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OPTIMIZATION OF RESERVOIR OPERATION FOR PERIYAR - VAIGAI SYSTEM

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PREFACE

Reservoirs are constructed across the rivers to change the spatial and temporal availability of water in accordance with the requirements of mankind. More than 3000 major and medium dams have already been completed and multipurpose reservoir projects are quite common among them. Efficient utilization of the water resources requires that the reservoirs must be operated in the most judicious and scientific manner. Efficient regulation of the reservoirs can lead to increased benefits from the reservoir as well as significant reduction in damage due to floods.

The management of reservoirs on streams is a very challenging problem because it deals with a natural system with all the associated uncertainties. That is why, a tailor-made solution methodology for this problem is not available. Systems approach is being applied to modelling and solving the single or multiple reservoir operation problem. In the present report, the Periyar-Vaigai system, located in the state of Tamil Nadu and Kerala, has been studied. It is an inter-basin transfer system with the two reservoirs, the Periyar and the Vaigai, located in the different states and different catchment areas. The various purposes of the system include irrigation demands of the Periyar and Vaigai reservoirs, water supply demands of the Madurai city and the hydropower development. A simulation model has been developed to simulate the operation of the Periyar and Vaigai reservoirs for 26 years of record and the reliability analysis for the system has been carried out. Based on the behaviour of the system, a few recommendations and conclusions have been drawn. I hope that the recommended procedure will be useful for the operating authorities at the dam site in deciding the release from the dam at any time.

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ABSTRACT

Once the structured facilities like dams, barrages, hydropower plants etc. come into being, the benefits that could be reaped depend to a large extent upon how these facilities are managed. The efficient use of water resources requires not only judicious design but also proper management after construction. Reservoir operation forms a very important part of planning and management of water resources system. Detailed guidelines are formulated for enabling the operator at the dam site to take appropriate management decisions.

In the present report, the Periyar-Vaigai system, located in the state of Tamil Nadu and Kerala, has been studied. The various purposes of the system include irrigation demands of the Periyar reservoir and the Vaigai reservoir, water supply demands of the Madurai city and the hydropower development. It may be mentioned that the power development is only incidental and the releases from the Periyar reservoir are routed through the power plant. A simulation model has been developed to simulate the operation of the Periyar and Vaigai reservoirs. The operation has been simulated for 26 years of record (1962 - 1988) and the reliability analysis for the system has been carried out. Detailed operation table with the recommended policy has also been prepared. As the system is constructed mainly for the irrigation and water supply purposes and the hydropower development is incidental, the aim of the developed policy is to satisfy the priority demands.

It is concluded that the selection of demand pattern is a very important criterion in achieving high reliability of the system. Rule levels have been prescribed for selecting the appropriate cropping pattern in a particular year. Unnecessary spill from the Periyar dam must be avoided and the excess water in this dam must be sent to the Vaigai dam before spilling. The capacity of the tunnel is also a constraint. Detailed guidelines have been prescribed towards the end of this report.

CHAPTER 1
INTRODUCTION

In view of increasing demands, the aim of water resources systems planning is to search for plans which can satisfy the social, ecological and political needs and goals to the extent possible. For developing operation policies of the projects, it is imperative to understand the complex water systems. Mathematical models are constructed to analyze and understand the systems. System analysis has been proved to be a potential tool in the planning and management of the available water resources. It is useful in guiding the decision maker in looking at the potential configurations, sizing the project elements in a new project and improving the operating policies of the existing projects. There are several cases where system analysis techniques have been used to arrive at the operation policies for multipurpose reservoirs and the derived policies have shown to result in an improvement over the historic performance. The integrated operation of a complex system is necessary for efficient management of the limited resources to meet various target demands.

The management of reservoirs on streams is a very challenging problem because it deals with a natural system with all the associated uncertainties. That is why, a tailor-made solution methodology for this problem is not available. Application of the systems approach to modelling and solving the single or multiple reservoir operation problem can be classified into four categories: simulation, optimization, multiobjective analysis and combinations of these techniques. Simulation models are better suited to analyze the performance of past operation of the systems and can be used to evolve optimized releases by running the model repeatedly using different policies. Optimization models are developed with objective function and constraints to get optimized releases at one step. The issue of conflicting objectives is addressed by the multiobjective models. A combination of these techniques is necessary to get the best operation policies.

In the present report, the Periyar-Vaigai system, located in the state of Tamil Nadu and Kerala, has been studied. The various purposes of the system include irrigation demands of the Periyar reservoir and the Vaigai reservoir, water supply demands of the Madurai city and the hydropower development. It may be mentioned that the releases from the Periyar and Vaigai reservoir are routed through the power plants and the power development is only incidental. A simulation model has been developed to simulate the operation of the Periyar and Vaigai reservoirs. The operation has been simulated for 26 years of record (1962 - 1988) and the reliability analysis for the system has been carried out. Based on the behaviour of the system, a few recommendations and conclusions have been drawn.

1.1 SCOPE OF THE REPORT

The scope of this report includes policy development for the Periyar and Vaigai reservoirs. The operation of the system has been modelled to optimize the reservoir operation policies for meeting the target demands to the best possible extent. Detailed operation table with the recommended policy has also been prepared. As the system is constructed mainly for the irrigation and water supply purposes and the hydropower development is incidental, the aim of the developed policy is to satisfy the priority demands. However, the amount of generated hydropower has been calculated and presented in the operation simulation tables also.

A brief description of the system has been presented in Chapter 2. The procedure for developing the policy, the details of the model developed and the recommended procedure for the operation of system have been presented in Chapter 3. The conclusions drawn from the study and the recommendations are given in Chapter 4. The data used for the study and the recommended rule curves have been presented in tabular and graphical form. The detailed operation simulation tables for both the reservoirs have also been presented.

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CHAPTER 2
DESCRIPTION OF THE STUDY AREA

2.1 GENERAL DESCRIPTION OF THE SYSTEM

The Periyar-Vaigai system is one of the oldest irrigation systems in India. It is a trans-basin scheme which came into existence towards the end of the nineteenth century. The system consists of two reservoirs namely, the Periyar reservoir on the Periyar river in the Kerala state, the Vaigai reservoir on the Vaigai river in the state of Tamil Nadu, and the irrigation command areas in the Vaigai basin. The Periyar river, which originates on the western slope of the Western Ghats, flows westwards and discharges into the Arabian sea. The Vaigai river, which originates on the eastern slope of the Western Ghats, flows east and discharges into the Bay of Bengal. The index map of the system is shown in Figure - 1.

The system is benefitted from both the South-West monsoon and the North-East monsoon. The Periyar river catchment receives rainfall during the South-West monsoon. The Vaigai river catchment and the command area receive rainfall during the North-East monsoon. The natural flows in the Vaigai basin (east of the Western Ghats) were fully utilized towards the end of the nineteenth century and water shortage was experienced in the basin. This led to the construction of Periyar reservoir and the Periyar-Vaigai trans-basin scheme which made it possible to divert the waters from the Periyar basin in the state of Kerala to the Vaigai basin in the state of Tamil Nadu for supplementing the irrigation in the command area of the system.

The irrigation command area of the Periyar-Vaigai system covers parts of the Madurai and Ramanathapuram districts of Tamil Nadu and is located on the plains between the Western Ghats and the Bay of Bengal. It covers a gross area of 1,30,000 ha of which 73,396 ha is cultivable. Madurai, the second largest city in Tamil Nadu with a population of 8,17,562 (1981), is located on the fringe of the project area. The major hydraulic structures of the system are briefly explained in the following.

2.2 MAJOR WATER RESOURCES PROJECTS IN THE SYSTEM

There are three main hydraulic structures in the Periyar-Vaigai system. The most important among them is the Periyar reservoir which is located in the state of Kerala and satisfies most of the demands of the system. Deficiency or poor management of water in this reservoir directly affects the performance of the system. The releases from the Periyar reservoir are picked up at the Vaigai reservoir which is a balancing reservoir. Upstream of Vaigai reservoir, the releases from the Periyar reservoir are required to satisfy the irrigation

demands of the Cumbum valley. Peranai regulator is located downstream of the Vaigai dam. The main function of this regulator is to distribute the releases from the Vaigai reservoir in accordance with the downstream demand. Brief description of these structures is as follows:

2.2.1 Periyar Reservoir

Periyar dam is located on the river Periyar in the hilly terrain of the Anai Malai ranges of the Western Ghats in the Kerala state. The latitude and longitude of the dam are 9° 31′ N and 77° 9′ E respectively. It is a gravity type masonry dam which was completed in the year 1898. The catchment area at the dam site is 612 sq. km. The full reservoir level and the minimum drawdown level for the reservoir are at level 872.25 m and 857.62 m respectively. These values are with reference to the mean sea level. The corresponding gross capacities are 443.5 M Cum and 144.3 M Cum respectively. In the present report, the levels have been taken with reference to the bottom of the dam and hence, the FRL is at level 46.33 m (152 ft) and MDDL is at level 32.92 m (108 ft). The MDDL has been taken 4 ft. above the actual MDDL (104 ft) to account for conserving water for the wild life habitat. The evaporation from Periyar reservoir is considered to be negligible.

The release from the Periyar dam is carried through a 1860m long open channel into a 1740 m long tunnel (bored through the hills) with 45.34 cumec capacity. The flow from the tunnel is then routed through the Periyar power house (capacity 140 MW), located near Thekkady. Issuing from the power house, the flow is carried through the Cumbum valley and is let into the Vairavanar river, which is a tributary of the Suraliyar river, which in turn, is a tributary of the Vaigai river.

The spill from the Periyar reservoir is released through the spillway gates in the Periyar river towards the Arabian sea. This spill is picked up at the Iddiky dam which lies downstream of the Periyar dam on the river Periyar in the Kerala state.

2.2.2 Vaigai Reservoir

During early nineteen fifties, it was found that the entire Periyar water was not fully utilized and considerable surplus was going waste into the Arabian sea. In order to utilize the surplus water going through the Vaigai river, Vaigai reservoir was constructed across the Vaigai river at a point just below the confluence of the Suruliyar and the Vaigai rivers. The latitude and longitude of the dam are 10° 3′ N and 77° 35′ E respectively. It is a composite earth and masonry dam which was completed in the year 1958. The catchment area at the dam site is 2253 sq. km. The full reservoir level is at 279.20 m above the mean sea level. The corresponding gross capacity is 193.32 M Cum. The sill of the river sluices is at level

257.56 m. The Vaigai dam is only a balancing reservoir in which the Periyar river water and the Vaigai natural flows are impounded.

The release from the Vaigai dam are picked up at the Peranai regulator which is located 42 km downstream of the dam. At the regulator, the flow is distributed in the command area in accordance with the demand. In the present report, the gross capacity of Vaigai dam at FRL has been taken as 173.95 M Cum. It is assumed that this value is reached after taking the reservoir sedimentation into account. Since the Vaigai reservoir is only a balancing reservoir, no separate policy has been developed for this reservoir. Evaporation loss from this reservoir has been calculated using the pan evaporation data at the dam site.

2.2.3 Peranai Regulator

Peranai regulator was constructed across the river Vaigai in the year 1899. Large irrigation potential has been created in the Nilakkottai, Madurai and Melur talukas by the Periyar Main Canal (PMC) which takes off from the left flank and the Thirumangalam Main Canal (TMC) which takes off from the right flank of the Peranai regulator. Both the canals are contour canals. The PMC has a network of 12 branch canals and 64 distributaries and one extension main canal. The TMC has a network of 5 branch canals and 7 distributaries and one extension main canal.

2.3 CLIMATE OF THE BASIN

The project area has a tropical monsoon climate. The normal annual rainfall of the Periyar reservoir catchment is about 2000 mm. Major portion of the rainfall in this area falls during the South-West monsoon from June to September. The normal annual rainfall for the Vaigai reservoir catchment is about 750 mm. This area receives a major portion of the annual rainfall during the North-East monsoon from October to December. January and February are the months of cold and dry weather while April and May are months of hot and dry weather and the maximum daily temperature sometimes exceeds 40° C. Although the project area experiences two monsoons in a year, the distribution pattern of rainfall is not suitable to grow crops without irrigation. The actual pan evaporation is high, nearly 2400 mm per year. Evaporation rates in the Vaigai catchment in the months from March through August are of the order of 7 to 8 mm per day.

2.4 COMMAND AREA OF THE SYSTEM

Based on the source of water, Periyar-Vaigai system can be essentially sub-divided into two irrigation systems. These are the Periyar irrigation system and the Vaigai irrigation system. An index map of the Vaigai command area is given in Fig. 2. These two systems

are described below.

2.4.1 Periyar Irrigation System

After coming out of the Periyar power house, the releases of the Periyar reservoir and the natural flows of the Vaigai basin flow through the Cumbum valley. The Cumbum valley agriculture areas are irrigated through the channels taking off from 15 anicuts constructed across the rivers Vairavanar and Suruliyar. This command area enjoys the perennial supply of water from the Periyar reservoir in addition to the natural inflows. It consists of two distinctive areas:

a) The old command of 6017 ha, served by 17 channels.

b) New command of 2082 ha, served by recently constructed P.T. Rajan channel.

The old command is designed for two paddy crops (June-February); the first coinciding with the South-West monsoon and the second with North-East monsoon. The new command is designed for single crop during September - March.

2.4.2 Vaigai Irrigation System

The command area of the Vaigai irrigation system lies downstream of the Vaigai reservoir and is in the rain shadow region of the Western Ghats. The total command area of this system is 76,736 ha. Paddy is the principal crop grown in this area. The command area consists of pre-project area of 58,827 ha and extension area of 17,909 ha. The pre-project area and the extension areas are distributed in PMC and TMC. Of the pre-project area, 53,312 ha lies in PMC and 5,515 ha in TMC. In the pre-project command area of PMC, double crops are cultivated in 18,227 ha as per the present practice. In other area, single crop is cultivated. Of the total extension area, 15,567 ha lies under PMC command and 2,342 ha lies under TMC. In the extension area, single rice crop is cultivated. Pre-project area and extension area are together known as the post-project area. The double crop areas lie between the Peranai regulator and the Kallandiri regulator. The single(main) crop areas get distributed in the entire system. As far as normal irrigation supply is concerned, the pre-project areas have priority for irrigation water over the extension areas. The command area of the Vaigai irrigation system is shown in Figure - 2.

In addition, the command area has a number of system tanks which store the runoff from their own catchment areas and the irrigation return flows. There are 251 tanks up to the Kallandiri regulator which is located downstream of the Peranai regulator. The water available in the tanks is used for irrigation. This irrigation system is mainly operated for cultivation of rice crop in the command area. The command area consists of double crop area

and the single crop area on the downstream of the Vaigai reservoir.

2.5 CROPPING PATTERN

Paddy is the principal crop raised in the project area. The farmers use short duration varieties of paddy for the first crop which has a crop period of 105 days commencing from 1st June. For the second crop, medium duration varieties of paddy are used which have a crop period of 135 days commencing from the middle of September to the end of January. In single cropped area, paddy is raised from mid August with a crop period of 120 days. Other crops raised under irrigated area are groundnut (2 to 3 percent), sugarcane and cotton.

In a year of normal rainfall with respect to time and space, water is released for the cultivation of two crops (rice crops) in double crop area and single crop in the rest of the pre-project. The single crop is known as the main crop. Depending on the availability, water is released to raise single rice crop in extension area. If the water available in the system is inadequate to raise two crops in double crop area, water is released for cultivation of single rice crop in the entire pre-project area. The farmers grow rice crop of 105 days duration in the double crop area and of 120 days duration in the main crop area and the extension area.

2.6 VARIOUS DEMANDS OF THE SYSTEM

The various demands of the system include Periyar Irrigation System Demands (Cumbum valley), Vaigai Irrigation system demands (PMC and TMC) and the Madurai water supply demands. The data pertaining to irrigation demands was supplied by the Public Works Department of the state of Tamil Nadu. The proposed annual water supply demand for the Madurai city is 42.48 M Cum (1500 M Cuft). The monthly water release made from Vaigai reservoir for the Madurai city water supply for the period 1985-86 to 1992-93 was available. Average monthly water supply requirement for each month was computed from these data. The ratio of monthly supply to annual supply for each month has been worked out and the proposed supply is distributed to each month in the same ratio as worked out above. The total demands of the system are presented in Table - 6.

In the present report, for releasing water from the Periyar reservoir, highest priority has been given to the Cumbum valley irrigation demands and the Madurai city water supply demands. Next priority has been given for meeting single crop area demands under the Vaigai irrigation. If water is still available, then the double crop requirements and the extension area demands are satisfied. Detailed description regarding the selection of demand pattern in a year is given in Chapter 3.

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CHAPTER - 3
DEVELOPMENT OF OPERATION POLICY

3.1 DATA USED FOR THE STUDY

The reservoir inflow data of sufficient duration are most crucial for a reservoir operation study. Since this study was concerned with operation for conservation demands, monthly inflow data at the two reservoir sites was required. For the Periyar reservoir, the virgin inflows into the reservoir were available for the period 1962 - 1988. For the Vaigai reservoir, the virgin inflows for the corresponding period were not available. However, observed monthly local inflows at the Ammachiapuram gauging site were available for this period. These flows are known as *Vaigai credit* in the local parlance. A number of tributaries join the river Vaigai upstream of the dam. The local inflow from the Vaigai catchment into the Vaigai reservoir has been (somewhat arbitrarily) assumed to be twice of the Vaigai credit. The two inflow series are presented in Table - 1 and Table - 2.

The Elevation-Release_capacity-Tunnel_capacity-Maximum_power_generation table for the Periyar reservoir is given in Table - 3. Since evaporation loss at the Periyar reservoir is negligible, data for the water spread area has not been incorporated in the above table. The Elevation-Area-Capacity table of the Vaigai reservoir has been given in Table - 4. The normal values of monthly evaporation for the Vaigai reservoir are presented in Table - 5. The Elevation - Capacity curves for the Periyar and Vaigai reservoirs have been plotted in Figure - 3 and Figure - 4 respectively. The information about the average monthly irrigation demands from the system was provided by the Public Works Department and the same is given in Table - 6.

3.2 THE SOLUTION STRATEGY ADOPTED

The rule curves based policy has been adopted for the conservation regulation of the Periyar reservoir. Based on the type, nature and priority of demands, two rule curves have been derived for the Periyar reservoir. Since the Vaigai reservoir is a balancing reservoir only, no separate policy was developed for this reservoir. Thus, the main regulation of the system will be carried through the Periyar reservoir only.

The methodology of simulation has been adopted for iteratively arriving at the optimized rule curves. In essence, simulation aims to duplicate the system behaviour under the given hydrologic conditions. Though this approach is not well suited for direct derivation

of operation policy, it is very useful in policy evaluation. In the present study, the system operation was simulated using monthly time interval. The results of simulation runs were used to refine the rule curves so as to achieve the best possible results.

