8
4000.	41178.	0.	999999.	8
5000.	17276.	0.	999999.	8
5000.	7921.	0.	999999.	1
4000.	7866.	0.	999999.	1
3500.	5376.	0.	999999.	11
3494.	12628.	0.	999999.	

	1000 KW-HR POWER			FLOW IN CFS AT DOWNSTREAM CONTROL POINT					
PER	REQ	ACTUAL	SHRTG	QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	44879.	0.	25.	0.	3279.	4224.	0.	999999.
11	20900.	39834.	0.	36.	0.	1813.	3980.	0.	999999.
12	21600.	38769.	0.	32.	0.	1348.	3826.	0.	999999.
1	21600.	60264.	0.	26.	0.	1421.	6232.	0.	999999.
2	19500.	45319.	0.	50.	0.	3191.	5156.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	8275.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	41527.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	41192.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	17286.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	7927.	0.	999999.
8	21600.	60264.	0.	4.	0.	4642.	7870.	0.	999999.
9	20900.	57744.	0.	5.	0.	3620.	5381.	0.	999999.
YR	254300.	645005.	0.	126.	0.	3464.	12755.	0.	999999.

YEAR 1958

	CFS	END OF MONTH STORAGE IN AC-FT			
PER	INFLOW	MIN	BUFFER	ACTUAL	MAX
10	3752.	570000.	570000.	850000.	850000.
11	5667.	520000.	520000.	800000.	800000.
12	6429.	500000.	500000.	750000.	750000.
1	5519.	476000.	476000.	730000.	730000.
2	6997.	471300.	471300.	712622.	700000.
3	12980.	735000.	735000.	1062730.	880000.
4	21254.	1015000.	1015000.	1391000.	1130000.
5	12798.	1190000.	1190000.	1391000.	1350000.
6	6925.	1135000.	1135000.	1331771.	1320000.
7	3918.	980000.	980000.	1170000.	1170000.
8	2586.	810000.	810000.	1043865.	1060000.
9	2803.	670000.	670000.	920000.	920000.
YR	7650.				

RELEASE TO RIVER IN CFS				
REQ	ACTUAL	SHRTG	MAX	CASE
3000.	4890.	0.	999999.	11
3000.	6507.	0.	999999.	11
2500.	7242.	0.	999999.	11
2500.	6144.	0.	999999.	11
3000.	7310.	0.	999999.	1
3200.	7286.	0.	999999.	1
3200.	15737.	0.	999999.	8
4000.	12798.	0.	999999.	8
5000.	7921.	0.	999999.	1
5000.	6549.	0.	999999.	11
4000.	4637.	0.	999999.	4
3500.	4885.	0.	999999.	11
3494.	7650.	0.	999999.	

	1000 KW-HR POWER			FLOW IN CFS AT DOWNSTREAM CONTROL POINT					
PER	REQ	ACTUAL	SHRTG	QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	52266.	0.	25.	0.	3279.	4915.	0.	999999.
11	20900.	58320.	0.	36.	0.	1813.	6543.	0.	999999.
12	21600.	60264.	0.	32.	0.	1348.	7274.	0.	999999.
1	21600.	60264.	0.	26.	0.	1421.	6170.	0.	999999.
2	19500.	54432.	0.	50.	0.	3191.	7360.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7809.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	16526.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	12811.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	7931.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	6555.	0.	999999.
8	21600.	53350.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	52227.	0.	5.	0.	3620.	4869.	0.	999999.
YR	254300.	688550.	0.	126.	0.	3464.	7776.	0.	999999.

TABLE A-3

YEAR 1959

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	3298.	570000.	570000.	850000.	850000.
11	3756.	520000.	520000.	800000.	800000.
12	4085.	500000.	500000.	750000.	750000.
1	3860.	476000.	476000.	730000.	730000.
2	4599.	471300.	471300.	700000.	700000.
3	16848.	735000.	735000.	1281810.	880000.
4	21563.	1015000.	1015000.	1391000.	1130000.
5	12469.	1190000.	1190000.	1391000.	1350000.
6	5726.	1135000.	1135000.	1320000.	1320000.
7	3211.	980000.	980000.	1170000.	1170000.
8	1973.	810000.	810000.	1006165.	1060000.
9	2426.	670000.	670000.	920000.	920000.
YR	6989.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	4437.	0.	999999.	11
3000.	4596.	0.	999999.	11
2500.	4698.	0.	999999.	11
2500.	4185.	0.	999999.	11
3000.	5139.	0.	999999.	11
3200.	7386.	0.	999999.	1
3200.	19728.	0.	999999.	8
4000.	12469.	0.	999999.	8
5000.	6919.	0.	999999.	11
5000.	5650.	0.	999999.	11
4000.	4637.	0.	999999.	4
3500.	3874.	0.	999999.	11
3494.	6989.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	47417.	0.	25.	0.	3279.	4461.	0.	999999.
11	20900.	46420.	0.	36.	0.	1813.	4633.	0.	999999.
12	21600.	50052.	0.	32.	0.	1348.	4930.	0.	999999.
1	21600.	42084.	0.	26.	0.	1421.	4211.	0.	999999.
2	19500.	46112.	0.	50.	0.	3191.	5189.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7909.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	20517.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	12483.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	6929.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	5656.	0.	999999.
8	21600.	53117.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	41145.	0.	5.	0.	3620.	3879.	0.	999999.
YR	254300.	623778.	0.	126.	0.	3464.	7115.	0.	999999.

YEAR 1960

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2543.	570000.	570000.	850000.	850000.
11	3457.	520000.	520000.	800000.	800000.
12	4129.	500000.	500000.	750000.	750000.
1	3350.	476000.	476000.	730000.	730000.
2	4135.	471300.	471300.	700000.	700000.
3	6708.	735000.	735000.	880000.	880000.
4	15848.	1015000.	1015000.	1375486.	1130000.
5	22242.	1190000.	1190000.	1391000.	1350000.
6	7829.	1135000.	1135000.	1385551.	1320000.
7	3354.	980000.	980000.	1170000.	1170000.
8	2397.	810000.	810000.	1032275.	1060000.
9	2112.	670000.	670000.	920000.	920000.
YR	6517.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3682.	0.	999999.	11
3000.	4297.	0.	999999.	11
2500.	4942.	0.	999999.	11
2500.	3675.	0.	999999.	11
3000.	4645.	0.	999999.	11
3200.	3781.	0.	999999.	11
3200.	7521.	0.	999999.	1
4000.	21969.	0.	999999.	8
5000.	7921.	0.	999999.	1
5000.	6659.	0.	999999.	11
4000.	4637.	0.	999999.	4
3500.	3999.	0.	999999.	11
3494.	6517.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	39348.	0.	25.	0.	3279.	3706.	0.	999999.
11	20900.	43400.	0.	36.	0.	1813.	4334.	0.	999999.
12	21600.	50498.	0.	32.	0.	1348.	4974.	0.	999999.
1	21600.	36954.	0.	26.	0.	1421.	3701.	0.	999999.
2	19500.	41683.	0.	50.	0.	3191.	4695.	0.	999999.
3	21600.	36862.	0.	524.	0.	3584.	4305.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	8310.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	22003.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	7931.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	6865.	0.	999999.
8	21600.	53279.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	42676.	0.	5.	0.	3620.	4004.	0.	999999.
YR	254300.	583389.	0.	126.	0.	3464.	6643.	0.	999999.

YEAR 1961

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2503.	570000.	570000.	850000.	850000.
11	2977.	520000.	520000.	800000.	800000.
12	2844.	500000.	500000.	750000.	750000.
1	2600.	476000.	476000.	730000.	730000.
2	2972.	471300.	471300.	700000.	700000.
3	7338.	735000.	735000.	880000.	880000.
4	25275.	1015000.	1015000.	1391000.	1130000.
5	20935.	1190000.	1190000.	1391000.	1350000.
6	6900.	1135000.	1135000.	1330271.	1320000.
7	3173.	980000.	980000.	1170000.	1170000.
8	2249.	810000.	810000.	1023145.	1060000.
9	2138.	670000.	670000.	920000.	920000.
YR	6847.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3641.	0.	999999.	11
3000.	3817.	0.	999999.	11
2500.	3657.	0.	999999.	11
2500.	3125.	0.	999999.	11
3000.	3512.	0.	999999.	11
3200.	4411.	0.	999999.	11
3200.	16686.	0.	999999.	8
4000.	20935.	0.	999999.	8
5000.	7921.	0.	999999.	1
5000.	5779.	0.	999999.	11
4000.	4637.	0.	999999.	4
3500.	3672.	0.	999999.	11
3494.	6847.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	33915.	0.	25.	0.	3279.	3666.	0.	999999.
11	20900.	36555.	0.	36.	0.	1813.	3954.	0.	999999.
12	21600.	37371.	0.	32.	0.	1348.	3569.	0.	999999.
1	21600.	31421.	0.	26.	0.	1421.	3150.	0.	999999.
2	19500.	31514.	0.	50.	0.	3191.	3562.	0.	999999.
3	21600.	45356.	0.	524.	0.	3584.	4934.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	17477.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	20948.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	7931.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	5785.	0.	999999.
8	21600.	53222.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	41252.	0.	5.	0.	3620.	3876.	0.	999999.
YR	254300.	554775.	0.	126.	0.	3464.	6973.	0.	999999.

YEAR 1962

	CFS	END OF MONTH STORAGE IN AC-FT				RELEASE TO RIVER IN CFS				
PER	INFLOW	MIN	BUFFER	ACTUAL	MAX	REQ	ACTUAL	SHRTG	MAX	CASE
10	431.	570000.	570000.	746400.	850000.	3000.	3254.	0.	999999.	4
11	3008.	520000.	520000.	746896.	800000.	3000.	3000.	0.	999999.	5
12	2989.	500000.	500000.	750000.	750000.	2500.	2938.	0.	999999.	11
1	2986.	476000.	476000.	730000.	730000.	2500.	3311.	0.	999999.	11
2	3440.	471300.	471300.	700000.	700000.	3000.	3980.	0.	999999.	11
3	5056.	735000.	735000.	814147.	880000.	3200.	3200.	0.	999999.	5
4	11626.	1015000.	1015000.	1130000.	1130000.	3200.	6318.	0.	999999.	11
5	9868.	1190000.	1190000.	1350000.	1350000.	4000.	6290.	0.	999999.	11
6	4684.	1135000.	1135000.	1320000.	1320000.	5000.	5188.	0.	999999.	11
7	1970.	980000.	980000.	1119795.	1170000.	5000.	5226.	0.	999999.	4
8	1530.	810000.	810000.	928740.	1060000.	4000.	4637.	0.	999999.	4
9	1796.	670000.	670000.	820468.	920000.	3500.	3615.	0.	999999.	4
YR	4108.					3494.	4246.	0.	999999.	

	1000 KW-HR POWER			FLOW IN CFS AT DOWNSTREAM CONTROL POINT					
PER	REQ	ACTUAL	SHRTG	QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	34076.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	29287.	0.	36.	0.	1813.	3036.	0.	999999.
12	21600.	29667.	0.	32.	0.	1348.	2970.	0.	999999.
1	21600.	33294.	0.	26.	0.	1421.	3337.	0.	999999.
2	19500.	35712.	0.	50.	0.	3191.	4030.	0.	999999.
3	21600.	32442.	0.	524.	0.	3584.	3724.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	7107.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	6304.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	5198.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	51900.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	37255.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	520800.	0.	126.	0.	3464.	4372.	0.	999999.

YEAR 1963

	CFS	END OF MONTH STORAGE IN AC-FT				RELEASE TO RIVER IN CFS				
PER	INFLOW	MIN	BUFFER	ACTUAL	MAX	REQ	ACTUAL	SHRTG	MAX	CASE
10	2209.	570000.	570000.	756233.	850000.	3000.	3254.	0.	999999.	4
11	2346.	520000.	520000.	717298.	800000.	3000.	3000.	0.	999999.	5
12	2464.	500000.	500000.	715057.	750000.	2500.	2500.	0.	999999.	5
1	2340.	476000.	476000.	705196.	730000.	2500.	2500.	0.	999999.	5
2	2562.	471300.	471300.	673033.	700000.	3000.	3141.	0.	999999.	4
3	4219.	735000.	735000.	735700.	880000.	3200.	3200.	0.	999999.	5
4	7916.	1015000.	1015000.	1016334.	1130000.	3200.	3200.	0.	999999.	5
5	18059.	1190000.	1190000.	1391000.	1350000.	4000.	11965.	0.	999999.	8
6	7650.	1135000.	1135000.	1374871.	1320000.	5000.	7921.	0.	999999.	1
7	2790.	980000.	980000.	1170000.	1170000.	5000.	6122.	0.	999999.	11
8	1763.	810000.	810000.	994515.	1060000.	4000.	4637.	0.	999999.	4
9	1702.	670000.	670000.	880643.	920000.	3500.	3615.	0.	999999.	4
YR	4685.					3494.	4602.	0.	999999.	

	1000 KW-HR POWER			FLOW IN CFS AT DOWNSTREAM CONTROL POINT					
PER	REQ	ACTUAL	SHRTG	QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	33439.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	29148.	0.	36.	0.	1813.	3036.	0.	999999.
12	21600.	24650.	0.	32.	0.	1348.	2532.	0.	999999.
1	21600.	24777.	0.	26.	0.	1421.	2526.	0.	999999.
2	19500.	27627.	0.	50.	0.	3191.	3191.	0.	999999.
3	21600.	31625.	0.	524.	0.	3584.	3724.	0.	999999.
4	20900.	32993.	0.	789.	0.	3840.	3989.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	11979.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	7931.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	6129.	0.	999999.
8	21600.	53045.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	38026.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	474577.	0.	126.	0.	3464.	4728.	0.	999999.

YEAR 1964

	CFS	END OF MONTH STORAGE IN AC-FT				RELEASE TO RIVER IN CFS				
PER	INFLOW	MIN	BUFFER	ACTUAL	MAX	REQ	ACTUAL	SHRTG	MAX	CASE
10	2072.	570000.	570000.	807948.	850000.	3000.	3254.	0.	999999.	4
11	2901.	520000.	520000.	800000.	800000.	3000.	3035.	0.	999999.	11
12	2731.	500000.	500000.	750000.	750000.	2500.	3544.	0.	999999.	11
1	2828.	476000.	476000.	730000.	730000.	2500.	3153.	0.	999999.	11
2	4248.	471300.	471300.	700000.	700000.	3000.	4786.	0.	999999.	11
3	12862.	735000.	735000.	1043829.	880000.	3200.	7270.	0.	999999.	1
4	27140.	1015000.	1015000.	1391000.	1130000.	3200.	21305.	0.	999999.	8
5	15902.	1190000.	1190000.	1391000.	1350000.	4000.	15902.	0.	999999.	8
6	6173.	1135000.	1135000.	1320000.	1320000.	5000.	7366.	0.	999999.	11
7	2697.	980000.	980000.	1170000.	1170000.	5000.	5337.	0.	999999.	11
8	1928.	810000.	810000.	1003395.	1060000.	4000.	4637.	0.	999999.	4
9	1788.	670000.	670000.	894663.	920000.	3500.	3615.	0.	999999.	4
YR	6950.					3494.	6931.	0.	999999.	

	1000 KW-HR POWER			FLOW IN CFS AT DOWNSTREAM CONTROL POINT					
PER	REQ	ACTUAL	SHRTG	QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	34231.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	30377.	0.	36.	0.	1813.	3071.	0.	999999.
12	21600.	36211.	0.	32.	0.	1348.	3576.	0.	999999.
1	21600.	31739.	0.	26.	0.	1421.	3179.	0.	999999.
2	19500.	42964.	0.	50.	0.	3191.	4835.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	22094.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	15915.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	7376.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	5343.	0.	999999.
8	21600.	53100.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	38193.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	564219.	0.	126.	0.	3464.	7057.	0.	999999.

YEAR 1965

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2491.	570000.	570000.	847718.	850000.	3000.	3254.	0.	999999.	4
11	2901.	520000.	520000.	800000.	800000.	3000.	3603.	0.	999999.	11
12	3039.	500000.	500000.	750000.	750000.	2500.	3852.	0.	999999.	11
1	3642.	476000.	476000.	730000.	730000.	2500.	4008.	0.	999999.	11
2	4880.	471300.	471300.	700000.	700000.	3000.	5420.	0.	999999.	11
3	15636.	735000.	735000.	1207290.	880000.	3200.	7386.	0.	999999.	1
4	29514.	1015000.	1015000.	1391000.	1130000.	3200.	26427.	0.	999999.	8
5	31087.	1190000.	1190000.	1391000.	1350000.	4000.	31087.	0.	999999.	8
6	15133.	1135000.	1135000.	1391000.	1320000.	5000.	15133.	0.	999999.	8
7	6393.	980000.	980000.	1297070.	1170000.	5000.	7921.	0.	999999.	1
8	3793.	810000.	810000.	1060000.	1060000.	4000.	7649.	0.	999999.	11
9	3111.	670000.	670000.	920000.	920000.	3500.	5464.	0.	999999.	11
YR	10146.					3494.	10111.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	34602.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	38371.	0.	36.	0.	1813.	3639.	0.	999999.
12	21600.	39360.	0.	32.	0.	1348.	3884.	0.	999999.
1	21600.	40300.	0.	26.	0.	1421.	4033.	0.	999999.
2	19500.	48634.	0.	50.	0.	3191.	5470.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7909.	0.	999999.
4	20900.	58320.	0.	789.	0.	3843.	27216.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	31101.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	15143.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	7927.	0.	999999.
8	21600.	60264.	0.	4.	0.	4642.	7653.	0.	999999.
9	20900.	58320.	0.	5.	0.	3620.	5468.	0.	999999.
YR	254300.	615283.	0.	126.	0.	3464.	10237.	0.	999999.

YEAR 1966

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	3481.	570000.	570000.	850000.	850000.	3000.	4619.	0.	999999.	11
11	3643.	520000.	520000.	800000.	800000.	3000.	4483.	0.	999999.	11
12	3319.	500000.	500000.	750000.	750000.	2500.	4133.	0.	999999.	11
1	3576.	476000.	476000.	730000.	730000.	2500.	3901.	0.	999999.	11
2	4205.	471300.	471300.	700000.	700000.	3000.	4748.	0.	999999.	11
3	4973.	735000.	735000.	809037.	880000.	3200.	3200.	0.	999999.	5
4	11862.	1015000.	1015000.	1130000.	1130000.	3200.	6468.	0.	999999.	11
5	13116.	1190000.	1190000.	1350000.	1350000.	4000.	6538.	0.	999999.	11
6	4635.	1135000.	1135000.	1320000.	1320000.	5000.	5339.	0.	999999.	11
7	2138.	980000.	980000.	1136175.	1170000.	5000.	5226.	0.	999999.	4
8	1659.	810000.	810000.	947020.	1060000.	4000.	4637.	0.	999999.	4
9	1770.	670000.	670000.	837228.	920000.	3500.	3615.	0.	999999.	4
YR	4625.					3494.	4740.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	49370.	0.	25.	0.	3279.	4644.	0.	999999.
11	20900.	45279.	0.	36.	0.	1813.	4520.	0.	999999.
12	21600.	42227.	0.	32.	0.	1348.	4164.	0.	999999.
1	21600.	39230.	0.	26.	0.	1421.	3927.	0.	999999.
2	19500.	42607.	0.	50.	0.	3191.	4798.	0.	999999.
3	21600.	32403.	0.	524.	0.	3584.	3724.	0.	999999.
4	20900.	58320.	0.	789.	0.	3846.	7257.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	6552.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	5349.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	52266.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	57477.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	578028.	0.	126.	0.	3464.	4866.	0.	999999.

YEAR 1967

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2217.	570000.	570000.	773467.	850000.	3000.	3254.	0.	999999.	4
11	2469.	520000.	520000.	743032.	800000.	3000.	3000.	0.	999999.	5
12	2304.	500000.	500000.	730981.	750000.	2500.	2500.	0.	999999.	5
1	2223.	476000.	476000.	713940.	730000.	2500.	2500.	0.	999999.	5
2	3627.	471300.	471300.	700000.	700000.	3000.	3878.	0.	999999.	11
3	7656.	735000.	735000.	880000.	880000.	3200.	4729.	0.	999999.	11
4	25764.	1015000.	1015000.	1391000.	1130000.	3200.	17196.	0.	999999.	8
5	25464.	1190000.	1190000.	1391000.	1350000.	4000.	25464.	0.	999999.	8
6	10657.	1135000.	1135000.	1391000.	1320000.	5000.	10657.	0.	999999.	8
7	4737.	980000.	980000.	1195250.	1170000.	5000.	7921.	0.	999999.	1
8	3070.	810000.	810000.	1060000.	1060000.	4000.	5269.	0.	999999.	11
9	2643.	670000.	670000.	920000.	920000.	3500.	4995.	0.	999999.	11
YR	7746.					3494.	7631.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	33680.	0.	25.	0.	3279.	3279.	0.	999999.
11	20900.	27450.	0.	36.	0.	1813.	3036.	0.	999999.
12	21600.	25102.	0.	32.	0.	1348.	2532.	0.	999999.
1	21600.	24926.	0.	26.	0.	1421.	2526.	0.	999999.
2	19500.	34857.	0.	50.	0.	3191.	3927.	0.	999999.
3	21600.	45029.	0.	524.	0.	3584.	5252.	0.	999999.
4	20900.	58320.	0.	789.	0.	3846.	17985.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	25496.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	10667.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	7927.	0.	999999.
8	21600.	60264.	0.	4.	0.	4642.	5274.	0.	999999.
9	20900.	55547.	0.	5.	0.	3620.	5001.	0.	999999.
YR	254300.	547424.	0.	126.	0.	3464.	7756.	0.	999999.

YEAR 1968

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	3179.	570000.	570000.	850000.	850000.	3000.	4318.	0.	999999.	11
11	3523.	520000.	520000.	800000.	800000.	3000.	4363.	0.	999999.	11
12	2941.	500000.	500000.	750000.	750000.	2500.	3754.	0.	999999.	11
1	2886.	476000.	476000.	730000.	730000.	2500.	3211.	0.	999999.	11
2	3717.	471300.	471300.	700000.	700000.	3000.	4257.	0.	999999.	11
3	12256.	735000.	735000.	1006569.	880000.	3200.	7270.	0.	999999.	1
4	18923.	1015000.	1015000.	1391000.	1130000.	3200.	12462.	0.	999999.	8
5	17850.	1190000.	1190000.	1391000.	1350000.	4000.	17850.	0.	999999.	8
6	9507.	1135000.	1135000.	1391000.	1320000.	5000.	9507.	0.	999999.	8
7	3679.	980000.	980000.	1170000.	1170000.	5000.	7273.	0.	999999.	11
8	2207.	810000.	810000.	1023545.	1060000.	4000.	4637.	0.	999999.	4
9	2500.	670000.	670000.	920000.	920000.	3500.	4190.	0.	999999.	11
YR	693[illegible].					3494.	6939.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	46146.	0.	25.	0.	3279.	4342.	0.	999999.
11	20900.	44069.	0.	36.	0.	1813.	4400.	0.	999999.
12	21600.	38358.	0.	32.	0.	1348.	3786.	0.	999999.
1	21600.	32290.	0.	26.	0.	1421.	3237.	0.	999999.
2	19500.	38198.	0.	50.	0.	3191.	4307.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	13251.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	17864.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	9517.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	7279.	0.	999999.
8	21600.	53206.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	44619.	0.	5.	0.	3620.	4194.	0.	999999.
YR	254300.	594319.	0.	126.	0.	3464.	7065.	0.	999999.

YEAR 1969

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2779.	570000.	570000.	850000.	850000.	3000.	3917.	0.	999999.	11
11	3264.	520000.	520000.	800000.	800000.	3000.	4104.	0.	999999.	11
12	2232.	500000.	500000.	750000.	750000.	2500.	3045.	0.	999999.	11
1	4132.	476000.	476000.	730000.	730000.	2500.	4457.	0.	999999.	11
2	6961.	471300.	471300.	710612.	700000.	3000.	7310.	0.	999999.	1
3	17868.	735000.	735000.	1354642.	880000.	3200.	7394.	0.	999999.	1
4	29561.	1015000.	1015000.	1391000.	1130000.	3200.	28950.	0.	999999.	8
5	20154.	1190000.	1190000.	1391000.	1350000.	4000.	20154.	0.	999999.	8
6	11729.	1135000.	1135000.	1391000.	1320000.	5000.	11729.	0.	999999.	8
7	5242.	980000.	980000.	1226300.	1170000.	5000.	7921.	0.	999999.	1
8	3013.	810000.	810000.	1060000.	1060000.	4000.	5717.	0.	999999.	11
9	2788.	670000.	670000.	920000.	920000.	3500.	5141.	0.	999999.	11
YR	9132.					3494.	9132.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	41869.	0.	25.	0.	3279.	3942.	0.	999999.
11	20900.	41447.	0.	36.	0.	1813.	4140.	0.	999999.
12	21600.	31113.	0.	32.	0.	1348.	3077.	0.	999999.
1	21600.	44820.	0.	26.	0.	1421.	4483.	0.	999999.
2	19500.	54432.	0.	50.	0.	3191.	7360.	0.	999999.
3	21600.	60264.	0.	524.	0.	3584.	7917.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	29738.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	20167.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	11739.	0.	999999.
7	21600.	60264.	0.	6.	0.	5232.	7927.	0.	999999.
8	21600.	60264.	0.	4.	0.	4642.	5722.	0.	999999.
9	20900.	55094.	0.	5.	0.	3620.	5145.	0.	999999.
YR	254300.	626470.	0.	126.	0.	3464.	9258.	0.	999999.

YEAR 1970

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	3078.	570000.	570000.	850000.	850000.	3000.	4217.	0.	999999.	11
11	5280.	520000.	520000.	800000.	800000.	3000.	6120.	0.	999999.	11
12	3858.	500000.	500000.	750000.	750000.	2500.	4672.	0.	999999.	11
1	3965.	476000.	476000.	730000.	730000.	2500.	4290.	0.	999999.	11
2	4070.	471300.	471300.	700000.	700000.	3000.	4610.	0.	999999.	11
3	6611.	735000.	735000.	880000.	880000.	3200.	3683.	0.	999999.	11
4	13384.	1015000.	1015000.	1228906.	1130000.	3200.	7521.	0.	999999.	1
5	7567.	1190000.	1190000.	1350000.	1350000.	4000.	5598.	0.	999999.	11
6	2885.	1135000.	1135000.	1219940.	1320000.	5000.	5070.	0.	999999.	4
7	1760.	980000.	980000.	1006635.	1170000.	5000.	5226.	0.	999999.	4
8	1818.	810000.	810000.	833460.	1060000.	4000.	4637.	0.	999999.	4
9	1668.	670000.	670000.	717598.	920000.	3500.	3615.	0.	999999.	4
YR	4654.					3494.	4934.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	45065.	0.	25.	0.	3279.	4241.	0.	999999.
11	20900.	58320.	0.	36.	0.	1813.	6156.	0.	999999.
12	21600.	47734.	0.	32.	0.	1348.	4703.	0.	999999.
1	21600.	43142.	0.	26.	0.	1421.	4316.	0.	999999.
2	19500.	4136[illegible].	0.	50.	0.	3191.	4659.	0.	999999.
3	21600.	37878.	0.	524.	0.	3584.	4207.	0.	999999.
4	20900.	58320.	0.	789.	0.	3840.	8310.	0.	999999.
5	21600.	60264.	0.	14.	0.	4508.	5611.	0.	999999.
6	20900.	58320.	0.	10.	0.	5080.	5080.	0.	999999.
7	21600.	60210.	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	50108.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	35758.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	596482.	0.	126.	0.	3464.	5060.	0.	999999.

1. Basis - For explanation of headings see Table A-3.

2. Results - The following averages are obtained from the study:

Average inflow	6854 cfs
Average local inflow	120 cfs
Average irrigation demand	3463 cfs
Average shortage in irrigation demand	23 cfs
Average annual power required	254.3 GWH
Actual annual power generated	839.9 GWH

YEAR 1947

PER	CFS INFLOW	MIN	BUFFER	ACTUAL	MAX
		END OF MONTH STORAGE IN AC-FT			
10	2142.	570000.	570000.	660790.	870000.
11	2540.	520000.	520000.	633435.	840000.
12	2785.	500000.	500000.	650964.	810000.
1	3016.	476000.	476000.	682683.	760000.
2	3613.	471300.	471300.	700000.	700000.
3	6077.	735000.	735000.	653260	880000.
4	7763.	1015000.	1015000.	1086700.	1130000.
5	4961.	1190000.	1190000.	1190000.	2140000.
6	2668.	1135000.	1135000.	1135000.	2050000.
7	1100.	980000.	980000.	980000.	1730000.
8	680.	810000.	810000.	810000.	1340000.
9	856.	670000.	670000.	670000.	1070000.
YR	3177.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3279.	0.	999999.	4
3000.	3000.	0.	999999.	5
2500.	2500.	0.	999999.	5
2500.	2500.	0.	999999.	5
3000.	3301.	0.	999999.	11
3200.	3584.	0.	999999.	4
3200.	3840.	0.	999999.	4
4000.	3281.	719.	999999.	10
5000.	3592.	1408.	999999.	10
5000.	3621.	1379.	999999.	10
4000.	3445.	555.	999999.	10
3500.	3208.	292.	999999.	10
3494.	3261.	365.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	32265.	0.	0.	0.	3279.	3279.	0.	999999.
11	20900.	27879.	0.	0.	0.	1813.	3000.	0.	999999.
12	21600.	23942.	0.	0.	0.	1348.	2500.	0.	999999.
1	21600.	24252.	0.	0.	0.	1421.	2500.	0.	999999.
2	19500.	29278.	0.	0.	0.	3191.	3301.	0.	999999.
3	21600.	36651.	0.	0.	0.	3584.	3584.	0.	999999.
4	20900.	40890.	0.	0.	0.	3840.	3840.	0.	999999.
5	21600.	38025.	0.	0.	0.	4508.	3281.	1227.	999999.
6	20900.	40509.	0.	0.	0.	5080.	3592.	1488.	999999.
7	21600.	41180.	0.	0.	0.	5232.	3621.	1611.	999999.
8	21600.	36937.	0.	0.	0.	4642.	3445.	1196.	999999.
9	20900.	31222.	0.	0.	0.	3620.	3208.	411.	999999.
YR	254300.	403030.	0.	0.	0.	3464.	3261.	499.	999999.

YEAR 1948

PER	CFS INFLOW	MIN	BUFFER	ACTUAL	MAX
		END OF MONTH STORAGE IN AC-FT			
10	1366.	570000.	570000.	570000.	870000.
11	1867.	520000.	520000.	520000.	840000.
12	2157.	500000.	500000.	500000.	810000.
1	2108.	476000.	476000.	476000.	760000.
2	2607.	471300.	471300.	471300.	700000.
3	9661.	735000.	735000.	869837.	880000
4	21195.	1015000.	1015000.	1685425.	1130000.
5	13163.	1190000.	1190000.	2140000.	2140000.
6	3781.	1135000.	1135000.	2050000.	2050000.
7	1942.	980000.	980000.	1730000.	1730000.
8	1164.	810000.	810000.	1340000.	1340000.
9	1371.	670000.	670000.	1070000.	1070000.
YR	5201.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	2992.	8.	999999.	10
3000.	2707.	293.	999999.	10
2500.	2482.	18.	999999.	10
2500.	2498.	2.	999999.	10
3000.	2692.	308.	999999.	10
3200.	3200.	0.	999999.	5
3200.	7489.	0.	999999.	1
4000.	5771.	0.	999999.	11
5000.	5294.	0.	999999.	11
5000.	7146.	0.	999999.	11
4000.	7507.	0.	999999.	11
3500.	5909.	0.	999999.	11
3494.	4649.	50.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	28307.	0.	0.	0.	3279.	2992.	286.	999999.
11	20900.	23727.	0.	0.	0.	1813.	2707.	0.	999999.
12	21600.	21943.	0.	0.	0.	1348.	2482.	0.	999999.
1	21600.	21743.	0.	0.	0.	1421.	2498.	0.	999999.
2	19500.	20945.	0.	0.	0.	3191.	2692.	499.	999999.
3	21600.	31101.	0.	524.	0.	3584.	3724.	0.	999999.
4	20900.	86892.	0.	789.	0.	3840.	8277.	0.	999999.
5	21600.	78864.	0.	14.	0.	4508.	5784.	0.	999999.
6	20900.	72049.	0.	10.	0.	5080.	5304.	0.	999999.
7	21600.	97279.	0.	6.	0.	5232.	7152.	0.	999999.
8	21600.	95845.	0.	4.	0.	4642.	7511.	0.	999999.
9	20900.	67320.	0.	5.	0.	3620.	5913.	0.	999999.
YR	254300.	645817.	0.	113.	0.	3464.	4761.	63.	999999.

YEAR 1949

PER	CFS INFLOW	MIN	BUFFER	ACTUAL	MAX
		END OF MONTH STORAGE IN AC-FT			
10	1878.	570000.	570000.	870000.	870000.
11	2363.	520000.	520000.	832085.	840000.
12	2508.	500000.	500000.	810000.	810000.
1	2529.	476000.	476000.	760000.	760000.
2	3997.	471300.	471300.	700000.	700000.
3	11563.	735000.	735000.	963979.	880000.
4	30656.	1015000.	1015000.	2210000.	1130000.
5	16397.	1190000.	1190000.	2210000.	2140000.
6	6013.	1135000.	1135000.	2064983.	2050000.
7	2914.	980000.	980000.	1730338.	1730000.
8	1991.	810000.	810000.	1352122	1340000.
9	1589.	670000.	670000.	1070000.	1070000.
YR	7049.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	5131.	0.	999999.	11
3000.	3000.	0.	999999.	5
2500.	2867.	0.	999999.	11
2500.	3342.	0.	999999.	11
3000.	5078.	0.	999999.	11
3200.	7270.	0.	999999.	1
3200.	9716.	0.	999999.	8
4000.	16397.	0.	999999.	8
5000.	8450.	0.	999999.	1
5000.	8357.	0.	999999.	1
4000.	8142.	0.	999999.	1
3500.	6630.	0.	999999.	11
3494.	7049.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	56459.	0.	25.	0.	3279.	5156.	0.	999999.
11	20900.	30624.	0.	36.	0.	1813.	3036.	0.	999999.
12	21600.	29870.	0.	32.	0.	1348.	2899.	0.	999999.
1	21600.	34295.	0.	26.	0.	1421.	3368.	0.	999999.
2	19500.	45894.	0.	50.	0.	3191.	5127.	0.	999999.
3	21600.	76092.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	103680.	0.	789.	0.	3840.	10505.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	16410.	0.	999999.
6	20900.	103380.	0.	10.	0.	5080.	8460.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8363.	0.	999999.
8	21600.	103872.	0.	4.	0.	4642.	8146.	0.	999999.
9	20900.	75658.	0.	5.	0.	3620.	6635.	0.	999999.
YR	254300.	874394.	0.	126.	0.	3464.	7175.	0.	999999.

YEAR 1950

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2462.	570000.	570000.	870000.	870000.	3000.	5715.	0.	999999.	11
11	2916.	520000.	520000.	840000.	840000.	3000.	3420.	0.	999999.	11
12	3025.	500000.	500000.	810000.	810000.	2500.	3513.	0.	999999.	11
1	3604.	476000.	476000.	760000.	760000.	2500.	4417.	0.	999999.	11
2	4049.	471300.	471300.	700000.	700000.	3000.	5130.	0.	999999.	11
3	7792.	735000.	735000.	880000.	880000.	3200.	4864.	0.	999999.	11
4	17078.	1015000.	1015000.	1448666.	1130000.	3200.	7521.	0.	999999.	1
5	27472.	1190000.	1190000.	2210000.	2140000.	4000.	15090.	0.	999999.	8
6	9932.	1135000.	1135000.	2210000.	2050000.	5000.	9932.	0.	999999.	8
7	3402.	980000.	980000.	1899622.	1730000.	5000.	8450.	0.	999999.	1
8	1833.	810000.	810000.	1505015.	1340000.	4000.	8250.	0.	999999.	1
9	1860.	670000.	670000.	1138760.	1070000.	3500.	8015.	0.	999999.	1
YR	7135.					3494.	7040.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	62883.	0.	25.	0.	3279.	5740.	0.	999999.
11	20900.	34966.	0.	36.	0.	1813.	3456.	0.	999999.
12	21600.	36660.	0.	32.	0.	1348.	3545.	0.	999999.
1	21600.	45326.	0.	26.	0.	1421.	4443.	0.	999999.
2	19500.	46366.	0.	50.	0.	3191.	5179.	0.	999999.
3	21600.	50022.	0.	524.	0.	3584.	5388.	0.	999999.
4	20900.	84849.	0.	789.	0.	3840.	8310.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	15104.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	9942.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8456.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8255.	0.	999999.
9	20900.	94012.	0.	5.	0.	3620.	8020.	0.	999999.
YR	254300.	880172.	0.	126.	0.	3464.	7166.	0.	999999.

YEAR 1951

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2391.	570000.	570000.	870000.	870000.	3000.	6762.	0.	999999.	11
11	2647.	520000.	520000.	840000.	840000.	3000.	3151.	0.	999999.	11
12	2654.	500000.	500000.	810000.	810000.	2500.	3142.	0.	999999.	11
1	2755.	476000.	476000.	760000.	760000.	2500.	3568.	0.	999999.	11
2	3160.	471300.	471300.	700000.	700000.	3000.	4240.	0.	999999.	11
3	10867.	735000.	735000.	921179.	880000.	3200.	7270.	0.	999999.	1
4	22338.	1015000.	1015000.	1802233.	1130000.	3200.	7531.	0.	999999.	1
5	32253.	1190000.	1190000.	2210000.	2140000.	4000.	25622.	0.	999999.	8
6	12535.	1135000.	1135000.	2210000.	2050000.	5000.	12535.	0.	999999.	8
7	4394.	980000.	980000.	1960622.	1730000.	5000.	8450.	0.	999999.	1
8	2303.	810000.	810000.	1592503.	1340000.	4000.	8290.	0.	999999.	1
9	2180.	670000.	670000.	1242800.	1070000.	3500.	8057.	0.	999999.	1
YR	8399.					3494.	8255.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	75215.	0.	25.	0.	3279.	6786.	0.	999999.
11	20900.	32217.	0.	36.	0.	1813.	3187.	0.	999999.
12	21600.	32791.	0.	32.	0.	1348.	3174.	0.	999999.
1	21600.	36615.	0.	26.	0.	1421.	3594.	0.	999999.
2	19500.	38327.	0.	50.	0.	3191.	4290.	0.	999999.
3	21600.	75413.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	89179.	0.	789.	0.	3840.	8320.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	25635.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	12545.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8456.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8294.	0.	999999.
9	20900.	96676.	0.	5.	0.	3620.	8061.	0.	999999.
YR	254300.	901520.	0.	126.	0.	3464.	8381.	0.	999999.

YEAR 1952

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2472.	570000.	570000.	915595.	870000.	3000.	7793.	0.	999999.	1
11	2968.	520000.	520000.	840000.	840000.	3000.	4236.	0.	999999.	11
12	3046.	500000.	500000.	810000.	810000.	2500.	3534.	0.	999999.	11
1	3183.	476000.	476000.	760000.	760000.	2500.	3996.	0.	999999.	11
2	5382.	471300.	471300.	700000.	700000.	3000.	6462.	0.	999999.	1
3	12186.	735000.	735000.	1002279.	880000.	3200.	7270.	0.	999999.	1
4	22842.	1015000.	1015000.	1905753.	1130000.	3200.	7659.	0.	999999.	1
5	14730.	1190000.	1190000.	2210000.	2140000.	4000.	9782.	0.	999999.	8
6	5574.	1135000.	1135000.	2050000.	2050000.	5000.	8263.	0.	999999.	11
7	2607.	980000.	980000.	1730000.	1730000.	5000.	7811.	0.	999999.	11
8	1682.	810000.	810000.	1540000.	1340000.	4000.	8024.	0.	999999.	11
9	1961.	670000.	670000.	1070000.	1070000.	3500.	6499.	0.	999999.	11
YR	6543.					3494.	6781.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	89085.	0.	25.	0.	3279.	7818.	0.	999999.
11	20900.	43728.	0.	36.	0.	1813.	4274.	0.	999999.
12	21600.	[illegible]	0.	32.	0.	1348.	3566.	0.	999999.
1	21600.	41004.	0.	26.	0.	1421.	4022.	0.	999999.
2	19500.	55409.	0.	50.	0.	3191.	6512.	0.	999999.
3	21600.	75689.	0.	524.	0.	3584.	7704.	0.	999999.
4	20900.	92695.	0.	789.	0.	3840.	8447.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	9795.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	8275.	0.	999999.
7	21600.	106334.	0.	6.	0.	5232.	7817.	0.	999999.
8	21600.	102234.	0.	4.	0.	4642.	8029.	0.	999999.
9	20900.	74041.	0.	5.	0.	3620.	6503.	0.	999999.
YR	254300.	[illegible]	0.	126.	0.	3464.	6908.	0.	999999.

YEAR 1953

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2522.	570000.	570000.	870000.	870000.
11	2914.	520000.	520000.	840000.	840000.
12	2924.	500000.	500000.	810000.	810000.
1	2957.	476000.	476000.	760000.	760000.
2	4606.	471300.	471300.	700000.	700000.
3	12542.	735000.	735000.	1024179.	880000.
4	15600.	1015000.	1015000.	1499251.	1130000.
5	11670.	1190000.	1190000.	1943493.	2140000.
6	6452.	1135000.	1135000.	2022683.	2050000.
7	2337.	980000.	980000.	1730000.	1730000.
8	1713.	810000.	810000.	1340000.	1340000.
9	1914.	670000.	670000.	1070000.	1070000.
YR	5577.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	5775.	0.	999999.	11
3000.	3418.	0.	999999.	11
2500.	3412.	0.	999999.	11
2500.	3770.	0.	999999.	11
3000.	5686.	0.	999999.	11
3200.	7270.	0.	999999.	1
3200.	7517.	0.	999999.	1
4000.	4464.	0.	999999.	4
5000.	5070.	0.	999999.	4
5000.	7097.	0.	999999.	11
4000.	8055.	0.	999999.	11
3500.	6452.	0.	999999.	11
3494.	5577.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT GLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	63545.	0.	25.	0.	3279.	5800.	0.	999999.
11	20900.	34748.	0.	36.	0.	1813.	3454.	0.	999999.
12	21600.	35608.	0.	32.	0.	1348.	3444.	0.	999999.
1	21600.	38684.	0.	26.	0.	1421.	3795.	0.	999999.
2	19500.	51395.	0.	50.	0.	3191.	5736.	0.	999999.
3	21600.	77026.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	88030.	0.	789.	0.	3840.	8405.	0.	999999.
5	21600.	59389.	0.	14.	0.	4508.	4508.	0.	999999.
6	20900.	67839.	0.	10.	0.	5080.	5080.	0.	999999.
7	21600.	98383.	0.	6.	0.	5232.	7103.	0.	999999.
8	21600.	102628.	0.	4.	0.	4642.	8059.	0.	999999.
9	20900.	73505.	0.	5.	0.	3620.	6456.	0.	999999.
YR	254300.	788980.	0.	126.	0.	3464.	5803.	0.	999999.

YEAR 1954

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2355.	570000.	570000.	870000.	870000.
11	2643.	520000.	520000.	840000.	840000.
12	2825.	500000.	500000.	810000.	810000.
1	3428.	476000.	476000.	760000.	760000.
2	6018.	471300.	471300.	700000.	700000.
3	14019.	735000.	735000.	1114970.	880000.
4	27282.	1015000.	1015000.	2210000.	1130000.
5	21344.	1190000.	1190000.	2210000.	2140000.
6	7638.	1135000.	1135000.	2161683.	2050000.
7	3623.	980000.	980000.	1866815.	1730000.
8	2335.	810000.	810000.	1504405.	1340000.
9	2227.	670000.	670000.	1159980.	1070000.
YR	7973.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	5517.	0.	999999.	11
3000.	3148.	0.	999999.	11
2500.	3313.	0.	999999.	11
2500.	4241.	0.	999999.	11
3000.	7098.	0.	999999.	11
3200.	7270.	0.	999999.	1
3200.	8880.	0.	999999.	8
4000.	21344.	0.	999999.	8
5000.	8450.	0.	999999.	1
5000.	8419.	0.	999999.	1
4000.	8229.	0.	999999.	1
3500.	8015.	0.	999999.	1
3494.	7849.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT GLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	61809.	0.	25	0.	3279.	5642.	0.	999999.
11	20900.	32182.	0.	36.	0.	1813.	3184.	0.	999999.
12	21600.	34573.	0.	32.	0.	1348.	3345.	0.	999999.
1	21600.	43524.	0.	26.	0.	1421.	4267.	0.	999999.
2	19500.	64154.	0.	50.	0.	3191.	7147.	0.	999999.
3	21600.	78248.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	103680.	0.	789.	0.	3840.	9668.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	21356.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	8460.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8425.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8234.	0.	999999.
9	20900.	94235.	0.	5.	0.	3620.	8019.	0.	999999.
YR	254300.	937497.	0.	126.	0.	3464.	7975.	0.	999999.

YEAR 1955

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2825.	570000.	570000.	870000.	870000.
11	3240.	520000.	520000.	840000.	840000.
12	3114.	500000.	500000.	810000.	810000.
1	3245.	476000.	476000.	760000.	760000.
2	3227.	471300.	471300.	700000.	700000.
3	10251.	735000.	735000.	883279.	880000.
4	10811.	1015000.	1015000.	1130000.	1130000.
5	13292.	1190000.	1190000.	1670942.	2140000.
6	6468.	1135000.	1135000.	1754132.	2050000.
7	2636.	980000.	980000.	1607217.	1730000.
8	1612.	810000.	810000.	1340000.	1340000.
9	1652.	670000.	670000.	1070000.	1070000.
YR	5230.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	7541.	0.	999999.	11
3000.	3744.	0.	999999.	11
2500.	3602.	0.	999999.	11
2500.	4059.	0.	999999.	11
3000.	4307.	0.	999999.	11
3200.	7270.	0.	999999.	1
3200.	6665.	0.	999999.	11
4000.	4494.	0.	999999.	4
5000.	5070.	0.	999999.	4
5000.	5226.	0.	999999.	4
4000.	5957.	0.	999999.	11
3500.	6220.	0.	999999.	11
3494.	5354.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT GLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	84159.	0.	25.	0.	3279.	7556.	0.	999999.
11	20900.	36282.	0.	36.	0.	1813.	3780.	0.	999999.
12	21600.	37594.	0.	32.	0.	1348.	3634.	0.	999999.
1	21600.	41639.	0.	26.	0.	1421.	4083.	0.	999999.
2	19500.	53927.	0.	50.	0.	3191.	4357.	0.	999999.
3	21600.	74812.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	71795.	0.	789.	0.	3840.	7453.	0.	999999.
5	21600.	55503.	0.	14.	0.	4508.	4508.	0.	999999.
6	20900.	64752.	0.	10.	0.	5080.	5080.	0.	999999.
7	21600.	66571.	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	74553.	0.	4.	0.	4642.	5762.	0.	999999.
9	20900.	70862.	0.	5.	0.	3620.	6224.	0.	999999.
YR	254300.	721749.	0.	126.	0.	3464.	5480.	0.	999999.

YEAR 1956

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2161.	570000.	570000.	870000.	870000.
11	2571.	520000.	520000.	840000.	840000.
12	3669.	500000.	500000.	810000.	810000.
1	3389.	476000.	476000.	760000.	760000.
2	4145.	471300.	471300.	700000.	700000.
3	15670.	735000.	735000.	1209360.	880000.
4	37921.	1015000.	1015000.	2210000.	1130000.
5	15847.	1190000.	1190000.	2210000.	2140000.
6	5371.	1135000.	1135000.	2050000.	2050000.
7	6523.	980000.	980000.	1937848.	1730000.
8	2319.	810000.	810000.	1571629.	1340000.
9	2338.	670000.	670000.	1232163.	1070000.
YR	8490.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	5414.	0.	999999.	11
3000.	3075.	0.	999999.	11
2500.	4157.	0.	999999.	11
2500.	4202.	0.	999999.	11
3000.	5225.	0.	999999.	11
3200.	7386.	0.	999999.	1
3200.	21105.	0.	999999.	8
4000.	15847.	0.	999999.	8
5000.	8060.	0.	999999.	11
5000.	8347.	0.	999999.	1
4000.	8275.	0.	999999.	1
3500.	8042.	0.	999999.	1
3494.	8266.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS ADD REQ		ACTUAL	SHRTG	MAX
10	21600.	59572.	0.	25.	0.	3279.	5439.	0.	999999.
11	20900.	31443.	0.	36.	0.	1813.	3112.	0.	999999.
12	21600.	43382.	0.	32.	0.	1348.	4189.	0.	999999.
1	21600.	43123.	0.	26.	0.	1421.	4228.	0.	999999.
2	19500.	47229.	0.	50.	0.	3191.	5275.	0.	999999.
3	21600.	80798.	0.	524.	0.	3584.	7939.	0.	999999.
4	20900.	103680.	0.	789.	0.	3840.	21894.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	15861.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	8070.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8353.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8279.	0.	999999.
9	20900.	96146.	0.	5.	0.	3620.	8247.	0.	999999.
YR	254300.	930461.	0.	126.	0.	3464.	8393.	0.	999999.

YEAR 1957

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	3061.	570000.	570000.	941650.	870000.
11	3164.	520000.	520000.	840000.	840000.
12	2981.	500000.	500000.	810000.	810000.
1	5881.	476000.	476000.	760000.	760000.
2	4566.	471300.	471300.	700000.	700000.
3	18969.	735000.	735000.	1413450.	880000.
4	49736.	1015000.	1015000.	2210000.	1130000.
5	41178.	1190000.	1190000.	2210000.	2140000.
6	17276.	1135000.	1135000.	2210000.	2050000.
7	6837.	980000.	980000.	2110822.	1730000.
8	3791.	810000.	810000.	1828265.	1340000.
9	2791.	670000.	670000.	1506153.	1070000.
YR	12628.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	7785.	0.	999999.	1
3000.	3812.	0.	999999.	11
2500.	3469.	0.	999999.	11
2500.	6694.	0.	999999.	11
3000.	5647.	0.	999999.	11
3200.	7386.	0.	999999.	1
3200.	27352.	0.	999999.	8
4000.	41178.	0.	999999.	8
5000.	17276.	0.	999999.	8
5000.	8450.	0.	999999.	1
4000.	8386.	0.	999999.	1
3500.	8205.	0.	999999.	1
3494.	12250.	0.	999999	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	DD REQ	ACTUAL	SHRTG	MAX
10	21600.	89154.	0.	25.	0.	3279.	7810.	0.	999999.
11	20900.	49863.	0.	36.	0.	1813.	4848.	0.	999999.
12	21600.	36202.	0.	32.	0.	1348.	3501.	0.	999999.
1	21600.	68690.	0.	26.	0.	1421.	6720.	0.	999999.
2	19500.	51037.	0.	50.	0.	3191.	5696.	0.	999999.
3	21600.	83984.	0.	524.	0.	3584.	7909.	0.	999999.
4	20900.	103680.	0.	789.	0.	3840.	28140.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	41192.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	17286.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8456.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8391.	0.	999999.
9	20900.	103680.	0.	5.	0.	3620.	8209.	0.	999999.
YR	254300.	1011379.	0.	126.	0.	3464.	12376.	0.	999999.

YEAR 1958

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	3752.	570000.	570000.	1243941.	870000.
11	5667.	520000.	520000.	1117344.	840000.
12	6429.	500000.	500000.	1039232.	810000.
1	5819.	476000.	476000.	927227.	760000.
2	6997.	471300.	471300.	896291.	700000.
3	12980.	735000.	735000.	1231187.	880000.
4	21254.	1015000.	1015000.	2030516.	1130000.
5	12798.	1190000.	1190000.	2210000.	2140000.
6	6925.	1135000.	1135000.	2119283.	2050000.
7	3918.	980000.	980000.	1844191.	1730000.
8	2586.	810000.	810000.	1493076.	1340000.
9	2803.	670000.	670000.	1188263.	1070000.
YR	7650.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	8016.	0.	999999.	1
3000.	7794.	0.	999999.	1
2500.	7699.	0.	999999.	1
2500.	7641.	0.	999999.	1
3000.	7554.	0.	999999.	1
3200.	7533.	0.	999999.	1
3200.	7821.	0.	999999.	1
4000.	9679.	0.	999999.	8
5000.	8450.	0.	999999.	1
5000.	8392.	0.	999999.	1
4000.	8215.	0.	999999.	1
3500.	8010.	0.	999999.	1
3494.	8089.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS ADD REQ		ACTUAL	SHRTG	MAX
10	21600.	[illegible]	0.	25.	0.	3279.	8041.	0.	999999.
11	20900.	[illegible]	0.	36.	0.	1813.	7831.	0.	999999.
12	21600.	[illegible]	0.	32.	0.	1348.	7731.	0.	999999.
1	21600.	[illegible]	0.	26.	0.	1421.	7666.	0.	999999.
2	19500.	73558.	0.	50.	0.	3191.	7604.	0.	999999.
3	21600.	85801.	0.	524.	0.	3584.	8057.	0.	999999.
4	20900.	98339.	0.	789.	0.	3840.	8610.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	9892.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	8460.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8398.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8219.	0.	999999.
9	20900.	94425.	0.	5.	0.	3620.	8014.	0.	999999.
YR	254300.	1130276.	0.	126.	0.	3464.	8215.	0.	999999.

YEAR 1959

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	3298.	570000.	570000.	914376.	870000.
11	3756.	520000.	520000.	840000.	840000.
12	4085.	500000.	500000.	810000.	810000.
1	3860.	476000.	476000.	760000.	760000.
2	4599.	471300.	471300.	700000.	700000.
3	16848.	735000.	735000.	1281810.	880000.
4	21563.	1015000.	1015000.	2097604.	1130000.
5	12469.	1190000.	1190000.	2210000.	2140000.
6	5726.	1135000.	1135000.	2050000.	2050000.
7	3211.	980000.	980000.	1734168.	1730000.
8	1973.	810000.	810000.	1354702.	1340000.
9	2426.	670000.	670000.	1070000.	1070000.
YR	6989.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	7752.	0.	999999.	1
3000.	5086.	0.	999999.	11
2500.	4573.	0.	999999.	11
2500.	4673.	0.	999999.	11
3000.	5679.	0.	999999.	11
3200.	7386.	0.	999999.	1
3200.	7853.	0.	999999.	1
4000.	10641.	0.	999999.	8
5000.	8415.	0.	999999.	11
5000.	8347.	0.	999999.	1
4000.	8144.	0.	999999.	1
3500.	7211.	0.	999999.	11
3494.	7152.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	87934.	0.	25.	0.	3279.	7777.	0.	999999.
11	20900.	51636.	0.	36.	0.	1813.	5042.	0.	999999.
12	21600.	47727.	0.	32.	0.	1348.	4605.	0.	999999.
1	21600.	47953.	0.	26.	0.	1421.	4699.	0.	999999.
2	19500.	51332.	0.	50.	0.	3191.	5729.	0.	999999.
3	21600.	81818.	0.	524.	0.	3584.	7909.	0.	999999.
4	20900.	99886.	0.	789.	0.	3840.	8642.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	10655.	0.	999999.
6	20900.	103680.	0.	10.	0.	5060.	8425.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8353.	0.	999999.
8	21600.	103972.	0.	4.	0.	4642.	8148.	0.	999999.
9	20900.	82306.	0.	5.	0.	3620.	7215.	0.	999999.
YR	254300.	972516.	0.	126.	0.	3464.	7279.	0.	999999.

YEAR 1960

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2543.	570000.	570000.	870000.	870000.
11	3457.	520000.	520000.	840000.	840000.
12	4129.	500000.	500000.	810000.	810000.
1	3350.	476000.	476000.	760000.	760000.
2	4105.	471300.	471300.	700000.	700000.
3	6708.	735000.	735000.	880000.	880000.
4	15848.	1015000.	1015000.	1375486.	1130000.
5	22242.	1190000.	1190000.	2210000.	2140000.
6	7829.	1135000.	1135000.	2173061.	2050000.
7	3354.	980000.	980000.	1861155.	1730000.
8	2397.	810000.	810000.	1502779.	1340000.
9	2112.	670000.	670000.	1151634.	1070000.
YR	6517.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	5796.	0.	999999.	11
3000.	3961.	0.	999999.	11
2500.	4617.	0.	999999.	11
2500.	4163.	0.	999999.	11
3000.	5166.	0.	999999.	11
3200.	3781.	0.	999999.	11
3200.	7521.	0.	999999.	1
4000.	8670.	0.	999999.	8
5000.	8450.	0.	999999.	1
5000.	8426.	0.	999999.	1
4000.	8226.	0.	999999.	1
3500.	8014.	0.	999999.	1
3494.	6404.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	63774.	0.	25.	0.	3279.	5821.	0.	999999.
11	20900.	40500.	0.	36.	0.	1813.	3997.	0.	999999.
12	21600.	48181.	0.	32.	0.	1348.	4648.	0.	999999.
1	21600.	42718.	0.	26.	0.	1421.	4189.	0.	999999.
2	19500.	46871.	0.	50.	0.	3191.	5235.	0.	999999.
3	21600.	38882.	0.	524.	0.	3584.	4305.	0.	999999.
4	20900.	84140.	0.	789.	0.	3840.	8310.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	8683.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	8460.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8433.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8230.	0.	999999.
9	20900.	94110.	0.	5.	0.	3620.	8018.	0.	999999.
YR	254300.	884264.	0.	126.	0.	3464.	6531.	0.	999999.

YEAR 1961

PER	CFS INFLO	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2503.	570000.	570000.	870000.	870000.
11	2977.	520000.	520000.	840000.	840000.
12	2944.	500000.	500000.	810000.	810000.
1	2800.	476000.	476000.	760000.	760000.
2	2972.	471300.	471300.	700000.	700000.
3	7338.	735000.	735000.	880000.	880000.
4	25275.	1015000.	1015000.	1933189.	1130000.
5	20935.	1190000.	1190000.	2210000.	2140000.
6	6900.	1135000.	1135000.	2117783.	2050000.
7	3173.	980000.	980000.	1796931.	1730000.
8	2249.	810000.	810000.	1431963.	1340000.
9	2138.	670000.	670000.	1085853.	1070000.
YR	6847.				

RELEASE TO RIVER IN CFS

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	7083.	0.	999999.	11
3000.	3481.	0.	999999.	11
2500.	3332.	0.	999999.	11
2500.	3613.	0.	999999.	11
3000.	4052.	0.	999999.	11
3200.	4411.	0.	999999.	11
3200.	7576.	0.	999999.	1
4000.	16433.	0.	999999.	8
5000.	8450.	0.	999999.	1
5000.	8391.	0.	999999.	1
4000.	8184.	0.	999999.	1
3500.	7955.	0.	999999.	1
3494.	6937.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	78947.	0.	25.	0.	3279.	7108.	0.	999999.
11	20900.	35595.	0.	36.	0.	1813.	3518.	0.	999999.
12	21600.	34775.	0.	32.	0.	1348.	3364.	0.	999999.
1	21600.	37072.	0.	26.	0.	1421.	3638.	0.	999999.
2	19500.	36528.	0.	50.	0.	3191.	4102.	0.	999999.
3	21600.	45356.	0.	524.	0.	3584.	4934.	0.	999999.
4	20900.	90673.	0.	789.	0.	3840.	6365.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	16447.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	8460.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8397.	0.	999999.
8	21600.	105991.	0.	4.	0.	4642.	8189.	0.	999999.
9	20900.	91874.	0.	5.	0.	3620.	7959.	0.	999999.
YR	254300.	874862.	0.	126.	0.	3464.	7064.	0.	999999.

YEAR 1962

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	431.	570000.	570000.	870000.	870000.
11	3008.	520000.	520000.	840000.	840000.
12	2989.	500000.	500000.	810000.	810000.
1	2986.	476000.	476000.	760000.	760000.
2	3440.	471300.	471300.	700000.	700000.
3	5056.	735000.	735000.	814147.	880000.
4	11626.	1015000.	1015000.	1130000.	1130000.
5	9868.	1190000.	1190000.	1460402.	2140000.
6	4684.	1135000.	1135000.	1437402.	2050000.
7	1970.	980000.	980000.	1237197.	1730000.
8	1530.	810000.	810000.	1046142.	1340000.
9	1796.	670000.	670000.	937870.	1070000.
YR	4108.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3941.	0.	999999.	11
3000.	3512.	0.	999999.	11
2500.	3477.	0.	999999.	11
2500.	3799.	0.	999999.	11
3000.	4520.	0.	999999.	11
3200.	3200.	0.	999999.	5
3200.	6318.	0.	999999.	11
4000.	4494.	0.	999999.	4
5000.	5070.	0.	999999.	4
5000.	5226.	0.	999999.	4
4000.	4637.	0.	999999.	4
3500.	3615.	0.	999999.	4
3494.	4312.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT GLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	43485.	0.	25.	0.	3279.	3966.	0.	999999.
11	20900.	35913.	0.	36.	0.	1813.	3549.	0.	999999.
12	21600.	36284.	0.	32.	0.	1348.	3506.	0.	999999.
1	21600.	38983.	0.	26.	0.	1421.	3825.	0.	999999.
2	19500.	40856.	0.	50.	0.	3191.	4570.	0.	999999.
3	21600.	32442.	0.	524.	0.	3584.	3724.	0.	999999.
4	20900.	67328.	0.	789.	0.	3840.	7107.	0.	999999.
5	21600.	54122.	0.	14.	0.	4508.	4508.	0.	999999.
6	20900.	61294.	0.	10.	0.	5080.	5080.	0.	999999.
7	21600.	63569.	0.	6.	0.	5232.	5232.	0.	999999.
8	21500.	53780.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	38772.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	566825.	0.	126.	0.	3464.	4439.	0.	999999.

YEAR 1963

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2209.	570000.	570000.	870000.	870000.
11	2346.	520000.	520000.	831065.	840000.
12	2464.	500000.	500000.	810000.	810000.
1	2340.	476000.	476000.	760000.	760000.
2	2562.	471300.	471300.	700000.	700000.
3	4219.	735000.	735000.	762667.	880000.
4	7916.	1015000.	1015000.	1043301.	1130000.
5	18059.	1190000.	1190000.	1877343.	2140000.
6	7650.	1135000.	1135000.	2030833.	2050000.
7	2790.	980000.	980000.	1730000.	1730000.
8	1783.	810000.	810000.	1340000.	1340000.
9	1702.	670000.	670000.	1070000.	1070000.
YR	4685.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3313.	0.	999999.	11
3000.	3000.	0.	999999.	5
2500.	2808.	0.	999999.	11
2500.	3153.	0.	999999.	11
3000.	3642.	0.	999999.	11
3200.	3200.	0.	999999.	5
3200.	3200.	0.	999999.	5
4000.	4494.	0.	999999.	4
5000.	5070.	0.	999999.	4
5000.	7683.	0.	999999.	11
4000.	8126.	0.	999999.	11
3500.	6239.	0.	999999.	11
3494.	4502.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT GLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	35620.	0.	25.	0.	3279.	3338.	0.	999999.
11	20900.	30618.	0.	36.	0.	1813.	3036.	0.	999999.
12	21600.	29230.	0.	32.	0.	1348.	2838.	0.	999999.
1	21600.	32352.	0.	26.	0.	1421.	3178.	0.	999999.
2	19500.	32920.	0.	50.	0.	3191.	3692.	0.	999999.
3	21600.	32043.	0.	524.	0.	3584.	3724.	0.	999999.
4	20900.	33284.	0.	789.	0.	3840.	3989.	0.	999999.
5	21600.	56295.	0.	14.	0.	4508.	4508.	0.	999999.
6	20900.	67538.	0.	10.	0.	5080.	5080.	0.	999999.
7	21600.	104415.	0.	6.	0.	5232.	7689.	0.	999999.
8	21600.	103529.	0.	4.	0.	4642.	8130.	0.	999999.
9	20900.	71084.	0.	5.	0.	3620.	6244.	0.	999999.
YR	254300.	628929.	0.	126.	0.	3464.	4628.	0.	999999.

YEAR 1964

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2072.	570000.	570000.	870000.	870000.
11	2901.	520000.	520000.	840000.	840000.
12	2731.	500000.	500000.	810000.	810000.
1	2828.	476000.	476000.	760000.	760000.
2	4248.	471300.	471300.	700000.	700000.
3	12862.	735000.	735000.	1043829.	880000.
4	27140.	1015000.	1015000.	2200576.	1130000.
5	15902.	1190000.	1190000.	2210000.	2140000.
6	6173.	1135000.	1135000.	2074513.	2050000.
7	2897.	980000.	980000.	1738451.	1730000.
8	1928.	810000.	810000.	1356046.	1340000.
9	1768.	670000.	670000.	1070000.	1070000.
YR	6950.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	5324.	0.	999999.	11
3000.	3405.	0.	999999.	11
2500.	3219.	0.	999999.	11
2500.	3641.	0.	999999.	11
3000.	5328.	0.	999999.	11
3200.	7270.	0.	999999.	1
3200.	7700.	0.	999999.	1
4000.	15748.	0.	999999.	8
5000.	8450.	0.	999999.	1
5000.	8363.	0.	999999.	1
4000.	8147.	0.	999999.	1
3500.	6595.	0.	999999.	11
3494.	6950.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT GLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	53586	0.	25.	0.	3279.	5349.	0.	999999.
11	20900.	34514	0.	36.	0.	1813.	3441.	0.	999999.
12	21600.	33590	0.	32.	0.	1348.	3251.	0.	999999.
1	21600.	37366	0.	26.	0.	1421.	3667.	0.	999999.
2	19500.	45161	0.	50.	0.	3191.	5378.	0.	999999.
3	21600.	77328	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	96655	0.	789.	0.	3840.	8489.	0.	999999.
5	21600.	107135.	0.	14.	0.	4508.	15762.	0.	999999.
6	20900.	103680	0.	10.	0.	5080.	8460.	0.	999999.
7	21600.	107138	0.	6.	0.	5232.	8369.	0.	999999.
8	21600.	104067	0.	4.	0.	4642.	8151.	0.	999999.
9	20900.	75295	0.	5.	0.	3620.	6600.	0.	999999.
YR	254300.	883816	0.	126.	0.	3464.	7076.	0.	999999.

YEAR 1965

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2491.	570000.	570000.	870000.	870000.
11	2801.	520000.	520000.	840000.	840000.
12	3039.	500000.	500000.	810000.	810000.
1	3882.	476000.	476000.	760000.	760000.
2	4880.	471300.	471300.	700000.	700000.
3	15636.	735000.	735000.	1207290.	880000.
4	29514.	1015000.	1015000.	2210000.	1130000.
5	31087.	1190000.	1190000.	2210000.	2140000.
6	15133.	1135000.	1135000.	2210000.	2050000.
7	8393.	980000.	980000.	2083532.	1730000.
8	3793.	810000.	810000.	1802194.	1340000.
9	3111.	670000.	670000.	1500099.	1070000.
YR	10146.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	9743.	0.	999999.	11
3000.	3365.	0.	999999.	11
2500.	3527.	0.	999999.	11
2500.	4496.	0.	999999.	11
3000.	5960.	0.	999999.	11
3200.	7386.	0.	999999.	1
3200.	12663.	0.	999999.	8
4000.	31087.	0.	999999.	8
5000.	15133.	0.	999999.	8
5000.	8450.	0.	999999.	1
4000.	8369.	0.	999999.	1
3500.	8188.	0.	999999.	1
3494.	9552.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	63194.	0.	25.	0.	3279.	5768.	0.	999999.
11	20900.	33794.	0.	36.	0.	1813.	3342.	0.	999999.
12	21600.	36806.	0.	32.	0.	1348.	3559.	0.	999999.
1	21600.	46132.	0.	26.	0.	1421.	4521.	0.	999999.
2	19500.	53872.	0.	50.	0.	3191.	6010.	0.	999999.
3	21600.	80766.	0.	524.	0.	3584.	7909.	0.	999999.
4	20900.	103680.	0.	789.	0.	3840.	13452.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	31101.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	15143.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8456.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8373.	0.	999999.
9	20900.	103378.	0.	5.	0.	3620.	8192.	0.	999999.
YR	254300.	946711.	0.	126.	0.	3454.	9678.	0.	999999.

YEAR 1966

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	3481.	570000.	570000.	1221536.	870000.
11	3643.	520000.	520000.	975520.	840000.
12	3319.	500000.	500000.	810000.	810000.
1	3576.	476000.	476000.	760000.	760000.
2	4208.	471300.	471300.	700000.	700000.
3	4973.	735000.	735000.	809037.	880000.
4	11862.	1015000.	1015000.	1130000.	1130000.
5	10116.	1190000.	1190000.	1475642.	2140000.
6	4835.	1135000.	1135000.	1461652.	2050000.
7	2138.	980000.	980000.	1271827.	1730000.
8	1659.	810000.	810000.	1086672.	1340000.
9	1770.	670000.	670000.	978880.	1070000.
YR	4625.				

RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
3000.	8011.	0.	999999.	1
3000.	7777.	0.	999999.	1
2500.	6011.	0.	999999.	11
2500.	4389.	0.	999999.	11
3000.	5289.	0.	999999.	11
3200.	3200.	0.	999999.	5
3200.	6468.	0.	999999.	11
4000.	4494.	0.	999999.	4
5000.	5070.	0.	999999.	4
5000.	5226.	0.	999999.	4
4000.	4637.	0.	999999.	4
3500.	3615.	0.	999999.	4
3494.	5345.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	98005.	0.	25.	0.	3279.	8036.	0.	999999.
11	20900.	86423.	0.	36.	0.	1813.	7814.	0.	999999.
12	21600.	64404.	0.	32.	0.	1348.	6043.	0.	999999.
1	21600.	45041.	0.	26.	0.	1421.	4415.	0.	999999.
2	19500.	47802.	0.	50.	0.	3191.	5338.	0.	999999.
3	21600.	32403.	0.	524.	0.	3584.	3724.	0.	999999.
4	20900.	68866.	0.	789.	0.	3840.	7257.	0.	999999.
5	21600.	54223.	0.	14.	0.	4508.	4508.	0.	999999.
6	20900.	61580.	0.	10.	0.	5080.	5080.	0.	999999.
7	21600.	64017.	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	54256.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	39340.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	716358.	0.	126.	0.	3464.	5472.	0.	999999.

YEAR 1967

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX
10	2217.	570000.	570000.	870000.	870000.
11	2489.	520000.	520000.	839565.	840000.
12	2304.	500000.	500000.	810000.	810000.
1	2223.	476000.	476000.	760000.	760000.
2	3627.	471300.	471300.	700000.	700000.
3	7656.	735000.	735000.	880000.	880000.
4	25784.	1015000.	1015000.	1963449.	1130000.
5	25484.	1190000.	1190000.	2210000.	2140000.
6	10657.	1135000.	1135000.	2210000.	2050000.
7	4737.	980000.	980000.	1981712.	1730000.
8	3070.	810000.	810000.	1659916.	1340000.
9	2643.	670000.	670000.	1335436.	1070000.
YR	7746.				