A computer software was developed at NIH for simulating the operation of a multipurpose multireservoir system for conservation purposes (NIH Report No. UM-46). This software was modified so as to meet the special requirements of the Periyar-Vaigai system. The program simulates the monthly operation of this system for conservation regulation. Based on the availability of water in the reservoir and the inflows from the monsoon in initial months, the program selects the suitable cropping pattern for a particular year. For each time step, the program calculates the release to be made for each demand in accordance with the trial policy, spill (if any) and the actual evaporation losses at the prevailing water spread area etc. At the end of simulation, the number of months when the release is less than the demand and thus the monthly time reliability of the reservoir for the trial policy is calculated. In addition, the number of months of marginal and critical failure when the release is less than 75% and 50% of the target demand respectively are also calculated.

A number of iterations have been taken to find out "what is the appropriate proportion of Vaigai irrigation area demands that can be satisfied from the Periyar reservoir without affecting the demands of the Cumbum valley and Madurai city". It is found that 85% of the Vaigai command area demands can be satisfactorily satisfied from the Periyar reservoir. Since the local inflow in the Vaigai reservoir is quite small, lowering this proportion (85%) affects the reliability of the Vaigai command area. An increase in this proportion affects the reliability of the Cumbum valley. Two initial trial rule curves were derived for the Periyar reservoir using the various scenarios of reservoir inflows and level of demands. The upper rule curve is critical for satisfying 85% of the Vaigai irrigation system demands and full Cumbum valley and Madurai water supply demands. The lower rule curve is critical for satisfying full Periyar irrigation system and Madurai water supply demands only.

Monthly reservoir inflows of different probabilities were considered in deriving initial rule curve levels. A statistical analysis of the monthly inflow series for the reservoir was performed. The power transformation approach was used to estimate the monthly inflows to the reservoir corresponding to 50%, 60%, 70%, 75%, 80% and 90% dependabilities. This approach is briefly described here.

3.2.1 Power Transformation Technique

The objective of frequency analysis is to derive from the limited sample data, design events useful in practice. An assumption must be made of a theoretical frequency distribution which fits the population events and the statistical parameters of the distribution must be computed from the sample data. Instead of assuming a known distribution to fit the data, it is better to transform the data to a particular distribution of known characteristics and then analyze the transformed series. Since the properties of a normal distribution are completely defined, it is a common procedure to transform the given data to normal distribution. Power transformation is one of the procedure available for transforming the given data series to near normalization.

The near normal distribution of the given series is obtained using power transformation, the form of which is given as

$$Z_i = (X_i^{\lambda} - 1)/\lambda \qquad \text{for } \lambda \neq 0$$
$$= \ln X_i \qquad \text{for } \lambda \to 0$$

where

X_i is the variate of the original series,

Z_i is the transformed series,

λ is an exponent which near normalizes the series.

The near normalization is considered to be achieved when the coefficient of skewness of the transformed series approaches zero. The exponent λ which near normalizes the data series is obtained by grid search technique. The transformed series is said to be near normally distributed as the coefficient is kurtosis of the transformed series is nearly equal to 3.0 as required for normal distribution. Statistical estimates of the near normalized series are computed for the required return period and it is transformed to the original domain using the following expression

$$X_T = (Z_T \lambda + 1)^{1/\lambda}$$

where X and Z are the peak magnitudes in the original and the transformed domain respectively.

For the Periyar reservoir, the coefficient of skewness for all months comes out to be nearly equal to zero. The value of λ ranges between -0.141 and 0.522. However, for some of the month, the value of Kurtosis were not close to 3.0. The results of this analysis for the Periyar reservoir for 12 months have been presented in Table - 7. It needs to be emphasized that inflows corresponding to different probabilities have been used in arriving at the initial

rule levels only. These levels have been modified based on the results of simulation runs. Hence, the assumptions of the power transformation approach do not affect the final recommended policy.

3.3 DERIVATION OF INITIAL RULE CURVE LEVELS

Since more than 80% of the annual rainfall in India occurs in the four monsoon months from June to September, it is a general tendency to fill up the reservoirs (to the extent possible) during the monsoon months. This stored water can be used to supplement the natural flows to satisfy the various conservation demands for the remaining months of the water year.

The computations for deriving various rule curve levels for the Periyar reservoir were made using the monthly inflow series for different probability levels along with the average monthly demands. Using the monthly dependable inflow series, the water availability was assumed as corresponding to particular monthly inflow series. Computations of end-of-month reservoir levels were made for 12 months after allowing for full target water demands. The evaporation losses are negligible for the Periyar reservoir and the same were ignored in this analysis. The Elevation-Capacity table has been used and intermediate values have been linearly interpolated whenever required.

Since the Periyar-Vaigai system is meant to serve for irrigation and water supply, it has been considered appropriate to decide two rule curves for this reservoir. As the hydropower development is only incidental, no separate rule curve/policy was developed for this purpose. The main use of the upper rule curve is to decide the cropping pattern for the year. It is used to decides whether the double crop in the Vaigai irrigation area should be started or not and whether any crop should be grown in the extension area or not. The lower rule curve is used to decide the amount of water that can be released from the Periyar reservoir for meeting the Vaigai irrigation area demands. It further ensures the availability of water for meeting full Periyar irrigation system demands (Cumbum valley demands) and the Madurai water supply demands.

A) Upper Rule Curve

If levels specified by the upper rule curve are maintained throughout the year in the Periyar reservoir, all the target demands from the reservoir can be met. The upper rule curve levels were calculated assuming that the reservoir level reaches at the dead storage level (32.92 m) at the end of May (end of water year). For computing these levels, 75% reliable inflows and full target demands (85% of Vaigai irrigation system demands with double crop

pattern + full Cumbum valley demands + Madurai water supply demands) from the reservoir were considered. Backward calculations were carried out from the end-of-May using the following formula:

$$Storage_{begin} = Storage_{end} - Inflow + Demand + Evaporation$$

If the reservoir water level is at or above the upper rule curve in different months, it is reasonably likely that all the target demands for the remaining months in the water year can be met in full. If the reservoir level goes below this level, either supply for irrigation will have to be curtailed or the demand pattern needs to be changed so that the actual irrigation demands can be met for as far as possible.

B) Lower Rule Curve

This rule curve is critical for satisfying full Cumbum valley demands and the Madurai water supply demands. If the scarcity of water is so severe that this level cannot be maintained in any month, the Vaigai irrigation system demands will have to be curtailed so that the Cumbum valley demands and the Madurai water supply demands can be maintained for the remaining part of the year. For computing these levels, the inflow data with 90% reliability, full Cumbum valley demands and Madurai water supply demands were used. Backward calculations were carried out in the same way as for the upper rule curve.

Using these initial rule curve levels, a number of simulation runs were taken for the Periyar-Vaigai system. The performance of the system, when operated in accordance with the trial rule curve levels, was evaluated. The operation procedure and the results of this analysis have been detailed in the later sections.

3.4 MONTHLY SYSTEM OPERATION SIMULATION MODEL

A computer software has been developed to simulate the monthly operation of the Periyar-Vaigai system. The program simulates the operation of the system in accordance with the recommended rule curves based operation policy. The monthly local inflow data series, target monthly domestic water supply demand (M Cum), irrigation demands of the Cumbum valley (M Cum) and irrigation demands of the Vaigai irrigation scheme (with double crop, single main crop and extension area crop separately), storage details, hydropower generation details and the normal values of monthly evaporation for the Vaigai reservoir are input to the program. Various initial rule curve levels, derived earlier for the Periyar reservoir, are also input to the program. The program simulates the operation of the system in accordance with the operation policy. Detailed working table for the reservoir operation is also prepared. The following quantities are computed for each month:

1. Initial storage (M Cum) in the reservoir at the start of the month for both the reservoirs.
2. Based on the water availability situation in both the reservoirs, actual demands of the Vaigai irrigation system to be met from the Periyar reservoir and the demand pattern to be followed in the year (whether double crop is to be grown or not, whether extension area be included or not etc.)
3. Actual evaporation losses (M Cum) from the Vaigai reservoir based on the initial and final water spread area. This is calculated iteratively till sufficient accuracy is achieved.
4. Release of water from the reservoir for different purposes like domestic & industrial demand, irrigation demand and any downstream structure demand, based on the policy.
5. The actual amount of power generated (M Kwh), based on the actual release from the reservoir and the average elevation.
6. The spill (M Cum) from the reservoir, if any.
7. End level (m) in the reservoir after each time step.

In addition, some performance ratios are also calculated and if a ratio is less than the desired target, it is appropriately flagged. The ratios and indicator flags are as follows:

1. Total release for irrigation/Total irrigation demand. If this ratio is less than 1.00, "I" appears after the Tot_Rel column indicating that it is a failure month for irrigation. If this ratio is less than 0.75, "M" appears after the Tot_Rel column indicating that it is a marginal failure month for irrigation. If this ratio is less than 0.50, "C" appears after the Tot_Rel column indicating that it is a critical failure month for irrigation.
2. Total Release for water supply/Total domestic water demand. If this ratio is less than 1.00, "W" appears after the Tot_Rel column indicating that it is a water supply failure month.

After completing the simulation, the program calculates the total number of failure months when the supply is less than the total of target demand for all purposes and hence, calculates the monthly time reliability of the reservoir for the trial policy. It also calculates the total number of marginal and critical failure months when the supply is less than 75% and 50% respectively of the demand and hence, the monthly time reliability for marginal and critical failures.

3.4.1 Operation Procedure Followed in the Software

The procedure for the operation of the Periyar-Vaigai system, that is followed in the software is described below:

a) Irrigation return flow from the Cumbum valley to the Vaigai reservoir has been assumed as 15% of the release for the Cumbum valley irrigation demand.

b) The operation is simulated starting from June, 1962. Periyar reservoir is generally operated (except in the months of June, July and August) to meet 85% of the total Vaigai irrigation system demands and full Cumbum valley demands and the Madurai domestic supply demands. The release of water from the Periyar reservoir for Vaigai irrigation system is picked up at the Vaigai reservoir. From this reservoir, it is sent to the Peranai regulator and then distributed in the PMC and TMC areas. Excess water at the Vaigai dam, if any, is spilled in the Bay of Bengal.

c) In the month of June every year, the program checks the water level in both the reservoirs. If the water level in Periyar reservoir is at or above the upper rule level or the storage available in the Vaigai reservoir is more than 150 M Cum, double crop is started in the Vaigai command area. Otherwise, double crop is not started in the month of June.

d) In those years in which double crop could not be started in the month of June, the program checks the water level situation in the month of July. If the water level in Periyar reservoir is above or at the upper rule level or the storage available in the Vaigai reservoir is more than 125 M Cum, double crop is started in the Vaigai command area in the month of July. Otherwise, double crop is not started at all in that year.

e) In those years in which double crop is not grown at all, the program checks the water level situation in the month of August. If the water level in Periyar reservoir is at or above the upper rule level, the main crop is grown in the extension area of PMC and TMC along with the single main crop in the whole of the pre-project area. If the water level is less than the upper rule level, the crop is not grown in the extension area in that year.

f) If the water level in the Periyar reservoir, after satisfying all demands, is more than FRL, spill is made from the reservoir. This spill is not received in the Vaigai reservoir. If a spill is required from the Periyar reservoir, then the situation is first monitored in the Vaigai reservoir. If the water available in the Vaigai reservoir is less than the maximum capacity, the Vaigai reservoir is filled to capacity and the excess water, if any, is then spilled from the Periyar reservoir in the Iddiky dam.

g) Looking at the capacity constraints of the tunnel, if the water level in the Periyar reservoir is at or above the upper rule level in the months of June, July and August,

full Vaigai irrigation demands (instead of 85% of the Vaigai irrigation demands) are met from the Periyar reservoir. Secondly, if the available water in the Vaigai reservoir is less than 15% (100-85 =15) of the Vaigai irrigation demand and the water level in Periyar reservoir is more than the lower rule level, full demands of Vaigai irrigation system are satisfied from the Periyar reservoir.

h) In the months of June, July and August, if the water level in the Periyar reservoir is in between the upper rule level and the lower rule level, it is operated to meet 40% of the demands of the Vaigai irrigation system (instead of 85%) and full Cumbum valley and Madurai water supply demands. However, if the water available in the Vaigai reservoir is less than 60% (100-40=60) of the Vaigai demands, then full Vaigai irrigation area demands are met as long as lower rule level is not reached. In all other months, Periyar reservoir is operated to meet 85% of the demands of Vaigai irrigation area and other demands for that year. The release for demands is made as long as the lower rule curve level is not reached.

i) If the water level in the Periyar reservoir reaches at or below the lower rule curve level, the supply for Vaigai irrigation demands is cut off completely. In this case, supply is made to meet the full Cumbum valley irrigation demands and the Madurai water supply demands only as far as possible. If the storage in the Vaigai reservoir is more than the Madurai water supply demand, then water supply demand is satisfied from the Vaigai reservoir and only Cumbum valley demand is satisfied from the Periyar reservoir.

j) Release from the Periyar reservoir is restricted to the maximum release capacity of the tunnel.

k) For the Periyar dam, the actual power generated has been calculated by interpolating the power generation capacity table for the mean elevation in the month and then ratioing the same in the ratio of the actual release to the maximum release. For the Vaigai dam, power generation has been calculated by multiplying the mean effective head with the actual release.

l) For the Vaigai reservoir, only water accounting was carried out. The release from the Periyar reservoir less the Cumbum valley irrigation demand, is picked up at the Vaigai reservoir and the same is added to the initial storage in the reservoir. The local flow from the Vaigai catchment is also added and thus, the monthly availability of water is calculated. For releasing water from the reservoir, first, the water is sent for the Madurai water supply demand. Based on the initial and final levels in the reservoir, the average water spread area and hence the evaporation loss from the reservoir in that month is calculated. The remaining water is released to satisfy the irrigation demands of the PMC and TMC (based on the selected cropping pattern) to

the extent possible till the reservoir level reaches MDDL. If the water available in the reservoir is in excess of the maximum capacity, the excess water is spilled and the reservoir level is brought back to FRL. Based on the final storage capacity in the reservoir, the end-of-month water level is calculated. The actual evaporation loss has been calculated iteratively.

3.5 RESULTS OF SIMULATION RUNS FOR THE SYSTEM

An exhaustive operation simulation study for the Periyar-Vaigai system was undertaken using the two initial rule curve levels. The results of the simulation analysis were intercompared using the performance indices of the model. The policy was refined using the detailed operation simulation table of the reservoir. The operation policy which best meets the objectives of the system has finally been recommended for adoption. For optimizing the initial rule curve levels (those giving the highest monthly time reliability with the least number of critical failure months), the detailed operation table has been utilized. Initially, the upper rule curve levels were kept unchanged. Based on the observations from the simulated operation table, the rule curve levels for Madurai domestic supply and Cumbum valley demands have been modified as long as the number of failure months could be reduced. After finalizing the lower rule curve levels, the upper rule curve levels have been modified till the improvement in the reliability for the system could be achieved. A number of simulation runs have been taken in the process and the various rule curve levels have been finalized. Simulation runs for the Periyar and Vaigai reservoirs with the recommended policy have been presented in Table - 9 and Table - 10 respectively. The results in respect of this are discussed as follows.

A number of simulation runs were taken with the initial rule curve levels and the refinement was made till the reliability of the system for various demands could be improved. It was observed that decision regarding selecting the demand pattern in a year is very important factor in achieving the reliability of the system. Secondly, the release capacity of the tunnel is a constraint and the water in excess of the demands must be transferred from Periyar to the Vaigai reservoirs in the initial months (June - August) of a water year. The spill from the Periyar dam towards Iddiky dam must be made only after filling the Vaigai reservoir to its capacity.

Based on the recommended policy, the monthly time reliability for Madurai city water supply and full Cumbum valley demands comes out to be 100%. For the Vaigai irrigation system, 100% irrigation demands could not be met in 3 months which happen to fall in the years 1965 and 1977. The reason for failure in these months is that a) South-West monsoon

was weak in the years 1965 and 1977 and b) The conditions of the system in the beginning of the water year indicated that double crop could be grown for that year. Out of these three months, only in one month (February, 1977) supply was less than 75%, but more than 50% of the irrigation demands. In the 26 years of operation, double crop could not be grown in 5 years. As indicated earlier, the decision to grow double crop decision is based on the initial water level conditions in both the reservoirs and the South-West monsoon in the months of June and July. Because of these reasons, double crop could not be grown in the years 1969, 1975, 1982, 1986 and 1987. Out of these 5 years, irrigation water could not be supplied to the extension area in 3 years.

From the operation table, it is observed that the rule curves based decisions have resulted in good management of the system. In most of the failure months, the shortage of water is very less and can be managed. No unnecessary spill was made from the system and full utilization of the available water has been made. Two rule curves have been suggested in the recommended policy. The upper rule curve has been termed as Curve A, and the lower rule curve as Curve B. These have been presented in Table - 8 and plotted in Figure - 5.

3.6 RECOMMENDED OPERATION PROCEDURE FOR THE PERIYAR-VAIGAI SYSTEM

The recommended procedure for conservation operation of the Periyar-Vaigai system using the two rule curves A and B is given in the following. The upper rule curve in the months from June to August is critical for the selection of cropping pattern in the Vaigai irrigation area. The lower rule curve is critical for the Cumbum valley and Madurai water supply demands. The recommended procedure is described as follows:

3.6.1 Selection of Cropping Pattern

a) In the month of June, observe the water levels in the Periyar and Vaigai reservoirs. If the Periyar level is above the rule level A or the storage in Vaigai reservoir is more than 150 M Cum, start the double crop in the Vaigai irrigation system. Otherwise, suspend the double crop till the month of July. Cumbum valley cropping is to be started without regard to the water level in the Periyar reservoir.

b) If the decision to plant double crop could not be taken in the month of June due to shortage of water, again observe the water levels in the Periyar and Vaigai reservoirs in the month of July. If the Periyar level is above the rule level A or the storage in Vaigai reservoir is more than 125 M Cum, start the double crop in the Vaigai

irrigation system. Otherwise, drop the double crop in the Vaigai irrigation area for that water year.

c) If the double crop has been dropped in a year, observe the water levels in the Periyar and Vaigai reservoirs in the month of August. If the Periyar level is above the rule level A, start the crop in the extension area of the Vaigai irrigation system along with the single main crop in the PMC and TMC area. Otherwise, drop the extension area crop and give water for only the single main crop of PMC and TMC area.

3.6.2 Operation of the System

a) If in any month, the water level in the Periyar reservoir is above the upper rule level and the storage in the Vaigai reservoir is less than the maximum capacity, send more water from the Periyar reservoir than the actual demand of the Vaigai irrigation area. Continue this till either the Vaigai dam is filled to capacity or the upper rule level is reached in the Periyar reservoir. If the water available in the Periyar still exceeds FRL, spill the excess water towards the Iddiky dam and bring the Periyar reservoir back to FRL.

b) If the Vaigai reservoir is filled to the capacity, the spill from this reservoir must be stored in the downstream tanks before releasing the excess water in the Bay of Bengal.

c) If the water level in the Periyar reservoir in the months of June, July and August, is in between the upper and the lower rule level, the reservoir should be operated to meet 40% of the Vaigai irrigation system demands and full Cumbum valley and Madurai water supply demands. However, if the water available in the Vaigai reservoir is less than 60% (100-40=60) of the Vaigai demands, full Vaigai irrigation area demands are met from the Periyar dam as long as the lower rule level is not reached. In all other months, Periyar reservoir is operated to meet 85% of the demands of the Vaigai irrigation area and all other demands for that year. The release for Vaigai demands is made as long as the lower rule curve level is not reached.

d) In the months from September through May, if the available water in the Vaigai dam is less than 15% of the demands, then full Vaigai irrigation demands should be met from the Periyar reservoir in addition to the Cumbum valley and the Madurai water supply demands till lower rule level is reached.

e) If the water level in the Periyar reservoir falls below the lower rule level at any stage, the release for Vaigai irrigation system should be stopped and water should be sent to meet only the Cumbum valley demands and the Madurai water supply demands as long as possible.

f) Below the lower rule level in the Periyar reservoir, if the water available in the

Vaigai reservoir is more than the Madurai water supply demand in any month, then only Cumbum valley water is released from the Periyar reservoir. The Madurai water supply demand is satisfied from the Vaigai reservoir.

g) The release from the Periyar dam is always restricted to the maximum discharge capacity of the tunnel.