REQ	ACTUAL	SHRTG	MAX	CASE
3000.	3988.	0.	999999.	11
3000.	3000.	0.	999999.	5
2500.	2785.	0.	999999.	11
2500.	3036.	0.	999999.	11
3000.	4707.	0.	999999.	11
3200.	4729.	0.	999999.	11
3200.	7576.	0.	999999.	1
4000.	21474.	0.	999999.	8
5000.	10657.	0.	999999.	8
5000.	8450.	0.	999999.	1
4000.	8383.	0.	999999.	1
3500.	8396.	0.	999999.	1
3494.	7253.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	45148.	0.	25.	0.	3279.	4012.	0.	999999.
11	20900.	30670	0.	36.	0.	1813.	3836.	0.	999999.
12	21600.	29560.	0.	32.	0.	1348.	2817.	0.	999999.
1	21600.	31154.	0.	26.	0.	1421.	3362.	0.	999999.
2	19500.	42544.	0.	50.	0.	3191.	4757.	0.	999999.
3	21600.	48529.	0.	524.	0.	3584.	5252.	0.	999999.
4	20900.	91000.	0.	789.	0.	3840.	6365.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	21488.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	10667.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8456.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8303.	0.	999999.
9	20900.	98988.	0.	5.	0.	3620.	5131.	0.	999999.
YR	254300.	840281.	0.	126.	0.	3464.	7379.	0.	999999.

YEAR 1968

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	3179.	570000.	570000.	1046721.	870000.	3000.	7875.	0.	999999.	1
11	3523.	520000.	520000.	840000.	840000.	3000.	6997.	0.	999999.	11
12	2941.	500000.	500000.	810000.	810000.	2500.	3429.	0.	999999.	11
1	2886.	476000.	476000.	760000.	760000.	2500.	3699.	0.	999999.	11
2	3717.	471300.	471300.	700000.	700000.	3000.	4797.	0.	999999.	11
3	12256.	735000.	735000.	1006569.	880000.	3200.	7270.	0.	999999.	1
4	18923.	1015000.	1015000.	1680220.	1130000.	3200.	7602.	0.	999999.	1
5	17850.	1190000.	1190000.	2210000.	2140000.	4000.	9234.	0.	999999.	8
6	9507.	1135000.	1135000.	2210000.	2050000.	5000.	9507.	0.	999999.	8
7	3679.	980000.	980000.	1916512.	1730000.	5000.	8450.	0.	999999.	1
8	2207.	810000.	810000.	1544313.	1340000.	4000.	8261.	0.	999999.	1
9	2500.	670000.	670000.	1214189.	1070000.	3500.	8048.	0.	999999.	1
YR	6939.					3494.	7106.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	92380.	0.	25.	0.	3279.	7899.	0.	999999.
11	20900.	73760.	0.	36.	0.	1813.	7034.	0.	999999.
12	21600.	35783.	0.	32.	0.	1348.	3460.	0.	999999.
1	21600.	37958.	0.	26.	0.	1421.	3725.	0.	999999.
2	19500.	43360.	0.	50.	0.	3191.	4847.	0.	999999.
3	21600.	76755.	0.	524.	0.	3584.	7794.	0.	999999.
4	20900.	89625.	0.	789.	0.	3840.	8391.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	9248.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	9517.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8455.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8266.	0.	999999.
9	20900.	95695.	0.	5.	0.	3620.	8052.	0.	999999.
YR	254300.	970405.	0.	126.	0.	3464.	7232.	0.	999999.

YEAR 1969

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	2779.	570000.	570000.	907185.	870000.	3000.	7772.	0.	999999.	1
11	3264.	520000.	520000.	840000.	840000.	3000.	4393.	0.	999999.	11
12	2232.	500000.	500000.	810000.	810000.	2500.	2720.	0.	999999.	11
1	4132.	476000.	476000.	760000.	760000.	2500.	4945.	0.	999999.	11
2	6961.	471300.	471300.	738663.	700000.	3000.	7345.	0.	999999.	1
3	17868.	735000.	735000.	1381398.	880000.	3200.	7415.	0.	999999.	1
4	29561.	1015000.	1015000.	2210000.	1130000.	3200.	15636.	0.	999999.	8
5	20154.	1190000.	1190000.	2210000.	2140000.	4000.	20154.	0.	999999.	8
6	11729.	1135000.	1135000.	2210000.	2050000.	5000.	11729.	0.	999999.	8
7	5242.	980000.	980000.	2012762.	1730000.	5000.	8450.	0.	999999.	1
8	3013.	810000.	810000.	1656242.	1340000.	4000.	8323.	0.	999999.	1
9	2788.	670000.	670000.	1369353.	1070000.	3500.	8113.	0.	999999.	1
YR	9132.					3494.	8918.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	88457.	0.	25.	0.	3279.	7797.	0.	999999.
11	20900.	45246.	0.	36.	0.	1813.	4429.	0.	999999.
12	21600.	26383.	0.	32.	0.	1348.	2751.	0.	999999.
1	21600.	50745.	0.	26.	0.	1421.	4971.	0.	999999.
2	19500.	67010.	0.	50.	0.	3191.	7395.	0.	999999.
3	21600.	84379.	0.	524.	0.	3584.	7938.	0.	999999.
4	20900.	103680.	0.	789.	0.	3840.	16424.	0.	999999.
5	21600.	107136.	0.	14.	0.	4508.	20167.	0.	999999.
6	20900.	103680.	0.	10.	0.	5080.	11739.	0.	999999.
7	21600.	107136.	0.	6.	0.	5232.	8456.	0.	999999.
8	21600.	107136.	0.	4.	0.	4642.	8327.	0.	999999.
9	20900.	99872.	0.	5.	0.	3620.	8118.	0.	999999.
YR	254300.	992860.	0.	126.	0.	3464.	9044.	0.	999999.

YEAR 1970

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE
10	3078.	570000.	570000.	1072687.	870000.	3000.	7903.	0.	999999.	1
11	5236.	520000.	520000.	930712.	840000.	3000.	7666.	0.	999999.	1
12	3858.	500000.	500000.	810000.	810000.	2500.	5822.	0.	999999.	11
1	3965.	476000.	476000.	760000.	760000.	2500.	4778.	0.	999999.	11
2	4070.	471300.	471300.	700000.	700000.	3000.	5150.	0.	999999.	11
3	6611.	735000.	735000.	880000.	880000.	3200.	3683.	0.	999999.	11
4	13384.	1015000.	1015000.	1228906.	1130000.	3200.	7521.	0.	999999.	1
5	7567.	1190000.	1190000.	1417628.	2140000.	4000.	4494.	0.	999999.	4
6	2885.	1135000.	1135000.	1287768.	2050000.	5000.	5070.	0.	999999.	4
7	1763.	980000.	980000.	1074663.	1730000.	5000.	5226.	0.	999999.	4
8	1818.	810009.	810003.	901288.	1340000.	4000.	4637.	0.	999999.	4
9	1568.	670000.	670000.	785426.	1070000.	3500.	3615.	0.	999999.	4
YR	4654.					3494.	5461.	0.	999999.	

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS	ADD REQ	ACTUAL	SHRTG	MAX
10	21600.	93422.	0.	25.	0.	3279.	7928.	0.	999999.
11	20900.	82453.	0.	36.	0.	1813.	7702.	0.	999999.
12	21600.	61864.	0.	32.	0.	1348.	5853.	0.	999999.
1	21600.	49033.	0.	26.	0.	1421.	4804.	0.	999999.
2	19500.	46548.	0.	50.	0.	3191.	5200.	0.	999999.
3	21600.	37878.	0.	524.	0.	3584.	4267.	0.	999999.
4	20900.	82685.	0.	789.	0.	3840.	8319.	0.	999999.
5	21600.	54492.	0.	14.	0.	4508.	4508.	0.	999999.
6	20900.	59911.	0.	10.	0.	5080.	5080.	0.	999999.
7	21600.	61154.	0.	6.	0.	5232.	5232.	0.	999999.
8	21600.	51324.	0.	4.	0.	4642.	4642.	0.	999999.
9	20900.	36792.	0.	5.	0.	3620.	3620.	0.	999999.
YR	254300.	717577.	0.	126.	0.	3464.	5587.	0.	999999.

SUMMARY OF UNCONTROLLED FLOOD DISCHARGES FROM KAJAKAI RESERVOIR

Average Monthly Discharge (cfs)**

	Ungated			Gated			Gated		
	Present Level			Intermediate Level			Present Level		
	April	May	June	April	May	June	April	May	June
1947		-		-	-			-	
1948		12,437	13,163		*			*	
1949	23,366	16,397		20,241	16,397		9,716	16,397	
1950	8,490	27,472	9,932		23,243			15,090	9,932
1951	14,442	32,253	12,535	12,086	32,253			25,622	12,535
1952	16,309	14,730		12,591	14,730			9,782	
1953	9,436	11,670		-	*			*	
1954	22,643	21,344		17,031	21,344		8,880	21,344	
1955		9,047		-	*			*	
1956	34,869	15,847		27,670	15,847		21,105	15,847	
1957	40,738	41,178	17,276	32,433	41,178		27,352	41,178	17,276
1958	15,737	12,798		11,002	12,798			9,879	
1959	19,728	12,469		11,312	12,469			10,641	
1960		21,989			18,013			8,670	
1961	16,688	20,935		12,456	20,935			16,433	
1962		-			-			-	
1963		13,163			*			*	
1964	21,305	15,092		16,888	15,902			15,748	
1965	26,427	31,087		19,263	31,087	15,133	12,663	31,087	15,133
1966		-		-	-			-	
1967	17,196	25,484	10,657	12,446	25,484	10,657		21,474	10,657
1968	12,462	17,850	9,507		15,984			9,234	9,507
1969	28,950	20,154	11,729	20,097	20,154	11,729	15,636	20,154	11,729
1970		-			-			-	

* Flood controlled completely by gates

** Discharges are from operation studies

TABLE A-5

RATING OF PEAK DISCHARGES FROM KAJAKAI RESERVOIR OPERATION STUDIES

	Ungated		Gated	
Order	Year	Outflow (cfs)	Year	Outflow (cfs)
1	1967	59,370	1957	42,500
2	1957	46,870	1956	39,700
3	1969	45,880	1965	35,000
4	1956	44,280	1951	32,000
5	1951	40,140	1969	28,000
6	1949	39,600	1954	25,000
7	1965	37,690	1967	25,000
8	1950	33,310	1949	24,000
9	1964	32,910	1950	23,500
10	1954	32,160	1961	21,000
11	1961	31,000	1964	20,500
12	1968	28,220	1968	13,000
13	1952	25,380	1960	13,000
14	1948	24,720	1952	12,000
15	1960	23,910	1948	8,000
16	1953	15,280	1953	7,720
17	1955	11,450	1955	7,580

NOTE

Values for years 1958 and 1959 and years of low run-off were not obtained and are not included in the above tabulation.

ANNUAL FLOODS PEAKS FROM MUSA QALA TRIBUTARY

Year	Jan	Feb	Mar	Apr	Dec	Remarks
1953		42,000 (6,000)				Reduces effect of control by Kajakai
1954				7,600 (5,900)		No improvement from Kajakai was assumed
1955			38,000 (6,000)		16,200 (5,100)	Reduces effect of control by Kajakai
1956			14,000 (10,000)			No improvement from Kajakai was assumed
1957			71,000 (50,000)			No improvement from Kajakai was assumed
1959			22,000 (3,500)			Reduces effect of control by Kajakai
1960				6,000 (4,500)		Not significant
1964			22,000 (3,500)			Not significant; same magnitude as controlled flood
1968	12,000 (1,500)					Not significant

NOTE

Values shown in parenthesis are mean daily peak discharges. Other values are instantaneous peaks.

ANNUAL PEAK FLOODS AT DARWESHAN (cfs)

Year	February	March	April	May	Remarks	Improvement in Gated Performance (see note) 1	2	3	4	5	6
1947						1					
1948										1	
1949		133,000			Reduces effect of control by Kajakai		1				
1950	65,000				Reduces effect of control by Kajakai		1				
1951				86,000	Reduces effect of control by Kajakai		1				
1952									1		
1953	13,000				Minor effect					1	
1954			48,000		No improvement from Kajakai		1				
1955		38,000								1	
1956			65,000		No improvement from Kajakai		1				
1957		133,000			No improvement from Kajakai		1				
1958								1			
1959		48,000			No improvement from Kajakai			1			
1960				24,000	Not significant				1		
1961			123,000		No improvement at Darweshan		1				
1962						1					
1963				25,000	Not significant					1	
1964	44,000				Reduces effect of control by Kajakai			1			
1965			75,000		No improvement from Kajakai		1				
1966		11,000			Not significant	1					
1967			50,000		Not significant due to reduced outflow from Kajakai						1
1968				40,000	Reduces effect of control by Kajakai			1			
1969					Records not available			1			
1970						1					
					Totals	4	8	5	2	4	1

NOTE Improvement is listed in the following categories -

1. No prior flooding
2. No improvement
3. Little improvement
4. Significant improvement
5. Floods controlled completely by gates
6. Major improvement

TABLE A-8

INCREASE IN YIELD FROM KAJAKAI RESERVOIR AFTER INSTALLATION OF GATES

Year	Increased Yield (ac-ft x 1,000)* At Present Level	At Intermediate Level
1947	-	-
1948	0	385
1949	728	306
1950	745	230
1951	819	279
1952	819	319
1953	730	230
1954	703	230
1955	788	176
1956	434	230
1957	730	230
1958	635	331
1959	889	219
1960	730	230
1961	788	165
1962	788	220
1963	80	191
1964	656	175
1965	755	230
1966	819	319
1967	142	251
1968	819	319
1969	792	265
1970	819	319

* The increased yield is the change in the difference in storage volumes from the end of June to the end of the subsequent February after installation of the gates.

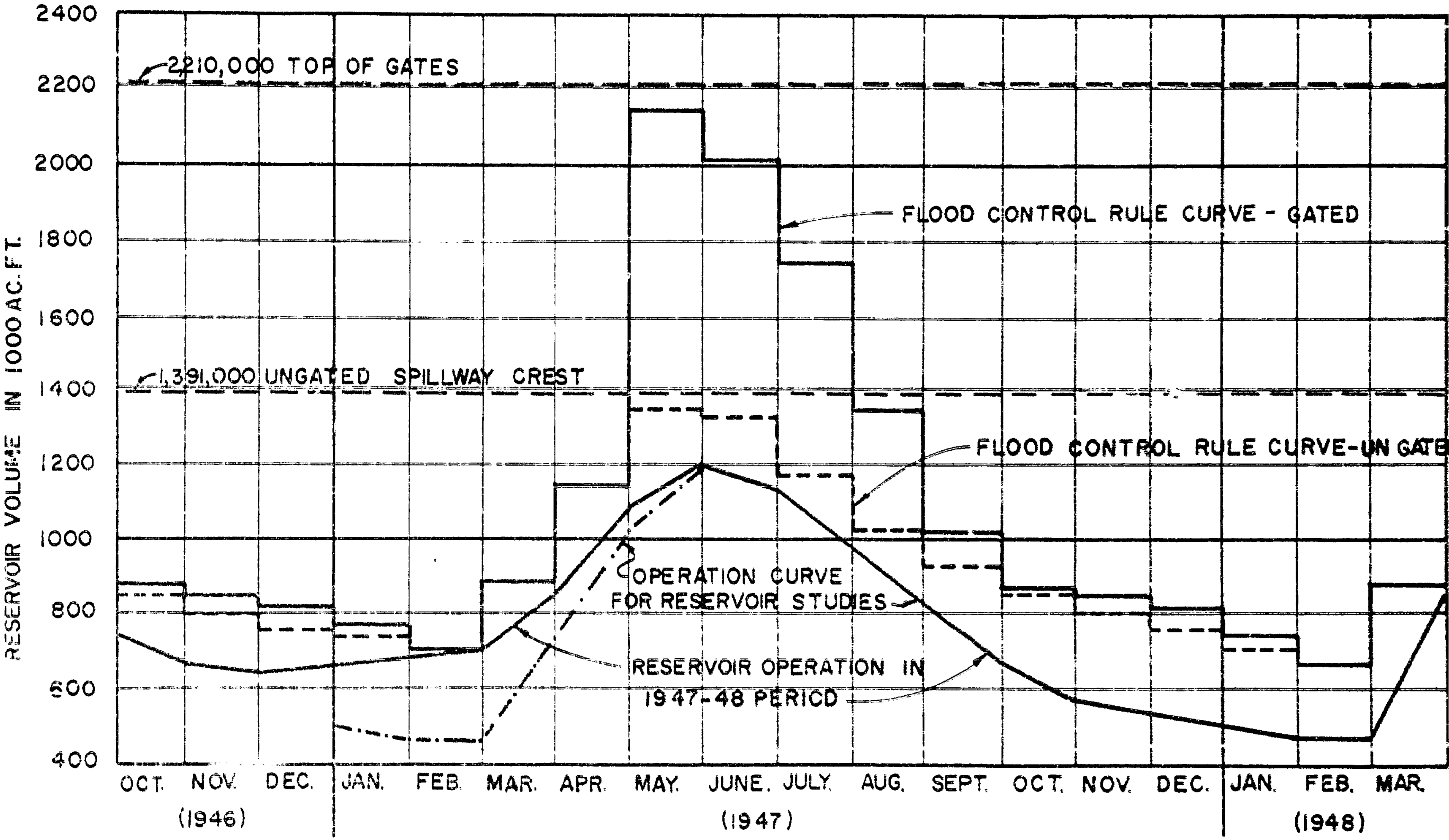
TABLE A-10

RESERVOIR OPERATION IN CRITICAL PERIOD -
FUTURE LEVEL OF DEVELOPMENT, IMMEDIATE DEMAND

(Units are ac-ft x 1,000 except as noted)

Year/ Month	Irrigation Demand: 100% all Months	Irrigation Demand: Months of 30% Shortage	Minimum Flow: 100% All Months cfs	Minimum Flow: 100% All Months 1,000 af	Minimum Flow: Months of 30% Shortages cfs	Minimum Flow: Months of 30% Shortages 1,000 af	Total Irrigation Demand: 100%	Total Irrigation Demand: With Shortage	Inflow	Power Demand (50 MW)	Total Demand	EOM Storage	Minimum Operation	Flood Control Rule Curve
1946														
Sep												1,365.8	1,365	1,550
Oct	240.3		3,000	184.5			240.3	240.3	131.7	198	240.3	1,257.2	1,260	1,400
Nov	123.6		3,000	178.5			178.5	178.5	151.2	190	190	1,218.4	1,220	1,330
Dec	90.5		2,500	153.7			153.7	153.7	171.2	197	197	1,192.6	1,190	1,300
1947														
Jan	92.2		2,500	153.7			153.7	153.7	185.4	197	197	1,181.0	1,180	1,250
Feb	187.2		3,000	166.6			187.2	187.2	200.7	178	187.2	1,194.5	1,195	1,200
Mar	236.2		3,200	196.8			236.2	236.2	373.7		236.3	1,331.9	1,330*	1,600
Apr	261.3		3,200	190.4			261.3	261.3	461.9		261.3	1,532.5	1,245	2,000
May	329.1	230	4,000	246.0	3,400	209.1	329.1	230	305.0		230	1,607.5	1,610	2,140
Jun	354.4	248	5,000	297.5	3,500	208.3	354.4	248	158.8		248	1,518.3	1,520	2,050
Jul	379.4	266	5,000	307.4	3,500	215.2	379.4	266	67.6		266	1,319.9	1,320	1,900
Aug	339.9	238	4,000	246.0	3,400	209.1	339.9	238	41.8		238	1,123.7	1,125	1,750
Sep	257.5	180	3,500	208.3	3,200	190.4	257.5	190.4	50.9	190	190.4	984.2	984	1,550
Oct	240.3	168	3,000	184.5	3,000	184.5	240.3	184.5	84.0	209	209	859.2	860	1,400
Nov	123.6	87	3,000	178.5	2,700	160.7	178.5	160.7	111.1	212	212	758.3	760	1,330
Dec	90.5	63	2,500	153.7	2,500	153.7	153.7	153.7	132.6	222	222	668.9	670	1,300
1948														
Jan	92.2	64	2,500	153.7	2,500	153.7	153.7	153.7	129.6	240	240	558.5	558	1,250
Feb	187.2	131	3,000	166.6	2,600	149.6	187.2	149.6	144.8	232	232	471.3	471.3	1,200
Mar	236.2	165	3,200	196.8			236.2	236.2	595.3		236.2	830.4	830	
Apr	261.3		3,200	190.4			261.3	261.3	1,261.2		261.3	1,830.3		

*Modified for 1963 operation



CURVES USED FOR OPERATION OF KAJAKAI RESERVOIR
PRESENT LEVEL OF DEVELOPMENT

NOTE: FOR RESERVOIR VOLUMES SEE TABLE A-1

APPENDIX B

DERIVATION OF BENEFITS

B.1 INTRODUCTION

The Kajakai Reservoir now has a total reservoir storage volume of 1,391,000 ac-ft at spillway crest level and, with a minimum pool level at El. 1012.0, an active volume of about 920,000 ac-ft. With the installation of gates on the spillway, the total storage volume would increase to 2,210,000 ac-ft and the active volume to 1,739,000 ac-ft. The benefits that would result from installing the gates are those that would be obtained by utilizing the additional 819,000 ac-ft of active storage, and the increased average power head then made available.

This storage could potentially be utilized to provide flood control, irrigation water supply, and hydroelectric power; operation of the reservoir to satisfy these, at times, conflicting functions is discussed in Appendix A. The benefits are discussed hereunder in the following categories:

- Flood control
- Improved supply of irrigation water to present farm land
- Provision of irrigation water for new farm land
- Power benefits

In considering flood control and irrigation water supply, the lands below Kajakai (see Exhibit 2) may be divided into:

- Project Areas, which are served by irrigation water from the canals and concrete diversion dams constructed by MKA and controlled by HAVA, and

- Non-Project Areas, which are comprised of tracts of land, each served by its own canal, normally without permanent headworks, and operated and controlled by the farmers served by the canal. This is the traditional method of irrigation and is described in some detail in the McMahon Report (Reference 16). This category may be further subdivided into:

  - An Upper Area containing the Seraj and Kajakai-Shamalan subdivisions,
  - A Lower Area, containing the Garmsel and Chakhansur subdivisions, and
  - Iranian Territory.

The present and potential irrigable areas, in the above categories of Afghanistan, are listed in Table B-1. Little benefit will accrue to the Project Areas, since their headworks and canals are so designed that a satisfactory supply of water from the river is possible, and floods of the type normally experienced can occur with little damage.

The following derivation of the value of benefits is based on the use of local market prices for farm produce. An alternative basis for deriving these benefits is to use socio-economic prices in which recognition is made of the export-import value of these crops to the nation. An alternative analysis on this basis is discussed in Section B.5.

The main flood control and irrigation potential, therefore, exists in the areas with individual canals. Unfortunately, these areas are generally outside the control of a central agency such as HAVA and are also lacking in data that would enable a reasonably precise study of irrigation and flood control effects. Due to the extent of the area involved and to the difficulty of access to these areas, it was not possible in the time available for the present study to undertake the detailed field work necessary to obtain such data. However, to obtain as much information as possible, a survey was made using teams from the Engineering and Agricultural Departments of HAVA. A questionnaire was completed for the Upper Area, providing generalized information on flood damage and agricultural yields based on interviews with the ditch-rider (mirab) controlling the canals or with other prominent individuals in the area.

The quality of the information received is highly variable and subject to considerable latitude and has been so interpreted in the study. For this reason, the results are not reproduced in entirety herein, but are available in the HAVA files. It would be highly desirable for HAVA, or others, to continue this work in a more detailed and extensive fashion for future projects. In addition, some hydrographic measurements were made in a few of the canals to give a sampling of the effects of river flows in the canals. Field inspection of many of the principal canals and headworks and of the farm areas was made by the IECO field team, which provided a basis for evaluating the data obtained.

When the project team visited the area, the river was in a very low stage as the reservoir was drawn down in earlier anticipation of the construction of power facilities and because the year was very dry. The effect of low river stages was thus very apparent as many canals were without water or operating at low capacity. This was particularly noticeable in the Chakhansur, and it is apparent that the maintenance of firm flows would benefit this area more than the upper areas. Therefore, any benefits of improved water supply should be considered as applying to the Chakhansur area as well as the Upper Areas.

On the other hand, while flood damage occurs all the way from Kajakai down to the Lower Chakhansur area, the effect of flood control from increased storage at Kajakai is taken to extend to just below Darweshan since the effect of intermediate stream inflow below Kajakai diminishes the effect of control at Kajakai, although flood volumes in the Chakhansur Hamuns will be reduced.

In addition, due to lack of information, no benefit has been attributed to the lands in Iranian Territory. Irrigable land in Iran, however, was estimated in the Delta Commission report (Reference 13) to be about 150,000 acres.

B.2 FLOOD CONTROL

A. <u>General</u> - Although Kajakai Reservoir was not designed originally to provide flood control, the provision of storage facilities in the main stem of the Helmand River would alleviate flood severity. The reservoir volume, even with the provision of gates, is not sufficient to completely control all or even the majority of floods that have historically occurred. The addition of storage capacity to the reservoir can, therefore, only serve to reduce the magnitude of floods to some degree.

The area below Kajakai Reservoir is largely undeveloped except for a few farms or villages. Therefore, damage from flooding mainly affects the developed farmland or irrigation facilities. Damage occurs to irrigation canals and headings, to crops by flooding, and to project structures or buildings. There is also a reduction in yield of farm crops due to floods.

B. <u>Improvement in Flood Control</u> - The effect of reservoir operation in providing flood control is discussed in Appendix A. To evaluate the effect of flood control downstream, the operation studies were utilized and, in years of significant flood, routings were made by electronic computer to determine the peak discharges that would have prevailed for both the gated and ungated conditions under similar modes of operation. The results are shown in Tables A-2 and 5, assuming operation at the present level of development.

The monthly discharges in Table A-5 show that with the mode of operation assumed, the ungated reservoir would spill in 20 of the 24 years of record, whereas with gates it would spill in 16 out of 24 years. Spills would have been eliminated, therefore, in an additional four of the 24 years, although the spills in some of these four years would not have been great in the ungated condition. In the other years, the effect of the gates was to reduce the average monthly spills and the peak daily flows as shown in Tables A-2 and A-5. Also shown in Table A-2 is a column listing the ratios of the gated peak outflows to the ungated peak outflows. Also, in the columns headed "Range of Flows" are the flows experienced before and after the peak, demonstrating in a general way a reduction, in most cases, of the volume and intensity of the outflows.

The column at the end of Table A-2 shows, by years, a qualitative evaluation of the improvement in flood control effected by the gates. These data are summarized in Table B-2.

Table B-2 also estimates the improvement that occurred in flood control according to the six categories listed. The percentage improvement attached to each of these categories has been arrived at as a matter of judgment based on field observation, discussion and study of the data available and the field questionnaire. The number of years in each category is derived from Table A-2. Allowance was made also for the effect of downstream inflow from other tributaries, such as the rivers Musa Qala and Arghandab.

As can be seen from Table A-7, there are significant floods from the Musa Qala River that cannot be controlled by Kajakai. These floods are generally of very short duration as can be seen from the comparison of instantaneous and daily average flows (the years 1956 and 1957 being exceptions). The flood effect of this inflow will therefore tend to be more localized due to river storage and, because of their short duration, to be of considerably less severity. They normally occur before the Kajakai spills. In only three years (1953, 1955, 1959) is there a flooding effect from this river that would reduce the value of the control exercised at Kajakai. In other years, either no control is possible or assumed at Kajakai or the flood effect is not of significance when compared with floods occuring from Kajakai. To account for the lack or recorded data from 1947-52 and 1969-70, an additional two years are assumed to have produced flood effects. The total of five years is included in Table B-2 under the heading of "Musa Qala Inflow" and is accounted for as a reduction in the flood control effect from Kajakai Reservoir.

Application of the number of years in each category to the percentage improvement assigned to each catergory results in a weighted improvement of 22 percent per annum as a flood control effect of the gates on the areas situated above the Arghandab River.

Significant floods at Darweshan, below the Arghandab River, are shown in Table A-8. Consideration of the effect of tributary flows below Kajakai at this location led to less improvement in the gated performance computed in Table A-2. Recomputation in gated performance for this reach of the river is shown in Table A-8, which, with modification, was applied to the years 1949, 1950, 1951, 1961, 1964, 1968, and 1969. A weighted improvement of 17 percent per annum was then obtained for the reach below the Arghandab River in the same manner as for the reach above Arghandab River and as indicated in Table B-2.

C. Flood Damage to Canals and Headings - Flood damage occurs to the irrigation canals and headings of the individual canals in the Non-Project Areas. Some repair or protective work has been necessary at project structures and is discussed in Section D below. In a survey made by MKA some years ago, an inventory of some 80 or more canals was made in the river between Kajakai and Chahar Burjak. In the survey made for this report, some 49 canals were identified and are listed in Table B-3 covering the area between Kajakai and Malakhan.

These canals, which vary in size and capacity over a long period of time, have been adapted to the local terrain and normally enter the river without any formal structural headworks. Small brush dams are utilized at the heading to raise the river level at low water or to direct the flow into the canals. These dams vary in size. Mostly they consist of a small bank rising only a few inches above water surface and extending perhaps 100 feet into the river. However, a complete dam crossing the river several feet in height and perhaps 15 feet in width was seen in the Chakhansur. The dams are made of local materials - brush, wood, rocks, and earth. The brush material is sometimes carried for considerable distances as any such material is scarce. A frequent arrangement is for the canal to enter the river below an island and to utilize one of the river's bifurcations as an extension of the canal by damming off the river between the main bank and the downstream end of the island.

The upper end of the canals frequently follow the river bank for considerable distances with only a small embankment separating the canal from the river course. The tenacity and industriousness of the farmers in devising and maintaining these canals (known locally as "juis") is an indication of their importance in providing water for irrigation and domestic purposes.

The brush dams and the upper reaches of the canals are extremely susceptible to flood damage. Damage to lower areas of the canals is also possible since the discharge capacity of the canals is essentially uncontrolled, and high river levels can cause over-topping and washouts along the canal system. A further and serious problem results from the changes that take place in the river location due to floods, which leave the intakes isolated, and necessitate construction of a new stretch of canal to rejoin the main river with the possible result of changes in the discharge capacity of the canal. Degradation of the river bed also reduces the canal capacity and requires considerable effort to deepen the canal or extend the canal headwaters upstream, though the topography in some instances prevents this. This degradation process is particularly noticeable in the Chakhansur area.

Data that would permit the evaluation of the problem are not available, and a long period of time would be required to accumulate this information. Table B-3 shows information extracted from the field survey made by the teams from the Engineering and Agricultural Departments of HAVA. The table shows the canals investigated together with rough estimates of the annual costs involved in repairing the canals and headways. Reporting of this data would naturally be affected by recent events; however, the survey was assisted by the fact that the last year (1970) was a dry year in which no spill occurred while the previous year had one of the highest flood discharges.

Table B-3 shows the costs attributed to repair of flood damage. Where the amounts reported seemed excessive they were reduced to give a cost of damage of 200 Afghanis per acre applied to the area reported for each canal. The costs of damage repair adapted for use herein are also shown in Table B-3, and indicate a total value of Afs. 15,248,700 per annum for damage to canals and headings. The reduction in damage due to installation of gates at Kajakai is computed in Table B-4. In this computation, the reduction in damage is obtained by application of a weighted factor, which is based on the assumption that 30 percent of the damage costs is allocated to repair of brush dams and 70 percent to repair canals and relocation of headings. The improvement in damage to brush dams is assumed to occur in an average of three out of 24 years above the Arghandab River and two out of 24 years below. Improvement of damage to the canals and headings is assumed to occur according to the percentages established in Table B-2.

In Table B-4 the total reduction in damage cost is thus found to be Afs. 2,590,000 or U.S. $31,000. This value is further reduced by 20 percent to allow for general inaccuracies inherent in the survey prodecures, giving a net reduction in the cost of damage from floods of Afs. 2,070,000 or U.S. $25,000 per annum.

D. Damage to Project Works and Structures - Since construction of the original project canals and dams, HAVA has undertaken maintenance work as a result of or to avoid flood damage to the project works. Details of the works carried out and the costs associated with them were provided by HAVA and are listed in Table B-5. The various projects completed are indicative of the maintenance needs of the area, and are taken as being representative of the continuing cost of such maintenance. The total cost of these works, escalated to present-day costs, is Afs. 35,655,000. Assuming that the cost could be allotted to a 10-year period, the annual cost of such maintenance is taken as Afs. 3,566,000. The reduction in cost due to provision of gates is obtained by using the factors in Table B-2 and totals Afs. 749,000 or U.S. $9,000 per annum.

The field survey indicated that damage occurred to over 285 buildings in the area surveyed at a total cost of Afs. 2,950,000. Allocating this cost to a 10-year period with an improvement factor of 20 percent to average the values in Table B-2 gives an annual reduction in cost of damages to buildings of 59,000 Afghanis or U.S. $700.

E. Agricultural Land Flooded - In the field survey, the area of agricultural land actually flooded was estimated for the various areas and found to total 18,000 acres. Since the frequency of occurrence of this reported flooding was high, a 5-year frequency should be assigned to this type of flood damage. Table B-6 shows the derivation of the agricultural loss in yield due to flooding. Yield losses were estimated from the information reported in the questionnaire. The total annual loss is shown to be U.S. $31,300. The reduced loss due to installation of the gates is estimated to be U.S. $6,900 per annum, using the improvement factor shown in Table B-2 for the area above the Arghandab River.

F. Reduction in Agricultural Yield Due to Floods - As a consequence of the loss of headings, brush dams and general canal damage resulting from floods, there is a reduction in crop yield. This loss results from a lack of irrigation water in the damaged system and from the need to utilize farm labor for repair work at a time when labor is urgently needed for attending to crops and generally is in short supply. The field survey indicates that shortages of irrigation water are reported to occur from June through August in almost all of the canals, whereas only about 25 percent of the questionnaires indicated shortages as occurring from October through November, 1969.

In Table B-7, the derivation of the present gross income from crops is shown for the various subdivisions of the Non-Project Areas. Due to the flood effects described above, the estimated yields have been diminished by the amounts shown (approximately 10 percent). This reduction is based on the field survey, on comparisons with the yields on Project Areas and portions of the Non-Project Areas where flood effects are minimal, and on experience in other areas of the world. A further check of this reduction was made, using theoretical estimates of the effect of water shortages on yields. The benefit from installing the spillway gates is then computed in Table B-7 by applying the percentage improvement of flood control from Table B-2 to the reduction on gross income from crops due to flood damage. No further allowance is made for additional farm costs required to obtain this incremental income as they are being included in the estimated percentage reduction in yield from flood damage. The total annual value of increase in crop yield due to flood control from installation of gates is therefore estimated to be U.S. $44,400 for the Kajakai-Shamalan and Seraj areas, the only areas for which this benefit is taken.

G. Effects of Changes in Reservoir Operation in the Future - As the mode of operation of the reservoir changes to meet the requirements at the intermediate level of demand, the flood control effect will be reduced as discussed in Appendix A (see Table A-5). While floods have been controlled completely in four out of the 24 years, the discharges in other years have been increased. The benefits from the flood control effect is therefore assumed to be reduced to 30 percent of the values derived above when the full demand is met at the intermediate level.

B.3 IMPROVED SUPPLY OF IRRIGATION WATER TO PRESENT FARM LAND

A. Present Level of Demand - Lands in the Non-Project Areas presently experience shortages of water even when releases from the reservoir are adequate to supply the theoretical amounts necessary for efficient irrigation. In Project Areas, adequate water is provided by the diversion dams and main canals designed for this purpose. However, distribution of this water to the farms even in the Project Areas is frequently inefficient due to improper use of the water. In the Shamalan subdivision of the Project Area, irrigation water is distributed by the old traditional canal system that is supplied, however, from a main project canal. In this area, it is presently planned to spend over $10,000,000 at a cost of about $337 per acre partly with a view to improving the irrigation efficiency. This sum is indicative of the expenditures necessary and considered acceptable to improve irrigation efficiency.