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CHAPTER - 4
CONCLUSIONS

The Periyar-Vaigai system in the states of Tamil Nadu and Kerala has been analyzed in the present study. A computer software has been developed to simulate the monthly operation of the system. Various demand and operation features of the system have been incorporated in the model. Twenty six years of operation of the system (1962 - 88) has been simulated and the results have been analyzed. The analysis shows that it is a well planned system with very high system reliability. Some of the conclusions of the study are briefly described in the following:

a) Selection of demand pattern is a very important criterion in achieving high reliability of the system. Based on the water availability, it is better to curtail or stop excess cropping in the initial stage than not maintaining the same in the later stage. Rule levels have been prescribed for selecting the appropriate cropping pattern in a particular year.

b) The Madurai water supply demands and Cumbum valley demands have been considered the highest priority demands. Next priority has been rendered to the single main crop in the pre-project area under PMC and TMC of Vaigai irrigation scheme. Next priority has been assigned to the extension area demands and the double crop area demands.

c) In between the upper and the lower rule levels, it is better to satisfy partial Vaigai irrigation system demands (40% in June, July and August and 85% in all other months) and full Cumbum valley and Madurai water supply demands from the Periyar reservoir. However, in case of shortage of water in the Vaigai reservoir, full demands should be met from the Periyar reservoir till the lower rule level is reached.

d) Periyar dam is the main dam in the system and the performance of the system mainly depends on the operation of this dam. Unnecessary spill from this dam must be avoided and full utilization of available water (filling the excess water in the Vaigai dam) must be made before spilling the excess water from this dam.

e) The capacity of the tunnel is a constraint and many a times, it is not possible to divert full water because of this constraint. Thus, if the water level in the Periyar reservoir

is above upper rule curve in initial months (June - August), water more than demand must be diverted to the Vaigai dam and the same must be stored in the Vaigai dam.

f) Below the lower rule level in Periyar reservoir, if the water available in Vaigai reservoir is more than the Madurai water supply demand, only Cumbum valley demand should be released from the Periyar reservoir. The Madurai water supply demand, for that month, must be met from the Vaigai reservoir.

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SALIENT FEATURES OF PERIYAR RESERVOIR

General

River	:	Periyar
Basin	:	Periyar
District	:	Idukki (Kerala)
Construction Period	:	1887 - 97
Purpose	:	Irrigation and Hydropower
Cost	:	Rs. 108 lakhs

Reservoir Details

Catchment Area	:	601 sq. km
Full Reservoir Level	:	872.03 m
Maximum Water Level	:	872.95 m
Maximum Drawdown Level	:	857.40 m
Water Spread Area at FRL	:	26.44 sq. km
Gross Capacity at FRL	:	443.50 M Cum
Gross Capacity at MDDL	:	144.20 M Cum

Dam Details

Type	:	Masonry
Maximum Height	:	53.64 m
Length of Main Dam	:	378.25 m
Length of Baby Dam	:	73.17 m
Top Width of Roadway	:	6.40 m

Spillway Details

Type	:	Lift Gates
Crest Level	:	857.16 m
Vents	:	10 nos. (10.97 x 4.88 m)
		3 nos. (12.20 x 4.88 m)
Discharge Capacity	:	3463 cumec

Tunnel Details

Sill Level	:	857.40 m
Size	:	4.27 m diameter
Maximum Discharge	:	50.93 cumec
Installed Power Capacity	:	4 x 35 MW

SALIENT FEATURES OF VAIGAI RESERVOIR

General

River	:	Vaigai
Basin	:	Vaigai
District	:	Madurai (Tamil Nadu)
Construction Period	:	1954 - 59
Purpose	:	Irrigation and Hydropower
Cost	:	Rs. 330 lakhs

Reservoir Details

Catchment Area	:	2253.3 sq. km
Full Reservoir Level	:	279.20 m
Maximum Water Level	:	279.20 m
Maximum Drawdown Level	:	257.56 m
Water Spread Area at FRL	:	26.44 sq. km
Gross Capacity at FRL	:	173.95 M Cum
Gross Capacity at MDDL	:	1.46 M Cum

Dam Details

Type	:	Earthen and Masonry
Maximum Height	:	33.83 m
Length of Earthen Dam	:	3243.07 m
Length of Masonry Dam	:	315.47 m
Top Level of Dam	:	282.23 m

Spillway Details

Type	:	Lift Gates
Crest Level	:	274.61 m
Vents	:	7 nos. (12.19 x 4.70 m)
Discharge Capacity	:	1780 cumec

River Sluice Details

Sill Level	:	257.56 m
Vents	:	7 nos. (1.52 x 2.74 m)
Maximum Discharge	:	452.55 cumec

TABLE - 1
Local Inflow into the Periyar Reservoir (M Cum)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1962	-	-	-	-	-	13.394	236.672	89.878	106.953	122.669	27.184	18.236
1963	46.241	3.370	24.551	6.796	5.239	24.975	102.677	64.109	33.810	79.684	124.311	95.031
1964	1.359	0.000	5.239	1.416	3.087	5.239	65.723	257.428	83.818	52.075	81.411	14.385
1965	8.070	4.248	4.616	19.142	10.506	19.737	51.905	27.099	16.509	57.257	61.476	85.007
1966	17.273	13.507	23.899	27.581	25.797	39.842	109.020	44.061	47.091	163.841	116.326	40.040
1967	16.056	4.899	6.286	4.899	19.510	33.499	76.597	90.727	42.589	58.078	62.693	15.546
1968	6.371	7.504	16.112	10.760	3.568	21.634	224.496	107.491	45.788	70.622	65.695	47.148
1969	11.582	1.812	1.501	4.644	4.417	7.929	121.139	94.295	48.224	86.310	41.201	58.673
1970	19.992	6.173	10.930	35.141	11.638	62.127	60.230	133.712	47.431	117.458	67.989	19.539
1971	12.035	3.002	17.471	5.692	8.042	81.269	112.729	102.875	73.850	139.404	61.901	130.059
1972	21.946	6.173	6.230	3.171	31.035	7.023	115.731	62.212	30.327	85.205	119.610	44.316
1973	12.374	7.589	4.106	7.872	7.844	43.919	143.255	90.925	40.097	71.160	61.278	98.175
1974	30.157	7.362	5.182	11.270	6.145	9.203	115.051	197.057	79.344	58.248	71.415	16.933
1975	6.456	1.388	11.298	4.417	1.246	91.605	99.052	207.194	120.941	77.333	66.120	28.628
1976	7.306	3.341	3.540	13.451	4.870	4.304	32.423	49.498	26.108	29.421	102.082	50.574
1977	9.288	18.831	8.438	29.988	43.127	47.459	99.449	41.626	67.479	249.500	191.280	37.690
1978	10.137	16.339	6.909	7.476	6.881	30.327	80.788	119.865	51.480	73.312	124.339	52.160
1979	18.519	16.112	10.987	4.786	34.462	39.275	124.707	140.310	56.435	81.411	287.189	94.550
1980	13.790	7.051	4.304	14.810	10.845	53.066	117.487	87.329	37.293	98.203	115.136	46.298
1981	12.431	4.757	2.435	4.248	3.766	132.041	71.019	157.300	154.327	159.027	94.267	38.879
1982	8.778	1.784	2.917	13.960	6.654	38.398	63.571	66.346	22.597	27.835	109.813	36.840
1983	6.513	0.736	0.255	1.642	7.192	30.356	60.258	100.100	59.805	75.521	90.217	45.222
1984	43.721	55.529	94.408	35.453	11.497	85.319	168.287	59.239	60.060	66.743	78.041	18.094
1985	67.026	26.646	16.764	32.479	7.419	132.976	106.386	45.760	41.229	55.954	98.231	59.069
1986	17.132	27.241	15.603	18.208	8.608	28.515	51.905	146.483	25.344	51.820	61.561	24.494
1987	14.781	3.171	6.966	3.285	12.686	19.992	9.543	43.410	25.344	94.692	87.754	84.243
1988	20.445	6.173	12.629	24.721	9.543	46.525	76.427	65.412	85.545	28.487	42.220	13.705

TABLE - 2
Local Inflow into the Vaigai Reservoir (M Cum)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1962	-	-	-	-	-	12.443	25.357	30.885	16.163	105.042	43.468	39.951
1963	15.968	11.668	34.627	8.445	4.472	5.082	20.469	26.219	25.524	41.867	124.741	213.634
1964	17.306	0.000	0.000	0.000	7.813	0.899	24.060	36.776	21.256	56.830	112.072	39.601
1965	32.988	1.525	6.175	7.869	1.627	1.419	3.763	6.323	13.317	36.278	37.697	86.908
1966	10.368	8.250	10.363	5.586	8.191	1.062	15.114	10.899	27.186	134.529	137.261	71.463
1967	4.321	3.434	7.872	8.245	4.517	3.299	3.063	1.705	1.107	44.584	65.428	11.337
1968	5.033	0.000	0.250	6.387	0.841	0.565	3.670	3.260	9.295	6.480	18.535	36.167
1969	12.403	3.777	7.433	22.272	5.581	0.189	8.337	31.113	13.396	55.569	33.041	33.921
1970	1.117	0.000	2.231	0.152	1.726	2.178	5.464	9.508	21.722	50.109	49.831	12.790
1971	20.068	0.695	0.000	0.000	14.076	0.000	0.520	11.774	6.043	59.869	37.041	177.189
1972	0.000	0.000	0.000	0.000	0.000	3.442	0.000	0.000	32.183	50.478	125.000	23.684
1973	13.955	0.000	0.000	5.393	2.880	4.821	0.000	0.000	12.414	46.613	16.553	86.468
1974	2.354	0.000	0.000	5.276	0.270	0.731	0.000	0.000	3.369	7.843	17.088	0.289
1975	0.000	0.000	0.000	4.048	0.000	0.000	19.151	6.647	72.415	13.738	21.050	4.536
1976	0.000	5.404	2.420	0.852	0.000	0.000	0.000	0.244	1.130	40.942	136.241	22.967
1977	0.000	4.687	5.452	4.705	11.041	0.000	0.264	0.000	31.186	351.035	487.850	35.776
1978	25.195	16.356	6.344	0.000	0.000	0.000	0.707	0.603	5.624	79.159	62.730	170.701
1979	8.561	0.000	0.000	25.358	8.229	0.749	1.190	0.000	0.000	0.000	0.056	126.372
1980	0.000	0.000	0.000	0.000	1.716	0.000	0.000	0.000	26.221	70.906	139.365	36.617
1981	0.000	0.000	0.000	0.655	0.846	5.254	0.000	1.151	26.694	0.883	28.657	9.168
1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.081	7.352	72.972	8.538
1983	15.891	50.173	249.932	24.454	0.000	4.182	0.000	0.000	0.000	29.996	58.043	30.093
1984	18.444	0.000	0.000	0.000	0.000	0.000	0.587	0.000	18.047	5.269	43.225	6.425
1985	0.000	1.871	3.313	0.000	0.000	0.063	0.509	0.000	16.266	22.340	49.198	5.318
1986	1.165	0.000	0.000	0.000	0.000	0.000	0.000	11.119	1.791	24.501	22.695	4.662
1987	0.000	0.000	0.460	4.524	0.000	0.000	0.000	0.000	0.000	108.184	93.134	16.189
1988	0.000	0.000	0.000	0.553	0.000	0.000	0.000	0.254	20.610	6.591	13.368	0.000

TABLE - 3

Elevation - Capacity - Release Capacity - Maximum Power Generation for Periyar Reservoir

Elevation (m)	Reservoir Capacity (M Cum)	Release Capacity (M Cum)	Maximum Power Generation (MW)
32.92	161.15	5.50	00.00
33.22	165.56	10.28	12.00
33.53	169.98	17.98	20.00
33.83	174.48	24.59	28.00
34.14	179.04	25.69	30.00
34.44	183.60	36.70	42.00
34.75	188.33	44.04	50.00
35.05	193.09	46.24	53.00
35.36	198.19	49.77	56.00
35.66	203.28	54.68	70.00
35.97	208.38	67.89	77.00
36.27	213.51	71.56	81.00
36.58	218.60	74.87	85.00
36.88	224.21	78.90	90.00
37.19	229.82	91.02	103.00
37.49	235.42	97.62	110.00
37.80	241.03	99.82	113.00
38.10	246.64	99.82	119.00
38.41	252.75	104.60	123.00
38.71	258.87	110.83	130.00
39.01	264.99	117.44	136.00
39.32	271.10	117.44	140.00
39.62	275.77	117.44	140.00
39.93	283.82	117.44	140.00
40.23	290.44	117.44	140.00
40.54	297.07	117.44	140.00
40.84	303.58	117.44	140.00
41.15	310.29	117.44	140.00
41.45	317.43	117.44	140.00
41.76	324.56	117.44	140.00
42.06	331.70	117.44	140.00
42.37	338.84	117.44	140.00
42.67	345.97	117.44	140.00
42.98	353.62	117.44	140.00
43.28	361.26	117.44	140.00
43.59	368.91	117.44	140.00
43.89	376.58	117.44	140.00
44.20	384.51	117.44	140.00
44.50	392.58	117.44	140.00
44.81	400.76	117.44	140.00
45.11	409.09	117.44	140.00
45.42	417.50	117.44	140.00
45.72	426.05	117.44	140.00
46.03	434.72	117.44	140.00
46.33	443.50	117.44	140.00

TABLE - 4
Elevation - Area - Capacity Table for Vaigai Reservoir

Elevation (m)	Reservoir Area (M Sqm)	Reservoir Capacity (M Cum)
257.56	0.00	1.46
258.47	0.78	1.47
260.61	1.48	1.83
262.13	2.09	2.68
265.18	4.25	7.37
266.70	5.54	11.88
269.45	8.27	26.07
271.28	10.45	41.19
273.10	12.87	61.60
274.02	14.37	73.94
274.63	15.52	83.04
275.85	18.09	103.44
276.76	19.76	120.41
277.98	22.02	145.49
279.20	24.20	173.95

TABLE - 5
Normal Monthly Evaporation Depths for Vaigai Reservoir in meter/month

Month	Evaporation Depth (m)	Month	Evaporation Depth (m)
Jan	0.1332	Jul	0.1945
Feb	0.1393	Aug	0.2363
Mar	0.1884	Sep	0.1841
Apr	0.1942	Oct	0.1798
May	0.2475	Nov	0.1292
Jun	0.1929	Dec	0.1106

TABLE - 6
Average Monthly Irrigation and Water Supply Demands of Periyar - Vaigai System (in M Cum)

MONTH	Cumbum Valley Demand	Vaigai Irrigation System Demands				Madur. Water Supply Demand
		PMC Double Crop Demand	PMC Single Main Crop Demand	PMC Ext. Area Demand	TMC with Ext.Area Demand	
Jan	16.15	28.65	25.12	9.67	5.71	2.00
Feb	0.00	0.00	0.00	3.43	0.00	3.40
Mar	0.00	0.00	0.00	0.00	0.00	3.60
APR	0.00	0.00	0.00	0.00	0.00	4.40
May	0.00	0.00	0.00	0.00	0.00	5.20
Jun	14.68	20.66	0.00	0.00	0.00	7.10
Jul	15.17	38.30	0.00	0.00	0.00	6.30
Aug	15.17	34.16	0.00	0.00	0.00	4.50
Sep	14.68	32.23	20.93	0.00	4.76	2.00
Oct	18.96	23.42	61.75	3.31	14.03	2.10
Nov	18.35	36.36	62.80	9.01	14.27	0.50
Dec	18.96	34.16	64.89	9.67	14.74	1.40

TABLE - 7
Monthly Yield Estimation for Periyar Reservoir

MONTH	Monthly Yield (Million Cubic Meter)					
	Probability Level for Value to be Equalled or Exceeded					
	50%	60%	70%	75%	80%	90%
Jan	13.98	11.51	9.31	8.23	7.18	4.96
Feb	6.26	4.51	3.06	2.41	1.83	0.77
Mar	7.68	5.83	4.31	3.62	2.98	1.75
Apr	9.74	7.68	5.91	5.07	4.28	2.67
May	8.55	6.99	5.64	4.99	4.38	3.10
Jun	31.97	25.24	19.34	16.52	13.82	8.32
Jul	94.39	81.90	69.52	62.94	56.11	39.87
Aug	87.74	76.14	65.38	59.95	54.51	42.31
Sep	47.27	41.35	35.96	33.26	30.57	24.58
Oct	78.22	69.16	60.70	56.40	52.07	42.22
Nov	84.31	75.03	66.34	61.90	57.43	47.20
Dec	41.56	35.40	29.84	27.08	24.36	18.42

TABLE - 8
Recommended Rule Curve Levels for Periyar Reservoir

Month	Upper Rule Curve (m)	Lower Rule Curve (m)
Jan	37.25	34.00
Feb	34.00	33.50
Mar	33.75	33.30
Apr	33.75	33.15
May	33.75	33.00
Jun	40.50	32.92
Jul	42.50	32.92
Aug	44.25	32.92
Sep	46.33	32.92
Oct	46.00	32.92
Nov	44.50	32.92
Dec	42.00	34.50

TABLE - 9
Monthly Operation Simulation of Periyar Reservoir
Using Recommended Policy

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Tir_Dem m m3	Ds_Dem m m3	Tot_Dem m m3	Rel_Ir m m3	Tot_Rel m m3	Pw_Gen M kwh	Spill m m3	End_Lev m	Low_Rul m	Upr_Rul m
1962-06	300.00	13.39	14.68	7.10	21.78	14.68	21.78	36.06	0.00	40.28	32.92	40.50
1962-07	291.61	236.57	15.17	44.60	59.77	15.17	84.79	140.38	0.00	46.33	32.92	42.50
1962-08	443.50	89.38	15.17	38.65	53.83	15.17	68.10	112.75	21.78	46.33	32.92	44.25
1962-09	443.50	106.95	14.68	51.23	65.91	14.68	65.91	109.13	41.04	46.33	32.92	45.33
1962-10	443.50	122.57	18.96	89.23	108.19	18.96	117.44	194.44	5.23	46.33	32.92	46.00
1962-11	443.50	27.18	18.35	104.57	122.92	18.35	117.44	194.44	0.00	42.96	32.92	44.50
1962-12	353.24	18.24	18.96	106.35	125.31	18.96	117.44	194.44	0.00	38.47	34.50	42.00
1963-01	254.04	46.24	16.15	60.78	76.93	16.15	76.93	120.69	0.00	36.83	34.00	37.25
1963-02	223.35	3.37	0.00	6.32	6.32	0.00	6.32	9.99	0.00	36.68	33.50	34.00
1963-03	220.42	24.55	0.00	3.60	3.60	0.00	3.60	5.65	0.00	37.82	33.30	33.75
1963-04	241.36	6.80	0.00	4.40	4.40	0.00	4.40	7.02	0.00	37.95	33.15	33.75
1963-05	243.76	5.24	0.00	5.20	5.20	0.00	5.20	8.39	0.00	37.95	33.30	33.75
1963-06	243.79	24.98	14.68	15.35	30.04	14.68	30.04	47.32	0.00	37.67	32.92	40.50
1963-07	238.73	102.58	15.17	21.62	36.79	15.17	36.79	60.69	0.00	40.89	32.92	42.50
1963-08	304.62	64.11	15.17	18.15	33.33	15.17	33.33	55.19	0.00	42.22	32.92	44.25
1963-09	335.39	33.81	14.68	51.23	65.91	14.68	65.91	109.13	0.00	40.83	32.92	45.33
1963-10	303.29	79.58	18.96	89.23	108.19	18.96	108.19	179.14	0.00	39.56	32.92	46.00
1963-11	274.78	124.31	18.35	104.57	122.92	18.35	117.44	194.44	0.00	39.85	32.92	44.50
1963-12	281.65	95.03	18.96	106.35	125.31	18.96	117.44	193.86	0.00	38.73	34.50	42.00
1964-01	259.24	1.36	16.15	60.78	76.93	16.15	75.54	119.20	0.00	34.53	34.00	37.25
1964-02	185.06	0.00	0.00	6.32	6.32	0.00	6.32	10.10	0.00	34.12	33.50	34.00
1964-03	178.75	5.24	0.00	3.60	3.60	0.00	3.60	5.82	0.00	34.23	33.30	33.75
1964-04	180.39	1.42	0.00	4.40	4.40	0.00	4.40	7.13	0.00	34.03	33.15	33.75
1964-05	177.40	3.09	0.00	5.20	5.20	0.00	5.20	8.31	0.00	33.88	33.00	33.75
1964-06	175.29	5.24	14.68	15.35	30.04	14.68	16.96	26.31	0.00	33.09	32.92	40.50
1964-07	163.57	65.72	15.17	21.62	36.79	15.17	34.67	55.27	0.00	35.69	32.92	42.50
1964-08	194.62	257.43	15.17	38.66	53.83	15.17	53.83	89.13	0.00	44.71	32.92	44.25
1964-09	398.22	83.32	14.68	51.23	65.91	14.68	65.91	109.13	0.00	45.37	32.92	45.33
1964-10	416.12	52.07	18.96	89.23	108.19	18.96	108.19	179.14	0.00	43.23	32.92	46.00
1964-11	360.00	81.41	18.35	104.57	122.92	18.35	117.44	194.44	0.00	41.73	32.92	44.50
1964-12	323.97	14.38	18.96	106.35	125.31	18.96	117.44	192.64	0.00	36.70	34.50	42.00
1965-01	220.92	8.07	16.15	60.78	76.93	16.15	50.53	80.78	0.00	34.11	34.00	37.25
1965-02	178.46	4.25	0.00	6.32	6.32	0.00	6.32	10.16	0.00	33.96	33.50	34.00
1965-03	176.39	4.52	0.00	3.60	3.60	0.00	3.60	5.77	0.00	34.03	33.30	33.75
1965-04	177.41	19.14	0.00	4.40	4.40	0.00	4.40	6.98	0.00	34.99	33.15	33.75
1965-05	192.15	10.51	0.00	5.20	5.20	0.00	5.20	8.23	0.00	35.32	33.00	33.75
1965-06	197.46	19.74	14.68	15.35	30.04	14.68	30.04	47.75	0.00	34.67	32.92	40.50
1965-07	187.15	51.90	15.17	21.62	36.79	15.17	36.79	58.25	0.00	35.60	32.92	42.50
1965-08	202.26	27.10	15.17	18.15	33.33	15.17	33.33	53.50	0.00	35.23	32.92	44.25
1965-09	196.03	16.51	14.68	51.23	65.91	14.68	38.53	61.11	0.00	33.81	32.92	45.33
1965-10	174.00	57.26	18.96	89.23	108.19	18.96	37.04	58.85	0.00	35.11	32.92	46.00
1965-11	194.22	61.48	18.35	104.57	122.92	18.35	51.00	82.64	0.00	35.75	32.92	44.50
1965-12	204.70	85.01	18.96	124.87	143.83	18.96	70.45	110.81	0.00	36.61	34.50	42.00
1965-01	219.26	17.27	16.15	60.78	76.93	16.15	52.70	89.39	0.00	34.46	34.00	37.25
1965-02	183.83	13.51	0.00	6.83	6.83	0.00	6.83	10.79	0.00	34.89	33.50	34.00
1965-03	190.50	23.90	0.00	3.60	3.60	0.00	3.60	6.00	0.00	36.11	33.30	33.75
1965-04	210.80	27.58	0.00	4.40	4.40	0.00	4.40	6.96	0.00	37.41	33.15	33.75
1965-05	233.98	25.80	0.00	5.20	5.20	0.00	5.20	8.40	0.00	38.50	33.00	33.75
1965-06	254.58	39.84	14.68	7.10	21.78	14.68	21.78	35.10	0.00	39.42	32.92	40.50
1965-07	272.64	109.02	15.17	44.60	59.77	15.17	59.77	98.96	0.00	43.24	32.92	42.50
1965-08	321.89	44.06	15.17	18.15	33.33	15.17	33.33	55.19	0.00	42.10	32.92	44.25
1965-09	332.62	47.09	14.68	51.23	65.91	14.68	65.91	109.13	0.00	41.30	32.92	45.33
1965-10	313.80	163.84	18.96	89.23	108.19	18.96	108.19	179.14	0.00	43.61	32.92	46.00
1965-11	369.45	116.33	18.35	104.57	122.92	18.35	117.44	194.44	0.00	43.57	32.92	44.50
1965-12	368.33	40.04	18.96	106.35	125.31	18.96	117.44	194.44	0.00	40.25	34.50	42.00
1967-01	290.93	16.06	16.15	60.78	76.93	16.15	76.93	125.22	0.00	37.20	34.00	37.25
1967-02	230.06	4.90	0.00	6.32	6.32	0.00	6.32	9.93	0.00	37.13	33.50	34.00
1967-03	228.64	6.29	0.00	3.60	3.60	0.00	3.60	5.66	0.00	37.27	33.30	33.75
1967-04	231.33	4.90	0.00	4.40	4.40	0.00	4.40	6.91	0.00	37.30	33.15	33.75
1967-05	231.83	19.51	0.00	5.20	5.20	0.00	5.20	8.16	0.00	38.07	33.00	33.75
1967-06	246.14	33.50	14.68	15.35	30.04	14.68	30.04	49.61	0.00	38.25	32.92	40.50
1967-07	249.60	76.50	15.17	21.62	36.79	15.17	36.79	60.33	0.00	40.18	32.92	42.50
1967-08	289.40	90.73	15.17	18.15	33.33	15.17	33.33	55.19	0.00	42.70	32.92	44.25
1967-09	346.80	42.59	14.68	51.23	65.91	14.68	65.91	109.13	0.00	41.71	32.92	46.33
1967-10	323.47	58.08	18.96	89.23	108.19	18.96	108.19	179.14	0.00	39.46	32.92	46.00
1967-11	273.36	62.59	18.35	104.57	122.92	18.35	104.15	170.31	0.00	37.30	32.92	44.50
1967-12	231.90	15.55	18.96	106.35	125.31	18.96	62.93	101.53	0.00	34.50	34.50	42.00
1968-01	184.52	6.37	16.15	60.78	76.93	16.15	18.15	29.36	0.00	33.71	34.00	37.25
1968-02	172.74	7.50	0.00	6.32	6.32	0.00	6.32	9.94	0.00	33.79	33.50	34.00
1968-03	173.93	16.11	0.00	3.60	3.60	0.00	3.60	5.80	0.00	34.63	33.30	33.75
1968-04	186.44	10.76	0.00	4.40	4.40	0.00	4.40	6.96	0.00	35.03	33.15	33.75
1968-05	192.80	3.57	0.00	5.20	5.20	0.00	5.20	8.26	0.00	34.93	33.00	33.75

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Tir_Dem m m3	Ds_Dem m m3	Tot_Dem m m3	Rel_Ir m m3	Tot_Rel m m3	Pw_Gen M kwh	Spill m m3	End_Lev m	Low_Rul m	Upr_Rul m
1968-06	191.17	21.63	14.68	7.10	21.78	14.68	21.78	34.54	0.00	34.93	32.92	40.50
1968-07	191.02	224.50	15.17	44.60	59.77	15.17	59.77	96.21	0.00	43.06	32.92	42.50
1968-08	355.75	107.49	15.17	38.66	53.83	15.17	53.83	89.13	0.00	45.12	32.92	44.25
1968-09	409.41	45.79	14.68	51.23	65.91	14.68	65.91	109.13	0.00	44.38	32.92	46.33
1968-10	389.28	70.62	18.96	89.23	108.19	18.96	108.19	179.14	0.00	42.90	32.92	46.00
1968-11	351.71	65.70	18.35	104.57	122.92	18.35	117.44	194.44	0.00	40.67	32.92	44.50
1968-12	299.97	47.15	18.96	106.35	125.31	18.96	116.35	187.52	0.00	37.25	34.50	42.00
1969-01	230.76	11.58	16.15	60.78	76.93	16.15	54.03	94.65	0.00	34.00	34.00	37.25
1969-02	188.32	1.81	0.00	6.32	6.32	0.00	6.32	9.99	0.00	34.45	33.50	34.00
1969-03	183.81	1.50	0.00	3.60	3.60	0.00	3.60	5.74	0.00	34.32	33.30	33.75
1969-04	181.71	4.64	0.00	4.40	4.40	0.00	4.40	7.04	0.00	34.33	33.15	33.75
1969-05	181.96	4.42	0.00	5.20	5.20	0.00	5.20	8.33	0.00	34.28	33.00	33.75
1969-06	181.18	7.93	14.68	7.10	21.78	14.68	21.78	34.41	0.00	33.34	32.92	40.50
1969-07	167.32	121.14	15.17	6.30	21.47	15.17	21.47	33.76	0.00	39.11	32.92	42.50
1969-08	266.99	94.30	15.17	4.50	19.67	15.17	19.67	32.57	0.00	42.49	32.92	44.25
1969-09	341.62	48.22	14.68	31.90	46.58	14.68	46.58	77.13	0.00	42.56	32.92	46.33
1969-10	343.26	86.31	18.96	90.26	109.22	18.96	109.22	180.84	0.00	41.58	32.92	46.00
1969-11	320.35	41.20	18.35	90.17	108.52	18.35	108.52	179.67	0.00	38.42	32.92	44.50
1969-12	253.03	58.67	18.96	94.04	113.00	18.96	96.01	150.41	0.00	36.41	34.50	42.00
1970-01	215.69	19.99	16.15	37.86	54.01	16.15	51.20	83.44	0.00	34.49	34.00	37.25
1970-02	184.49	6.17	0.00	3.40	3.40	0.00	3.40	5.38	0.00	34.68	33.50	34.00
1970-03	187.26	10.93	0.00	3.60	3.60	0.00	3.60	5.71	0.00	35.14	33.30	33.75
1970-04	194.59	35.14	0.00	4.40	4.40	0.00	4.40	6.93	0.00	36.94	33.15	33.75
1970-05	225.33	11.64	0.00	5.20	5.20	0.00	5.20	8.19	0.00	37.29	33.00	33.75
1970-06	231.77	62.13	14.68	7.10	21.78	14.68	21.78	35.68	0.00	39.39	32.92	40.50
1970-07	272.12	60.23	15.17	21.62	36.79	15.17	36.79	60.91	0.00	40.47	32.92	42.50
1970-08	295.56	133.71	15.17	38.66	53.83	15.17	53.83	89.13	0.00	44.63	32.92	44.25
1970-09	375.44	47.43	14.68	51.23	65.91	14.68	65.91	109.13	0.00	43.11	32.92	46.33
1970-10	356.96	117.46	18.96	89.23	108.19	18.96	108.19	179.14	0.00	43.48	32.92	46.00
1970-11	366.22	67.99	18.35	104.57	122.92	18.35	117.44	194.44	0.00	41.42	32.92	44.50
1970-12	316.77	19.54	18.96	106.35	125.31	18.96	117.41	188.85	0.00	36.59	34.50	42.00
1971-01	218.91	12.03	16.15	60.78	76.93	16.15	50.56	80.93	0.00	34.22	34.00	37.25
1971-02	180.38	3.00	0.00	6.32	6.32	0.00	6.32	10.22	0.00	34.01	33.50	34.00
1971-03	177.06	17.47	0.00	3.60	3.60	0.00	3.60	5.72	0.00	34.91	33.30	33.75
1971-04	190.93	5.69	0.00	4.40	4.40	0.00	4.40	6.98	0.00	35.00	33.15	33.75
1971-05	192.22	8.04	0.00	5.20	5.20	0.00	5.20	8.26	0.00	35.17	33.00	33.75
1971-06	195.07	81.27	14.68	7.10	21.78	14.68	21.78	34.48	0.00	38.50	32.92	40.50
1971-07	254.56	112.73	15.17	21.62	36.79	15.17	36.79	60.91	0.00	42.01	32.92	42.50
1971-08	330.50	102.88	15.17	38.66	53.83	15.17	53.83	89.13	0.00	44.78	32.92	44.25
1971-09	379.54	73.85	14.68	51.23	65.91	14.68	65.91	109.13	0.00	44.31	32.92	46.33
1971-10	387.48	139.40	18.96	89.23	108.19	18.96	108.19	179.14	0.00	45.46	32.92	46.00
1971-11	418.69	61.90	18.35	104.57	122.92	18.35	117.44	194.44	0.00	43.36	32.92	44.50
1971-12	363.15	130.06	18.96	106.35	125.31	18.96	117.44	194.44	0.00	43.86	34.50	42.00
1972-01	375.77	21.95	16.15	60.78	76.93	16.15	76.93	127.37	0.00	41.60	34.00	37.25
1972-02	320.79	6.17	0.00	6.32	6.32	0.00	6.32	10.46	0.00	41.60	33.50	34.00
1972-03	320.65	6.23	0.00	3.60	3.60	0.00	3.60	5.96	0.00	41.70	33.30	33.75
1972-04	323.28	3.17	0.00	4.40	4.40	0.00	4.40	7.29	0.00	41.65	33.15	33.75
1972-05	322.05	31.04	0.00	5.20	5.20	0.00	5.20	8.61	0.00	42.75	33.00	33.75
1972-06	347.88	7.02	14.68	27.76	42.44	14.68	42.44	70.27	0.00	41.24	32.92	40.50
1972-07	312.47	115.73	15.17	44.60	59.77	15.17	59.77	98.96	0.00	43.57	32.92	42.50
1972-08	368.43	62.21	15.17	38.66	53.83	15.17	53.83	89.13	0.00	44.68	32.92	44.25
1972-09	376.81	30.33	14.68	51.23	65.91	14.68	65.91	109.13	0.00	42.47	32.92	46.33
1972-10	341.22	85.21	18.96	89.23	108.19	18.96	108.19	179.14	0.00	41.49	32.92	46.00
1972-11	318.24	119.61	18.35	104.57	122.92	18.35	117.44	194.44	0.00	41.58	32.92	44.50
1972-12	320.41	44.32	18.96	106.35	125.31	18.96	117.44	194.44	0.00	38.13	34.50	42.00
1973-01	247.28	12.37	16.15	60.78	76.93	16.15	72.83	114.64	0.00	34.65	34.00	37.25
1973-02	186.82	7.59	0.00	6.32	6.32	0.00	6.32	9.97	0.00	34.73	33.50	34.00
1973-03	188.10	4.11	0.00	3.60	3.60	0.00	3.60	5.68	0.00	34.77	33.30	33.75
1973-04	188.60	7.87	0.00	4.40	4.40	0.00	4.40	6.97	0.00	34.99	33.15	33.75
1973-05	192.08	7.84	0.00	5.20	5.20	0.00	5.20	8.27	0.00	35.15	33.00	33.75
1973-06	194.72	43.92	14.68	15.36	30.04	14.68	30.04	51.52	0.00	35.98	32.92	40.50
1973-07	208.59	143.26	15.17	21.62	36.79	15.17	36.79	59.96	0.00	41.35	32.92	42.50
1973-08	315.06	90.93	15.17	18.16	33.33	15.17	33.33	55.19	0.00	43.74	32.92	44.25
1973-09	372.65	40.10	14.68	51.23	65.91	14.68	65.91	109.13	0.00	42.71	32.92	46.33
1973-10	346.84	71.16	18.96	89.23	108.19	18.96	108.19	179.14	0.00	41.13	32.92	46.00
1973-11	309.80	61.28	18.35	104.57	122.92	18.35	117.44	194.44	0.00	38.45	32.92	44.50
1973-12	253.64	98.17	18.96	106.35	125.31	18.96	103.34	169.37	0.00	38.20	34.50	42.00
1974-01	248.48	30.16	16.15	60.78	76.93	16.15	76.93	121.87	0.00	35.57	34.00	37.25
1974-02	201.71	7.36	0.00	6.32	6.32	0.00	6.32	10.97	0.00	35.63	33.50	34.00
1974-03	202.75	5.18	0.00	3.60	3.60	0.00	3.60	6.35	0.00	35.72	33.30	33.75
1974-04	204.34	11.27	0.00	4.40	4.40	0.00	4.40	7.03	0.00	36.14	33.15	33.75
1974-05	211.21	6.14	0.00	5.20	5.20	0.00	5.20	8.18	0.00	36.19	33.00	33.75
1974-06	212.15	9.20	14.68	15.36	30.04	14.68	30.04	51.48	0.00	34.94	32.92	40.50
1974-07	191.31	115.05	15.17	21.62	36.79	15.17	36.79	57.96	0.00	39.24	32.92	42.50
1974-08	269.57	197.06	15.17	38.66	53.83	15.17	53.83	89.13	0.00	45.25	32.92	44.25
1974-09	412.80	79.34	14.68	51.23	65.91	14.68	65.91	109.13	0.00	45.73	32.92	46.33
1974-10	426.23	58.25	18.96	89.23	108.19	18.96	108.19	179.14	0.00	43.88	32.92	46.00
1974-11	376.29	71.42	18.35	104.57	122.92	18.35	117.44	194.44	0.00	42.00	32.92	44.50
1974-12	330.26	16.93	18.96	106.35	125.31	18.96	117.44	194.44	0.00	37.19	34.50	42.00
1975-01	229.75	6.46	16.15	60.78	76.93	16.15	53.59	92.89	0.00	34.00	34.00	37.25
1975-02	182.62	1.39	0.00	6.32	6.32	0.00	6.32	10.18	0.00	34.05	33.50	34.00
1975-03	177.70	11.30	0.00	3.60	3.60	0.00	3.60	5.77	0.00	34.56	33.30	33.75
1975-04	185.39	4.42	0.00	4.40	4.40	0.00	4.40	6.97	0.00	34.56	33.15	33.75
1975-05	185.41	1.25	0.00	5.20	5.20	0.00	5.20	8.27	0.00	34.30	33.00	33.75