During the visit of the IECO Project Team in November, 1970, the river was at a low stage with approximately 2400 cfs being discharged from Kajakai Reservoir. The affect of this on the Non-Project Areas was quite marked, some canals being left with little or no water. In the Chakhansur area, one left bank canal was being deepened by about 1.0 meter or more and extended several hundred feet by a force of several hundred men. Although part of this work is due to river degradation from flooding, low water stages acerbate the situation. The report of R.H. Brigham of the HAVA Hydrology Unit in October, 1962 (see Appendix C, Table C-2) illustrates the problems. Since the upper irrigation areas on the Helmand River can more readily utilize discharges from the reservoir, it is apparent that any significant increase in flows will benefit the Lower Area (Garmsel and Chakhansur) to a much larger degree than the Upper Area, and should reasonably be included in any benefit determination of this factor. In December, 1970, the river flows were increased and again the effect of the improved flow was marked. Farmland in the Seraj area, for example, was observed to have been put under cultivation even though it was late in the season.

As mentioned earlier in Section C, the farmers report shortages mostly in the months of high irrigation demand following the flood season. This is attributed both to flood damage and also to inadequacies of the non-project canal systems. In addition, the yields reported at the lower ends of the canals are considerably below those at the upper ends.

With the exception of the Seraj canal, little information is available about the discharge capacities of these canals or about their distribution systems. Records of water diversions at the Seraj intake show that an average of about 5.2 feet of water annually are diverted based on the estimated 35,000 acres under irrigation. This represents about 75 percent of the estimated optimum requirements. As a sample, some field gagings were made of a few of the non-project canals and approximate estimates were made of their discharge capacities. Studies on the Seraj, Deh Adam Khan, Sarwan Qala, and Qala Bist Canals show that they would be capable of carrying the discharges necessary to meet the theoretical maximum demand during the peak irrigation season at river levels corresponding to the flows released from Kajakai Reservoir under the operation conditions described in Appendix A. A comparison of the actual releases from the reservoir over the last 10 years with those from the operation studies made herein indicate that, except for 1970, the flow conditions in the river were not substantially different. Therefore, operation of the canals to provide the theoretical maximum demand will not in fact give an adequate supply of water. Increasing the river levels by use of the additional water stored behind the gates would supply additional water that could be benefically used in most years. This may represent an inefficient use of water; nevertheless, so long as the water cannot be used elsewhere it represents a valid use to produce increased crop yields.

Flows in the river from an ungated reservoir at the peak irrigation season in normal years would range from 4500 to 6500 cfs. By adding gates, additional water could be made available for discharge in the river. This water would otherwise have been part of the uncontrolled spill in April and May. After the flood season in May, the additional stored water could be released in any reasonable pattern. Table A-9 shows the increase in yield from June to February each year due to the addition of gates, obtained by comparison of the two operation studies contained in Appendix A. This table shows that in 16 of the 24 years studied, the increased yield is about 730,000 ac-ft or more. If this 730,000 ac-ft is distributed over a six-month period, it would result in an average of approximately 2000 cfs per month available to increase the river flows. For flows in the 4500 to 6000 cfs range, this would correspond to an increase of 30 to 45 percent and its effect would be to increase the flows in the canals correspondingly. Reference to the discharge capacities of the canals studied and probable limitations on the upper physical limit of the canals, indicates that a 20 percent increase in the canal discharge could be anticipated from these increased river flows.

Application of 20 percent more water permits the increase in crop yield of the Upper Area by the percentages (approximately 10 percent) shown in Table B-7. For the Lower Area, the improved effect of additional water will be amplified since about 1000 to 2000 cfs would normally be diverted into the project canals. For this reason, higher percentages (approximately 20 percent) have been adopted for these Areas. It is highly probable that the additional water could make the cultivation of additional land possible and improve the overall yield by considerably more than this factor.

Table A-9 also shows that in four years the increase in yield is from zero to 142,000 ac-ft and in the remaining four years from 434,000 to 703,000 ac-ft. If zero improvement in assumed for the four dry years, a 50 percent improvement for the next four years, and a 100 percent improvement for the remaining 16 years, a weighted improvement of 75 percent as an average annual value is derived.

The values of the increased yields shown in Table B-7 for the various areas is then multiplied by a factor of 75 percent to allow for the drier years. The net benefits attributable to the improved supply of irrigation water from installation of the gates is then found to total $368,000 per annum, as shown in this table.

B. Effect of Changes in Reservoir Operation in the Future - Changes in the mode of operation of the reservoir to meet the requirements of power and increased irrigation are discussed in Appendix A. The effect of this change is to reduce the yield from the reservoir that is available to improve the water supply to the present land (see Table A-9). In consequence, it has been assumed that benefits would be reduced to 30 percent of the values obtained above when the full demand at the intermediate level is met.

B.4 PROVISION OF IRRIGATION WATER FOR NEW LAND

The installation of gates will provide additional water for development of new land - those presently and potentially irrigable are listed in Table B-1.

No benefit is taken for the additional area irrigable in Darweshan since it is assumed that this area could be irrigated without gates. The most recent report, which was written in 1955 (Reference 14), on the Chakhansur Area doubts the economic value of development in that area and suggests that land in other areas be developed first. Further studies may reach other conclusions; however, for this present study, no benefit is attributed to developments in the Chakhansur, although this represents 53 percent of the lands now considered potentially irrigable.

Benefits, therefore, are only considered as attributable to new lands in the Kajakai-Shamalan, Seraj and Garmsel Areas, totalling 61,000 acres, and representing an increase of 23.6 percent on the 258,000 acres presently under irrigation.

To develop benefits from land brought into use because of increased storage at Kajakai Reservoir reference is made to a detailed feasibility study prepared in September, 1968, by a U.S. Bureau of Reclamation Team for the Shamalan Unit (Reference 17). This report represents the most recent detailed study of the area and proposes the construction of an improved irrigation system, drainage, land levelling, roads, domestic water systems and resettlement. This work would supplement the work previously done in providing main canals and a partial irrigation and drainage system. Field surveys of present agricultural conditions were made for this report and, under optimum conditions of irrigation, the future net income for the Shamalan area would be $51.66 per acre. The derivation of this value is shown in Table B-8, which is reproduced from the USBR report by courtesy of HAVA and USAID-USBR.

New developments in the Upper Areas would produce conditions similar to those of the Shamalan Unit. In the Garmsel area, agricultural income would be lower due to soil quality and less favorable climatic factors of heat and wind. This led to a selection of the values shown in Table B-9.

which were used to determine the potential annual net income from these lands under full and optimum development. Shown also in this table are the allocated operation and maintenance charges of $3.00 per acre for the main canal systems as used in the USBR Study.

An estimate for these capital costs of developments was made on the basis of the USBR studies and an earlier study made by MKA (Reference 6) for development of the Seraj area. The MKA estimate provided for construction of an additional intake, main canal and laterals and was updated by applying present day prices to the quantities used in the original estimate, arriving at a unit costs of $90 per acre for these facilities. The USBR Shamalan estimate was then used to derive a cost for sub-laterals, drainage, land development, roads, domestic waters, soil amendments, and resettlements. The cost of these features, which was found to be $250 per acre, was then added to the canal system cost to arrive at a development cost of $350 per acre, applicable to the Seraj area. This value was increased to $375 per acre for Kajakai, Shamalan and Garmsel areas since the Seraj costs for main canals and headwater made partial use of existing facilities. The capital costs for these areas, based on these unit costs per acre are shown in Table B-9.

B.5 ALTERNATIVE BASIS FOR DERIVATION OF AGRICULTURAL BENEFITS

A. General - The foregoing discussion has been based on the use of local market prices to evaluate agricultural benefits. An alternative basis is to use socio-economic prices to obtain the value of agricultural produce. The value of the farm produce is then determined from its relation to the national economy by using export or import prices, as appropriate. The crops which are affected basically are wheat and cotton. In this analysis, the values of the remaining crops continue to be based on their local market prices.

B. Wheat Prices - The value for wheat is determined from its import prices, since Afghanistan has been importing this commodity in recent years from the USSR and USA. Data on this subject may be found in the ILACO Report (Reference 19). In that report the price of wheat was determined to be 84.0 barter dollars per metric ton imported from the USSR c.i.f. Termez, and U.S. $85.00 per metric ton imported from USA c.i.f. Karachi. Table B-10 shows the derivation of the prices for wheat from both the Lower and Upper Areas, based on importing from USSR and USA.

Transportation costs are based on delivery to Lashkargah. From this Table the average prices for wheat from the Upper and Lower Areas are U.S. $2.51 and U.S. $1.92 per bushel, assuming that equal amounts are imported from each source.

It should be noted that the export/import prices to the USSR are based on barter, or bilateral, dollars which have recently been valued at 1 barter dollar equivalent to 55 Afghanis, as compared with the free market rate of U.S. $1.00 equivalent to 83.5 Afghanis used herein. Since the computations herein are based on U.S. dollars, the barter dollar prices have been converted in the ratio 55/83.5 = 0.66, to account for this difference.

Since it is expected that Afghanistan will be self-sufficient in the production of wheat in the next decade, the above prices are assumed to be applicable only for a period of ten years, after which local market prices will prevail.

C. Cotton Prices - The value of cotton is determined from its export price since Afghanistan has been exporting cotton, principally to the USSR. Data obtained from the ILACO Report (Reference 19) indicates that the export prices for lint are barter dollars 740 f.o.b. Termez per metric ton for sales to the USSR market, and U.S. $515 per metric ton for sales to USA. The price for cotton seed sold to USSR is barter dollars 68.50 per metric ton, f.o.b. Termez. Table B-10 shows the derivation of the average prices for cotton from both the Lower and Upper Areas based on 87% of the lint being exported to USSR and 13% to USA, while all seed is assumed exported to USSR. The resulting prices for cotton are, therefore, U.S. $0.067 and U.S. $0.057 per pound for the Upper and Lower Areas respectively. These rates are assumed to be applicable over the next fifty years.

D. Revised Agricultural Benefits - The above socio-economic prices for wheat and cotton are then used to obtain alternative values for the agricultural benefits attributable to the installation of the gates in the same manner as for the local market prices. Table B-11 shows the derivation of the value of crop damage by direct flooding in two periods (1 to 10 years, and 11 to 50 years) reflecting the variation in wheat prices in those periods. Table B-12 shows for the same periods, the value of agricultural benefits due to flood control and river regulation, while Table B-13 shows the revised benefits applicable to development of new lands. As can be seen in Figure IV-1 only the Seraj development falls within the 1 to 10 year period. The opportunity cost of labor has been taken as zero in relation to agricultural benefits. The cost of damage to canals and headings as derived in Tables B-3 and B-4 has therefore been reduced by the cost of the labor component and further modified, as discussed on page B-6. Fertilizer costs are based on actual imported costs at the farm exclusive of any subsidy. The same is true of cotton seed which is furnished free of charge to farmers.

A summary of the benefits applicable to this analysis has been made in Table IV-10. The results may be compared directly with those summarized in Table IV-2 for the analysis made on the basis of local market prices. As can be seen, there is a net increase in benefits for the revised analysis.

B.6 POWER BENEFITS

A. Background - There is presently no power installation at Kajakai. Provision was made for such an installation during the initial construction, and it is now planned to complete the first stage installation by mid 1974.

Power studies and sizing of the power installation were made in the two reports prepared by R.W. Beck and Associates (References 4 and 8). Further studies were made by IECO in 1970, and details of the proposed power plant are given in the IECO report (Reference 10). Therefore, it is now planned to construct a power plant capable of housing three 16.5 mW units, only two of which will be installed initially. The R.W. Beck studies indicated that the capacity could be increased to 150 mW as the ultimate stage of development.

B. Power Load Projections - Power from the Kajakai power plant will be utilized only in the Helmand and Arghandab Valleys, basically in the Girishk and Kandahar electric systems. The power requirements for the valleys were determined by R.W. Beck in 1964 and later by Thomas M. Hill (Reference 3) in 1966. The Hill load projection showed somewhat greater increases than did Beck's. In their 1967 report, R.W. Beck modified these studies and presented two possible load projections: one based on their earlier rate of load increase, the other based on the Hill rate of increase - each projection starting from a common demand load of 14,400 kW, which was assumed to begin on year after construction of the Kajakai power plant.

Pertinent studies were also made by USAID in their Capital Assistance Paper of April, 1967 (Reference 1). The Beck 1964 projections were decreased in this study, which included considerations of the individual income required in Afghanistan to permit such a load growth.

Table B-14 shows the load projections derived by USAID and the two R.W. Beck studies. The 1964 R.W. Beck estimate is shown advanced to 1967 and is modified in the latter three years apparently by deducting an amount equal to the requirements for rural areas, as was done in the USAID study. The estimates for load projection made in the past have been based on the assumption that growth would only occur after the provision of an adequate power source such as Kajakai. This is, in fact, the case since the actual generation in Afghan year 1348 (1969-70) was 11,442,000 kWH (Reference 12), as shown in Table B-14. The 1964 Beck and the USAID estimates could therefore be advanced to start in 1970 rather than in 1967 as shown in the table.

For the present study, the load projection has been based on the [illegible] Beck estimate, assuming completion of the Ka kai power plant first stage in mid-1974 and a system load requirement - occurring one year later - of 54.24 gWH and a 14.4 mW demand (Table B-14).

The Beck peak demand, being based on a constant annual increment, shows an annual rate of increase declining from 5 percent to 4 percent in the latter years, while the USAID estimate indicates a rate of increase of about 8 percent over these years. For this report, the load projection beyond the last Beck value in 1984 has been extended at a compound rate of 5 percent. The resulting load curve, shown in Figure B-1, is intended only as a basis for evaluating benefits and not as a forecast of the future load demand. Figure B-1 also shows the energy requirements in mW years corresponding to the 5 percent load demand curve estimated beyond 1984 by an annual load factor varying linearly from 0.46 in 1984 to 0.55 in the year 2000 on the basis of values suggested by Beck. For comparison, Figure B-1 shows the peak load demand projection escalated at an annual compound rate of 8 percent.

C. Kajakai Power Installation - Present plans call for three units, each 16.5 mW, to comprise the first stage of development with two units installed initially. Each unit will have a dependable capacity of 11.0 mW at minimum reservoir elevation of 1012.0. As proposed in the Beck report, four additional units - each of 25.0 mW - would comprise the ultimate stage of development for a total capacity of 149.5 mW.

In the operation studies described in Appendix A, the present reservoir would support a minimum generation of 29.0 mW-years at all times, and at the present level of irrigation demand. Assuming only the inclusion of the Boghra units with 2.4 mW of capacity and 2.0 mW-years of energy, the prime energy of the system would be 31.0 mW-years. The dependable capacity of the system would then be 6.20 mW, and at Kajakai, 59.6 mW, assuming a system load factor of 0.50 at the time the new capacity would be required. This would permit the first stage installation of three 11.0-mW units and a second stage installation of up to 26.6 mW without the need for installing gates.

From the 5 percent load projection curve shown on Figure B-1, a new power source would therefore not be required until the year 2004. With the 8 percent curve, this plant would be required in about 1997, or seven years earlier. Thus, on the above assumptions, the present reservoir would be sufficient to meet power needs for about 25 years or more. Furthermore, the rate used in projecting the demand beyond 1984 becomes of more significance than the differences in various estimates made at present.

When a new power source is required, it could be provided (1) by installing additional capacity at Kajakai that is dependent upon increasing the reservoir volume through use of spillway gates or (2) by a thermal plant. The power benefit associated with the gate installation is therefore the additional cost of the alternative thermal plant.

With the installation of the gates, Beck gives the ultimate hydro-generating capacity as 120 mW dependable capacity, based on a prime energy of 66.0 mW years and a system load factor of 0.55. Operation studies made for the present report indicate that it would not be possible to generate this much prime energy in the critical year if all the potential irrigable lands are to be developed. Since the economic analysis being made herein assumes no benefit for the development of the Chakhansur areas - which would require a large increase in water use - the benefit calculation assumes that the full capacity could be installed. The additional dependable hydro-capacity is therefore based on the intermediate level of demand, which gives a prime power of 50 mW-years for Kajakai and 52.0 for the system. The resulting dependable capacity at Kajakai, based on a load factor of approximately 0.53, would be 96.0 mW. This would be satisfied by a first stage installation of three 11-mW units, dependable capacity, and a second stage of four 15.75-mW units. The installation diagram for this development pattern is shown on Figure B-1.

D. <u>Alternate Thermal Power Plant</u> - The alternative thermal plant should have a dependable capacity of 36.4 mW, which is the difference in the initial and second stage dependable capacities.

The plant is assumed to be located at Kandahar. Due to the long period (25 years or more) before installation, only an approximate estimate is made of the value of this plant. The installation is assumed to consist of three 12.13-mW diesel units because of the low load factor at which they would operate, as discussed hereunder. For simplicity, the capacities used in benefit evaluation have not been rounded to standard units. Replacement of these units is assumed to occur at 15-year intervals.

The cost of the units is based on an installed price of $250 per kW. Fuel costs are based on the value adopted by R.W. Beck for diesel fuel delivered at Kandahar, namely 26.0¢ per U.S. gallon. With heat rates of 15,000 Btu per kWH and a calorific value of 143,000 Btu per U.S. gallon, the fuel cost is found to be 2.72¢ per kWH. Operation and maintenance costs are taken as $3.00 per kW per year, exclusive of fuel.

Since the Kajakai hydro plant has considerable secondary energy available, the thermal plant would sit at the top of the load curve. The thermal portion would satisfy approximately the upper 35 percent of the demand, and the load duration curves derived in Reference 4 by Beck show that this would require approximately 3 percent (13.7 gWH) of the system energy requirement of 52 mW years (455 gWH). The Kajakai hydro power plant without gates could generate an average of about 569 gWH, which is greater than the system energy requirement. The thermal plant is thus assumed to generate 13.7 gWH annually when the load is fully developed.

Hydro power plant installation costs were obtained from estimates made for the first stage installation. The incremental cost of dependable capacity was then found to be $375 per kW. No allowance is made for additional re-regulating structures downstream of Kajakai. Incremental operation and maintenance costs are taken to be $1.10 per kW per year, based on data from the U.S. Federal Power Commission for a change in plant size from 60 mW to 90 mW.

Table B-15 shows the derivation of the costs of the ultimate hydro installation and of the alternative thermal installation. In this table, the switchyard costs as assumed to be the same as for the hydro installation and are omitted. No transmission line cost is assumed, since the present lines would be adequate for a thermal plant located at Kandahar, and the proposed first stage transmission line from Kajakai Hydro will be adequate up to a capacity of about 110 mW.

The benefit attributable to the addition of the spillway gates and the hydro plant made possible from this addition, is calculated as the cost of the equivalent thermal plant minus the cost of the hydro plant. This benefit would, however, begin to accrue at completion of this installation, which would be at least 25 to 30 years from now.

IRRIGABLE LAND IN THE HELMAND VALLEY
(Acres)

Area	Land Presently Irrigated	Land Potentially Irrigable	Total Irrigable Land
Project Areas			
Nadi Ali	13,000	0	13,000
Marja	20,000	0	20,000
Shamalan	44,000	0	44,000
Darweshan	40,000	5,000	45,000
Non-Project Areas			
Upper Areas:			
Kajakai-Shamalan	36,000	14,000	50,000
Seraj	35,000	25,000	60,000
Lower Areas:			
Garmsel	20,000	22,000	42,000
Chakhansur	50,000	75,000	125,000
TOTAL	258,000	141,000	399,000

EFFECTS OF FLOOD CONTROL BY GATED RESERVOIR

Flood Control Effect	Above Arghandab River: No. Years	Above Arghandab River: Improvement %	Above Arghandab River: Improvement % Weighted	Below Arghandab River: No. Years	Below Arghandab River: Improvement %	Below Arghandab River: Improvement % Weighted
Non-flood years	4	0	0	4	0	0
No improvement	4	0	0	8	0	0
Small reduction	5	5	25	5	5	25
Significant reduction	6	50	300	2	45	90
Floods controlled completely	4	60	220	4	55	220
Major reduction	1	80	80	1	80	80
Subtotal	24		625	24		415
Musa Qala inflow	(5)	-20	-100	-	-	-
TOTALS	24	(22)	525	24	(17)	415

COSTS OF FLOOD DAMAGE TO CANALS IN NON-PROJECT AREAS (Afghanis)

No.	Canals	Data Obtained from Survey: Man Days	Labor Costs	Mat'l Cost	Total Costs	Modified Total Cost
	Left Bank					
L1	Kajakai Ulya 1	3,000	120,000	36,000	156,000	156,000
L2	Kajakai Ulya 2	100	4,000	1,200	5,200	5,200
L3	Kajakai Sufla 1	2,000	80,000	336,000	416,000	416,000
L4	Kajakai Sufla 2	240	9,600	7,900	17,500	17,500
L5	Sarwan Qala (Potay)	600	24,000	7,200	31,200	31,200
L6	Sarwan Qala 2	400	16,000	608,000	624,000	624,000
L7	Sarwan Qala (Sudali)	1,000	40,000	12,000	52,000	52,000
L8	Sarwan Qala (Kang)	3,000	120,000	-	120,000	120,000
L9	Sarwan Qala	3,000	120,000	36,000	156,000	156,000
L10	Sarwan Qala	16,000	640,000	192,000	832,000	400,000
L11	Sarwan Qala (Num Ser)	900	36,000	24,800	60,800	60,800
L12	Sarwan Qala (Ferozay)	1,500	60,000	41,400	101,400	101,400
L13	Josyalay	1,200	48,000	14,400	62,400	62,500
L14	Myan Roday	1,500	60,000	96,000	156,000	156,000
L15	Gharakay	1,500	60,000	96,000	156,000	156,000
L16	Sangin	1,800	72,000	162,000	234,000	234,000
L17	Seraj	60,000	2,400,000	1,240,000	3,640,000	800,000
L18	Abdullah	3,000	120,000	36,000	156,000	156,000
L19	Hazarzai	400	16,000	4,800	20,800	20,800
L20	Saidan	1,800	72,000	21,600	93,600	93,600
L21	Janubi Nurzai	12,000	480,000	-	480,000	480,000
L22	Abbazai	4,000	160,000	48,000	208,000	208,000
L23	Nahr-i Sarkar	24,000	960,000	288,000	1,248,000	500,000
L24	Kariz	4,000	160,000	48,000	208,000	208,000

TABLE B-3
Sheet 2 of 2

No.	Canals	Data Obtained from Survey: Man Days	Labor Costs	Mat'l Cost	Total Costs	Modified Total Costs
	Left Bank (Cont'd)					
L25	Qala Bist	3,000	120,000	36,000	156,000	156,000
L26	Lachmi	3,000	120,000	36,000	156,000	156,000
L27	Karame	1,500	60,000	18,000	78,000	78,000
L28	Hazar Juft	3,000	120,000	36,000	156,000	156,000
L29	Bugat Ulia	12,000	480,000	152,000	632,000	632,000
L30	Bugat Sufla	12,000	480,000	152,000	632,000	632,000
L31	Landi	4,000	160,000	64,000	224,000	224,000
	Subtotal Canals L1-L25					5,371,000
	Subtotal Canals L26-L31					1,878,000
	TOTAL Modified Cost (Afghanis)					7,249,000
	Right Bank					
R1	Maydanay	1,500	60,000	18,000	78,000	78,000
R2	Alizai	4,000	160,000	48,000	208,000	208,000
R3	Lalazai	4,000	160,000	48,000	208,000	208,000
R4	Qala-i-Gaz	13,000	520,000	104,000	624,000	624,000
R5	Sorakyan	12,000	480,000	144,000	624,000	624,000
R6	Deh Adam Khan	20,000	800,000	240,000	1,040,000	1,040,000
R7	Nehr-i-Sofia	360	14,400	39,400	54,000	54,000
R8	Sulaim-i-Shazai	600	24,000	80,000	104,000	104,000
R9	Qala-i-Nou	24,000	960,000	288,000	1,248,000	770,000
R10	Bertaka Ulia	12,000	480,000	144,000	624,000	400,000
R11	Bertaka Sufla	12,000	480,000	144,000	624,000	400,000
R12	Sabar	12,000	480,000	144,000	624,000	360,000
R13	Darwelak	24,000	960,000	288,000	1,248,000	800,000
R14	Khan-i-Shin	30,000	1,200,000	360,000	1,560,000	130,000
R15	Khairabad	30,000	1,200,000	360,000	1,560,000	110,000
R16	Taghaz	30,000	1,200,000	360,000	1,560,000	130,000
R17	Malakhan	30,000	1,200,000	360,000	1,560,000	1,560,000
R18	Chowki Malakhan	12,000	480,000	152,000	632,000	400,000
	Subtotal Canals R1-R8					2,940,000
	Subtotal Canals R9-R18					5,060,000
	TOTAL Modified Cost (Afghanis)					7,000,000

VALUE OF FLOOD DAMAGE IMPROVEMENT TO CANALS IN NON-PROJECT AREAS

	Value of Damage (Afghanis)	Value of Reduced Damage (Afghanis)
Above Arghandab		
Left Bank (Canals L1-L25)	5,371,000	
Right Bank (Canals R1-R8)	2,940,000	
	8,311,000	
Reduction in Damage: factors		
$(.30 \times \frac{3}{24} + .70 \times 22\%) = .1915$		
$.1915 \times 8,311,000 =$		1,591,000
Below Arghandab		
Left Bank (Canals L26-L31)	1,878,000	
Right Bank (Canals R9-R18)	5,060,000	
	6,938,000	
Reduction in Damage: factors		
$(.30 \times \frac{2}{24} + .70 \times 17\%) = .144$		999,000
TOTALS	15,249,000	2,590,000
	= U.S $	31,000

TABLE B-5

COSTS OF FLOOD MAINTENANCE OF PROJECT WORKS
(Afghanis)

Feature	Year Completed	Actual Cost	Cost Escalated (3%)	Reduced Cost from Flood Control
Boghra Diversion Dam	1970	5,350,000	5,511,000	1,212,000
Shamalan Dike				
-Station 16	1957-69	11,730,400	14,600,000	
-Station 22	1958-67	4,304,000	5,900,000	
-Station 31	1961-69	1,892,000	2,600,000	
Subtotal			23,100,000	5,082,000
Hazar Juft				
-Headworks	1963	3,530,000	4,469,000	760,000
Darweshan Dike	1970			
-Station 25		2,500,000	2,575,000	438,000
TOTAL Adjusted Cost of Maintenance		Afghanis	35,655,000	7,492,000
Adjusted Annual Costs (10 year)		Afghanis	3,566,000	749,000
Adjusted Annual Costs (equivalent)		U.S. $	42,800	9,000

CROP DAMAGE BY DIRECT FLOODING IN NON-PROJECT AREAS

INCOME BASED ON LOCAL MARKET PRICE

Crops Reported Damaged	Damage as Percentage of Average Yield	Value of Weighted Average Yield U.S. $/Acre	Value of Damage U.S. $/Acre
Wheat	35	19.68	6.89
Corn	30	4.59	1.38
Cotton	30	1.42	0.43
			$8.70

Average Value per acre with flood frequency of 1 in 5 years		$1.74
Number of acres reported inundated		18,000
Annual Value of Damage		$31,300
Value of annual reduction (22%)	Equiv. U.S:	$6,900

IN NON-PROJECT AREAS (U.S. $)

INCOME BASED ON LOCAL MARKET PRICES

Crop	% Land in Crop	Average Yield/ac	Price	Weighted Gross Income/ac	Reduction in Yield from Flood Effects %	Flood Effects Amount	Poor Water Sup. %	Poor Water Sup. Amount	Value of Improvement in Yield from gates by Flood Control (x 22%)	River Reg. (x 75%)
Kajakai-Shamalan (36,000 acres)										
Wheat	60	20 bu	1.64	19.68	10	70,900	10	70,900		
Corn	27	17 bu	1.00	4,59	10	16,600	10	16,600		
Cotton	4	500 lb	0.071	1.42	10	5,000	15	7,600		
Alfalfa	7	2.2 T	6.84	1.05	10	4,000	10	4,000		
Mung Beans	10	300 lb	0.021	0.63	5	1,200	5	1,200		
Total						$97,700		$100,300	22,100	75,200
Seraj (35,000 acres)										
Wheat	56	20 bu	1.64	18.37	10	64,400	10	64,400		
Corn	35	17 bu	1.00	5.95	10	21,000	10	21,000		
Cotton	5	500 lb	0.071	1.78	10	6,300	15	9,500		
Alfalfa	9	2.2 T	6.84	1.35	10	4,900	10	4,900		
Mung Beans	11	300 lb	0.021	0.69	5	1,200	5	1,200		
Total						$97,800		$101,000	22,200	75,800
Garmsel (20,000 acres)										
Wheat	85	13 bu	1.64	18.12			20	72,500		
Corn	6	14 bu	1.00	0.84			20	3,300		
Cotton	5	325 lb	0.071	1.15			25	5,800		
Alfalfa	1	1.5 T	6.84	0.10			20	400		
Mung Beans	8	200 lb	0.021	0.34			10	700		
Total								$82,700		62,000
Chakhansur (50,000 acres)										
Wheat	85	13 bu	1.64	18.12			20	181,200		
Corn	6	14 bu	1.00	0.84			20	8,400		
Cotton	5	325 lb	0.071	1.15			25	14,400		
Alfalfa	1	1.5 T	6.84	0.10			20	1,000		
Mung Beans	8	200 lb	0.021	0.34			10	1,700		
Total								$206,700		155,000
GRAND TOTAL									44,400	368,100

Anticipated Conditions 25th Year of Project Development, Shamalan Unit
Units in English System and U.S. Dollars

	Land Use %	Acres	Yield: Unit/Acre	Yield: Total	Price/Unit $	Gross Income, $: Per Acre	Gross Income, $: Per Composite Acre	Gross Income, $: Total		Gross Costs $	Net Income $
Single Crop											
Wheat	36.3	11,398	56 bu	638,288 bu	1.640 bu	87.45	31.75	996,731	1/		
Barley	4.5	1,413	32 bu	45,216 bu	0.560 bu	18.12	0.82	25,609			
Cotton: Seed Cotton	[illegible]	6,594	1,710 lb	11,275,740 lb	0.071 lb	121.76	25.57	802,985			
Lint			(600 lb)	(3,956,400 lb)	(0.178 lb)	(107.15)	(22.50)	(706,580)			
			(1.20 bale)	(7,913 bale)	(89.000 bale)						
Seed			(1,110 lb)	(7,319,340 lb)	(0.013 lb)	(14.61)	(3.07)	(96,405)			
Alfalfa, Hay	22.9	7,190	4.6 ton	33,074.0 ton	6.840 ton			-	1/		
Orchard	3.2	1,005	20,260 lb	20,361,300 lb	0.012 lb	239.11	7.65	240,306			
Garden	3.1	973	16,870 lb	15,414,510 lb	0.004 lb	68.91	2.14	67,051			
Vineyard	3.4	1,067	12,380 lb	13,209,460 lb	0.011 lb	134.83	4.58	143,836			
Subtotal, Single Crop	94.4	29,640					72.51	2,276,548			
Double Crop											
Wheat	10.5	3,297	45 bu	148,365 bu	1.640 bu	72.90	7.65	240,360			
Corn	14.7	4,616	73 bu	336,968 bu	1.000 bu	60.23	8.85	278,003	1/		
Carrots	2.9	911	11,620 lb	10,585,820 lb	0.003 lb	36.92	1.07	33,641			
Mung Beans	9.9	3,108	930 lb	2,890,440 lb	0.021 lb	19.36	1.92	60,183			
Sesame or Sunflower	2.7	848	940 lb	797,120 lb	0.053 lb	49.88	1.35	42,298			
Subtotal, Double Crop	(40.7)	(12,780)					20.84	654,485			
Crop Residue						0.17		-	1/		
Idle and Farmstead	5.6	1,759									
Subtotal, Crops	100.0	31,399					93.35	2,931,033			
Livestock and Products			No/Acre	Number							
Oxen			0.03 hd	942 hd	6.35/hd	0.19	0.19	5,982			
Milk Cows			0.22 hd	6,908 hd	2.89 hd	0.64	0.64	19,964			
Other Cattle			0.20 hd	6,280 hd	2.31 hd	0.46	0.46	14,507			
Donkeys and Horses			0.02 hd	628 hd	0.26 hd	0.01	0.01	163			
Sheep and Goats			0.30 hd	9,420 hd	10.72 hd	3.23	3.23	100,982			
Chickens and Other Poultry			6.21 hd	194,988 hd	0.36 hd	2.24	2.24	70,196			
Milk			452.44 lb	14,206,163 lb	0.014/lb	6.34	6.34	199,763			
Eggs			133.00 eggs	4,176,067 eggs	0.013/egg	1.73	1.73	54,289			
Hides and Skins			1.82 lb	57,146 lb	0.061/lb	0.11	0.11	3,503			
Subtotal, Livestock and Products							14.95	469,349			
Fuel Income							1.50	47,143			
Total Income							$109.80	$3,447,525		$1,937,690	$1,509,719
Average per Acre									109.79	61.71	48.08
Grazing Income, Nonarable Land											111,720
Grazing Income, per acre 2/											3.58
Grand Total Income											1,621,439
Grand Total Income, per Acre											51.66

1/

	Total Production	Livestock Feed	Surplus Over Livestock Feed
Wheat	638,288 bu	25,740 bu	612,548 bu
Alfalfa	33,074 ton	28,366 ton	Balance Turned Under
Corn	336,968 bu	56,268 bu	280,710 bu

Crop Residue Fed to Livestock

2/ Per Acre of Nonarable Land (31,229 Acres)

TABLE B-8

Source: Appendix A, Agricultural Economics, Table 19-B - Shamalan Draft Feasibility Report, USBR. September, 1967

INCOME AND DEVELOPMENT COSTS FOR NEW LANDS

INCOME BASED ON LOCAL MARKET PRICES

Area	Area Acres	Present Net Income $/Acre	Future Net Income $/Acre	Alloc. O/M Costs $/Acre	Increase in Net Income $/Acre	Total Incremental Income	Development Cost $/Acre	Total Development Costs
Kajakai-Shamalan	14,000	5	50	3	42	$588,000	375	$5,250,000
Seraj	25,000	5	50	3	42	$1,050,000	350	$8,750,000
Garmsel	22,000	5	45	3	37	$[illegible]14,000	375	$8,250,000

TABLE B-9

ALTERNATIVE ANALYSIS

SOCIO-ECONOMIC PRICES FOR WHEAT AND COTTON

IN HELMAND VALLEY

WHEAT

From U.S.S.R.

	Value U.S. $	
Import price (c.i.f. Termez)* Barter $84.-/m.ton x 0.66**	55.44	/m.ton
Transportation to Kabul	15.38	"
Farm to market cost	(- 1.68)	"
Inter-market differential Kabul-Lashkargah	1.83	"
Price at Lashkargah for wheat from Upper Areas	70.97	"
Additional transportation costs from Lower Areas	21.60	"
Price at Lashkargah for wheat from Lower Areas (Carmsel and Chakhansur)	49.37	"

From U.S.A.

	Value U.S. $	
Import price (c.i.f. Karachi)*	85.00	/m.ton
Transportation to Lashkargah	30.00	"
Farm to market cost	(- 1.68)	"
Price at Lashkargah for wheat from Upper Areas	113.32	"
Additional transportation costs from Lower Areas	21.60	"
Price at Lashkargah for wheat from Lower Areas (Garmsel and Chakhansur)	91.72	"
Average price for wheat - Upper Area	92.15	/m.ton ($2.51/bushel)
- Lower Area	70.54	/m.ton ($1.92/bushel)

COTTON*

	Value U.S. $	
Export revenue for 0.287 metric tons of lint to USSR at Barter $740 /m.ton x 0.66**	140.17	
Export revenue for 0.043 metric tons of lint to Western Europe at $515 /metric ton	22.14	
Export revenue for 0.67 metric tons seed to USSR at Barter $68.50 /m.ton x 0.66**	30.29	
Buying and ginning costs	(- 15.10)	/m.ton
Transportation costs	(- 29.93)	"
Total net revenue for seed cotton from Upper Areas	147.57	/m.ton ($0.067/lb.)
Additional transportation costs from Lower Areas	21.60	"
Total net revenue for seed cotton from Lower Areas (Garmsel and Chakhansur)	125.97	/m.ton ($0.057/lb.)

* Source - ADB Report Gawargan and Car-Darrah projects: adjusted for Helmand Valley Area. (Reference 19).

** Barter dollar converted to U.S. dollar in ratio 55/83.5 = 0.66.

ALTERNATIVE ANALYSIS

CROP DAMAGE BY DIRECT FLOODING IN NON-PROJECT AREAS

INCOME BASED ON SOCIO-ECONOMIC PRICES

Crops Reported Damaged	Damage as Percentage of Average Yield	Value * of Weighted Average Yield U.S. $/Acre	Value of Damage U.S. $/Acre
YEARS 1 TO 10			
Wheat	35	30.12	10.54
Corn	30	4.59	1.38
Cotton	30	1.34	0.40
			$12.32
Average value per acre with flood frequency in 1 in 5 years			$2.46
Number of acres reported inundated			18,000
Annual value of damage			$44,300
Value of annual reduction (22%)		Equiv. U.S.	$9,700
YEARS 11 TO 50			
Wheat	35	19.68	6.89
Corn	30	4.59	1.38
Cotton	30	1.34	0.40
			$8.67
Average value per acre with flood frequency in 1 in 5 years			$1.73
Number of acres reported inundated			18,000
Annual value of damage			$31,100
Value of annual reduction (22%)		Equiv. U.S.	$ 7,000

* Refer Table B-12

CROP BENEFITS FROM IMPROVED RIVER CONTROL IN NON-PROJECT AREAS (U.S. $)

INCOME BASED ON SOCIO-ECONOMIC PRICES

YEARS 1 TO 10* Crop	% Land In Crop	Average Yield/ac	Price	Weighted Gross Income/ac	Reduction in Yield from Flood Effects %	Flood Effects Amount	Reduction in Yield from Poor Water Sup. %	Poor Water Sup. Amount	Value of Improvement in Yield from Gates by Flood Control (x 22%)	River Reg. (x75%)
Kajakai-Shamalan (36,000 acres)										
Wheat	60	20 bu	2.51	30.12	10	108,400	10	108,400		
Corn	27	17 bu	1.00	4.59	10	16,600	10	16,600		
Cotton	4	500 lb	0.067	1.34	10	4,800	15	7,200		
Alfalfa	7	2.2 T	6.84	1.05	10	4,000	10	4,000		
Mung Beans	10	300 lb	0.021	0.63	5	1,200	5	1,200		
Total						$135,000		$137,400	$29,700	$103,000
Seraj (35,000 acres)										
Wheat	56	20 bu	2.51	28.11	10	98,400	10	98,400		
Corn	35	17 bu	1.00	5.95	10	21,000	10	21,000		
Cotton	5	500 lb	0.067	1.68	10	5,900	15	8,800		
Alfalfa	9	2.2 T	6.84	1.35	10	4,900	10	4,900		
Mung Beans	11	300 lb	0.021	0.69	5	1,200	5	1,200		
Total						$131,400		$134,300	$28,900	$101,000
Garmsel (20,000 acres)										
Wheat	85	13 bu	1.92	21.22			20	84,900		
Corn	6	14 bu	1.00	0.84			20	3,300		
Cotton	5	325 lb	0.057	0.93			25	4,700		
A[illegible]	1	1.5 lb	6.84	0.10			20	400		
Mung Beans	8	200 lb	0.021	0.34			10	700		
Total								$ 94,000	-	$71,000
Chakhansur (50,000 acres)										
Wheat	85	13 bu	1.92	21.22			20	212,200		
Corn	6	14 bu	1.00	0.84			20	8,400		
Cotton	5	325 lb	0.057	0.93			25	11,600		
Alfalfa	1	1.5 T	6.84	0.10			20	1,000		
Mung Beans	8	200 lb	0.021	0.34			10	1,700		
Total								$234,900	-	$175,000
GRAND TOTAL									$58,600	$451,000

YEARS 11 to 50** Crop	% Land In Crop	Average Yield/ac	Price	Weighted Gross Income/ac	Reduction in Yield from Flood Effects %	Flood Effects Amount	Reduction in Yield from Poor Water Sup. %	Poor Water Sup. Amount	Value of Improvement in Yield from Gates by Flood Control (x 22%)	River Reg. (x 75%)
Kajakai-Shamalan (36,000 acres)										
Wheat	60	20 bu	1.64	19.68	10	70,900	10	70,900		
Corn	27	17 bu	1.00	4.59	10	16,600	10	16,600		
Cotton	4	500 lb	0.067	1.34	10	4,800	15	7,200		
Alfalfa	7	2.2 T	6.84	1.05	10	4,000	10	4,000		
Mung Beans	10	300 lb	0.021	0.63	5	1,200	5	1,200		
Total						$ 97,500		$ 99,900	$21,500	$75,000
Seraj (35,000 acres)										
Wheat	56	20 bu	1.64	18.37	10	64,400	10	64,400		
Corn	35	17 bu	1.00	5.95	10	21,000	10	21,000		
Cotton	5	500 lb	0.067	1.68	10	5,900	15	8,800		
Alfalfa	9	2.2 T	6.84	1.35	10	4,900	10	4,900		
Mung Beans	11	300 lb	0.021	0.69	5	1,200	5	1,200		
Total						$ 97,400		100,300	$21,500	$75,000
Garmsel (20,000 acres)										
Wheat	85	13 bu	1.64	18.12			20	72,500		
Corn	5	14 bu	1.00	0.84			20	3,300		
Cotton	5	325 lb	0.057	0.93			25	4,700		
Alfalfa	1	1.5 T	6.84	0.10			20	400		
Mung Beans	8	200 lb	0.021	0.34			10	700		
Total								$81,600	-	$61,000
Chakhansur (50,000 acres)										
Wheat	85	13 bu	1.64	18.12			20	181,200		
Corn	6	14 bu	1.00	0.84			20	8,400		
Cotton	5	325 lb	0.057	0.93			25	11,600		
Alfalfa	1	1.5 T	6.84	0.10			20	1,000		
Mung Beans	8	200 lb	0.021	0.34			10	1,700		
Total								$203,900		$153,000
GRAND TOTAL									$43,000	$364,000

*Import price for wheat, export price for cotton and local market prices for other crops.

**Export price for cotton and local market prices for other crops.

ALTERNATIVE ANALYSIS

INCOME AND DEVELOPMENT COSTS FOR NEW LANDS

(U.S. $)

INCOME BASED ON SOCIO-ECONOMIC PRICES

		Income					Costs	
Area	Area Acres	Present Net Income $/Acre	Future Net Income $/Acre	Alloc. O/M Costs $/Acre	Increase in Net Income $/Acre	Total Incremental Income	Development Cost $/Acre	Total Development Costs
Years 1 to 10*								
Seraj	25,000	5	72.5	3	64.5	1,613,000	350	$8,750,000
Years 11 to 50**								
Kajakai-Shamalan	14,000	5	49	3	41	574,000	375	$5,250,000
Seraj	25,000	5	49	3	41	1,025,000	350	$8,750,000
Garmsel	22,000	5	41.5	3	33.5	737,000	375	$8,250,000

*Import Price for wheat, export price for cotton, and local market prices for other items.
**Export Price for cotton, and local market prices for other items.

TABLE B-13

POWER LOAD PROJECTIONS, HELMAND-ARGHANDAB VALLEYS

Year	Total Generation (1,000 kwh)				Peak Demand (MW)		
	Beck* Estimate 1964	AID Estimate 1967	Beck*** Estimate 1967	Actual Generation≠	Beck* Estimate 1964	AID Estimate 1967	Beck*** Estimate 1967
1967	12,483	11,987		12,553	4.2		
1968	13,162	12,596		11,710	4.4		
1969	19,918	19,960		11,442	6.3		
1970	27,049	23,206			8.0		
1971	38,289	29,283			13.2		
1972	54,763	45,501			15.1	11.6	
1973	61,057**	50,581			16.5	12.8	
1974	67,367	55,065			18.4	14.0	
1975	72,733	59,486	54,240		20.0	15.1	14.4≠≠
1976	78,311	64,422	58,680		21.5	16.4	15.4
1977	83,373	69,432	63,210		22.9	17.7	16.4
1978	88,824	74,786	66,680		24.3	19.0	17.3
1979			71,340			20.6	18.3
1980			76,080			22.3	19.3
1981			80,020			24.1	20.3
1982			84,900				21.3
1983			88,880				22.3
1984			93,490				23.2

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*Beck estimate moved foward to 1967 from 1964.

**After 1974 AID reduced Beck estimates by amount equal to the Projection for Rural Areas.

***Starting one year after Kajakai Powerplant complete (mid 1974).

≠Total of Boghra Hydro, and Kandahar Hydro and Diesel as given in Reference 12. Values are actually for Afghan years 1346, 1347 and 1348.

≠≠Values assumed to occur at mid-year.

TABLE B-15

HYDROELECTRIC AND THERMAL PLANT COSTS

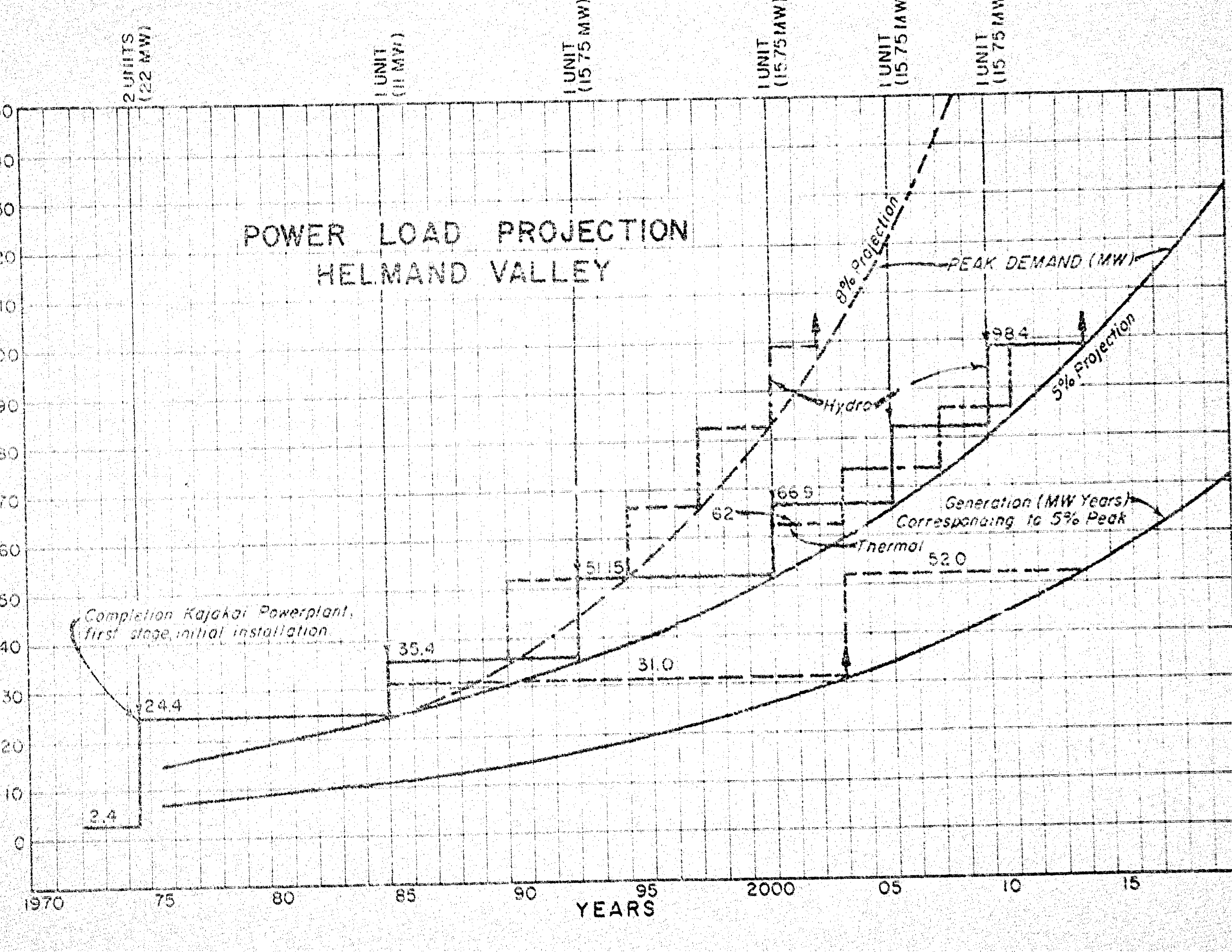
Installation	Capacity MW	Construction Cost $/kW	Construction Cost Amount $	Annual Costs ($) O/M	Annual Costs ($) Insurance	Annual Costs ($) Interim Replace-ments	Annual Costs ($) Total Amount
Hydro-Electric							
5th Unit	4.9	375	1,840,000	5,000	2,000	23,000	30,000
6th Unit	15.75	375	5,910,000	17,000	6,000	74,000	97,000
7th Unit	15.75	375	5,910,000	17,000	6,000	74,000	97,000
Total	36.40		13,660,000				224,000
Thermal							
1st Stage	12.133	250	3,050,000	36,500	7,500	15,000	59,000
2nd Stage	12.133	250	3,050,000	36,500	7,500	15,000	59,000
3rd Stage	12.133	250	3,050,000	36,500	7,500	15,000	59,000
Total	36.40		9,150,000				177,000

Total Fuel Cost 13,700,000 kwh at 2.72c/kwh = $373,000 per year

Fuel Cost per Stage 124,300 per year

Annual Thermal Costs per Stage 59,000 per year

Total Annual Thermal Cost per Stage = $183,300 per year


POWER LOAD PROJECTION
HELMAND VALLEY
2 UNITS (22 MW)
1 UNIT (11 MW)
1 UNIT (15.75 MW)
1 UNIT (15.75 MW)
1 UNIT (15.75 MW)
1 UNIT (15.75 MW)
8% Projection
PEAK DEMAND (MW)
5% Projection
Hydro
Thermal
Generation (MW Years) Corresponding to 5% Peak
Completion Kajakai Powerplant, first stage, initial installation.
2.4
24.4
35.4
31.0
51.15
62
66.9
52.0
98.4
YEARS
1970
75
80
85
90
95
2000
05
10
15

APPENDIX C

HYDROLOGY

C.1 HYDROLOGY RECORDS

A. Climate and Runoff - The Helmand River Valley has a very arid climate with low relative humidity and long periods of cloudless weather. The sparse rainfall occurs during the winter from December through March with the heaviest monthly precipitation normally in January.

Observed average annual precipitation varies from 253 mm at Arghandab Reservoir at the eastern edge of the irrigated area to 76 mm at Qala Kang in the western part of the watershed. Average annual pan evaporation has been reported to be 1790 mm at Arghandab Reservoir and 4316 mm at Qala Kang. This pan evaporation would indicate potential evapotranspiration of 1250 mm and 3020 mm, respectively. Because of the dryness, practically no vegetation can be supported on rainfall alone. Land that is not irrigated, either from canals or by sub-irrigation, as along the rivers, is almost bare.

The area of most precipitation in the Helmand River Valley is at the highest elevation, which is in the northern and eastern parts of the valley. During the winter months, precipitation accumulates there as snow (above an elevation of about 2600 meters). This snow is the major source of discharge in the Helmand River during most of the year.

The usual spring runoff pattern of the Helmand River is a sustained high flow from snowmelt that may last from one to three months, depending on the amount of snow and on the temperature. In many years there are no high flood peaks above the sustained flow level. The yearly hydrographs are similar in shape and once the peak flow has been reached it is possible to forecast the flow for the remainder of the year with fair accuracy by using recession curves developed from the yearly hydrographs.

The highest annual floods that occur are due to rainfall during the snow melt period. On rare occasions (three times since 1885), very heavy rains have occurred over large parts of the valley during the early months of the year when the snow pack was still nearly intact, causing major floods. The most outstanding flood that has occurred in the valley was in April, 1885, which is estimated to have reached 668,000 cusecs at Chahar Burjak.

The area to the south and west of Kajakai Dam, which includes much of the irrigated land in the valley, is very arid and so the river in the dry season loses flow to natural causes as well as to irrigation. This is illustrated by Table C-2. In the dry season, the tributaries downstream from Kajakai cease flowing or contribute very little, and the only source of water along the main river is from Kajakai.

The residual water in the Helmand River at its downstream end flows into marshy lakes or "Hamuns" in the Chakhansur area in Afghanistan and Iran. There is no outlet to the sea from this area and water level in the Hamuns is maintained by evaporation. The water balance is delicate, and a series of wet years or dry years can change the level considerably. A single flood, such as that of 1885, can raise the general water level enough to inundate large areas of land for a number of years.

A map showing the extent of the Helmand River System concerned with this project and indicating the major inflows and diversions is given in Exhibit 2.

B. Hydrologic Records Available - The earliest know hydrologic records in the Helmand Valley were compiled in 1903-04, and are summarized in the MacMahon Report (Reference 16). These records show weather and discharges in the downstream reaches of the river before the construction of Kajakai Dam. However, the estimate of the discharges of the flood of 1885, which is given in this report, appears valid and has been used as a factor in the determination of the maximum flood for the Kajakai spillway design.

1. Discharge Records - River and canal discharges have been measured at many stations in the Helmand River Valley during various periods since 1946. Most of these stations and their periods of record are given on the bar graph in Figure C-1. This bar graph shows the stations in downstream order, and their relative location with regard to tributary inflow and large diversions can be found on Exhibit 2.

The earlier discharge records from 1946 to 1964 are complete and appear to be accurate. After 1964, however, some of the records are incomplete and some have been found to be in error.

Monthly and annual inflows to Kajakai Reservoir, in acre-feet and corrected for evaporation, are shown on Table C-1 for 1947 to 1970.

The records used in the hydrologic computations from this report for the period up to September 1960 were taken from the U.S. Geological Survey report "Compilation of Hydrologic Data, Helmand River Valley, Afghanistan, through September 1960". Records after that time have not been published and were obtained from HAVA and from the Soils and Water Division of the Ministry of Agricultures.

2. Meteorologic Records - Meteorologic observations have been made at about 10 sites in the Helmand Valley for various periods of time.

The factors observed have included precipitation, temperature, pan evaporation, relative humidity and wind velocity.

The oldest continuous record, which was started in 1940, is at Kandahar. Observations taken include daily records of precipitation, maximum and minimum temperatures and pan evaporation.

The precipitation records available in the valley are not complete enough to define rainfall fully on an areal basis, particularly at higher elevations where the precipitation is the heaviest. In the irrigated areas at lower elevations, precipitation is relatively unimportant, and the other records obtained there are adequate to define general climatic conditions for agricultural planning.

3. Snow Surveys - Observations of water content of snow in Afghanistan were started in 1954 at four snow courses along the highway in the vicinity of Ghazni, which is just east of the upper part of the Helmand River watershed. These courses were located so that they could be reached by automobile, and as a result all of them are below 2530 meters elevation - below the zone of accumulation of the effective snow pack. None of these courses has shown any noticeable correlation with streamflow, and several other courses have been located nearby with no better results.

About 1965, two additional courses were located northwest of Kabul at Shibur Pass and two at Salang Pass, 90 kilometers north of Kabul. One of these courses, Salang Pass South, located about 90 kilometers northeast of the Helmand Valley at elevation 2740, shows a fairly good end-of-season correlation with flow in the Helmand River at Kajakai. This correlation is shown in Figure C-2.

Snow depths, without water content, have been observed since 1968 by the Civil Air Authority. One of their sites, Punjab, is located at the north edge of the Helmand River watershed. This course at elevation 2700 meters does not indicate much snow for reasons which are not known at this time. Other depth observations taken at Salang Pass at elevations 3122 and 3366 appear to correlate with streamflow in the Helmand River, but records are too short to be reliable.

There appear to be three principal reasons why snow surveys in Afghanistan have not given good results in forecasting streamflow: (1) most of the snow courses are located at low elevations where the snow pack is not stable (2) observations have been made on an erratic schedule, which will give poor results, and (3) there is little vegetation and some courses were bare because of winds.

C.2 SPILLWAY DESIGN FLOOD

A. Prior Studies - When the spillway design flood for Kajakai dam was estimated (1950), little hydrologic information was available. The flood was derived from indices that were based on experience in the United States, and on estimates of discharge based on the great Helmand River flood of April, 1885 - details of which was given in the McMahon Report (Reference 16) - and on a flood that occured in 1939. The peak of the 1885 flood at Chahar Burjak was estimated in the McMahon Report to be 668,000 cfs, and was derived from a drainage area of 63,000 square miles, which may be compared with the drainage area of 16,300 square miles at Kajakai. The corresponding peak at Kajakai was then computed to have been 334,000 cfs. This figure was checked by envelope curves developed for the Colorado River basin and central plains streams in the United States. The 1939 flood, reported to have been the largest of more recent years, was estimated to have a peak discharge of 140,000 cfs.

The criterion finally adopted for spillway design was to use two hypothetical floods as follows:

1. A flood with a peak inflow of 318,000 cfs to be routed through the reservoir without encroachment on normal freeboard, and

2. A flood with a 24-hour peak inflow of 480,000 cfs to be routed through the reservoir without overtopping the dam; this flood had a 9-day volume of about 4,900,000 ac-ft.

The spillway presently in use was designed to accomodate these two floods.

B. Revised Design Flood - For the design herein, a review was made of the spillway design flood, using the hydrologic records collected since 1950 and the theoretical methods developed in recent years.

Very large floods could occur at Kajakai dam from either optimum melting conditions on a maximum snow accumulation or from a probable maximum precipitation over the watershed. A simultaneous occurrence of these two events is meteorologically possible at this site and would logically cause the maximum possible flood. The spillway design flood has, therefore, been computed as the combination of snowmelt and precipitation based on the procedures of the U.S. Weather Bureau (Reference 11) and the U.S. Army Corps of Engineers (Reference 15).

1. A maximum snowpack was assumed from runoff precipitation data and the optimum net basin snowmelt was derived from temperature data and the estimated percent age of the area under snow cover (Reference 15).

2. The probable maximum 6-hour per 10-square mile precipitation (Reference 11) was determined and adjusted to the Kajakai site and a 96-hour duration.

3. The adjusted probable maximum precipitation was added to the net basin snowmelt so as to give the maximum sequence of daily water availability.

4. A basin unit hydrograph was derived by computer analyses of actual flood peaks on the Helmand River at Kajakai, using procedures outlined in Reference 2.

5. The maximum daily sequence of net water available for runoff was applied to the unit hydrograph to derive a maximum flood hydrograph.

6. The probable base flow was estimated from Kajakai flood hydrograph characteristics and added to the computed maximum flood hydrograph to give the spillway design flood.

The design flood computed by this method reaches a high sustained flow from snowmelt of about 150,000 cfs and then increases rapidly to 440,000 cfs when the maximum probably precipitation occurs. A hydrograph of this flood is shown on Figure C-3. The ordinates of the hydrograph are given in Table C-3.

C-3 RUNOFF FORECASTING SYSTEM

A. Present Situation - During the months of January through March, Kajakai Reservoir could be operated either to save water in anticipation of a low inflow year, or releases could be made to provide space for flood storage as described in Appendix A. The difference in reservoir storages between these methods of operation could be about 360,000 ac-ft per month.

In the 17 years that Kajakai Reservoir has been in operation, the annual inflow has varied from 2.3 million to 9.1 million ac-ft with five years of distinct shortage and three years of very high flow. Without any knowledge of whether the forthcoming snow runoff will be above normal, this large range in discharge makes efficient operation of the reservoir particularly difficult. There is presently no effective method of forecasting the expected inflow to the reservoir.

B. The Forecasting Method - Snow surveys that measure the water content of the snow at certain exact sites on the first of each month from January through April could provide information on which to base operation of the Kajakai Reservoir as efficiently as possible during the months of January through March.

A system of forecasting seasonal flow by snow surveys depends on the relationship between water in storage on the ground as snow and the yield from that snow that will appear as streamflow. Curves of this relationship must be made for each month that requires a forecast.

In addition to the observations of snow depths and water content, precipitation and temperature records are also taken in conjunction with snow surveys. Precipitation records are useful in determining antecedent soil moisture conditions, which are a factor in water yield. They are also useful as a supplementary record of the total moisture that might be available. Temperature observations are a measure of the amount of melting and also of how much of the stored moisture will be lost to evaporation.

Other factors such as soil moisture, wind, relative humidity, etc., are sometimes taken in snow survey programs. However, these observations are not recommended for the Helmand Valley system at this time as the extra expense and trouble of obtaining them would not be worth the little additional accuracy that they might add to the forecasts.

C. Accuracy of Forecasting - The accuracy of forecasts of streamflow from snow survey data depends on a number of factors. One of the most important of these is the amount of precipitation that occurs as the season progresses. The first seasonal forecast could be made on January 1 in the Helmand Valley, but it might be relatively inaccurate because, in some years, the pattern of the coming year's snow accumulation has not been fully established by that time. Each succeeding months forecast would be more accurate.

Good snow survey data are of prime importance in forecasting. The accuracy of the field data depends on proper location of the snow survey courses, the adherance to a strict monthly time schedule, and proper methods in making water content observations.

The snow surveys that have been made in Afghanistan have not been particularly successful (Section C-1). This has been due principally to poor location of the courses and to the lack of consistent dates of observation each year.

It is nevertheless possible to make accurate forecasts of the seasonal flow in the Helmand River. This can be demonstrated by use of data collected at Salang Pass, one of the survey sites in present use. Water content for the end of February, observed at Salang Pass for the years 1965 to 1969, are plotted on Figure C-2 against the seasonal flow of the Helmand River into Kajakai for the same years.

The data, although meager, indicates a fair degree of correlation between snow at Salang Pass and subsequent flow in the Helmand River. This correlation is apparent even though the Salang Pass snow course is about 80 kilometers from the Helmand Valley, and, in addition, the observations were made at somewhat random dates.

Forecasts of inflow to Kajakai Reservoir using Salang Pass snow survey data would be only fair for dates earlier than March 1. However, very good results might be expected from courses properly located within the Helmand Valley.

D. Snow Survey Program for the Helmand Valley - The Upper Helmand Valley is quite large and precipitation (and snow accumulation) varies from heaviest in the northeast to lightest in the southwest. To cover the area thoroughly would require observations in three or four generalized areas.

Ideally, snow survey courses should be well distributed over the snow accumulation area, which is above about 2600 meters elevation. In addition, the courses should cover the range in elevation up to about 4500 meters.

The lack of roads in the Helmand Valley makes this ideal situation impractical and some compromise is necessary. Realistically, location of courses will be limited to the northern and eastern edges of the watershed. Fortunately, this is the area of heaviest precipitation and the one that is the most important in determining flow in the river.

In establishing a snow survey network, it is necessary to start with more courses than will be needed. Some of the sites selected will not correlate well with streamflow because of wind effect or poor exposure, and some may turn out to be too difficult to operate because of physical reasons. As soon as a course is recognized as unsuitable, it can be dropped from the program. The rest of the courses must be operated for about five years before correlations with stream flow can be developed. If after five years there are insufficient good courses to make accurate forecasts, it will take an additional five years to obtain others. For this reason, it is necessary to start with sufficient stations at the beginning of a snow survey program to ensure that at least three to five good sites will eventually be included.

Snow survey courses can be located and visited in three or four general areas in the Upper Helmand River watershed. Two or three snow survey courses should be established if possible in each of these general areas at various elevations above 2600 meters. This will be a total of eight to ten courses to be measured at the start of the program.

Snow surveys must be made each year on a strict monthly schedule within about three days of a set report date. Because of transportation difficulties, it seems probably that three 2-man crews and three sets of measuring equipment will be needed to meet such a schedule with eight to 10 courses in three general locations to be measured.

E. Location of Snow Survey Courses - To locate snow survey courses, access in the winter time might be possible along the road running west from Kabul to Panjao and also along the road that goes west from Ghazni to Dashti-Nawar. It is unlikely that any satisfactory courses can be located at the edges of these roads where cars can go, and some travel on snow shoes will probably be necessary to reach a likely site.

Suggested areas for consideration and for possible reconnaissance are given in Table C-4 in the approximate order of their importance.

These general areas are given for preliminary consideration. Other locations may be selected elsewhere in the general area because of easier access. Snow courses can be located close enough to the roads so that they can be visited and measured within a day by car. In some of the areas, where automobile traffic is difficult, it may be possible to obtain monthly measurements by hiring an educated local official, such as a school teacher or someone in a military post, to make the readings. If it takes more than a day to reach and measure any course it will be necessary to provide suitable shelter for an overnight stay; therefore, lightweight camping equipment will also be needed.

F. Equipment - The selected snow courses must have permanent markers that are tall enough to extend above any possible snow. These markers are necessary as each observation point must be measured at exactly the same place every month and every year to be consistent.

A manual precipitation gage should be set up in each of the general snow survey areas chosen. This gage will be observed by a local man. It should be located as close as is practical to the most important snow course in the area but will usually be at a lower elevation than the snow course.

If there is no local observer available, it will be necessary to install an accumulation precipitation gage which is a permanently anchored standpipe that can store a full months precipitation in the form of snow and which can be read monthly by the measuring crew.

If there is any possibility that a snow survey crew may have to spend a night near the course, a closed shelter must be provided.

The general basic snow surveying methods developed by the U.S. Department of Agriculture are recommended as suitable for use in Afghanistan. These are given in U.S. Department of Agriculture Miscellaneous Publication No. 380, "Snow Surveying", which should be used as a guide in establishing and operating the system.

The Mount Rose type of measuring equipment is recommended. This consists of calibrated, slotted aluminum sampling tubes with weighing scales that are calibrated directly in centimeters of water. Metric system equipment must be specified in ordering.

G. Snow Surveying Consultant - The successful establishment and operation of a snow survey streamflow forecasting system is a difficult problem that requires specialized experience.

The two principal reasons that snow surveys in Afghanistan have not correlated with streamflow appear to be (1) that the courses were not properly located and (2) that no uniform schedule of measurement has ever been maintained. Locations of the existing snow survey courses are generally too low in elevation so that the sites are bare of snow much of the time. Also, notes given in some year's records show that wind effect makes some of the courses unrepresentative of the area in which they are located.

The lack of an operating schedule indicates that when the snow courses were first established there were no firm rules for operation.

It is recommended that, if funds are available, a snow survey consultant be employed for about two months to assist in establishing the proposed forecasting system. His activities should include furnishing assistance in locating and establishing the snow survey courses and in setting up operating rules and procedures.

H. Cost Estimates - The cost of establishing and operating a forecasting system based on snow surveys for streamflow in the Helmand Valley are shown in Table C-5.

I. Time Schedule - A discharge forecasting system will require five to 10 years to become established because this type of system is based on the correlation between water content of the snow at a particular time and the succeeding years' runoff. It is necessary to draw a separate curve showing the relationship of each month's snow water content to the recorded runoff.

After about five years of snow surveys have been obtained, satisfactory curves can usually be drawn for the later months requiring forecasts. It may take 10 or more years to get satisfactory relationships established for the early months in the season.

As the Kajakai Reservoir, either with or without gates, can be more efficiently operated if a reasonably accurate estimate of the year's flow can be made and because a long lead time is necessary before a forecasting system can be used, it is imperative that such a system should be established as soon as funds are available.

(Discharg

Water Year	Oct	Nov	Dec	Jan	Feb	Mo Ma
1947	131,690	151,160	171,250	185,440	200,650	373
1948	84,000	111,100	132,600	129,600	144,800	595
1949	115,500	140,600	154,200	155,500	222,000	711
1950	151,400	173,500	186,000	221,600	224,900	479
1951	147,000	157,500	163,200	169,400	175,500	668
1952	152,000	176,600	187,300	195,700	298,900	749
1953	155,100	173,400	179,800	181,800	255,800	771
1954	145,400	157,300	173,700	210,800	334,200	862
1955	173,700	192,800	191,500	199,500	179,200	630
1956	132,900	153,000	225,600	208,400	230,200	963
1957	188,200	184,700	183,300	361,600	253,600	1,167
1958	230,700	337,200	395,300	357,800	388,600	798
1959	202,800	223,500	251,200	237,340	255,410	1,035
1960	156,380	205,710	253,880	205,970	228,000	412
1961	153,890	177,160	174,890	172,140	165,060	451
1962	26,485	179,011	183,780	183,590	191,040	310
1963	135,850	139,580	151,480	143,860	142,280	259
1964	127,390	172,620	167,910	173,900	235,930	790
1965	153,140	166,680	186,860	226,430	271,020	96[illegible]
1966	214,040	216,780	204,110	219,890	233,720	30[illegible]
1967	136,324	148,080	141,670	136,680	201,414	47[illegible]
1968	195,490	209,650	180,330	177,450	206,430	73[illegible]
1969	170,880	154,200	137,230	254,070	386,590	1,0[illegible]
1970	189,270	314,170	237,250	243,610	226,020	40[illegible]

THE RESERVOIR

(...rges are in Acre-Feet)

Monthly							
Mar	Apr	May	June	July	Aug	Sept	Annual
373,680	461,920	303,060	158,750	67,640	41,840	50,920	2,300,000
595,300	1,261,200	809,400	255,000	119,400	71,600	81,600	3,795,600
711,000	1,824,200	1,008,200	357,800	179,200	122,400	112,400	5,103,000
479,100	1,016,200	1,689,200	591,000	209,200	112,700	110,700	5,165,500
668,200	1,329,200	1,983,200	745,900	270,200	141,600	129,700	6,080,600
7[illegible],300	1,359,200	905,700	331,700	160,300	103,400	116,700	4,736,800
771,200	928,300	717,600	383,900	143,700	105,300	113,900	4,109,800
[illegible]2,000	1,623,400	1,312,400	454,500	222,800	143,600	132,500	5,772,600
630,300	643,300	817,300	384,900	174,400	99,100	100,100	3,786,100
[illegible]3,500	2,256,500	974,400	319,600	401,100	142,600	139,100	6,146,900
167,600	2,424,100	2,532,000	1,028,000	420,400	233,100	166,100	9,142,700
778,100	1,264,700	786,900	412,100	240,900	159,000	166,800	5,538,100
035,950	1,283,100	766,700	340,740	197,420	121,300	144,360	5,059,820
412,490	943,020	1,367,600	465,880	206,210	147,410	125,700	4,718,250
451,200	1,504,010	1,287,240	410,600	195,080	138,280	127,240	4,956,790
310,910	691,800	606,760	278,710	121,110	94,080	106,860	2,974,136
259,430	471,050	1,110,400	455,200	171,580	109,650	101,260	3,391,620
790,850	1,614,950	977,760	367,330	178,160	118,530	106,400	5,031,730
961,430	1,756,240	1,911,510	900,470	393,110	233,240	185,120	7,345,250
305,800	705,870	622,000	287,720	131,490	101,980	105,340	3,348,740
470,774	1,534,270	1,566,980	634,160	291,290	188,750	157,300	5,607,692
733,590	1,126,010	1,097,560	565,710	226,190	135,680	148,770	5,023,360
098,660	1,759,000	1,239,210	697,910	322,340	185,260	165,890	6,611,240
406,490	796,440	465,280	171,650	108,210	111,760	99,270	3,369,610

HELMAND VALLEY LOW FLOWS

October, 1962

Submitted by Hydrology Unit of HVA - R. H. Brigham*

The following are low flow discharge determinations in the Helmand River Valley:

		Discharge
9-26	Helmand R. near Dehraout	1,960 cfs
9-25	Tirin R. at Dehraout	82 cfs
9-24	Helmand R. below Kajakai Reservoir	1,890 cfs
9-27	Helmand R. at Lashkar Gah	653 cfs
9-28	Arghandab R. above Arghandab Reservoir	176 cfs
9-28	Arghandab R. below Arghandab Reservoir	607 cfs
10-1	Arghastan R. near Kandahar	no flow
10-1	Arghandab R. at Qala Bist	no flow
10-1	Helmand R. at Darweshan (recorder record and 2 measurements)	700 cfs
10-3	Chahar Burjak Canal	48 cfs
10-3	Deh Dost Moh'd Canal	no flow
10-2	Helmand R. at Chahar Burjak	458 cfs
10-3	Qala Fateh Canal	22 cfs
10-4	Khoabgah Canal	8.3 cfs
10-4	Nar-i-Shahee Canal	27.6 cfs
10-4	Helmand R. at Khoabgah	411 cfs
10-5	Gul Meer Canal (per Iran men at canal)	no flow
10-5	Sekh Sar Canal	7.3 cfs
10-5	Helmand R. at Shela Charkh	129 cfs

Note: the tabulation above is in downstream order.