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Tir_Dem m m3	Ds_Dem m m3	Tot_Dem m m3	Rel_Ir m m3	Tot_Rel m m3	Pw_Gen M kwh	Spill m m3	End_Lev m	Low_Rul m	Upr_Rul m
1975-06	281.46	91.61	14.68	7.10	21.78	14.68	21.78	34.26	0.00	38.34	32.92	40.50
1975-07	251.28	99.05	15.17	6.30	21.47	15.17	21.47	35.55	0.00	41.94	32.92	42.50
1975-08	328.87	207.19	15.17	4.50	19.67	15.17	92.56	153.25	0.00	46.33	32.92	44.25
1975-09	443.50	120.94	14.68	33.11	47.79	14.68	93.47	154.76	27.47	46.33	32.92	46.33
1975-10	443.50	77.33	18.96	96.62	115.58	18.96	115.58	191.36	0.00	44.97	32.92	46.00
1975-11	405.25	66.12	18.35	101.43	119.78	18.35	117.44	194.44	0.00	42.99	32.92	44.50
1975-12	353.93	28.63	18.96	105.98	124.94	18.96	117.44	194.44	0.00	39.02	34.50	42.00
1976-01	265.12	7.31	16.15	47.53	63.68	16.15	63.68	99.68	0.00	35.99	34.00	37.25
1976-02	208.75	3.34	0.00	6.32	6.32	0.00	6.32	10.19	0.00	35.81	33.50	34.00
1976-03	205.78	3.54	0.00	3.60	3.60	0.00	3.60	6.00	0.00	35.81	33.30	33.75
1976-04	205.72	13.45	0.00	4.40	4.40	0.00	4.40	6.93	0.00	36.35	33.15	33.75
1976-05	214.77	4.87	0.00	5.20	5.20	0.00	5.20	8.18	0.00	36.33	33.00	33.75
1976-06	214.44	4.30	14.68	7.10	21.78	14.68	21.78	36.41	0.00	35.29	32.92	40.50
1976-07	196.96	32.42	15.17	21.62	36.79	15.17	36.79	58.20	0.00	35.02	32.92	42.50
1976-08	192.60	49.50	15.17	18.16	33.33	15.17	33.33	55.74	0.00	35.99	32.92	44.25
1976-09	208.76	26.11	14.68	51.23	65.91	14.68	48.96	76.83	0.00	34.59	32.92	46.33
1976-10	185.90	29.42	18.96	89.23	108.19	18.96	25.67	41.61	0.00	33.68	32.92	46.00
1976-11	189.66	102.08	18.35	122.94	141.29	18.35	68.32	107.59	0.00	37.18	32.92	44.50
1976-12	223.42	50.57	18.96	106.35	125.31	18.96	71.10	111.81	0.00	35.63	34.50	42.00
1977-01	202.89	9.29	16.15	60.78	76.93	16.15	35.20	55.63	0.00	34.00	34.00	37.25
1977-02	176.98	18.83	0.00	6.83	6.83	0.00	6.83	10.88	0.00	34.79	33.50	34.00
1977-03	188.98	8.44	0.00	3.60	3.60	0.00	3.60	5.71	0.00	35.09	33.30	33.75
1977-04	193.82	29.99	0.00	4.40	4.40	0.00	4.40	7.21	0.00	36.62	33.15	33.75
1977-05	219.41	43.13	0.00	5.20	5.20	0.00	5.20	8.16	0.00	38.63	33.00	33.75
1977-06	257.33	47.46	14.68	7.10	21.78	14.68	21.78	35.88	0.00	39.90	32.92	40.50
1977-07	283.01	99.45	15.17	44.60	59.77	15.17	59.77	98.96	0.00	43.27	32.92	42.50
1977-08	322.69	41.63	15.17	18.16	33.33	15.17	33.33	55.19	0.00	42.03	32.92	44.25
1977-09	330.98	67.48	14.68	59.92	74.60	14.68	74.60	123.51	0.00	41.73	32.92	46.33
1977-10	323.86	249.50	18.96	89.23	108.19	18.96	117.44	194.44	12.42	46.33	32.92	46.00
1977-11	443.50	191.28	18.35	104.57	122.92	18.35	122.92	203.52	68.36	46.33	32.92	44.50
1977-12	443.50	37.69	18.96	106.35	125.31	18.96	117.44	194.44	0.00	43.38	34.50	42.00
1978-01	363.75	10.14	16.15	60.78	76.93	16.15	76.93	127.37	0.00	40.53	34.00	37.25
1978-02	296.96	16.34	0.00	6.32	6.32	0.00	6.32	10.46	0.00	41.00	33.50	34.00
1978-03	306.98	6.91	0.00	3.60	3.60	0.00	3.60	5.96	0.00	41.15	33.30	33.75
1978-04	310.29	7.48	0.00	4.40	4.40	0.00	4.40	7.29	0.00	41.28	33.15	33.75
1978-05	313.37	6.88	0.00	5.20	5.20	0.00	5.20	8.61	0.00	41.35	33.00	33.75
1978-06	315.05	30.33	14.68	27.76	42.44	14.68	42.44	70.27	0.00	43.81	32.92	40.50
1978-07	302.94	80.79	15.17	44.60	59.77	15.17	59.77	98.96	0.00	42.71	32.92	42.50
1978-08	323.95	119.87	15.17	38.66	53.83	15.17	53.83	89.13	0.00	44.40	32.92	44.25
1978-09	389.99	51.48	14.68	51.23	65.91	14.68	65.91	109.13	0.00	43.85	32.92	46.33
1978-10	375.56	73.31	18.96	89.23	108.19	18.96	108.19	179.14	0.00	42.45	32.92	46.00
1978-11	340.68	124.34	18.35	104.57	122.92	18.35	117.44	194.44	0.00	42.74	32.92	44.50
1978-12	347.58	52.16	18.96	106.35	125.31	18.96	117.44	194.44	0.00	39.87	34.50	42.00
1979-01	282.30	18.52	16.15	60.78	76.93	16.15	76.93	125.87	0.00	35.86	34.00	37.25
1979-02	223.89	16.11	0.00	6.32	6.32	0.00	6.32	9.94	0.00	37.40	33.50	34.00
1979-03	233.68	10.99	0.00	3.60	3.60	0.00	3.60	5.64	0.00	37.80	33.30	33.75
1979-04	241.07	4.79	0.00	4.40	4.40	0.00	4.40	6.93	0.00	37.82	33.15	33.75
1979-05	241.46	34.46	0.00	5.20	5.20	0.00	5.20	8.48	0.00	39.30	33.00	33.75
1979-06	270.72	39.28	14.68	15.36	30.04	14.68	30.04	49.74	0.00	38.78	32.92	40.50
1979-07	279.95	124.71	15.17	44.60	59.77	15.17	59.77	98.96	0.00	42.62	32.92	42.50
1979-08	344.89	140.31	15.17	38.66	53.83	15.17	53.83	89.13	0.00	45.91	32.92	44.25
1979-09	431.37	56.44	14.68	51.23	65.91	14.68	65.91	109.13	0.00	45.57	32.92	46.33
1979-10	421.89	81.41	18.96	89.23	108.19	18.96	108.19	179.14	0.00	44.60	32.92	46.00
1979-11	395.11	287.19	18.35	104.57	122.92	18.35	117.44	194.44	121.36	46.33	32.92	44.50
1979-12	443.50	94.55	18.96	106.35	125.31	18.96	117.44	194.44	0.00	45.53	34.50	42.00
1980-01	420.61	13.79	16.15	60.78	76.93	16.15	76.93	127.37	0.00	43.13	34.00	37.25
1980-02	357.47	7.05	0.00	6.32	6.32	0.00	6.32	10.46	0.00	43.16	33.50	34.00
1980-03	358.21	4.30	0.00	3.60	3.60	0.00	3.60	5.96	0.00	43.19	33.30	33.75
1980-04	358.91	14.81	0.00	4.40	4.40	0.00	4.40	7.29	0.00	43.61	33.15	33.75
1980-05	369.32	10.85	0.00	5.20	5.20	0.00	5.20	8.61	0.00	43.83	33.00	33.75
1980-06	374.97	53.07	14.68	27.76	42.44	14.68	42.44	70.27	0.00	44.24	32.92	40.50
1980-07	385.59	117.49	15.17	44.60	59.77	15.17	59.77	98.96	0.00	46.32	32.92	42.50
1980-08	443.31	87.33	15.17	38.66	53.83	15.17	85.20	141.06	1.94	46.32	32.92	44.25
1980-09	443.50	37.29	14.68	51.23	65.91	14.68	65.91	109.13	0.00	45.32	32.92	46.33
1980-10	414.88	98.20	18.96	89.23	108.19	18.96	108.19	179.14	0.00	44.96	32.92	46.00
1980-11	404.89	115.14	18.35	104.57	122.92	18.35	117.44	194.44	0.00	44.88	32.92	44.50
1980-12	402.59	46.30	18.96	106.35	125.31	18.96	117.44	194.44	0.00	42.05	34.50	42.00
1981-01	331.45	12.43	16.15	60.78	76.93	16.15	76.93	127.37	0.00	39.11	34.00	37.25
1981-02	266.95	4.76	0.00	6.32	6.32	0.00	6.32	10.22	0.00	39.03	33.50	34.00
1981-03	265.39	2.44	0.00	3.60	3.60	0.00	3.60	5.79	0.00	38.97	33.30	33.75
1981-04	264.23	4.25	0.00	4.40	4.40	0.00	4.40	7.09	0.00	38.97	33.15	33.75
1981-05	264.07	3.77	0.00	5.20	5.20	0.00	5.20	8.39	0.00	38.89	33.00	33.75
1981-06	262.64	132.04	14.68	27.76	42.44	14.68	42.44	70.27	0.00	42.92	32.92	40.50
1981-07	352.24	71.02	15.17	44.60	59.77	15.17	59.77	98.96	0.00	43.37	32.92	42.50
1981-08	363.49	157.30	15.17	38.66	53.83	15.17	77.29	127.97	0.00	46.33	32.92	44.25
1981-09	443.50	154.33	14.68	51.23	65.91	14.68	70.91	117.41	83.41	46.33	32.92	46.33
1981-10	443.50	159.03	18.96	89.23	108.19	18.96	117.44	194.44	41.59	46.33	32.92	46.00
1981-11	443.50	94.27	18.35	104.57	122.92	18.35	117.44	194.44	0.00	45.52	32.92	44.50
1981-12	420.33	38.88	18.96	106.35	125.31	18.96	117.44	194.44	0.00	42.49	34.50	42.00
1982-01	341.77	8.78	16.15	60.78	76.93	16.15	76.93	127.37	0.00	39.48	34.00	37.25
1982-02	273.62	1.78	0.00	6.32	6.32	0.00	6.32	10.46	0.00	39.22	33.50	34.00
1982-03	269.09	2.92	0.00	3.60	3.60	0.00	3.60	5.89	0.00	39.18	33.30	33.75
1982-04	268.40	13.96	0.00	4.40	4.40	0.00	4.40	7.29	0.00	39.70	33.15	33.75
1982-05	277.96	6.65	0.00	5.20	5.20	0.00	5.20	8.61	0.00	39.76	33.00	33.75

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Tir_Dem m m3	Ds_Dem m m3	Tot_Dem m m3	Rel_Ir m m3	Tot_Rel m m3	Pw_Gen M kwh	Spill m m3	End_Lev m	Low_Rul m	Upr_Rul m
1982-06	279.42	38.40	14.68	7.10	21.78	14.68	21.78	36.06	0.00	40.49	32.92	40.50
1982-07	296.03	63.57	15.17	6.30	21.47	15.17	21.47	35.55	0.00	42.34	32.92	42.50
1982-08	338.14	66.35	15.17	4.50	19.67	15.17	19.67	32.57	0.00	44.21	32.92	44.25
1982-09	384.81	22.60	14.68	31.90	46.58	14.68	46.58	77.13	0.00	43.26	32.92	46.33
1982-10	360.83	27.84	18.96	90.26	109.22	18.96	109.22	180.84	0.00	39.76	32.92	46.00
1982-11	279.44	109.81	18.35	90.17	108.52	18.35	108.52	179.67	0.00	39.81	32.92	44.50
1982-12	280.74	36.84	18.96	94.04	113.00	18.96	100.51	166.08	0.00	36.48	34.50	42.00
1983-01	217.07	6.51	16.15	37.86	54.01	16.15	46.60	73.31	0.00	34.00	34.00	37.25
1983-02	176.98	0.74	0.00	3.40	3.40	0.00	3.40	5.41	0.00	33.82	33.50	34.00
1983-03	174.32	0.25	0.00	3.60	3.60	0.00	3.60	5.65	0.00	33.60	33.30	33.75
1983-04	170.97	1.64	0.00	4.40	4.40	0.00	4.40	6.82	0.00	33.41	33.15	33.75
1983-05	168.21	7.19	0.00	5.20	5.20	0.00	5.20	8.08	0.00	33.55	33.00	33.75
1983-06	170.21	30.36	14.68	15.36	30.04	14.68	23.48	37.03	0.00	34.01	32.92	40.50
1983-07	177.08	60.26	15.17	21.62	36.79	15.17	36.79	58.02	0.00	35.50	32.92	42.50
1983-08	200.55	100.10	15.17	18.16	33.33	15.17	33.33	52.30	0.00	39.13	32.92	44.25
1983-09	267.31	59.81	14.68	51.23	65.91	14.68	65.91	106.16	0.00	38.82	32.92	46.33
1983-10	261.21	75.52	18.96	89.23	108.19	18.96	100.85	166.47	0.00	37.51	32.92	46.00
1983-11	235.88	90.22	18.35	104.57	122.92	18.35	95.16	149.15	0.00	37.24	32.92	44.50
1983-12	230.94	45.22	18.96	106.35	125.31	18.96	73.41	115.61	0.00	35.64	34.50	42.00
1984-01	202.75	43.72	16.15	60.78	76.93	16.15	50.79	81.81	0.00	35.22	34.00	37.25
1984-02	195.68	55.53	0.00	6.32	6.32	0.00	6.32	9.96	0.00	38.01	33.50	34.00
1984-03	244.90	94.41	0.00	3.60	3.60	0.00	3.60	5.96	0.00	42.23	33.30	33.75
1984-04	335.70	35.45	0.00	4.40	4.40	0.00	4.40	7.29	0.00	43.50	33.15	33.75
1984-05	366.76	11.50	0.00	5.20	5.20	0.00	5.20	8.61	0.00	43.75	33.00	33.75
1984-06	373.05	85.32	14.68	27.76	42.44	14.68	42.44	70.27	0.00	45.36	32.92	40.50
1984-07	415.93	168.29	15.17	44.60	59.77	15.17	117.44	194.44	23.28	46.33	32.92	42.50
1984-08	443.50	59.24	15.17	38.66	53.83	15.17	59.24	98.08	0.00	46.33	32.92	44.25
1984-09	443.50	60.06	14.68	51.23	65.91	14.68	65.91	109.13	0.00	46.13	32.92	46.33
1984-10	437.65	66.74	18.96	89.23	108.19	18.96	108.19	179.14	0.00	44.64	32.92	46.00
1984-11	396.20	78.04	18.35	104.57	122.92	18.35	117.44	194.44	0.00	43.10	32.92	44.50
1984-12	356.80	18.09	18.96	106.35	125.31	18.96	117.44	194.44	0.00	38.64	34.50	42.00
1985-01	257.45	67.03	16.15	60.78	76.93	16.15	76.93	125.73	0.00	38.15	34.00	37.25
1985-02	247.55	26.65	0.00	6.32	6.32	0.00	6.32	10.29	0.00	39.16	33.50	34.00
1985-03	267.88	16.76	0.00	3.60	3.60	0.00	3.60	5.96	0.00	39.82	33.30	33.75
1985-04	281.05	32.48	0.00	4.40	4.40	0.00	4.40	7.29	0.00	41.10	33.15	33.75
1985-05	309.13	7.42	0.00	5.20	5.20	0.00	5.20	8.61	0.00	41.19	33.00	33.75
1985-06	311.34	132.98	14.68	27.76	42.44	14.68	42.44	70.27	0.00	44.85	32.92	40.50
1985-07	401.88	106.39	15.17	44.60	59.77	15.17	64.77	107.24	0.00	46.33	32.92	42.50
1985-08	443.50	45.76	15.17	38.66	53.83	15.17	53.83	89.13	0.00	46.05	32.92	44.25
1985-09	435.43	41.23	14.68	51.23	65.91	14.68	65.91	109.13	0.00	45.17	32.92	46.33
1985-10	410.75	55.95	18.96	89.23	108.19	18.96	108.19	179.14	0.00	43.17	32.92	46.00
1985-11	358.51	98.23	18.35	104.57	122.92	18.35	117.44	194.44	0.00	42.39	32.92	44.50
1985-12	339.30	59.07	18.96	106.35	125.31	18.96	117.44	194.44	0.00	39.82	34.50	42.00
1986-01	280.93	17.13	16.15	60.78	76.93	16.15	76.93	126.42	0.00	36.72	34.00	37.25
1986-02	221.13	27.24	0.00	6.32	6.32	0.00	6.32	9.91	0.00	37.85	33.50	34.00
1986-03	242.06	15.60	0.00	3.60	3.60	0.00	3.60	5.94	0.00	38.47	33.30	33.75
1986-04	254.06	18.21	0.00	4.40	4.40	0.00	4.40	7.13	0.00	39.16	33.15	33.75
1986-05	267.87	8.61	0.00	5.20	5.20	0.00	5.20	8.55	0.00	39.33	33.00	33.75
1986-06	271.28	28.52	14.68	7.10	21.78	14.68	21.78	36.06	0.00	39.71	32.92	40.50
1986-07	278.01	51.90	15.17	6.30	21.47	15.17	21.47	35.55	0.00	41.06	32.92	42.50
1986-08	308.45	146.48	15.17	4.50	19.67	15.17	19.67	32.57	0.00	46.05	32.92	44.25
1986-09	435.26	25.34	14.68	33.11	47.79	14.68	47.79	79.13	0.00	45.25	32.92	46.33
1986-10	412.81	51.82	18.96	96.62	115.58	18.96	115.58	191.36	0.00	42.79	32.92	46.00
1986-11	349.05	61.56	18.35	101.43	119.78	18.35	117.44	194.44	0.00	40.36	32.92	44.50
1986-12	293.17	24.49	18.96	105.98	124.94	18.96	103.41	169.45	0.00	36.31	34.50	42.00
1987-01	214.26	14.78	16.15	47.53	63.68	16.15	48.71	76.53	0.00	34.22	34.00	37.25
1987-02	180.33	3.17	0.00	6.32	6.32	0.00	6.32	10.23	0.00	34.01	33.50	34.00
1987-03	177.18	6.97	0.00	3.60	3.60	0.00	3.60	5.83	0.00	34.24	33.30	33.75
1987-04	180.55	3.28	0.00	4.40	4.40	0.00	4.40	7.10	0.00	34.17	33.15	33.75
1987-05	179.43	12.69	0.00	5.20	5.20	0.00	5.20	8.28	0.00	34.66	33.00	33.75
1987-06	186.92	19.99	14.68	7.10	21.78	14.68	21.78	34.47	0.00	34.54	32.92	40.50
1987-07	185.13	9.54	15.17	6.30	21.47	15.17	21.47	34.81	0.00	33.75	32.92	42.50
1987-08	173.21	43.41	15.17	4.50	19.67	15.17	19.67	31.20	0.00	35.28	32.92	44.25
1987-09	196.95	25.34	14.68	31.90	46.58	14.68	43.13	68.07	0.00	34.14	32.92	46.33
1987-10	179.16	94.69	18.96	90.26	109.22	18.96	51.44	84.37	0.00	36.78	32.92	46.00
1987-11	222.41	87.75	18.35	90.17	108.52	18.35	84.83	133.84	0.00	37.28	32.92	44.50
1987-12	225.33	84.24	18.96	94.04	113.00	18.96	87.39	137.65	0.00	37.25	34.50	42.00
1988-01	222.18	20.44	16.15	37.86	54.01	16.15	54.01	91.60	0.00	34.77	34.00	37.25
1988-02	188.62	6.17	0.00	3.40	3.40	0.00	3.40	5.38	0.00	34.94	33.50	34.00
1988-03	191.39	12.63	0.00	3.60	3.60	0.00	3.60	5.67	0.00	35.49	33.30	33.75
1988-04	200.42	24.72	0.00	4.40	4.40	0.00	4.40	6.93	0.00	36.69	33.15	33.75
1988-05	220.74	9.54	0.00	5.20	5.20	0.00	5.20	8.23	0.00	36.93	33.00	33.75