During the time that the above discharge measurements were made, there was no change in the reservoir releases or in the major diversions to the central project areas.

It will be observed that between Darweshan and Chahar Burjak Canal Diversion, about 125 miles river distance, about 194 cfs had been lost to valley irrigation and evaporation. From Chahar Burjak to Khoabgah the three canals, Qala Fateh, Khoabgah and Nar-i-Shahee, account for (58 cfs) slightly more than the difference in flow at the two main stem points (47 cfs). The difference (11 cfs) is within the accuracy of the main stem measurements and particularly that at Khoabgah as that discharge measurement had a mean velocity of only 0.51 feet per second. Assuming from the above that the flow at Khoabgah was 400 cfs, then the diversion to Iran through the Seistan Diversion Canal is about 264 cfs. As the flow reaching the Chahar Burjak Canal diversion point is 506 cfs, the data indicates that about 52% of flow at this point goes to Iran and 48% to Afghanistan.

During these extreme low flows, the available water for irrigation in the Chakhansur is so low that but very little wheat can be planted and this is the beginning of their normal planting season.

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*Reprinted from a report by R. H. Brigham.

KAJAKAI RESERVOIR
SPILLWAY DESIGN FLOOD

Day	Discharge (cfs)	Day	Discharge (cfs)
1	5,000	28	143,000
2	9,000	29	143,000
3	20,000	30	144,000
4	30,000	31	144,000
5	35,000	32	144,000
6	43,000	33	144,000
7	55,000	34	145,000
8	69,000	35	145,000
9	75,000	36	146,000
10	84,000	37	169,000
11	94,000	38	227,000
12	101,000	39	379,000
13	105,000	40	444,000
14	113,000	41	280,000
15	122,000	42	205,000
16	128,000	43	175,000
17	131,000	44	155,000
18	134,000	45	142,000
19	137,000	46	132,000
20	138,000	47	122,000
21	139,000	48	113,000
22	140,000	49	105,000
23	141,000	50	98,000
24	142,000	51	91,000
25	142,000	52	84,000
26	142,000	53	78,000
27	143,000		

POSSIBLE SNOW COURSE AREAS

Order No.	Nearest Town	Latitude	Longitude	Possible Range in Elevation
1	Panjao	34°30'	67°0'	2600 to 3800 meters
2	Ghazni*	33°40'	67°55'	2600 to 3500 meters
3	Rahkol	34°20'	67°51'	2500 to 3700 meters
4	Garmao	34°28'	65°55'	2900 to 3300 meters

*The area west of Ghazni would be suitable for courses that would indicate snow cover in the Arghandab River Watershed as well as in the upper Helmand River watershed.

COST ESTIMATE FOR RUNOFF FORECASTING*

	Annual Costs		
	Dollars	Afghanis	Total Equivalent Dollars
First year's cost	17,000	565,000	23,800
Annual operations		226,000	2,700

*These figures are based on an exchange rate of 83.5 Afghanis to one U.S. dollar. Detailed costs are given below:

FIRST-YEAR DOLLAR COST

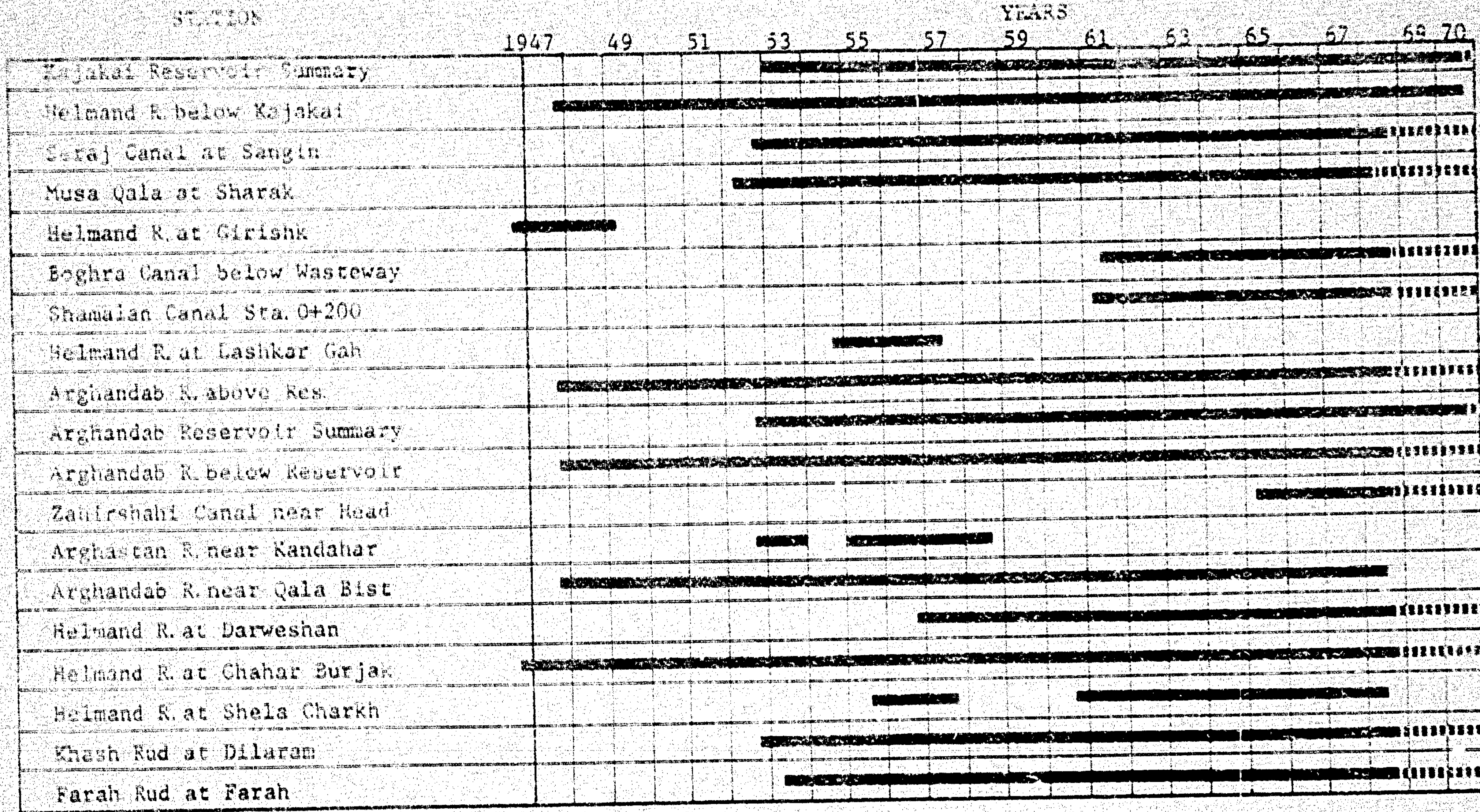
1. Instrumentation		
3 sets snow surveying equipment with 6.1-meter capacity	$ 2,240	
4 manual 8-in. diam rain gages with Alter wind shields	640	
1 8-in. opening, 3-meter capacity accumulation precip. gage	250	
4 sets max-min thermometers with spare tubes	175	
3 50-meter metallic cloth tapes	21	
Approximate shipping cost	400	
Total		3,726
2. Equipment		
8 pairs of snowshoes with ski poles	420	
3 ski packs	120	
6 lightweight parkas	90	
6 pairs snow goggles	60	
Notebooks, 10 years supply of recording forms	85	
Approximate shipping cost	100	
Total		875
3. Consulting Services (2 months)		
Salary, overhead, etc.	8,500	
Fare to Afghanistan and expense enroute	1,550	
Local expenses - 2 months @ $12/day	732	
Total		10,782
4. Contingency Fund		
Possible necessary purchases (i.e., camping equipment if overnight stays are required)	1,617	
Total first-year dollar cost		17,000

FIRST-YEAR LOCAL COST

1.	Materials		
	600 feet 2-in. galv. iron pipe for course monuments	$ 49,500	
	30 metal signs for course markers	4,800	
	40 sacks of cement for basis, etc.	7,500	
	Misc. hardware, parts, steel, etc.	8,300	
		Afs	70,100
2.	Personnel (including allowances)		
	Engineer-in-Charge, 2 months @ Afs 10,500	21,000	
	Project Engineer, 6-1/2 months @ 5,000	32,500	
	Snow surveys, 7-1/2 man months @ 3,500	26,250	
	Surveyor's Asst., 7-1/2 man months @ 3,100	23,250	
	Precip. Gage Observers (part time), 4 years @ 12,600	50,400	
	Drivers, 7-1/2 man months @ 3,300	24,750	
	Laborers, 3 man months @ 700	2,100	
	Per Diem and Overtime	20,000	
		Afs	200,290
3.	Transportation, 30,000 km @ 7 Afs		210,000
4.	Contingency Fund		
	Possible construction of shelters at courses and other similar expenditures that may be necessary	84,610	
	Total first-year Local Costs	Afs	565,000

ANNUAL OPERATION COST

1.	Personnel		
	Engineer-in-Charge, 1 month @ 10,500	10,500	
	Project Engineer, 4-1/2 months @ 5,000	20,000	
	Snow Surveyors, 14 months @ 3,300	49,500	
	Gage Observers, 4 years @ 12,600	50,400	
	Drivers, 6-1/2 months @ 3,300	24,750	
	Per Diem and Overtime	16,000	
	Transportation, 25,000 km @ 7 Afs	17,500	
	Miscellaneous and overhead	37,350	
		Afs	226,000



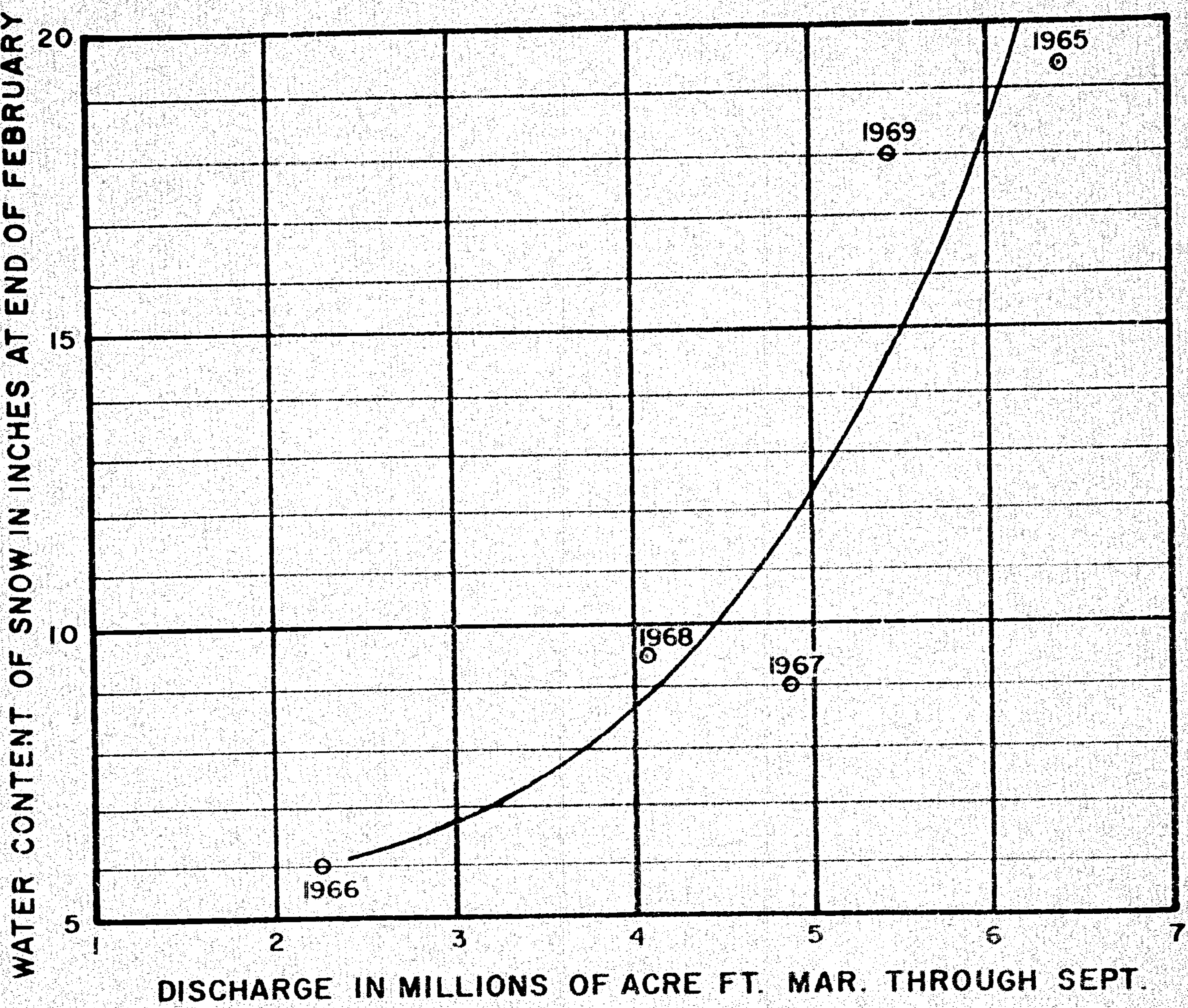
The following stations are reported to have been established but no records are available:

Helmand R. at Gazab
Helmand R. above Kajakai
Tirin R. at Oroz Gan
Tirin R. at Tirin Kot
Tirin R. at Anar Jui
Tirin R. above Kajakai
Darweshan Canal
Helmand R. at Khaubgah
Khash Rud at Ghorghori
Helmand R. at Mala Khan

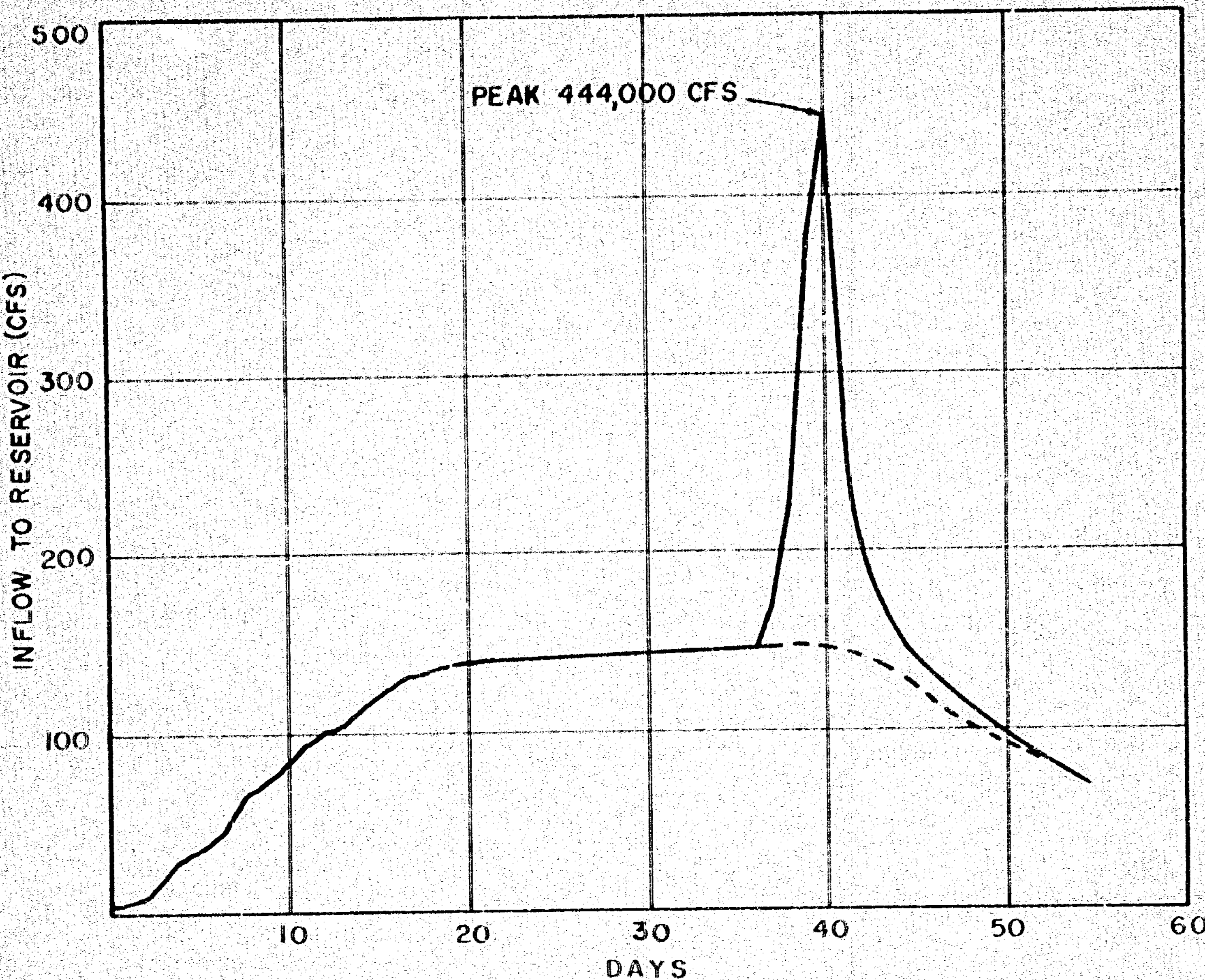
IIIIIIIIIIII Station in operation but records not computed
▬▬▬▬ Records computed

DISCHARGE RECORDS AVAILABLE

YEAR	WATER CONTENT IN INCHES	INFLOW IN MILLIONS OF AC-FT
1965	19.4	6.34
1966	8.3	2.26
1967	10.8	4.84
1968	11.2	4.05
1969	18.2	5.47



RELATION BETWEEN WATER CONTENT IN SNOW AT SALANG PASS AND MARCH TO SEPTEMBER INFLOW TO KAJAKAI RESERVIOR



KAJAKAI RESERVOIR SPILLWAY DESIGN FLOOD

APPENDIX D

AGRICULTURE

D.1 IRRIGATION REQUIREMENTS

The water requirements for the agricultural areas in the Middle and Lower Helmand Valley have been determined in the past by IECO (References 14 and 18) and more recently by the USBR in their detailed studies for the Shamalan Unit (Reference 17). These studies were considered in arriving at the unit water requirements for diversion to irrigated farm lands, the distribution of this water throughout the year, and potential losses to non-beneficial uses. The total unit water requirements used in this report for the Project and Upper Areas is 6.56 ac-ft per acre per year, and for the Lower Areas, 7.38 ac-ft per acre per year. These areas are defined in Table B-1; the monthly requirements making up these totals are shown in Table D-1.

These unit requirements were used to determine the normal monthly and annual irrigation demand to be supplied from the Helmand River. In arriving at the total demand figures, these unit requirements were reduced by 15 percent to allow for the return flows from all lands except those in the Chakhansur. The demand for the Chankhansur lands should include all the return flow at the present and intermediate levels of demand and two-thirds of the return flow at the ultimate level of demand. The reasons for determining differing demands for these three levels are discussed in Appendix A. The derivation of the water demand for the various levels of demand is shown in Table D-1. Included in this table, under "Other Water Requirements", are allowances for other water users in the Chakhansur area, based on the Delta Commission Report, page 95 (Reference 13), and for losses to non-beneficial vegetation. The total annual water demands obtained are 2,507,800, 2,891,600 and 3,399,300 ac-ft per year for the present, intermediate and ultimate levels of demand, respectively.

D.2 IMPROVEMENT OF IRRIGATION PRACTICES

The importance of and need for improvement in irrigation practices and water management in the Helmand Valley has been the subject of numerous studies and reports. Almost every facet of the subject, including causes and possible remedies, have been exhaustively studied and discussed.

The problems, therefore, are well appreciated by the technical personnel of HAVA, USAID and USBR - who are associated with the development of the area - and have resulted in such measures as farmer education and the preparation of operation manuals (Reference 9) and have influenced the proposed new development of the Shamalan area. The main problem is to overcome sociological and economical barriers that impede the necessary improvements. While detailed discussion of these factors would be outside the context of this study, the following is a brief outline of the situation.

Traditional methods of irrigation, as practiced through the centuries, have been mostly based on a rather meager water supply. Furthermore, the farmers have used Karizes or direct uncontrolled river diversion structures, which gave a continuous flow regardless of irrigation need. The water supply was used for domestic uses and for livestock as well as for irrigation. If there was any more water than required, it was wasted or returned to the river.

In many places, water has been fairly efficiently used with this system, although land preparation for proper irrigation is poor in most instances, and ditches are inadequate to deliver water efficiently without excessive seepage losses. River diversions must usually carry water for long distances to reach the land to be irrigated, and there is a great duplication of more or less parallel ditches due to the custom of each village having its own ditch. The farmer near the head end of a ditch usually receives a disproportionate share of the water.

In project areas such as Shamalan, Marja, Nadi-Ali and Darweshan, generous amounts of water have been made available from main project canals, undersized, inadequate ditches and with the land which is not leveled for efficient application of water. Coupled with this is the need for a continuous flow for domestic use and livestock. Farmers do not generally have much knowledge of the efficient use of irrigation water for crops. The result is that farmers along project canals are using excessive amounts, which among other things is overloading the drainage systems and aggravating salinity problems.

A comparison of water diverted into the Seraj and Darweshan Canals indicates that land along the Seraj Canal is receiving about 5.27 feet of water annually, while land under irrigation from the Darweshan is receiving a diversion of 9.3 feet annually. This compares with an annual diversion of 6.56 feet estimated as being adequate for full development. Land along the Boghra Canal probably uses even more water than in the Darweshan area. There are no data on how much water is returned to the river.

Thus, efficient water use is a large factor in determining the area and ultimate benefits that can accrue from the use of Kajakai water, not to mention losses directly attributable to water logging, salinity, and the increased cost of providing drainage.

Efficient water use is not technically difficult. However, to achieve this efficiency, the irrigation system and land preparation have first to be designed and constructed properly so that adequate water is brought to each farm. Secondly, the farmer must be trained in the proper use of his irrigation system and given the incentive to apply the water efficiently and with respect for other users. In many places, domestic water storage systems or wells would help in alleviating the need for a continuously flowing canal system for domestic use. These problems, simple though they may seem, are in fact difficult and expensive to solve. Providing distribution systems, as is being done for the Shamalan Unit at a cost of over $10,000,000 is a satisfactory solution where the organization exists to undertake such projects. In Non-Project Areas, the pattern of land use, canal system and water rights will require considerable change to permit greater efficiency.

The education of the local farmers in farm practices and the use of new types of seed and fertilizers is progressing, however. Farm income in some cases has shown a marked increase with the adoption of these measures, and it is possible that the demand for fertilizers may soon exceed the available supply.

D.3 IMPROVEMENTS TO CANALS AND HEADINGS

Basic factors in evaluating the feasibility of installing spillway gates were their potential for eliminating damage to canals and headings and their ability to improve the water supply to these headings. The possibility of making improvements to these canals and headings, either as a result of possible improvements from the gated operation or as an alternative to gates was considered. Such improvements could only be applied to the non-project canals, since project canal intakes have been designed to account for discharge variations in the river. A description of these canals may be found in Appendix B.

The non-project canals, 49 of which are listed in Table B-3, are traditional canals and have generally been adapted to meet farm requirements according to the nature of the terrain and river conditions. The most satisfactory solution, but one requiring a large investment, would be to incorporate groups of these canals in a project served by a single, properly designed intake and main canal.

In trying to improve present methods, the peculiarities of each canal would have to be considered. The degree of flood control provided by the spillway gates is illustrated by Tables A-5, -6, -14, and -15. For example, reference to Table A-5 shows that if an intake was required to pass the fifth largest peak, it would be designed for 40,000 cfs without spillway gates and for 28,000 cfs with gates. The corresponding values for the tenth largest peak would be 32,000 cfs and 21,000 cfs. While some improvement in discharge is evident, it does not appear enough to warrant large expenditures by farmers to make only marginal improvements to their headings and intakes or to permit adoption of a different form of small diversion dam. This is particularly so when recalling that changes in the location of the riverbed could still occur, thereby destroying the effectiveness of a more permanent type of improvement. Consequently any improvement, except perhaps for favorable specific cases, would have to be a low cost alternative to the temporary brush dams. Unfortunately, the area has little in the way of construction materials: stone, timber and, of course, steel are practically unavailable. While such solutions as the use of fascines, individual piles to support removable flash boards, or simple check structures near the headings might be considered, a more detailed study than can presently be given is required. Therefore, such improvements cannot be seen as an alternative to deriving potential benefits of river control by the addition of spillway gates. Neither will they become possible because of the addition of the gates. With the increase in controlled releases during the irrigation season after gate installation, it is possible that some minor improvements could be made in canal heading locations. This, however, could only be determined on an individual canal basis.

IRRIGATION WATER DEMAND

(demand and requirements shown in 1,000 ac-ft;
unit water requirements are in ac-ft per acre)

Area Irrigated	Area/Acres	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
NIT WATER REQUIREMENTS														
Project and Upper Areas		0.061	0.200	0.357	0.656	0.963	0.793	0.969	0.736	0.715	0.725	0.302	0.087	6.564
Lower Areas		0.138	0.138	0.138	0.433	0.844	1.195	1.145	1.447	0.824	0.618	0.233	0.233	7.386
RRIGATION WATER DEMAND														
resently Irrigated Land*														
• Present Level Demand														
Project Areas	117,000													
Upper Areas	71,000													
Subtotal	188,000	11.5	37.6	61.1	123.3	181.0	149.1	182.1	138.4	134.4	136.3	56.8	16.4	1,234.0
Lower Areas	70,000	9.7	9.7	9.7	30.3	59.0	83.6	80.2	101.2	57.7	43.3	16.3	16.3	517.0
Total Demand	258,000	21.2	47.3	76.8	153.6	240.0	232.7	262.3	239.6	192.1	179.6	73.1	32.7	1,751.0
Total Demand less return flows**	258,000	19.0	41.2	66.3	133.8	210.4	206.8	231.6	214.6	169.5	157.3	63.9	29.5	1,543.8
otentially Irrigable Land*														
• Intermediate Demand														
Project Areas	122,000													
Upper Areas	110,000													
Subtotal	232,000	14.2	46.4	82.8	152.2	223.4	184.0	224.8	170.7	165.9	168.2	70.0	20.2	1,522.8
Lower Area (Garmsel)	42,000	5.8	5.8	5.8	18.2	35.5	50.2	48.1	60.8	34.6	26.0	9.8	9.8	310.4
Lower Area (Chakhansur)	50,000	6.8	6.8	6.8	21.7	42.2	59.8	57.3	72.4	41.2	30.9	11.7	11.7	369.3
Total Demand	312,000	26.8	59.0	95.4	192.1	301.1	294.0	330.2	303.9	241.7	225.1	91.5	41.7	2,202.5
Total Demand less return flows**	312,000	23.8	51.2	82.1	166.6	262.3	258.9	289.[illegible]	269.1	211.6	195.9	79.6	37.2	1,927.6
otentially Irrigable Land*														
• Ultimate Demand														
Project & Upper Areas	232,000	14.2	46.4	82.8	152.2	223.4	184.0	224.8	170.7	165.9	168.2	70.0	20.2	1,522.8
Lower Areas	167,000	23.1	23.1	23.1	72.3	141.0	199.5	191.2	241.6	137.6	103.2	38.9	38.9	1,233.5
Total Demand	399,000	37.3	69.5	105.9	224.5	364.4	383.5	416.0	412.3	303.5	271.4	108.9	59.1	2,756.3
Total Demand less return flows**	399,000	33.4	60.7	91.7	196.2	320.3	341.0	357.9	368.6	268.3	238.4	95.6	53.1	2,435.2
ther Water Requirements														
Downstream Water Users		63.9	129.5	134.5	55.5	16.6	35.1	25.2	17.0	4.3	9.3	22.4	42.7	556.0
Non-beneficial Vegetation		4.5	6.5	19.6	39.2	50.2	60.4	64.9	53.8	41.6	35.1	21.6	10.6	408.0
Subtotal		68.4	136.0	154.1	94.7	66.8	95.5	90.1	70.8	45.9	44.4	44.0	53.3	964.0
TOTAL PRESENT DEMAND		87.4	177.2	220.4	228.5	277.2	302.3	321.7	285.4	215.4	201.6	107.9	8..8	2,507.8
TOTAL INTERMEDIATE DEMAND		92.2	187.2	236.2	261.3	329.1	354.4	379.4	339.9	257.5	240.3	123.6	90.5	2,891.6
TOTAL ULTIMATE DEMAND		101.8	196.7	245.8	290.9	387.1	436.5	458.0	439.4	314.2	282.8	139.6	105.	3,399.2

*For details of areas, see Table B-1.
**Return flows taken as 15% of all demand except for Chakhansur area.

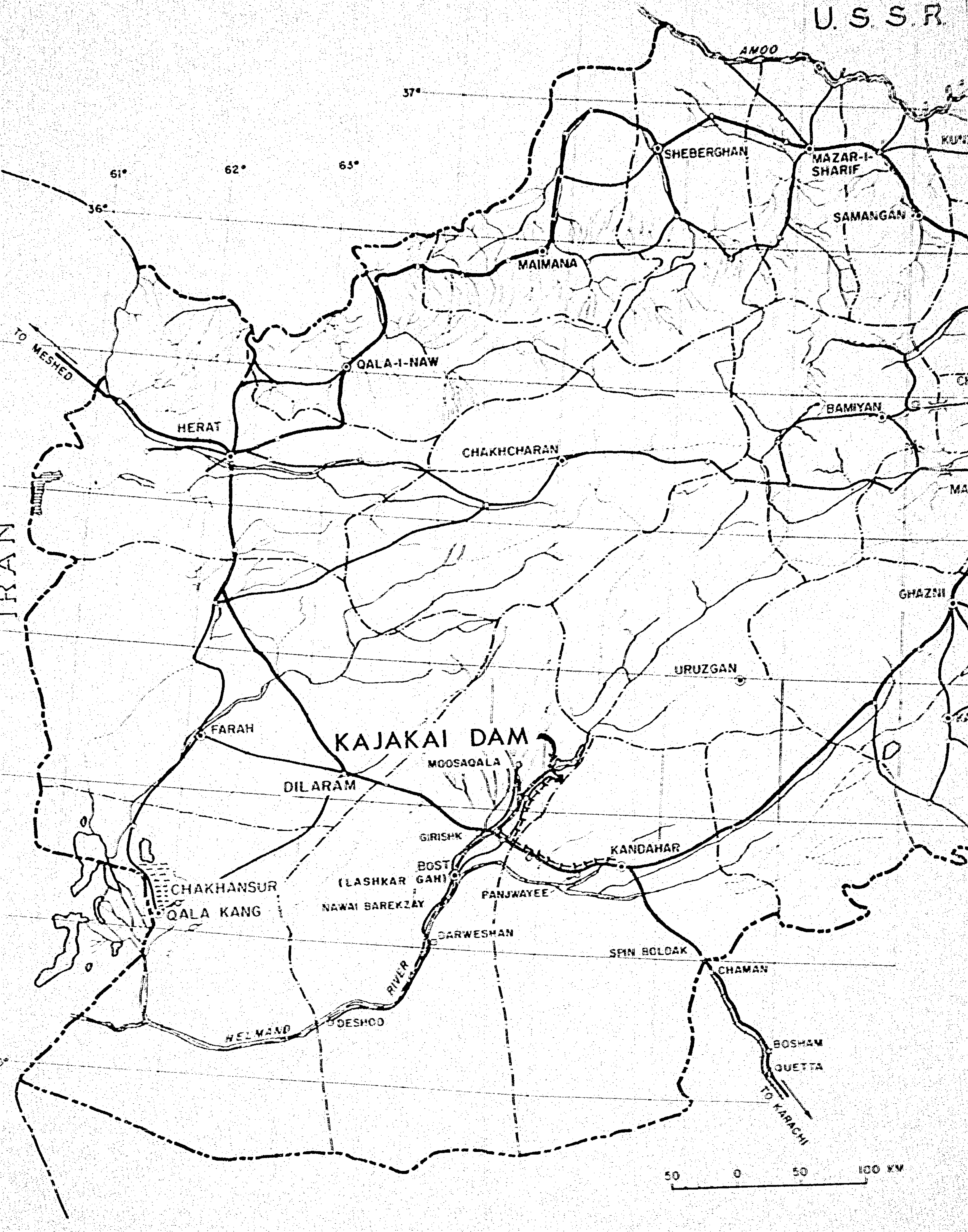
APPENDIX E

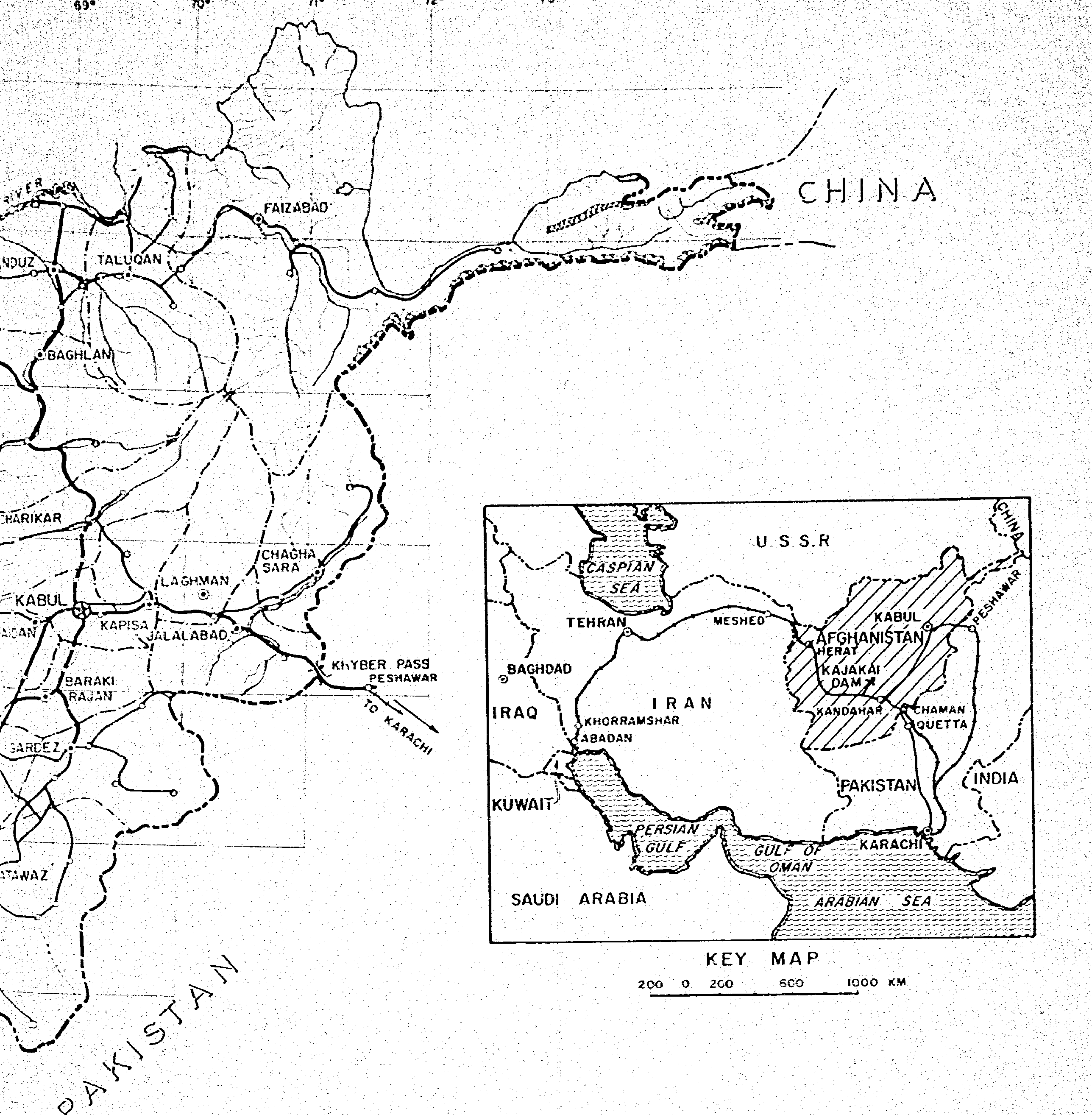
REFERENCES

Number	Title
1	Capital Assistance Paper, Proposal and Recommendations for Review of the Development Loan (Part IV)--Loan Committee, Kajakai Hydroelectric Power Plant, USAID, April, 1967.
2	Computer-Determined Unit Hydrograph from Floods--D.W. Newton and J.W. Vinyard, ASCE Journal of Hydrological Division, September, 1967.
3	Economic Appraisal Study and Power Requirements Study of Kandahar and Girishk Areas for USAID--Thomas M. Hill, July, 1966.
4	Electric Power Survey Report, Helmand and Arghandab Valleys--R.W. Beck and Associates, November, 1964.
5	Final Design Report on Kajakai Dam, Arghandab Dam and Borghra Canal Projects, December, 1959--International Engineering Company, Inc.
6	Helmand Valley Development Program under Second Export-Import Bank Loan; Estimate of Cost (2 vol)--Morrison-Knudsen Afghanistan, Inc., August, 1953.
7	Hydrolographic and Sedimentation Survey of Kajakai Reservoir--U.S. Geological Survey for USAID, December, 1968.
8	Loan Study Report, Kajakai Project--R.W. Beck and Associates, January, 1967.
9	Operation and Water Management Manual--USBR, 1968. (Draft report, not published).
10	Preliminary Plans, Kajakai Hydroelectric Power Plant--International Engineering Company, Inc., May, 1970.
11	Probably Maximum Precipitation--Northwest States, U.S. Weather Bureau Hydrometeorological Report No. 43, November, 1966.

Number	Title
12	Report (in Farsi) by Da Afghanistan Breshna Moassessa, 1970 (1349).
13	Report of the Helmand River Delta Commission, Afghanistan and Iran, February, 1951.
14	Report on Reclamation of Chakhansur Area--International Engineering Company, Inc., December, 1955.
15	Runoff from Snowmelt--U.S. Corps of Engineers Manual EM 1110-2-1406, January, 1960.
16	Seistan. Irrigation Report of the Perso-Afghan Arbitration Commission, 1902-05 (2 vol).
	Seistan. Revenue Report and Notes of the Perso-Afghan Arbitration Commission, 1902-05 (3 vol).
	(The above are frequently referred to as the McMahon Report).
17	Shamalan Unit, Helmand Arghandab Valley Development Project, Afghanistan. Feasibility Report, with Appendixes A and B--by USBR for HAVA and USAID, September, 1968.
18	Soil and Water Resources of Southwest Afghanistan, 1958--International Engineering Company, Inc.
19	Feasibility Study of the Gawargan and Car-Darrah Projects - ADB Report by International Land Development Consultants, Arnhem, The Netherlands (ILACO), January 1971, (2 vol).

EXHIBITS


U.S.S.R.
AMOO
37°
61°
62°
63°
36°
SHEBERGHAN
MAZAR-I-SHARIF
SAMANGAN
MAIMANA
TO MESHED
QALA-I-NAW
BAMIYAN
HERAT
CHAKHCHARAN
IRAN
GHAZNI
URUZGAN
FARAH
KAJAKAI DAM
MOOSAQALA
DILARAM
GIRISHK
BOST
(LASHKAR GAH)
KANDAHAR
CHAKHANSUR
QALA KANG
NAWAI BAREKZAY
PANJWAYEE
DARWESHAN
SPIN BOLDAK
CHAMAN
RIVER
HELMAND
DESHOO
BOSHAM
QUETTA
TO KARACHI
50
0
50
100 KM



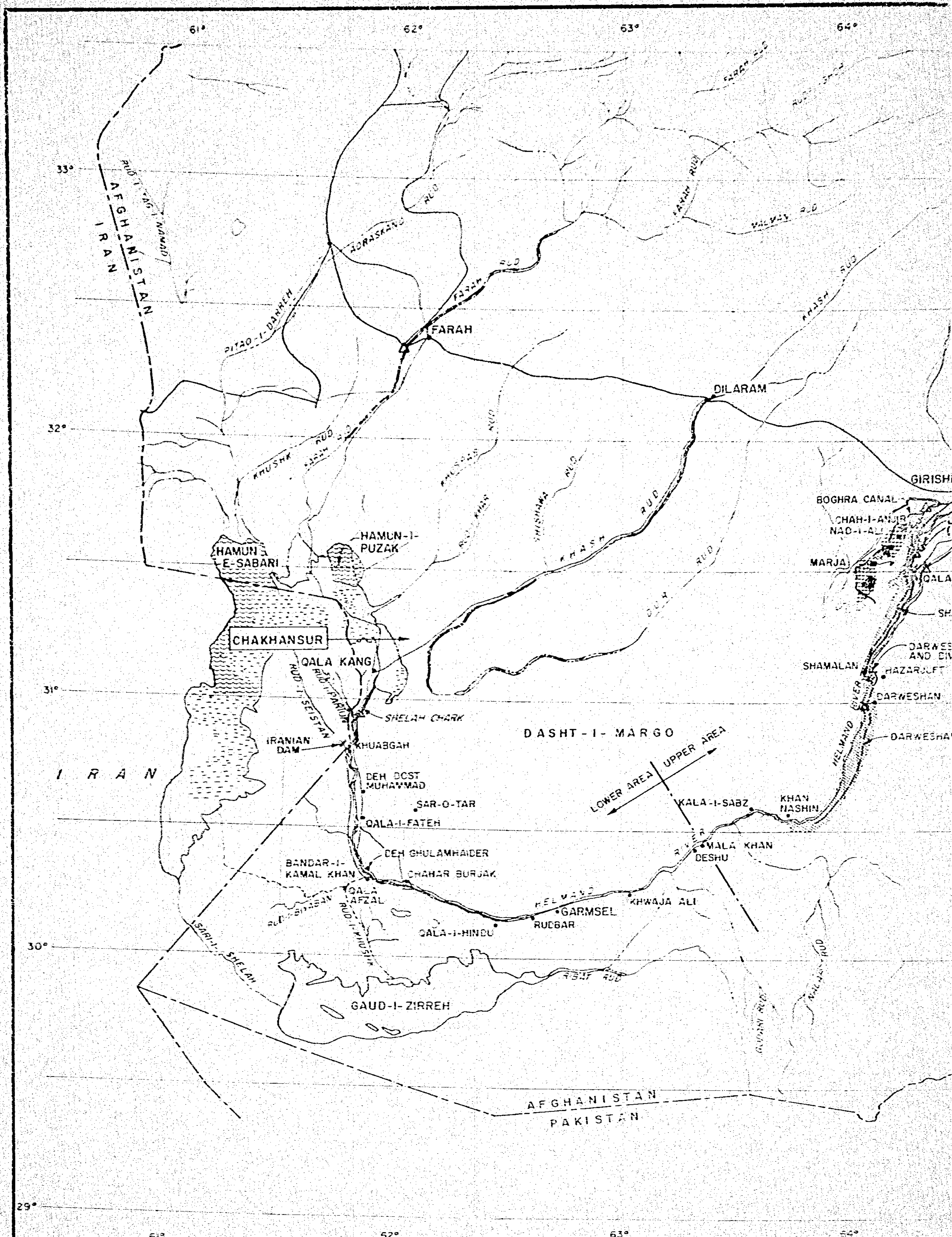
KEY MAP

200 0 200 600 1000 KM.

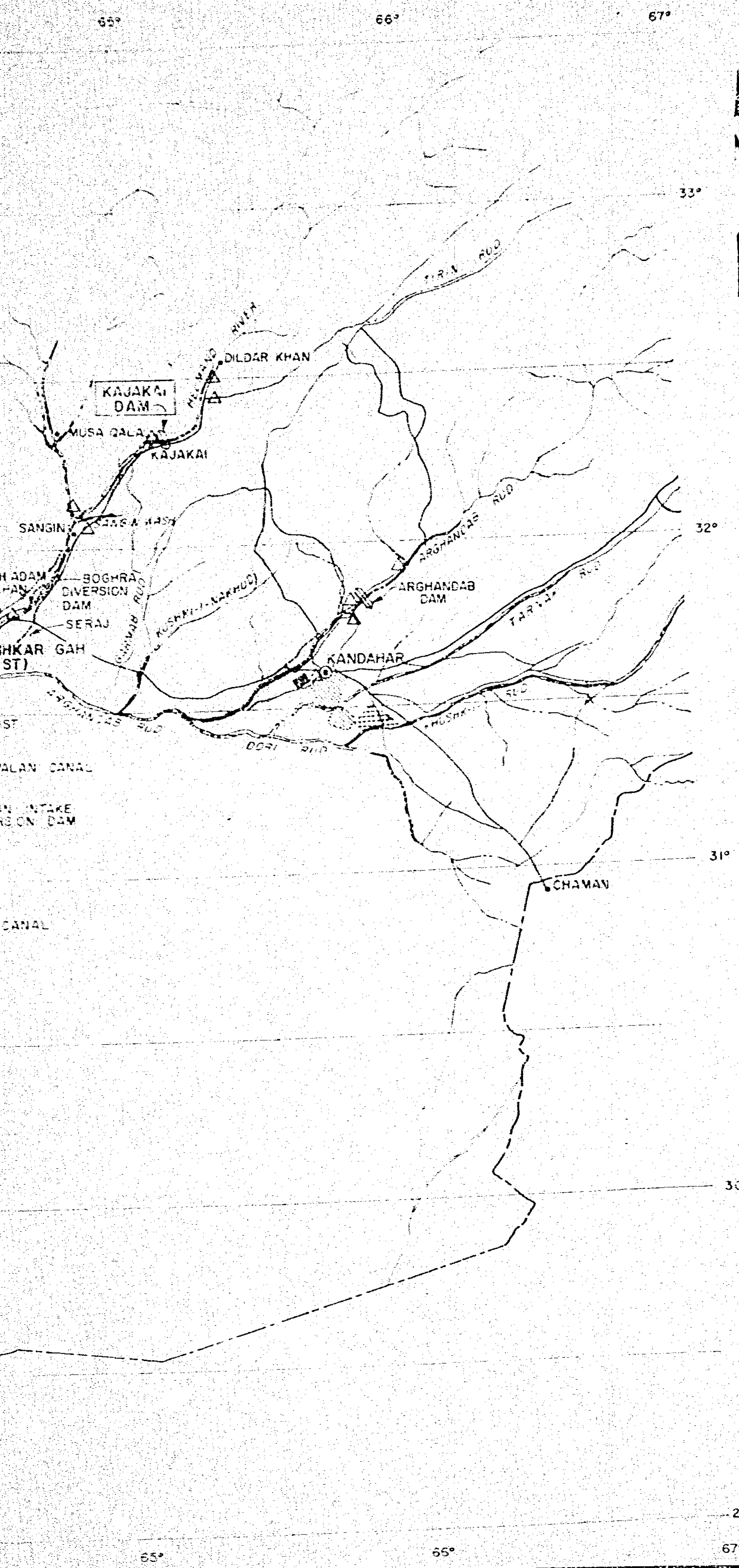
LEGEND:

- PROVINCIAL CAPITALS
- DISTRICT CENTERS
- INTERNATIONAL BOUNDARY (BOUNDARY ARE NOT OFFICIAL)
- PROVINCIAL BOUNDARY
- PRINCIPAL ROAD
- SECONDARY ROAD
- RAILROAD
- RIVER OR STREAM
- SEA OR LAKE
- MOUNTAIN PASS
- SNOW AND ICE
- TRANSMISSION LINE

ASIAN DEVELOPMENT BANK	
KAJAKAI SPILLWAY GATE STUDY	
LOCATION MAPS	
INTERNATIONAL ENGINEERING COMPANY, INC.	
DESIGNED I.E.C.O. DRAWN E.L. CHKD HR INSP.	SUBMITTED [signature] RECOMMENDED [signature] APPROVED [signature]
SAN FRANCISCO, CAL. DATE APRIL, 1971	HA-03-200



61°
62°
63°
64°
33°
32°
31°
30°
29°
AFGHANISTAN
IRAN
FARAH
DILARAM
GIRISHK
BOGHRA CANAL
CHAH-I-ANJIR
NAD-I-ALI
MARJA
HAMUN-I-PUZAK
HAMUN-E-SABARI
CHAKHANSUR
QALA KANG
SHELAH CHARK
IRANIAN DAM
KHUABGAH
DASHT-I-MARGO
DEH DOST MUHAMMAD
SAR-O-TAR
QALA-I-FATEH
DEH GHULAMHAIDER
BANDAR-I-KAMAL KHAN
CHAHAR BURJAK
QALA AFZAL
QALA-I-HINDU
RUDBAR
GARMSEL
KHWAJA ALI
MALA KHAN
DESHU
KALA-I-SABZ
KHAN NASHIN
LOWER AREA
UPPER AREA
SHAMALAN
HAZARJUFT
DARWESHAN
HELMAND RIVER
GAUD-I-ZIRREH
FARAH RUD
KHASH RUD
KHUSPAS RUD
KHUSHK RUD
ADRASKAND RUD
PITAO-I-DARREH
RUD-I-SEISTAN
RUD-I-PARIUN
RUD-I-BIABAN
RUD-I-KHUSHK
SHELAH
RIBAT RUD
NALMAN RUD
PAKISTAN



LEGEND

Lands under HAVA constructed canals completely developed

Lands under HAVA constructed laterals partially drained and leveled

Lands irrigated by old irrigation channels (juis) which obtain water from HAVA-constructed canals. Throughout this area, except central Argnandab, outlet drains exists, bulk by HAVA

Lands under old river diversions (non project areas)

△ Gaging stations for which records are available

"Hamuns", or Lakes

NOTES:

Data on location of irrigated land in Lower Area is not available

Scale 10 0 20 40 60 80 100 KM
1: 1,000,000

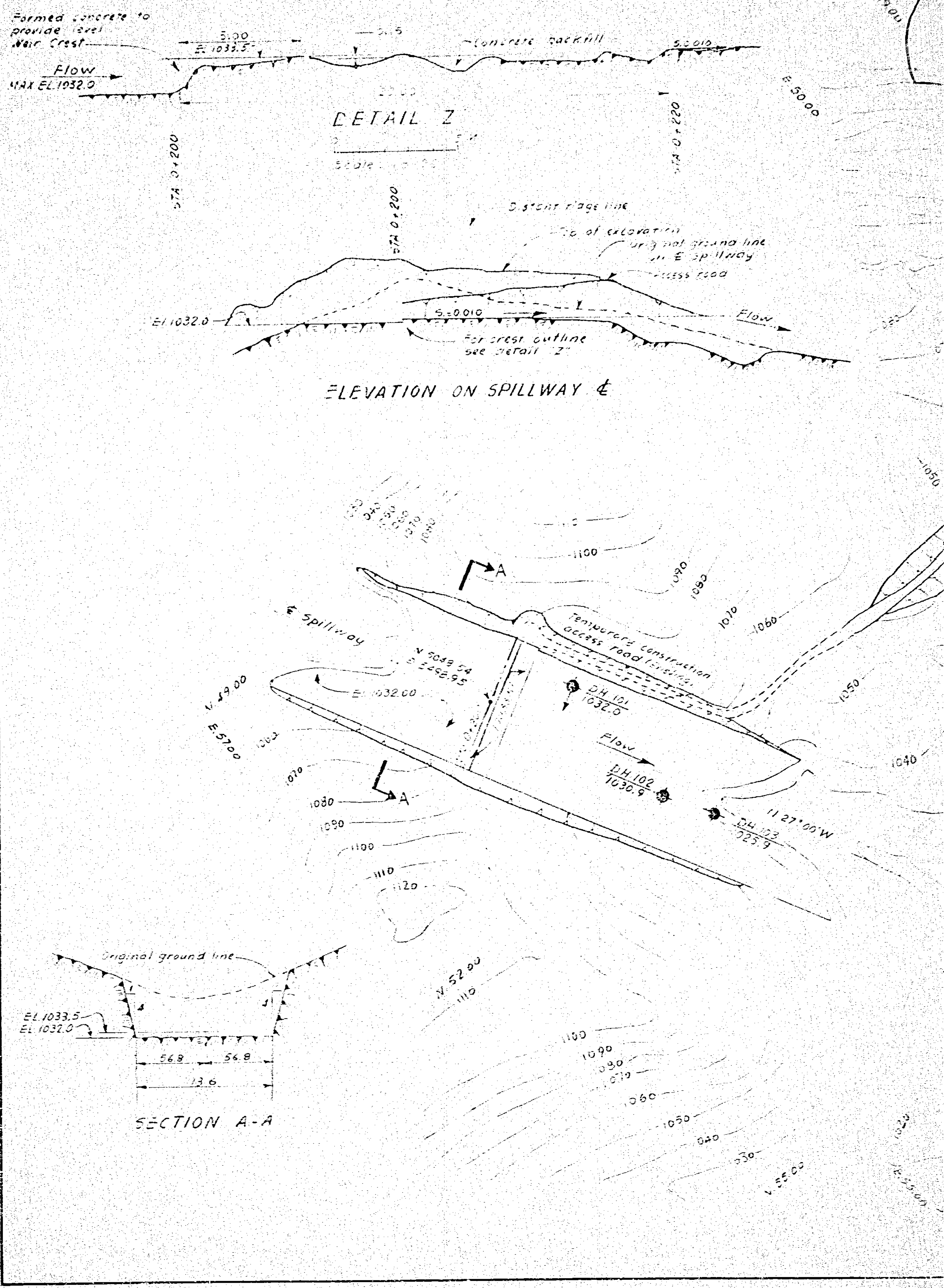
ASIAN DEVELOPMENT BANK

KAJAKAI SPILLWAY GATE STUDY

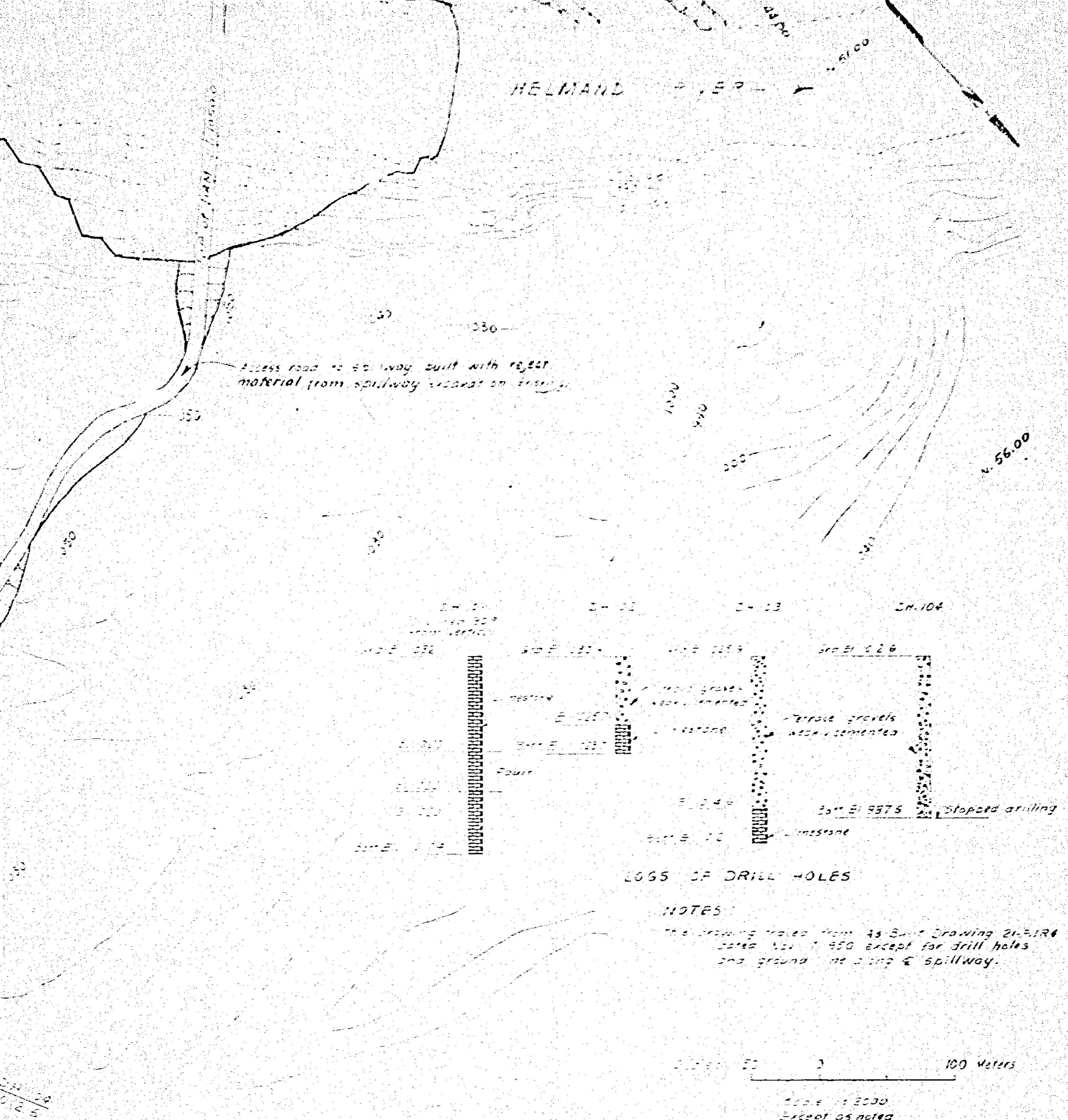
HELMAND VALLEY LOCATION OF PROJECTS

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED ____ DRAWN E.L.	CHKD ____ NBP ____	SUBMITTED ____ RECOMMENDED ____ APPROVED ____
SAN FRANCISCO, CAL. DATE APRIL 1, 1971		HA-03-201



Formed concrete to provide level Weir Crest
Flow
MAX EL.1032.0
EL 1033.5
Concrete backfill
S.0.010
DETAIL Z
STA 0+200
STA 0+220
E 50.00
Distant ridge line
Top of excavation
Original ground line on ℄ Spillway
Access road
EL.1032.0
S.=0.010
Flow
For crest outline see detail "Z"
ELEVATION ON SPILLWAY ℄
℄ Spillway
Temporary construction access road (Existing)
N 5049.54
E 5498.95
EL 1032.00
N 49.00
E 5700
DH 101
1032.0
DH 102
1030.9
DH 103
Flow
N 27°00'W
1100
1090
1080
1070
1060
1050
1040
1110
1120
N 52.00
N 55.00
Original ground line
EL.1033.5
EL.1032.0
56.8
56.8
SECTION A-A



NOTES:
This drawing traced from As-Built Drawing ... except for drill holes and ground line along ℄ spillway.

ASIAN DEVELOPMENT BANK

KAJAKAI SPILLWAY GATE STUDY

EXISTING SPILLWAY
PLAN AND SECTIONS

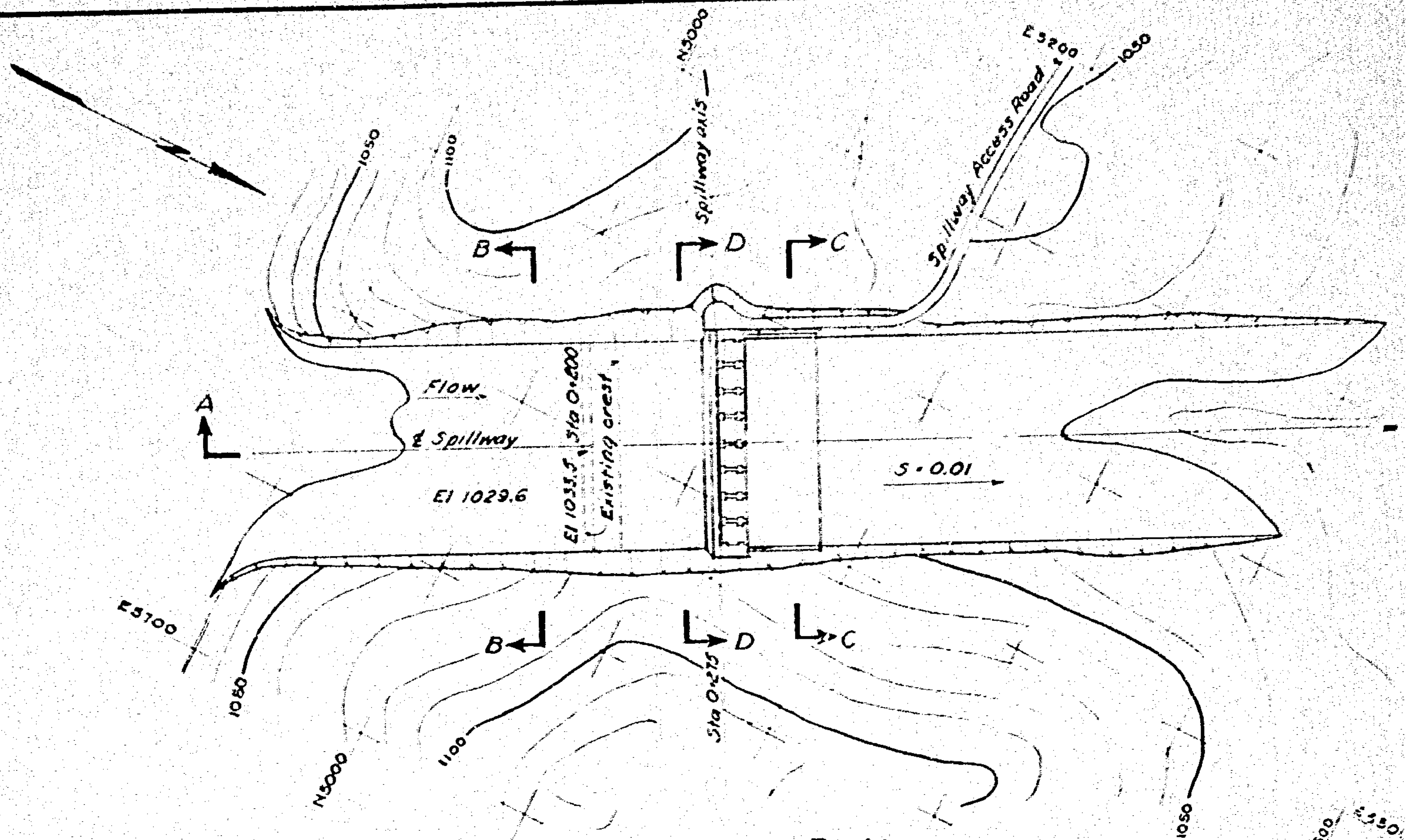
INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED | CHKD | SUBMITTED
DRAWN | NSP | RECOMMENDED
| | APPROVED

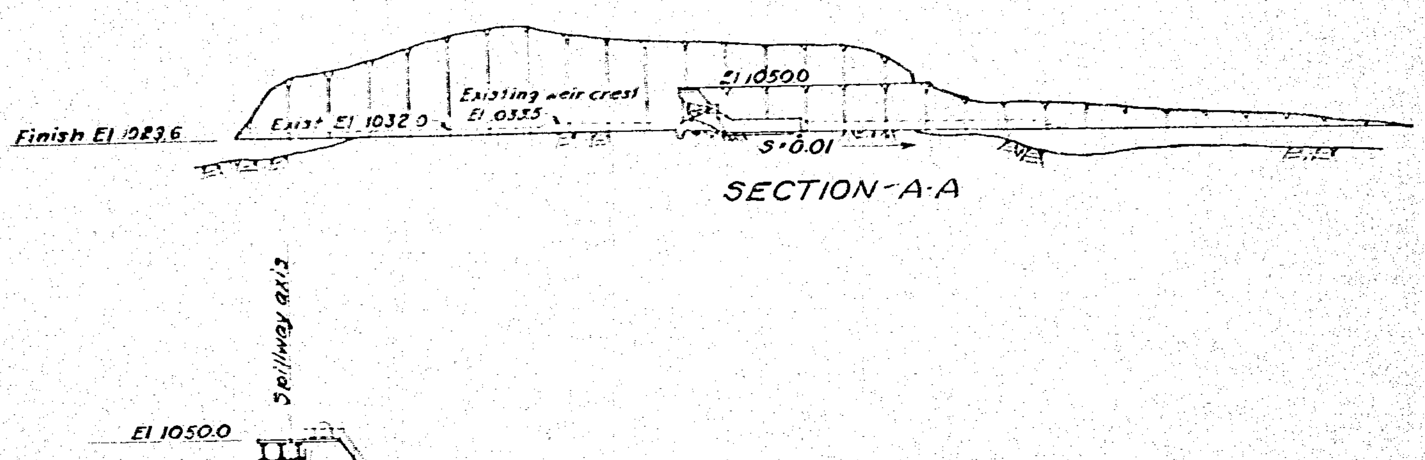
SAN FRANCISCO, CAL.