Number of months of water supply failure = 0, Monthly Time Reliability = 100%
Number of months of full irrigation failure = 0, Monthly Time Reliability = 100%
Number of months of marginal irr. failure = 0, Monthly Time Reliability = 100%
(Supply < 75% but > 50% of Irr. Demand)
Number of months of critical irr. failure = 0, Monthly Time Reliability = 100%
(Supply < 50% of Irrigation Demand)

TABLE - 10
Monthly Operation Simulation of Vaigai Reservoir
Using Recommended Policy

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Ws_Dem m m3	Releas m m3	PW_Gen M kwh	Spill m m3	End_Lev m
1962-06	100.00	12.44	9.30	3.53	0.00	7.10	7.10	0.41	0.00	276.27
1962-07	111.12	25.36	71.89	4.08	38.30	6.30	44.60	2.76	0.00	278.59
1962-08	159.66	30.88	33.42	5.59	34.16	4.50	38.66	2.53	5.79	279.20
1962-09	173.95	16.16	12.39	4.20	57.92	2.00	59.92	3.85	0.00	277.63
1962-10	138.39	105.04	96.10	4.10	102.51	2.10	104.61	6.71	56.87	279.20
1962-11	173.95	43.47	101.84	3.13	122.44	0.50	122.94	8.12	19.24	279.20
1962-12	173.95	39.95	101.32	2.68	123.47	1.40	124.87	8.25	13.73	279.20
1963-01	173.95	15.97	63.20	3.22	69.15	2.00	71.15	4.70	4.80	279.20
1963-02	173.95	11.67	6.32	3.37	3.43	3.40	6.83	0.45	7.78	279.20
1963-03	173.95	34.63	3.60	4.56	0.00	3.60	3.60	0.24	30.07	279.20
1963-04	173.95	8.44	4.40	4.70	0.00	4.40	4.40	0.29	3.75	279.20
1963-05	173.95	4.47	5.20	5.98	0.00	5.20	5.20	0.34	0.00	279.13
1963-06	172.45	5.08	17.57	4.57	20.66	7.10	27.76	1.82	0.00	278.72
1963-07	162.76	20.47	23.90	4.50	38.30	6.30	44.60	2.88	0.00	278.52
1963-08	158.02	26.22	20.44	5.45	34.16	4.50	38.66	2.50	0.00	278.53
1963-09	160.57	25.52	53.43	4.36	57.92	2.00	59.92	3.92	1.29	279.20
1963-10	173.95	41.87	92.08	4.35	102.51	2.10	104.61	6.91	24.98	279.20
1963-11	173.95	124.74	101.84	3.13	122.44	0.50	122.94	8.12	100.52	279.20
1963-12	173.95	213.63	101.32	2.68	123.47	1.40	124.87	8.25	187.41	279.20
1964-01	173.95	17.31	61.81	3.22	69.15	2.00	71.15	4.70	4.74	279.20
1964-02	173.95	0.00	6.32	3.35	3.43	3.40	6.83	0.45	0.00	279.03
1964-03	170.09	0.00	3.60	4.47	0.00	3.60	3.60	0.24	0.00	278.34
1964-04	165.61	0.00	4.40	4.54	0.00	4.40	4.40	0.29	0.00	278.55
1964-05	161.07	7.81	5.20	5.76	0.00	5.20	5.20	0.34	0.00	278.74
1964-06	163.12	0.90	4.48	4.30	20.66	7.10	27.76	1.76	0.00	277.54
1964-07	136.44	24.06	21.78	4.10	38.30	6.30	44.60	2.76	0.00	277.40
1964-08	133.58	36.78	40.94	5.28	34.16	4.50	38.66	2.46	0.00	278.92
1964-09	167.35	21.26	53.43	4.41	57.92	2.00	59.92	3.94	3.76	279.20
1964-10	173.95	56.83	92.08	4.35	102.51	2.10	104.61	6.91	39.95	279.20
1964-11	173.95	112.07	101.84	3.13	122.44	0.50	122.94	8.12	87.85	279.20
1964-12	173.95	39.60	101.32	2.68	123.47	1.40	124.87	8.25	13.38	279.20
1965-01	173.95	32.99	36.80	3.20	69.15	2.00	71.15	4.69	0.00	279.00
1965-02	169.39	1.53	6.32	3.31	3.43	3.40	6.83	0.45	0.00	278.91
1965-03	167.09	6.18	3.60	4.47	0.00	3.60	3.60	0.24	0.00	278.98
1965-04	168.79	7.87	4.40	4.65	0.00	4.40	4.40	0.29	0.00	279.12
1965-05	172.01	1.63	5.20	5.91	0.00	5.20	5.20	0.34	0.00	278.93
1965-06	167.73	1.42	17.57	4.48	20.66	7.10	27.76	1.80	0.00	278.36
1965-07	154.48	3.76	23.90	4.24	38.30	6.30	44.60	2.80	0.00	277.38
1965-08	133.29	6.32	20.44	4.76	34.15	4.50	38.66	2.35	0.00	276.55
1965-09	116.63	13.32	26.06	3.34	57.92	2.00	59.92	3.48	0.00	275.21
1965-10	92.75	36.28	20.93	2.38	102.51	2.10	104.61	5.42	0.00	271.44
1965-11	42.96	37.70	35.40	0.49	122.44	0.50	114.11I	3.47	0.00	257.56
1965-12	1.46	86.91	54.33	0.27	123.47	1.40	124.87	3.24	0.00	267.80
1966-01	17.55	10.37	38.98	0.33	69.15	2.00	65.11I	1.69	0.00	257.56
1966-02	1.46	8.25	6.83	0.27	3.43	3.40	6.83	0.16	0.00	265.88
1966-03	9.44	10.36	3.60	1.09	0.00	3.60	3.60	0.13	0.00	268.02
1966-04	18.71	5.59	4.40	1.41	0.00	4.40	4.40	0.18	0.00	268.83
1966-05	22.89	8.19	5.20	2.02	0.00	5.20	5.20	0.22	0.00	269.81
1966-06	29.07	1.06	9.30	1.70	0.00	7.10	7.10	0.31	0.00	270.00
1966-07	30.63	15.11	46.88	1.94	38.30	6.30	44.60	2.04	0.00	271.72
1966-08	46.09	10.90	20.44	2.45	34.16	4.50	38.66	1.80	0.00	270.69
1966-09	36.32	27.19	53.43	2.00	57.92	2.00	59.92	2.85	0.00	272.51
1966-10	55.01	134.53	92.08	3.25	102.51	2.10	104.61	6.06	0.89	279.20
1966-11	173.76	137.26	101.84	3.12	122.44	0.50	122.94	8.12	112.84	279.19
1966-12	173.95	71.46	101.32	2.68	123.47	1.40	124.87	8.25	45.24	279.20
1967-01	173.95	4.32	63.20	3.19	69.15	2.00	71.15	4.68	0.00	278.91
1967-02	167.13	3.43	6.32	3.30	3.43	3.40	6.83	0.45	0.00	278.89
1967-03	166.76	7.87	3.60	4.48	0.00	3.60	3.60	0.24	0.00	279.04
1967-04	170.15	8.24	4.40	4.67	0.00	4.40	4.40	0.29	0.00	279.19
1967-05	173.72	4.52	5.20	5.97	0.00	5.20	5.20	0.34	0.00	279.13
1967-06	172.27	3.30	17.57	4.56	20.66	7.10	27.76	1.81	0.00	278.63
1967-07	160.82	3.06	23.90	4.34	38.30	6.30	44.60	2.83	0.00	277.65
1967-08	136.83	1.70	20.44	4.83	34.16	4.50	38.66	2.36	0.00	276.60
1967-09	117.49	1.11	53.43	3.50	57.92	2.00	59.92	3.55	0.00	276.12
1967-10	108.61	44.58	92.08	3.58	102.51	2.10	104.61	6.32	0.00	277.57
1967-11	137.07	65.43	88.55	2.90	122.44	0.50	122.94	7.83	0.00	278.83
1967-12	165.22	11.34	46.82	2.26	123.47	1.40	124.87	7.62	0.00	275.42
1968-01	96.24	5.03	4.42	1.67	69.15	2.00	71.15	3.60	0.00	270.27
1968-02	32.88	0.00	6.32	1.27	3.43	3.40	6.83	0.30	0.00	270.06
1968-03	31.09	0.25	3.60	1.67	0.00	3.60	3.60	0.16	0.00	269.88
1968-04	29.67	6.39	4.40	1.77	0.00	4.40	4.40	0.19	0.00	270.45
1968-05	34.28	0.84	5.20	2.31	0.00	5.20	5.20	0.23	0.00	270.26

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Ws_Den m m3	Releas m m3	PW_Gen M kwh	Spill m m3	End_Lev m
1968-06	32.81	0.56	9.30	1.80	0.00	7.10	7.10	0.32	0.00	270.38
1968-07	33.78	3.67	46.88	1.88	38.30	6.30	44.60	2.02	0.00	270.88
1968-08	37.84	3.26	40.94	2.41	34.16	4.50	38.66	1.79	0.00	271.26
1968-09	40.97	9.30	53.43	1.93	57.92	2.00	59.92	2.81	0.00	271.34
1968-10	41.85	6.48	92.08	1.79	102.51	2.10	104.61	4.80	0.00	270.41
1968-11	34.01	18.53	101.84	1.18	122.44	0.50	122.94	5.43	0.00	269.95
1968-12	30.26	36.17	100.23	1.06	123.47	1.40	124.87	5.64	0.00	271.22
1969-01	40.73	12.40	40.30	1.17	69.15	2.00	71.15	3.09	0.00	268.49
1969-02	21.12	3.78	6.32	1.05	3.43	3.40	6.83	0.28	0.00	268.93
1969-03	23.33	7.43	3.60	1.54	0.00	3.60	3.60	0.15	0.00	269.83
1969-04	29.22	22.27	4.40	1.95	0.00	4.40	4.40	0.20	0.00	272.02
1969-05	49.55	5.58	5.20	2.87	0.00	5.20	5.20	0.25	0.00	272.27
1969-06	52.25	0.19	9.30	2.27	0.00	7.10	7.10	0.35	0.00	272.28
1969-07	52.38	8.34	8.58	2.39	0.00	6.30	6.30	0.32	0.00	273.02
1969-08	60.60	31.11	6.78	3.41	0.00	4.50	4.50	0.24	0.00	275.08
1969-09	90.58	13.40	34.10	3.12	35.18	2.00	37.18	2.10	0.00	275.52
1969-10	97.79	55.57	93.11	3.48	103.72	2.10	105.82	6.31	0.00	277.57
1969-11	137.16	33.04	92.92	2.84	105.49	0.50	105.99	6.69	0.00	278.36
1969-12	154.29	33.92	79.89	2.51	108.99	1.40	110.39	7.07	0.00	278.40
1970-01	155.20	1.12	37.47	2.99	42.19	2.00	44.19	2.81	0.00	278.03
1970-02	146.61	0.00	3.40	3.06	0.00	3.40	3.40	0.21	0.00	277.88
1970-03	143.55	2.23	3.60	4.10	0.00	3.60	3.60	0.23	0.00	277.79
1970-04	141.68	0.15	4.40	4.17	0.00	4.40	4.40	0.27	0.00	277.60
1970-05	137.66	1.73	5.20	5.24	0.00	5.20	5.20	0.32	0.00	277.43
1970-06	134.15	2.18	9.30	4.05	0.00	7.10	7.10	0.44	0.00	277.44
1970-07	134.48	5.46	23.90	3.92	38.30	6.30	44.60	2.71	0.00	276.48
1970-08	115.32	9.51	40.94	4.63	34.16	4.50	38.66	2.32	0.00	276.86
1970-09	122.47	21.72	53.43	3.77	57.92	2.00	59.92	3.66	0.00	277.42
1970-10	133.94	50.11	92.08	4.02	102.51	2.10	104.61	6.65	0.00	278.92
1970-11	167.50	49.83	101.84	3.09	122.44	0.50	122.94	8.08	19.18	279.20
1970-12	173.95	12.79	101.29	2.62	123.47	1.40	124.87	8.17	0.00	278.62
1971-01	160.54	20.07	36.84	3.00	69.15	2.00	71.15	4.54	0.00	277.87
1971-02	143.30	0.70	6.32	3.02	3.43	3.40	6.83	0.43	0.00	277.73
1971-03	140.46	0.00	3.60	4.03	0.00	3.60	3.60	0.22	0.00	277.54
1971-04	136.43	0.00	4.40	4.08	0.00	4.40	4.40	0.27	0.00	277.34
1971-05	132.35	14.08	5.20	5.26	0.00	5.20	5.20	0.32	0.00	277.77
1971-06	141.17	0.00	9.30	4.16	0.00	7.10	7.10	0.44	0.00	277.67
1971-07	139.21	0.52	23.90	3.96	38.30	6.30	44.60	2.72	0.00	276.47
1971-08	115.07	11.77	40.94	4.65	34.16	4.50	38.66	2.32	0.00	276.96
1971-09	124.47	6.04	53.43	3.67	57.92	2.00	59.92	3.62	0.00	276.76
1971-10	120.36	59.87	92.08	3.89	102.51	2.10	104.61	6.55	0.00	278.77
1971-11	163.81	37.04	101.84	3.08	122.44	0.50	122.94	8.06	2.73	279.20
1971-12	173.95	177.19	101.32	2.68	123.47	1.40	124.87	8.25	150.97	279.20
1972-01	173.95	0.00	63.20	3.17	69.15	2.00	71.15	4.66	0.00	278.72
1972-02	162.83	0.00	6.32	3.23	3.43	3.40	6.83	0.44	0.00	278.56
1972-03	159.09	0.00	3.60	4.31	0.00	3.60	3.60	0.23	0.00	278.38
1972-04	154.77	0.00	4.40	4.38	0.00	4.40	4.40	0.28	0.00	278.19
1972-05	150.39	0.00	5.20	5.49	0.00	5.20	5.20	0.33	0.00	277.95
1972-06	144.90	3.44	29.96	4.25	20.66	7.10	27.76	1.75	0.00	278.02
1972-07	146.30	0.00	46.88	4.28	38.30	6.30	44.60	2.81	0.00	277.92
1972-08	144.29	0.00	40.94	5.15	34.16	4.50	38.66	2.43	0.00	277.78
1972-09	141.42	32.18	53.43	4.15	57.92	2.00	59.92	3.82	0.00	278.74
1972-10	162.97	50.48	92.08	4.28	102.51	2.10	104.61	6.85	22.69	279.20
1972-11	173.95	125.00	101.84	3.13	122.44	0.50	122.94	8.12	100.78	279.20
1972-12	173.95	23.68	101.32	2.67	123.47	1.40	124.87	8.24	0.00	279.09
1973-01	171.42	13.95	59.11	3.19	69.15	2.00	71.15	4.68	0.00	279.04
1973-02	170.14	0.00	6.32	3.31	3.43	3.40	6.83	0.45	0.00	278.87
1973-03	166.32	0.00	3.60	4.42	0.00	3.60	3.60	0.23	0.00	278.68
1973-04	161.90	5.39	4.40	4.53	0.00	4.40	4.40	0.29	0.00	278.72
1973-05	162.77	2.88	5.20	5.75	0.00	5.20	5.20	0.34	0.00	278.60
1973-06	159.90	4.82	17.57	4.39	20.66	7.10	27.76	1.78	0.00	278.18
1973-07	150.13	0.00	23.90	4.14	38.30	6.30	44.60	2.77	0.00	277.00
1973-08	125.29	0.00	20.44	4.51	34.16	4.50	38.66	2.29	0.00	275.80
1973-09	102.56	12.41	53.43	3.34	57.92	2.00	59.92	3.48	0.00	275.94
1973-10	105.15	46.61	92.08	3.54	102.51	2.10	104.61	6.28	0.00	277.50
1973-11	135.69	16.55	101.84	2.69	122.44	0.50	122.94	7.57	0.00	277.15
1973-12	128.45	86.47	87.22	2.47	123.47	1.40	124.87	7.94	0.85	279.20
1974-01	173.95	2.35	63.20	3.18	69.15	2.00	71.15	4.67	0.00	278.82
1974-02	165.18	0.00	6.32	3.26	3.43	3.40	6.83	0.44	0.00	278.66
1974-03	161.40	0.00	3.60	4.35	0.00	3.60	3.60	0.23	0.00	278.47
1974-04	157.06	5.28	4.40	4.45	0.00	4.40	4.40	0.28	0.00	278.51
1974-05	157.88	0.27	5.20	5.63	0.00	5.20	5.20	0.33	0.00	278.28