DATE APRIL 1, 1971

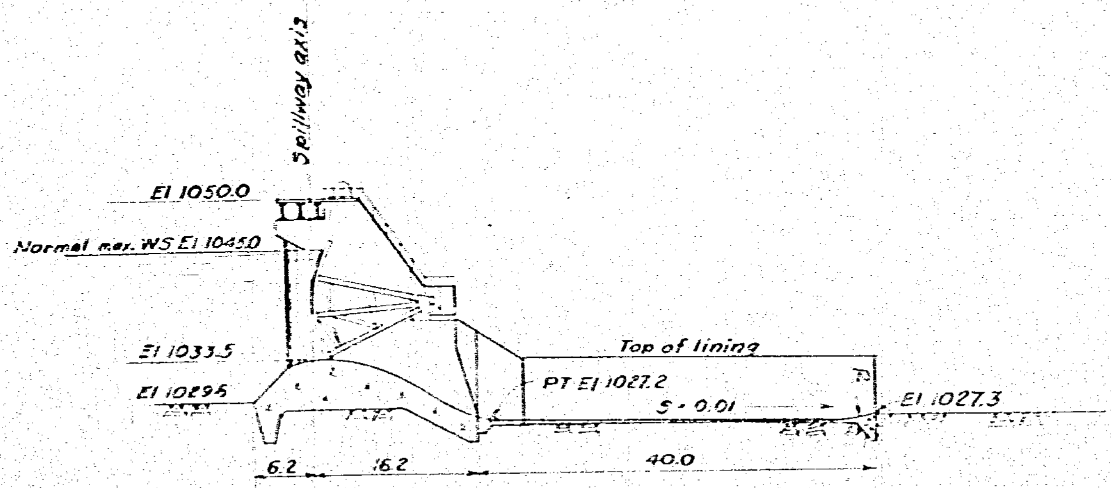
HA-03-205



PLAN

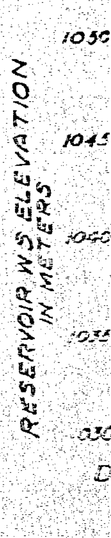


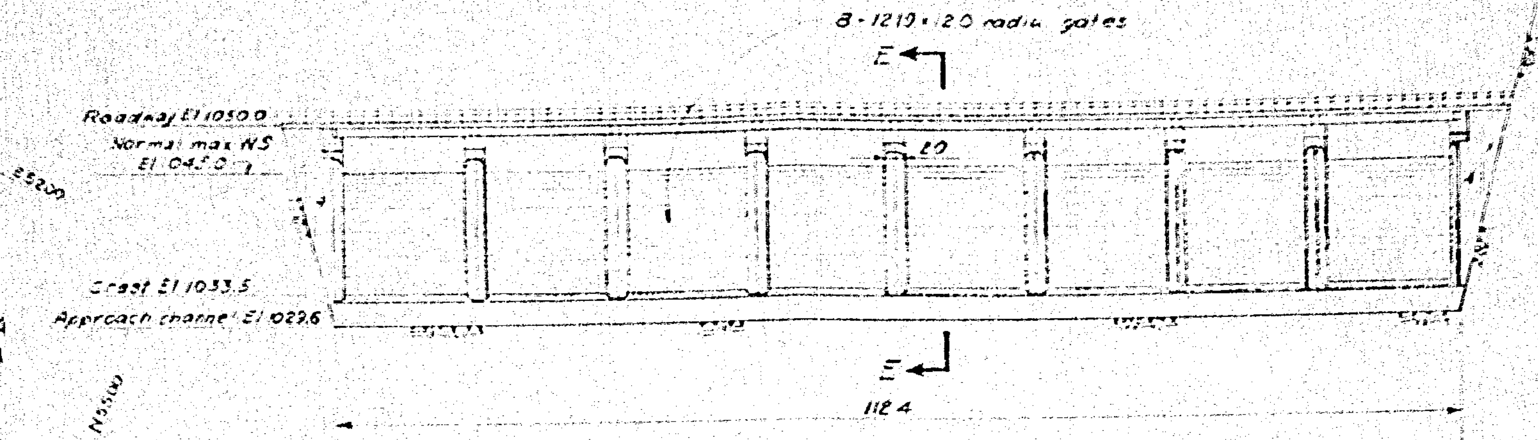
SECTION-A-A



SECTION E-E

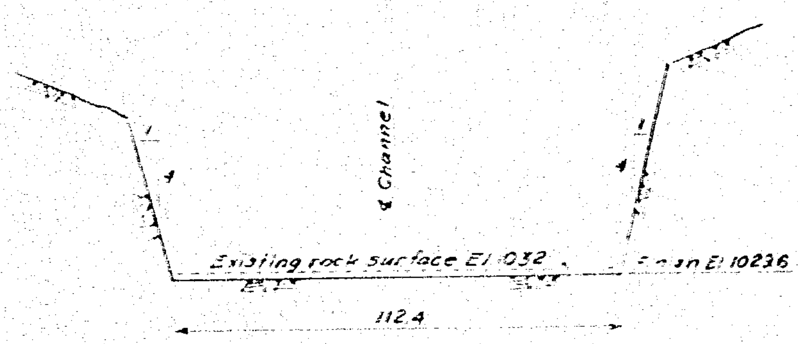
Scale: 0 10 Meters





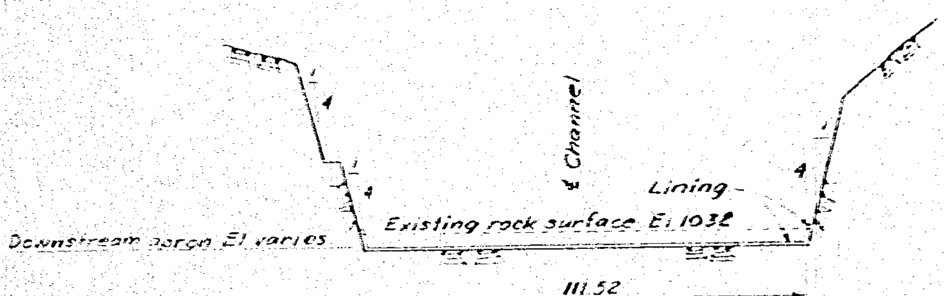
SECTION D-D

Scale 0 10 Meters



SECTION B-B

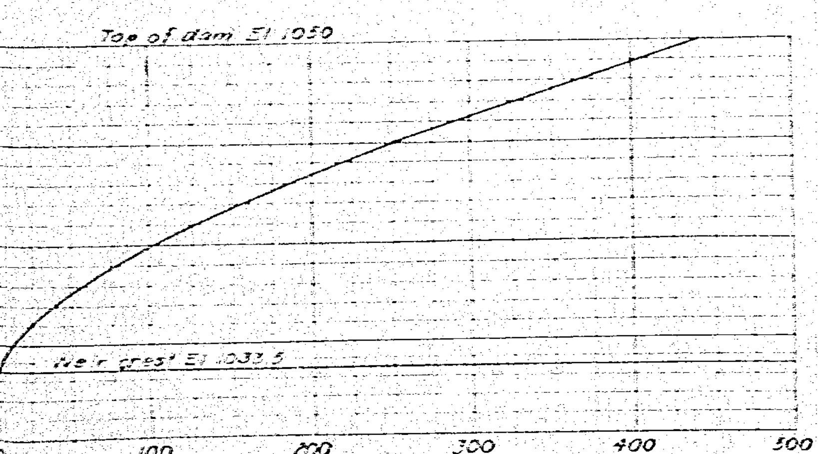
Scale 0 20 Meters



SECTION C-C

Scale 0 20 Meters

NOTES:
1. All dimensions are in meters.
2. Drains and rock anchors are not shown



DISCHARGE IN THOUSANDS OF CUBIC FEET PER SECOND

SPILLWAY DISCHARGE

Scale 0 50 100 Meters
Except as noted

ASIAN DEVELOPMENT BANK

KAJAKAI SPILLWAY GATE STUDY

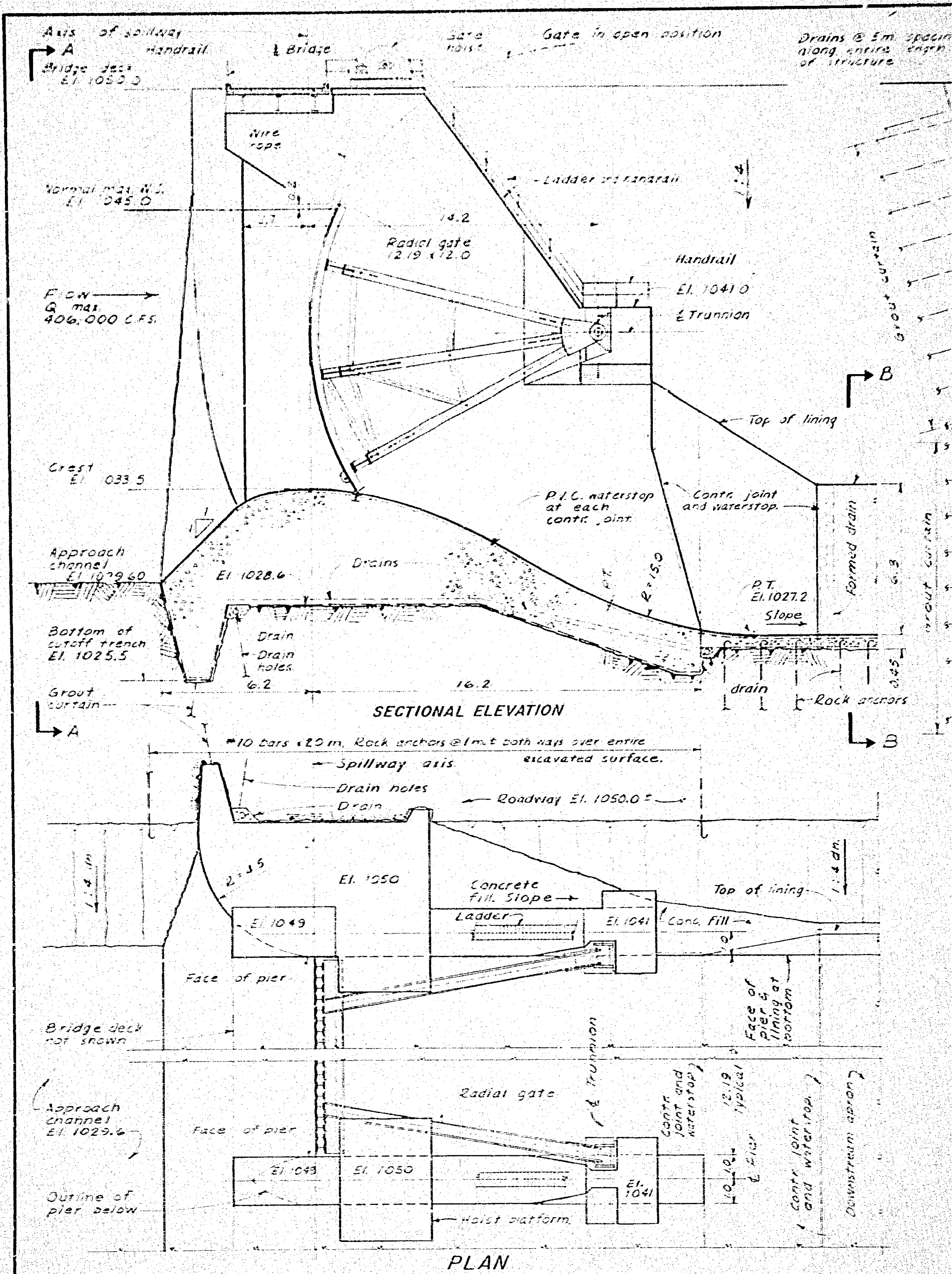
PROPOSED SPILLWAY ARRANGEMENT

INTERNATIONAL ENGINEERING COMPANY, INC.

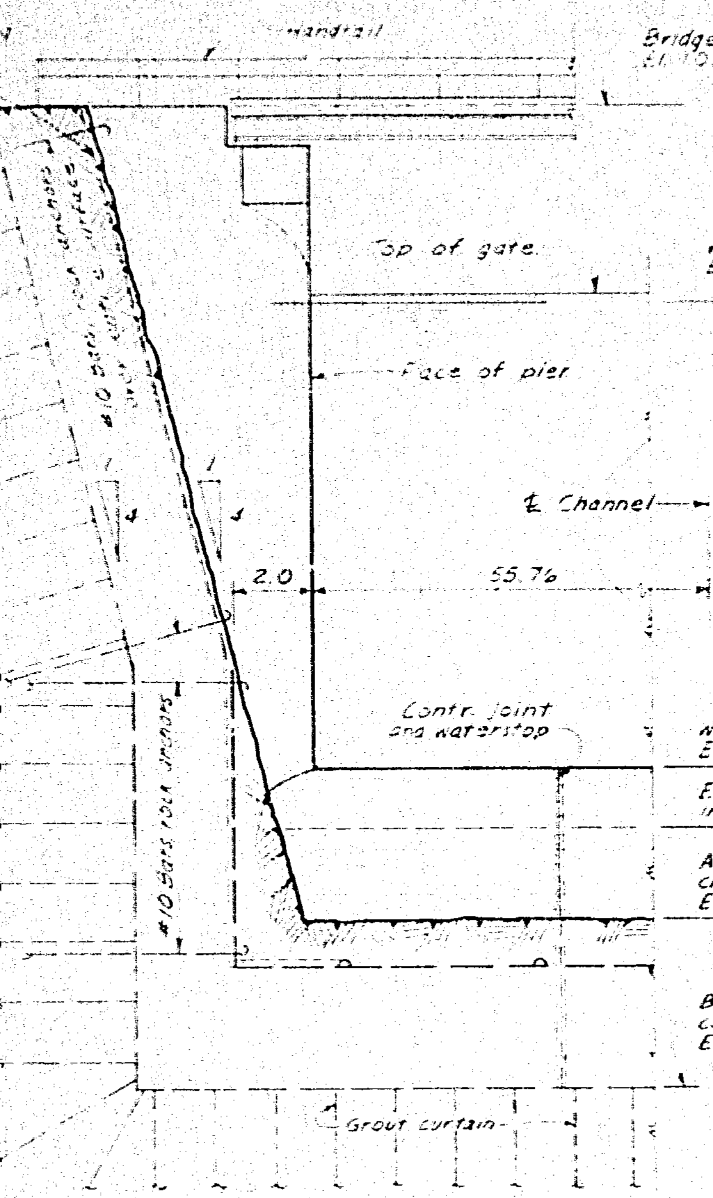
SAN FRANCISCO, CAL

DATE APRIL 1, 1971

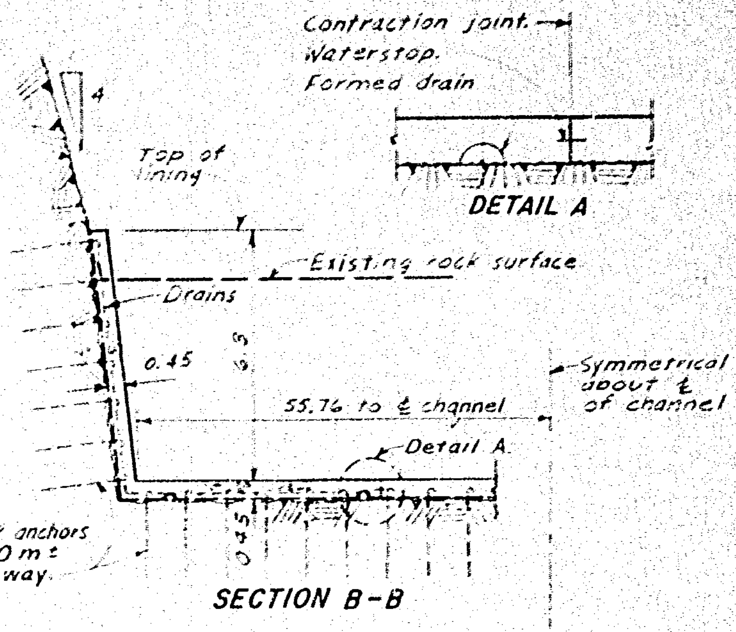
HA-03-206



Axis of spillway
Handrail
℄ Bridge
Gate hoist
Gate in open position
Drains @ 5m spacing along entire length of structure
Bridge deck El. 1050.0
Wire rope
Ladder and handrail
1:1.4
Normal max. W.S. El. 1045.0
14.2
Radial gate 12.19 x 12.0
Handrail
El. 1041.0
℄ Trunnion
Flow
Q max. 406,000 C.F.S.
Grout curtain
Top of lining
Crest El. 1033.5
P.V.C. waterstop at each contr. joint
Contr. joint and waterstop.
Formed drain
Approach channel El. 1029.60
El. 1028.6
Drains
P.T.
R=15.0
P.T. El. 1027.2
Slope
6.3
Bottom of cutoff trench El. 1025.5
Drain
Drain holes
6.2
16.2
drain
0.45
Rock anchors
Grout curtain
SECTIONAL ELEVATION
#10 bars x 2.0 m. Rock anchors @ 1 m ± both ways over entire excavated surface.
Spillway axis
Drain holes
Drain
Roadway El. 1050.0 ±
1:1.4 dn.
El. 1050
Concrete fill. Slope
Top of lining
El. 1049
Ladder
El. 1041
Conc. Fill
Face of pier
Face of pier & lining at bottom
Bridge deck not shown
℄ Trunnion
Radial gate
Contr. joint and waterstop
12.19 typical
Approach channel El. 1029.6
Face of pier
Contr. joint and waterstop
Downstream apron
El. 1049
El. 1050
El. 1041
1.0
1.0
℄ Pier
Outline of pier below
Hoist platform
PLAN



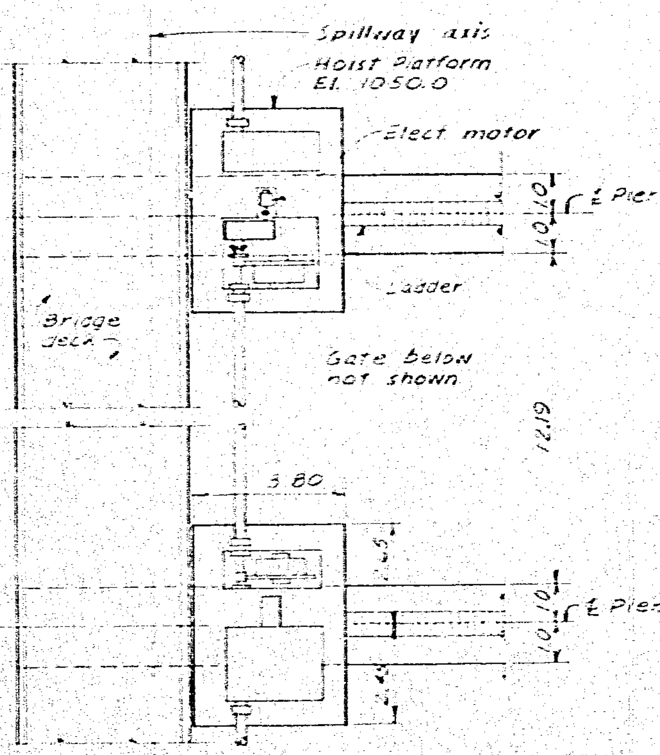
SECTION A-A



DETAIL A

SECTION B-B

All dimensions are in meters.



HOIST ARRANGEMENT
AT ELEVATION 1050

Scale 1:100 (0 to 5 Meters)

ASIAN DEVELOPMENT BANK

KAJAKAI SPILLWAY GATE STUDY

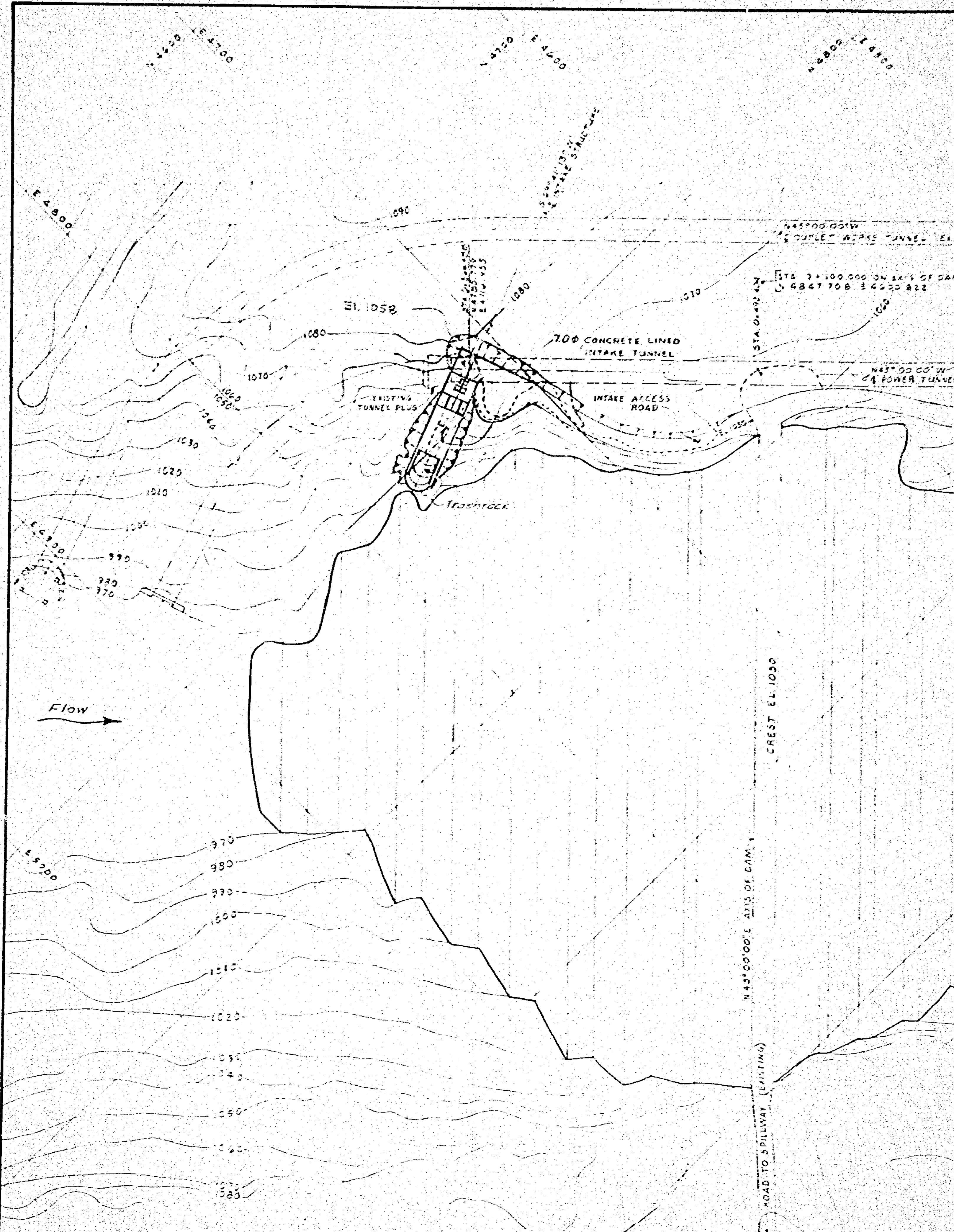
PROPOSED SPILLWAY CREST DETAILS

INTERNATIONAL ENGINEERING COMPANY, INC.

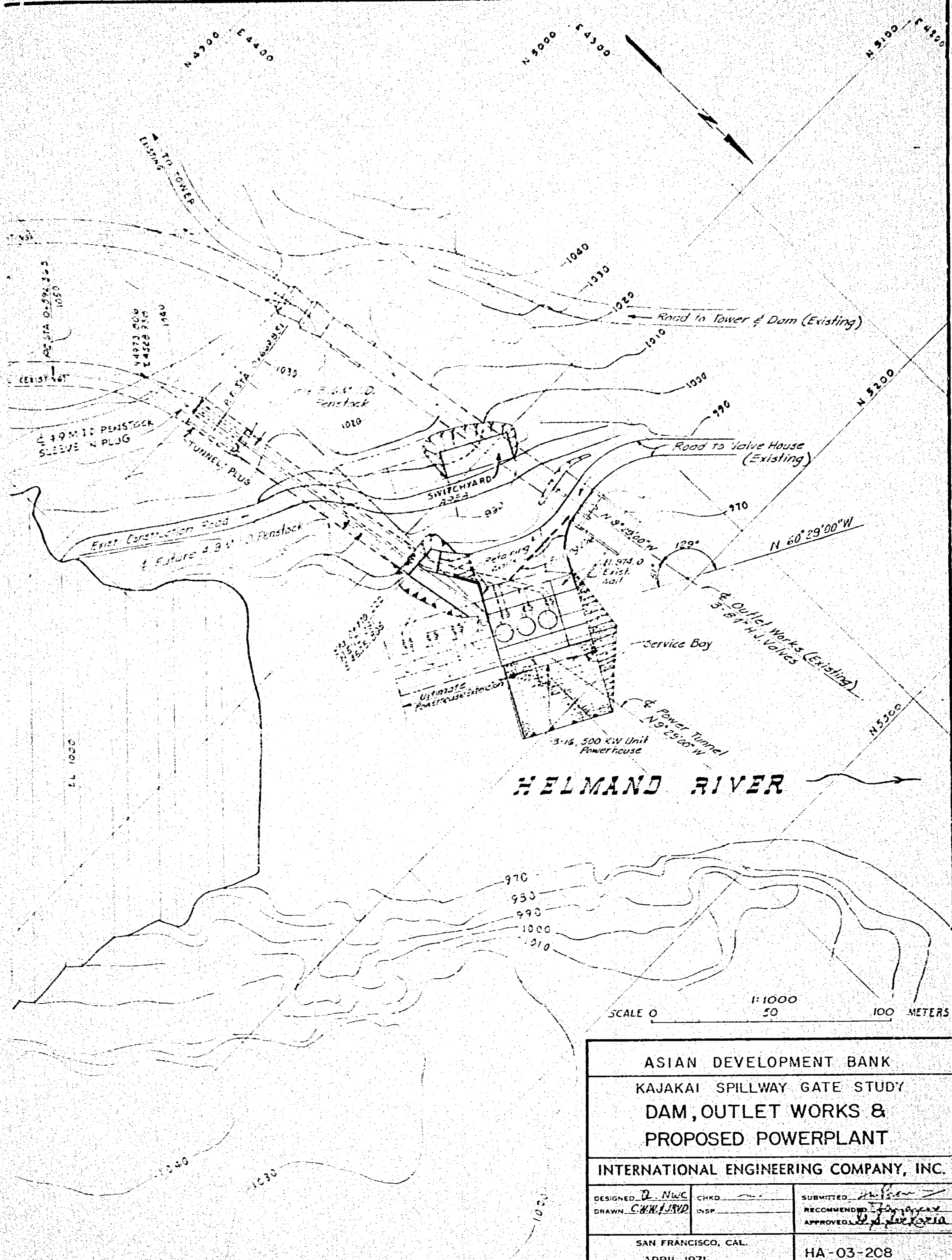
DESIGNED FC — DRAWN REH — CHKD FC — INSP — SUBMITTED — RECOMMENDED — APPROVED

SAN FRANCISCO, CAL.
APRIL 1, 1971

HA-03-207



N 4700 E 4600
N 4800 E 4500
E 4800
EL 1058
1090
1080
1070
1060
1050
1030
1020
1010
990
980
970
7.0Φ CONCRETE LINED INTAKE TUNNEL
INTAKE ACCESS ROAD
EXISTING TUNNEL PLUG
Trashrack
N45°00'00"W
℄ POWER TUNNEL
Flow
E 4900
E 5000
CREST EL 1050
N45°00'00"E AXIS OF DAM
ROAD TO SPILLWAY (EXISTING)
1000
1040



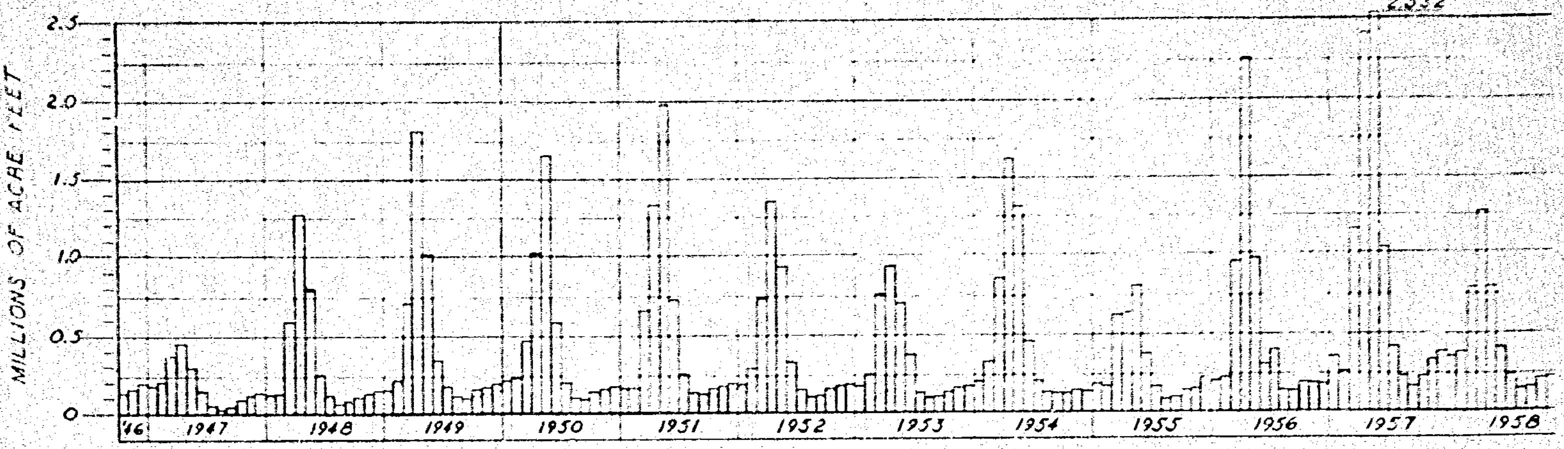
ASIAN DEVELOPMENT BANK

KAJAKAI SPILLWAY GATE STUDY

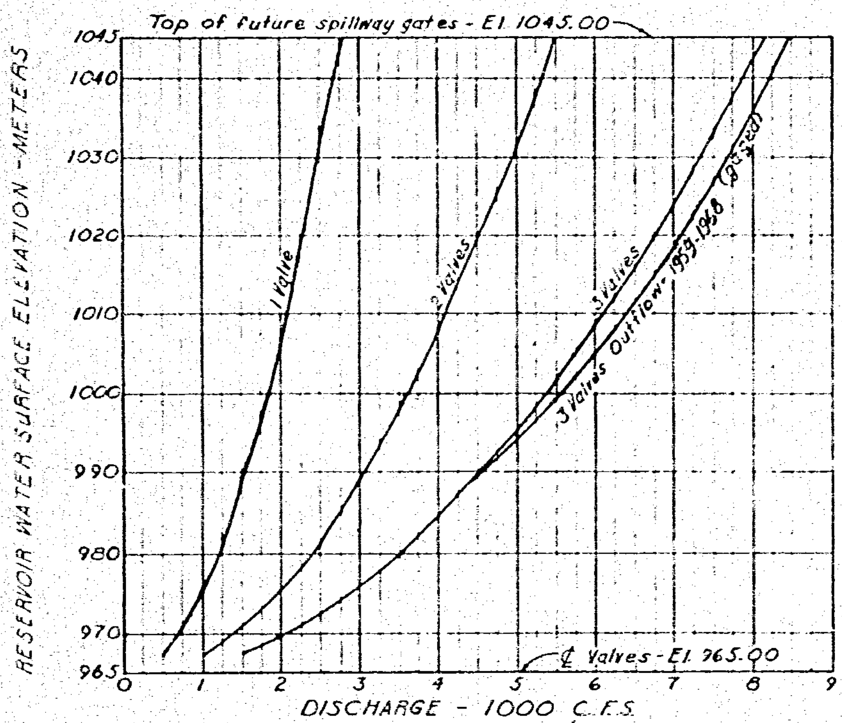
DAM, OUTLET WORKS & PROPOSED POWERPLANT

INTERNATIONAL ENGINEERING COMPANY, INC.

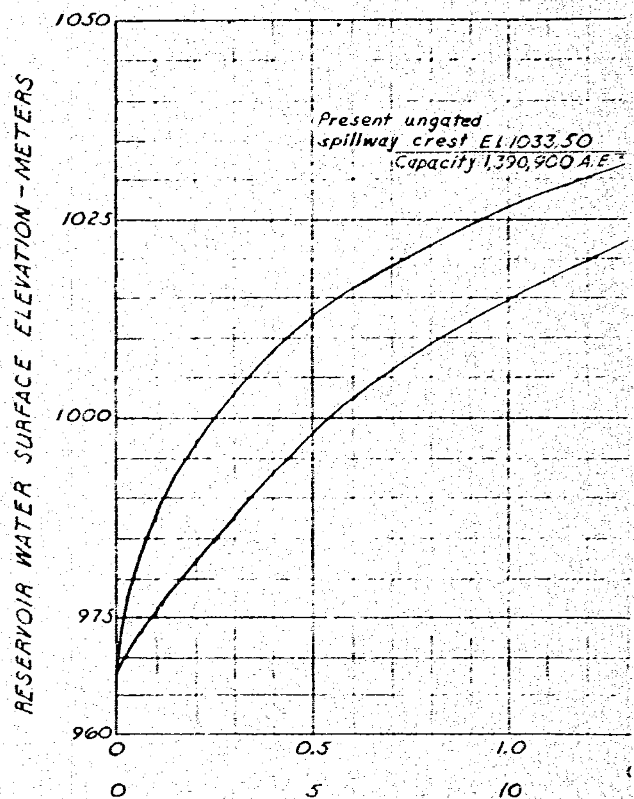
DESIGNED D. NWC DRAWN CWW/JRVD	CHKD INSP	SUBMITTED RECOMMENDED APPROVED
SAN FRANCISCO, CAL. APRIL 1971		HA-03-208



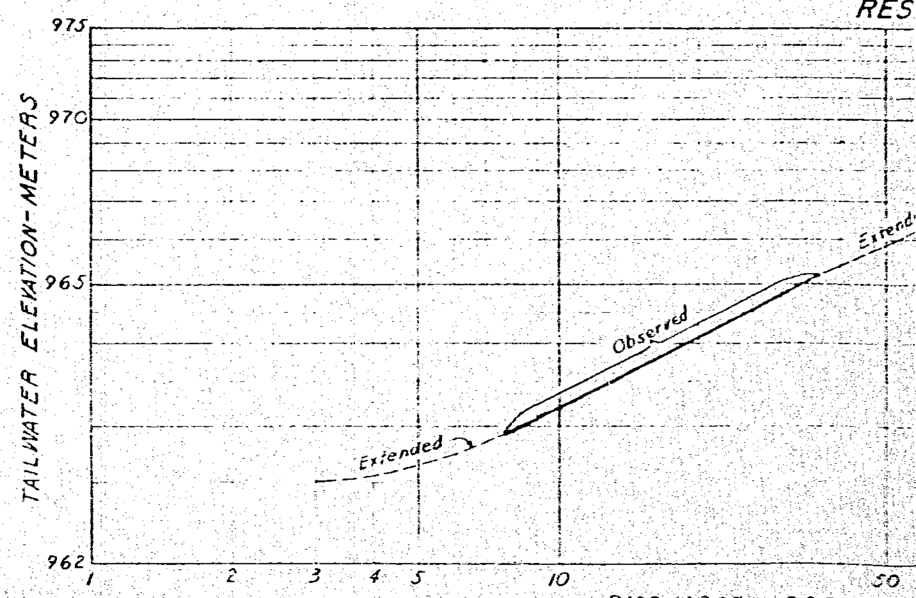
RESERVOIR INFLOW MINUS LOSSES



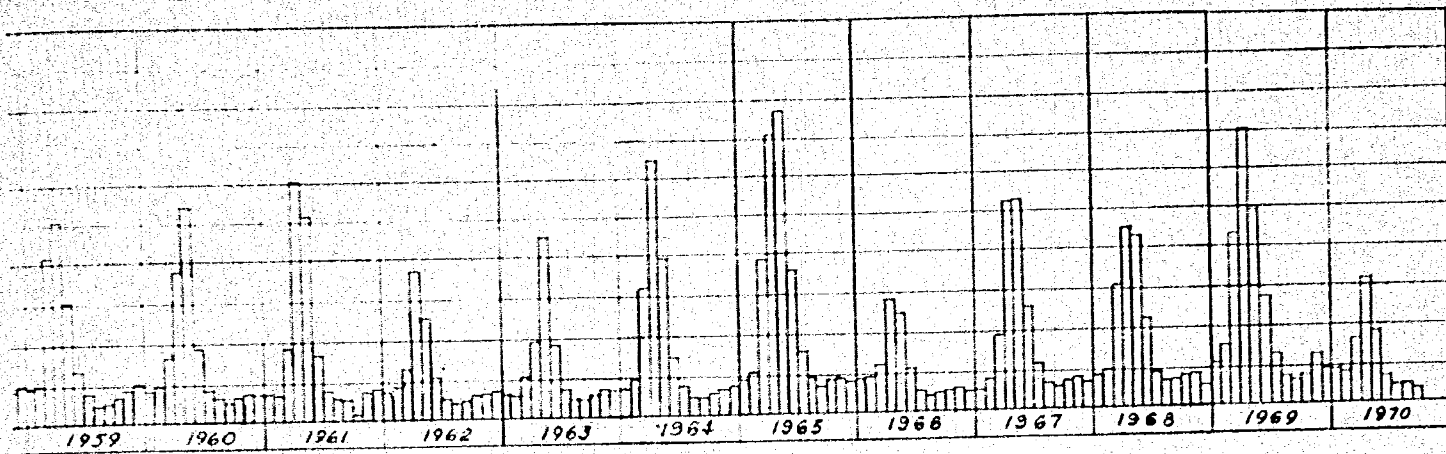
OUTLET DISCHARGE CURVES-
84" HOLLOW JET VALVES

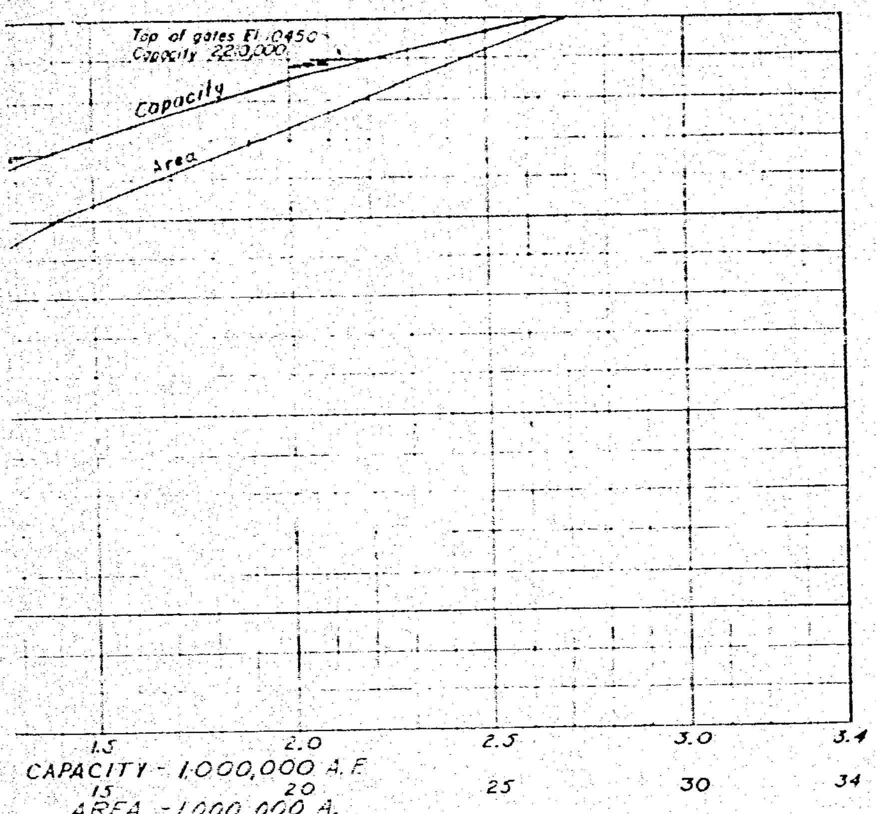


RES

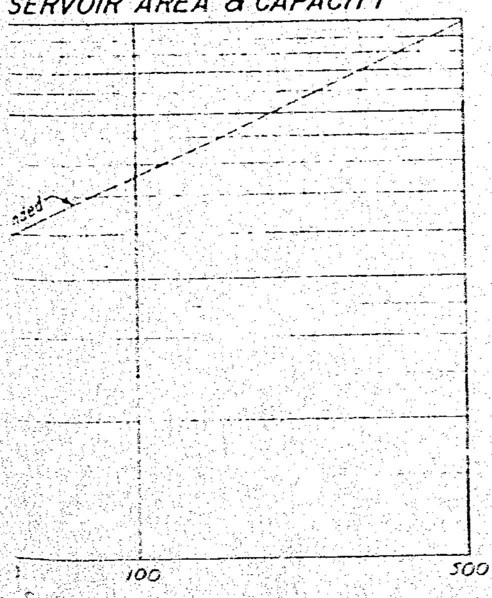


TAILWATER CURVE





SERVOIR AREA & CAPACITY



NOTES:

1. The reservior capacity curve is revised according to data from the 1968 Sedimentation Survey Report for the Kajakai Reservoir by USGS.
2. The outlet discharge capacity curve for 3-84" Hollow Jet Valves has been revised according to reservoir operation records of the Water and Soil Survey Authority of AFGHANISTAN for period of 1959-1968.

ASIAN DEVELOPMENT BANK

KAJAKAI SPILLWAY GATE STUDY

HYDROLOGY

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED IECO DRAWN JRYD	CHKD INSP	SUBMITTED RECOMMENDED APPROVED
SAN FRANCISCO, CAL. DATE APRIL 1, 1971		HA-03-209