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Ws_Dem m m3	Releas m m3	PW_Gen M kwh	Spill m m3	End_Lev m
1974-06	152.52	0.73	17.57	4.24	20.66	7.10	27.76	1.75	0.00	277.65
1974-07	138.81	0.00	23.90	3.94	38.30	6.30	44.60	2.71	0.00	276.42
1974-08	114.16	0.00	40.94	4.50	34.16	4.50	38.66	2.29	0.00	276.30
1974-09	111.94	3.37	53.43	3.42	57.92	2.00	59.92	3.51	0.00	275.95
1974-10	105.40	7.84	92.08	3.20	102.51	2.10	104.61	6.03	0.00	275.49
1974-11	97.50	17.09	101.84	2.19	122.44	0.50	122.94	6.96	0.00	275.12
1974-12	91.30	0.29	101.32	1.65	123.47	1.40	124.87	6.76	0.00	273.46
1975-01	66.40	0.00	39.86	1.50	69.15	2.00	71.15	3.44	0.00	270.36
1975-02	33.60	0.00	6.32	1.29	3.43	3.40	6.83	0.30	0.00	270.14
1975-03	31.81	0.00	3.60	1.69	0.00	3.60	3.60	0.16	0.00	269.94
1975-04	30.11	4.05	4.40	1.75	0.00	4.40	4.40	0.19	0.00	270.22
1975-05	32.41	0.00	5.20	2.23	0.00	5.20	5.20	0.23	0.00	269.94
1975-06	30.18	0.00	9.30	1.72	0.00	7.10	7.10	0.31	0.00	270.01
1975-07	30.66	19.15	8.58	1.98	0.00	6.30	6.30	0.29	0.00	272.08
1975-08	50.11	6.65	79.67	3.66	0.00	4.50	4.50	0.25	0.00	277.14
1975-09	128.27	72.41	53.52	4.12	36.60	2.00	38.60	2.45	37.54	279.20
1975-10	173.95	13.74	99.46	4.32	111.20	2.10	113.30	7.46	0.00	279.01
1975-11	169.53	21.05	101.84	3.09	118.74	0.50	119.24	7.83	0.00	279.04
1975-12	170.10	4.54	101.32	2.55	123.04	1.40	124.44	8.04	0.00	278.13
1976-01	148.96	0.00	49.95	2.92	53.56	2.00	55.56	3.50	0.00	277.73
1976-02	140.43	5.40	6.32	3.02	3.43	3.40	6.83	0.43	0.00	277.83
1976-03	142.31	2.42	3.60	4.08	0.00	3.60	3.60	0.23	0.00	277.74
1976-04	140.65	0.85	4.40	4.16	0.00	4.40	4.40	0.27	0.00	277.58
1976-05	137.33	0.00	5.20	5.21	0.00	5.20	5.20	0.32	0.00	277.33
1976-06	132.13	0.00	9.30	4.00	0.00	7.10	7.10	0.44	0.00	277.24
1976-07	130.33	0.00	23.90	3.79	38.30	6.30	44.60	2.67	0.00	275.98
1976-08	105.83	0.24	20.44	4.01	34.16	4.50	38.66	2.19	0.00	274.68
1976-09	83.84	1.13	36.49	2.57	57.92	2.00	59.92	3.17	0.00	272.87
1976-10	58.97	40.94	9.55	1.19	102.51	2.10	104.61	4.02	0.00	262.76
1976-11	3.66	136.24	52.72	0.91	122.44	0.50	122.94	4.84	0.00	273.63
1976-12	68.77	22.97	54.99	1.12	123.47	1.40	124.87	5.77	0.00	268.42
1977-01	20.73	0.00	21.47	0.36	69.15	2.00	40.38M	1.08	0.00	257.56
1977-02	1.46	4.69	6.83	0.22	3.43	3.40	6.83	0.15	0.00	264.24
1977-03	5.92	5.45	3.60	0.81	0.00	3.60	3.60	0.12	0.00	266.26
1977-04	10.56	4.71	4.40	1.08	0.00	4.40	4.40	0.16	0.00	267.15
1977-05	14.19	11.04	5.20	1.70	0.00	5.20	5.20	0.20	0.00	268.96
1977-06	23.53	0.00	9.30	1.51	0.00	7.10	7.10	0.29	0.00	269.09
1977-07	24.22	0.26	46.88	1.56	38.30	6.30	44.60	1.86	0.00	269.29
1977-08	25.20	0.00	20.44	1.30	34.16	4.50	38.66	1.38	0.00	264.08
1977-09	5.67	31.19	62.12	1.16	57.92	2.00	59.92	2.25	0.00	270.88
1977-10	37.90	351.04	88.90	2.95	102.51	2.10	104.61	5.86	196.33	279.20
1977-11	173.95	487.85	38.97	3.13	122.44	0.50	122.94	8.12	400.75	279.20
1977-12	173.95	35.78	101.32	2.68	123.47	1.40	124.87	8.25	9.55	279.20
1978-01	173.95	25.20	63.20	3.22	69.15	2.00	71.15	4.70	14.02	279.20
1978-02	173.95	16.36	6.32	3.37	3.43	3.40	6.83	0.45	12.47	279.20
1978-03	173.95	6.34	3.60	4.56	0.00	3.60	3.60	0.24	1.78	279.20
1978-04	173.95	0.00	4.40	4.66	0.00	4.40	4.40	0.29	0.00	279.00
1978-05	169.29	0.00	5.20	5.85	0.00	5.20	5.20	0.34	0.00	278.75
1978-06	163.44	0.00	29.96	4.50	20.66	7.10	27.76	1.80	0.00	278.65
1978-07	161.15	0.71	46.33	4.50	38.30	6.30	44.60	2.88	0.00	278.59
1978-08	159.62	0.60	40.94	5.44	34.16	4.50	38.66	2.49	0.00	278.48
1978-09	157.07	5.62	53.43	4.18	57.92	2.00	59.92	3.84	0.00	278.26
1978-10	152.02	79.16	92.08	4.20	102.51	2.10	104.61	6.79	40.50	279.20
1978-11	173.95	62.73	101.84	3.13	122.44	0.50	122.94	8.12	38.51	279.20
1978-12	173.95	170.70	101.32	2.68	123.47	1.40	124.87	8.25	144.48	279.20
1979-01	173.95	8.56	63.20	3.21	69.15	2.00	71.15	4.69	0.00	279.09
1979-02	171.35	0.00	6.32	3.32	3.43	3.40	6.83	0.45	0.00	278.92
1979-03	167.51	0.00	3.60	4.43	0.00	3.60	3.60	0.23	0.00	278.73
1979-04	163.08	25.36	4.40	4.62	0.00	4.40	4.40	0.29	9.87	279.20
1979-05	173.95	8.23	5.20	5.99	0.00	5.20	5.20	0.34	2.24	279.20
1979-06	173.95	0.75	17.57	4.56	20.66	7.10	27.76	1.81	0.00	278.60
1979-07	159.94	1.19	46.88	4.49	38.30	6.30	44.60	2.88	0.00	278.56
1979-08	158.92	0.00	40.94	5.42	34.16	4.50	38.66	2.49	0.00	278.42
1979-09	155.77	0.00	53.43	4.12	57.92	2.00	59.92	3.81	0.00	277.96
1979-10	145.17	0.00	92.08	3.82	102.51	2.10	104.61	6.59	0.00	277.16
1979-11	128.81	699.14	-19.52	2.89	122.44	0.50	122.94	7.82	508.66	279.20
1979-12	173.95	126.37	101.32	2.68	123.47	1.40	124.87	8.25	100.15	279.20
1980-01	173.95	0.00	63.20	3.17	69.15	2.00	71.15	4.65	0.00	278.72
1980-02	162.83	0.00	6.32	3.23	3.43	3.40	6.83	0.44	0.00	278.56
1980-03	159.09	0.00	3.60	4.31	0.00	3.60	3.60	0.23	0.00	278.38
1980-04	154.77	0.00	4.40	4.38	0.00	4.40	4.40	0.28	0.00	278.19
1980-05	150.39	1.72	5.20	5.51	0.00	5.20	5.20	0.33	0.00	278.03

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Ws_Dem m m3	Releas m m3	PW_Gen M kwh	Spill m m3	End_Lev m
1980-06	146.60	0.00	29.96	4.25	20.66	7.10	27.76	1.75	0.00	277.93
1980-07	144.56	0.00	46.88	4.25	38.30	6.30	44.60	2.81	0.00	277.84
1980-08	142.58	0.00	70.36	5.39	34.16	4.50	38.66	2.48	0.00	278.98
1980-09	168.90	26.22	53.43	4.42	57.92	2.00	59.92	3.94	10.26	279.20
1980-10	173.95	70.91	92.08	4.35	102.51	2.10	104.61	6.91	54.02	279.20
1980-11	173.95	139.37	101.84	3.13	122.44	0.50	122.94	8.12	115.14	279.20
1980-12	173.95	36.62	101.32	2.68	123.47	1.40	124.87	8.25	10.39	279.20
1981-01	173.95	0.00	63.20	3.17	69.15	2.00	71.15	4.66	0.00	278.72
1981-02	162.83	0.00	6.32	3.23	3.43	3.40	6.83	0.44	0.00	278.56
1981-03	159.09	0.00	3.60	4.31	0.00	3.60	3.60	0.23	0.00	278.38
1981-04	154.77	0.65	4.40	4.39	0.00	4.40	4.40	0.28	0.00	278.22
1981-05	151.04	0.85	5.20	5.51	0.00	5.20	5.20	0.33	0.00	278.02
1981-06	146.38	5.25	29.96	4.28	20.66	7.10	27.76	1.76	0.00	278.16
1981-07	149.55	0.00	46.88	4.33	38.30	6.30	44.60	2.83	0.00	278.07
1981-08	147.50	1.15	64.40	5.44	34.16	4.50	38.66	2.49	0.00	278.99
1981-09	168.95	26.69	-24.98	3.89	57.92	2.00	59.92	3.71	0.00	276.03
1981-10	106.85	0.88	59.74	2.75	102.51	2.10	104.61	5.72	0.00	272.97
1981-11	60.11	28.66	101.84	1.68	122.44	0.50	122.94	6.33	0.00	273.43
1981-12	65.99	9.17	101.32	1.37	123.47	1.40	124.87	6.30	0.00	272.08
1982-01	50.24	0.00	63.20	1.46	69.15	2.00	71.15	3.40	0.00	271.23
1982-02	40.83	0.00	6.32	1.43	3.43	3.40	6.83	0.32	0.00	271.00
1982-03	38.89	0.00	3.60	1.88	0.00	3.60	3.60	0.17	0.00	270.77
1982-04	37.01	0.00	4.40	1.89	0.00	4.40	4.40	0.20	0.00	270.54
1982-05	35.12	0.00	5.20	2.33	0.00	5.20	5.20	0.23	0.00	270.26
1982-06	32.79	0.00	9.30	1.79	0.00	7.10	7.10	0.32	0.00	270.31
1982-07	33.21	0.00	8.58	1.82	0.00	6.30	6.30	0.28	0.00	270.37
1982-08	33.67	0.00	6.78	2.21	0.00	4.50	4.50	0.20	0.00	270.37
1982-09	33.73	10.08	34.10	1.80	35.18	2.00	37.18	1.69	0.00	271.02
1982-10	38.94	7.35	93.11	1.73	103.72	2.10	105.82	4.78	0.00	270.15
1982-11	31.85	72.97	92.92	1.58	105.49	0.50	105.99	5.31	0.00	275.06
1982-12	90.17	8.54	84.39	1.67	108.99	1.40	110.39	6.02	0.00	273.80
1983-01	71.04	15.89	32.87	1.89	42.19	2.00	44.19	2.35	0.00	274.01
1983-02	73.72	50.17	3.40	2.39	0.00	3.40	3.40	0.19	0.00	276.81
1983-03	121.51	249.93	3.60	4.16	0.00	3.60	3.60	0.23	193.33	279.20
1983-04	173.95	24.45	4.40	4.70	0.00	4.40	4.40	0.29	19.75	279.20
1983-05	173.95	0.00	5.20	5.93	0.00	5.20	5.20	0.34	0.00	278.94
1983-06	168.02	4.18	11.01	4.45	20.66	7.10	27.76	1.79	0.00	278.21
1983-07	150.99	0.00	23.90	4.16	38.30	6.30	44.60	2.78	0.00	277.04
1983-08	126.13	0.00	20.44	4.53	34.16	4.50	38.66	2.30	0.00	275.85
1983-09	103.38	0.00	53.43	3.22	57.92	2.00	59.92	3.43	0.00	275.26
1983-10	93.68	30.00	84.73	3.11	102.51	2.10	104.61	5.97	0.00	275.69
1983-11	100.69	58.04	79.56	2.38	122.44	0.50	122.94	7.18	0.00	276.37
1983-12	112.97	30.09	57.30	1.84	123.47	1.40	124.87	7.03	0.00	274.00
1984-01	73.64	18.44	37.06	1.76	69.15	2.00	71.15	3.68	0.00	272.62
1984-02	56.24	0.00	6.32	1.69	3.43	3.40	6.83	0.34	0.00	272.42
1984-03	54.04	0.00	3.60	2.23	0.00	3.60	3.60	0.18	0.00	272.22
1984-04	51.81	0.00	4.40	2.25	0.00	4.40	4.40	0.22	0.00	272.02
1984-05	49.56	0.00	5.20	2.79	0.00	5.20	5.20	0.25	0.00	271.77
1984-06	46.77	0.00	29.96	2.14	20.66	7.10	27.76	1.33	0.00	271.78
1984-07	46.83	0.59	81.27	2.52	38.30	6.30	44.60	2.29	0.00	274.53
1984-08	81.56	0.00	46.34	3.68	34.16	4.50	38.66	2.13	0.00	274.78
1984-09	85.57	18.05	53.43	3.02	57.92	2.00	59.92	3.35	0.00	275.30
1984-10	94.11	5.27	92.08	2.92	102.51	2.10	104.61	5.84	0.00	274.68
1984-11	83.92	43.22	101.84	2.18	122.44	0.50	122.94	6.95	0.00	275.88
1984-12	103.87	6.43	101.32	1.87	123.47	1.40	124.87	7.07	0.00	274.73
1985-01	84.87	0.00	63.20	2.01	69.15	2.00	71.15	3.87	0.00	274.08
1985-02	74.91	1.87	6.32	2.01	3.43	3.40	6.83	0.37	0.00	274.04
1985-03	74.25	3.31	3.60	2.72	0.00	3.60	3.60	0.19	0.00	274.08
1985-04	74.84	0.00	4.40	2.78	0.00	4.40	4.40	0.23	0.00	273.88
1985-05	72.07	0.00	5.20	3.45	0.00	5.20	5.20	0.27	0.00	273.62
1985-06	68.62	0.06	29.96	2.64	20.66	7.10	27.76	1.46	0.00	273.59
1985-07	68.24	0.51	51.87	2.72	38.30	6.30	44.60	2.36	0.00	273.98
1985-08	73.30	0.00	40.94	3.36	34.16	4.50	38.66	2.06	0.00	273.89
1985-09	72.22	16.27	53.43	2.69	57.92	2.00	59.92	3.22	0.00	274.39
1985-10	79.31	22.34	92.08	2.78	102.51	2.10	104.61	5.75	0.00	274.83
1985-11	86.34	49.20	101.84	2.26	122.44	0.50	122.94	7.04	0.00	276.32
1985-12	112.18	5.32	101.32	1.97	123.47	1.40	124.87	7.20	0.00	275.16
1986-01	91.97	1.16	63.20	2.14	69.15	2.00	71.15	3.96	0.00	274.63
1986-02	83.05	0.00	6.32	2.14	3.43	3.40	6.83	0.37	0.00	274.45
1986-03	80.39	0.00	3.60	2.83	0.00	3.60	3.60	0.20	0.00	274.26
1986-04	77.57	0.00	4.40	2.84	0.00	4.40	4.40	0.24	0.00	274.07
1986-05	74.72	0.00	5.20	3.53	0.00	5.20	5.20	0.28	0.00	273.81

YYYY-Mn	Ini_Sto m m3	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Ws_Dem m m3	Releas m m3	PW_Gen M kwh	Spill m m3	End_Lev m
1986-06	71.20	0.00	9.30	2.70	0.00	7.10	7.10	0.38	0.00	273.78
1986-07	70.70	0.00	8.58	2.71	0.00	6.30	6.30	0.33	0.00	273.75
1986-08	70.26	11.12	6.78	3.43	0.00	4.50	4.50	0.24	0.00	274.45
1986-09	80.22	1.79	35.31	2.74	36.60	2.00	38.60	2.09	0.00	274.15
1986-10	75.99	24.50	99.46	2.72	111.20	2.10	113.30	6.17	0.00	274.69
1986-11	83.93	22.69	101.84	2.05	118.74	0.50	119.24	6.60	0.00	274.88
1986-12	87.18	4.66	87.29	1.52	123.04	1.40	124.44	6.53	0.00	272.35
1987-01	53.18	0.00	34.99	1.38	53.56	2.00	55.56	2.59	0.00	270.07
1987-02	31.22	0.00	6.32	1.24	3.43	3.40	6.83	0.30	0.00	269.86
1987-03	29.47	0.46	3.60	1.63	0.00	3.60	3.60	0.16	0.00	269.72
1987-04	28.30	4.52	4.40	1.71	0.00	4.40	4.40	0.19	0.00	270.07
1987-05	31.11	0.00	5.20	2.19	0.00	5.20	5.20	0.23	0.00	269.79
1987-06	28.93	0.00	9.30	1.68	0.00	7.10	7.10	0.31	0.00	269.86
1987-07	29.45	0.00	8.58	1.71	0.00	6.30	6.30	0.27	0.00	269.93
1987-08	30.01	0.00	6.78	2.09	0.00	4.50	4.50	0.20	0.00	269.95
1987-09	30.20	0.00	30.66	1.50	35.18	2.00	37.18	1.56	0.00	268.69
1987-10	22.17	108.18	35.32	1.76	103.72	2.10	105.82	4.82	0.00	272.79
1987-11	58.09	93.13	69.24	1.99	105.49	0.50	105.99	5.81	0.00	276.33
1987-12	112.48	16.19	71.28	1.95	108.99	1.40	110.39	6.34	0.00	274.89
1988-01	87.61	0.00	40.28	2.09	42.19	2.00	44.19	2.44	0.00	274.53
1988-02	81.62	0.00	3.40	2.12	0.00	3.40	3.40	0.19	0.00	274.39
1988-03	79.50	0.00	3.60	2.81	0.00	3.60	3.60	0.20	0.00	274.20
1988-04	76.69	0.55	4.40	2.83	0.00	4.40	4.40	0.24	0.00	274.05
1988-05	74.42	0.00	5.20	3.52	0.00	5.20	5.20	0.28	0.00	273.79

Number of months of water supply failure = 0, Monthly Time Reliability = 100%

Number of months of full irrigation failure = 3, Monthly Time Reliability = 99%
(Supply = 100% of Irrigation Demand)

Number of months of marginal irr. failure = 1, Monthly Time Reliability = 99.7%
(Supply < 75% but > 50% of Irr. Demand)

Number of months of critical irr. failure = 0, Monthly Time Reliability = 100%
(Supply < 50% of Irrigation Demand)

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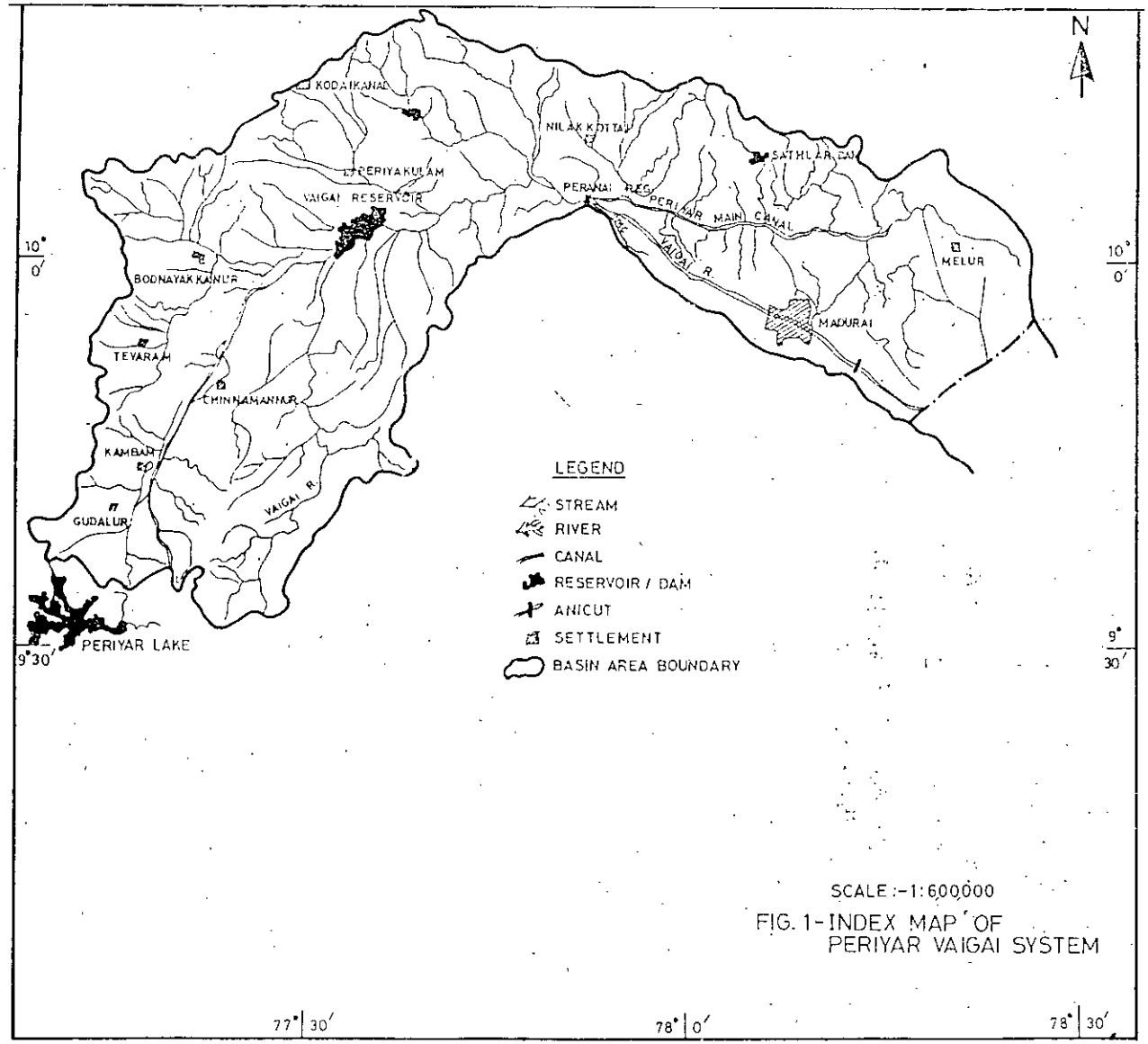

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FIG. 1-INDEX MAP OF PERIYAR VAIGAI SYSTEM

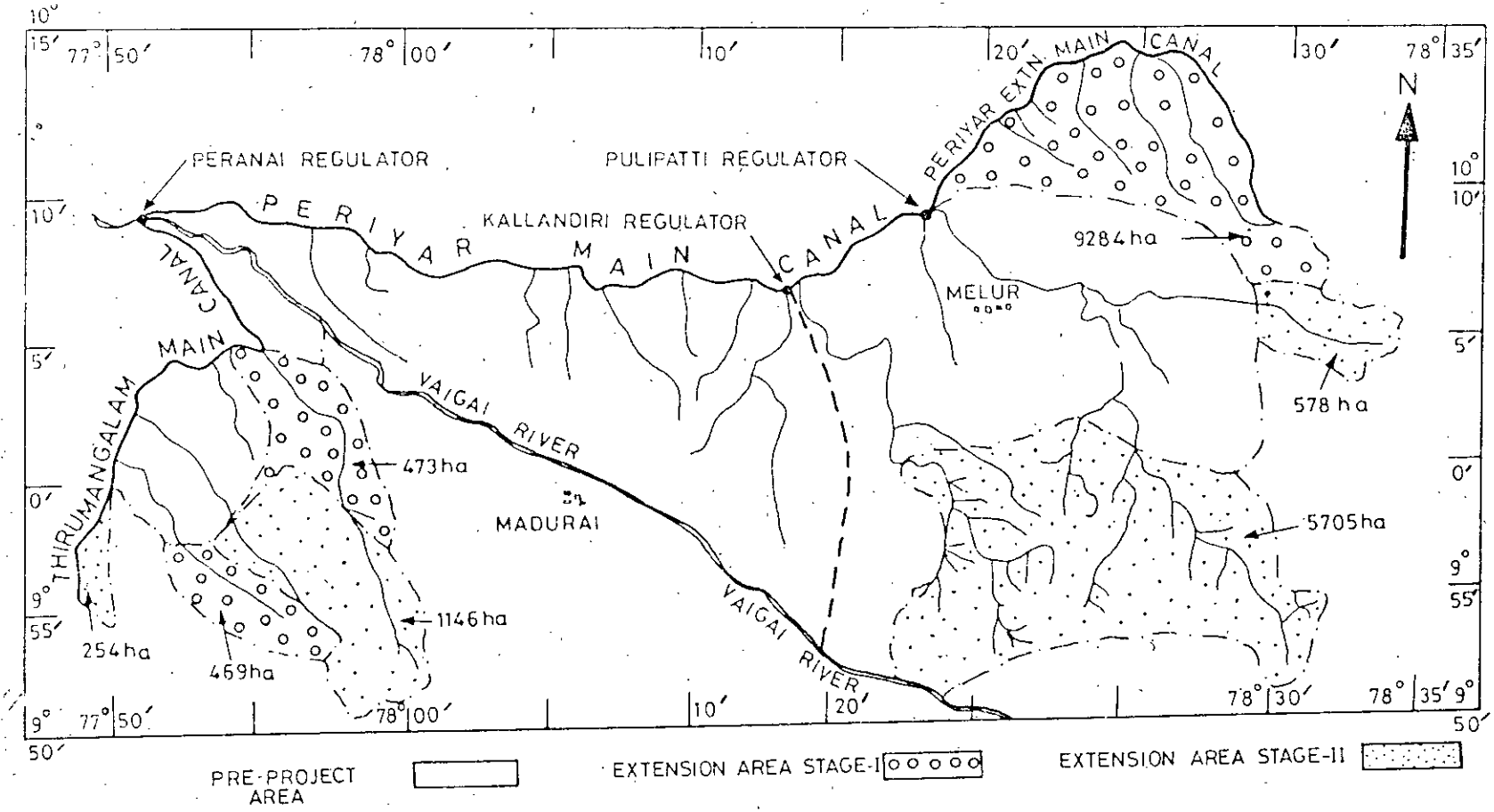
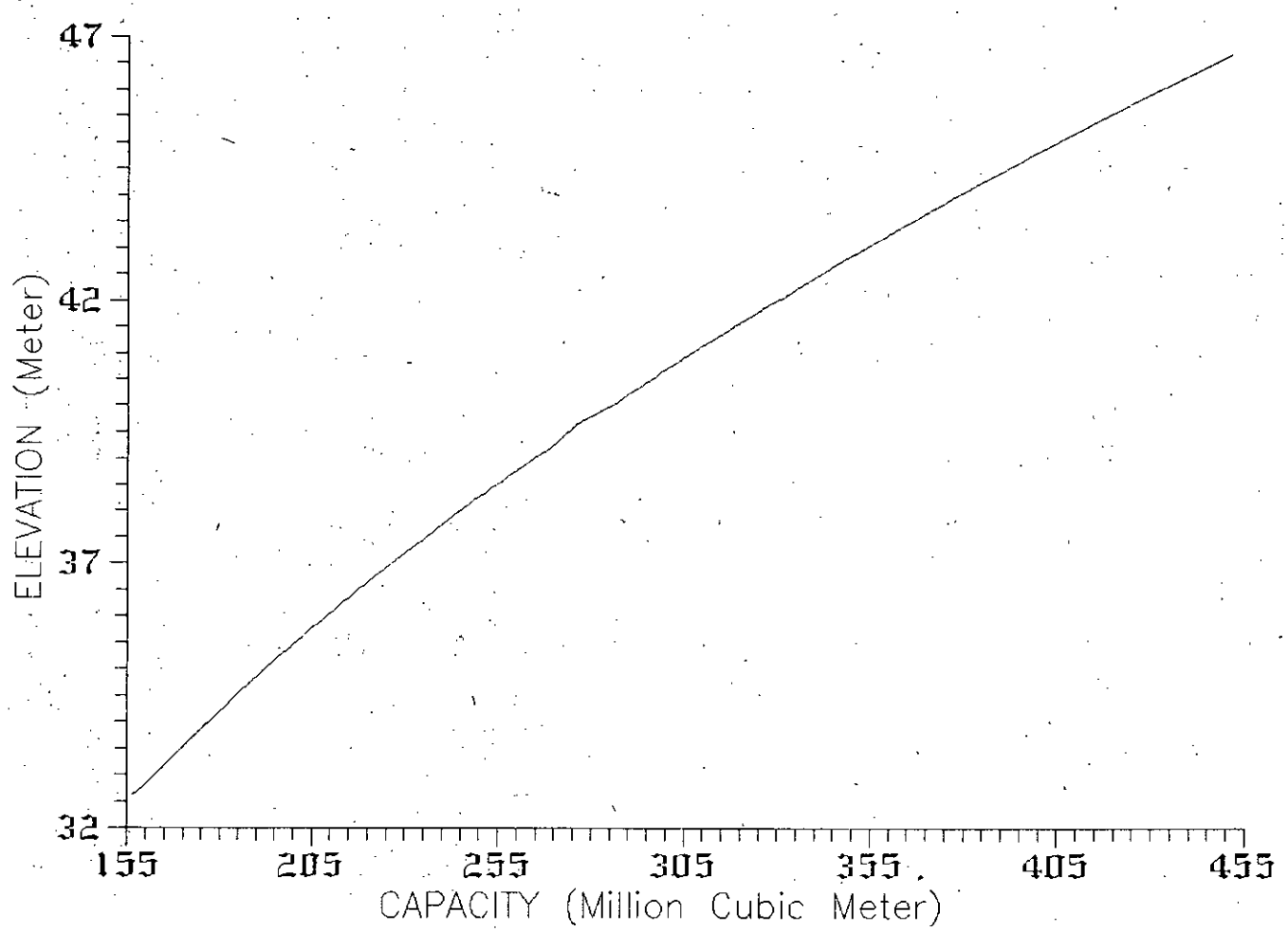


FIG. 2 VAIGAI IRRIGATION SYSTEM COMMAND AREA

Fig.4: Elevation-Capacity Curve for Vaigai Reservoir



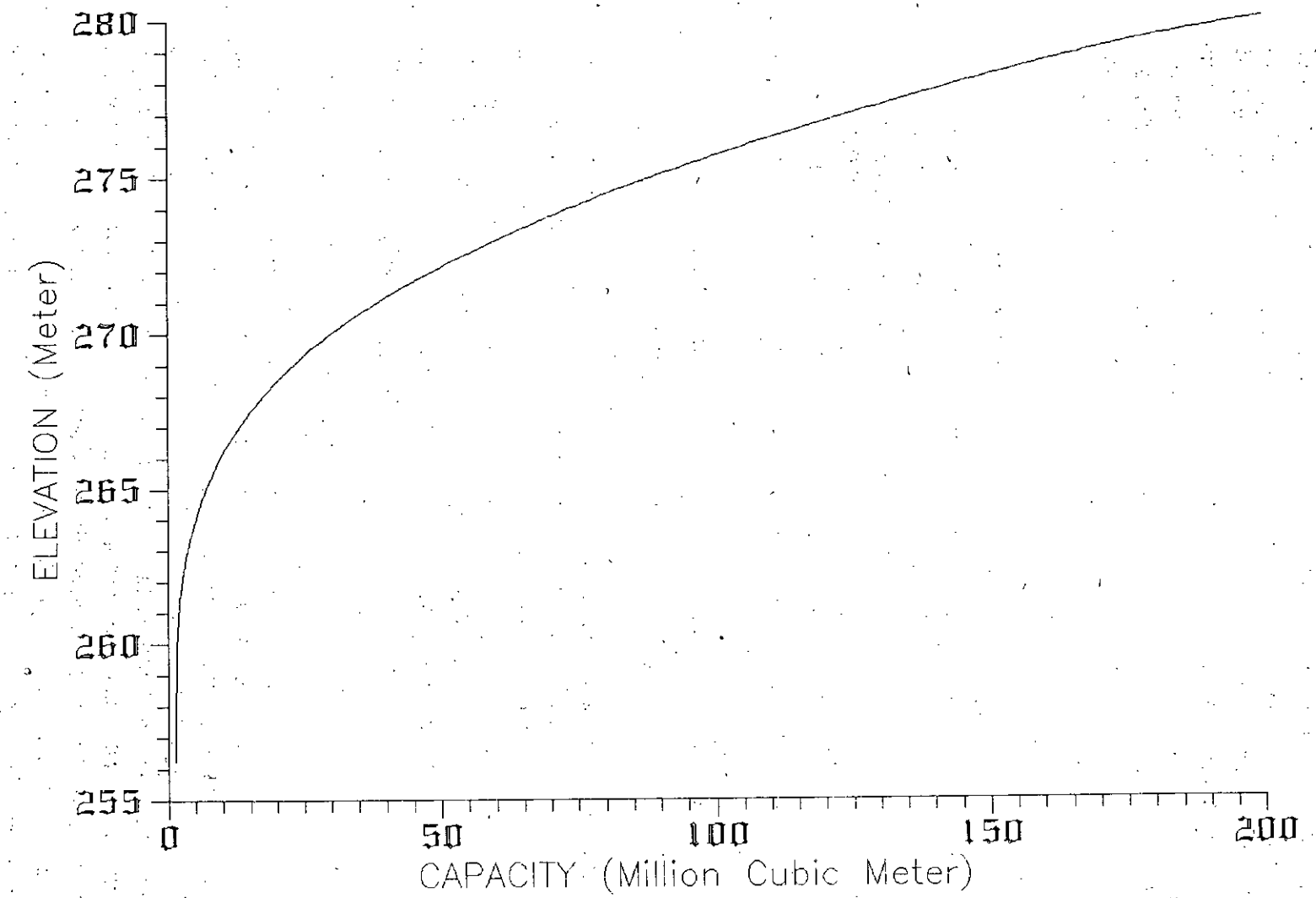

280
275
270
265
260
255
ELEVATION (Meter)
0
50
100
150
200
CAPACITY (Million Cubic Meter)

Fig.3: Elevation-Capacity Curve for Periyar Reservoir

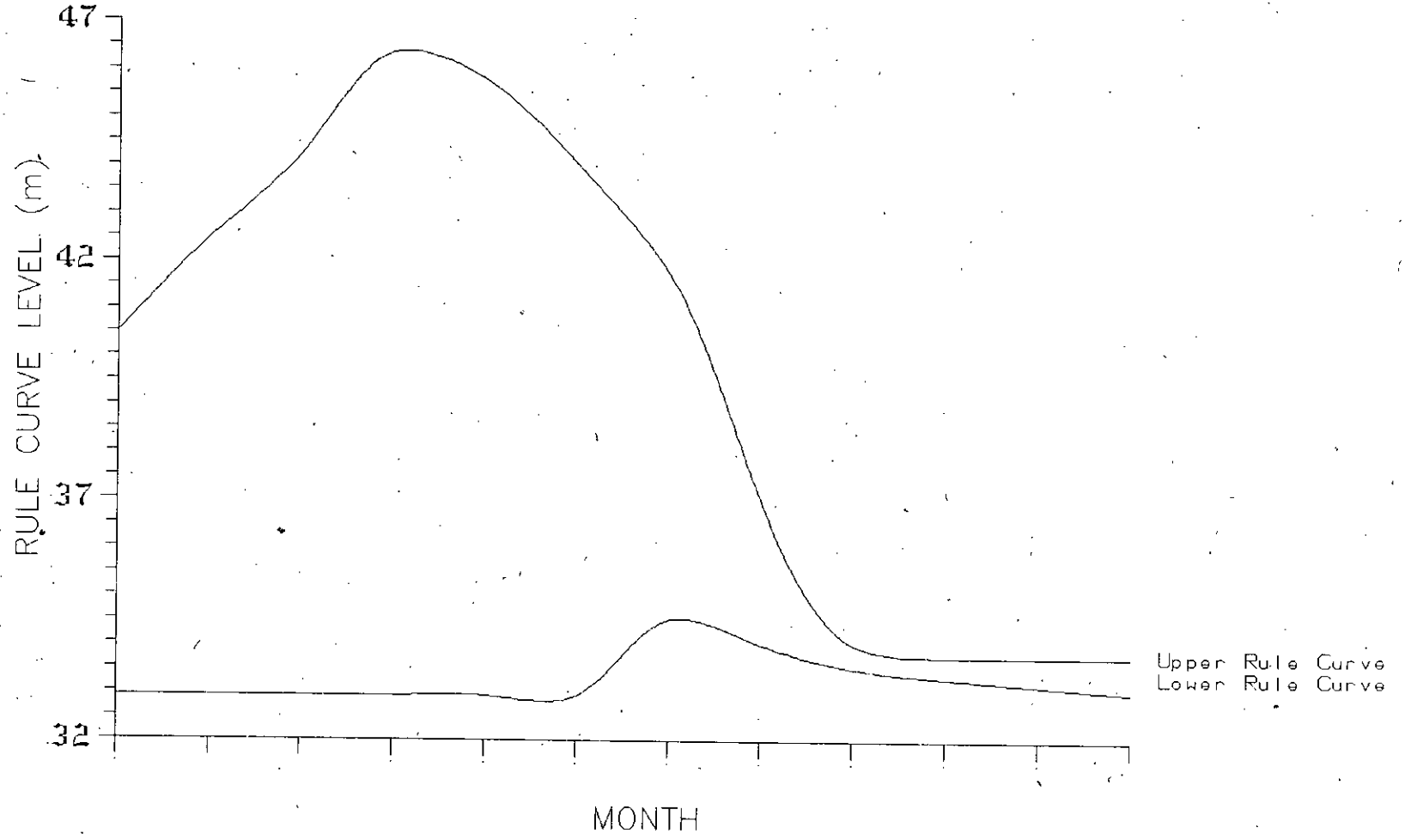


Fig. 5: Rule Curves for Periyar Reservoir

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